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Morten Dyrholm
Chairman, Global Wind Energy Council

Word from the Chairman

At this point last year, the global disruption of COVID-19 was only just beginning to take shape. I sincerely hope that 2021 will see the world overcoming the pandemic. Until then however, to paraphrase Albert Einstein, ''In the middle of difficulty lies opportunity.'' Right now, we are in the midst of a rare period of opportunity: to build back better, to create more resilient societies, and to get serious about combating climate change.

The indications look promising. Recovery and stimulus measures are getting greener. The number of countries, cities and companies striving for net zero is on the rise. COP26 could become the climate summit that will yield tangible action, leaving the work of persuasion and promises firmly in the past.

I venture a bet here: 2021 will mark our entry into the decade of renewables. The stage is set for global commitment to the Sustainable Energy Transition, the only road that can lead us to net zero by 2050.

We have an important task ahead of us. As renewable energy grows, wind energy will become the backbone of energy systems in many parts of the world, requiring us to move beyond the focus on simply increasing wind energy capacity to instead instigating new collaborations with stakeholders across the global energy system to uncover more powerful policies and unlock greater investments to fuel the Sustainable Energy Transition. This entails expanding our reach to cover key issues such as grid build-out, storage, market redesign and accelerating the deployment of renewable energy to new sectors.

Succeeding in our task entails shifting the focus of both policy makers and the private sector from cost to value. Adopting a system value lens means looking beyond the size of recovery packages, investment needs or the cost of energy. It requires a holistic view, whereby we build robust frameworks that support solutions that maximise positive impacts while discouraging negative impacts. Renewables will be part of the solutions as plenty of data proves that renewables drive a higher system value than fossil fuel-based options time and again. They are cleaner, safer, cheaper, more labor-intensive and use less water.

Experience also shows that the benefits of historic green recovery measures have exceeded the level of investment by far. Analysis from IRENA shows that every dollar spent on Sustainable Energy Transformation will deliver a payoff between $3-7. It's now up to us to take this evidence forward to drive change.

The system value approach also requires us to look inwards and evaluate our own sustainability ambitions. Are we doing enough to decarbonise our own operations, to promote diversity and inclusion, to improve health and safety, or to nurture circularity? Many of us have the power and autonomy to drive progress in our own organisations.

GWEC will continue to support our industry with every step of this transformational journey. 2021 will be a pivotal year for our planet's future. I'm looking forward to it.

Source of the return on investment: IRENA, Transforming the energy system, 2019, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Sep/IRENA_Transforming_the_energy_system_2019.pdf

Welcome to the Global Wind Report 2021

Ben Backwell
CEO, Global Wind Energy Council

When we look back, in years to come, at this 2021 edition of the Global Wind Report, we hope we will see it as marking a true inflection point.

If we are successful as a society, we will remember 2021 as the year when the world finally turned the corner in confronting the climate crisis by adopting a decisive path of collective action at the COP26 meeting in Glasgow.

We will also remember 2021 as the year when we started to heal the scars left by the novel Coronavirus pandemic, and started to rebuild our economies and communities in a more sustainable and humane way.

And for the wind industry, we will remember this year as not only marking the biggest year ever in terms of new installation, but also the year when a real breakthrough was made in the energy transition, and a new, accelerated path of growth was established as countries and regions started to implement their plans to reach net zero CO_2 emissions in earnest.

That, then, is the hope. And that's why the Global Wind Energy Council has produced this special report in the run up to COP26, which will focus on the role of renewable energy and wind power in particular in the world's net zero objectives, as well as the rapid transition to renewable energy that oil and gas companies will need to make to in order to survive and play their role in the transition.

> We need to be installing around 180 GW per year to get to where we need to be. Every year we fall short, the mountain to climb gets higher.

The report pulls no punches. For while the world's sense of urgency has increased, particularly driven by the growing concern, anger and activism of young people, progress on the ground is still far from the level needed to get the world on a trajectory that will restrict global average temperature increases to no more than 1.5°C.

As an example, global annual installations of renewable energy are probably below half the level needed to get to an IPCC-compatible scenario. For wind energy, this means that while we installed a record 82 GW of new wind capacity in 2020, we need to be installing around 180 GW per year to get to where we need to be. Every year we fall short, the mountain to climb gets higher.

The danger is that governments increase their long-term ambitions around reaching net zero in 2050 (or 2060 in the case of China), while shorter term targets are left vague or missed: in effect, kicking the problem into the "long grass" for future administrations and, eventually, creating a situation where it really is too late.

For this reason, GWEC has been strongly advocating for a re-set in our everyday approach to the energy transition.

Firstly, we need to create a sense of urgency by being honest about where we are right now and the gap between aspirations and progress on the ground. We need to explain to policymakers and regulators that reaching net zero depends on the actions that we take now.

Secondly, we need to propose immediate and practical solutions. In contrast to a decade ago, there is plenty of investment looking to flow into wind and renewables projects, but red tape and antiquated planning and permitting systems are slowing down the Energy Transition all over the world. So GWEC is advocating for policy makers to take a true ''Climate Emergency'' approach to administrative procedures and institutions.

Thirdly, we are calling on governments to move to rapidly ensure that the social costs of emitting carbon are paid, and that polluting energy use is pushed off the system. The experience of the last decade shows that once governments make clear signals, the investment community will take the decisions which are necessary.

Red tape and antiquated planning and permitting systems are slowing down the Energy Transition all over the world. So GWEC is advocating for policy makers to take a true "Climate Emergency" approach to administrative procedures and institutions.

And fourthly, we are going to have to find new allies, partners and customers, as the challenge of transitioning to renewable energy becomes more about helping harder-to-transform sectors such as heavy industry, chemicals, transport and agriculture to decarbonise. The terms ''Power-to-X'' and ''Sector Coupling'' will move rapidly from being buzz-phrases to new sectors, industries and technological advances.

And this brings me to my final point. To achieve this re-set, and the wider dream which I have described, we are all going to have to work together.

This means governments, communities and industry getting together and finding rapid solutions to planning and permitting bottlenecks. It means technologies such as wind, solar, storage and next-gen transmission and distribution working together to ensure that the transition can be made as seamlessly and efficiently as possible. It means renewables working together with completely different technologies which have their own unique challenges and trajectories.

It also means working together to evolve the highly skilled and diverse workforce that will carry out a true paradigm shift in how society organises its energy economy.

This, then, is our challenge and invitation to you all.

INTRODUCTION

Feng Zhao
Head of Strategy and
Market Intelligence, GWEC

2020 - A record year for the wind industry

2020 was the best year in history for the global wind industry showing year-over-year (YoY) growth of 53%. Installing more than 93 GW wind power in a challenging year with disruption to both the global supply chain and project construction has demonstrated the incredible resilience of the wind industry.

Market status

The 93 GW of new installations brings global cumulative wind power capacity up to 743 GW. In the onshore market, 86.9 GW was installed, an increase of 59% compared to 2019. China and the US remained the world's largest markets for new onshore additions, and the world's two major economies together increased their market share by 15% to 76%, driven by the Feed-in Tariff (FiT) cut-off in China and the scheduled phase-out of the full-rate Production Tax Credit (PTC) in the US, respectively.

On the regional level, 2020 was also record year for onshore installations in Asia Pacific, North America and Latin America. The three regions combined installed a total of 74 GW of new onshore wind capacity last year, or 76% more than the previous year. Due to the slow recovery of onshore installations in Germany last year, Europe saw only a 0.6% YoY growth in new onshore wind installations. Developing markets in Africa and the Middle East reported 8.2 GW onshore installations last year, almost the same as in 2019.

In the offshore market, 6.1 GW was commissioned worldwide last year, making 2020 the second-best year ever. China installed half of all new global offshore wind capacity in a record year. Steady growth was recorded in Europe with the Netherlands taking the lead followed by Belgium, the UK, Germany and Portugal. The remaining new offshore wind installations in 2020 were shared by the US and South Korea. Total offshore wind capacity has now passed 35 GW, representing 4.8% of total global cumulative wind capacity.

Market dynamics

While the first half of 2020 saw auctions being postponed or cancelled due to COVID-19, the sector bounced back with vigour in the second half of the year as key mature and emerging wind markets began to overcome the impacts of the pandemic. According to GWEC Market Intelligence, nearly 30 GW of new wind power capacity was awarded globally through auctions in the second half of 2020, which is a slight increase compared to the 28 GW awarded during H2 2019. Although only 1 GW offshore wind capacity was awarded through auctions worldwide, more than 7 GW of offshore wind auctions/ tenders were launched in 2020. This surge in new capacity to be auctioned is a clear signal that the industry is back on track and that the global pipeline of wind power projects continues to grow.

Through technology innovations and economies of scale, 2020 saw wind power continue to build its competitive advantage throughout the world. Last summer, a consortium of Shell and Eneco won the third zero-subsidy offshore wind tender in the Netherlands. In Latin America, as wind power already had very competitive

prices, private auctions or bilateral PPAs have already emerged as an alternative mechanism to government auctions to drive growth. According to BloombergNEF, 6.5 GW wind power was signed through corporate PPAs globally last year, 29% lower than the previous year. Considering the fact that COVID-19 disruptions across the world have caused revenues to plummet for many corporates, the level of commitment to sustainable green energy remains impressive.

Last year also witnessed governments of countries such as China, Japan and South Korea making net zero/carbon neutrality commitments, and similar commitments were also made by major corporates including oil and gas companies. To reach the net zero targets, completing a systematic and radical energy transition from fossil fuels to renewable energy and low-carbon solutions is imperative. The current crisis offers a unique window of opportunity to put the world on a sustainable trajectory and meet our international climate goals, but we must act now - or miss the opportunity. Although reaching net zero will require bold actions by a large number of sectors and actors, wind power is placed to be one of the cornerstones of green recovery and to play an important role in accelerating the global energy transition.

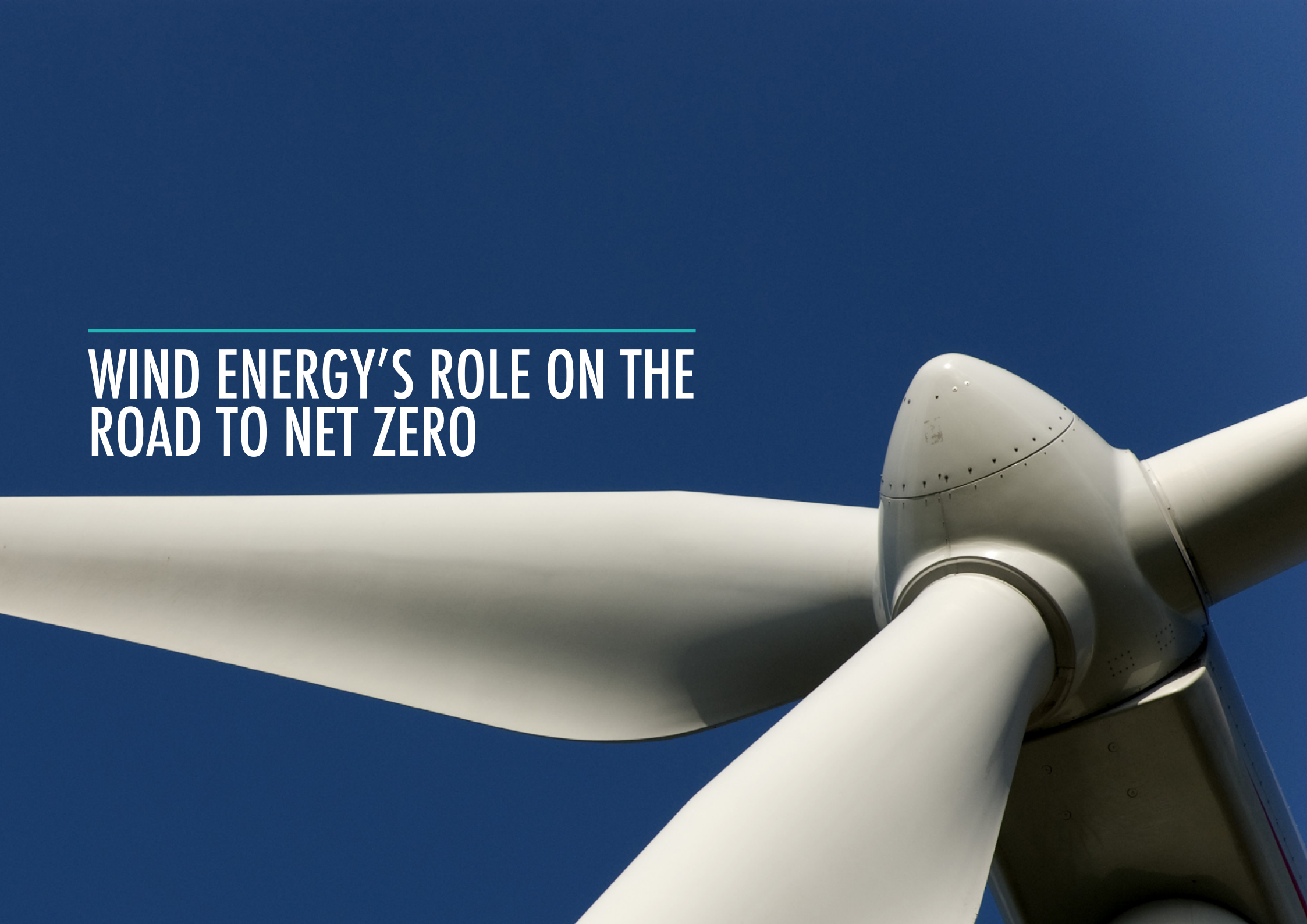
Although reaching net zero will require bold actions by a large number of sectors and actors, wind power is placed to be one of the cornerstones of green recovery and to play an important role in accelerating the global energy transition.

Market Outlook

After an unusual 2020, global wind market growth is likely to slow down in the near-term primarily due to an expected drop in onshore installations in China and the US following the expiry of incentive schemes. Nevertheless, the market outlook for our forecast period remains positive. GWEC Market Intelligence expects that over 469 GW of new onshore and offshore wind capacity will be added in the next five years - that is nearly 94 GW of new installations annually until 2025, based on present policies and pipelines. We hope and expect that governments will significantly increase their ambitions and targets following COP26, and for that reason we are upwardly revising our forecasts for the GWR2022.

The CAGR for onshore wind in the next five years is 0.3% and GWEC expects annual installation of 79.8 GW. In total, 399 GW is likely to be built in 2021-2025. The CAGR for offshore wind in the next five years is 31.5%. The level of annual installations is likely to quadruple by 2025 from 6.1 GW in 2020, bringing offshore's market share in global new installations from today's 6.5% to 21% by 2025. In total, more than 70 GW offshore is expected to be added worldwide in 2021-2025.

WIND ENERGY'S ROLE ON THE ROAD TO NET ZERO



1. Wind energy's role on the road to net zero

Like a high-resolution satellite image, 2020 offered a sharpened reality of the state of our planet. The COVID-19 pandemic brought greater recognition to the consequences of human development on the natural world, and of the cascading knock-on effects an event can wield on our economies, livelihoods and security.

As policymakers chart the way out of the pandemic, and emissions show signs of returning to pre-pandemic levels in the world's fastest growing economies, there is unprecedented agreement that climate change is the true global emergency. The concept of a runaway threat crippling the entire world is now not only credible, but relatable. This has prompted the UN to underscore the call for urgent action to reach net zero greenhouse gas (GHG) emissions by 2050 – a call which has since been echoed by more than 120 countries representing over half of global GDP, alongside thousands of businesses, investors, cities, regions and universities.[1]

It is worth looking back at a long year in which the global wind industry demonstrated its resilience and its role in green recovery. But the events of 2020 also defined the outlines of what lies ahead: the role of wind energy in a carbon-neutral world.

The pandemic accelerates shifts in the global energy matrix

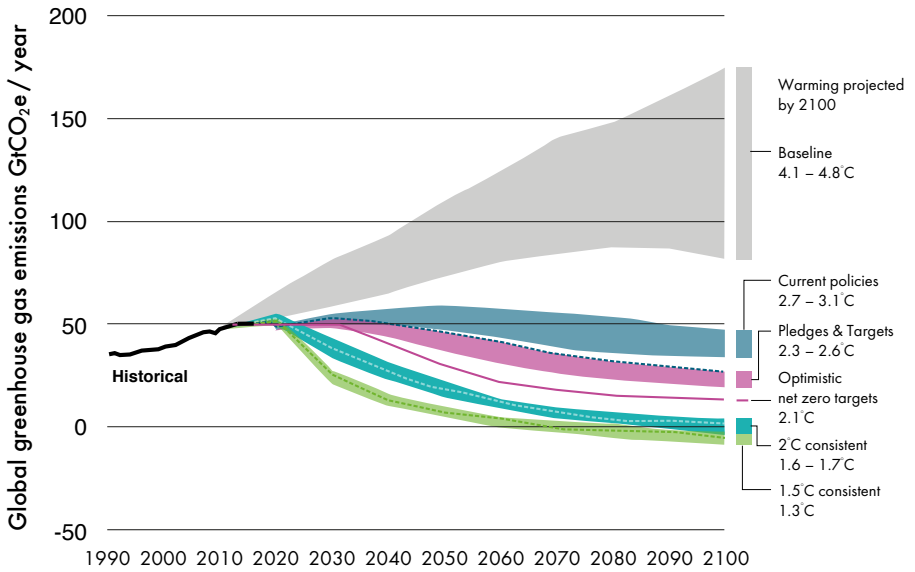
The pandemic cast a long shadow across the world, posing a challenge to economies and to the global wind industry as never before. Its impacts reverberated throughout the wind supply chain, disrupting manufacturing and export flows. From the US to South Africa, projects were hit by delays.

