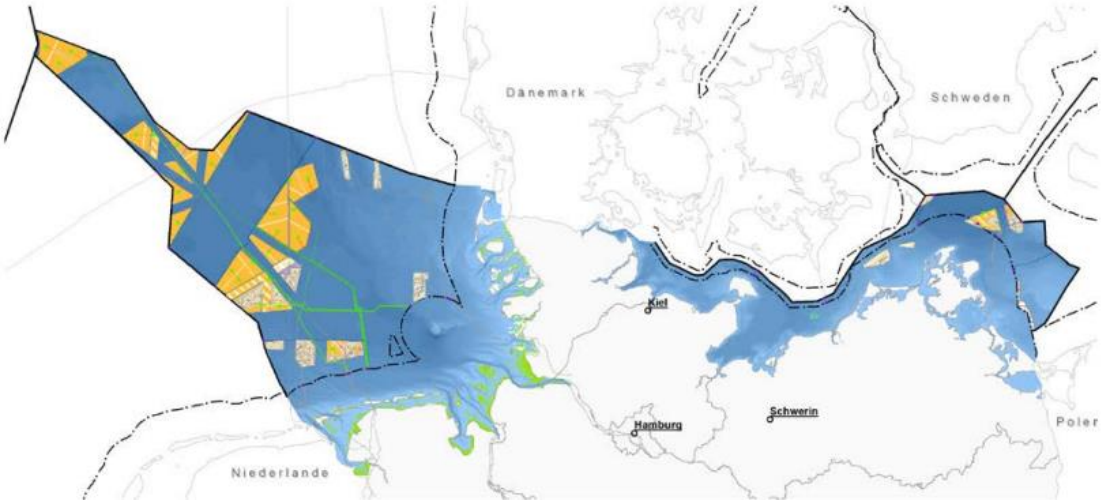

Offshore Wind Development in Germany

an analysis of market developments, main player movements, and the framework of the 2023 OFW auctions

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Thesis to obtain the Master of Science Degree in

Energy Engineering and Management

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October 2023

Declaration

I declare that this document is an original work of my own authorship and that it fulfills all the requirements of the Code of Conduct and Good Practices of the Universidade de Lisboa.

Acknowledgments

I want to express my sincere gratitude to Franck Leglise, my supervisor at TotalEnergies, for their guidance and for sharing their extensive experience with me throughout this internship. I also thank Professor Duarte for supporting me in this company project. My family and friends have been a constant source of encouragement and motivation, and I am grateful for their unwavering support. Finally, I would like to thank the German government for its efforts in promoting renewable energy sources and technologies, which have been instrumental in shaping this thesis.

Abstract

Offshore wind development in Germany has been a key focus of the country's energy transition strategy. The government has ambitious targets for offshore wind power, looking to install 30, 45, and 70 GW by 2030, 2035, and 2045 respectively. This expansion in capacity targets has required a significant auction design overhaul, with the state tendering 1.8 GW of pre-examined and 7 GW of unexamined sites in parallel for the first time in 2023. The German government has scaled back its economic support for developers in recent years, pointing to recent zero-subsidy bids as an indication that competition in the industry is heating up. Bid value remains the most important tender criterion, making financial backing an enterprise's most significant competitive advantage. Germany's first dynamic bidding process generated EUR 12.6 billion in proceeds, paid for by the O&G majors TotalEnergies and BP. For the pre-examined sites, German corporations RWE and Luxcara secured 3 and 1 sites, respectively, with legacy developer Vattenfall exercising its step-in right for one site in September. Germany intends to utilize a large share of the proceeds to reduce consumer costs. However, fear exists that additional costs for offshore wind developers will eventually be passed on to an already struggling supply chain or to the consumers suffering under increased power prices and cost of living due to the 2022 energy crisis. In response, the industry has proposed reforms for upcoming auctions, including a limited number of sites per developer, price caps, or more weight given to qualitative criteria.

Keywords

Offshore wind energy 2023, Germany, Auction design, North Sea, Renewable energy, Competitor analysis

Resumo

O desenvolvimento da energia eólica offshore na Alemanha tem sido um foco principal da estratégia de transição energética do país. O governo tem metas ambiciosas para a energia eólica offshore, pretendendo instalar 30, 45 e 70 GW até 2030, 2035 e 2045, respetivamente. Esta expansão nas metas de capacidade exigiu uma revisão significativa do projeto do leilão, com o estado licitando 1,8 GW de locais pré-examinados e 7 GW de locais não examinados em paralelo pela primeira vez em 2023. O governo alemão reduziu o seu apoio económico aos promotores em últimos anos, apontando as recentes propostas de subsídio zero como uma indicação de que a concorrência na indústria está a aquecer. O valor da proposta continua a ser o critério de concurso mais importante, tornando o apoio financeiro a vantagem competitiva mais significativa de uma empresa. O primeiro processo de licitação dinâmico da Alemanha gerou 12,6 mil milhões de euros em receitas, pagos pelas grandes empresas de petróleo e gás TotalEnergies e BP. Para os sites pré-examinados, as empresas alemãs RWE e Luxcara garantiram 3 e 1 sites, respectivamente, com o desenvolvedor legado Vattenfall exercendo seu direito de intervenção para um site em setembro. A Alemanha pretende utilizar uma grande parte das receitas para reduzir os custos do consumidor. No entanto, existe o receio de que os custos adicionais para os promotores eólicos offshore acabem por ser transferidos para uma cadeia de abastecimento já em dificuldades ou para os consumidores que sofrem com o aumento dos preços da energia e do custo de vida devido à crise energética de 2022. Em resposta, a indústria propôs reformas para os próximos leilões, incluindo um número limitado de locais por promotor, limites de preços ou maior peso dado aos critérios qualitativos.

Palavras-Chave

Energia eólica offshore 2023, Alemanha, Projeto de leilão, Mar do Norte, Energia renovável, Análise da concorrência.

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List of Abbreviations

OFW	Offshore Wind
GW	Gigawatt
TJ	Terajoule
O&G	Oil & Gas
TWh	Terawatt-hour
CO_2	Carbon Dioxide
GHG	Greenhouse Gas
LNG	Liquified Natural Gas
MWh	Megawatt-hour
EEG	Renewable Energy Act
WindSeeG	Wind Energy at Sea Act
RES	Renewable Energy Sources
TTE	TotalEnergies
PEZ	Princess Elizabeth Zone
EEZ	Exclusive Economic Zone
NSEO	North Sea Energy Outlook
TSO	Transmission System Operator
FEP	Site development plan
BNetzA	Federal Network Agency
BSH	Federal Maritime and Hydrographic Agency
CfD	Contract for Difference
PPA	Power Purchasing Agreement
kWh	Kilowatt-hour
COD	Commercial Operation Date
SWOT	Strengths Weaknesses Opportunities Threats
CAPEX	Capital Expenditure
OPEX	Operational Expenditure
DEVEX	Developmental Expenditure
NPV	Net Present Value
WACC	Weighted Average Cost of Capital
REN	Renewable division of TTE

1. Introduction

1.1 Global Energy Outlook

In the wake of the Covid-19 pandemic, global energy consumption is again reaching new heights. Primary energy consumption increased from 168 450 TWh in 2020 to 177 050 TWh in 2021 (+5.1%) and exceeded 178 900 TWh in 2022 (+1.7%). Figure 1 below displays the trend in global energy consumption by source since 1990. It remains evident that the vast majority of energy is still produced using fossil fuels such as coal, oil, and natural gas [43].

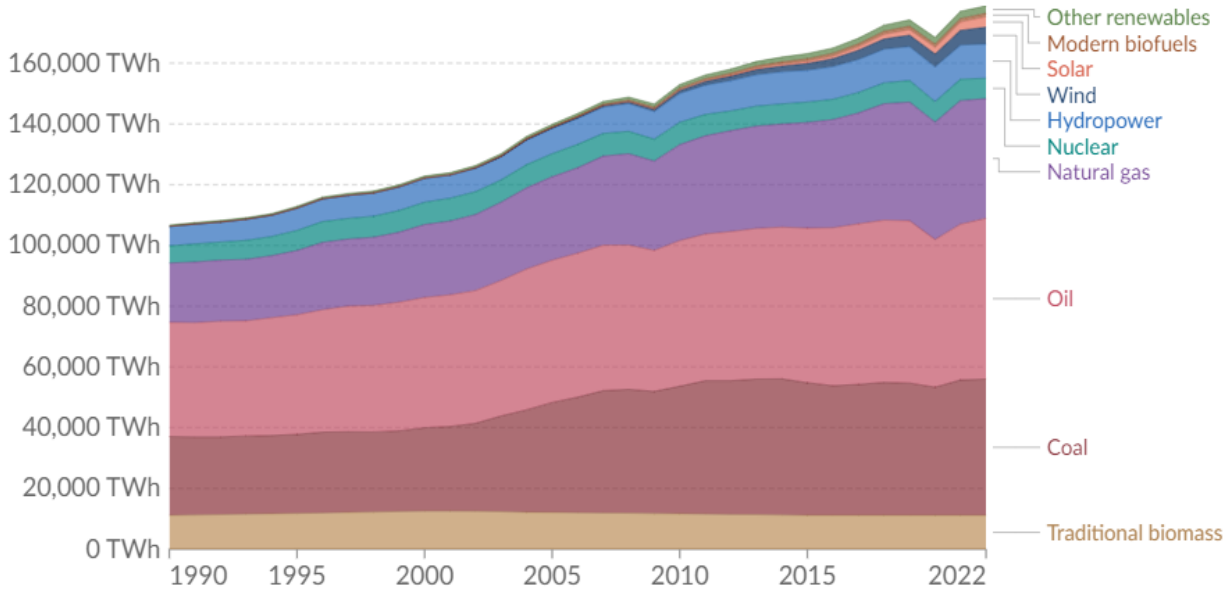

Figure 1: Global primary energy consumption by source. In 2022, consumption peaked at 178 900 TWh [38].

Fossil energy releases CO_2 and various other greenhouse gases and pollutants. With an ever-growing energy demand, annual CO_2 emissions have reached record levels, at 34.3 Gt in 2022. Extensive scientific studies detail the pivotal role of CO_2 as a driving force in anthropogenic warming through the enhanced greenhouse effect [26]. Figure 2 below demonstrates this causal correlation between CO_2 emissions and the global temperature delta relative to pre-industrial times.

To curb continued human-induced global warming, mitigating CO_2 emissions has quickly become of paramount importance to governments across the world. In 2005, a record 196 nations came together to commit to an international climate treaty called the 'Paris Agreement.' This legally binding treaty was centered around restricting global warming to well below 2 degrees Celsius compared to pre-industrial levels, with efforts to limit it to 1.5°C [22]. Upholding this pledge requires a complete 'energy transition.'

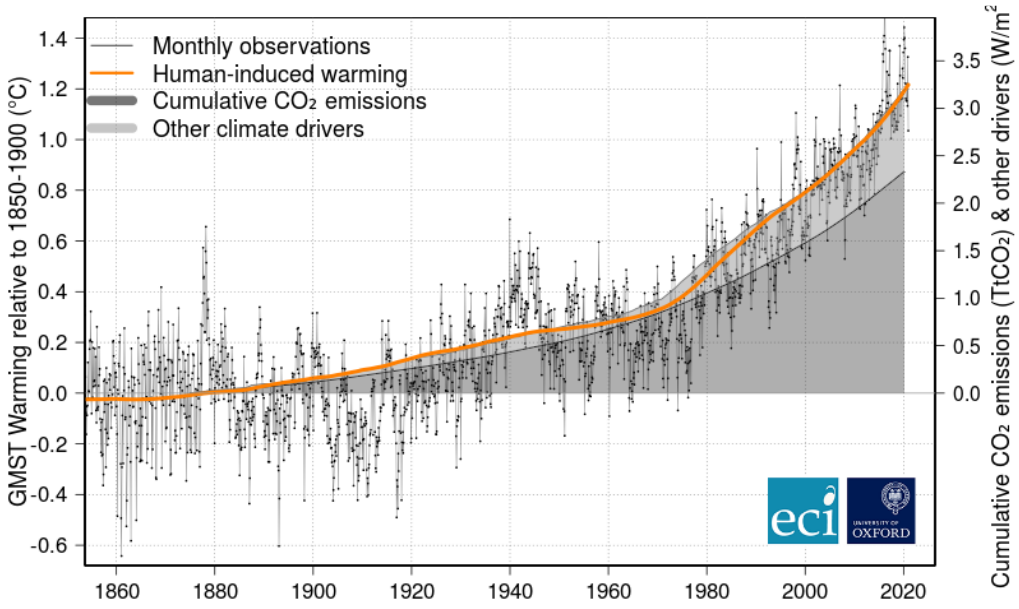

Figure 2: Global warming index showing the causal correlation between CO2 emissions and the global temperature delta from 1850 – 2020. Other climate drivers are included for reference [5].

The 'energy transition' is a term used to denote the global shift of the energy sector away from reliance on fossil fuels such as oil, natural gas, and coal towards the adoption of 'clean energy' alternatives like wind, solar, and lithium-ion batteries [41]. Since the introduction of this term during US President Jimmy Carter's 'Address on the Nation of Energy' in 1977, interest in the energy transition has grown exponentially. In 2016, global investment in clean energy technologies superseded that in fossil fuels for the first time in history. This trend has continued, with worldwide clean energy investments expected at 1750 billion USD in 2023 as opposed to 1050 billion USD spent on fossil energies for that same year (see Figure 3 below) [52].

