GWEC FINANCE PAPER

Financing Offshore Wind in APAC

Assessing the Cost Competitiveness of Offshore Wind

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GWEC
GLOBAL WIND ENERGY COUNCIL

The Global Wind Energy Council (GWEC) is the global trade association for the wind power industry, with over 1,500 members responsible for 70% of the world's wind capacity. Our members include major turbine manufacturers, energy companies, developers, and technology providers. GWEC advocates for the wind industry globally, collaborating with organizations like the IRENA, IEA, local associations and development banks to help governments and policymakers unlock wind energy's full potential.

GWEC's mission is to ensure that wind power fulfills its role as one of the key technology solutions to today's energy and climate challenges, forming the backbone of a new clean energy system and enabling trillions of dollars of investment while providing substantial economic and social benefits to host countries.

Authors:
Janice Cheong

Reviewers:
Liming Qiao
Mark Hutchinson

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Executive Summary

The offshore wind industry has faced significant macroeconomic challenges over the past three years, including rising raw material costs, inflation, increased financing expenses, and supply chain uncertainties. However, the worst of these headwinds now appears to be subsiding, and policymakers are responding to market conditions by implementing targeted solutions to support the sector. This paper highlights the drivers of offshore wind costs, exploring the impact of economic and regulatory challenges on the levelised cost of electricity (LCOE). Despite macroeconomic volatility, offshore wind remains cost-competitive— already evident in mature offshore wind markets such as the UK, Germany, and China.

Cost reductions in offshore wind are closely tied to market maturity. In new markets, LCOE is typically higher as early projects establish technical, regulatory, legal, and financial capabilities while laying the groundwork for local supply chains. As markets develop and gain experience, costs tend to decline dramatically. This evolution often reaches a tipping point as market confidence grows, full competition emerges, and access to lower-cost financing improves due to reduced real and perceived risks. This tipping point is usually after the first 2-3 GW.

APAC governments are actively responding to market dynamics that are reflected in local policies and regulations to mitigate risks for investors. Examples of this proactive approach are already visible in South Korea with the passing of the 'One Stop Shop Bill', a package of 20 trillion yen as part of Japan's Climate Transition Bond Framework, the Philippines running their first offshore wind auctions by the end of 2025, and Vietnam progressing their offshore wind ambitions through its PDP8 Implementation Plan. These markets are expected to follow the cost reduction trajectories of mature markets, driven by increasing installed capacity, economies of scale, supply chain improvements, and already evident robust regulatory support.

In summary, while the offshore wind sector remains capital-intensive and sensitive to macroeconomic fluctuations, the combination of markets maturation, declining costs, and proactive policymaking positions the industry in APAC for sustained growth and resilience.

1. Introduction

As the Asia-Pacific (APAC) region ramps up its shift towards renewable energy, countries are committing to carbon neutrality by 2050 and aiming to triple renewables by 2030. Offshore wind energy is becoming a key component of this transition, helping the region move closer to the 1.5°C pathway. While APAC represents the new wave of offshore wind markets, the global offshore wind industry in 2023 saw remarkable growth, connecting 11 GW of new capacity to the grid, representing a 24% increase from the previous year and bringing the worldwide total of offshore wind capacity to 75GW. Despite this success, the sector has faced significant economic challenges due to the macroeconomic environment over recent years. 2024 has seen a declining inflation and interest rate environment, although inflation and costs of lending remain elevated compared to pre-2022.

This report explores the drivers of offshore wind costs, exploring the impact of economic and regulatory challenges' on the levelised cost of electricity (LCOE). As data for emerging markets is limited (as many have not yet implemented offshore wind), data from mature markets is used to provide a benchmark for the APAC region. It provides a comparison of offshore wind LCOE to other technologies and offers recommendations to enhance the economic viability of APAC offshore wind projects.

2. LCOE Definition and Methedology

Bloomberg NEF defines levelized cost of electricity (LCOE) as the long-term breakeven price a power project needs to recoup all costs and meet the required rate of return[1]. The LCOE is measured in dollars per megawatt-hour ($/MWh).

$$\text{LCOE} = \frac{\text{(Annualised Capital Expenditures (CapEx) + Annualised Operational Expenditures (OpEx) + Annualised Financing Expenditures)}}{\text{Annual Energy Production (AEP)}}$$

$$\text{AEP} = \text{Installed Capacity} \times \text{Capacity Factor} \times \text{Hours Per Year}$$

- CapEx represents costs incurred in construction until commercial operations begin and is measured in dollars per kilowatt ($/KW). This includes equipment costs (e.g. turbines), non-equipment construction costs (e.g. substructure and foundation, facilities, security, assembly and installation, electrical infrastructure, engineering management), pre-construction costs (e.g. permitting, application, siting and seabed lease), and other financial costs (e.g. taxation, decommissioning bond, contingency).