While some impacts were temporary, the pandemic also accelerated energy shifts already in motion. Global energy demand declined by roughly 5% in 2020, according to the IEA, including falls of 8% and 7% for oil and coal demand, respectively.[2] Credit agencies are now expecting global oil demand to continue declining steadily over the next decade; in its most conservative outlook, BP forecasts peak oil demand as soon as 2025.[3] Last year, capex committed to offshore wind overtook investment in offshore oil and gas for the first time.[4]

From the EU to large Japanese trading houses to the world's largest investment funds and development finance institutions, there are calls to phase out coal and the financing of new coal plants. Although coal reduction still lags in parts of Eastern Europe, in 2020 renewables

2100 Warming projections

Emissions and expected warming based on pledges and current policies



Source: Climate Action Tracker, December 2020.

1. https://unfccc.int/climate-action/race-to-zero-campaign; https://eciu.net/analysis/briefings/net-zero/net-zero-the-scorecard#:~:text=Net%20zero%20economies,(World%20Bank%2C%202018)
2. https://www.iea.org/reports/world-energy-outlook-2020
3. https://www.carbonbrief.org/analysis-world-has-already-passed-peak-oil-bp-figures-reveal
4. https://www.tradewindsnews.com/offshore/-51bn-in-wind-farm-capital-spending-outstrips-oil-and-gas-for-first-time/2-1-955552

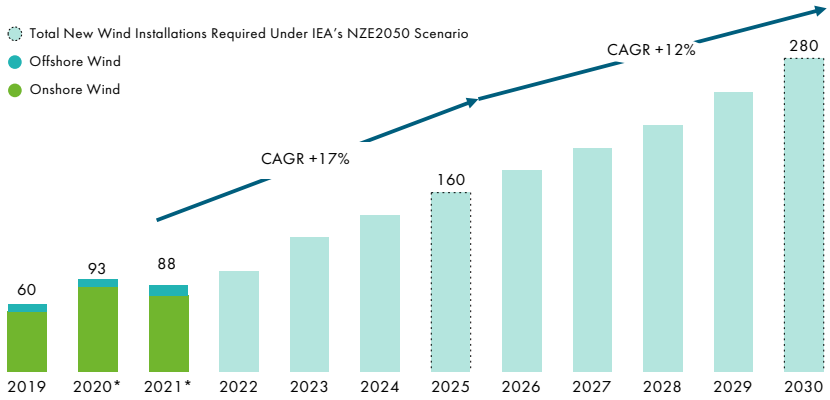
generated more electricity in the EU than fossil fuels for the first time, powered by 14.7GW of new wind plants reaching grid connection.

2020 also saw milestone commitments to carbon neutrality, with the EU, Japan, South Korea, Canada and South Africa each pledging to reach net zero by 2050. Combined with China's net zero by 2060 target and the US intention to reach net zero by 2050 under the Biden administration, countries which have adopted or considered net zero targets now represent two-thirds of the global economy and 63% of global GHG emissions.[5]

These are no longer just market trends, at least in the sense of cyclical movements. It is clearer than ever that the era of fossil fuels is over, and the global energy transition is here to stay. 2020 presented a once-in-a-generation opportunity to reset human development. **The question is whether we can turn the newfound sense of optimism and urgency into accelerated implementation and deliver the transition in time.** 2021 must be the time to turn long-horizon net zero roadmaps into actions, via concrete policy interventions, interim target-setting and robust delivery plans. Otherwise, even in the most optimistic scenarios, we will miss our Paris targets.

Annual wind installations must increase dramatically to reach net zero by 2050

New global wind installations (GW)



Source: GWEC Market Intelligence; IEA World Energy Outlook (2020), volume in 2022-2024 and 2026-2029 are estimates

Wind energy's role in achieving net zero

One year on from the beginning of the pandemic, the wind industry has demonstrated incredible resilience. In Q2 2020, GWEC Market Intelligence was predicting a 20-30% reduction to the end-of-year forecast. But the industry more than bounced back to deliver a record year of growth with 93 GW, largely spurred by installations in China. Investment in offshore wind surpassed 2019 levels to reach US$303 billion in 2020, partly due to the sector's longer project development timelines which are more resilient to the pandemic impacts.[6]

While jobs have been lost and projects delayed, the global wind industry defied expectations and is set to continue growing at a steady pace. Before 2025, the industry will exceed 1TW in global cumulative installations of onshore and offshore wind, according to GWEC Market Intelligence.

Cost reduction from larger turbines, innovations in installation/O&M and reduced investor risk will further drive deployment: Out to 2030, IRENA expects average LCOE of onshore wind to continue declining by 25% from 2018 levels, while offshore wind LCOE will shrink 55% from 2018.[7]

But accelerated growth of wind and renewable energy is required to "bend the curve" and put us on a trajectory which can limit global warming to "well below" 2°C, as set out in the Paris Agreement. Current policies are propelling us towards a 2.9°C pathway by 2100. If all pledges and NDCs as of December 2020 were implemented, we might reach 2.1°C and will miss a net zero by 2050 target.

With a few exceptions, the energy sector, which makes up around three-quarters of global GHG emissions, is characterised by long investment and development timelines – an accelerated pace for change must be set now. Every year we fall short of the dramatic action needed to change our pathway

5. http://www3.weforum.org/docs/WEF_Net_Zero_Challenge_The_Supply_Chain_Opportunity_2021.pdf; https://climateactiontracker.org/publications/global-update-paris-agreement-turning-point/
6. https://webcache.googleusercontent.com/search?q=cache:SJo8SyYNV5cJ:https://www.windpowermonthly.com/article/1704954/offshore-wind-spending-reaches-record-high-2020+&cd=1&hl=en&ct=clnk&gl=uk
7. https://www.irena.org/publications/2020/Apr/Global-Renewables-Outlook-2020

deepens the decarbonisation cuts required in years to come,

and locks in the devastating burdens of climate change for future generations.

To have a chance of meeting the Paris targets, fossil fuel-based capacity needs to be phased out concurrent to an increasingly steep expansion of renewables and related infrastructure. For wind, annual deployment must surge to around 180 GW, according to IRENA's Transforming Energy Scenario. Under the IEA's Net Zero by 2050 scenario, annual run rates for wind would need to be even steeper, reaching 160 GW by 2025 and then 280 GW by 2030 – 3 times the volume built in 2020.

Over the next 10 years, international institutions are calling for profound system transformation to take place. The UN Race for Zero has pegged the tipping point in the clean power sector as reaching a 60% renewable energy share in the global power mix, including 30% from wind and solar power. Total annual global investment in clean power and enabling system infrastructure needs to rise from US$380 billion in 2020 to $1.6 trillion by 2030, according to the IEA.

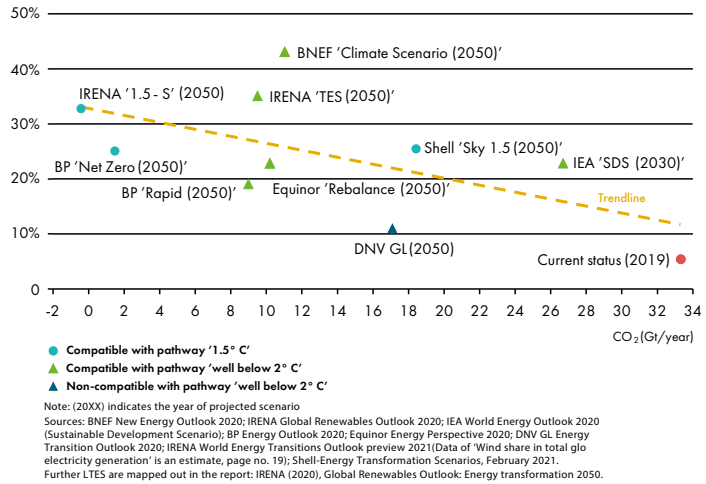
Wind energy in long-term energy scenarios

GWEC Market Intelligence analysed different long term energy scenarios (LTES) to map the role of wind energy in the global energy transition and, eventually, carbon neutrality. Selection of LTES was based on compatibility with Paris Agreement targets for a 1.5°C pathway by end-of-century and the recent UN goal to reach net zero emissions by 2050. Not all scenarios extended to 2050 (year of the forecast is indicated in parentheses on the graphs), and each depends on a unique set of system transformations, technology innovations and behavioural changes.

Institutional and commercial LTES call for higher shares of wind energy in the total power mix due to its stable generation profile – 43% in the case of BNEF's scenario and 35% in the case of IRENA's Transforming Energy Scenario – paired with widescale electrification measures for system-wide decarbonisation. The general trendline reflects that wind energy must rise from today's roughly 6% share of the global power mix to more than 30% by 2050, to achieve proximity to a pathway well below 2°C.

LTES diverge when it comes to the scale of electrification for a Paris-compliant pathway. The scenarios with higher rates of global electricity generation (BNEF, IRENA and BP) emphasise both higher shares of wind and renewable energy

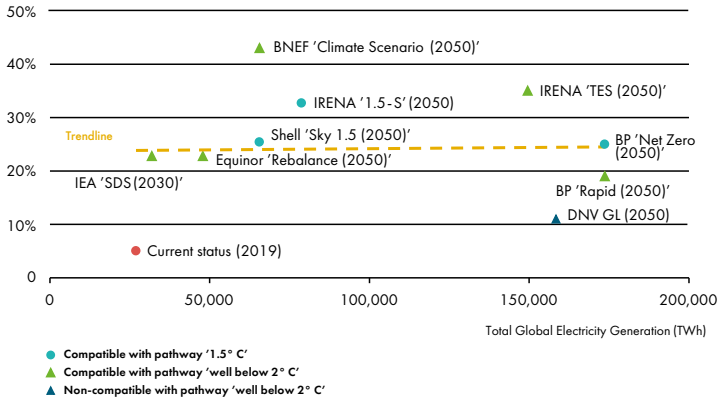
Share of wind energy (%) in total global electricity mix versus global energy-related CO2 emissions



Note: (20XX) indicates the year of projected scenario

Sources: BNEF New Energy Outlook 2020; IRENA Global Renewables Outlook 2020; IEA World Energy Outlook 2020 (Sustainable Development Scenario); BP Energy Outlook 2020; Equinor Energy Perspective 2020; DNV GL Energy Transition Outlook 2020; IRENA World Energy Transitions Outlook preview 2021(Data of 'Wind share in total glo electricity generation' is an estimate, page no. 19); Shell-Energy Transformation Scenarios, February 2021.
Further LTES are mapped out in the report: IRENA (2020), Global Renewables Outlook: Energy transformation 2050.

Share of wind energy (%) in total global electricity mix versus total electricity generation



Note: (20XX) indicates the year of projected scenario

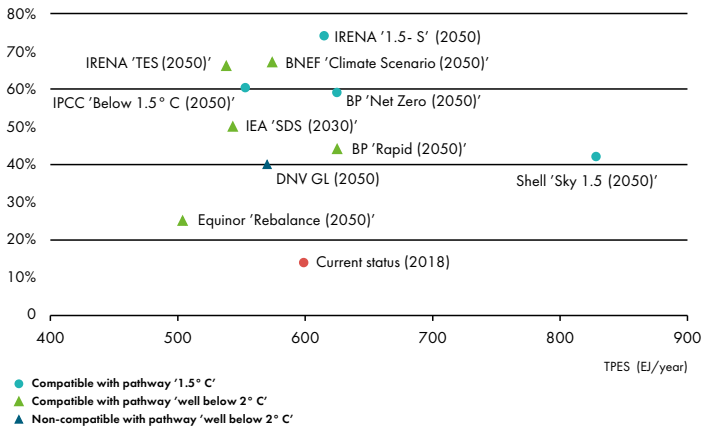
Sources: BNEF New Energy Outlook 2020; IRENA Global Renewables Outlook 2020; IEA World Energy Outlook 2020 (Sustainable Development Scenario); BP Energy Outlook 2020; Equinor Energy Perspective 2020; DNV GL Energy Transition Outlook 2020; IRENA World Energy Transitions Outlook preview 2021(Data of 'Wind share in total glo electricity generation' is an estimate, page no. 19); Shell-Energy Transformation Scenarios, February 2021.
Further LTES are mapped out in the report: IRENA (2020), Global Renewables Outlook: Energy transformation 2050.

combined with green hydrogen and Power-to-X solutions to meet final energy consumption needs.

Outside of electrification rates, LTES are aligned in calling for a rapid acceleration of wind energy deployment alongside improvements in energy efficiency, demand-side flexibility and sector coupling for a clean, resilient and secure energy system. This convergence of different policies is reflected in the graph below, where most scenarios which are 1.5°C-compatible and closer to net zero by 2050 call for at least a 60% share of renewable energy in the total primary energy supply. Scenarios are also aligning around a bandwidth of 500-650 EJ/year, requiring a degree of structural and behavioural changes to reduce energy demand.

As of the end of 2020, 127 countries covering 63% of global GHG emissions have expressed or are considering net zero goals. This balance of measures in these LTES can be instructive for national long-term energy planners, particularly as they align policies with net zero targets. The backdrop of major LTES comprises large-scale renewable energy penetration for onshore wind, offshore wind and solar energy, widescale electrification, energy efficiency measures and the deployment of technological innovations like Power-to-X and green hydrogen for storage and system flexibility.

Share of renewable energy (%) in total primary energy supply



Note: (20XX) indicates the year of projected scenario

Sources: BNEF New Energy Outlook 2020; IRENA Global Renewables Outlook 2020; IEA World Energy Outlook 2020 (Sustainable Development Scenario); BP Energy Outlook 2020; Equinor Energy Perspective 2020; DNV GL Energy Transition Outlook 2020; IRENA World Energy Transitions Outlook preview 2021(Data of 'Wind share in total glo electricity generation' is an estimate, page no. 19); Shell-Energy Transformation Scenarios, February 2021. Further LTES are mapped out in the report: IRENA (2020), Global Renewables Outlook: Energy transformation 2050.

The backdrop of most energy transition scenarios combines large-scale renewable energy generation, widescale electrification (particularly in the power, industry and short-distance transport sectors) and energy efficiency measures. A mix of innovative technologies, from green hydrogen to digitalisation and storage solutions, will be required to enable high rates of renewables penetration, adequate security and flexibility of the power system and decarbonisation of hard-to-abate sectors. These scenarios require decarbonisation of molecules, not just electrons.

Can we more than treble the volume of wind energy projects being installed worldwide over the next 10 years? Onshore wind is already a mature and mainstream energy source which is cost-competitive with new coal/gas plants and, in many markets, undercuts the operating costs of fully depreciated conventional generation assets.[10] There is expanding recognition of the economic growth, job creation, water consumption savings and health cost savings attached to wind energy. Meanwhile, initiatives like the UN-linked Ocean Panel and Ocean Renewable Energy Action Coalition have highlighted offshore wind as a vital technology which will provide 10% of the needed carbon mitigation by 2050 for a 1.5°C pathway.[11]

But in practical terms, the scale of build envisioned by 2030 means that actions to set the global wind industry on this path need to be taken now, given the time required for policy commitments to materialise, project development, financing decisions and more. Increasing capacity for wind and renewables will also require urgent forward-planning of infrastructure and grid buildout, as well as investment in storage technologies and demand-side management.

Even a concentrated sprint of action in the run-up to COP26 in November 2021 will not be enough to win the race to net zero. To bend the curve, policymakers must adopt the principle of continuous improvement in line with the "ratchet mechanism" of the Paris Agreement, and continue to push for higher ambitions at regular intervals.

10. https://www.irena.org/publications/2020/Jun/Renewable-Power-Costs-in-2019
11. https://oceanpanel.org/sites/default/files/2019-10/HLP_Report_Ocean_Solution_Climate_Change_final.pdf

Working together to accelerate wind energy deployment

In every major institutional scenario for energy system transformation, the wind market must rapidly expand over the next decade. The industry must be resoundingly clear that this growth will not happen spontaneously and requires urgent policy interventions worldwide.

A "climate emergency" approach to act now

As with wartime-era measures, the experience in 2020 demonstrated the mandate for governments to act in a crisis and free up bandwidth for public institutions. As we freewheel forwards on an "off-track" pathway to 2050, governments should similarly react to convene resources to radically scale up the deployment of renewable energy. Among other measures, this could entail:

- Committing to ambitious capacity targets for wind energy which increase over time;
- Granting "must-run" status, priority dispatch and priority grid connection to wind and renewable projects;
- Categorising wind projects as nationally significant and critical infrastructure, with improvements to streamline permitting and simplify license applications;
- Investing in long-term grid and transmission planning and infrastructure;
- Safeguarding existing and awarded wind projects, and avoiding retroactive changes to approved remuneration schemes;
- Enabling open-access regulation for a bilateral market of renewable energy;
- Creating policy frameworks for repowering of older wind plants in mature wind markets;
- Accelerating net zero commitments, carbon budgets, carbon pricing and science-based approaches among government bodies, and sense-checking reliance on CO_2 removal technologies in net zero plans; and
- Creating frameworks for a just transition, including ending direct and indirect subsidies for fossil fuel plants, providing fair compensation for early retirement of conventional assets and redirecting subsidies into worker training funds and diversity strategies for workforce development.

