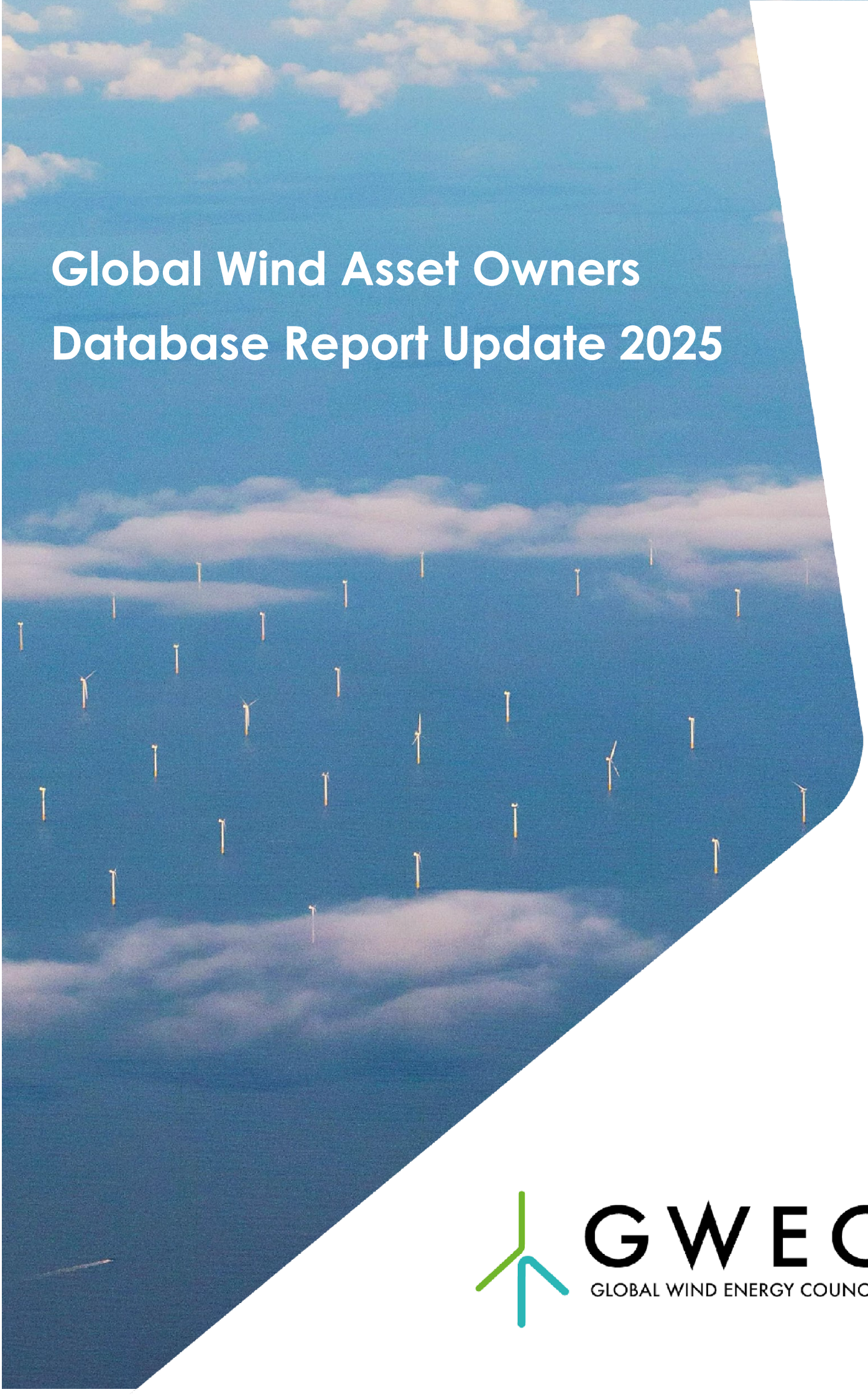

Global Wind Asset Owners Database Report Update 2025

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I. INTRODUCTION

Globally, with new installations reaching 117 GW and the cumulative installations reaching 1,136GW by the end of 2024, the wind industry has achieved scale and become mature. Wind is increasingly being seen as a solution to not just climate change, but energy security, economic development, and the creation of quality jobs. Wind is now competitive, affordable, and predictable in price (compared to the volatility of hydrocarbons) and chosen by many governments and companies for investment.

The imperative to reduce both pollution and national dependence on foreign fuel supplies means that political pressure is mounting on energy generation companies to integrate renewable energy (RE) in the supply mix. That pressure greatly increased in 2015 when 195 countries committed to the Paris Agreement, reached in December at the 21st meeting of the Conference of Parties (COP) under the UN's Framework Convention on Climate Change. The agreement sent a clear and strong signal to the world that the global transition to clean energy is inevitable.

Countries accounting for nearly 3/4th of global CO_2 emissions and GDP have committed to reaching net zero (usually by 2050) in 2021-2022; many countries are now working on following through on those commitments. It became clearer than ever that the traditional global energy landscape is changing, and the global energy transition is here to stay.

With all those commitments, however, global CO_2 emissions grew to an all-time high in history in 2024 (IEA). Increased coal use and global shortfall in hydropower generation due to droughts were the main factors driving up emissions.

During COP29 in 2024, nearly 200 countries reaffirmed their commitment to tripling global renewable energy capacity by 2030, aligning with the Paris Agreement's 1.5°C pathway. Specifically, for wind energy, this translates to increasing the total global installed capacity from approximately 1 TW to 2.75–3.5 TW by 2030, as projected by the International Energy Agency (IEA) and the International Renewable Energy Agency (IRENA) in their latest net-zero roadmap reports. However, under the current policy scenario, GWEC forecasts that we are only set to reach 2.1 TW of wind installed capacity by 2030.

The top 15 asset owners-operators accounted for 38% of total global wind power capacity installed by the end of 2024 (1136 GW), a 1% decrease from 2023.

While the large players continue to dominate global installations, will this continue? As increasingly more pressure is created by governments, corporates and industries (C&I) to decarbonize, will this bring even more players into the market and reduce

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the current dominance of the big players? It is going to be an interesting transition to watch, and GWEC will cover this topic in future reports.

There are currently no oil & gas companies in the top 15 globally (or in the top 10 for offshore). This situation is likely to retain as several major oil and gas players have recently scaled back their investments in renewable energy—particularly offshore wind—due to challenges in operating income and investment returns. The recent increases in hydrocarbon and other commodity costs, as well as high inflation, increased interest rates and supply chain challenges have really squeezed developers and OEMs. How long will this situation last? And what impact will they have on developer appetite to take on increased risks is yet to be seen? And will the dominant players be able to manage these risks better than the smaller players? GWEC Market Intelligence is following this closely.

II. TRENDS IN WIND ASSET OWNERSHIP

With more diversification of the ownerships and investors of wind assets, there are common drivers to invest in wind energy among the owners: stable investment with a predictable return over the lifetime of twenty or more years combined with a comparatively low risk profile. These drivers apply to greenfield investments in new capacity but also to the investment in already operating assets for the onshore and offshore wind market. See the table on the next page for a summary of the different types of asset owners, their motivations and some example companies in the category.