[1] *Bloomberg NEF, Assessed: 21 August 2024, https://about.bnef.com/blog/2h-2023-lcoe-update-an-uneven-recovery/*

- OpEx represents the costs incurred thereafter associated with operations and maintenance, measured in dollars per kilowatt yearly ($/KW/yr). Fixed O&M costs do not change with level of production (e.g. administrative, lease contract costs, insurance, wages), while variable O&M are costs that vary with the level of production (e.g. ad hoc maintenance). There are no fuel costs associated with wind energy.

- Financing expenditures include the cost of debt, the annual principal repayment with interest, and equity, calculated as an annual required return as a percent of the total equity invested (Equity IRR).

- AEP is the total amount of energy produced by the wind farm in a year, measured in megawatt-hours (MWh), reflecting the installed capacity and capacity factor. Wind speeds are typically the biggest determinants of the capacity factor.

Although BNEF's LCOE includes corporate taxes, it excludes all subsidies and incentives. It also excludes costs of grid connection and transmission given there is an assumption that all energy technologies will need to pay equivalent costs, as well as other possible externalities, such as social and environmental costs.

This report extracted LCOE data for fixed-bottom offshore wind obtained from BNEF from mature markets, including the United Kingdom, Netherlands, United States, Germany, for the time period of 2014-2023.

CapEx is highly correlated with market maturity as shown in Figure 1.

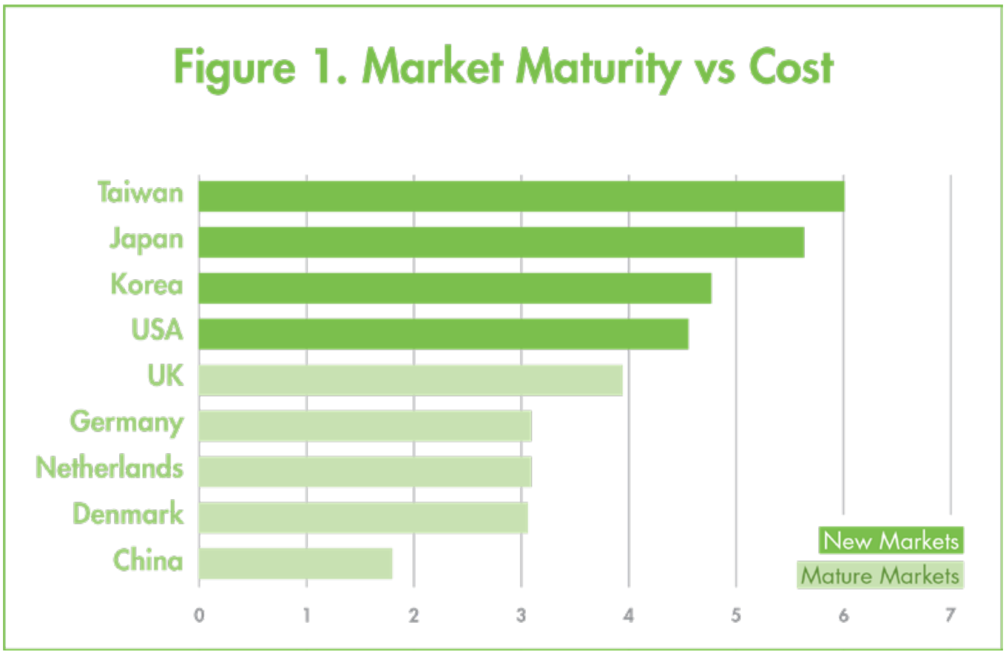

Figure 1.
Market Maturity vs Cost
Source: BNEF 2023 2H Data

It is important to note that there is a limitation on the data provided in newer markets, such as Japan, South Korea and Taiwan. However, it is assumed that the projections and shifts in the cost curve for these markets will follow the trends seen historically in mature markets, i.e. that after the first few GW of installations, prices tend to dramatically drop.

3. Drivers Affecting LCOE

LCOE is driven by a range of factors including macroeconomic conditions, supply chains, market maturity as well as technological advancements and innovation.

For example, the development of larger turbines has been a major factor in driving down the per megawatt (MW) cost of offshore wind. Larger turbines reduce the cost of foundations, installation, and maintenance per MW, while capturing more energy by reaching higher into the wind field. This increased efficiency per MW installed lowers the overall LCOE.