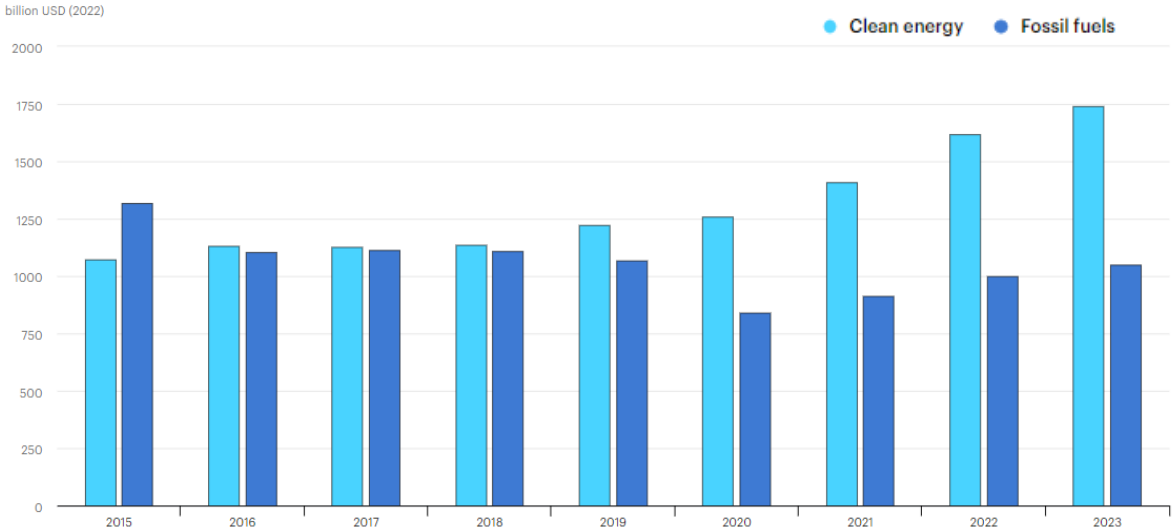

Figure 3: Global energy investment in clean energy and fossil fuels, 2015 – 2023 [52].

By breaking down the annual investment in clean energy (Figure 4 below) over that same time period, it is clear that renewable power has become the focal point of the energy transition, followed by energy efficiency measures and power grid initiatives.

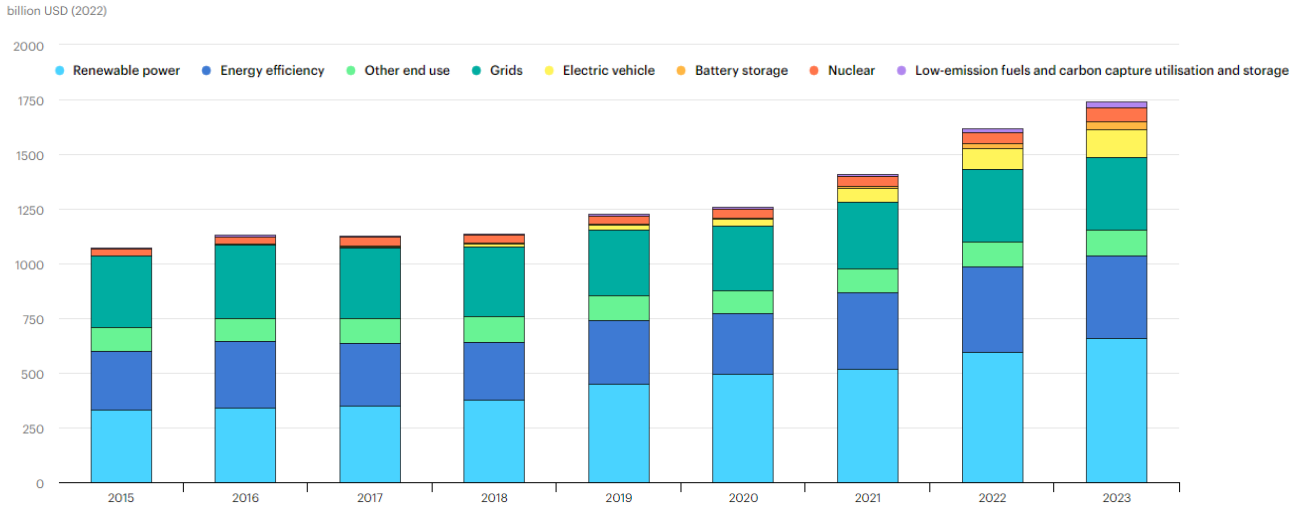

Figure 4: Annual clean energy investment, 2015 - 2023 [52].

1.2 The European Union's Energy Landscape

The European Union (EU) is particularly dedicated when it comes to clean energy investments. The bloc possesses a wealth of renewable energy sources, and several of its core members have emerged as frontrunners in spearheading the adoption of renewable technologies. Figure 5 below highlights European energy investment efforts in relation to economic superpowers such as China and the United States over the last four years. There is a continual endeavor to enhance the sustainability of energy systems across Europe, with every member nation establishing its rigorous renewable objectives. European Commission President Ursula von der Leyen declared that the objective is "for Europe, with its European Green Deal, to become the first climate-neutral continent by 2050" [48].

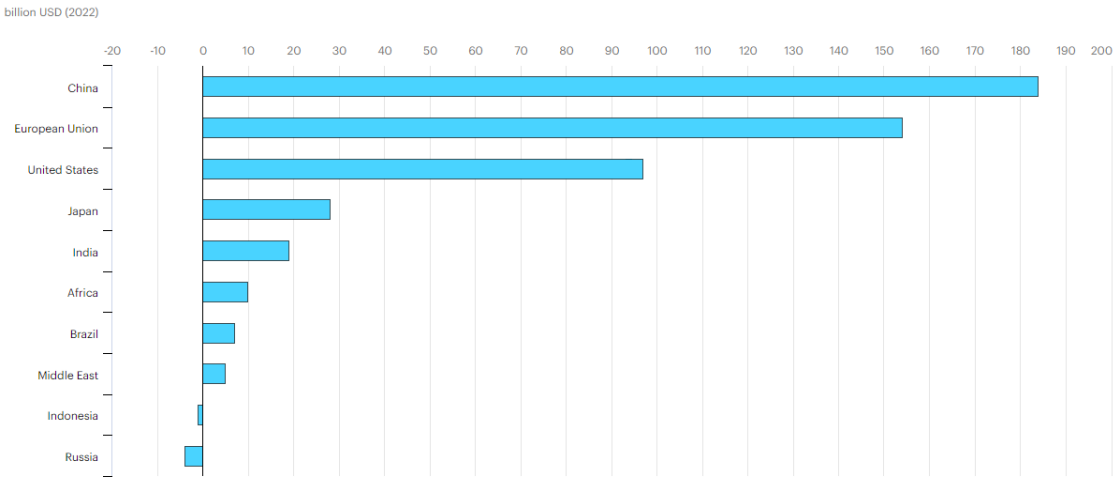

Figure 5: Increase in annual clean energy investment in selected countries/regions, 2019 - 2023 [52].

1.2.1 EU Energy Mix

Since the industrialization of Europe, the continent's energy mix has been dominated by fossil fuels. Despite the rapid expansion of renewables, biofuels, and waste, 70% of the EU's energy supply still stemmed from oil, natural gas, and coal combustion in 2020 [9]. Figure 6 below illustrates this trend over the past three decades. Whilst nuclear power accounted for a sizable 9 000 000 TJ of energy in 2020, it has become highly controversial in the aftermath of the 2011 Fukushima Daiichi accident, with member states such as Germany and Belgium announcing their complete phase-out by 2023 and 2025, respectively [50]. Notably, the economic crises of 2008 and 2020 are reflected through a sharp decline in the energy supply in those years.

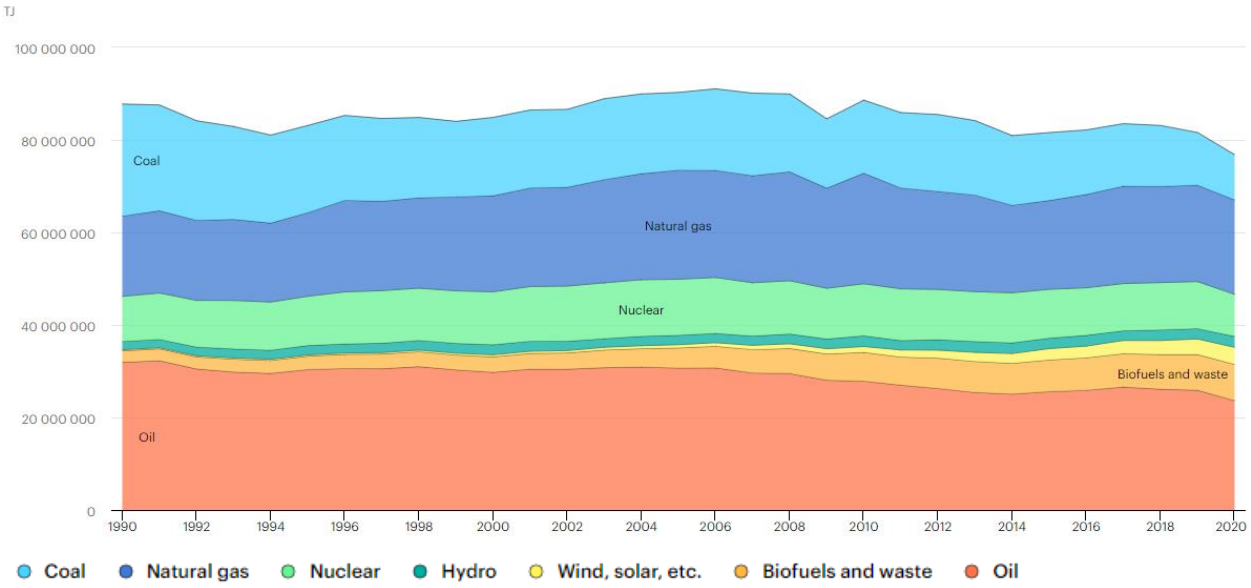

Figure 6: EU total energy supply by source [11].

Electricity generation accounted for 22.8% of final energy consumption in 2021 [25]. The EU has recognized significant potential to decarbonize through a process known as 'electrification,' suggesting this share is likely to grow, with renewable sources set to play a significant role in obtaining a fossil-free electricity supply. Figure 7 below highlights the rapid rollout of renewables in the EU's electricity mix, with wind power seeing particularly rapid expansion since the advent of the 21st century. However, it also illustrates the bloc's continued dependence on natural gas (Italy, United Kingdom, Netherlands) and coal (Poland, Estonia, Germany) to power its member states.

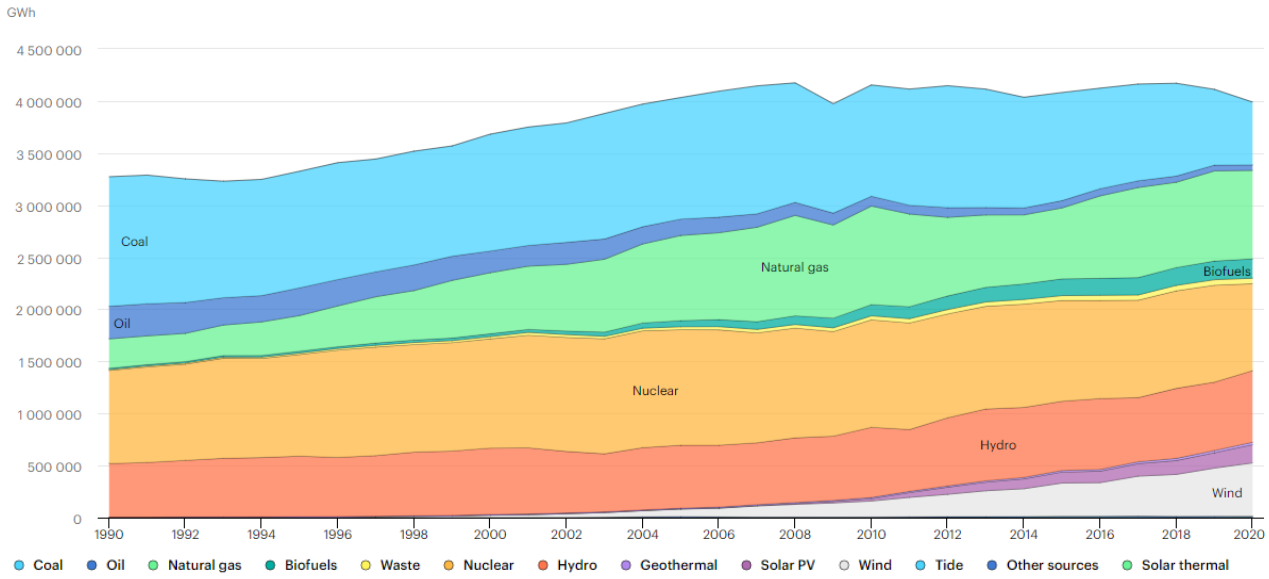

Figure 7: EU electricity generation by source [11].

1.3 The Green Deal & EU Climate Ambitions

In 2020, the European Commission endorsed the Green Deal, comprising a comprehensive series of policy initiatives to achieve carbon neutrality for the European Union by the year 2050. This comprehensive strategy involves the evaluation of all current laws to assess their environmental impact and the implementation of fresh legislation concerning various aspects such as circular economy, biodiversity, building renovation, agriculture, and innovation. The goal of attaining climate neutrality by 2050 was enshrined in June of 2021. Additional targets were added for 2030, including a 55% reduction in GHG emissions compared to 1990 levels. Key elements of the "Fit for 55" package introduced in July of 2021 were increased renewable energy targets (40% renewable energy by 2030), measures to promote energy efficiency (36-39% for final and primary energy consumptions), and updates to the EU emissions trading system [17].

1.3.1 RePower EU

"REPowerEU" is the European Union's three-pronged initiative to reduce its dependence on Russian fossil fuels, save energy, and accelerate the clean energy transition [36]. The plan was proposed by the European Commission in May 2022 and adopted by the council on October 4, 2022. In the wake of the full-scale invasion of Ukraine, the EU's energy security was shown to be excessively vulnerable as Russia threatened to blackmail the bloc through restrictions on their natural gas supply contracts. Prior to the war, 41% of the bloc's natural gas came directly from Russian pipelines. As seen in Figure 8 below, a united European response in energy diversification reduced dependence on Russian gas to less than 10 percent in just one year. New supply contracts with EU allies such as the USA (LNG) and Norway (pipeline) played a critical role in bolstering the energy security of the union. New natural gas infrastructure is intended to serve hydrogen transport, ensuring today's investments will also contribute to the EU's decarbonization plans [36].