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Summary table:

Type of investors and asset owner	Motivation	Examples
Utilities active beyond their home market	Policy-driven motivation to integrate and increase the share of wind energy in the market's energy mix Due to the size of large utilities, balance-sheet financing is feasible, especially for offshore projects Offering sustainable supply opportunities to (retail) customers Willing to invest in home markets and abroad	Iberdrola, NextEra, EDP, EDF, ENEL, RWE, Orsted, SSE,Vattenfall, EnBW, Enbridge, China Energy, SPIC, Huaneng, Huadian, Datang, CTG, CGN
Local utilities	Increasing share of wind energy for their local portfolio Seeking attractive investment opportunities with stable returns	Stadtwerke München (Germany), Duke Energy (USA), Eneco (Netherlands), TaiPower (Taiwan)
Independent Power Producers	Seeking long-term purchase agreements with offtakers Focus on greenfield development of projects to own projects over the majority of the project lifetime Willingness to open markets	Acciona, Mainstream Renewable, RES, Parkwind, Invenergy, Northland Power, Pattern Energy, Eurus Energy, CR Power, Eurus Energy, RENOVA
Community/ citizen-owners	involvement of local community along side with an investment opportunity for small-size investors Very low risk appetite and require high involvement of developer/ operator Focus on greenfield small-scale projects in the mature onshore markets	Community-based wind development is spreading in countries in Europe and in the U.S., Canada
Global oil companies	Broaden portfolio and alternative investment opportunity compared to existing portfolio in the oil business Utilising existing capabilities, e. g. large-scale project management and working in deep water, for offshore wind, but also interested in onshore wind	Equinor, Shell, TotalEnergies, BP, Eni, Petronas
Regional oil companies	Similar to global oil companies, utilising local opportunities to broaden portfolio of assets	CNOOC (China), Petrobras (Brazil). Gulf Energy (Thailand)
Institutional investors (pension funds/ insurance funds)	Entering projects in different development stages, often close to COD, with small stake and willingess to increase stake over project lifetime	PensionDenmark, PGGM, Allianz, Munich Re, Caisse de Depot et Placement du Quebec
Infrastructure investors	Long-term investment opportunities with stable returns and low risk, also seeking opportunities in new and emerging onshore and offshore wind markets Similar to infrastructure investors, entering projects during different development stages with small stake-ownership and plan to increase share of ownership as project matures	Macquarie (Green Investment Group/Corio Energy), Borealis, Copenhagen Infrastructure Partner (CIP), Global Infrastructure Partners (GIP), The Renewables Infrastructure Group (TRIG)
Self-supply industrial end-users	Securing stable prices and steady supply by-passing public market conditions with possible shortage of supply and volatile prices Solid understanding of corporate's own energy needs and the business case provided by investing in wind projects Focus on onshore markets with market-based capacity-allocation mechanism (Green certificates, auction/tenders)	YPF (Argentina), Norsk Hydro (Norway)
Sovereign wealth funds	Long-term investment with low risks Investments must comply with wealth funds' missions in terms of social responsibility and sustainability	Masdar (Middle East), Norwegian Government Fund (Norway)
Private equity companies	Higher risk profile compared to institutional investors Evaluating investment strategy including exit point and optimization of value	Blackstone (USA), Partners Group (Switzerland)
Corporate investors	Long-term investment goals Securing stable supply over lifetime of the project Fulfilment of sustainability goals	Google, Facebook, IKEA, Amazon, Microsoft, BASF

Source: GWEC Market Intelligence, June 2022

Global

According to GWEC Market Intelligence, 117 GW of new wind power capacity was added into the power grid worldwide in 2024, bringing total installed wind capacity to 1,136GW (including 83.2 GW offshore wind) by the end of last year.

For the next six years 2025-2030, Global wind power installation growth will continue to rely on three market support mechanisms: 1) The 'grid-parity' scheme (China); 2) tax credit (PTC and ITC) and technology- neutral credits in the US; and 3) wind-specific, technology-neutral, renewable and hybrid auctions (Europe, Latin America, Africa & Middle East and Southeast Asia). In addition, corporate/private power purchase agreements (PPAs) will drive wind energy growth in 2025 and the next five years.

In 2024, global wind energy investment remained robust, though showing a mixed trend between offshore and onshore segments. Investment in onshore wind reached approximately $69 billion, reflecting a modest decline from previous years due to permitting delays and grid connection constraints in Europe and North America. Offshore wind investment totalled around $31billion, down from record levels of 2023, partly offset by project cancellations in the United States.

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Despite these fluctuations, wind energy continues to be a core component of global renewable energy expansion. Relying on the strong growth in China, the Asia-Pacific region represented over half of global wind investment in 2024. Investment levels in the United States remained relatively stable, whereas Europe experienced a slowdown.

While global wind energy financing has reached significant levels, it remains below the scale required to align with the 1.5 °C or net-zero pathway by 2030, highlighting the need for accelerated deployment, streamlined permitting, and stronger policy support across all major markets. [1]

Rarely in history has such a rapid scale up of relatively new types of investments and technologies occurred at the speed that renewables and clean tech are seeing now. The energy crisis triggered by Russia's invasion of Ukraine has provided further impetus for this scale up for energy security. A key question: can the existing players scale up fast enough, or will there be openings for new players with new structures and business models ?

The answer is clear, to reach the tripling of renewables target by 2030 and long-term net zero targets, which require tripling of the annual global new wind installations over the course of the decade from the level achieved in 2024, existing investors need to accelerate the current investment in wind while new players need to be motivated to bring fresh "blood" into the sector.

North America

Despite a robust project pipeline, new onshore wind installations in the US dropped sharply in 2024, with less than 4 GW commissioned – the lowest level since 2014. The glacial pace of deployment reflected transmission constraints, higher interest rates, delays in electrical components, and the lack of clear tax credit guidance. According to the American Clean Power Association (ACP), nearly 16 GW of onshore wind was under construction and 9 GW in advanced development across 79 projects as of Q4 2024, with demand increasingly driven by data centres. While only a small portion of capacity sits on federal land, uncertainty created by President Trump's Executive Order and ongoing tariff risks continue to cast a shadow on development. GWEC Market Intelligence forecasts that 63 GW of onshore wind will be added in North America over 2025–2030, of which 88% will be in the US.

In offshore wind, North America remains the only region outside Europe and APAC with projects in operation. The commissioning of the 130 MW South Fork wind farm in 2024 brought the region's total capacity to 172 MW. As of May 2025, the US had 5 GW of offshore wind under construction across four projects. GWEC expects

[1] BloombergNEF (BNEF), *Energy Transition Investment Trends 2025*, January 30, 2025.

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that 13 GW of offshore wind capacity will be built in this region in the next ten years (2025–2034), with 92% in the US.

However, the sector has been hit by a "perfect storm" of inflation, high capital costs, and supply chain constraints. By early 2024, nearly 12 GW of fixed-bottom projects off the east coast were affected, with 7.7 GW cancelled outright. President Trump's suspension of new leasing on the Outer Continental Shelf and the looming risk of permit revocations for projects approved under the Biden Administration, such as Atlantic Shores, Revolution wind project, Maryland offshore wind project, New England Wind 1 and 2 wind projects, and South Coast wind project, have added further uncertainty. Against this backdrop, GWEC has downgraded its 2030 US offshore wind outlook to below 6 GW, compared with 15 GW in last year's forecast. Expected additions now rely on Vineyard 1, Revolution Wind, CVOW, Empire 1, and Sunrise. Even if a future administration reopens the sector, it will likely take several years to bring GW-scale projects online, leaving the medium-term prospects for US offshore wind highly uncertain. North America had 172 GW of wind power capacity in operation by the end of 2024, of which 90% is in the US. As of June 30, 2025, the US had 332.5 GW of clean power capacity in operation, enough to power more than 81 million homes.