Macroeconomic Conditions

Monetary policy across the APAC region has been significantly influenced by the global economic fallout from the Russia-Ukraine war. Central banks faced the dual challenge of managing rising consumer inflation driven by surging energy and commodity prices, while also supporting economic recovery from the COVID-19 pandemic[2]. Monetary tightening, following the U.S Federal Reserve's repeated increases of interest rates, took place in major APAC economies such as South Korea, India, Singapore and Thailand[3]. This resulted in increased costs of borrowing, which directly impacted the LCOE by raising overall financing costs.

Macroeconomic trends over the past four years—such as rising inflation, increasing interest rates, and supply chain disruptions—caused volatility and price increases in all technologies in the power sector. However, the offshore wind industry (and all RE), with the upfront nature of its costs (as there is no "fuel" in the LCOE analysis) was particularly hard hit.

Despite recent market fluctuations, there are signs of stabilisation as central banks ease inflation-control measures and governments introduce supportive policies. Notably, initiatives such as the U.S. Inflation Reduction Act have helped to reduce risks and enhance the financial viability of projects. With these policies in place, investor confidence should remain strong, as the long-term growth outlook for offshore wind remains positive.

However, supply chain costs, inflation and interest rates have declined since their peaks over the last few years, but still remain high compared to history. In addition, governments have implemented many supportive policies like the USA's Inflation Reduction Act, the European Union's REPower EU plan, and others. In general, GWEC believes that the offshore wind industry has a bright future, but some cost challenges remain.

[2] S&P Global, Economic Research: Asia Pacific Economic Risks, Thy Name is Inflation, Assessed: 21 August 2024, https://www.spglobal.com/ratings/en/research/articles/220328-economic-research-asia-pacific-economic-risks-thy-name-is-inflation-12322259

[3] Nikkei, Assessed: 22 August 2024, https://asia.nikkei.com/Business/Business-Spotlight/Asia-s-rising-interest-rates-boost-banks-but-risks-grow-for-2023

Secured Overnight Financing Rate as an Interest Rate Indicator

The Secured Overnight Financing Rate (SOFR) is published by the Federal Reserve Bank of New York and is a benchmark interest rate that reflects the cost of borrowing cash overnight using U.S Treasury securities as collateral and is based on actual U.S dollar-denominated transactions. The primary driver of the SOFR is the Federal Reserve's monetary policy, meaning that when the Fed raises or lowers its interest rate target, SOFR typically follows a similar pattern. We discuss SOFR here as it replaced LIBOR (London Interbank Overnight Rate), an international benchmark that has been used in many US$ financings internationally.

Figure 2.

Secured Overnight Financing Rate Chart from 2018-2024

Source: New York Federal Reserve [4]