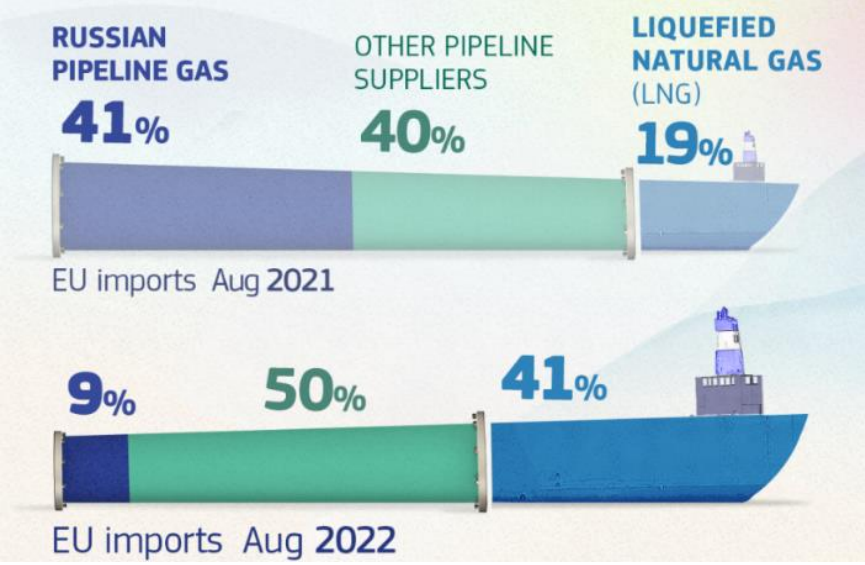

Figure 8: Energy diversification bolstered the EU's energy security significantly in the wake of Russia's Ukraine invasion [36].

RePower EU expands further on the targets set by the Fit for 55 package, including a union-wide revised energy savings target of 13% by 2030, up from 9%. Stronger legislation introduced in March of 2023 has also raised the bloc's binding target in renewable energy capacity to 42.5 - 45% by 2030 [36]. As seen in Figure 9 below, most of this renewable energy capacity will stem from aggressive expansion in wind and solar plants, with offshore wind particularly important to the EU.

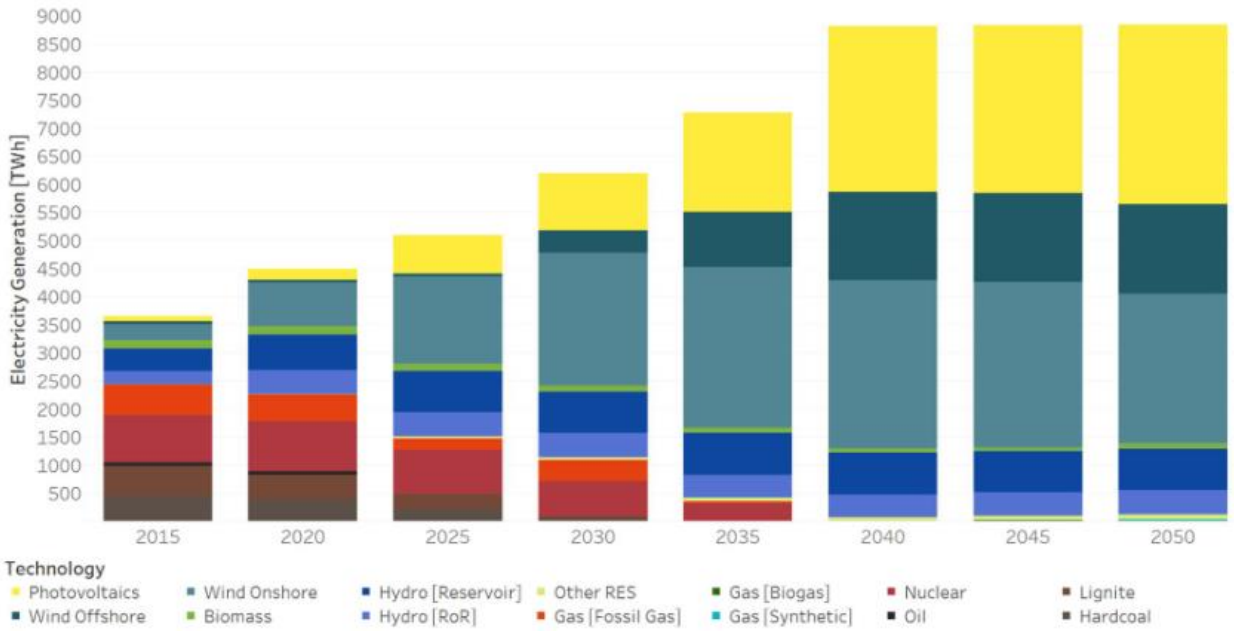

Figure 9: Europe's power generation mix, 2015 – 2050. Solar, onshore and offshore wind farms will form the bulk of the expanded renewable capacity [19].

1.4 Country Spotlight: Germany

Germany is one of the founding nations of the EU and is widely regarded as the key member state shaping the bloc's future. With a population of 83.2 million (2023) and a nominal GDP of 4.3 trillion euros (est 2023), Germany is both the most populated country and the largest economy in the European Union, featuring the single largest energy demand [16]. In 2021, the primary energy demand totaled 3448 TWh, with the vast majority (77%) originating from fossil fuel sources such as coal, gas, and mineral oil, as depicted in Figure 10 below. 72% of this energy was imported, with local sources concentrated in brown coal and renewable electricity [44]. Renewable energy sources accounted for just 16% of primary demand.

Figure 10: Primary energy demand of Germany, 2021 (Adapted from [42]).

After consumption and conversion losses are considered, the final energy consumption of Germany in 2021 totaled 2407 TWh. Mineral oil and gas represented similar shares of 33% and 27%, respectively, whilst electricity was responsible for 20% of final energy consumption [42]. Although 41% of electricity was produced with renewable sources, Figures 10 and 11 highlight how hydrocarbon sources still dominate Germany's energy system.

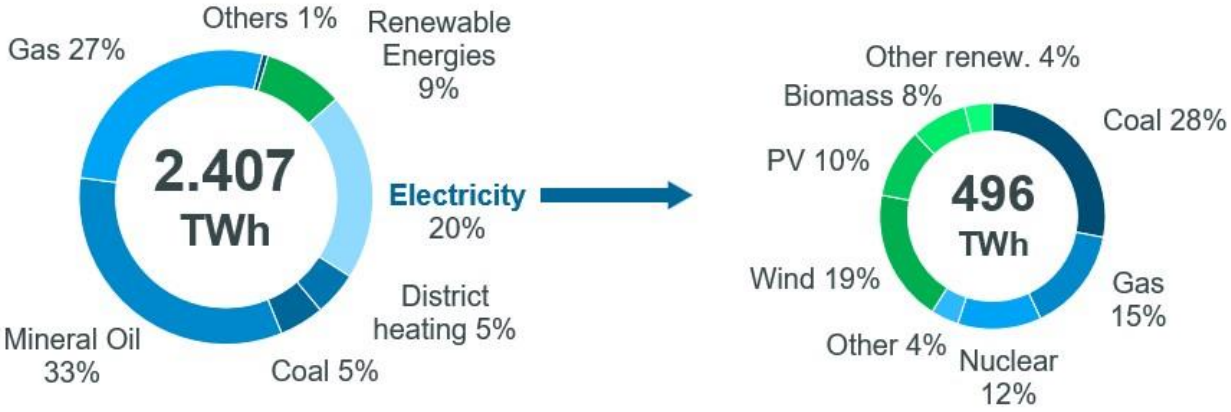

Figure 11: Final energy consumption and electricity mix in Germany, 2021 (Adapted from [42]).

Germany's energy strategy, known as the 'Energiewende', was initially designed to map out the country's transition towards a low-carbon, nuclear-free energy future. Targets for a complete coal phase-out were set for 2038, whilst the nation's nuclear exit was planned for 2022 [35, 49]. Weaning off nuclear energy was a direct response to the Fukushima Daichi accident that occurred due to the 2011 Tōhoku earthquake and subsequent tsunami in Japan. From its peak nuclear production of 167 TWh in 2006, it only generated 34.7 TWh in 2022, with the last 3 German reactors going offline in April 2023. These reactors briefly had their operating lifetime extended to cope with the energy crisis induced by the Russian invasion of Ukraine. Prior to the conflict (<2022), primary energy demand was projected to drop to <2000 TWh by 2050, in line with the country's net-zero ambitions (see Figure 12 below).

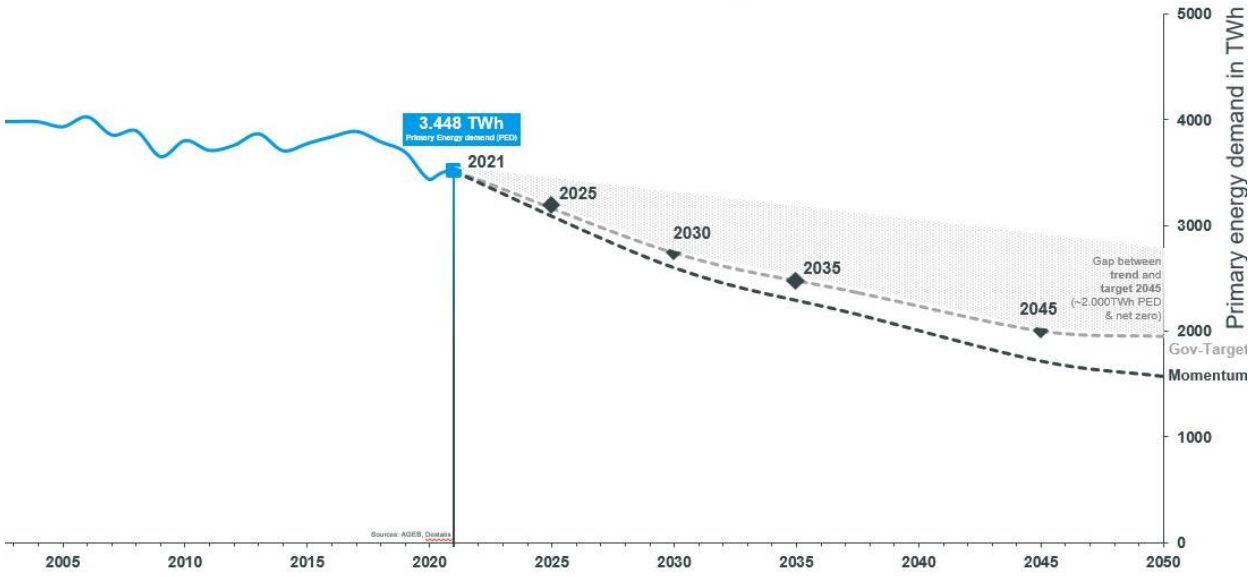

Figure 12: Primary energy demand projection for Germany in line with net-zero ambition by 2050 (Adapted from [6]).

The sweeping energy sector reforms announced by the German government in 2021 have received additional impetus since the energy crisis triggered by the Russia-Ukraine conflict. Their dependence on Russian natural gas (>50% of imported gas) presented a major threat to national energy security, inspiring a massive policy amendment of the 8th of July in 2022. Renewable targets were expanded significantly as electricity from both wind and solar were identified as adequate substitutes. A study by the Fraunhofer Institute revealed that every GW of peak power generation coming from renewables had lowered wholesale prices by 4 euros per MWh [28]. The Renewable Energy Act (EEG) and the Onshore and Offshore Wind Act (WindSeeG) were crucial laws subject to amendments. The overall evolution of German energy policy is summarized in Figure 13 below.

Figure 13: Main energy policy evolution, 2019 - present [51].

1.5 Objectives and deliverables

This company project titled has a dual objective. Firstly, it aims to provide a comprehensive and in-depth analysis of the current state of offshore wind energy development in Germany. This includes an examination of the market trends and auction advancements. It seeks to understand the trajectory of the industry and predict future trends based on current data and market analysis.

Secondly, the report intends to identify the key players in the German offshore wind energy sector, their strategies, and movements as compared to TotalEnergies. This involves a study condensed study of the major industry players, their financial outlook, bid aggressivity and market appetite. It also includes an analysis of TotalEnergies' strengths, weaknesses, opportunities, and threats (SWOT) to understand the enterprise's competitive positioning in the market.

Furthermore, the report scrutinizes the regulatory framework governing the 2023 offshore wind auctions. It aims to provide a thorough understanding of the auction process, the rules and regulations involved, and the implications for the stakeholders. This includes an analysis of the bidding process, the criteria for selection, and the potential impact of the auction results on the market dynamics.

The deliverables of the report are manifold. It offers detailed insights into the market dynamics of the offshore wind energy sector in Germany, including growth factors, challenges, and opportunities. It provides key information on some of the major industry players, their strategies, and market movements, offering a competitive landscape of the sector. Moreover, it delivers a comprehensive understanding of the 2023 offshore wind auction framework, which will be invaluable for stakeholders, policymakers, and investors in the offshore wind energy sector. It serves as a tool for business developers in TTE to strategize for future OFW auctions in Germany.

1.6 TotalEnergies & OFW in Germany

With their recent rebranding, TotalEnergies has shifted from a traditional oil and gas major towards a multi-energy company. In an effort to become carbon neutral by 2050, TTE is looking to expand its renewable portfolio from 1.5 GW at present to 100 GW by 2030, becoming a top 5 player in renewables in the process. Offshore wind is of significant strategic importance as part of the renewable portfolio development, particularly when it comes to delivering a more baseload-like production profile to end-users. Germany is one of the key target markets. TTE is already one of the leading energy players in a market without major national champions. They employ more than 4500 people, own 12.1% of the market in refining, and rank 3rd by number of service stations [47]. There exists a real opportunity to leverage key advantages such as strong international expertise and a significant customer/partner base. TTE Germany will diversify its hydrocarbon-centered portfolio to develop a multi-energy offer.