Looking at the ownership structure of the existing wind assets in the US, it is concentrated heavily among the top owners. According to ACP 2024 annual statistics, the top 25 asset owner-operators controlled nearly 70% of total installed wind power capacity in the country. Of the top 25 companies, half are utilities and collectively they made up more than 60% of total installations in the US.

The main asset owners in the U.S. wind market remain long-established local companies and European energy firms US based companies such as NextEra Energy, AES Clean Energy, Xcel Energy and Southern Company continue to dominate the onshore wind sector. NextEra Energy Resources (NEER) operates approximately 119 wind projects across the U.S. and Canada, with a total of 21 GW of wind power in operation by the end of 2024 and is developing roughly 30 GW of additional projects expected to be online by 2029. Among European companies, Iberdrola (through its wholly owned subsidiary Avangrid), ENEL, EDP Renewables, RWE, ENGIE, Ørsted, and EDF Renewables continue to play a significant role. Iberdrola operates over 170,000 km of electricity transmission lines in the U.S., covering New York, Connecticut, and Maine, and through Avangrid generated approximately 13,000 GWh across 80 energy facilities in the first half of 2025 – enough to power 2.4 million households. Due to political and policy uncertainties, RWE announced in April 2025 the suspension of its offshore wind project development in the US. The North American power market can also be named as the most mature when it comes to corporate PPAs Corporate buyers have become an

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increasingly important driver of clean energy demand in the US.

According to the ACP 2024 Annual Market Report, PPA announcements in the US surged by 56% in 2024, reaching 42.4 GW of clean power contracts, driven in large part by increased corporate demand. Corporate and industrial (C&I) purchasers accounted for 39% of all new PPAs in 2024, up from 36% in 2023. Over the longer term, corporate buyers have consolidated their role as the second-largest group of clean power off-takers in the US, procuring 25% of all operating clean power capacity by the end of 2024, compared to 21% in 2023. Leading technology companies remained at the forefront, with Amazon, Microsoft, Meta and Google collectively contracting around 10 GW of clean energy last year, a volume nearly equivalent to the entire clean power capacity installed in the state of Florida.

Europe

Europe is accelerating renewables development to achieve energy security in the aftermath of Russia's invasion of Ukraine. The continent has started turning its ambitious targets into action. As of end of 2024, a total of 288 GW wind power capacity was installed in Europe.

Progress was also made in wind auctions in Europe last year. In 2024, Germany awarded a total of 11 GW of onshore wind capacity, nearly 72% more than in 2023. The UK also awarded 5.3 GW of wind capacity through CfD Auction Round 6. This progress is attributed to higher ceiling bid prices and the implementation of EU emergency measures aimed at streamlining permitting and accelerating renewable energy projects. However, the current pace of annual wind power auctions in Europe remains insufficient and must accelerate further if the EU is to achieve its energy security and climate targets. The European wind market has the highest level of maturity compared with other region, with owner and investor structures like North America. In this continent, utilities, including state-owned and smaller regional/local utilities, take the lead in wind project development together with IPPs and developers with their long-standing experience.

European Pension funds and institutional investors joined by their counterparts from North America and Australia have a solid position as they seek stable investment opportunities (PFA, PKA, Copenhagen Infrastructure Partners, PGGM, Caisse de Depot et Placement du Quebec, Macquarie).

Last year saw the overall renewable energy (RE) PPA market grow to around 19 GW in Europe in 2024; however, corporate PPAs did not see a substantial increase. They remained close to 5.2 GW, down from 10.4 GW in 2023, with the decline largely driven by a significant reduction in contracted volumes under utility (non-corporate) PPAs.

Moreover, with the goal of reducing price volatility for consumers and accelerating investments in renewables, EU Legislation is in

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progress to reform the EU electricity market. EU Wind Power Package is further expected to have a positive impact on permitting, finance, and auctioning mechanisms, crucial aspects for expanding wind energy and reinforcing European energy security. In the UK, the new elected government has just lifted the ban on onshore wind which means additional growth will come from UK's onshore upcoming wind auctions.

Europe, the birthplace of the offshore wind industry, has a total of 37 GW offshore wind capacity installed by the end of last year. Last year, Europe awarded 23.2 GW of offshore wind capacity, of which 8 GW was from Germany, 5.3GW from the UK, 1.6GW from Norway and 0.75GW from France.

Additionally, at least 37 GW of new offshore wind auctions capacity is expected to be announced between 2025-2030 according to GWEC Market Intelligence's offshore wind project database.

For the European offshore market, the trend is toward more joint ownership and investment. In the earlier days, utilities such as Ørsted, Vattenfall and RWE took on offshore projects financing through their balance sheets. As offshore wind in Europe is proving its position as a large-scale and cost-competitive energy source, utilities are joined by institutional investors, for example, Global Infrastructure Partners (now BlackRock) and Copenhagen Offshore Partners, Sovereign wealth funds like Masdar & NBIM, and big oil companies such as Shell, Equinor, TotalEnergies and Eni and BP.

China

In China, the world's largest wind power market, wind energy assets are predominantly controlled by state-owned power enterprises. Among the top 10 wind farm owners and operators in China, nine are state-owned companies. As of the end of 2024, these enterprises accounted for over 62% of the country's total wind power installed capacity—a dominance that is expected to persist going forward.

This centralized development model has significantly driven large-scale growth of China's wind power industry. One of its most notable outcomes is the rapid increase in renewable energy installations. By the end of July 2024, the combined installed capacity of wind and solar power in China reached 1,206 GW, achieving—six years ahead of schedule—the country's Nationally Determined Contribution (NDC) target of "over 1,200 GW of wind and solar capacity by 2030." The NDC also includes a goal for non-fossil fuels to account for 25% of primary energy consumption by 2030.

In Feb 2025, a new policy jointly issued by the National Development and Reform Commission (NDRC) and the National Energy Administration (NEA)—known as Document No. 136—mandates the full marketization of feed-in tariffs for new energy projects. While this policy may bring short-term disruptions to wind developers (e.g.,

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impacting financing and requiring recalibration of financial models), it reflects an inevitable shift toward market-based electricity pricing, which is expected to support the long-term health of the industry as grid-connected capacity grows.

As of the end of April 2025, China's total installed renewable energy capacity had risen to 2,017 GW, marking a year-on-year increase of 58%. Of this, wind and solar power installations reached a combined 1,530 GW—surpassing coal-fired power for the first time in history. Offshore wind capacity alone reached 43.51 GW, maintaining China's global lead in both annual additions and cumulative installations for four consecutive years. China now accounts for more than 50% of the world's total installed offshore wind capacity.

Although the central government ceased national subsidies for offshore wind in 2022, certain provinces—such as Guangdong, Shandong, and Zhejiang—have continued to provide limited local fiscal support over the past two to three years. In addition to the six central SOEs with offshore wind portfolios (with China National Nuclear Corporation joining in 2025), provincial energy groups such as Guangdong Energy, Zhejiang Energy, and Guangxi Energy are playing key roles in the sector's stable development.