Policy and regulation provide the signals to the private sector for action and investment, allowing for economical decision-making. Making benefits and consequences clear to businesses, via "pull" signals like targets and "push" signals like taxes, will allow business to reorganise in line with a carbon-neutral pathway.

The last year has demonstrated that investment in the wind industry is plentiful. **The pandemic has tipped the scales, irreversibly, for private investment in clean energy.** In the first half of 2020 alone, while overall investment in power generation slumped, offshore wind financing quadrupled compared to the same period in 2019, reaching US$35 billion.[12] Retail and institutional investors increasingly view clean energy as a safe harbour. Major utilities like Engie, Enel Green Power, Iberdrola, TEPCO and KEPCO have been future-proofing their balance sheets by increasing investment in clean energy assets and avoiding the risk of stranded assets.

The challenge will be deploying capital into bankable wind projects at a sufficient rhythm to accelerate annual installations to the near-200 GW level. In 2020, there were more credit rating downgrades for emerging markets and developing countries than in all previous economic crises over the last 40 years.[13] For emerging economies, the pandemic has raised the spectre of higher financing costs, due to increased fiscal pressure on the balance sheets of public utilities and grid operators, as well as higher regulatory, currency and counterparty risks.

Greater coordination is needed to de-risk climate and renewable energy finance in emerging economies. Temporary debt suspension by actors like the G20 and IMF will not be enough. Governments should work together with multilateral development banks (MDBs), development finance institutions (DFIs) and the financial sector to create financing mechanisms

12. https://www.theguardian.com/environment/2020/jul/13/offshore-wind-energy-investment-quadruples-despite-covid-19-slump
13. https://www.bu.edu/gdp/files/2020/11/DRGR-report-Jan-2021.pdf

Photo Credit: Equinor

which build on the strong economics of wind energy, record-low global interest rates and the availability of low-cost funding for renewables and storage capacity.[14]

Such mechanisms could be developed with an "emergency" or "rapid response" approach to quickly move to supporting emerging economies and redirect private financial flows to climate change mitigation solutions like wind energy.

Case Study: Optimising wind plant performance

Provided by: WindESCo

Optimisation is playing an increasingly important role in the growth of wind energy and enabling energy transition. WindESCo provides solutions to help owners and operators maximize their assets' performance, energy production and reliability to unlock hidden value and promote a carbon-free energy future. WindESCo's mission is ensuring that every turbine produces its maximum energy output and operates reliably beyond its intended lifetime, a critical step on the journey to Net Zero.

About the Project

WindESCo was engaged by UPC Renewables to optimize 79 MW of in-warranty turbines under an OEM full-service agreement (FSA). The Sidrap Wind Farm, located in Indonesia, is operated by UPC Renewables, the leading independent power producer (IPP) in Asia-Pacific. Globally, UPC has 4,500 MW of installed capacity.

In 2019, UPC Renewables' new 30 tower wind plant was generating less-than-expected revenues compared to pre-construction estimates. The wind plant was not meeting its P50 projection and turbines were failing their power curve tests. No solution was being offered by the OEM to address the issues and increase production.

Scalable Solutions

UPC Renewables sought a cost-effective, scalable solution that would provide immediate ROI. WindESCo offers a comprehensive wind farm AEP improvement software which leverages SCADA data to increase AEP between 1–7%. The WindESCo solution required no hardware be installed at the site and provides analytics beyond existing asset monitoring platforms. Throughout the process the two companies worked closely to determine optimised parameters, verify that they were implemented correctly, and calculate the gains in energy output.

After collecting enough data, the WindESCo team performed analytics consisting of proprietary SCADA data checks. Three checks came out as requiring further investigation. Working with UPC Renewables, WindESCo determined that addressing Static Yaw Misalignment would provide the best short-term value. Two additional recommendations were identified for further improvement.

Out of 30 turbines, WindESCo determined that 27 were experiencing greater than 2° of static yaw misalignment and needed correction. The company worked with UPC Renewables to implement recommendations, and to confirm the recommended offsets were implemented correctly.

Measurable Results

In just a few months, WindESCo was able to optimize plant output, an endeavor that would have taken over a year with other technologies. The insights gained through WindESCo's solutions directly resulted in a 2% increase in AEP for the project.

The impact to the bottom line? An increase of $5,700/MW/Yr for a total benefit of $450,000/Yr. All without invalidating UPC Renewables' FSA and Warranty with the OEM.

From hydrocarbons to electrons

The central logic of the road to net zero will be to electrify everything we can in line with a cost-optimal clean energy transition. Widescale direct electrification can leverage existing technologies, with wind and renewable energy dispatched to power homes, industry, short-distance transport and the infrastructure of our cities. With more stable generation profiles, offshore wind, hybrid projects and virtual renewable power plants can provide strong complementarity to the continuous power demands of the industry and buildings sectors.

Electrification will itself compound the demand for green power, as the market incentives to decarbonise (e.g. carbon caps and border adjustment taxes) and to electrify (e.g. electric vehicle subsidies and electrification of industrial processes, such as heat generation for petrochemical cracking) will aggregate the demand for data analytics, cloud-based storage and machine communication.

14. https://www.weforum.org/agenda/2021/01/how-to-accelerate-the-energy-transition-in-developing-economies

For the wind industry, the advancement of cyber-physical networks will enable smarter and more efficient grids, greater transparency in how we consume and stronger civic engagement. The expansion of an ''Internet of Things'' will mean more assets along the value chain will become connected devices to be monitored in real-time and optimised for performance.

Current applications range from intelligent factory cranes to remote monitoring of wind turbines by autonomous devices. A pilot project for predictive analytics has already enabled wind turbines to supply the Danish system operator with balancing reserves at the end of 2020, paving the way for more flexible grid systems with large-scale renewables integration.[15]

Complementary technologies for energy flexibility

With higher capacity factors compared to other renewable energy sources, **onshore and particularly offshore wind provide greater energy reliability to emerging markets where power demand is growing,** especially if aggregated over large geographical areas. IRENA forecasts global weighted average capacity factors for onshore wind will increase to 32-58% by 2050 and to 43-60% by 2050 for offshore wind.[16] The world's first floating wind farm, the Hywind Scotland project in the North Sea, already achieved 56% capacity factors in its first two years of operation.[17]

Large-scale wind penetration will require balancing and storage technologies to maintain a cost-effective and secure transition. Hybrid renewable tenders with wind, solar and battery elements are now picking up around the world, from India's Round-the-Clock tenders to Germany's ''innovation auctions''. **But storage technologies will need to be competitive and scalable to disincentivise support of polluting and inflexible energy systems.**

This will be particularly critical for accelerating renewables in markets with weaker grids, which already face challenges in voltage and disruptions from extreme

Case study: Advanced monitoring systems to bring down costs

Provided by: Bonfiglioli

Bonfiglioli's products are continuously optimised to improve wind turbine performance for both offshore and onshore applications, with a strong focus on size and weight optimisation. With a market share of over 35% in wind turbine yaw and pitch drives and supplies to leading worldwide wind turbine OEMs, Bonfiglioli is a leader in advanced solutions for the wind industry. Its team of experts creates, designs and produces advanced solutions to deliver tailor-made solutions, predominantly led by a constant focus on LCOE reduction from both a direct and indirect standpoint.

LCOE indirect reduction is sought after through an evolving condition monitoring system that enables customers to maximise productivity and return on investment. Product reliability is undoubtedly an important parameter, but so is the ability to constantly check the health of the system and to plan maintenance operations. Bonfiglioli provides an IOT range that includes sensors on the gearbox and motor and an edge computer capable of conveying data and information to the customer's and/or Bonfiglioli's cloud, when a wireless connection is available.

All information relating to the RUL (Residual Useful Life), the operating conditions of the main components of products and any malfunction is obtained through algorithms that take into account fundamental aspects such as speed, temperature, relative humidity, operating torque and operating vibrations along the entire spectrum of frequencies. This allows the operating conditions of critical components to be constantly monitored in real time and to prevent unexpected downtimes by optimising maintenance interventions, particularly relevant for offshore wind applications where early fault detection is critical.

Already well accustomed to working with APQP methodology, specialising in APQP4Wind represents a distinctive element for the next generation of Wind products at the highest levels of quality, with a standardised approach.

With a unique global footprint, Bonfiglioli can guarantee the manufacture of local components to ensure a flexible and reactive supply chain. Ultimately a strong and global operation set up guarantees the right focus towards adopting a common culture regarding the Lean concept at global level.

15. https://en.energinet.dk/About-our-news/News/2020/12/16/Milestone-Wind-turbines-can-balance-the-electricity-grid
16. https://irena.org/-/media/Files/IRENA/Agency/Publication/2019/Oct/IRENA_Future_of_wind_2019_summ_EN.PDF
17. https://www.equinor.com/en/news/2019-11-28-hywind-scotland-data.html

weather events. Cost-effective storage solutions will be needed for grid resilience. Batteries are increasingly affordable for short-duration application; since 2010, prices have declined by two-thirds for stationary application (such as grid management) and by 90% for lithium-ion batteries in electric vehicles.[18]

System transformation will also require long-duration storage solutions (see: Enabling technology: Power-to-X and green hydrogen). A recent study of California's grid decarbonisation found that it would require up to 55 GW of long-duration storage by 2045 - more than 150 times the state's current storage capacity.[19]

For the hard-to-abate sectors, such as steel production, chemicals, aviation, maritime shipping and other forms of long-haul transport, there are higher barriers to electrification. Investment in energy carrier technology will be required, including in an efficient, versatile and scalable storage solution like green hydrogen.

Green hydrogen is increasingly a jewel in the crown of national climate action policies, after decades of failing to take off due to barriers in production costs, transport, demand and competitiveness in the transport sector. At least 13 countries have a national hydrogen strategy in place, and dozens more are considering one or have supported hydrogen projects.

Back in 2016, the Electricity Generating Authority of Thailand announced its 22 MW Lam Takhong wind project with a 1 MW electrolyser to provide 10 hours of clean energy supply to a local building. Now, there are numerous examples of green hydrogen projects under development, from NortH2 in Europe to Saudi Arabia's Neom city.

According to IRENA, around 95% of hydrogen production today is based on methane gas and coal.[20] Future deployment of hydrogen must prioritise green hydrogen. Its production is already technically viable, and will require investment, learning curves and further deployment to reduce the costs of electrolysers and supply chain logistics. Concurrently, the scaling-up of renewable energy capacity in proximity to hydrogen plants will support hydrogen's pathway to cost-competitiveness.

Pushing carbon-intensive assets off the grid

Looking ahead to COP26, one of the key set-pieces for the international negotiations will be the agreement of an effective global carbon tax mechanism. This will provide a crucial ''push'' factor to fossil fuels-dependent markets, going beyond current carbon trading schemes which allow entities to pay to continue emitting carbon. It will also send a strong signal on the urgency of emissions reductions – while net emissions continue to rise annually, the UN has stated that emissions need to rapidly decline by 7.6% annually from 2020 to 2030 to meet Paris Agreement targets.[21]

Case studies provide evidence for the effectiveness of carbon pricing, from the UK's ''carbon price floor'' for fossil fuels generators to the

18. https://www.iea.org/news/a-rapid-rise-in-battery-innovation-is-playing-a-key-role-in-clean-energy-transitions
19. https://static1.squarespace.com/static/5b96538250a54f9cd7751faa/t/5fcf9815caa95a391e73d053/1607440419530/LDES_CA_12.08.2020.pdf
20. file:///C:/Users/joyce/Downloads/IRENA_Green_hydrogen_cost_2020.pdf
21. https://unfccc.int/news/cut-global-emissions-by-76-percent-every-year-for-next-decade-to-meet-15degc-paris-target-un-report

reformed Emissions Trading Scheme (ETS) in the EU. China's newly launched national ETS will be an important step on its road to carbon neutrality and is set to become the world's largest emissions management scheme, with more than 2,200 power generators participating.

There are several challenges around gaining consensus on a global carbon tax, relating to carbon inequities between developing and developed countries, tax at the point of consumption versus production, allocation of revenues and appropriate pricing strategies. According to the IMF, a scheme needs to begin with initially low prices (US$6-20/ton) and then rapidly increase on an annual basis to reach US$40-150/ton by 2050.[22]

At the same time, there is mounting agreement that fossil fuels are immensely under-priced when it comes to the costs of production, air pollution, global warming and environmental impact. A global carbon tax can provide a significant lever to adequately price emissions, incentivise renewables uptake and redirect revenues into green funds for societal benefit.

Potential pinch points on growth in the decade ahead

Looking beyond the urgent policy interventions needed in the next few years, there are several other challenges on the horizon.

Addressing structural barriers in the Global South

The energy transition will adopt a different rhythm and form in every country. But many countries share similar challenges in market design, where investment in wind energy is available but policy conditions undermine the viability of projects. Wind and solar energy already became the cheapest energy options for two-thirds of the global population by the end of the last decade – for these areas, the issues centre on clearing market barriers to get projects through the development pipeline to grid connection.[23]

For the rest of the world, primarily countries in the Global South, renewable energy uptake faces structural barriers, such as energy access shortfalls and affordability gaps in the power sector. Worldwide, 770 million people still lack electricity access, and this is set to shrink only moderately to 430 million people by 2030, with concentration in sub-Saharan Africa and South Asia.[24] The economics of renewable energy, especially for utility-scale wind projects, are tougher in areas with limited customers on the grid.

A dramatic scale-up of wind energy will require international cooperation on grid infrastructure and cross-border interconnection, sustainable land and ocean management, technical standards, supply chain regulation, environmental protection and more.

While decentralised renewable solutions have been the least-cost response to date, an equitable energy transition will require systemic change. Expanding renewable energy in areas lacking power calls for long-term political economy planning, strong regulation of the power sector, innovative financing models to incentivise private investment in renewables and redirection of fossil fuels subsidies to electricity networks and clean energy assets.

An evolving global supply chain

As the wind market expands to new markets, the supply chain continues to evolve. The number of wind turbine suppliers has declined from 63 OEMs in 2013 to 33 OEMs in 2019, according to GWEC Market Intelligence. The top six turbine suppliers now control nearly three-quarters of the global market. More than half of the turbines installed in 2019 were in the Asia-Pacific region, strengthening the existing export hubs of China and India, and giving rise to new suppliers as East Asia and South East Asia markets build their offshore wind capacity.

Similar market consolidation is seen in the gearbox segment, where less than half of suppliers operational eight years ago remain active. In blades, the number of independent and SME suppliers has dwindled due to inability to compete on cost,

22. https://www.imf.org/-/media/Files/Publications/WEO/2020/October/English/ch3.ashx
23. https://www.bloomberg.com/news/articles/2019-08-27/solar-wind-provide-cheapest-power-for-two-thirds-of-globe-map
24. https://www.iea.org/reports/sdg7-data-and-projections/access-to-electricity; https://www.irena.org/newsroom/articles/2019/Dec/SDG-7-Win-Win-for-Ending-Energy-Poverty-and-Protecting-the-Climate

R&D investment and market coverage. As a result, 10 blade producers account for 80% of the total global blade supply today.

The heightened competition for terrain, rare earths and technology ahead raises the risk of price volatility and trade tensions. This can slow down cost reduction and learning curves for the wind industry, while inflating project capex. Concurrently, tariffs and protectionism are now heating up around sectors like battery manufacturing – which need to grow at pace to support the energy transition.

What does political agreement on net zero look like?

A dramatic scale-up of wind energy will require international cooperation on grid infrastructure and cross-border interconnection, sustainable land and ocean management, technical standards, supply chain regulation, environmental protection and more. While the COP process provides a framework for cooperation, much of the multilateral alignment required for the energy transition lies outside the scope of existing mechanisms.

The fuel for this cooperation will be recognition of common aims and mutual benefits. Take grid: Integrated electricity systems are not only a means for countries with low resource potential or system flexibility to gain access to clean energy; they are also a potential revenue stream for countries with significant resource, where the dividends from cross-border power trading can be re-invested for social value creation, such as in public health or education. The EU currently has at least 82 interconnectors across 22 borders, and grid integration is also strong in regions like Central America.[25] In other regions where clean energy demand is on the rise, like South East Asia, interconnection is still in the feasibility stage.

It remains to be seen whether the global expansion of renewable energy will result in greater self-sufficiency and trust-building among states or heightened vulnerabilities and competition. The former could unite a global alliance around the ideals of carbon neutrality, while the latter could yield a realpolitik of transactional cooperation which slows down the transition.

Conclusion

As a mainstream energy source in many parts of the world and in all major energy transition scenarios, wind energy has a responsibility to chart a clear path through the choppy waters ahead. This will require a unified voice on issues of global significance, from carbon pricing to market design, from just transition to circular economy. This also means strong representation in the evolving debate on the nature of energy security.

Wind energy will power the road to net zero, but to get there by mid-century requires credible and intensified efforts in the run-up to COP26 and ahead of the next deadline of NDCs in 2025. As a priority in the near term, the wind industry must work in tandem with its collaborators in the energy transition to increase national ambitions for renewables and raise awareness of their cross-cutting benefits for economies and people.

2021 has begun with lofty expectations, marking the start of the UN Decade of Action and the Decade of Ocean Science for Sustainable Development. It also marks the beginning of the decade which will determine whether we can reach net zero by 2050.