1.7 Structure of the Document

This introduction aims to define the report's scope and provide the contextual framework surrounding offshore wind development in Germany. Chapter 2 presents a detailed literature review on offshore wind. This includes a general EU overview, followed by a deep dive into the roadmap of German offshore wind. Chapter 3 outlines the methodology involved with dissecting the 2023 German OFW tenders and identifying the key parameters of the competitor analysis. Chapter 4 presents the outcome and subsequent discussion of the German OFW tender and competitor analyses. Chapter 5 concludes the report's main findings and highlights the importance of the project towards TTE's OFW ambitions.

2. Offshore Wind: a Literature Review

Despite the associated costs and technological hurdles an ocean environment presents, offshore wind as a renewable technology offers some distinct advantages. Offshore winds are unobstructed by topography or man-made structures, allowing for higher wind speeds (see Figure 14 below) and greater consistency. This makes offshore wind farms considerably more efficient, less intermittent, and capable of delivering more power than onshore installations [33]. Furthermore, the noise/visual pollution factor is much less of a limiting factor out at sea. Many European nations have recognized OFW's role in their renewable energy strategies. For energy companies from the oil & gas industry, offshore wind farms are attractive developments due to their size (up to several GWs) and the overlap in expertise compared to traditional offshore energy projects.

2.1 OFW in the EU

With its six sea basins (Figure 14 below) featuring favorable wind speeds (±10m/s, hub height of 100m), the potential for offshore wind (OFW) development in the EU is considerable, placing the technology at the core of delivering on the pledges made in the Green Deal [32]. The continent has historically been a first mover in offshore energy, with the first offshore wind farm commissioned in Denmark in 1991. The EU is also a leading manufacturer of turbine components, foundations, and cabling, with the close interplay of member states giving them a key competitive advantage. On the 24th of April 2023, 9 EU nations (Belgium, Denmark, Germany, The Netherlands, Luxembourg, France, Ireland, Norway, and Great Britain) signed the 'Ostend Declaration on The North Sea as Europe's Green Power Plant', declaring a combined target of 120 GW of OFW by 2030 and more than doubling this capacity to >300 GW by 2050 [34]. Below is a country outlook on some of the EU's most prominent offshore wind nations (+UK). Germany is discussed in more detail in a later section of the report.

Belgium has disclosed its ambition to add up to 3.5 GW of new capacity to its Princess Elizabeth Zone (PEZ) by the end of 2030 through tenders it expects to deliver in 2024 and 2026 after a 1-year delay. Belgium is looking to build the first North Sea energy island, emphasizing its focus on becoming a collection and transport hub for North Sea renewables. Spatial limitations are significant in the Belgian EEZ [10].

Denmark has pledged itself to 100% renewable power by 2030, with a total net zero target by 2050. In terms of OFW, Denmark is aiming for between 12.4 – 17.4 GW by the end of the decade. A new tender framework has been agreed upon for the next 9 GW of tenders, with the potential to install up to 14GW through 'overplanting'. Denmark is also looking into energy islands in both the North & the Baltic Sea. Its North Sea energy island will have 3 GW of OFW connected by 2033 and at least 10 GW by 2040, although recent cost estimations have cast significant doubt over its realization potential. In the Baltic Sea, Bornholm energy island is envisioned to become a cooperation between the Danish and German state in relation to production and transmission of up to 3.8 GW of OFW. Denmark will be responsible for tender arrangements, whilst Germany will act as off-taking state [1].

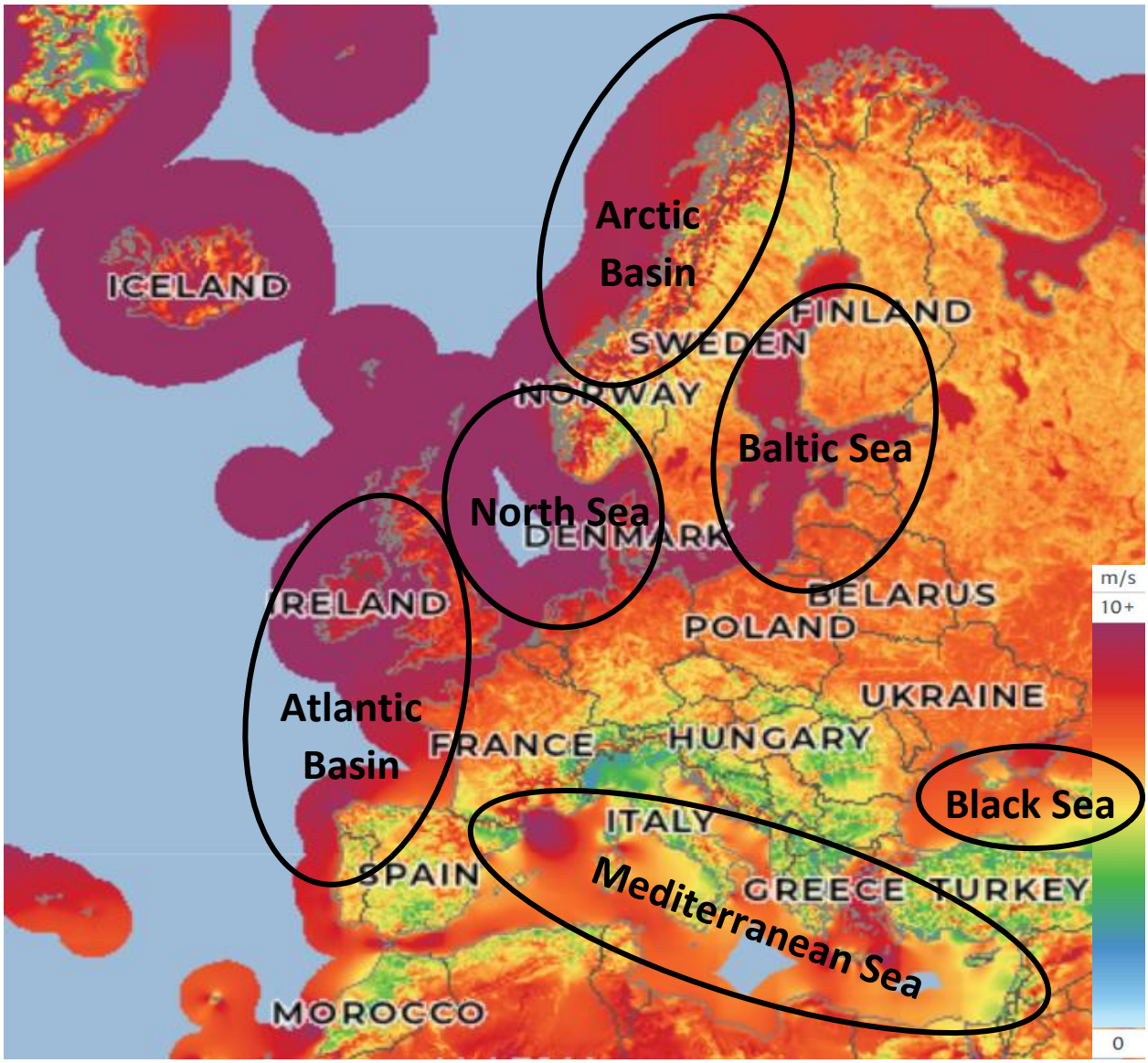

Figure 14: Wind speeds at 100m height. The 6 sea basins identified for OFW development are: North Sea, Baltic Sea, Atlantic & Arctic Ocean, Mediterranean Sea, Black Sea [18].

France is targeting 33% renewable power generation by 2030, with its sights on net zero by 2050. OFW is set to play a major role, with capacity targets of 18 GW by 2035 and 40 GW by 2050, split over the Atlantic and Mediterranean basin. France is currently struggling with long project lead times and delayed public debates & tenders in the aftermath of the COVID-19 slump. Its energy program update in 2024 is expected to deliver an amended tender schedule [37].

The Netherlands recently published an offshore wind roadmap detailing ambitions for 21 GW of capacity by 2030, enough to meet 3/4th of the domestic electricity demand. Further down the line, studies by the North Sea Energy Outlook (NSEO) have projected a need for 38-72 GW of OFW in the Dutch EEZ [29].

In line with the EU, **The UK** has set itself a net-zero target by 2050. OFW ambitions are some of the largest across the continent: 50 GW by 2030 and 65 – 125 GW by 2050. This includes several GWs of floating and hydrogen generation. Despite the appetite for the UK's seabed, significant challenges remain. These include lengthy permitting, strained supply chains, legal challenges, and grid transmission bottlenecks [21].

Ireland, Norway and **Portugal** are some of the emerging OFW markets. Ireland has set itself targets of 7, 20, and 37+ GW by 2030, 2040, and 2050, respectively. Norway has opened its first leasing tenders for 1.5 GW of fixed OFW and 1.5 GW of floating OFW in 2023, with further auctions scheduled for 2025. They target the leasing of areas with a 30 GW potential by 2040 but expect another decade before these leases translate into build-out targets. Despite significant targets in the order of tens of GWs, uncertainty around their delivery date remains. Although Portugal has set its expectations high at 10 GW by 2030, it still lacks a regulatory framework outlining its auction timeline and other competitive procedures [12, 24].

2.2 OFW in Germany

Germany is preparing to greatly expand its use of renewable energy sources as part of their strategy to ensure energy security and reduce greenhouse gas emissions. Offshore wind will play a key role in the nation's ambition of growing its renewable penetration in gross electricity consumption from 41% to 80% by the decade's end. In terms of installed renewable capacity, OFW is projected to grow from 6% of the total mix in 2020 to 9% in 2030 [13]. One of the key advantages of wind offshore is its relative consistency. The ability to reduce volatility in a grid where the share of variable renewables is ever-growing cannot be overstated. International grid connections coupling offshore assets to different member states will also reduce costs, ease congestion, and increase flexibility.

It is for this reason that Germany has set out some of the most ambitious OFW targets of all EU members. Their latest build-out targets, described in the amended WindSeeG, account for 30 GW by the end of the decade, increasing to 40 GW by 2035 and 70 GW by 2045. This rapid expansion, as pictured on the left of Figure 15 below, will contribute significantly towards Germany's renewable electricity production and green hydrogen demand. Green hydrogen is set to play a crucial role in the future of Germany's steel industry, with ThyssenKrupp, ArcelorMittal, and Salzgitter identified as major off-takers [46]. OFW is envisioned to become Germany's fastest-growing source of electricity, taking it from a mere 27 TWh in 2020 to a projected 197 TWh of the total power mix in 2045 (see right of Figure 15 below).

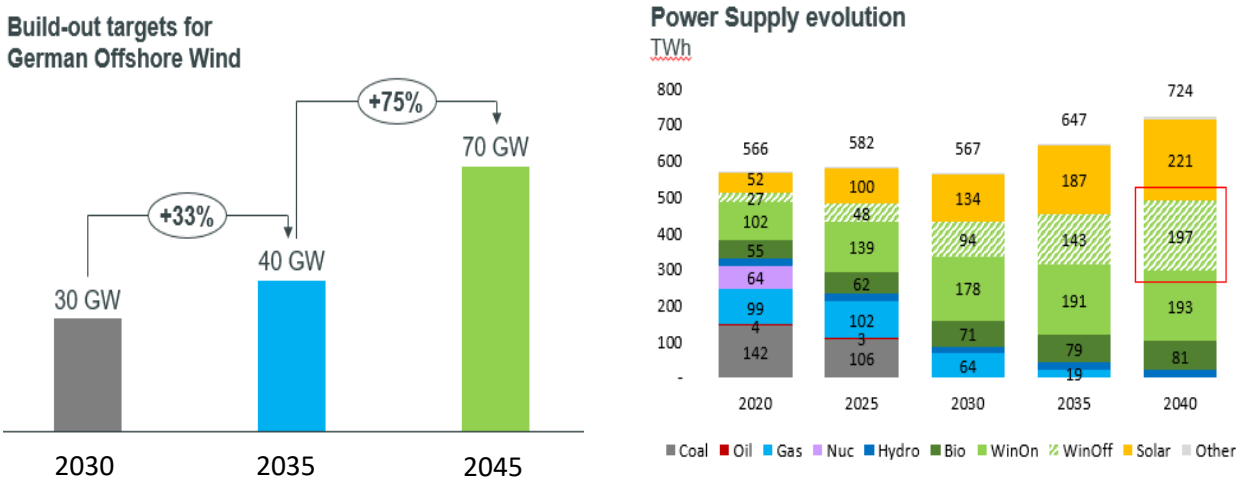

Figure 15: Germany's OFW build out targets and projected power supply evolution, 2020 – 2040. No other source of power, renewable or fossil, is projected to see growth to this extent (Adapted from [13]*).*

2.2.1 Germany's Offshore Potential

Due to its geography, Germany's OFW deployment faced challenges previously unseen in OFW frontrunners such as Denmark or the UK. The vast majority of Germany's territorial waters (12 miles closest to shore) are dedicated to the Wadden Sea National Park, complicating cabling routes as well as near-shore installation. Furthermore, its Exclusive Economic Zone (EEZ) envelopes a mere 33,000 km^2, compared to the 6.8 million km^2 in the UK, and faces further competition from intense shipping, fishing, and military activity. Through a dedicated site development plan, the nation's total OFW potential is now estimated at approximately 70 GW [31]. This 'site development plan' (FEP) is a document published by the Maritime and Hydrographic Agency (BSH) detailing the area planning of the German EEZ (see Figure 16 below). Through coordination with the Federal Network Agency (Bundesnetzagentur) and the TSOs, the FEP is updated regularly to reflect information on site-specific characteristics such as size, capacity, tendering, commissioning, and grid connection timelines.