With its vast market potential, China's offshore wind sector has also attracted non-Chinese investors. For instance, EDF acquired equity in two Chinese offshore wind projects (500 MW) in 2019 and signed a cooperation agreement with China Energy Investment Corporation in 2023 to co-develop an energy island project. Meanwhile, BASF and Mingyang have begun constructing a 500 MW offshore wind farm in Guangdong. The two companies have also signed an MoU to promote cooperation in Power-to-X technologies as well as materials and technological innovation.

Latin America

Total wind installations have reached 56 GW by the end of 2024 in LATAM, 60% of it is in Brazil. Wind assets in this region are mostly owned by utilities, both international and national, and IPPs. As wind power has had very competitive prices in the region (thanks to the excellent wind resource) and public auctions organized by governments have slowed down in recent years (like Brazil, Mexico and Argentina), capacity is increasingly allocated outside the regulatory schemes in so-called "private auctions" or long-term "private PPA's scheme" pushing the growth of C&I owners share in certain markets (e.g. MATER in Argentina, private PPAs in Brazil and the former self supply scheme in Mexico). However, state government-controlled assets ownership is strongly present in Uruguay by UTE, and to a smaller extent in Mexico, where the Federal

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Electricity Commission (CFE) owns and operates a couple of projects.

LATAM's listed IPPs and utilities have been leading the onshore wind M&A activity since 2020. A strategic shift towards corporate investments (PPAs) and platform takeovers for large development pipelines are driven by growing investor and institutional confidence in the region especially in Brazil. In the region, regional entities like Omega Energia are targeting operational assets and international firms like AES acquired development assets. Utilities like EDF are becoming the primary acquisition targets due to their mature projects up for divestments. On the other hand, Private Equity firms like KKR acquire operational assets for immediate revenue and early movers like Brookfield are divesting initial investments.

The level of uncertainty due to regulatory risk is increasing in the major markets (Brazil and Mexico) in which changes of rules, lack of grid infrastructure investments and increasing curtailments are changing the investment dynamics seen in the former years. GWEC Market Intelligence expects 32 GW of onshore wind to be added in this region in the next five years (2025 – 2030 period) and believes that private/corporate PPAs will continue to be one of the key growth drivers in this region. Overall, the role of international utilities and IPPs in emerging and developing markets as owners and investors of assets is crucial. They are not only responsible for the largest share of capital flowing into the region, but their experience and insights, e.g. in bringing projects through the complicated permitting process, also enable new opportunities for wind energy. There is a strong collaboration in many of the most relevant Latin America markets where IPPs and developers are working closely with the regulators to define solutions best suited to the specific markets.

III. GLOBAL TOP 15 WIND PLANT OWNER-OPERATOR RANKING

The dominance of power generation companies as the key players in wind plant ownership has grown in the past 10 years, especially as wind has become one of the cheapest and reliable energy sources and governments have recently stepped-up policies and mandates in support of low carbon development to address the twin challenges of ensuring secure and affordable energy supplies and meeting climate targets.

The chart lists the world's top 15 wind farm owner-operators. Established energy utilities, many of which are state-owned power generators in China, have shown most interest in wind power investment.

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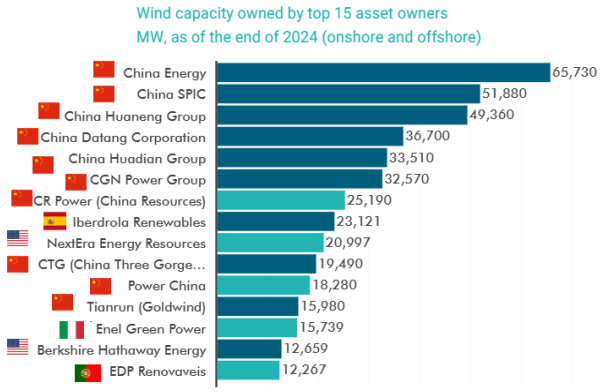

Source: GWEC Market Intelligence, August 2025

By the end of 2024, the top 15 wind farm owner-operators held 38% of total 1. 13 TW onshore and offshore assets. Of their total owned wind assets, 7.8 % was offshore wind.

China Energy continues to be the world's largest wind asset owner and operator followed by China SPIC, China Huaneng, China Datang corporation, China Huadian Group, China CGN Power Group, China Resources, China Three Gorges Corporation and Power China. The non-Chinese top asset owners active globally include - Iberdrola, NextEra, Enel Green Power, Berkshire Hathaway Energy and EDPR.

With China being the largest wind market and its carbon neutrality commitment, it is no surprise that Chinese utilities continue their dominance in the top 15 ranking of wind asset owners (10 of the top 15 in 2024 and 2023, up from 9 in 2022 and 8 in 2020).

Although half of Chinese utilities on the top 15 list own wind assets in Europe, most of the assets held by the 10 Chinese state-owned power generators are in Asia Pacific, and the vast majority of those are in China.

Nevertheless, Chinese ownership of overseas wind assets is expected to increase because of the country's "Belt and Road" foreign policy initiative to revive the centuries-old trading routes linking Asia, Europe, and Africa. The related Silk Road Infrastructure Fund and Asia Infrastructure Investment Bank are expected to provide financial support to assist Chinese state-owned EPC contractors and energy investors/developers to build energy infrastructure abroad.

GWEC Market Intelligence foresees a continuous dominance by the Chinese asset owners of the global wind assets, as the Chinese onshore and offshore market is expected to stay strong over the next decades.

IV. STRATEGIC TRENDS OF LEADING WIND PLANT OWNER-OPERATORS

The GWEC Market Intelligence team has been closely following the market trends in the asset owner-operator sector. This section gives a snapshot of the latest strategies pursued by medium and large asset owner operators in order to stay in the game.

a) Merger and acquisition

Merger and acquisition - merging with competitors, acquiring operating assets and project pipelines from competitors or the entire fleets owned by competitors- remain an important inorganic growth strategy for large wind project developers, operators,

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and owners, complementing their organic growth.

Two decades ago, several European utilities and industrial groups entered the wind sector through acquisitions of pure play wind companies. Indeed, many European utilities, including Iberdrola Renewables, EDF Energies Nouvelles and E. ON Renewable (RWE), relied on mergers and acquisitions (M&A) to expand their existing wind project portfolios and to enter the North American market.

As the market matured, the trend in M&A activities continues.

Key examples of such Mergers and acquisitions (M&A) from the year 2024 include:

- Bridgepoint acquired stake in Windar Renovables and acquisition of Energy Capital Partners;
- CIP acquired US-based onshore wind developer Liberty Renewables;
- Repsol acquired ConnectGen (has 20 GW RE projects in pipeline) to enter US onshore wind market;
- Hydro Rein acquired 80% stake in 2.4 GW of wind power projects from IOWN Energy;
- Enel acquired Julia Creek Renewables Project in Queensland;
- Eolus acquired SeaSapphire for floating offshore wind;
- Mitsubishi acquired 20% stake in European Energy (has 60 GW RE pipeline);
- Octopus Energy invested in Partners Group project and Germany and UK offshore wind projects;
- Masdar enters Greece through 67% stake in Terna Energy;
- Infroneer Holdings acquired Japan Wind Development from Bain Capital.
- TotalEnergies acquired European wind and solar developer VSB Group in 2024, boosting its renewable energy portfolio in Europe. VSB holds over 15 GW of projects, strengthening TotalEnergies' presence in Germany.
- Sitka Power acquired renewable energy and battery storage assets from Saturn Power. This deal highlights the trend of combining wind energy with battery storage to enhance grid flexibility.
- Oil giant BP and Japan's largest power company, Jera, completed the merge of their offshore wind turbine businesses into a new independent company called Jera Nex BP in 2025. The assets of the new company consist of 1 GW of commissioned capacity, a pipeline of development projects of around 7.5 gigawatts and secured lease rights to land with the potential to install 4.5 GW of capacity.
- Equinor acquired 10% stake at Ørsted in October 2024 and became the second largest shareholder of Europe's largest offshore wind asset owner-operator.