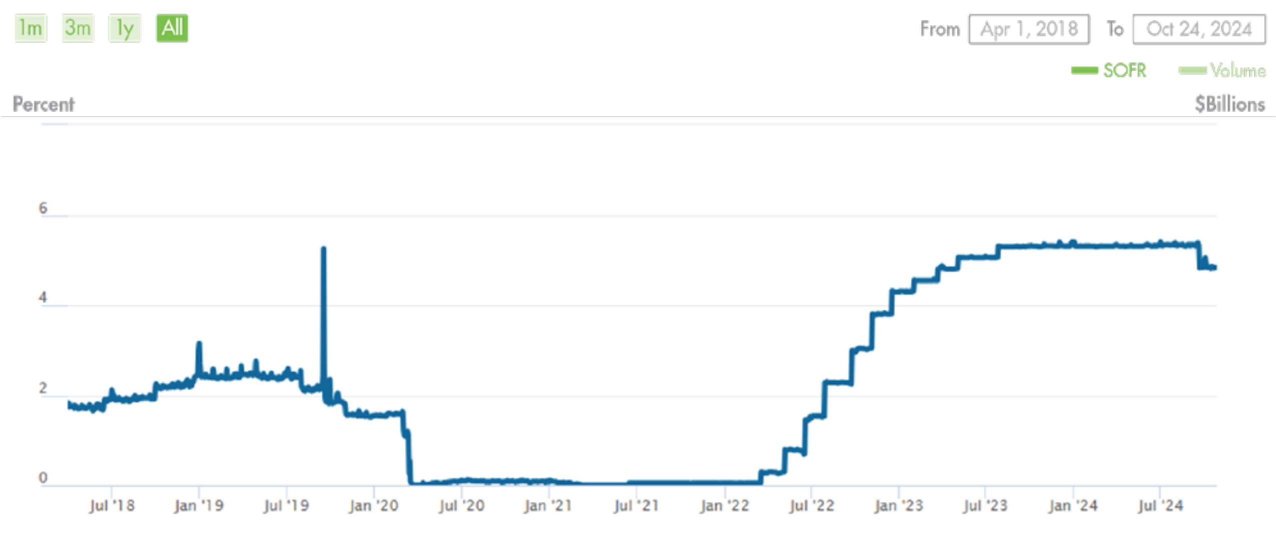

Figure 2 highlights the significant fluctuations in the SOFR since its inception in 2018. Whilst record lows were experienced during the COVID-19 pandemic, a sharp rise can be seen from 2022-2023. By the end of 2022, SOFR had risen to approximately 4.3%, a direct reflection of the Fed's interest rate hikes. This trend continues into H1 of 2023, where SOFR surges to over 5%. Even with recent declines, rates remain stubbornly high compared to recent history.

Offshore wind is a highly capital-intensive industry. Projects are typically financed with a 70%/30% split between debt and equity. For individual 1 GW projects, this translates to approximately USD $2 or more billion in debt financing. A risk premium is typically added to cover the elevated real and perceived risks of emerging markets like Vietnam and the Philippines. The rise of interest rates, and the up-front nature of costs in the offshore wind industry, makes such large-scale borrowing significantly more expensive than in the earlier lower interest rate environment. In the US markets offshore wind costs are estimated to be 30-50% higher than in 2021. In the UK market, costs are around 40% higher than pre-Ukraine War.[5] A general rule is that a 1% increase in interest rates increases LCOE by 8%.

[4] *New York Federal Reserve, Assessed: 29 October 2024, https://www.newyorkfed.org/markets/reference-rates/sofr*

[5] *Bloomberg NEF, Assessed: 22 August 2024, https://about.bnef.com/blog/soaring-costs-stress-us-offshore-wind-companies-ruin-margins/*

Commodity Index as a Commodity Price and Inflation Indicator

Various commodity price indices track the price movements of various commodities, including energy, metals, and agricultural products. When commodity prices increase, costs of raw materials rise, which leads to increased expenditures for projects.

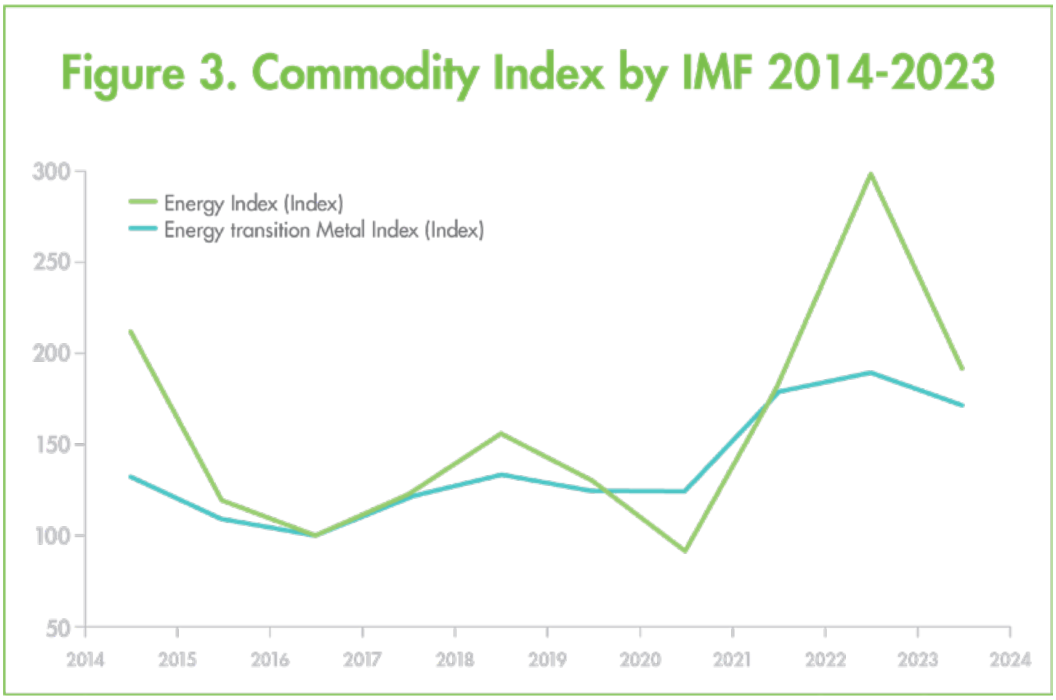

Figure 3.
Commodity Index by IMF 2014-2023
Source: IMF, 2024

Figure 3 shows that the IMF Commodity Price Indices have experienced significant volatility over the past few years. A continuous spike from H2 of 2020 to H1 of 2022 can be attributed to the economic recovery from the COVID-19 pandemic, but more importantly to the Russian invasion of Ukraine in 2022. The war caused the skyrocketing of energy and commodity prices, especially of natural gas and oil, as well as agricultural products such as wheat and corn due to supply disruptions[6], all of which contributed to increased inflation. By H2 of 2023, the index cooled, demonstrating signs of stabilisation, although commodity prices remained higher than pre-pandemic levels. Lingering effects of the war and continued supply chain disruptions contributed to this.