25. https://ec.europa.eu/energy/sites/ener/files/documents/2nd_report_ic_with_neighbouring_countries_b5.pdf

2. Enabling technology: Power-to-X and green hydrogen

Future clean energy systems 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. Power-to-X is set to become one of the breakthrough solutions which will dispatch green power to different end-use sectors to reduce their dependency on fossil fuels, from heating to manufacturing.

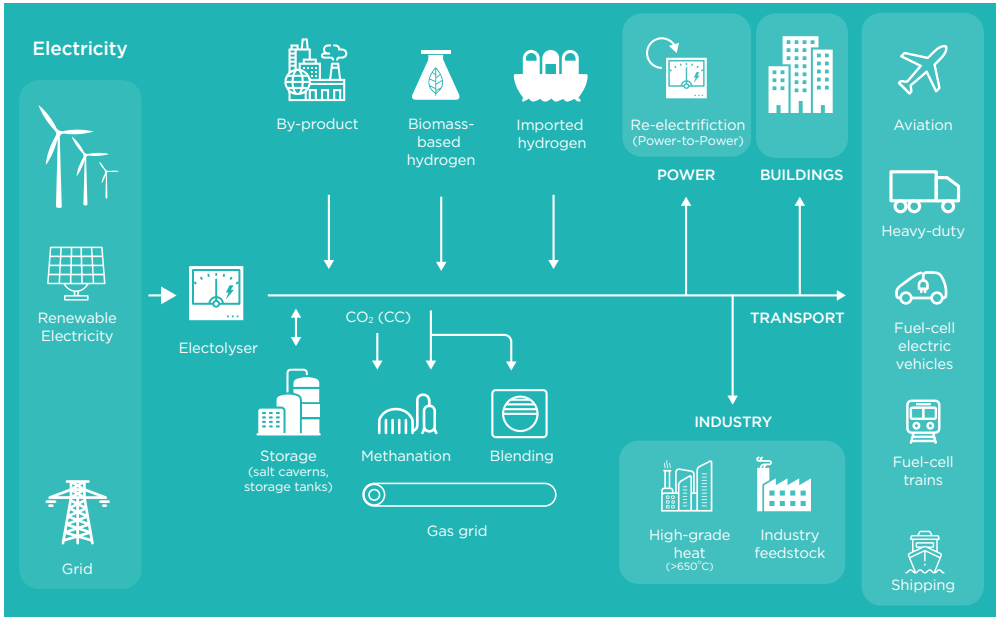
Like many innovative solutions, while technically proven, widespread deployment of Power-to-X must be backed by strong government policies and investment, uptake of new business models by end-users and power grid reinforcement which puts flexibility at the core of generation, transmission and distribution systems. IRENA's Deeper Decarbonisation Perspective, which outlines a path to carbon neutrality before 2060, calls for US$38 trillion in cumulative investment from 2016-2050 for renewable energy (three times the volume of investment under planned policies) and US$27 trillion for electrification, storage and grid infrastructure (double the volume of investment under planned policies).

Concurrent to the transformation of infrastructure to enable grid interconnectivity and sector coupling, the production of green hydrogen as a key storage solution will need to be economically viable. With hydrogen playing a prominent role in national energy strategies, from Germany to Australia to Chile to South Korea, it is no longer meaningful to dismiss it as over-hyped. But it is worth examining the political and economic constraints of Power-to-X and green hydrogen to understand the degree to which they can accelerate the shift to carbon neutrality, and whether we are indeed headed towards the age of the ''hydrogen economy''.

Innovation for multiple end-uses

Power-to-X is a promising and innovative storage solution for wind for a myriad of uses. Stored electricity can be electrolysed into hydrogen to be used as feedstock, to produce bulk chemicals like methanol or ammonia for industrial processes (Power-to-Gas or Power-to-Chemicals) or combined with captured CO_2 to make carbon-neutral liquid fuels such as crude, gasoline, diesel and aviation fuels (Power-to-Liquid Fuels). Stored green power can generate heat through heat pumps or electric boilers for houses and factories (Power-to-Heat), or contained in underground formations such as salt domes and fed back to the gas grid or transformed into electricity when needed (Power-to-Heat and Power-to-Power).

According to the IEA, the power sector accounts for nearly 40% of CO_2 emissions worldwide, and this share is declining due to the expansion of renewable generation; transport and industry make up nearly half of remaining global emissions, with buildings comprising around 10%. Each sector and end-use requires targeted solutions. Energy carriers and chemical products provide significant versatility in renewable energy storage,



transport and subsequent conversion to end-use products. The sector-coupling approach of Power-to-X is a critical response to the "hard-to-electrify" sectors, such as aviation, maritime shipping, steel production and chemicals manufacturing.

Government ambition is in place for green hydrogen to take off

Despite several false starts for hydrogen over the last few decades, 2020 saw several governments integrate hydrogen into pandemic recovery plans and long-term climate strategies. By the end of 2020, at least 33 countries had published or were preparing national hydrogen strategies, including the European Commission's Europe-wide hydrogen strategy targeting 40 GW of electrolyser capacity for green hydrogen by 2030.

Some have hailed the dawn of the "hydrogen economy" – a system-wide application of hydrogen as a storage solution with Power-to-X deploying it to heat homes, create gasses for industrial use and power airplanes and ships. In this scenario, hydrogen is transported via new and existing pipelines and transport channels, exported to different markets and used to make fertiliser, fuel, steam, power and more.

Given the commercial constraints of large-scale deployment and the urgency of the climate challenge, it is likely that hydrogen will need to work alongside widescale electrification to offer a diversified approach to sector decarbonisation, depending on the energy yield and storage option required. Where wind, sunshine and other sustainable energy sources can be harnessed for affordable green power and exported via interconnectors, this will be the cost-effective solution for the power, heating and cooling in buildings, short-distance transport and certain industrial sectors.

Hydrogen-specific targets send positive signals for a future cost reduction pathway. Now, concrete policies and regulation are needed to bring hydrogen to commercial scale, which will reinforce large-scale deployment of renewables and increase balancing capabilities for grids reliant on large shares of renewable power. As costs for electrolysers decline, they can also be used to produce hydrogen with curtailed generation that might otherwise be wasted during particularly windy or sunny periods when renewable supply exceeds demand on the grid.

Production must ensure that net zero is achieved

While much has been made of hydrogen's applications, the key is production: Hydrogen is a clean-burning gas which emits only water at the point of combustion. The emissions challenge is related to production: Conversion of fossil fuels with heat or steam is currently the primary method of production, but this process emits CO_2 and creates so-called "grey hydrogen". Most hydrogen production today is grey, based on methane and coal, and emits 830 million tonnes of CO_2 annually, according to Carbon Brief.

"Blue hydrogen" pairs this process with carbon capture and storage (CCS) technologies which are currently capital-intensive. "Green hydrogen" is produced via electrolysis, fed by green power sourced from an adjacent renewable asset or on the grid.

Expansion and investment of enabling infrastructure for hydrogen must emphasise green production, with support from blue production – this is not only an imperative to meet carbon neutrality goals, but also reflects the economics of declining costs for renewable power, electrolysers and CCS. Driven by R&D and economies of scale in manufacturing facilities, cost reduction and learning rates could make electrolysers 40% cheaper and green hydrogen cost-competitive as soon as 2030, according to IRENA.

A natural match: Wind-to-Hydrogen

Of all renewable energies, offshore wind and wind/solar hybrid projects have the highest potential to improve the economics of green hydrogen projects due to cost-competitiveness and scalability. Onshore wind became one of the cheapest new sources of electricity in 2020, while offshore wind has delivered incredible global LCOE reduction of more than 67% over the last 8 years, according to BNEF, and costs will decline by another third by 2030.

GW-scale wind projects at falling costs, paired with hydrogen, highlight the opportunity to achieve commercial viability by the end of the decade. The pipeline is certainly growing: 2020 saw 50 GW of green

hydrogen projects announced for development, out of a total 80 GW in the global pipeline. The costs for transporting hydrogen through gas infrastructure from offshore sites could also be as, if not more, cost-effective then transporting power through cabling, especially in areas farther out to sea.

The massive NortH2 project (Equinor, Gasunie, Groningen Seaports, RWE, Shell Nederland, with backing from the Groningen provincial authority) off the coast of the Netherlands aims to generate 4 GW of green hydrogen from offshore wind by 2030 and more than 10 GW by 2040, with a feasibility study due by end of 2021.

Green hydrogen innovation is also on the rise: At the top of 2021, Siemens Gamesa announced joint funding with Siemens Energy to develop an electrolysis system integrated into its 14 MW offshore wind turbine for a scalable offshore wind-to-hydrogen solution, with a full-scale demonstration targeted by 2026. A 20 MW green hydrogen facility is also being deployed for a steel pipe facility in Italy, while a 700 MW electrolysis project called Westküste100 brings together end-users including a cement manufacturer, with plans to produce synthetic green fuels for the aviation sector.

On the other side of the world, the massive 15 GW hybrid wind/solar Asian Renewable Energy Hub in Western Australia is expected to deliver first power by 2027. This will scale up to 26 GW of renewable power with green hydrogen and ammonia production for domestic use and export. In Hebei Province, China,

Case study: Is green hydrogen the perfect match for floating offshore wind?

Provided by: Principle Power

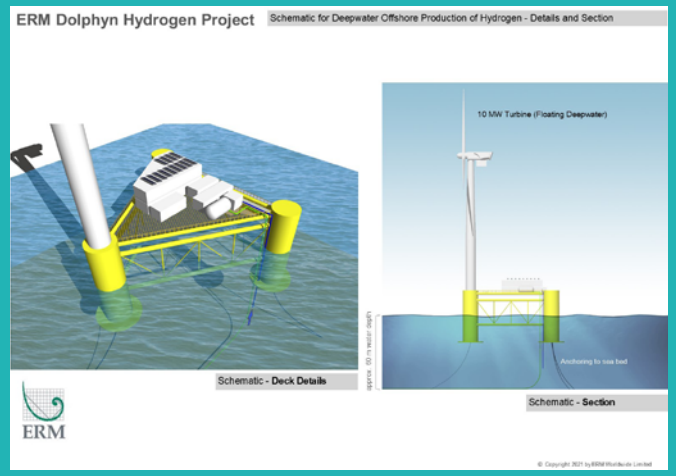
With global energy demand increasing, and an urgent need to decarbonise the current energy mix, hydrogen has emerged as an alternative to fossil fuels that has catapulted to the forefront of the net zero toolbox. Hydrogen energy is extremely versatile, in that it can be stored in either gas or liquid form and can be converted into electricity or transportation fuel when needed, with water as the only by product.

The bulk of hydrogen currently in use is derived from fossil fuel feedstock using energy intensive and polluting processes (grey hydrogen). If hydrogen is to truly deliver on its environmental potential, it needs to be produced from our planet's vast renewable energy resources (green hydrogen).

The ERM Dolphyn project aims to produce green hydrogen from floating wind turbines situated miles out to sea, a world-first.

The design is currently at FEED (front end engineering design) stage and consists of a large-scale floating wind turbine with an integrated water treatment unit and proton exchange membrane (PEM) electrolyser for localised hydrogen production. It incorporates its own standby power unit, supplied by hydrogen stored on the facility, and is therefore completely autonomous, requiring no electrical connection to shore. The first phase is initially aiming to get a 2MW proof of concept unit up and running by 2024.

The concept is being developed and led by ERM with support from industry frontrunners including Tractebel Engie and Principle Power, who are responsible for the floating sub-structure design and the wind turbine. Principle Power's WindFloat® platform will be



equipped with a V80 2 MW wind turbine and a platform deck supporting the hydrogen production factory. The hydrogen will then be exported to shore under pressure via a pipeline.

The Dolphyn concept allows the wind turbines to operate completely independent of the grid, removing the need for complex and costly electrical equipment, and setting the roadmap for cost competitiveness with grey hydrogen. When deployed at industrial scale, this innovative technology, coupling floating wind with hydrogen production, offers the potential to deliver the immense volumes of hydrogen that will be required to decarbonize everything, from electricity to transportation to heavy industry.

a 200 MW onshore wind farm that will use electrolysis to produce 10 MW of green hydrogen is due to be commissioned in 2021.

The unprecedented momentum for green hydrogen worldwide coupled with the improving economics of Power-to-X could provide a much-needed boost to global decarbonisation efforts. This transition will not happen overnight. Renewable plant capex, hydrogen capex (electrolysis, compression and balance-of-plant) and production incentives will be sensitive variables for increasing economic viability. However, technological understanding, urgency and willingness to invest are increasingly aligned across government, industry, financial backers and end-users.

This moment is reminiscent of the renewable energy revolution of the 2000s, which exceeded expectations in terms of cost and growth. Today, with broader commitment from the public and private sectors and a precedence of large-scale innovations, there are strong reasons to be optimistic about Wind-to-X via green hydrogen.

Selected Wind-to-Hydrogen projects under development

Project and Electrolyser Capacity	Location	Developers	Commissioning	Status as of Feb 2021
Asian Renewable Energy Hub (14GW)	Pilbara, Western Australia	InterContinental Energy, CWP Energy Asia, Vestas, Macquarie	2027-28	Utilising 16GW of onshore wind and 10GW of solar, the project is now being fast-tracked through permitting as the federal government has awarded it "major project status".
NortH2 (at least 10GW)	Eemshaven, northern Netherlands	Shell, Equinor, RWE, Gasunie, Groningen Seaports	2040 (1GW by 2027, 4GW by 2030)	Fully powered by offshore wind, feasibility study to be completed by mid-2021.
AquaVentus (10GW)	Heligoland, Germany	A consortium of 27 companies and research institutions, such as RWE, Shell, Siemens Gamesa, Vestas and more	2035 (30MW by 2025, 5GW by 2030)	Early stage, project announced mid-2020.
Murchison Renewable Hydrogen Project (5GW)	Near Kalbarri, Western Australia	Hydrogen Renewables Australia and Copenhagen Infrastructure Partners	2028	Early stage with a demonstration phase ahead that would produce H2 for transport fuels with onshore wind and solar; expansion stages would blend H2 into local natural gas pipelines and produce H2 for export to Asia.
Beijing Jingneng Inner Mongolia (5GW)	Eqianqi, Inner Mongolia, China	Chinese utility Beijing Jingneng	2021	Project using onshore wind and solar, under construction.
Helios Green Fuels Project (4GW)	NEOM, northwest Saudi Arabia	Air Products, ACWA Power, Neom	As early as 2025	Early stage, project announced in mid-2020.
Greater Copenhagen (1.3GW)	Denmark	Orsted, Maersk, DSV Panalpina, DFDS, SAS	2030 (10MW pilot as soon as 2023, 250MW by 2027)	Feasibility study under way for this full offshore wind to hydrogen project, with a view to a final investment decision in 2021.
Fuel Cells and Hydrogen 2 Joint Undertaking (FCH2-JU)	Europe	A consortium of Orsted, Siemens Gamesa, ITM Power and Element Energy	2021-2024	Investigating feasibility of offshore wind and 'fully marinised' electrolysers in a shoreside pilot trial.
'Deep Purple' Seabed Hydrogen Storage Pilot	Norway	A consortium led by TechnipFMC along with Vattenfall, ABB, DNV GL and more	2021-2023	Construction will commence in late 2021.
VindØ	Denmark	A consortium of PensionDanmark and PFA, utility company Andel and CIP	2030	Artificial island with initial 3GW of offshore wind capacity; plan to connect 10 GW offshore wind and host energy storage and Power-to-X facilities.

Source: GWEC Market Intelligence and industry media, February 2021

3. Net zero country case studies

China

In recognition of the strengthening global and domestic consensus behind climate action, China has made a series of climate pledges over the last six months. At the UN General Assembly in September 2020, President Xi Jinping announced that China will upgrade its NDC by targeting peak CO_2 emissions before 2030 and carbon neutrality by 2060. This pledge from the world's second-largest economy and a leading carbon-emitting nation formed one of the key global milestones to tackling climate change since the 2015 Paris Agreement.

The net zero target was followed by a series of commitments to scale up wind and renewable energy capacity, with various ministries and provincial-level bodies now undertaking strategic measures for planning and implementation.

Not all regions will be able to reach peak emissions at the same time. The initiation of China's 14th Five Year Plan (2021-2025) in 2021 requires each province to create its own development plan for renewable energy and timetable for emissions peaking, and earlier achievements may come where onshore and offshore wind capacity is targeted for development. For instance, Jiangsu aims to be the first province to reach peak emissions and is targeting cumulative onshore wind capacity of 12 GW and offshore wind capacity of 15

Six months of momentum to net zero

September 2020
President Xi Jinping announces that China aims for peak carbon emissions before 2030 and carbon neutrality by 2060.

December 2020
President Xi further commits to 1,200 GW of wind and solar installed capacity and 25% share of non-fossil fuels in a primary energy consumption by 2030.

January 2021
MEE (Ministry of Ecology and Environment) requires local governments to set goals for peak emissions and the issues regulations for the national carbon market.

February 2021
NEA (National Energy Administration) releases a notice to raise targets for renewable power utilization for 2030.

February 2021
Provinces begin issuing development plans (2021-2025) for renewable energy and timetables for the peak emissions.

February 2021
The State Council releases guidelines for low-carbon development and green transformation of the economy and society.