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M&A help to go global, by tapping into clean power generation demand growth opportunities. The past decade saw large European utilities, IPPs and investors expanding their portfolio, including offshore wind in emerging markets such as eastern Europe, Latin America, and Asia Pacific. This means applying the competencies, capabilities, knowledge about cost structures, off-taker agreements and overall experience in a new and developing market setting which clearly benefit regulators, governments and local players in market development, or vice versa. For example:

- Brookfield Asset Management acquired Banks Renewables in UK, partnered with Axis Energy Ventures to create a RE development platform in India and it is also set to acquire majority share in Leap Green Energy in India.
- 100% acquisition of Alianca Geracao de Energia by Vale in Brazil;
- Octopus Energy acquired Deep Wind Offshore (in Nordics) to enter Norway and South Korea;
- Sembcorp Industries acquired Gelex Group subsidiary in Vietnam.
- Masdar acquired a 67% stake in Terna Energy (Greece) in June 2024 for €3.2B, marking its entry into the Greek renewable market. In October 2024, the UAE-based investor also acquired Saeta Yield from Canadian investor Brookfield Renewable, the deal enables Masdar to strengthen its footprint in the Iberian Peninsula.
- In April 2025, Potentia Energy has reached completion under the agreement with CVC DIF and Cbus Super to acquire controlling stakes in a portfolio of more than 1GW of renewable assets across Australia. The deal makes the Potentia, co-owned by Enel Green Power and INPEX, one of the largest renewable energy companies in the country.

In addition, repowering potential for aged assets also drive the onshore wind M&A activity in mature markets. For example:

- Statkraft acquired operational onshore wind assets and some with repowering opportunities in Ireland (from TRIG at 26% premium), France, Germany and Brazil;
- EDPR bought back a 49% stake in its ~1 GW onshore wind portfolio across Europe which has potential for hybridization and repowering of assets; and
- Exus in North America planning to repower the acquired assets from Oppidum Green Energy.
- TotalEnergies acquired a portfolio of 1.5 GW of onshore wind and solar projects in Poland from Polenergia in October 2024, including operational assets and projects

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with repowering and hybridization potential

NeXtWind acquired 12 operating wind farms in Germany (~140 MW) in January 2025, with plans to repower the portfolio to more than 300 MW. Furthermore, there is a recent surge in investor demand for integrated utility platforms in the US to get exposure of regulated business. For example, Global Infrastructure Partners (GIP) and CPP Investments acquired US utility and renewables developer, Allee.

M&A activities that took place in the past few years also show that private equity firms and privately funded companies have been significantly effective in the offshore wind sector compared with onshore wind. Mostly Private Equity (PE) firms and PE-backed companies have been the investment driving force in global offshore wind deals, with most M&A activities sealed in Europe and the US. For example, BlackRock acquired Global Infrastructure Partners (GIP) for $12.5bn, which includes large offshore wind projects and RE portfolio;

GWEC Market Intelligence expects that M&A activities will continue to stay strong going forward, driven by gradual coal phaseout, energy security, climate change goals and net zero commitments.

b) **Forming new strategies to address macroeconomic headwinds and political instability**

For the last couple of years, wind project development is witnessing macroeconomic challenges due to the dramatic increase in price inflation, elevated interest rates, and infrastructure (grid, port, logistics etc.) and supply chain constraints. These are in addition to slow-paced growth driven by the war in Ukraine and the subsequent spikes in natural gas prices led twin crisis: energy security + climate change. Due to these, many large and medium asset owners have changed the strategic mindsets for growth especially in Europe and US offshore wind. To navigate this "storm," developers are restructuring portfolios through PPA renegotiations, halting or ceasing project development, and divesting from select markets to prioritize opportunities with greater value potential and lower development costs. In the U.S., the outlook has become even more complex in 2025 due to policy uncertainty and shifting federal priorities. Offshore projects such as Ørsted's Revolution Wind have faced stop-work orders, legal disputes, and significant impairments, while players like National Grid and RWE have written down investments or paused projects amid unfavourable conditions. Combined with high financing costs, these regulatory and political headwinds have forced developers to reassess timelines, scale back investment plans, and adopt more cautious growth strategies.

For example, Ørsted, the world's largest offshore wind asset owner, has restructured its portfolio by divesting projects such as Changhua 2 in

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Taiwan and Hornsea 3 in the UK, while also announcing plans to exit its European onshore portfolio to sharpen its focus on offshore wind in Europe. Other major asset owners—including EDPR, Shell, bp, and Equinor—are likewise prioritising capital discipline and selective growth in response to rising costs and policy uncertainties.

Meanwhile, players such as Brookfield, Blackstone, Octopus Energy, Equitix Group, and Greencoat are concentrating on operational assets in mature European markets like the UK, Germany, and the Netherlands, reflecting a shift toward lower-risk investments. Spanish developer BlueFloat Energy abandoned its 2.5 GW Gippsland Dawn offshore wind project in Victoria this summer and exited all global operations after its shareholder, Quantum Capital Group, deemed continued offshore wind development commercially unviable in today's market conditions. One month later, Equinor also pull out of the 2 GW Novocastrian floating offshore wind project. Similarly, Statkraft has scaled back offshore ambitions by withdrawing from several international markets to concentrate on core geographies, while Vattenfall and RWE are actively reviewing their pipelines to balance investment returns against inflationary pressures and supply chain constraints. At the same time, investors such as Ingka Group and GIP are redirecting capital toward developmental assets in emerging markets, particularly offshore wind in the Nordics.

Company	Summary of strategic decision
BP	Announced a strategic shift in early 2025 to increase oil and gas spending and significantly reduce planned transition and renewables investments, with reported cuts exceeding US$5 billion
Equinor	Scaled back its renewables capacity target to 10–12 GW by 2030 (down from 12–16 GW) and reduced the share of capex allocated to renewables, citing market headwinds and a strategic rebalancing toward oil and gas.
Iberdrola	The company has significantly scaled back its green hydrogen ambitions, cutting its 2030 target from ~350,000 tonnes/year to ~120,000 tonnes/year, citing funding delays, regulatory uncertainties, and weaker-than-expected demand.
Orsted	Company has cut its 2030 investment programme by 25% and withdrawn its capacity target, booking DKK 16bn+ in impairments due to U.S. project delays. The company abandoned Denmark P2X and green hydrogen pilots, refocusing on core offshore wind and profitability amid regulatory and political risks in the U.S.
RWE	The company halted U.S. offshore wind development due to regulatory and political uncertainty, re-evaluating € 1.3 bn in U.S. offshore assets. It has also reduced capital expenditure by €10 bn (22%) through 2030.
Shell	The company booked US$996 million in impairments related to U.S. offshore wind projects, including Atlantic Shores, exited Brazil onshore wind, and will no longer continue new offshore wind projects. It is refocusing on oil and gas, prioritizing core energy operations over renewables expansion.
SSE	The company has reduced its five-year investment plan by £3 billion, with renewables cut by ~£1.5 billion, and recorded £249.5 million in Southern Europe impairments. Rising costs and supply chain challenges put its 2030 50 TWh target at risk.
Statkraft	Company has revised its offshore wind and green hydrogen strategies, cutting its offshore wind target from 10 GW to 6–8 GW by 2040 and scaling back green hydrogen from 2 GW by 2030 to 1–2 GW by 2035, citing slower market development and funding constraints

c) Reversed strategies by Oil and Gas giants

Carbon neutrality commitments and growing environmental, social, and governance (ESG) pressures have made not only utilities and developers but also oil and gas (O&G) producers heavily invest into wind and other renewable and low carbon technologies. European oil companies such as, Shell, Total Energies, Equinor,

ENI and Repsol have released their net zero commitments, in turn, they have modified their corporate growth strategies and investment portfolios.