The volatility of commodity prices directly affects offshore wind capital and operational expenditures, given commodities like steel, copper, and rare-earth minerals are essential components for the construction of wind turbines, foundations, and cabling, among other items.

The height of global supply chain constraints and impacts of the Russia Ukraine war were most felt in the wind industry in 2022. As commodity prices cooled in 2023, the costs of new-build offshore wind projects fell, marginally (2%). Bloomberg NEF analysis highlights that by June 2023, the global LCOE for offshore wind was on par with coal[7].

[6] *World Bank, Assessed: 6 September 2024 https://blogs.worldbank.org/en/developmenttalk/commodity-prices-surge-due-war-ukraine*

[7] *Bloomberg NEF, Assessed: 6 September 2024 https://about.bnef.com/blog/cost-of-clean-energy-technologies-drop-as-expensive-debt-offset-by-cooling-commodity-prices/*

Figure 4. Global Levelised Cost of Electricity (2009 - 2023)

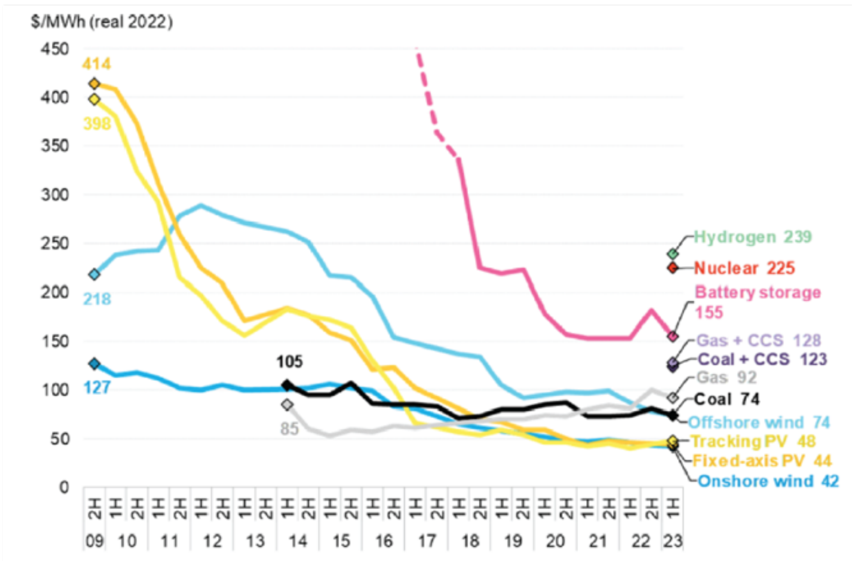

Figure 4.

Global Levelised Cost of Electricity (2009 - 2023)

Source: Bloomberg NEF

Market Maturity

National offshore wind policies and regulation, including market design and level of market maturity (policies, supply chain, workforce, etc.), affect LCOE.

In countries where prescriptive local content requirements are implemented, developers may face high costs if the local supply chain is not mature and well established. Requirements on a high percentage of materials sourced locally typically raise CapEx if the country lacks existing manufacturing capabilities or has not yet developed a skilled workforce specific to offshore wind. These requirements may also be perceived as additional risks to investors and make projects less attractive, which could drive up the risk premiums and cost of financing. In emerging markets for offshore wind where supply chain gaps still persist and infrastructure is limited, benefits that could be accrued through economies of scale, industrialisation and economic clustering can also prove to be more challenging.

Unclear, inefficient or the lack of policy and regulatory frameworks, as well as policy support mechanisms (often the case in emerging markets), can also push up risk premiums. For example, if permitting and leasing regimes are not streamlined, project delays may occur and drive-up costs.

To mitigate the 'emerging market' challenges related to policy and regulation, many options exist to incubate the capabilities required to reduce risks (or perceived risks). These options include pilot mechanisms to facilitate the commercialisation of offshore wind projects, accelerating their development prior to, or concurrently to that establishment of a comprehensive two-stage process in the market. An incubation of the first few GW of projects could allow for a stark decrease of LCOE after the first few GWs, as shown in Figure 5.