Source: GWEC Market Intelligence, February 2021

Carbon reduction commitments made by state-owned generators in China

Company	Peaking Target	Capacity Target
SPIC	Emissions peak by 2023	Clean energy accounts for 60% by 2025 and 75% by 2035
CHN Energy	Emissions peak by 2025	70-80 GW renewables added by 2025
Datang	Emissions peak by 2025	Clean energy accounts for 50% by 2025
Huadian	Emissions peak by 2025	75 GW new energy added by 2025, and clean energy accounts for 60% by 2025
Huaneng	Not disclosed yet	80 GW new energy added by 2025, and clean energy accounts for 50% by 2025 and 75% by 2035
CGN (China General Nuclear)	Not disclosed yet	30 GW renewables added by 2025
CTG (China Three Gorges)	Emissions peak by 2023	New energy reaches 70-80 GW by 2025 and carbon neutrality by 2040

"New energy" refers to non-hydro renewable energy sources. Source: GWEC Market Intelligence, February 2021

Overview of China's Net Zero Plans	
Net-zero target, if any	• Net zero carbon emissions by 2060
Status of the legislation	• Medium-term targets under the net-zero goal will be formulated in Five-Year Plans, including 14th Five-Year Plan (2021-2025)
Public investment announced alongside the net-zero target	• No such announcement available yet.
NDC, as of February 2021	• Lowering carbon intensity by more than 65% by 2030 from 2005 levels
Renewable energy targets	• Reduce share of non-fossil fuels in primary energy consumption to around 25% by 2030 • Increase installed capacity of wind and solar power to more than 1,200 GW by 2030.
Installed wind capacity as of end of 2020	• 272 GW onshore and 9 GW offshore
Key technology strategy on energy transition	• Wind and solar power will take a leading role, with nuclear and hydropower as subsidiary elements • Innovative grid system • Storage, hydrogen, CCS technologies to scale up
Other drivers of clean energy transition	• National carbon trading market will be established in 2021 • Promoting industrial restructuring • Improving energy efficiency (industry, building, transportation, public institutions) • Establishing market mechanisms (pricing, taxes, financial) for low-carbon development • Increasing carbon sequestration capacity

GW by 2025. Guangdong is planning to raise the share of non-fossil fuels in primary energy consumption to around 30% by 2025, when it is targeting cumulative offshore wind capacity of 15 GW.

In October 2020, more than 400 companies in the Chinese wind industry adopted the Beijing Declaration which aims for 50 GW of annual installations from 2021 to 2025 and 60 GW from 2026 onwards. This would bring China's

Case study: How to meet the "Beijing Declaration" targets

Provided by: Techstorm

Last autumn, China announced the plan to reach peak emissions before 2030 and achieve carbon neutrality before 2060. To support this commitment, the wind industry has released the "Beijing Declaration on Wind Energy" with the ambition of installing 3,000 GW of wind power by 2060.

This will require an average annual installation of 50 GW over the next five-year period (2021-2025) and at least 60 GW annually after 2025. At the same time China is scaling down both onshore and offshore wind subsidies. Turbine manufacturers will therefore keep focusing on LCOE reduction.

Techstorm believes that China's targets can be met mainly through the following improvements:

- Development of bigger turbines
- More efficient materials and production processes

As a leading resins and adhesives supplier, used to produce the blades, moulds and nacelles, Techstorm has developed new materials with increased mechanical properties, which help their customers to:

- Increase blade length
- Reduce costs
- Reduce cycle times

In order to meet increasing demand, Techstorm will open a new high-tech factory in Shanghai later this year to increase capacity and efficiency. Additionally, the company is also investigating recyclable materials and packaging solutions and plans to bring these new sustainable options to their global customers soon.

cumulative wind capacity to 800 GW by 2030 and 3,000 GW by 2060.

The tremendous showcase of China's wind industry growth in 2020 shows that 50 GW annually is not only possible, but would bolster the country's progress toward its goal of peak emissions before 2030 and ensure a cost-efficient path towards carbon neutrality in 2060.

Japan

In his first policy address in the Diet in October 2020, Prime Minister Suga declared Japan's ambition to reach carbon neutrality by 2050. This was an unambiguous statement from the newly appointed leader, but will require urgent action over the next few years to deliver.

As the world's third-largest economy by nominal GDP and fifth-largest carbon-emitter, Japan must implement a strict set of reforms to course-correct its emissions while maintaining economic health. Strategies for electrification of industry, transport and buildings will need to go hand-in-hand with market mechanisms like carbon pricing and funding incentives to accelerate the country's coal phaseout and shift to clean energy.

Since its net zero declaration, Japan has initiated a Green Growth Strategy calling for investment in 14 key fields. The strategy also increases the renewable share of power generation target to triple to 50% by 2050, building on its current target of 22-24% by 2030. In 2021, Japan is expected to improve its NDC – currently graded "highly insufficient" for a 1.5°C temperature limit by Climate Action Tracker – which will be a litmus test for the strength of climate-focused public policy interventions ahead.

With 4,437 MW of wind installations as of the end of 2020, including 65 MW of offshore wind, wind energy is becoming a mainstream source of support for Japan to reach its net zero target and decarbonise its heavy industry, such as steel manufacturing and shipping. As a densely populated island nation with complex permitting processes for onshore wind projects, offshore wind has been embraced as a particular solution of choice for large-scale renewable capacity, with opportunities for coupling with hydrogen and ammonia production.

Following strong government-industry coordination, led by the Japan Wind Power Association (JWPA) and GWEC, the government unveiled its Offshore Wind Industry Vision in late 2020. This vision outlines a plan to allocate 1 GW of offshore wind capacity annually through 2030, as well as a supply chain development and cost reduction pathway to reach JPY 8-9/kWh of LCOE by 2035 and 30-45 GW of cumulative capacity by 2040, cementing Japan as one of Asia's offshore wind leaders.

The clear targets, along with the rollout of fixed offshore wind centralised auctions in 2020, are an affirmation of public-sector ambition and confidence. The vision also sets out a long-term goal for 60% local content in the offshore wind supply chain by 2040, providing industry and other actors with enough runway to invest and reorganise. Critical to the success of the centralised auctions will be well-designed grid planning; Japan is aiming to expand grid in locations of high future, based on a forthcoming plan by the Organization for Cross-regional Coordination of Transmission Operators.

The next Basic Energy Policy is due in 2021 and set to reflect

Overview of Japan's Net Zero Plans	
Net-zero target, if any	• Net zero GHG emissions by 2050
Status of the legislation	• Not yet enshrined in national law, though Basic Energy Policy in 2021 is set to outline net-zero roadmap
Public investment announced alongside the net-zero target	• Green Innovation Fund of JPY 2 trillion (US$18.8 billion) over 10 years • Tax incentives to stimulate JPY 1.7 trillion (US$15.9 billion) in private investment
NDC, as of February 2021	• Expected update in 2021 to upgrade NDC from current reduction of 26% total national GHG emissions by 2030 from 2013 levels
Renewable energy targets	• Target 22-24% share of renewable energy in the 2030 power mix • Offshore Wind Industry Vision in late 2020 targets 10 GW cumulative capacity by 2030 and 30-45 GW by 2040
Installed wind capacity as of end of 2020	• 4372.2MW for onshore wind and 65.2 MW for offshore wind
Key technology strategy on energy transition	• "Green Growth Strategy" action plan targets 14 key fields, including offshore wind, electric vehicles and a strategic hydrogen roadmap and electric vehicles
Other drivers of clean energy transition	• From 2030, all new buildings and homes will be subject to zero emissions standards • Aim to increase annual hydrogen consumption to 3 million tonnes by 2030 and 20 million tonnes by 2050 • Aim to achieve 20% use of ammonia as a mixed combustion fuel at thermal power stations by 2030 • Planning for a carbon pricing scheme in progress

greater volumes of wind within an increased 2030 power generation target, as well as a net zero roadmap to 2050. Together, an action-oriented plan for carbon neutrality and programmatic vision for wind energy will reinforce Japan's capacity to achieve its decarbonisation commitments.

Beyond this, the factors which can accelerate the country's clean energy transition include: easing of overly complex permitting processes for onshore wind; availability of land for renewable projects; grid preparedness; change of curtailment rules; the ability to foster a competitive bilateral market for corporate procurement; continued momentum by large trading houses to divest fossil fuel assets and investments; and uptake of clean energy and storage solutions by Japan's heavy industries.

South Korea

With input from: Korean Wind Energy Industry Association (KWEIA)

South Korea's pledge, in October 2020, to reach net zero by 2050 was a major pronouncement from an Asian industrial powerhouse. The target is a tall order for the world's eighth-largest carbon-emitter and fourth-largest coal importer by value, home to significant activity from "hard-to-abate" sectors like steel and shipping. But it turned an election promise of a Green New Deal into a commitment to building a carbon-neutral nation.

In its 3rd Energy Master Plan (EMP) launched in 2019, the government aims to increase the share of renewable electricity from the current 6.5% to 20% by 2030 and then 30-35% by 2040. Implementation of the 9th Basic Plan for electricity to 2030 is expected to strengthen energy regulatory guidelines in line with the new net zero pledge.

To deliver these objectives, South Korea is targeting 9.2 GW of wind power by 2025 and 16 GW by 2030, of which 12 GW will comprise offshore wind. This may be an over-reach, considering the 1.5 GW of onshore wind and 145 MW of offshore wind installed today.

Still, there is no denying the country's ambition. The Moon administration's Green New Deal is a US$60.9 billion stimulus package designed to accelerate the energy transition with solar and wind projects, expansion of electric vehicles and smart green cities. As a signal of rising investor confidence, the government recently announced plans to build the world's largest 8.2 GW offshore wind farm by 2030 primarily financed by private capital.

A promising outlook in South Korea comes with barriers. The country followed its net zero pronouncement with an updated NDC in 2020, which now uses an absolute mitigation target instead of a reduction compared to a BAU scenario. However, the emissions target itself was not strengthened, leading Climate Action Tracker to maintain its assessment of South Korea's NDC as "highly insufficient" to limit global warming to even 2°C.

Additionally, the aggressive expansion of wind and renewables

Overview of South Korea's Net Zero Plans	
Net zero target, if any	• Net zero carbon emissions by 2050
Status of the legislation	• Net zero commitment has not been passed into legislation, as of February 2021. • Various proposed laws relate to net zero, including: (i) the Framework Act on the Implementation of Carbon-Free Society (ii) the Act on the Management of Climate Crisis, (iii) the Act on the Support for the Conversion of Energy, and (iv) the Act on the Promotion of the Green Financing.
Public investment announced alongside the net-zero target	• KRW1.9trillion (US$1.69 billion) to support carbon neutrality strategy
NDC, as of February 2021	• Reduce total GHG missions by 24.4% by 2030 compared to 2017 levels, equivalent to 709.1 $MtCO_2e$
Renewable energy targets	• Increase the share of renewable energy in the power mix to 20% by 2030 and 30-35% by 2040 • Targeting 9.2 GW of wind capacity by 2025 and 16 GW by 2030, including 12 GW of offshore wind • 2040 target of 77.8 GW of renewable energy capacity, including 25 GW of wind
Installed wind capacity as of end of 2020	• 1,500MW for onshore wind and 145 MW for offshore wind
Key technology strategy on energy transition	• R&D for smart grids, energy storage systems and smart heating • Promotion of a hydrogen-based economy
Other drivers of clean energy transition	• Nation-wide Emissions Trading Scheme • Forest management for carbon sinks • From 2020, all new public buildings to be subject the zero-energy standards, and from 2030, all new public and private buildings subject to the standards • Deployment of smart and low-carbon farming practices • Stated intention to create new job opportunities in new, alternative industries and provide re-training support to fossil fuels workers

faces a degree of local opposition and bureaucratic approval processes. As a result of overly complex consenting and under-resourced stakeholder management, offshore wind projects require 5-7 years for development in South Korea.

The government is making efforts to streamline permitting and provide clearer compensation guidelines for local communities with an offshore wind collaboration plan released in July 2020. The plan sets out specific measures to speed up large-scale offshore wind project development and clarify the benefits to local stakeholders:

1. **Government-led siting and streamlined permitting:** Mapping "offshore wind consideration zones" and providing a one-stop-shop to grant all required permits.

2. **Encouraging stakeholder acceptance:** government-led demonstration projects, public consultations and stakeholder participation/ profit-sharing models.

3. **Enhancing industrial competitiveness:** bolstering economic feasibility with low-interest loans, revising the REC scheme, expediting construction and grid connection.

While these measures alone are unlikely to fully resolve the complex challenges around wind growth, South Korea's ambition has exemplified how a country has captured the momentum of a green recovery response to COVID-19 and invested in a more sustainable development pathway. Charged by a powerful engine of political consensus, financial resources and increasing decarbonisation commitments from the country's industrial actors, the wind market is moving into pole position to support South Korea's road to net zero.

India

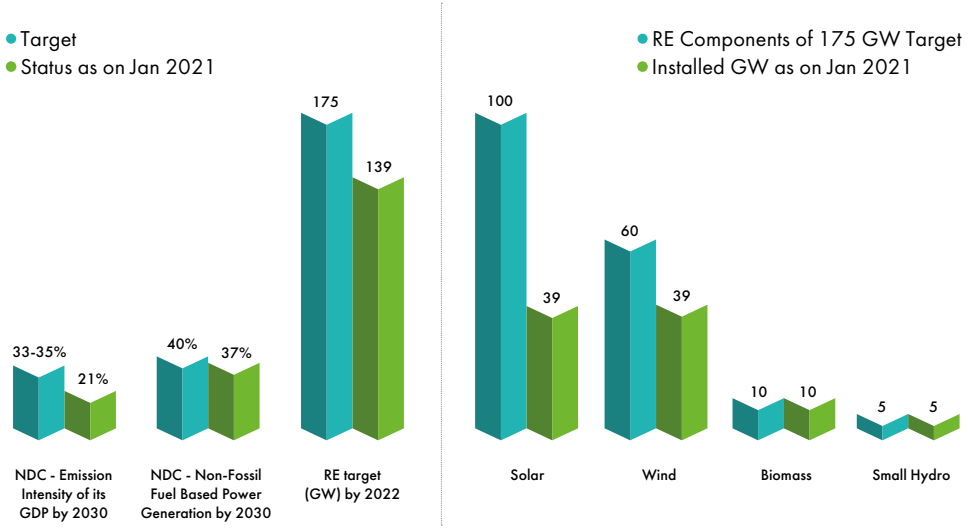
India is the world's fourth-largest energy consumer, and an important vector in the global trajectory to limit global warming. However, with more than 1.35 billion people, its per capita carbon footprint is only around 2 tonnes CO_2e, compared to the footprint of a country like Australia at 17 tonnes CO_2e. Due in part to this issue of "climate equity" and having ambitious renewables targets already in place, India has refrained from setting a net zero target to date.

India's steeply rising power demand has largely been fuelled by coal-fired generation to date. But political shifts have directed India towards a clean energy transition since 2015, when India pledged an NDC of 33-35% reduction in carbon emissions intensity of its economy by 2030 compared to 2005 levels. The country remains vulnerable to the impacts of climate change, with a series of droughts, floods, deforestation and depleting groundwater levels contributing to the shift in public opinion towards sustainability.

As a developing nation, India is still on a pathway to poverty eradication and middle-income status. Nonetheless, it has pursued an ambitious palette of low-carbon programmes, including liberalisation reforms to the power sector, 24/7 green power, clean cooking and energy efficiency.

India's renewable energy target of 175 GW by 2022 includes 60 GW onshore wind. As of February 2021, there was 39 GW of wind capacity

India's clean energy transition progress versus targets



installed, comprising 10.25% of the power mix. Growth of wind over the next five years will be driven by the expiry of the inter-state transmission (ISTS) charges waiver in 2023, as well as the trend of hybrid tenders combining wind, solar and storage technologies. The government has also shared its vision for longer-term renewable energy targets of 450 GW by 2030, including 140 GW of wind.

However, installations are falling short of the levels needed. Climate Action Tracker has deemed India ''2°C compatible'', i.e. on-track to achieve its NDC target and contributing a fair share of the global effort, but still falling short of the deeper reductions required to limit warming to 1.5°C. The government's 2022 targets may also be missed, due to constraints around land allocation, grid availability, recurring financial instability of DISCOMs, tender design and PPA sanctity. Reviving a long-term national mission to scale up wind and renewables by resolving these challenges, such as through increased government-industry coordination and knowledge-sharing, will provide a much-needed boost to the sector.

With wind and solar prices beating fossil fuel-based generation across India's grid, the expansion of affordable renewables can support decarbonisation of energy-intensive industries such as steel, iron, cement, transport and agriculture. Via the National Electric Mobility Mission Plan 2020, the Modi administration has already enacted an aggressive electric and hybrid vehicle scheme and aims to shift railways from coal dependency to the world's first net zero railway network by 2030. The government has also announced that green hydrogen auctions will be launched in 2021, although tender documents have not yet been issued, as of February 2021.

Meeting India's clean energy targets in the absence of a broader carbon neutrality strategy will require urgent and targeted implementation of regulatory reforms. Accelerating wind growth is also in line with the government's principles of Aatmnirbharta (self-reliance) and ''Make in India'' for energy security and supply chain competitiveness. The development of offshore wind and green hydrogen capacity will further support India's shift to a more flexible, resilient and clean energy system.