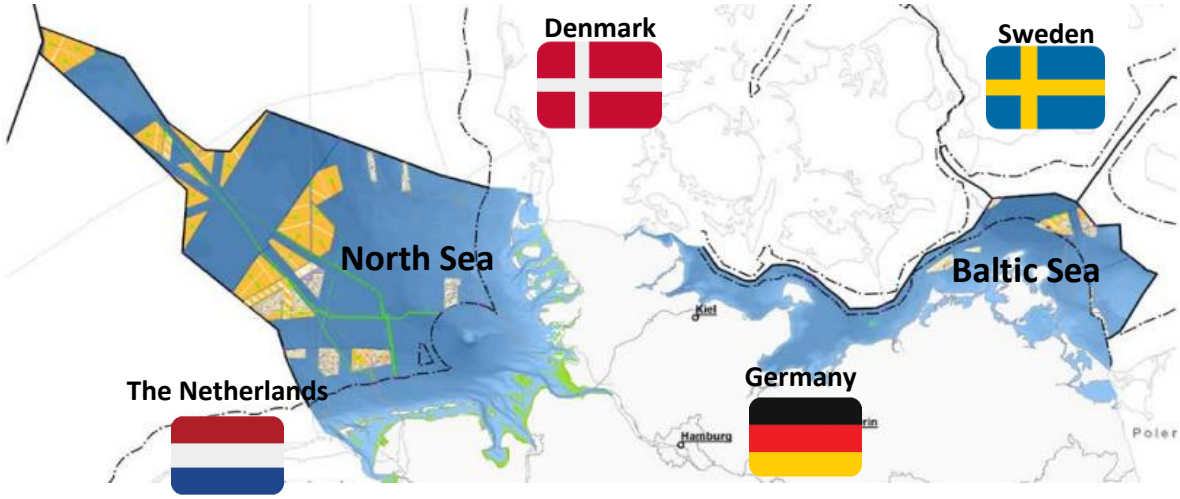

Figure 16: Germany's EEZ along with its North Sea and Baltic Sea neighbors. Areas highlighted in orange represent historical and future clusters marked for OFW development. Germany's OFW farms, past and future, will be centered around the North Sea basin but will include developments in the Baltic Sea as well [2].

2.2.2 OFW Auctions in Germany

Germany's first OFW farm, 'Alpha Ventus', was a 60 MW installation featuring 12 turbines and became fully operational in 2010. The aim of the project was to trial through the brand-new planning and permitting procedures, as well as to highlight unexpected technical challenges. A feed-in tariff not exceeding 19.4 cents / kWh was in effect from 2008 to 2014. The highest feed-in tariffs were awarded to the earliest projects, decreasing for projects commissioned later in the scheme's lifetime [8].

From 2017 onwards, defined sites were assessed by the BSH on a preliminary basis. This was done to provide potential bidders additional information on subsurface and metocean data. Sites evaluated in this manner are referred to as 'pre-investigated' or 'pre-examined' sites, and the developer with the winning bid is responsible for reimbursing the BSH for its associated costs. Their auctioning occurred such that developers promising the lowest cost to the tendering authority would be allocated the exclusive right to develop the sites (*BSH - Sectoral Planning*, 2023). Auctions would, from here on, utilize the 'centralized' model, with auction winners gaining the following rights:

- Right to connect to the grid, with the associated costs covered by electricity consumers through grid fees.
- The right to operate offshore wind farms for 25 years.
- The authorization to apply for a permit from the BSH to construct an offshore wind farm on the designated site [2]

Until 2022, bidders would indicate a capped minimum guaranteed price for the electricity they produce in cents / kWh, with the lowest bid winning the tender. This one-sided contract for difference (CfD), illustrated in Figure 17 below, would guarantee a minimum price through government subsidies if the wholesale price ever drops below the contract's strike price. The generator would still be exposed to upward power price changes, ensuring more considerable income as wholesale prices exceeded the agreed strike price. Power Purchase Agreements (PPAs) were also an option, where the operator of the OFW farm could strike an agreement for green electricity directly with an offtaking customer.

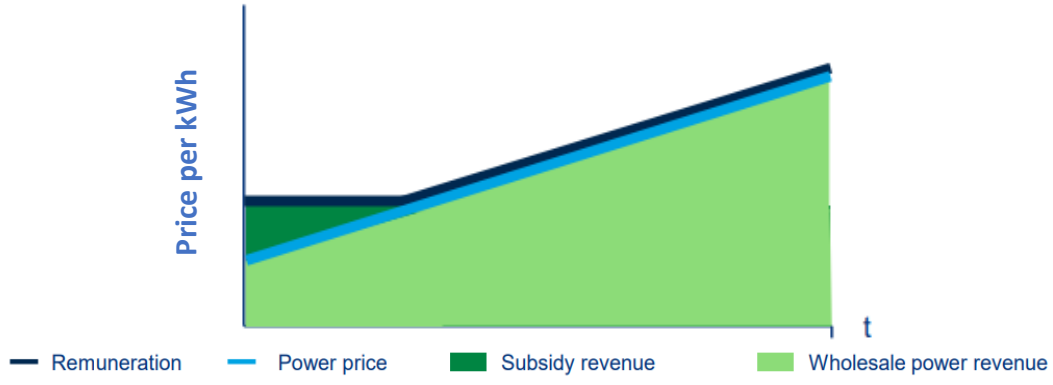

Figure 17: 1-sided CfD as adopted by OFW auctions showing downside price protection through subsidies and upside price potential during high wholesale power prices (Adapted from [30]).

In the event of multiple bids of 0 cents / kWh (no guaranteed minimum price), winners were chosen through a lottery system. Due to the degree of competition in the market, 0 cents / kWh bids became the norm, and an updated auctioning mechanism became necessary. The results of the 2021 and 2022 OFW auctions highlight this high degree of competition and are displayed in Table 1 below.

Site	Location	Capacity (MW)	Winning Bidder	Winning Bid* (cents / kWh)
N-3.7	North Sea	225	RWE	0
N-3.8	North Sea	433	RWE/Northland Power	0
O-1.3	Baltic Sea	300	Iberdrola	0
N-7.2	North Sea	980	RWE	0

Table 1: Results of 2021, 2022 auctions showing 0 cent bids for all sites. Successful bids were all selected through a lottery system (Adapted from [4]).

2.2.3 The 2023 OFW Auctions (and beyond)

This report's analysis will be centered around the OFW auctions of 2023. Under a new auctioning system, 2023 has seen a record 8.8 GW of OFW capacity tendered, 7.8 GW in the North Sea and 1 GW in the Baltic Sea. In 2023, the site development plan has, for the first time, defined sites that will not undergo assessment by the BSH prior to auctioning. These non-examined sites will be auctioned off in parallel with sites that have been pre-examined in an attempt to accelerate OFW deployment in Germany. To achieve 50 GW of installed capacity by 2035, the FEP has outlined 36.8 GW of tenders, as illustrated in Figure 18 below. The upcoming tenders are given by type and volume, indicating that by 2027, the split between pre-examined and non-examined sites will be 50-50.

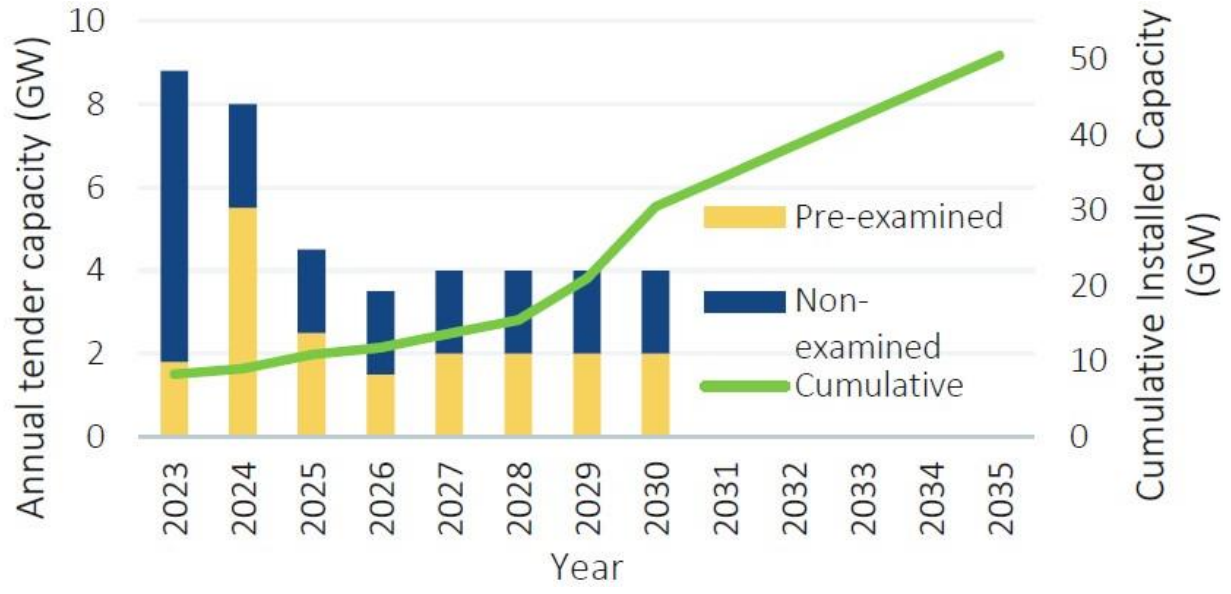

Figure 18: OFW capacity to be tendered by type and volume as per FEP schedule. By 2027, the split between pre-examined and non-examined sites will be 50-50 (Adapted from [4]*).*

OFW Site	Capacity (MW)	Date of Commissioning (COD)	Auction type
N-11.1	2000	2030 Q3	Non-examined
N-12.1	2000	2030 Q3	Non-examined
N-12.2	2000	2030 Q4	Non-examined
O-2.2 (Baltic Sea)	1000	2030 Q3	Non-examined
N-3.5*	420	2028	Pre-examined
N-3.6*	480	2028	Pre-examined
N-6.6*	630	2028	Pre-examined
N-6.7	270	2028	Pre-examined

Table 2: German OFW tenders 2023 (Adapted from [4]*). *Existing step-in rights.*

Of all the OFW sites listed in Table 2 above, only O-2.2 is located in the Baltic Sea. Non-examined sites feature significantly larger capacities (up to 2 GW) and a COD that is at least 2 years later than the pre-examined sites due to a lack of metocean data and the need for extensive site surveying prior to construction. Sites N-3.5, N-3.6, and N-6.6 are subject to 'step-in' or 'subrogation' rights, awarded to original developers that were already developing projects on sites that were re-auctioned through the centralized tendering system in 2017. These legacy developers have the right to acquire the sites won by another developer on the same terms. RWE holds subrogation rights for N-3.5 and N-3.6, whilst Vattenfall holds the subrogation rights for N-6.6. The 2023/2024 tender overview is illustrated in Figure 19 below, alongside existing and future OFW sites as per the site development plan. 2023 Auction scheme details will be described and analyzed in subsequent sections of this report.

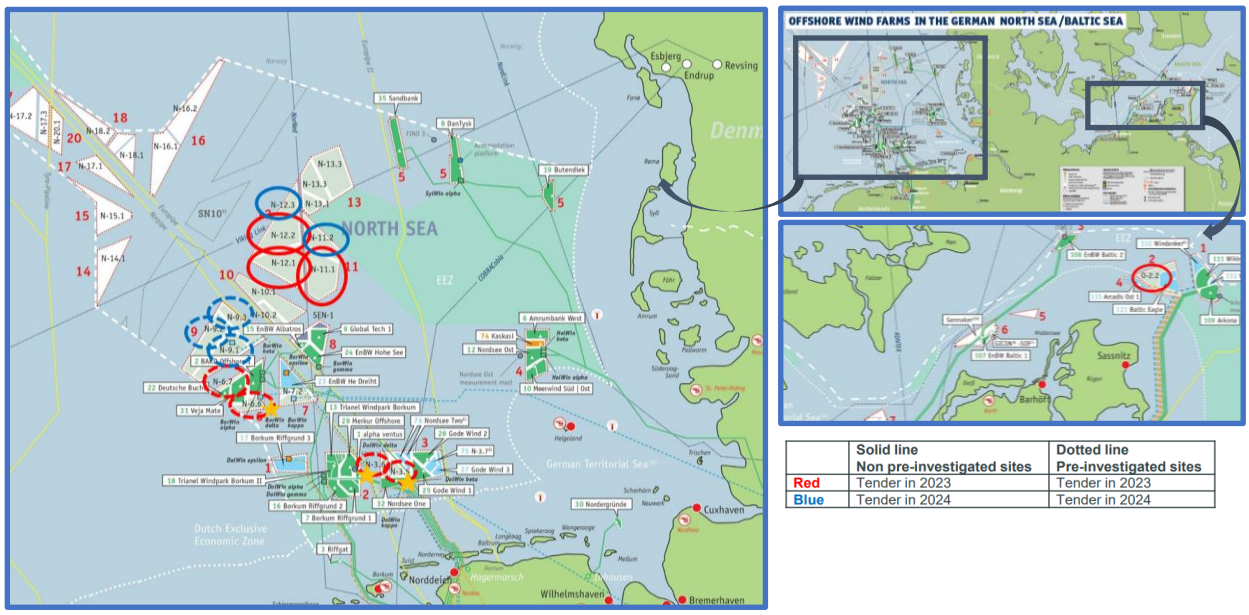

Figure 19: 2023/2024 North and Baltic Sea OFW tenders alongside some past and future developments (Adapted from [2]). Solid and dashed circles represent non-investigated and pre-investigated sites respectively, whilst red and blue encirclements represent the date of tendering (red for 2023, blue for 2024). Stars indicate an existing step-in right.

3. Methods

This report's analysis and discussion section will focus on the specifics of the 2023 tender regime and the main players/competitors involved. It is important to establish the framework under which this analysis will be conducted.

3.1 2023 Tender Analysis Framework

As mentioned, the 2023 auctions will be divided across non-investigated and pre-investigated sites. Critical tender information will be included under the following headers:

- **Tender authority** – the party responsible for regulating the auctions.
- **Auction date** – the bid submission date.
- **Subject of tender** – bid objective and rights tied to the winning bid.
- **Auction design** – tender criteria and scoring system.
- **Bid bond** & **lease fee** – mechanism describing how the bid bond & lease fee will be paid out**.**
- **Approval procedure** – description of post-bid milestones.