The O&G companies leveraging their offshore working expertise invested heavily in offshore wind project development in the last five years. However, the recent trends show reverse activities by O&G companies, which was driven by a short-term revenue gain strategy through new investment in a more profitable oil and gas portfolio.

To remain profitable, for example, Shell is doubling down on its oil and gas operations while scaling back certain investments in renewables. Earlier this year, the company withdrew from the Atlantic Shores Offshore Wind Project in New Jersey, citing regulatory and supply chain challenges. In Brazil, Shell discontinued its onshore wind projects as part of a broader portfolio restructuring in response to weak returns and regulatory hurdles. The company has also confirmed that it will no longer pursue new offshore wind developments, having sold or exited multiple projects worldwide—including stakes in South Korea, the Philippines, and the UK—while stressing strict profitability criteria for any future involvement. In India, Shell is preparing to divest its renewable energy subsidiary, Sprng Energy.

Similarly, TotalEnergies is exploring the sale of a 50% stake in a portfolio of renewable projects in the US and Europe. In July, the company sold half of its renewable portfolio in Portugal, which included wind assets.

Most recently, bp announced a pause on new offshore wind investments and indicated that it will prioritize certain low-carbon technologies capable of generating higher short-term revenues. In addition, BP has agreed to sell its US onshore wind business to LS Power while merging its offshore wind business with Jera.

This approach aligns with a broader trend of strategic asset reallocation among O&G giants. It is therefore important to closely monitor that the growth of capital-intensive technologies, such as offshore wind, is not disrupted by such low-carbon business restructuring.

d) Corporate PPAs for increasing clean energy mix

To meet net-zero commitments and address the growing 24/7 power demand from nearly all industrial sectors, as well as data centres and AI computing hubs of large tech companies, the demand for electricity from renewable energy sources in the Commercial and Industrial (C&I) sector is continuously rising. GWEC expects that the ongoing growth of PPAs will accelerate the expansion and off-take of wind and renewable energy capacity worldwide.

As of today, North America, Europe and APAC remain the largest corporate PPA markets. Energy-intensive sectors such as metals, steel, and chemicals, as well as major IT tech companies like Microsoft, Google, and Amazon, are continuously increasing their PPA capacities. At the same time, new form of PPA contracts are on the

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rise, especially in Europe, where an increase in negative pricing has led to a rise in contracts involving energy storage systems. For sectors like data centers, which require 24/7 electricity, PPAs combined with energy storage systems are able to better match the off-taker's demand curve, improving both the stability and flexibility of power supply.

Recent examples include:

- EnBW signed sixth long-term corporate PPA for the 960 MW He Dreht offshore wind farm in Germany with German railway operator Deustche Bahn;
- a European packaging company Ardagh Group signed 10-year PPA with RPC for 161 MW wind project in Sweden;
- Eneco, has signed a long-term power purchase agreement (PPA) with Albert Heijn to supply the company with power from the 760 MW Ecowende offshore wind farm in the Netherlands;
- Two Dutch companies operating in the food and agro industries, Plukon and De Heus, have decided to buy electricity from the Hollandse Kust West Site VI;
- BASF partnered with Vattenfall on German offshore wind farms Nordlicht 1 and 2 to supply clean electricity to its chemical production sites across Europe, in particular Ludwigshafen; and
- Vibrant Energy proposed 198 MW wind farm for Amazon India.
- February 2024: Rio Tinto signed a 25-year corporate PPA with Windlab for the 1.4 GW Bungaban wind project in Queensland, Australia, to supply renewable power to its Gladstone aluminum operations.
- September 2024: Omaha Public Power District (OPPD) signed a PPA with EDF Renewables for 300 MW of wind power (Milligan I), supporting its plan to add 3.2 GW by 2030—half from renewables—to meet surging demand and its net-zero carbon goal.
- June 11, 2025: Danske Commodities signed a PPA with German group E.optimum to deliver 180 GWh of electricity from July 2025 to December 2026, covering the needs of about 48,000 households.
- July 2025: Saudi Power Procurement Company signed a PPA with a consortium led by Marubeni for the 700-MW Yanbu wind project at an LCOE of SAR 64.6 (USD 17.22/MWh), located in western Saudi Arabia

In addition, most global tech giants have committed to achieving net-zero emissions for their overall operations and data centers by 2030, using clean energy. A recent BNEF Briefing Note for NY climate Week 2025 also shows that global power demand from data centers will quadruple accounting for 4.5% of expected global power demand in 2035.

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North America, as a hub for data centers, has seen a surge in clean energy demand driven by PPAs. Microsoft continues to sign substantial renewable energy deals to decarbonize its portfolio. In 2024 alone, the company signed 19 GW of new renewable energy PPAs across 16 countries through long-term agreements. These include deals in Ireland, continental Europe, and the U.S. Overall, the company's green energy portfolio now totals approximately 34 GW.[2]

According to Amazon, it has supported more than 600 wind and solar projects globally, with 40 of these in countries with high fossil fuel penetration, such as Australia, China, Greece, and India. The company has also invested in energy storage and nuclear power, claiming to have enabled 2.7 GW of energy storage and firming technology to date.[3]

Similarly, from 2010 to 2024, Google signed over 170 agreements, purchasing more than 22 GW of clean energy. In 2024 alone, Google signed additional contracts for over 8 GW of clean energy generation. Moreover, more than 25 clean energy projects signed in earlier years have gone into operation, contributing 2.5 GW of new clean energy to the grid. Once fully operational, the 2024 contracts are expected to generate nearly four times the electricity needed to meet Google's incremental load growth from 2023 to 2024. [4]

Below are some recent examples:

- May 2025: Google signed a PPA with Shell for 108 MW from the NoordzeeWind offshore wind farm, enabling repowering and extending the project's operational life to 2031, while expanding Google's renewable energy footprint in the Netherlands.
- February 2025: Amazon signed three PPAs with Iberdrola totaling 476 MW, including its first deal in Portugal for 219 MW from the Tâmega Wind Complex and two projects in Spain for 257 MW of solar and wind energy.
- November 2024: Amazon signed four PPAs in Greece for three wind projects, including the 44.4 MW Vermio, 35.4 MW Mesokorfi, and 29.5 MW Koukouras farms, all developed by Aersoleir. These projects will support Greece's decarbonization efforts and are expected to be operational by 2026.
- July 2024: OPPD partnered with Google and NextEra to access

[2] https://www.datacenterdynamics.com/en/news/microsoft-emissions-up-23-since-2020-blames-ai-data-centers/

[3] https://www.datacenterdynamics.com/en/news/amazon-was-the-largest-corporate-buyer-of-renewables-in-2024/

[4] https://www.gstatic.com/gumdrop/sustainability/google-2025-environmental-report.pdf

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600 MW of wind capacity from the High Banks Wind Energy Center, improving grid reliability, while Google retains the environmental attributes to support its 24/7 carbon-free energy goal.