Overview of India's Net Zero Plans	
Net zero target, if any	• N/A
Status of the legislation	• N/A
Public investment announced alongside the net-zero target	• N/A
NDC, as of February 2021	• Reduce emissions intensity of GDP by 33-35% by 2030 from 2005 levels • Raise renewables to 40% of total power generation capacity by 2030 • Create additional carbon sink of 2.5-3 billion tonnes CO_2e through afforestation by 2030
Renewable energy targets	• 175 GW by 2022, including 100 GW Solar; 60 GW Onshore Wind; 5 GW Offshore Wind; 10 GW Biomass; 5 GW Small Hydro • 450 GW by 2030, including 30 GW of offshore wind
Installed wind capacity as of end of 2020	• 38.6 GW onshore wind
Key technology strategy on energy transition	• Ambitious targets for wind and solar capacity • Round the Clock tenders, including hybrid tenders combining wind and solar with energy storage • National Hydrogen Energy Mission to expand green hydrogen uptake in steel, chemicals and transport sectors
Other drivers of clean energy transition	• Green Energy Corridor, Green Term Ahead Market and 'Aatmnirbhar Bharat' • National Electric Mobility Mission Plan 2020 • National Mission for Enhanced Energy Efficiency • Smart City Mission

Source: GWEC Market Intelligence, February 2021

United States

With input from: John Hensley, Vice President, Research & Analytics and Jesse Broehl, Research Analyst, the American Clean Power Association (ACP)

Currently the net zero goals for the United States are targets and not enshrined in binding federal legislation. The country's federal legislative priorities are first focused on addressing the pandemic and the vast economic disruption it has caused to the US economy.

However, the new administration under President Joe Biden has many levers of power under the executive branch. The administration unveiled a series of Executive Orders (EO) in late January that aim to combat climate change and achieve a carbon pollution-free power sector by 2035 and a net zero economy by 2050.

EOs are actions that a president's administration can put into effect on Day 1 of taking power and can govern wide swaths of the federal government's power, within limits. EOs are limited by existing laws

and can be rescinded by a new president. The EOs represent the most likely consequential government actions in the short and medium term towards achieving net zero emissions, in addition to the already booming market for renewable energy in the US

Deployment of wind and other renewables towards net zero emissions is already strongly underway thanks to non-governmental market forces in the US where wind has been growing relentlessly in recent years. This is expected to continue for the foreseeable future. Some of the actions in EO 14008, dated 27 January 2021, that will promote deployment of wind and other renewables include:

Overview of US's Net Zero Plans	
Net zero target, if any	• Carbon pollution-free power sector by 2035 and a net-zero economy by 2050
Status of the legislation	• Not enshrined in binding legislation yet.
Public investment announced alongside the net-zero target	• See EO 14008 points
NDC, as of February 2021	• The Biden administration will upgrade its NDC from the previous target 26% emissions reductions by 2025 compared to 2005 levels.
Renewable energy targets	• No current federal renewable energy mandate or target • 30 states plus DC and Puerto Rico have a Renewable Portfolio Standard (RPS), with targets ranging from 10-100% and 14 states or territories now have targets of 50% or more • 100% clean energy standards now implemented in 5 states – CA, NM, NV, WA, NY • Seven East Coast states have set a target of over 27 GW of offshore wind cumulatively
Installed wind capacity as of end of 2020	• 122,426 MW of onshore wind and 42 MW offshore wind
Key technology strategy on energy transition	• Rapid growth and large-scale deployment of wind and solar energy, with a wind energy pipeline of 34.8 GW under construction or in advanced development as of December 2020 • Offshore wind is in advanced development in the East Coast • Solar systems incorporating BESS storage to smooth output
Other drivers of clean energy transition	• Net-zeroemissions will rely on market forces, advancing technology, regulation and tax incentives • Biden Administration to establish interagency working group on coal and power plant communities and economic revitalisation brought by clean energy

- **Federal Clean Electricity and Vehicle Procurement Strategy:** Directs the Council on Environmental Quality (CEQ), Office of Management and Budget (OMB) and other agencies to create the Federal Clean Electricity and Vehicle Procurement Strategy, to achieve a carbon pollution-free electricity sector no later than 2035.
  - The EO could include increasing congressional appropriations and extending the ability for most federal agencies to enter into Power Purchase Agreements (PPAs) for durations greater than 10 years. That present limitation has stifled the use of renewables by the federal government because most wind and solar PPAs are 20-year contracts.
- **Renewable Energy on Public Lands and in Offshore Waters:** Directs the Department of the Interior (DOI) to review siting and permitting processes on public lands and in offshore waters to identify steps that can be taken to increase renewable energy production.
- **Fossil Fuel Subsidies:** Directs federal agencies to eliminate fossil fuel subsidies and identify new opportunities to spur clean energy technologies and infrastructure.
- **Sustainable Infrastructure:** Directs CEQ and OMB to take steps to ensure that federal infrastructure investment reduces climate pollution, and to require that federal permitting decisions consider the effects of greenhouse gas emissions and climate change.

Renewables have been a great success story in the US and the good news is that market forces, not government mandates, are the largest contributor behind renewables being deployed at higher rates than fossil fuels in coming years. Wind and solar costs in the US have fallen 70% and 90% respectively over the last decade (and similar rates in other countries), making them the most affordable new electricity sources in most of the US Wind power will play a foundational role, but increasingly solar coupled with battery energy storage systems (BESS), will pay a big role in reducing carbon emissions in the electricity sector.

UK

With input from: RenewableUK

The UK is the global leader in offshore wind with more capacity installed than any other country (10.4 GW). The UK Government has set the industry a target of reaching 40 GW by 2030, which represents a near-quadrupling of offshore wind capacity over the course of this decade. The industry is confident that this can be achieved, as the current total offshore wind pipeline already extends to more than 41 GW. The UK Government also recently set out a target of at least 1 GW by 2030 for floating wind.

Certainty is provided by the landmark Offshore Wind Sector Deal announced in 2019, in which the industry and Government set out a series of joint commitments aimed at maximising industrial and economic benefits of the sector. An example of this is the Offshore Wind Growth Partnership (OWGP), funded by the industry, which is investing £100m in building a strong UK supply chain over the course of this decade.

Prime Minister Boris Johnson has called for a Green Industrial Revolution after the pandemic and has set out a Ten Point Plan to achieve this, with offshore wind at the top of the list. This chimes with wider Government policy; in 2019, the UK was the first country to adopt a legally-binding target of net zero greenhouse gas emissions by 2050, compared to 1990 levels. The UK's NDC under the Paris Agreement is to reduce emissions by at least 68% by 2030.

Reaching net zero emissions as fast as possible will require significant investment in electricity infrastructure. Investment in a smart, flexible grid is vital and RenewableUK is urging the UK regulator Ofgem to put net zero at the centre of every decision it makes, to benefit current and future consumers.

This year the UK has a golden opportunity to highlight its role as global leader in renewable energy as host of COP26 in Glasgow. Government policy supports the development of renewables, especially by backing auctions for contracts to generate clean power, known as Contracts for Difference (CfDs). Although onshore wind was excluded from these auctions in 2015, it will take place in the next round to be held before the end of this year, following campaigning by RenewableUK to highlight its role as one of the cheapest forms of new power.

In its Sixth Carbon Budget published in December, the Government's adviser, the Climate Change Committee, suggested almost doubling UK onshore wind capacity to 25-30 GW by 2050. The industry believes it can reach 30 GW sooner, given the current pipeline. Overall, the industry expects that this year's CfD auction will support up to 12 GW of new renewable capacity, unlocking over £20bn of new investment in the economy.

Looking ahead, green hydrogen generated by offshore wind will become a significant new power source alongside innovative technologies such as floating wind, provided that the Government's policy framework encourages the deployment of these technologies. The UK already has the world's largest floating wind farms with 30 MW of operational capacity in Scotland and a further 150 MW in the pipeline in Scotland and Wales. The industry believes it can exceed the Government's target of 1 GW of UK floating wind by 2030, and is aiming to install 2 GW by 2030 and at least 20 GW of floating capacity by 2050.

Overview of UK's Net Zero Plans	
Net zero target, if any	• Net zero GHG emissions by 2050
Status of the legislation	• Legally-binding commitment passed by UK Parliament
Public investment announced alongside the net-zero target	• Ten Point Plan of the Green Industrial Revolution includes £12 billion of government investment • Aims to mobilise triple that amount from private investment, to support up to 250,000 green jobs
NDC, as of February 2021	• Reducing GHG emissions by at least 68% by 2030, compared to 1990 levels
Renewable energy targets	• 40 GW of offshore wind installed by 2030, including 1 GW of floating wind • Government adviser the Climate Change Committee suggests almost doubling UK onshore wind capacity to 25-30 GW by 2050 • 5 GW of low-carbon hydrogen production by 2030
Installed wind capacity as of end of 2020	• 13,740 MW of onshore wind and 10,415 MW of offshore wind
Key technology strategy on energy transition	• Offshore wind will be the backbone of the UK's energy system by 2030, alongside green hydrogen generated from offshore wind, onshore wind and floating wind • Smart, modernised grid for power flexibility
Other drivers of clean energy transition	• Clarity on carbon pricing mechanisms • Shift to electric vehicles • Greener buildings and improving energy efficiency • Other measures captured in the Ten Point Plan

South Africa

With input from: South African Wind Energy Association (SAWEA)

As a signatory to the Paris Agreement, South Africa has committed to reaching peak GHG emissions by 2025, whereupon it outlines that emissions should plateau and decline. The energy sector contributes close to 80% of the country's total GHG emissions, of which 50% are from electricity generation and liquid fuel production alone.

In 2020, the South African Government approved the Low Emission Development Strategy (LEDS), which commits to various interventions which ultimately move towards a goal of net zero carbon emissions by 2050. President Cyril Ramaphosa reaffirmed this commitment in his State of the Nation address in February 2021, when he stated that national utility Eskom, the country's largest GHG-emitter, has committed in principle to net zero emissions by 2050 and to increasing its renewable capacity.

The increase in renewable energy capacity is prioritised in South Africa's key planning documents, including the National Development Plan which commits to 30 GW of renewable energy by 2030. It is supported by the Integrated Resource Plan (IRP) 2019 which prioritises renewable energy, energy efficiency and public transport, and specifically targets 20.4 GW of renewable energy (14.4 GW of wind and 6 GW of solar PV) by 2030.

The key consideration for South Africa's net zero trajectory is the reduction of demand for coal resources, which has provided an economic anchor for provinces like Mpumalanga. The IRP 2019 stipulates that, to ensure a socially just transition, an engagement process must mitigate against adverse impacts of plant retirement on people and local economies.

Wind energy will have a significant role to play in achieving the country's net zero commitments. Due to cost-competitiveness and reduction in tariffs over the past decade, the technology has been allocated 14.4 GW in IRP 2019, which translates to about 50% of the new generation capacity planned for this decade and about 18% of the total installed capacity by end of 2030. South Africa is currently undergoing an energy crisis, resulting in part from reduced energy availability due to the existing fleet of coal power stations nearing end of life. Without additional capacity, Eskom estimates an electricity supply shortfall of between 4-6 GW over the next five years.

Currently, energy planning in South Africa is such that annual build limits are imposed on renewable energy, in order to facilitate a gradual and just energy transition. This will restrict the cumulative renewable installed capacity and the energy mix for this period. Moreover, IRP 2019 tested a scenario with no annual build limits on renewables and established that this scenario provides the least-cost option by 2050.

Although IRP 2019 extends to 2030, it is assumed that wind power will constitute an even larger share of new generation capacity beyond this decade. To meet the net zero target by 2050, energy planning policy will need to be implemented consistently. This goal will require action and coordination from private and public sectors to be successfully realised. Necessary actions from government include easing of the regulatory environment, implementation of approved policies and creating a conducive environment for private-sector investment.

Overview of South Africa's Net Zero Plans	
Net zero target, if any	• Vision to reach net zero carbon emissions by 2050.
Status of the legislation	• Not yet enshrined in law • Related Climate Change Bill is drafted and awaiting passage into legislation
Public investment announced alongside the net-zero target	• Specific net-zero investment strategy not yet announced.
NDC, as of February 2021	• Limiting GHG emissions 17-78% above 1990 levels by 2030 • Reach peak, plateau and decline of GHG emissions by 2025
Renewable energy targets	• 14,400 MW new onshore wind capacity between 2022 and by 2030 (cumulative wind capacity would be 18% of the total power mix by 2030) • 6,000 MW new solar PV capacity by 2030
Installed wind capacity as of end of 2020	• 2,495 MW onshore wind
Key technology strategy on energy transition	• An energy mix of onshore wind and solar PV, supplemented by battery storage and gas.
Other drivers of clean energy transition	• Energy efficiency, clean transport and solar water heaters • Carbon taxation and budgets • Sectoral-based emission targets • REIPPPP programme to raise climate finance • Municipal green bonds released by Cape Town and Johannesburg, and other green finance innovative mechanisms

4. Oil and gas producers: The path to net zero

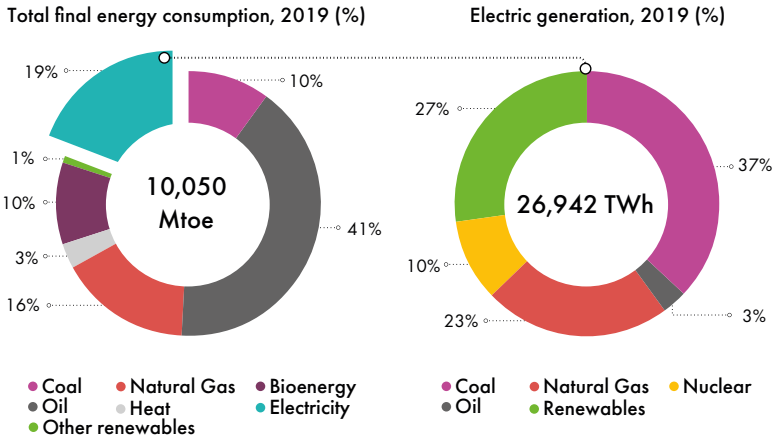
There is clear and unequivocal agreement that oil and gas consumption needs to be steadily and sharply reduced over the next three decades for the world to reach an energy pathway compliant with 1.5 °C and 2 °C scenarios.

"Peak demand" for oil has arguably arrived. In its annual report about the future of energy in 2020, BP affirmed that worldwide demand for oil may have already peaked and that the fossil fuel industry now faces a slow but inevitable decline over the coming decades. Demand for hydrocarbon-based fuels has been the hardest hit by COVID-19. By October 2020, the IEA assessed that global energy demand was set to drop by 5% in 2020, with estimated falls of 8% in oil demand and 3% in natural gas demand standing in sharp contrast to a rise in the contribution of renewables.

The climate imperative is permeating the investment community, shareholder actions, policymaking and regulation, meaning that companies traditionally focused on oil and gas production need to transition their business models to maintain a license to operate in a carbon-neutral future. The need to rapidly reallocate investment from hydrocarbon exploration and refining to renewable energy production, and in particular power generation, poses strong challenges for oil and gas companies.

But this transition presents equally significant opportunities. Over the last few decades, many leading players had amassed positions in renewable power generation and either shifted their focus away due to insufficient maturity or profitability, or maintained relatively small positions in their overall portfolios. Now, however, all the major oil and gas companies – with the exception of US-based outliers Exxon and Chevron – are seeking to shift capex investments into renewable energy and electrification, or renewable energy plus hydrogen businesses.

Global final energy consumption in 2019



Source: IEA World Energy Outlook 2020

Why set carbon neutrality targets?

The global energy system is still based on fossil fuels, despite GHG reduction and climate change mitigation becoming increasingly central focal points for global political action since the Kyoto Protocol was signed in 1997. Since the 2015 Paris Agreement, energy-related CO_2 emissions have risen by around 4%; the IEA even found that energy-related carbon emissions fully rebounded from the impacts of the pandemic, with December 2020 emissions 2% higher than the same period in 2019.

According to the IEA's World Energy Outlook 2020, oil and gas remain the world's two primary energy sources, accounting for more than half of total primary energy demand in 2019. Oil and gas extraction and processing, and the subsequent transport of oil and oil products to end-use consumers, were responsible for nearly 15% of global energy sector GHG emissions in 2019. The oil and gas sector is a key contributor of CO_2 and methane (CH4) emissions which are accelerating global warming. To reach carbon

neutrality, we need a systematic and radical energy transition from fossil fuels to renewable energy and low-carbon solutions. It is crucial and urgent for oil and gas companies to make credible net zero commitments, participate and even lead this transition.

How can oil and gas producers participate in the path to net zero?

As highlighted in the "Wind energy in long-term energy scenarios" section of this report, net zero and IPCC-compliant scenarios can only be realised through significant energy system changes (a major ramp-up in efficiency and fuel-switching to low-emission electricity and low-carbon fuels) and behavioural changes. The power sector will provide the bulk of emissions reductions via electrification, which will in turn drive the decarbonisation of end-use sectors like industry, short-duration transport and buildings.

Renewable energy sources such as onshore and offshore wind shoulder much of the responsibility for large-scale green power generation and displacing fossil fuels-based generation, such as coal, oil and gas.