3.2 Competitor Analysis Framework

A consolidated SWOT analysis of TTE Germany will provide insight into TTE's position in the country and on the front of OFW. This includes an internal and external outlook. Internal strengths and weaknesses are related to company presence, reputation, expertise, and organization, whilst external opportunities and threats are related to regulation, market demand, market ambition, and national infrastructure. Table 3 below shows the SWOT outline.

Internal Analysis: TTE

STRENGTHS ⊕	WEAKNESSES ⊖

External Analysis: Market

OPPORTUNITIES ⊕	THREATS ⊖

Table 3: SWOT analysis framework.

To select TTE's main competitors for the 2023 German OFW bids, it is useful to identify key competitor characteristics. These will represent a competing institution's ability to outmaneuver TTE in the upcoming tenders, financially or otherwise.

3.2.1 Identified Key Competitor Characteristics

Interest

TotalEnergies has identified Germany as a key market for its OFW ambitions. Tier 1 competitors will have the German North and Baltic seas listed as a priority market. Pre-existing developments are a measure of a competitor's presence/appetite in the German market. Competitors with a means of 'off-taking' the produced OFW electricity through relevant assets may hold a significant advantage, such as the possibility to agree internal PPAs. The offshore wind industry has seen a growing number of developers with an ever-increasing appetite. Serious competitors will see the German offshore wind auctions of 2023 as a priority in expanding their portfolio. Stated renewable & OFW ambition in MWs is a measure of a developers OFW appetite.

Bidding behavior

Bidding strategies and behavior in historical OFW auctions can be a useful indicator in determining competitive ability of developers in the upcoming auctions.

Financials

Given the considerable CAPEX, OPEX & DEVEX associated to developing an OFW project, financial prowess is a major indicator of competitive strength. The 'hurdle rate' or 'weighted average cost of capital' (WACC) is often used as an indicator of the NPV of an investment to determine its value. Higher hurdle rates can be indicative of weaker competitive ability.

For the sake of brevity, a shortlist of OFW developers was identified and displayed in Table 4 below. This shortlist will later be assessed as per the competitor analysis framework.

Category	Company	Logo
Oil & Gas majors	BP	
	Shell	
	Equinor	
	Eni	

Utilities	Iberdrola	IBERDROLA
	RWE	RWE
	EnBW	EnBW
	Ørsted	Ørsted
	Vattenfall	VATTENFALL
	EDF	EDF

Table 4: Short list of most dangerous competitors, split by traditional O&G majors and major utilities.

4. Analysis & Discussion

4.1 Non-examined Sites

Tender authority	The federal network agency, BNetzA, is Germany's regulatory authority for all electricity & gas projects.
Auction date	1st of June, 2023
Subject of the tender	Site exclusivity, permitting process & grid connection.
Auction design*	Bid price is sole auction component (100%). Bidders are required to have LoI with offtakers for at least 20% of production capacity for 5 years. 2-stage design: 1) Single feed-in tariff bid capped at 6.2ct/kWh 2) In the event of multiple 0-cent bids, dynamic bidding commences for all 4 sites in parallel
Bid bond & lease fee payments	The bid bond will be 100 €/kW, to be provided in cash or by bank guarantee. 25% is paid on bid submission, with the remaining 75% paid within 3 months after bid award. 10% of the lease fee is to be paid within 12 months of the bid award. - 5% is dedicated to marine nature conservation - 5% is dedicated to local fisheries The remaining 90% is to be paid in yearly installments over a period of 20 years, starting from COD.
Approval procedure	Complete permitting application is to be submitted no more than 24 months after bid award.

*Table 5: Key tender rules for non-examined sites. *Auction design will be covered in additional detail in the following section (Adapted from* [15]).

4.1.1 Detailed Auction Design

'Auction design' details the rules and procedures involved with procuring an OFW energy project. For the non-examined sites in Germany, bidders looking to participate were first required to pass pre-qualification. Through a letter of intent, interested developers would demonstrate power purchasing agreements accounting for at least 20% of installed capacity for at least five years.

The auction is described as 'price-based', as its sole award criteria is the bid value. Bidders are to submit a 'lowest bid value' for a market premium, in €ct/kWh, under which they are to bring the OFW project to completion. This value is capped at 6 €ct/kWh, with the lowest bid value securing the award. Bids for all four sites (see Table 2) are due on the 1st of June, 2023.

In the event of several 0-cent bids, BNetzA (OFW regulatory authority) would invite involved bidders to a second phase of uncapped 'negative bidding'. Instead of receiving state subsidies to develop a project, developers would pay the government to secure the rights to an OFW site, with bids expressed in €/MW.

This second phase is dynamic: developers are invited to a first-round bid with an initial price of 30,000 €/MW of capacity. In the event that all parties involved agree to match the bid, a new round commences, and the price is raised by a further 30,000 €/MW. Once a bidder drops out, the first subsequent round will see a price raise of 15 000 €/MW, after which the increment is restored to its original value. Bidding ends if only one remaining bidder is left (this for all sites in parallel). If all bidders drop at the same exit price, sites are awarded as per the lottery system of pre-2023 auctions. Figure 20 below displays the bidding process through its most important steps:

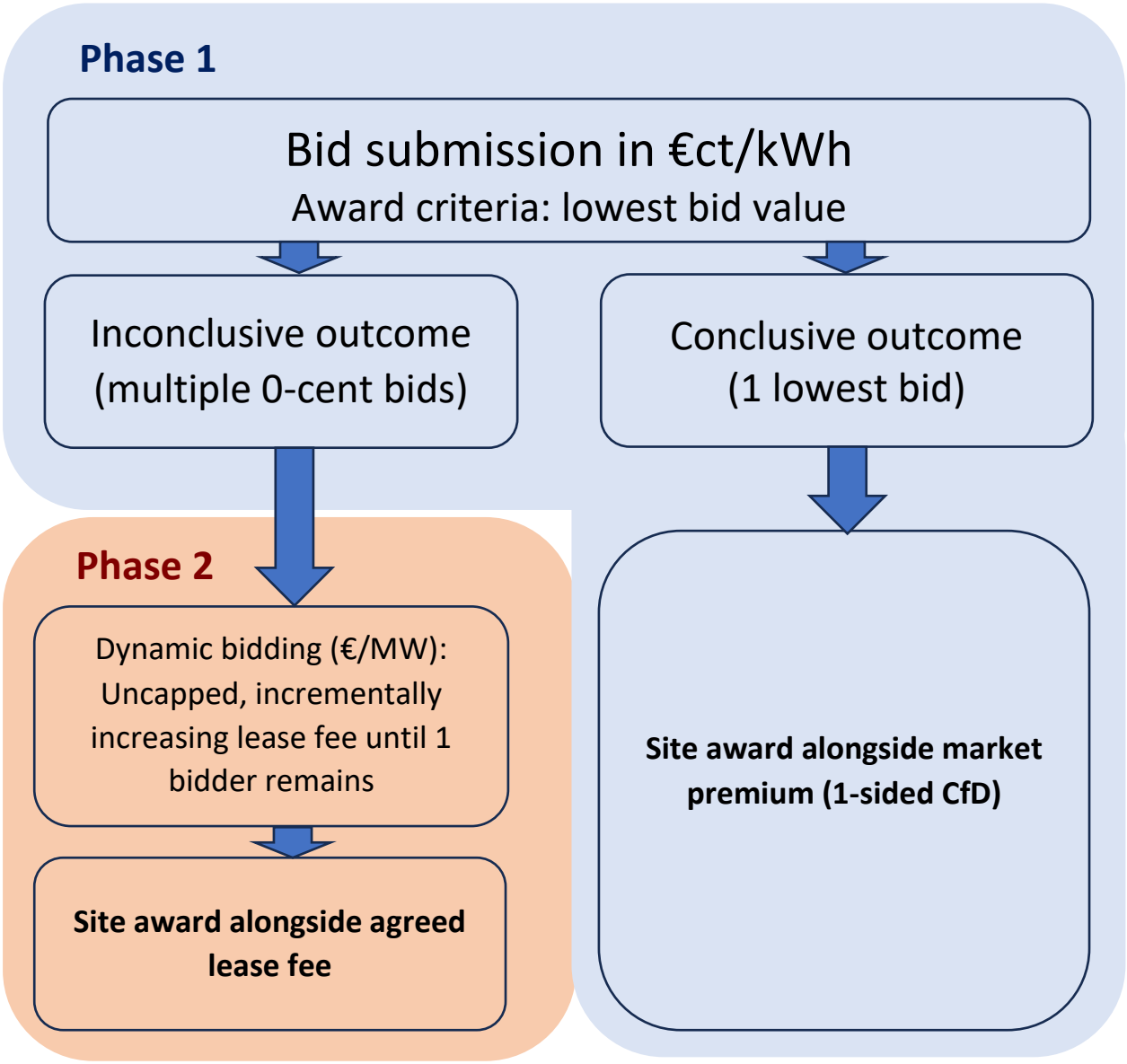

Figure 20: Bidding process of the non-examined sites of the 2023 German OFW auction (Adapted from [15]).

In recent auctions, there has been an observed demand for OFW sites at zero price (Table 1). The likelihood of all unexamined sites being awarded through uncapped negative bidding is therefore large. With the single award criteria being price, developers with strong financials will have a major advantage. However, due to the scale and cost of these sites, it is unlikely that a single developer would win all awards.

0-bid auctions and negative lease fees alleviate pressure on government subsidy schemes but may be more detrimental to renewable development than one might think. Extra costs incurred by developers limit their ability to develop other renewable projects and are ultimately passed down to either the consumer or the supply chain. Additionally, without a market premium, developers of OFW projects are fully exposed to the market price of electricity. This lack of clear revenue generation complicates the process of securing critical funding from lenders such as banks.

4.2 Pre-examined Sites

Tender authority	The federal network agency, BNetzA, is Germany's regulatory authority for all electricity & gas projects.
Auction date	1st of August, 2023
Subject of the tender	Site exclusivity, permitting process & grid connection.
Auction design*	**Financial component (60 points):** - Highest bid value in €/MW of capacity **Qualitative criteria (40 points):** - Decarbonization of offshore wind energy expansion (10 points) - Extent of supply of energy marketed via PPA's (10 points) - Noise pollution and sealing of the seabed (10 points) - Contribution to securing skilled labor (10 points) In case of a tie, the highest bid price wins. In case of identical bid price: additional auction round(s)
Bid bond & lease fee payments	The bid bond will be 200 €/kw, to be provided in cash or by bank guarantee. 25% is paid on bid submission, with the remaining 75% paid within 3 months after bid award. 10% of the lease fee is to be paid within 12 months of the bid award. - 5% is dedicated to marine nature conservation - 5% is dedicated to local fisheries The remaining 90% is to be paid in yearly installments over a period of 20 years, starting from COD.
Approval procedure	Complete permitting application is to be submitted no more than 12 months after bid award.

*Table 6: Key tender rules for pre-examined sites. *Auction design will be covered in detail in the following section (Adapted from* [14]*).*

4.2.1 Detailed Auction Design

Unlike for the non-examined sites, the auction design of the examined sites includes multiple award criteria, each weighted by their importance worth a cumulative total of 100 points. Bidders will aim to score as many points as possible in a closed envelope bid without a dynamic phase 2 (see non-examined auction design). These criteria can be subdivided into quantitative criteria (60 points) and qualitative criteria (40 points). The quantitative component of the auction is an uncapped flat bid value stated in €/MW. The highest bid value will score a maximum 60 points, with all other bids receiving a fraction dependent on their bid value relative to the highest bid. Qualitative criteria are assessed as follows:

Decarbonization of offshore wind energy expansion (10 points)

This refers to the share of the total electricity demand of the '*manufacturing process*' for the offshore wind turbines that is covered by '*unsubsidized electricity*' from '*renewable energy sources*'. The share is measured as a percentage, with 100% unsubsidized electricity from renewables yielding the maximum 10 points. Bidders are to ensure this share will be achieved through contractual agreements with suppliers and/or with guarantees of origin for renewable energy if the electricity is taken from the grid.

The '*manufacturing process*' includes all large components such as foundations, connectors, towers, turbines, rotor blades, generators, gearboxes, shafts & frames from the delivery of the raw materials up to the completion of the component. The assessment does not include any installations or attachments, such as ladders and railings. A shortfall in the quota for some components may be offset by an excess in the production others, with the weighted average of all components being the decisive share [14].

"*Unsubsidized electricity*" is electricity [6]:

a) for which no payment is claimed

   - aa) pursuant to section 19 or section 50 of the Renewable Energy Sources Act,
   - bb) under a provision corresponding to the provisions referred to in paragraph 1 in earlier versions of the Renewable Energy Sources Act, or
   - cc) pursuant to the Combined Heat and Power Act, or

b) which has been generated outside the territory of the Federal Republic of Germany and benefits from a *Guarantee of origin*.

"*Renewable energies*" means [6]:

a) Hydropower, including wave, tidal, salt gradient, and current energy, Wind energy, Solar radiation energy, Geothermal energy, Energy from biomass.

Extent of supply of energy produced marketed via PPA's (10 points)

This criterion refers to the total volume of supply of energy generated on the tendered area to other entities, measured in GWh. A separate bid form is to be included for every declaration serving as evidence of a PPA or supply contract with another entity. The annual amount of power shall be determined on the assumption of 3500 annual full-load hours (capacity factor of 40%).

Given that the offtake cannot exceed the total electricity generation on the tendered area, maximum values for this criterion are given per site:

N-3.5: 36 750 GWh (capacity: 420 MW)

N-3.6: 42 000 GWh (capacity: 480 MW)

N-6.6: 55 125 GWh (capacity: 600 MW)

N-6.7: 23 625 GWh (capacity: 270 MW)

To score maximum points, 100% of the energy supply should be marketed by a power purchasing agreement.

Noise pollution and sealing of the seabed (10 points)

This criterion refers to the share of offshore wind turbines in the total number of turbines installed by neither '*impulse pile driving*' nor '*gravity-based foundations'*, measured as a percentage.