- May 2024: Microsoft signed a PPA with SSE Renewables and FuturEnergy Ireland for energy from the 30 MW Lenalea Wind Farm in Ireland. This complements the 900 MW PPA announced in 2022.
- May 2024: Microsoft signed two 15-year PPAs with RWE for 446 MW of wind power from two Texas projects. In total, more than 800 MW of PPAs were signed in Texas in 2024.

e) Innovative Financing to fund green growth

Innovative financing instruments and strategies continue to play a critical role in managing healthy debt-to-equity ratios for large asset owners and operators, while enabling capability expansion, risk mitigation, and investment in next-generation renewable energy technologies such as floating offshore wind, green hydrogen, and Power-to-X.

However, due to increasing policy instability driven by extreme partisan ideology in the US, traditional divestment strategies (or farm-down strategies) —commonly used to reduce debt, recycle capital, and optimize portfolios—are currently facing significant challenges, particularly in the US offshore wind sector. Companies such as Ørsted have experienced disruptions in ongoing divestment processes for projects like Sunrise Wind due to regulatory delays, policy uncertainty, and partner withdrawal. As a result, planned capital recovery and debt reduction have been constrained, forcing firms to take on additional funding responsibilities and implement emergency equity measures.

Tax equity financing remains relevant in the U.S., especially under the transferability provisions of the Inflation Reduction Act (IRA), which can provide high short-term ROI. However, in the context of the current divestment challenges in offshore wind, its effectiveness is limited.

Similarly, other U.S. utilities and independent power producers, including NextEra, Algonquin Power & Utilities, PG&E, and Southern Company, are experiencing difficulties in executing asset divestitures as originally planned, undermining debt reduction and portfolio optimization goals.

Also, finance instruments such as green bonds, bank loans, subordinated hybrid capital instruments, and revolving credit facilities have been supporting the large wind and renewable projects globally. Examples include:

- Statkraft raised €1bn through the issuance of dual-tranche green bonds to support Eligible Projects outlined in its Green Finance Framework.

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- Following to Iberdrola's agreement with IFC, it has signed more than thousand million loans with the EIB to accelerate the construction of its significant portfolio of solar and wind in Italy, Spain, Portugal and Germany.
- GIP-backed BrightNight secured a $375mn credit facility to fund its 31 GW US renewable portfolio while Ørsted secured $784mn sustainability-linked revolving credit facility from a consortium of banks (JP Morgan, BNP Paribas and First Commercial Bank) for its 7.5 GW offshore wind portfolio in Taiwan.

GWEC's Global Offshore Wind Report 2025 has explicitly emphasised on the role of blended finance as an instrument and how it can be more effective in combination with other instruments to address a broader range of risks, especially in countries deemed to be high-risk (many emerging markets and developing economies).

GWEC Maret Intelligence expects that the increasing global trend of ESG, push for the tripling renewables target by 2030 and carbon credits will require huge investments, and the role of blended finance, equity based green bonds and insurances will be critical to support capital intensive RE technologies such as offshore wind, green hydrogen (+ammonia) and power to X.

f) Partnerships for security against risks

Historically, most small offshore wind projects have been constructed on the balance sheets of large European utilities such as Ørsted, Vattenfall and RWE. This strategy enabled them to maintain full control over risks and returns through construction and operation.

However, as projects grew in both size and complexity, a single equity investor was no longer able to shoulder the costs and risk alone, and joint ventures became the norm.

In most cases, two or more utilities/developers join forces to build and operate a large offshore project. Recent examples are the 1.08 GW Inch Cape offshore wind project in Scottish waters, being developed through a 50:50 joint venture, Inch Cape Offshore Limited, between ESB and Red Rock Renewables. BP and EnBW have secured development consent for the Mona Offshore Wind Farm in the Irish Sea, marking the first project from the UK's Round 4 leasing round to reach this milestone and the fastest in UK offshore wind history to progress from lease award to approval, the project is expected to be operational by the end of the decade.

Forming strategic partnerships and consortiums further help in knowledge building and de-risking in new markets, for example, Equinor and Polenergia have reached an FID for two offshore wind farms in Polish waters. Each wind farm will have an installed capacity of 720 MW, totalling 1,440 MW, with a combined investment of

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approximately EUR 6.4 billion. BP and Japan's JERA have signed an agreement to merge their global offshore wind assets into a 50:50 joint venture named "JERA Nex bp," targeting a total installed capacity of 13 GW. The new company just started the commence operations this summer.

Due to the turbulence created by macroeconomic challenges, a few partnerships were broken in US offshore wind market in the past 12 months. Several players decided to go solo to pursue their respective priorities under their corporate strategies. For example, Equinor entered into a swap transaction with bp, under which Equinor will take full ownership of the Empire Wind lease and projects and bp will take full ownership of the Beacon Wind lease and projects; and Ørsted completed the acquisition of Eversource's 50 % share of Sunrise Wind Project in New York. Shell announced in February 2025 that it is withdrawing from the Atlantic Shores Offshore Wind South project, which it was developing in partnership with EDF-RE Offshore Development.

g) Owner-Operators compete with Independent Service Providers

In the US and other mature wind markets, major wind farm owner-operators are competing with Independent Service Providers to provide O&M not only for their own wind assets, but also to wind farms owned by a third party. This strategy demonstrates their O&M capabilities and confidence in their ability to control costs and quality, thereby increasing revenues. Further, having assets consisting of different turbine types, and even other renewable assets, allow them to create synergies and therefore keep costs under control. Typical examples of this trend are utilities: EDF, EDP, RWE, EnBW, NextEra and IPPs such as Invenergy and ReNew Power whose renewable arms are offering IPS-type services in the marketplace.

In China, wind farm owner-operators have traditionally relied on in-house teams for routine maintenance, outsourcing more complex upgrades to OEMs or ISPs. However, as new capacity and out-of-warranty assets grow, the scale of their O&M teams have not expanded significantly. Facing increasing cost pressures, these owner-operators have been outsourcing a greater share of O&M tasks to OEMs and ISPs to optimize expenses.

h) Digital asset management and enhancing cybersecurity

Another strategic trend driven by digitalisation is the option of asset management and asset optimization. Leading utilities from Europe, United States and China have been building their own digital platforms to manage their renewable assets in recent years.

Utilities are expanding their offerings to include electricity trading and asset management/lifetime extension programs to increase profitability. Digitalisation plays a key role, with AI tools used to predict asset demand, optimize maintenance, and simulate

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equipment performance based on usage, failure rates, and lifespan.