Figure 5. LCOE Reduction Across Project Development Phases

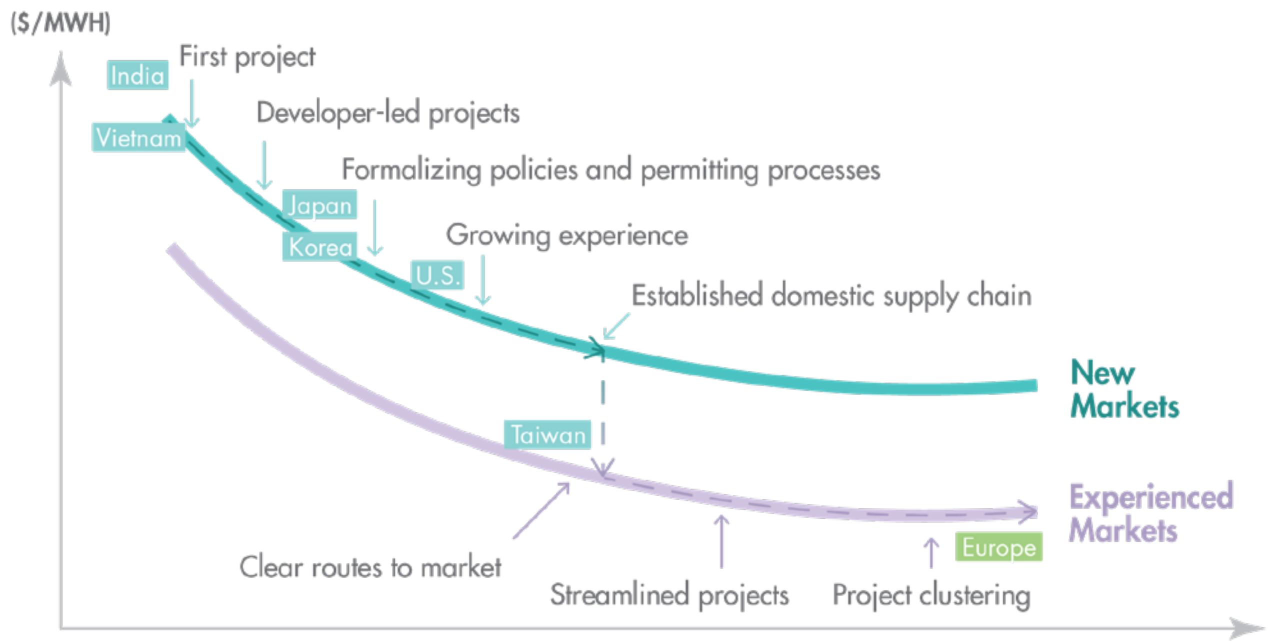

Figure 5.

Source: GWEC, BNEF

Figure 4 displays the evolution of cost in comparison to the maturity of a market. In new markets LCOE is typically higher, where early projects build in-market technical, regulatory, legal and financial capabilities and begin to build the supply chain. As the market develops and gains experience, costs typically fall. A phase change often occurs as market confidence builds, full competition occurs and lower-cost financing is achieved by reduced real and perceived risk perceptions.

4.

Offshore Wind LCOE Comparison

2014 - 2024: Significant Reduction in LCOE as Installations Increase

The LCOE for offshore wind farms in the United Kingdom, Germany and the Netherlands from 2014 to 2024 is illustrated in Figures 6, 7 & 8 below, all measured in USD per MWh. The countries have similar capacity factors at 50%, 46% and 46% respectively. There is steady decline in LCOE in all of the sample countries with two significant cost reduction shifts highlighted.