'Impulse pile driving' is any process in which a hammer transmits an impulse to a steel pile lying underneath, bringing it to the depth required to suit the foundation [27]. A '*gravity-based foundation'* for an offshore wind turbine is a type of foundation in which the weight of the structure is used to provide stability. The structure is secured in position using a heavy ballast that is denser than water, without any additional anchoring [14].

There are no bid documents specifically for this criterion, but the awarded bidder should provide proof during planning approval. The bidder must adhere to the details outlined in the bidding process. In the event that it becomes necessary to employ additional pulse ramming, either during or before installation, the ultimate decision regarding its permissibility rests with the plan approval authority (BSH). In case of rejection, the bidder must pay a penalty of 100% of the security deposit [14].

Contribution to securing skilled labor (10 points)

This criterion refers to the share of trainees in the total number of employees subject to social insurance contributions at the time of bid submission, measured as a percentage. Employees of the bidder, as well as those belonging to any affiliation of the bidder and those working for contracted companies during construction and maintenance are considered. The bidder with the largest share of trainees will receive maximum points, with competing bidders receiving reduced points proportional to their share.

Outside Germany, trainees are included if their contract is of a certain permanence and relevance for professional development, meaning that simple internships are not included. Evidence is not required during bid submission but may be requested by the regulatory authority if values are deemed not plausible. An external auditor will then procure this evidence.

Discussion

Besides the weighting of the criteria, it is important to identify the specific points where a competitive advantage can develop. 'Decarbonization of OFW expansion', 'extent of supply of energy produced marketed via PPA' and 'noise pollution and sealing of the seabed' are criteria for which multiple bidders will likely achieve the full 10 points. This is because they are very achievable by developers with more robust financials (renewable electricity and alternative pile driving methods are merely more expensive) or require a simple letter of intent. Contrarily, the criterion involving the share of apprentices/trainees in the overall workforce heavily favors local developers as Germany is one of the nations with the largest involvement of 'trainees' in the world [40].

Important to the 2023 auctions is that 3 out of 4 sites remain under step-in rights held by legacy developers (see Table 2). This guarantees RWE and Vattenfall the right to develop these sites, even without a winning bid. These rights are expected to reduce the appetite of other developers from bidding on the examined sites of the 2023 auctions. For the sake of comparability, Figure 21 below illustrates the bidding process of the non-examined sites of the 2023 German OFW auction:

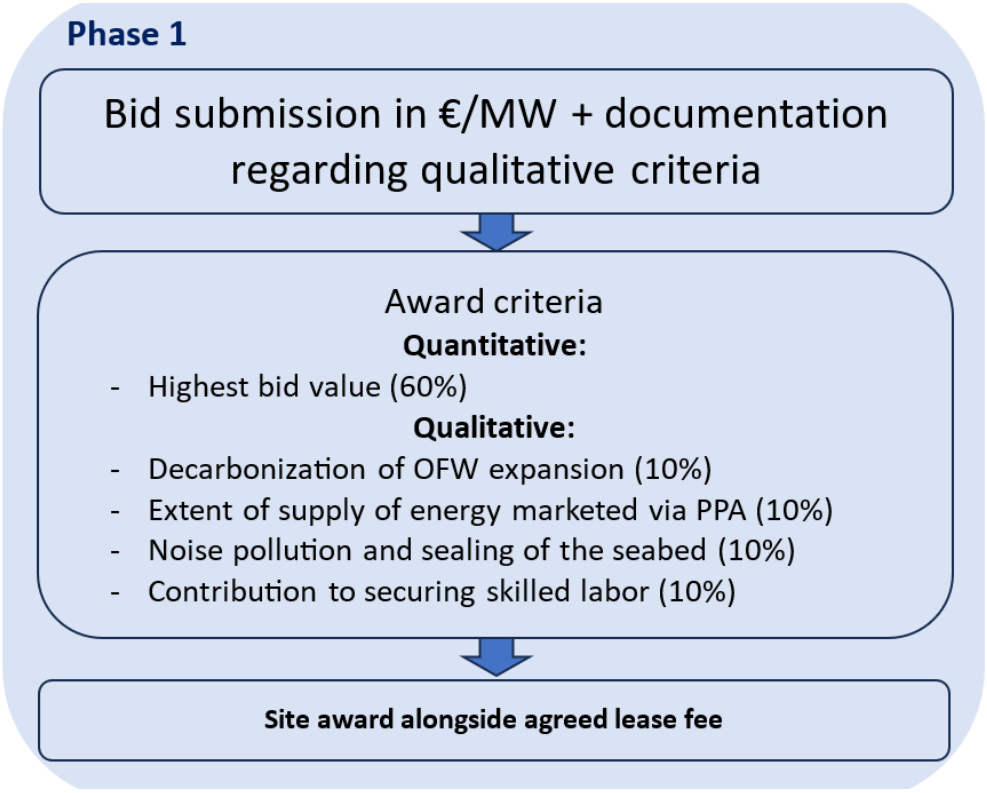

Figure 21: Bidding process of the examined sites of the 2023 German OFW auction (Adapted from [14])

4.3 Competitor Analysis

4.3.1 TTE SWOT Analysis

The complete SWOT analysis is displayed in Table 7 below.

TotalEnergies has a profound reputation as a multi-energy player on an international scale, with vast experience on large-scale offshore projects. One of their biggest strengths is their sizeable financial back-up, which will ensure competitive bidding in any price-based auction. Another internal strength is their presence in Germany: the electricity-intensive Leuna refinery for example could become an ideal off-taker for the offshore wind farms to be developed in the North Sea.

A potential weakness is the lack of renewable-specific expertise in Germany, as TTE has yet to develop an OFW farm in the region. This will require the recruitment and/or upskilling in a job environment that is very competitive. A further weakness may be the complex existing organization (REN) in charge of developing renewable projects. Due to its size and complexity, REN has a large number of interfaces that can make TTE less agile in terms of renewable development. Finally, TTE is still widely regarded as an 'oil company' in Germany, rather than a multi-energy corporation, and has initial rate of return expectations of >10%. This could reduce their competitive ability in an industry that has not had the same profitability as traditional oil and gas exploration projects.

Internal Analysis: TTE

STRENGTHS ⊕	WEAKNESSES ⊖
International reputation as multi-energy player	'Oil company' in Germany
Financial back-up & advanced trading experience	Lack of local-specific expertise in new areas
Strong presence in Germany (refinery, service stations)	Complex existing organization (REN)

External Analysis: Market

OPPORTUNITIES ⊕	THREATS ⊖
Strong national ambition	Insufficient grid infrastructure
Industry & mobility sectors with highest demand for H_2	Regulatory uncertainties and delays

Table 7: SWOT analysis of TTE in the German offshore wind market.

Vast opportunities lie in Germany's ambition to become a leader in renewable generation and particularly in offshore wind development. This ensures a strong will to simplify and accelerate new projects, something that has been a significant hurdle in historical OFW buildout across Europe. Furthermore, Germany has both the industry and mobility sectors with the highest demand for hydrogen (H_2) across the entire continent [23]. Considering the generation pathway of H_2 molecules, demand for renewable electricity will remain very strong in the foreseeable future.

A major threat to all developers interested in the German OFW market is a critical lack of grid infrastructure. Rapid renewable expansion requires upgrades to the infrastructure responsible for transporting electrons, and grid bottlenecks have been identified as one of the single biggest contributors to project delays [39]. Regulatory uncertainties and procedures are another concern to developers, as they are notoriously complex and lengthy.

4.3.2 Competitive Landscape

Bidder	Participation announced	Active in Germany	Consortium	Bidding behavior*
BP	No	Yes	No	• Very aggressive bidding behaviour in UK 2021 auction
Shell	No	No	No	• Recent CEO guidance suggests focus on oil & gas
Equinor	Yes	Yes	EnBW	• Limited experience in DE / limited success in US auctions • Synergies with hydrogen projects may positively affect bidding aggressiveness
Eni	No	No	No	• Limited aggressiveness in OFW bidding • No interest shown for Germany
Iberdrola	No	Yes	No	• Demonstrated strategic bidding in past DE auctions; limited aggressiveness elsewhere • Focus may be on Baltic Sea / international opportunities without negative bidding
RWE	No	Yes	Northland Power	• Aggressive bidding-behaviour in the US (California) and recent DE auctions • Synergies with trading business and sites likely to enhance competitiveness
EnBW	Yes	Yes	Equinor	• Demonstrated very aggressive bidding behaviour in the past • He Dreiht experience confirms ability to farm down and take merchant risk at low project returns • Potential synergies with existing sites in zone 2
Ørsted	Yes	Yes	BASF	• Strategic bidding in past German auctions • Flexibilities to withdraw from tenders due to global pipeline • JVs with BASF reduce merchant risk, allowing for high WTP without compromising hurdle rates
Vattenfall	No	Yes	No	• Bidding on Norwegian tenders • Owns step in right to German pre-examined site (N-6.6)
EDF	No	Yes	No	• Norway: partnered with Deep Wind Offshore to bid for offshore wind • Ireland: 50% stake in the Codling offshore wind farm project. • Belgium: partnered with Jan De Nul Group and Luminus to bid for OFW tender for the first phase of the Princess Elisabeth Zone 3.

*Table 8: Bidding behaviour of shortlisted competitors & main players. *Sources: Internal company communication*

Table 8 above gathers past bidding behavior of the suspected tier 1 competitors. Although subject to regional & temporal variability, an enterprise's bidding behavior may indicate future bidding strategy. From the table, it can be noted that BP, RWE & EnBW have demonstrated aggressive bidding behavior in the past, with the latter two also participating and winning in historical German auctions. The potential for synergies between these sites and the ones tendered in the 2023 auctions may increase their appetite. Equinor's announced partnership with EnBW and their potential synergies with proposed hydrogen projects is also indicative of significant appetite.

Iberdrola, Ørsted, and Vattenfall have adopted a more strategic bidding approach. Each of these developers already owns OFW assets in the German EEZ, either in the Baltic or in the North Sea, but they have announced muted enthusiasm for the uncapped negative bidding design of the unexamined sites of 2023. Vattenfall and RWE's step-in rights for pre-examined sites make them significantly greater competitors for the August auction than for the June auction. Eni has focused primarily on Italy, whilst Shell has announced it is shifting its strategy back to traditional hydrocarbon projects.

Further key characteristics were analyzed in Table 9 below. Offshore wind appetite based on announced targets and an appetite for the German market in general (power, hydrogen) will give a strong picture of competitive will in the 2023 summer tenders. Offtake advantage was also scored, as the most aggressive bidders will look to leverage regional assets & customers. Out of the O&G majors, BP and Equinor have demonstrated the largest appetite for OFW development in the region, with BP opening a new office in the critical seaport of Hamburg. BP, like TotalEnergies, operates a major refinery in Germany that could lead to significant synergies with a German offshore wind farm. Out of the list of utilities, EnBW & RWE are expected to have a major offtake advantage as they are operating on home turf, whilst Vattenfall also still has considerable thermal generation in Germany. An interesting distinction can be observed between the hurdle rates of the O&G majors and the utilities, in that the weighted average cost of capital for BP, Shell, Equinor, and Eni is significantly larger. This is due to the larger expected internal rate of return of shareholders for these companies as opposed to national utilities like EnBW (Germany) or Vattenfall (Sweden). A cumulative score is used to identify which corporations will likely be TTE's most prominent competitors in the 2023 auctions. BP leads the tally, followed closely by RWE, Vattenfall, and EnBW.

Category	Company	OFW appetite	Germany appetite	Green Hydrogen appetite	WACC*	Offtake advantage	Overall Score
Oil & Gas Majors	BP	+++	+++ new office in Hamburg	+++	7,8 %	+++	12
	Shell	-/+	++ (approached TTE)	+++ new venture in Hamburg	7,9 %	+++	7
	Equinor	+++	+++ Partner with EnBW	+++	7,4 %	+	10
	Eni	+	-	+	6,6 %	-	2
Utilities	Iberdrola	++	+++ Iberdrola Deutschland	+++	5,3 %	-	8
	RWE	+++	+++	+++	5,9 %	+++	12
	EnBW	+++	+++ Partner with Equinor	++	5,9 %	+++	11
	Orsted	+++	+++	+++	5,8 %	-	9
	Vattenfall	+++	+++ (grid, heating and wind)	++	2,4 %	+++	11
	EDF	+++	+++ (expanding presence)	++	5,6 %	-	8

*Table 9: Competitor chart with key characteristics scored. Most dangerous competitors have scores >10 points. *Sources: [45]; Internal company communication*