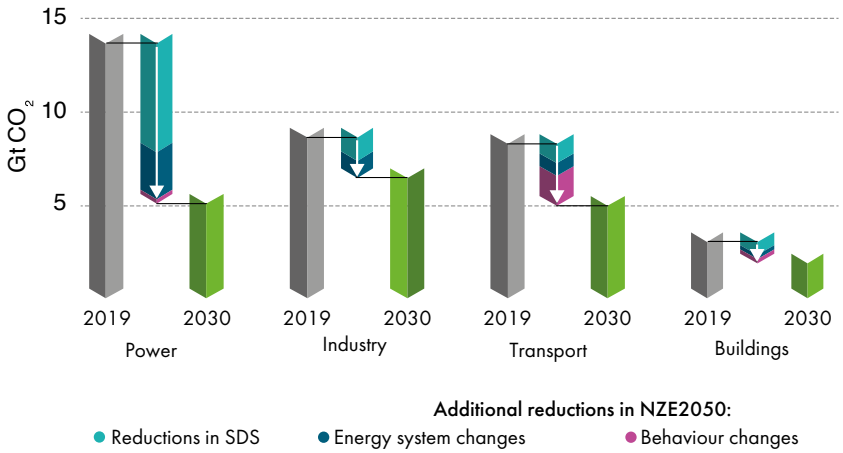
While efficiency gains and electrification deliver most of the reductions in energy-related CO_2 emissions in the industry sector, green hydrogen also makes a significant contribution. Alongside a shift in road transport from fossil fuels to battery-based and fuel cell-based electric vehicles, as well as extensive use of biofuels for aviation and shipping, these innovations will converge to deliver cross-sector GHG emissions reductions – and each transition area presents opportunities for oil and gas companies to participate.

Challenges and opportunities of oil and gas companies in transition

The transition from hydrocarbon exploration and refining to renewable energy poses strong challenges for oil and gas companies:

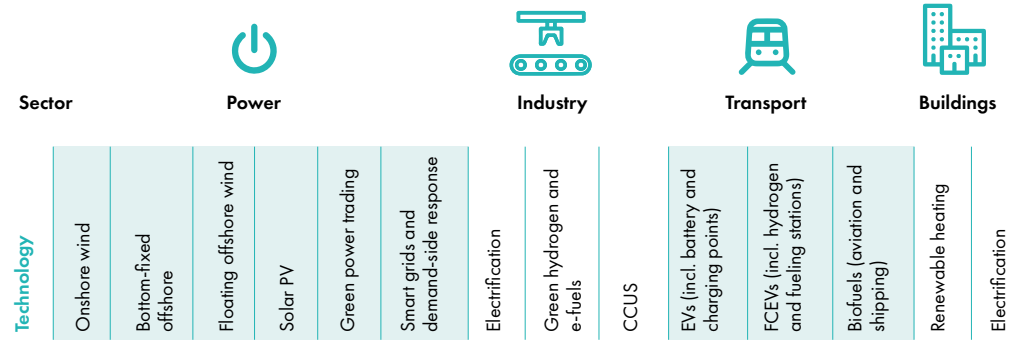
- **Shareholder expectations** based on previous cyclical high margins which have so far not been met by "utility" type returns from long-term investments in renewable power generation – although one should note that return expectations of investors from oil and gas are falling and could arguably fall to "zero".
- **Businesses models** which are driven and calibrated on redundant metrics, most notably hydrocarbon reserves and the ratio of company hydrocarbon reserves to annual production.
- **Scalability:** Despite many oil

CO_2 emission reductions by sector in the IEA's NZE2050 scenario, 2019-2030



Source: IEA World Energy Outlook 2020

Technologies and low-carbon solutions contributing to net-zero



Source: GWEC Market Intelligence, March 2021

Case study: Leveraging Oil and Gas experience to build the talent pools of the future

Provided by: NES Fircroft

NES Advantage (part of NES Fircroft) has had a long-standing partnership with Aker Solutions and is their staffing partner of choice, enabling Aker to achieve its strategic objectives by supplying highly skilled engineering and technical personnel across all parts of the business. Aker Solutions has an outstanding pedigree in the Oil and Gas market, and in recent years it has begun to leverage its experience and capabilities in this sector to transition the business to support sustainable energy production. In 2020 Aker tasked NES Advantage with sourcing staff that could support their renewables division, as they began to apply their long experience, together with their strong platform for project execution, to chase potential wind projects in Norway, the US and the UK.

As an example, Aker Solutions is already in the execute phase of the Hywind Tampen project in Norway, designing and building floating concrete hulls which will carry wind turbines. The project scope also includes assembly site management and installation of the floating wind turbine units offshore. Whilst the source of power may be different from Oil and Gas Industry, Aker has the necessary experience and expertise to build and install offshore structures.

NES Advantage is experienced in both the traditional and new energy markets and could apply their recruitment expertise combined with their global reach to quickly build a talent pool of suitable candidates for the Hywind Tampen project, with skill sets in project management, process engineering and planning, which could be applied to new sustainable projects. Campaigns focused on sourcing local talent as much as possible and mobilising specialist skillsets from around the world where needed.

This approach to talent management was complemented by upskilling the existing workforce to ensure Aker's talent is retained and the Group is perfectly positioned to deliver on its commitment to finding solutions which bring energy resources safely and cost effectively into production, whilst minimising the environmental footprint.

Aker Solutions has found they are well placed to act as the integrator on large wind projects, and with the support of NES Advantage the company has been able to build a team with skillsets sourced from both the Oil and Gas and the Renewables industries, supporting Aker's vision to #powerthechange to sustainable energy production.

and gas companies being rich in terms of financial resources, assets and revenue generation, it is not easy to scale organically in the renewable generation business due to the structural problems of growth addressed elsewhere in this report, and they will thus be pushed into the M&A space if they are to achieve rapid reallocation of capital. This, in turn, can produce strong competition for assets and inflation in company valuations and asset prices.

- **Competition from established renewables players**, including the new "renewable energy supermajors". A number of established utility-scale wind producers have been achieving scale, sometimes over two decades, formidable skills, operational teams and capex resources, built on a sustainable structure of shareholdings and margin expectations.

- **Credibility**: Oil and gas majors must also ensure net zero strategies avoid increasing fossil fuel extraction in the near term, while heavily depending on carbon removal technologies and offsetting to meet long-term targets.

Nevertheless the clean energy transition brings equally significant opportunities, value creation and socioeconomic benefits. Looking at the technological solutions on the road to net zero, some oil and gas companies have extensive relevant knowledge, know-how and experience which complements the need for renewable energy development. For example:

- **Offshore wind:** where foundation design and manufacturing, offshore construction and installation, vessel operation and subsea O&M are similar to the oil and gas industry. The economic effects of the transition into renewables through support of re-skilling and workforce development programs will not only outweigh the net loss of jobs in the oil and gas sector, but will bring sustainable value to society.

- **Floating offshore wind:** The current three basic floating base types used for floating offshore wind are derived from oil and gas industry, so investment into this particular sector can accelerate the pace of commercialisation and industrialisation of floating wind.

- **Large project engineering, delivery and budget control:** Oil and gas companies hold unparalleled skills in delivering huge engineering projects, which can help to ensure utility-scale wind projects are delivered safely and on budget.

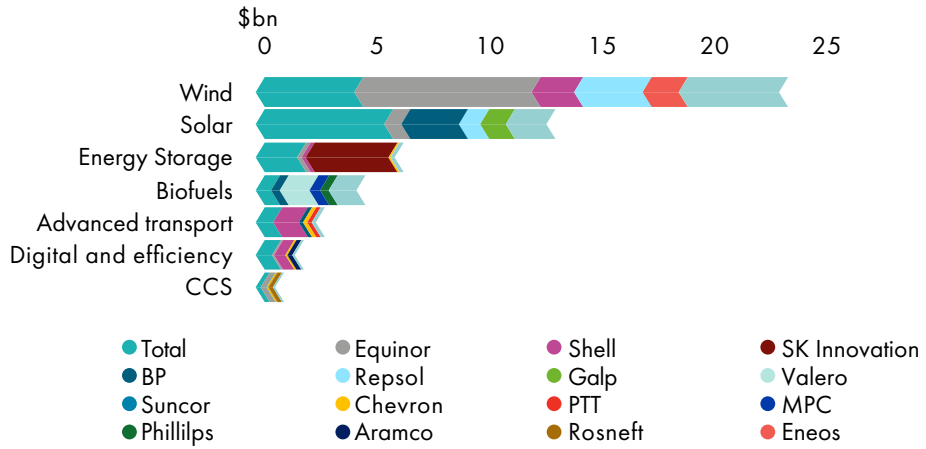
- **Global scale, capex and ability to raise finance:** Major oil and gas players can leverage their financial strengths such as the strict financial hurdle rate, which is equal to the company's costs of capital, to improve the returns on renewable investments.

- **Hydrogen:** Oil and gas producers have been providing blue hydrogen as feedstock to the industries like chemicals production and will know how to blend green hydrogen into existing gas pipelines for transport to end-users.

- **Power-to-X:** Major oil and gas companies can view the energy spectrum holistically and adopt system-wide approaches such as Power-to-X solutions which use renewable energy to

Photo Credit: Principle Power

Oil and gas sector investment in low-carbon technologies, 2015-2020



Source: BloombergNEF, company reports

Oil and gas companies' net zero commitments and renewable targets

Selected companies	Climate change targets	Renewable investment targets
BP	• Net zero by 2050 • Carbon intensity 50% lower in 2050 compared to 2019 levels	50 GW renewable installations by 2030
ENI	• Carbon intensity 50% lower in 2050 compared to 2018 levels	4 GW renewable installations by 2024, 15GW by 2030 and 60 GW by 2050
Equinor	• Net zero by 2050 • Reduce net carbon intensity to zero by 2050	4-6 GW renewable installations by 2026 and 12-16 GW renewable installations by 2035
Repsol	• First oil and gas company to target net zero by 2050 • Carbon intensity 20% lower in 2030 and 40% lower in 2040 compared to 2016 levels	7.5 GW low carbon power capacity by 2025, and 15GW by 2030
Shell	• Net zero by 2050 • Reduce carbon intensity of energy products by 100% by 2050 compared to 2016 levels	Investing $2-3bn a year in renewables and energy solutions including hydrogen, and doubling electricity sales by 2030 from current levels
Total	• Net zero by 2050 • Carbon intensity 60% lower in 2050	35GW renewable installations by 2025 and 100GW of renewables capacity by 2030
Petronas	• Net zero by 2050	3GW renewable installations by 2024
CNOOC	• Emissions peaking and carbon neutrality plan being drafted	Clean energy accounts for 60% of its energy mix by 2025

Source: GWEC Market Intelligence, March 2021

decarbonise industry and transport.

- **Experience in global operations, energy production, trading, services and networks:** Major oil and gas companies have a "deep" spread of operations across energy production, trading and retail, with customer relations and brand reach to billions of consumers. Their global footprint and public affairs capability can be brought to bear to accelerate a clean energy transition. Some Europe-based actors are transforming themselves into electricity or energy companies with green power and hydrogen as green commodities. Big oil and gas producers also operate fuelling stations across the world, offering networks and experience which can be transferred to electric vehicle charging and fuel-cell electric vehicle hydrogen-fuelling.

Recent BloombergNEF data shows that wind energy received US$22 billion in investment from a green push by oil and gas companies between 2015 and 2020 – a great deal more than any other low-carbon technology during this period. Still, only 4.3% of total oil and gas sector capex was invested in low-carbon assets and technologies in 2020 – a more meaningful reallocation of investment will be needed to for the global oil and gas sector to truly pivot to clean.

Commitments made by leading oil and gas producers

Under the environmental, social and economic pressures from growing net zero momentum and the COVID-19 pandemic, an increasing number of oil and gas producers are changing corporate growth strategies and investment portfolios.

There is still a concern about whether growth and emissions reduction targets are achievable;

some renewable development targets are fairly ambitious compared with current clean energy supermajors such as Enel Green Power and Iberdrola. However, what Ørsted (formerly Danish Oil and Natural Gas, or DONG) has accomplished in the past two decades has proven that a radical energy transition plan can be successfully executed by an oil and gas company.

To reach carbon neutrality, we need a systematic and radical energy transition from fossil fuels to renewable energy and low-carbon solutions.

Aside from technological solutions, large oil and gas companies are increasingly looking to M&A, cooperative projects and joint ventures to build renewable energy positions and expertise. A number of companies have invested large volumes of capex in wind and Power-to-X projects, particularly offshore wind.

Oil and gas companies' net zero targets and increasing volume of transactions in the renewables sector demonstrate willingness to undertake the challenges of the energy business transition. This shift will be an irreversible one, and will need to accelerate to reflect seriousness about the fundamental changes required for a net zero pathway.

Oil and gas companies' low carbon strategies and solutions

Companies	Onshore wind	Bottom-fixed offshore	Floating offshore wind	Solar PV	Green power trading	Green Hydrogen	CCUS	EVs	FCEVs	Biofuels
BP	•	•	•	•		•	•	•		•
ENI	•	•		•	•	•	•	•	•	•
Equinor		•	•	•		•	•	•		•
Repsol	•		•	•	•	•	•	•		•
Shell	•	•	•	•	•	•	•	•	•	•
Total	•	•	•	•	•	•	•	•	•	•
Petronas	•		•	•		•	•			
CNOOC		•				•	•	•	•	•

Source: GWEC Market Intelligence, March 2021

Recent wind transactions by major oil and gas companies

Company	Fixed bottom offshore	Floating offshore wind	Power-to-X
Equinor	• Portfolio of projects in the UK, Germany, Poland, the US and South Korea • Divestment of Dogger Bank A and B stakes in the UK to Eni • Divestment of Empire Wind and Beacon Wind stakes in the US to BP	• Pioneer in floating wind, with project installed in the UK • Building a floating wind farm in Norway to be commissioned in 2022 • Development of floating project in South Korea	Partner of NortH2 green hydrogen project in the Netherlands
BP	• Entered offshore wind market with a US$1.1 billion deal to acquire 50% of Empire Wind and Beacon Wind in the US from Equinor • Together with EnBW, selected as big winner in UK offshore wind Round 4	• Floating offshore wind opportunities with Equinor in the US	Partner with Ørsted to develop a hydrogen project in Germany
Shell	• Majority shareholder of Hollandse Kust farm in the Netherlands • Projects in US East Coast through 50:50 joint venture with EDPR	• Investment in TetraSpar project in Norway • Majority stake of Emerald floating wind project (1 GW) in Ireland • Co-developing project with CoensHexicon in South Korea	Partner of NortH2 green hydrogen project in the Netherlands
ENI	• Acquired 20% of Dogger Bank A and B from Equinor and SSE Renewables • Cooperation with Equinor on offshore renewable solutions		Eni and Enel announced cooperation to develop green hydrogen projects
Total	• Acquired 51% of Seagreen 1 in the UK from SSE Renewables • Together with GIG, selected in UK offshore wind Round 4	• Purchased 80% of Erebus floating wind project in the UK • Co-developing 2 GW floating wind project in South Korea with GIG	Developing a green hydrogen plant in France with ENGIE

Source: GWEC Market Intelligence, March 2021


Photo Credit: Equinor

Case study: Leading the way in the energy transition

Provided by: Equinor

Equinor aims to be a leader in the energy transition by building the energy industry of tomorrow and becoming a net zero company by 2050. The strategy demonstrates Equinor's continued commitment to long-term value creation in line with the Paris Agreement.

In 2020 Equinor announced its ambition to achieve carbon neutral global operations by 2030 and become a net zero energy company by 2050. The 2050 ambition includes emissions from production and final consumption of energy. To deliver on the ambitions, Equinor will:

- Continue to reduce emissions from oil and gas production
- Grow renewable energy
- Develop low-carbon technologies like CCS and hydrogen

Equinor will maintain its industry-leading role in carbon efficiency by continued reduction of CO_2 from production and achieving carbon neutral global operations by 2030. The main priority will be to reduce GHG emissions from own operations.

In 2026, Equinor expects production capacity from renewable projects of 4 to 6 GW, mainly based on the current project portfolio. This is around 10 times higher than today's capacity, implying an annual average growth rate of more than 30%. Towards 2035, the company expects to increase installed renewables capacity further to 12 to 16 GW, dependent on availability of attractive project opportunities. As a global offshore wind major, Equinor is building material offshore wind clusters in the North Sea, the US East Coast and in the Baltic Sea. The company is currently progressing the biggest offshore wind farm development in the world, Dogger Bank (3.6 GW) as well as developing Hywind Tampen; the first floating offshore wind farm to supply renewable power to offshore oil and gas installations.

Achieving net zero emissions by 2050 requires a well-functioning market for carbon capture and storage (CCS) and natural sinks, as well as the development of competitive technologies for hydrogen. Equinor is driving the development of these technologies through projects such as Northern Lights, which aims to store CO_2 from industrial sites across Europe. The project will be developed in phases where the first phase includes capacity to transport, inject and store up to 1.5 million tons of CO_2 per year. Equinor is also engaged in developing the hydrogen value chain through participation in several project partnerships with the aim to realize the development of value chains for both "green" and "blue" hydrogen. In 2020 Equinor joined Europe's biggest green hydrogen project, the NortH2 project which aims to produce green hydrogen at large scale using renewable electricity from offshore wind off the coast of Netherlands.

Climate change is a shared challenge. The combined efforts of governments, industries, investors and consumers are crucial to reaching net zero emissions, for Equinor and for society. Together, we can overcome technological and commercial challenges, cut emissions, and develop CCS and zero-emission value chains for a net zero future.

For more information about Equinor's plans to reach net zero, see:
https://www.equinor.com/en/how-and-why/climate.html

5. Sustainability in the wind energy industry

Given the unparalleled stakes of the climate challenge, every stakeholder holds responsibility to adapt to a more sustainable path. Non-state actors, including wind energy companies of all sizes, must be accountable to the imperatives of decarbonisation, particularly as the industry calls for a massive scale-up of wind projects and related industrial activity.