For example, Goldwind, through Tianrun (its asset operation arm), has innovated the O&M model through digitalization and AI technology. Its AI-powered renewable energy asset platform enables automated management, significantly improving the response speed of equipment anomaly detection. As a result, the O&M team can manage 2-3 times more capacity per person compared to the industry average, while boosting power generation by 15%. The platform intelligently allocates resources across regions to automate various O&M tasks, resulting in a 25% reduction in OPEX. Even more groundbreaking is the platform's ability to predict electricity prices using AI and dynamically adjust O&M plans. This shift moves asset management from "ensuring power generation" to "controlling electricity costs," fully demonstrating the value of intelligent technologies in improving efficiency, reducing costs, and increasing revenue. Utilities use AI-driven models to forecast supply-demand changes and price trends, helping them to make more informed trading decisions and develop effective strategies. Cybersecurity is of great concern in the energy sector. Major generation asset owners and operators are already boosting the number of cybersecurity experts in-house to safely guide the operation. Managing, controlling, and storing wind assets' operational data under their digital platforms has become a critical solution to ensure security. To address associated geopolitical concerns and data security, EU member states have implemented stricter pre-qualification standards, raising the bar for wind turbines to be installed in Europe. Specifically, in the area of cybersecurity, the EU has enacted regulations related to SCADA, data collection and remote control. In August 2025, India's Ministry of New and Renewable Energy (MNRE) revised its market access policy, specifically the Approved List of Models and Manufacturers (ALMM). Under the new policy, wind turbine OEMs are required to source key components — including blades, towers, gearboxes, generators, and specialized bearings — from manufacturers listed in the MNRE's ALMM. In addition, manufacturers must establish their wind turbine R&D centers, data centers, and/or servers within India to strengthen the country's cybersecurity ecosystem.

i) Seeking opportunities with hybrid or co-located projects

Hybrid or co-located projects are not new, what is new is that asset owners, including utilities, are seeking more of these types of projects to optimise their return opportunities. The combination of wind energy with other renewable energy sources and/or a storage solution is most common due to complementarity. It is also to bring the level of maturity, about how to implement circularity, systems integration, grid reliability and eco-innovation.

This trend is visible across markets and not specific to any one region, but

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countries like the US, Australia, and India are currently taking the lead in relying on this technical solution to support its energy transition. Utilities profit here, from their experience in managing different assets of varying scales jointly and providing the ancillary service.

In India, to provide 24*7 power and serve peak power from any corner of the country, new tenders such as RTC (round-the-clock) and FDRE (firm and dispatchable renewable power) require a similar set up of projects. Since 2018, India has awarded around 42 GW capacity through hybrid, RTC and FDRE tenders, of which wind is an important part. Additionally, another 25 GW tender capacity is at an early stage and is expected to be awarded soon. Furthermore, India's innovative tenders with targeted policy incentives are likely to further accelerate growth in this segment.

GWEC Market Intelligence expects this trend to continue, as value optimisation and revenue diversification are becoming increasingly more important for asset owners. Developing hybrid projects (e.g., wind-plus-solar, wind-plus-storage or hydrogen) enables surplus energy— which might otherwise drive negative prices— to be channelled into storage or alternative uses, thereby mitigating price drops and enhancing overall system flexibility.

j) Enabling Technology Diversification: floating offshore wind, green hydrogen and Power-to-X

The future clean energy systems under tripling RE target by 2030 and 2050 net zero scenarios call for large-scale integration of wind and renewable power, enabled by technological solutions for flexibility, storage at varying durations and responsive management of demand and supply.

Also, most European and Chinese utilities have to meet their growth goals and achieve their net zero commitment. The past several years saw major utilities using a combination of geographical and technological diversification as a key tool to maximising growth opportunities and minimising production risks.

Floating offshore wind technology is gradually maturing and attracting interest from frontrunners such as the UK, Japan, South Korea, Norway, and France, who are observing vast deep-water resources and new market opportunities. This technology is expected to reach commercial viability towards the end of the decade.

1.9 GW of floating wind capacity was awarded worldwide last year, including 750 MW in France through the AO5 and AO6 tenders across three floating projects, 750 MW in South Korea for the Bandibuli project, and 400 MW in the UK via CfD Allocation Round 6 to the Green Volt project. In Addition, Norway initiated its first floating offshore wind tender at the Utsira Nord site in May 2025.

Green hydrogen and Power-to-X are set to become breakthrough solutions which will dispatch green power and

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green hydrogen to different end-use sectors, especially those hard-to abate sector where direct electrification is challenging, to reduce their dependency on fossil fuels, from heating to manufacturing to transport (including aviation and shipping).

The past five years saw the investment in green hydrogen and Power-to-X gaining momentum. Projects with leading renewable asset owner-operators and major oil and gas companies (such as Ørsted, RWE, Vattenfall, Parkwind, CIP, Shell, Equinor and TotalEnergies) on board, have been reported on both sides of the Atlantic Ocean.

Power-to-X (PtX) and floating wind hold strong potential for large-scale deployment but face significant economic and technical hurdles. Several GW-scale PtX projects in Sweden, Denmark, and Germany have been cancelled or delayed due to high CAPEX, lack of committed offtakers, missing infrastructure, supply chain and policy uncertainty. While, floating wind is more expensive than bottom-fixed offshore wind, with added challenges from immature floating foundation technologies, limited infrastructure, and supply chain constraints. For example, Ørsted has withdrawn from several Danish hydrogen projects (e.g., H2RES) to refocus on its core offshore wind business, while Statkraft exited Norway's Utsira Nord tender citing high costs and market uncertainty. Reflecting on these setbacks, GWEC Market Intelligence has downgraded its global floating wind forecast in its latest Global Offshore Wind Report 2025.

Despite the near-term challenges, GWEC Market Intelligence still expects huge investment opportunity in renewable technologies, especially floating offshore wind, powered green hydrogen and Power to X in the coming decades.

V. CONCLUSION

The energy sector is navigating a period of heightened uncertainty, marked by volatile policy signals, cost inflation, and supply chain bottlenecks. However, these headwinds do not alter the structural imperative of the green transition because the fundamentals of wind energy have not changed. To stay on track for the Paris climate goals and ultimately reach net zero, the world must accelerate its shift from fossil fuels to renewables and low-carbon solutions — with the global commitment to triple renewable capacity, and double energy efficiency improvements by 2030 serving as a central benchmark of international climate ambition. This transition is not merely about unlocking new revenue streams or diversifying risk; it demands that asset owners and operators significantly scale up investment in renewable energy and enabling technologies such as green hydrogen, Power-to-X, and advanced storage systems, even in a challenging market environment.

Achieving this systemic transformation requires more than capital alone. It

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relies on clear long-term policy targets, predictable project pipelines, expanded supply chain and logistics capacity, and regulatory framework support that accelerates permitting and underwrites investment in grid and port infrastructure. At the same time, digital and AI-driven solutions will be indispensable in managing increasingly complex energy systems, enabling smarter forecasting, predictive maintenance, and real-time optimisation of wind assets across their lifecycles. Advanced analytics can further enhance grid integration, optimise storage dispatch, and coordinate distributed, hybrid, and off-grid generation, thereby reducing curtailment and operational costs. Despite the green transition being at multi-speed at present due to macroeconomic headwinds and policy instability, the transition remains the defining and irreversible structural shift of our time.

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Disclaimer – Data on operational wind power capacity for the Top 15 wind asset owners is taken directly from the annual reports and financial results of the utilities and IPPs listed or has come directly from contact with those companies. For Chinese asset owners, their operational data is quoted from CWEA's annual statistics. Cross-company ownership of wind assets, plant-owning consortiums and joint-venture ownership have become the norm for some large wind projects, particularly in the offshore wind sector. Individual equity stakes in each investment are taken into account. Where consolidated data (net installed capacity) for specific companies is not available, gross capacity is used.