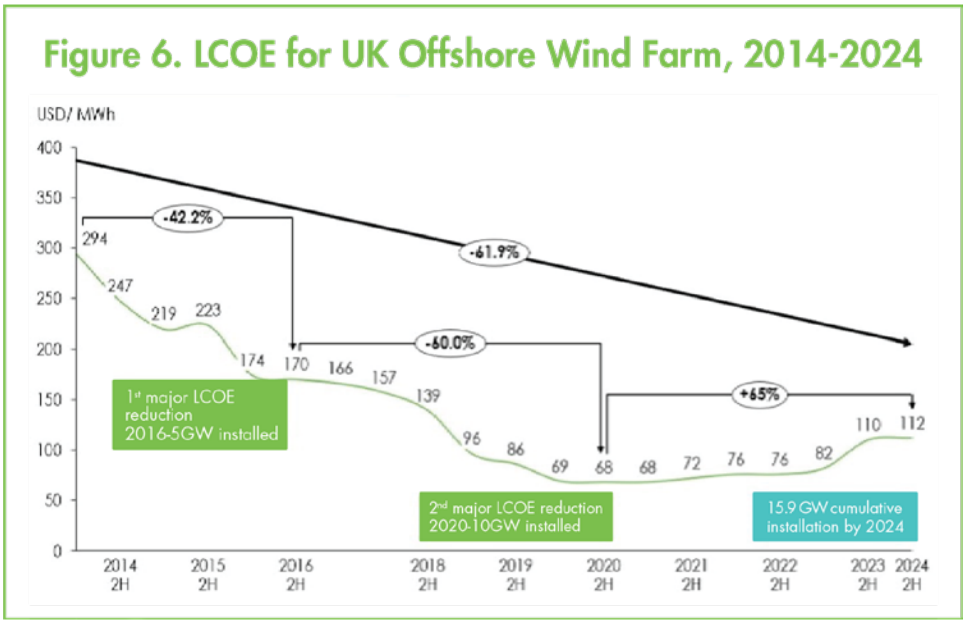

Figure 6.
LCOE for UK Offshore Wind Farm, 2014-2024
Source: BNEF

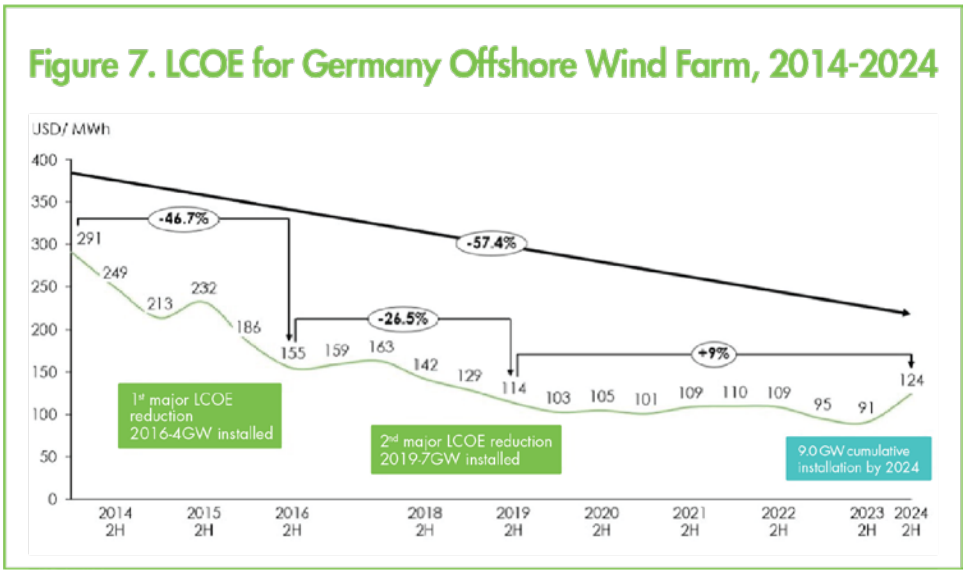

Figure 7.
LCOE for Germany Offshore Wind Farm, 2014-2024

Source: BNEF

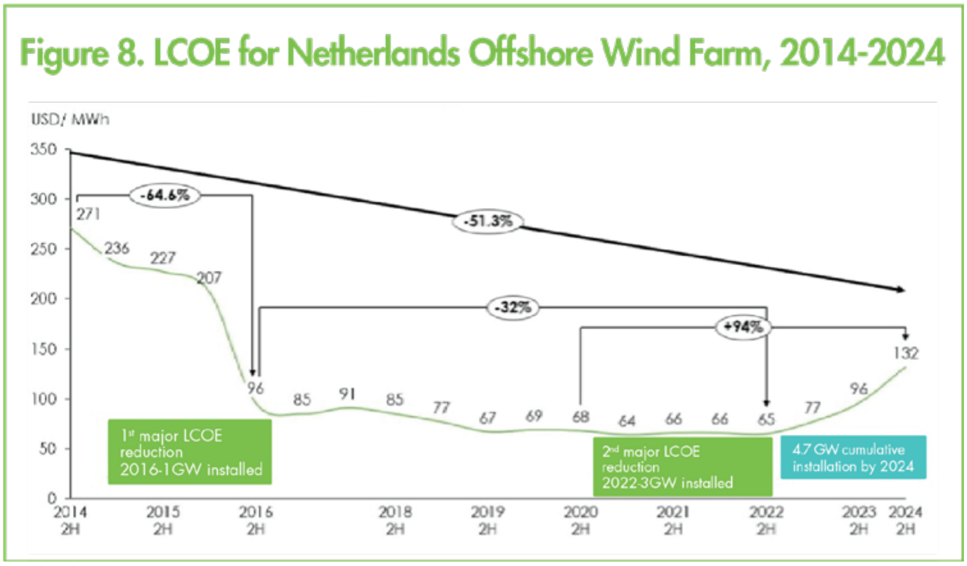

Figure 8.