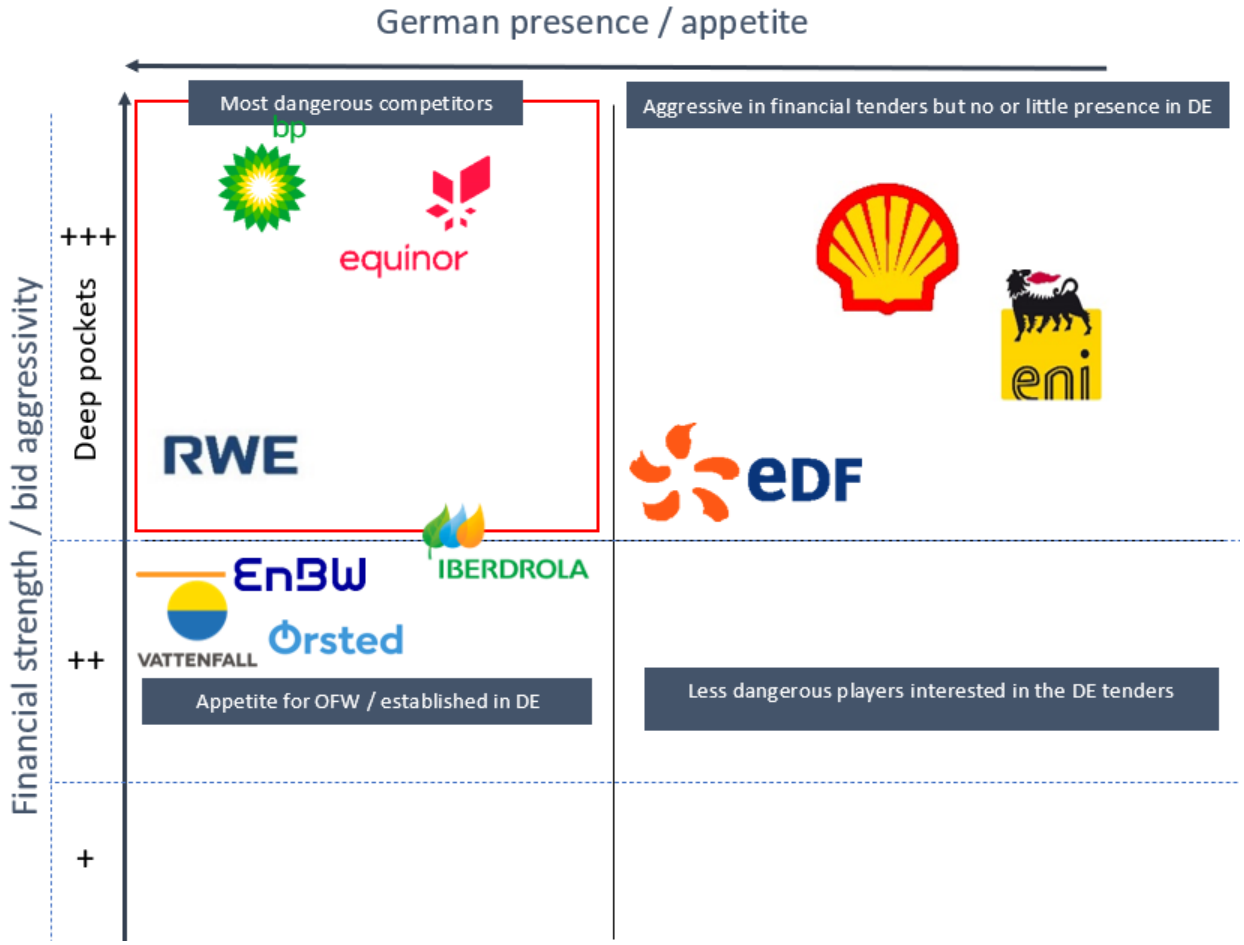

Figure 22: Competitor chart of the main players in the 2023 German OFW tenders. Most dangerous competitors are highlighted in the red square in the top left corner of the chart.

Figure 22 above is a chart combining all the key characteristics of the competitor analysis framework. BP, Equinor, and RWE are categorized as the 'most dangerous' competitors, featuring a combination of financial strength, German presence & appetite, as well as bid aggressivity. Strategic bidders such as Iberdrola, Vattenfall, and Ørsted also display significant appetite, but will likely not have the financial capacity to outlast BP or TotalEnergies in the event of prolonged uncapped negative bidding. EDF, Eni & Shell all have considerable resources but have thus far shown limited interest in the German offshore wind auctions.

This concludes the discussion of the competitive landscape prior to the publishing of the auction results. The section hereafter is a follow-up to the recent publications surrounding the winners of the 2023 auctions for both non-examined (June 2023) and examined sites (August 2023).

4.4 2023 Auction Results & Discussion

4.4.1 Non-examined Sites

The price-based non-examined sites tendered in June of 2023 were dominated by oil and gas majors, seeing record-high bids through the newly introduced uncapped dynamic bidding. Competition was expected to be tough, and as anticipated, several 0 subsidy bids were submitted for all four sites in both the North and Baltic Sea. Table 10 below describes the bidding patterns observed for sites N-11.1, N-12.1, N-11-2, and O-2.2, as well as the eventual winners.

N-11.1	**N-12.1**	**N-12.2**	**O-2.2 (Baltic Sea)**
2 GW	2 GW	2 GW	2 GW
8 zero-subsidy bids submitted	8 zero-subsidy bids submitted	8 zero-subsidy bids submitted	8 zero-subsidy bids submitted
6 bidders contending up to €1.8bn	6 bidders contending up to €1.8bn	6 bidders contending up to €1.8bn	5 bidders contending up to €1.5bn
3 bidders contending up to €2.5bn	3 bidders contending up to €2.8bn	3 bidders contending up to €2.5bn	3 bidders contending up to €2.0bn
Won by BP for €3.66bn (€1.83mn/MW)	**Won by TTE for €3.75bn (€1.875mn/MW**	**Won by BP for €3.12bn (€1.56mn/MW)**	**Won by TTE for €2.07bn (€2.07mn/MW)**

Table 10: Bidding pattern and winners of the 4 non-examined sites tendered in the June 2023 German OFW auction. Sources: [7]; internal company communication

BP's first OFW auction win in continental Europe amounts to a total of 4 GW, with TTE awarded 3 GW as per Table 10. The highest price per megawatt was observed for site O-2 (€2.07mn/MW), where coastal proximity and favorable wake effects likely played a role in the site's attractiveness. The record-breaking lease fees (average of €1.83mn/MW) produced by these enterprises highlight the high level of competition in the German OFW market, as well as the massive financial appetite developers display in an auction of this design. Figure 23 puts the 2023 German auction in perspective to previous benchmarks recently set in the UK, US, Lithuania, and the Netherlands. The 12.6bn euros price tag is expected to grossly inflate investment cost of these projects, forcing developers to look for value in their downstream operations through, for example, trading activities and/or farm-down.

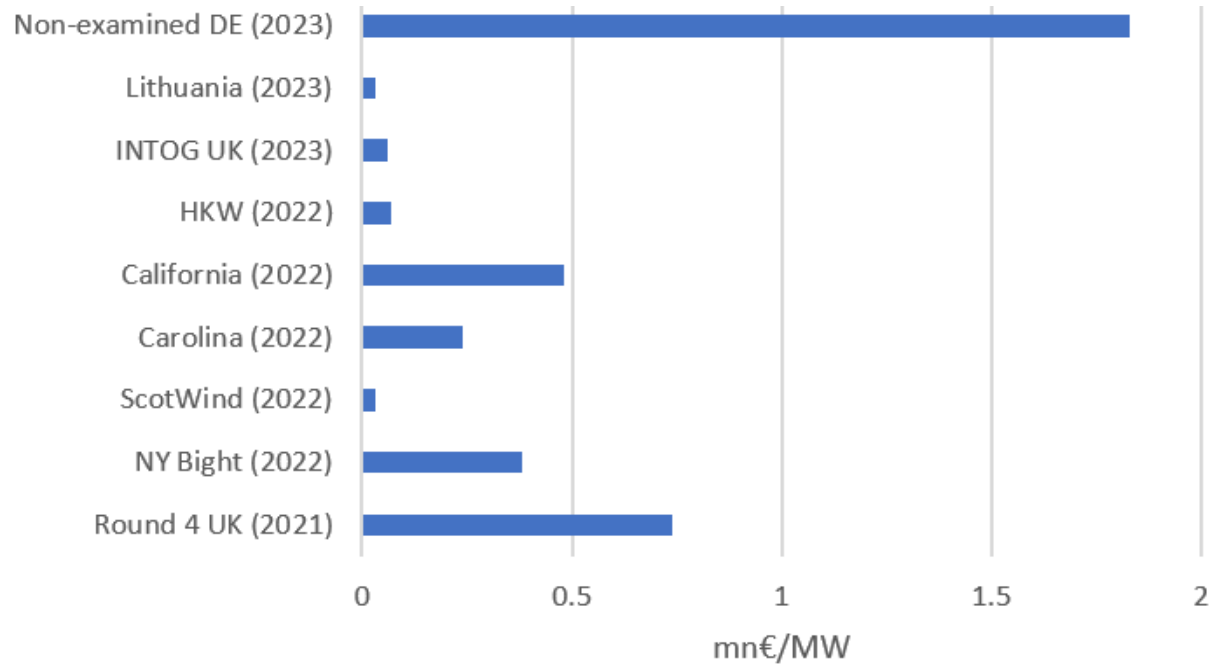

Figure 23: Price/MW of OFW capacity reaches all-time high in the auction of the German non-examined sites (Adapted from [20]).

Discussion of price escalation & bid winners

The root causes of the unique price escalation observed are found both in the target market as well as the auction design. Offshore wind projects represent significant risk to a developer due to their cost, technical difficulty, and lengthy commissioning process. The fact that Germany is an established renewables market with clear political backing and immense potential for purchasing power agreements in its industry help reduce this risk. Germany also has its transmission infrastructure built and operated by its TSOs without developer involvement. The resulting reduction in scope of German OFW projects is again a risk-reducing factor for developers. In terms of auction design, the tendering process can be described as 'straight-forward' in that it was based solely on price, making it especially attractive to developers with deep pockets, such as BP and TotalEnergies. Another key auction design criterion was the lease fee payment structure, as stated in Table 5. Unlike most other auctions (US, UK), the German auctions were designed such that the lease fee payment is spread over operational lifetime rather than being due at the start of the project. With only 10% of the costs due within the first year after the bid award, a vast majority of the cost burden is born during revenue-earning years, which again reduces the risk taken on by a developer as uncertainty decreases rapidly during project development. Considering these factors, it comes as no surprise that TTE and BP, each with considerable German assets available for leverage, have come out on top in the most recent non-examined auctions.

4.4.2 Pre-examined sites

The German pre-examined site tenders delivered what can be described as mostly 'predictable results', but also welcomed a new entrant. Sites N-3.5 and N-3.6 were awarded to German multinational energy company RWE without a negative bid component, with RWE also holding the step-in rights to these sites. Sites N-6.6 and N-6.7 were awarded for a total bid value of €784mn, to RWE and Luxcara (independent asset manager) respectively, although an exact price distribution was not published. On the 14th of September 2023, Swedish utility Vattenfall exercised its step-in rights for N-6.6, matching RWE's winning bid value and assuming the role of developer for the site [3]. Table 11 below summarizes winning bids and developers of the four pre-examined sites.

	N-3.5	**N-3.6**	**N-6.6**	**N-6.7**
Capacity (MW)	**420**	480	630	270
Winner	RWE	RWE	RWE	Luxcara
Step-in rights	RWE	RWE	Vattenfall	None
Bid Value	0	0	N/A*	N/A*

*Table 11: Bidding pattern and winners of the 4 pre-examined sites tendered in the August 2023 German OFW auction [3]. *No individual site bid values published.*

RWE had already secured nearby sites N-3.7 and N-3.8 in the 2021 auctions. Given the company's ambition to commission their 1.6GW 'Nordseecluster' project by 2029, the acquisition of sites N-3.5 and N-3.6 was widely anticipated. Similarly, Vattenfall was expected to seize development of site N-6.6 in light of its ongoing 'Atlantis 1' project. The disparity in bid values between the examined and non-examined auctions reflects varying levels of attractiveness and is the result of several key factors:

- Site size (capacity)
- Presence of step-in rights
- Proximity between neighboring wind farms

Multi-gigawatt projects are often more attractive as they are more cost-effective (cost per unit electricity) to developers. The cost of building and maintaining a wind farm decreases as the size of the farm increases as developers take advantage of economies of scale. Step-in rights deter competitors as they represent unwanted risk to competitors that do not hold these rights. Finally, the pre-examined sites presented in this report are in much closer proximity to one another and/or other existing/future projects. This creates higher risks for detrimental wake effects, reducing a project's overall capacity factor and revenue-generating ability.

4.4.3 Outlook

Offshore wind projects are seeing unprecedented competition, with record-breaking lease fees and rising costs making developers more and more selective. A prime example observed in the German 2023 auctions was leading OFW developer Ørsted, who did not participate in the uncapped bidding rounds of the unexamined sites citing unsustainable price levels, despite initial interest through a joint venture with chemical heavyweight BASF.

Auctions with an uncapped financial component are likely to favor players with deeper pockets, suggesting a rise in the involvement of O&G majors relative to traditional renewable energy companies and an overall reduction in developer diversity as smaller enterprises are no longer able to compete.

In the wake of the German auctions, renewable energy companies are likely to lobby for reforms to ensure a viable pathway towards new OFW projects remains even when in direct competition with energy giants like TTE, BP, or Shell. These reforms could include the removal of uncapped bidding, limiting the number of sites awarded per developer, and a heavier weighting on qualitative criteria such as local content.

Uncapped bidding has been particularly heavily criticized as causing unsustainable price levels that risk increasing the LCoE of projects that are critical to realizing renewable energy ambitions. Although the German government has indicated site acquisition fees will contribute to reducing consumer power prices, there is a considerable risk of the financial burden of these fees being passed down to consumers. In combination with the recent inflation and commodity price hikes, exorbitant lease fees are likely to cause an uptick in project abandonment as developers lose confidence in the viability of OFW projects.

5. Conclusion

Germany aims to generate 80% of its power from renewable sources by 2030, up from around 40% today, and to phase out coal and reduce its reliance on natural gas. Offshore wind has been identified as a key renewable technology, for which the nation has set an ambitious target of installing 30 GW of offshore wind power by 2030, which is expected to increase to 40 GW by 2035 and 70 GW by 2045. TotalEnergies is committed to being a world-class player in the energy transition and has set an ambitious target of having 35 GW of gross renewable power generation capacity by 2025. Offshore wind is a growing part of TotalEnergies' portfolio in renewable energy, and the company is leveraging its expertise in offshore oil to develop this resource, with Germany one of its key target markets.

In 2023, Germany's Federal Network Agency has auctioned a record of 8.8 GW of offshore wind power, with auctions held in June and August for non-examined and centrally pre-developed sites, respectively. The auction for non-examined sites was purely price-based, whereas the pre-examined site auction included qualitative criteria. As a result of the auction design (uncapped & dynamic negative bidding), financially dominant players were identified as the most significant competitors, with a focus on O&G majors. TotalEnergies, along with BP, won a total of 7 GW in the unexamined site auctions worth €12.6 billion, whilst RWE and Luxcara won the considerably smaller pre-examined sites for a total of €784mn. Site size, proximity to neighboring wind farms, and the presence of step-in rights are likely causes of the large disparity in total cost. Despite the government hailing the auctions as a success, fears exist that the record-breaking lease fees will result in additional costs for consumers and the OFW supply chain, with renewable developers and industry bodies calling for reforms.

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