LCOE for Netherlands Offshore Wind Farm, 2014-2024

Source: BNEF

The United Kingdom experienced the most significant drop in LCOE of 61.9% during this period, from USD 294 / MWh in early 2014 to USD 112 / MWh by the second half of 2021. The first shift occurred by 2016, where a substantial reduction of 42.2% occurred and LCOE reduced to USD 170 / MWh after just 5 GW of new offshore wind installation capacity. A further reduction 60% in LCOE occurred by 2020, bringing it down to USD 68 / MWh. This coincided with another 5 GW of new installations, largely supported by cohesive offshore wind policy. Similar trends are shown in the Netherlands as well as Germany, where the first shift is likely attributed to leveraging economies of scale in supply chains, and the second shift for further advancements in technology, larger turbines and improved project management to reduce installation and operation costs. Further, effective auction designs through competitive bidding processes had also contributed to driving down costs and delivering volume, for example the separation of technologies in the UK government's Contract for Difference (CfD) auctions.

2020 - 2024: Overall Cost Reduction Impacted By Macroeconomic Conditions

As described previously, macroeconomic conditions directly affect LCOE. When assessing the LCOE of offshore wind farms from 2014 to 2024 in the United Kingdom, Germany and the Netherlands in Figures 6, 7 ,8 the macroeconomic effects from 2020 to 2024 are demonstrated clearly as a key driver of LCOE. However Figure 6 highlights the LCOE for the United Kingdom stabilising from 2023-2024.

In all sample countries, there is a slight spike in LCOE that occurs around 2021 to 2022, likely caused by commodity prices increases resulting from the Russia-Ukraine war, as well as supply chain challenges post-COVID. From 2020 to 2024, LCOE rose for both the United Kingdom by 65% as well as the Netherlands by 94%, whilst Germany experienced less of an increase of 9% in LCOE.

In the UK, the recent Allocation Round 5 (AR5) resulted in no bids for offshore wind largely due to administrative strike prices failing to take account of cost increases in the last 2-3 years. Allocation Round 6 (AR6) for offshore wind in the UK announced in September 2024 saw notable developments, reflecting the challenges and adjustments required, including for inflation, to support the sector amid rising costs. Following the disappointing outcome of AR5, AR6 introduced higher Administrative Strike Prices (ASP) to better align with escalating project costs. The ASP for fixed-bottom wind rose from £44/MWh in AR5 to £73/MWh in AR6, offering more realistic financial incentives to developers[8]. Additionally, the UK government has raised the total budget for offshore wind, providing £1.1 billion for fixed-bottom projects. This shift in AR6 demonstrates the increasing pressure to balance costs with the need to accelerate renewable energy deployment to meet the UK's climate goals, currently set at 60 GW by 2030[9].

[8] *ORE Catapult, Allocation Round 6 (AR6) Results and Analysis. Assessed on 12 October 2024*

https://ore.catapult.org.uk/resource-hub/blog/allocation-round-6-results-and-analysis

[9] *WindEurope, Assessed on 12 October 2024. https://windeurope.org/newsroom/news/new-uk-government-plans-big-push-on-wind/#:~:text=The%20new%20UK%20Government%20is,fully%20decarbonise%20electricity%20by%202030.*

5. Conclusion

In conclusion, while offshore wind LCOEs have faced considerable pressure over the past three years due to rising raw material costs, inflation, higher financing expenses, and supply chain disruptions, the worst of these macroeconomic headwinds now appears to be behind us. Policymakers are increasingly attuned to market conditions and are actively crafting solutions to support the industry. In mature markets like the UK, Germany, and China, offshore wind continues to demonstrate strong cost competitiveness relative to other energy technologies. Although the sector remains capital-intensive and sensitive to economic fluctuations, emerging APAC markets are poised to replicate the cost reduction trajectories seen in more established regions. This will be driven by expanding installed capacity, economies of scale, enhanced supply chain efficiencies, and the implementation of supportive regulatory frameworks, all of which will play a pivotal role in sustaining the industry's growth and resilience.

For any questions, please contact:

Janice Cheong
Deputy Director - Asia Policy Advocacy
janice.cheong@gwec.net

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