There are increasingly strong business incentives to decarbonise, reflected in hardening retail and institutional investor sentiment on corporate sustainability. In 2020, the market for socially responsible impact investing funds, or ESG ETFs, reported a record influx of US$89 billion – almost nine times the level from 2018, according to Bloomberg Intelligence. Governments are also stepping forward to decarbonise industrial value chains, from enabling green power procurement to implementing zero-emissions building standards.

It no longer suffices to be a member of a sector focused on climate change mitigation; wind companies themselves must ensure growth does not come at unchecked cost. In short, the industry's own sustainability guarantees its "license to operate" in a carbon-neutral world.

Lifecycle environmental impacts of wind projects

As stewards of the fight against climate change, the wind industry must deploy optimal technology and processes, while minimising waste and decarbonising a supply chain which includes materials from "hard-to-abate" sectors like steel and cement. A full cradle-to-grave lifecycle assessment captures the emissions to air, water and land from a wind project, across manufacturing, transport, installation and decommissioning stages.

Lifecycle analysis shows that the carbon emissions payback period for wind is far shorter than for coal-based plants – about 5.4 months for a 2 MW onshore turbine and 7.8 months for a 6 MW offshore turbine, as of 2016 – and even outperforms hydro and solar generation. The manufacturing and installation stages account for over 90% of the total carbon emissions of an onshore wind farm and 70% of carbon emissions for an offshore wind farm (where shipping transport takes up a larger share).

More than 80% of total wind turbine mass is made up of recyclable materials, such as steel,

Circular economy theory of wind turbine blades

Source: GWEC Market Intelligence, March 2021

iron, copper and aluminum, according to NREL. But anywhere from 11-16% is composed of carbon fibre or fibreglass composites, plastics and resin, primarily for rotor blades which have a life expectancy of up to 25 years and are currently difficult to recycle commercially. These figures may be adjusted as turbine designs adapt, hub heights increase, blades become longer and lighter and components become more resilient or are replaced by more easily recyclable materials.

This is a particular challenge in mature onshore wind markets – Europe is home to nearly 12,000 wind turbines expected for decommissioning by 2024. While repowering should be pursued, the original blades, hubs, generators and gearboxes will need to be sustainably retired, reused or recycled. Industry-led initiatives like ZEBRA for zero-waste blade production and DecomBlades for recycling technologies are helping to close the loop.

As wind companies expand auditing to Scope 2 and 3 emissions across upstream and downstream activities, covering not just green electricity and transport but the emissions from manufacturing of components, pressure increases on the value chain for steel, cement and certain chemicals. These industries require enormous amounts of electricity at constant periods, providing a natural complement to affordable and large-scale wind power, particularly when paired with storage solutions. Greater coordination with upstream adjacent sectors is needed to jointly call for policy reforms that can unlock wind power at the scale of growth required for supply chain decarbonisation.

A paradigm shift in business

If carbon neutrality by 2050 is the grand challenge, industry sustainability calls for a multitude of action plans at the company level. The Science-Based Targets initiative (SBTi) provides a transparent and standardised measurement for companies moving towards net zero goals in line with a 1.5°C pathway. Today, well over 1,200 companies spanning 60 countries are working with the SBTi to reduce their emissions, but this volume must rise exponentially to constitute a true shift in how we do business.

The wind industry is a leader in this respect: Ørsted transformed over the last decade from a fossil fuels company to the world's highest ranked sustainable corporation, according to Corporate Knights 2020 rankings, where Iberdrola, Vestas, Siemens, Acciona, ABB and other energy companies appear in the top 50. Notably, these companies are driving comprehensive sustainability strategies that cover not only environmental impacts but social goals as well. Workforce inclusivity and diversity of all dimensions (gender and ethnicity among others) will be critical for ensuring sustainability is reflected at all levels and geographies of the industry, and that this continues as the industry expands.

A message from the UN's Race to Zero campaign: Building climate action momentum in the run-up to COP26

We encourage companies to join the UN-backed, global Race to Zero campaign. In doing so, companies will demonstrate the credibility of their sustainability commitments and highlight their taking immediate, meaningful action. This campaign, led by the High Level Champions for Climate Action, rallies leadership and support from businesses and others to achieve net zero emissions as soon as possible and by 2050 at the very latest. Building momentum ahead of COP26, already over 2,500 entities have joined the campaign – the largest collection of such commitments globally. Companies join through partner initiatives, including:

- Business Ambition for 1.5 – the main Race to Zero partner for businesses, requiring a science-based target
- SME Climate Hub – for small and medium-sized companies

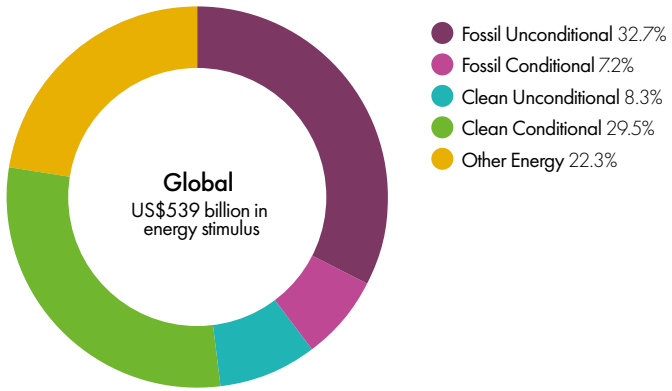
Wind sector companies already part of the Race to Zero include ACT Blade Ltd, EDP, Enel, Iberdrola, NKT Cables, Ørsted, SGRE and Vestas. More members from the wind industry would showcase the sector and support the scale up of government climate ambition. The Race to Zero has a 'breakthrough ambition' of 20% of major utilities joining the Race and a 'breakthrough outcome' goal by 2030 of 30% share of global electricity generation from wind and solar and 60% from all renewable sources.

6. Green recovery to catalyse a net zero course

The last year has seen unprecedented public recognition of climate change, high-level political gains, including net zero commitments from leading carbon-emitting countries. As of December 2020, 127 countries responsible for around 63% of global GHG emissions are either considering or have adopted net zero targets, according to the UNEP. The UNDP's "Peoples' Climate Vote" of 2020 determined that 64% of people covering 50 countries with more than half the world's population believe that climate change is the true global emergency, compared to the pandemic.

Nonetheless, COVID-19 has crippled emerging economies with rising public debt and ongoing social/healthcare crises, deepening the affordability gap in the power sector and accentuating the financing risks for renewable energy. Additionally, GWEC's Green Recovery Hub with real-time data on stimulus packages worldwide estimates that the global response to COVID-19 has been more favourable to fossil fuels. At least US$274 billion in public support packages are seen as supporting fossil fuels on a conditional or unconditional basis, compared to $259 billion for clean energy. Among G20 countries, for every $1/capita going to clean energy, $1.05/capita is being spent on support for fossil fuels industries.

Announced COVID-19 Economic Stimulus Packages for Energy, as of February 2021



Source: Energy Policy Tracker; see GWEC's Green Recovery Hub for category definitions.

That extra $0.05 per person could instead be reinvested in the drive for net zero, across energy efficiency solutions or grid reinforcement to enable large-scale integration of green power. Green recovery investments present a limited window of opportunity for state actors to agitate existing dependencies and invest in system-wide transformation, such as:

- **Ratcheting up wind volumes:** National capacity targets for wind need to scale up to align with net zero commitments and respond to the alarming gap between our BAU trajectory and the actions needed to sustain an IPCC-compliant scenario. Repowering regulation offers an efficient solution for wind projects nearing the end of lifetime in Europe, while streamlined permitting will go a long way in enabling wind projects in Asia, Africa and Latin America to close financing and reach grid connection more efficiently.

> More than half the world's population believe that climate change is the true global emergency, compared to the pandemic.

- **Safeguarding existing wind capacity to sustain investment attractiveness:** Ramping up global installed onshore and offshore wind capacity from its current 743 GW to more than 2,000 GW by 2030 would create additional annual investment of US$207 billion or over US$2 trillion in total. To deliver these

volumes of wind energy investment, governments must secure transparent and predictable project pipelines with policy certainty and long-term visibility.

- **Reducing administrative and permitting barriers:** Allocating resource to institutions which can streamline the administrative and permitting processes for renewable energy can support wind projects in efficiently moving into the construction phase.

- **Fostering green jobs and an inclusive transition:** The wind sector offers an increasingly diverse range of low-skill to high-skill occupations, with tremendous direct employment effects of 10,000 full-time jobs over the 25-year project lifetime of a 500-MW offshore wind farm. For example, a recent study found that accelerated wind and renewable energy growth in China could yield multiplier effects, including expenditure shifting, job creation and higher economic efficiency, adding as much as 7.5% to national GDP and 5.9% to total jobs by 2030 compared to a BAU pathway. Fossil fuel-dependent states have the opportunity to allocate public funding to support workforce retraining and up-skilling from sunset industries (e.g. coal-fired generation, offshore oil and gas) to growing clean energy sectors like onshore and offshore wind. New training programmes to fast-track the transition of workers into a low-carbon economy are the need of the hour, following the example of Scotland's Transition Training Fund.

The compound benefits of green recovery measures have been widely recognised – the IMF estimates that measures put in place for a sustainable recovery could boost global GDP by 3.5% in 2023 above usual levels. Governments should heed the growing body of evidence at global and market level, as well as the irreversible shift of public opinion, by making green economic recovery a vital component of long-term plans for decarbonisation.

MARKET STATUS

Photo Credit: Equinor

Overview

2020 saw global new wind power installations surpass 90 GW, a 53% growth compared to 2019, bringing total installed capacity to 743 GW, a growth of 14% compared to last year.

2020 saw global new wind power installations surpass 90 GW, a 53% growth compared to 2019

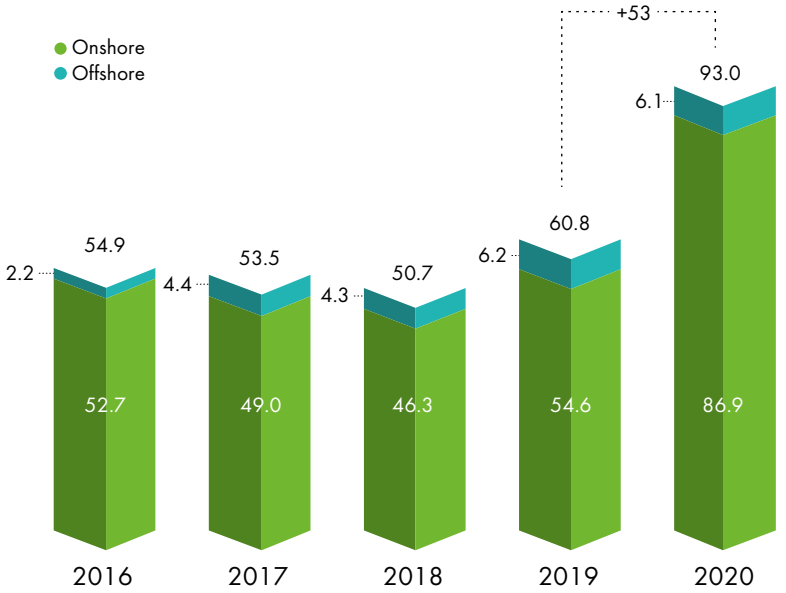
New installations in the onshore wind market reached 86.9 GW, while the offshore wind market reached 6.1 GW, making 2020 the highest and the second highest year in history for new wind installations for both onshore and offshore.

Thanks to the explosive growth of installations in China, Asia Pacific continues to take the lead in global wind power development with its share of the global market increasing by 8.5% last year. Driven by a record year of installations in the US, North America (18.4%) replaced Europe (15.9%) as the second largest regional market for new installations. Latin America remains the fourth largest regional market (5.0%) in 2020, followed by Africa & Middle East (0.9%).

The world's top five markets in 2020 for new installations were China, the US, Brazil, Netherlands and Germany. These five markets combined made up 80.6% of global installations last year, collectively more than 10% greater than 2019.

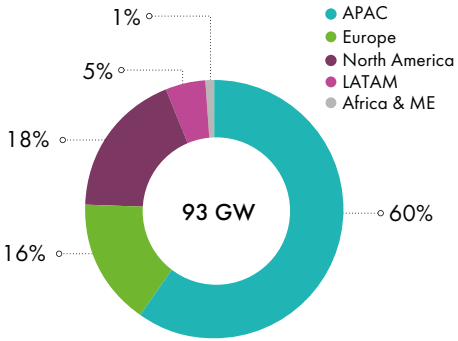
In terms of cumulative installations, the top five markets as of the end of 2020 remained unchanged. Those markets are: China, the US, Germany, India and Spain, which together accounted for 73% of the world's total wind power installations.

New installations



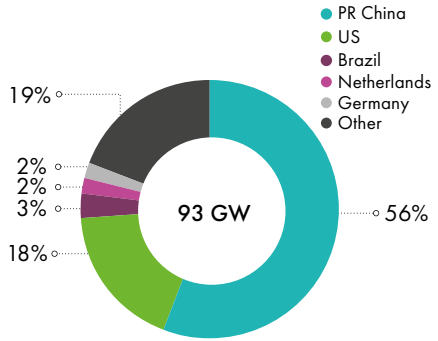
New wind power capacity in 2020 by region

Per cent



New wind power capacity in 2020 and share of top five markets

Per cent



Onshore Wind market – Status 2020

86.9 GW of onshore wind capacity was added globally in 2020, representing 59% YoY growth and taking cumulative onshore wind capacity beyond the 700 GW milestone. This outstanding increase in 2020 was driven primarily by explosive growth in the world's two largest wind power markets, China and the United States.

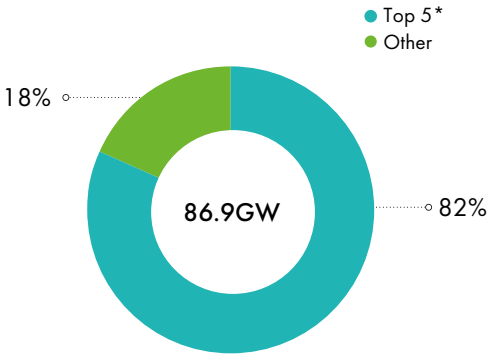
achieve grid connection until 2020. Excluding this latent volume, grid connected new installations in China in 2020 were 42.3 GW. Not including grid connection, new installations were 48.9 GW. The rush to complete onshore wind farms in 2020 was driven by new policy released by the National Development and Reform Commission (NDRC) that

This outstanding increase in 2020 was driven primarily by explosive growth in the world's two largest wind power markets, China and the United States.

In China, the National Energy Administration (NEA) reported 68.6 GW of grid-connected onshore wind installations last year, boosting its total onshore installations to more than 272 GW. Out of the 68.6 GW of grid-connected onshore wind, however, about 26 GW was installed by the end 2019, but didn't actually

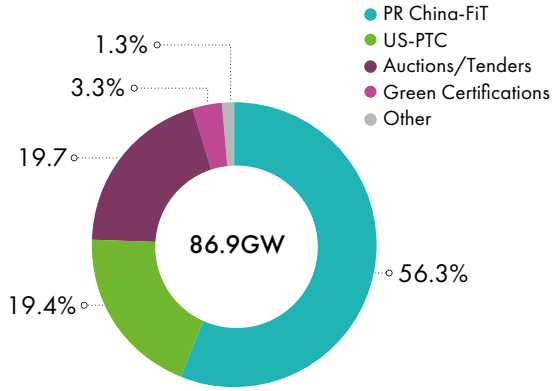
presented a clear roadmap towards "subsidy-free" onshore wind. This regulation means that projects already approved until 2018 will continue to receive the Feed-in-Tariff (FiT) if they are grid-connected before the end of 2020. Starting from 1 January 2021, all newly approved onshore wind projects must reach the grid parity

New wind power capacity in 2020 and share of top five onshore markets
Per cent, onshore



*(PR China, the US, Brazil, Norway,Germany)

New wind power capacity in 2020 by market support mechanism
Per cent, onshore



(currently based on the regulated price for coal power in each province).

The US onshore wind sector reported its highest-ever year of new installations in 2020, nearly 17 GW was commissioned, bringing its total above the 120 GW threshold. The US onshore wind installation rush was primarily driven by the planned Production Tax Credit (PTC) phase-out as project developers had to chase the 2020 deadline to qualify for the full PTC value. Although the Internal Revenues Service (IRS) extended the commissioning deadline for projects that started construction in 2016 and 2017 from four to five years, recognising the disruption of COVID-19 on supply chain and project construction execution, to ease the pressure on developers, a record of installation was still achieved. This has shown the resilience of onshore wind in a market where the COVID-19 pandemic had a strong negative impact on many industries. Last December, the Senate extended the PTC for a further year with 60% of the full PTC rate. Thus, PTC qualification will remain as the main driver for new onshore installations in the US throughout the forecast period (2021-2025).

In addition to China and the US, the top five onshore wind markets were Brazil (2.30 GW), Norway (1.53 GW) and Germany (1.43 GW).

Looking at the market support mechanisms behind the new onshore wind capacity added in 2020, the situation remains the same as the previous year. Excluding the two largest markets China and US, where the FiT and PTC were the key support schemes, mechanisms such as auctions, tenders and Green Certificates were the main drivers. Last year, 23% of new installations originated from these market mechanisms, 16% lower than in 2019, primarily due to the increased level of onshore installations in China and the US.

While the first half of 2020 saw auctions being postponed or cancelled due COVID-19 restrictions, the sector bounced back strongly in the second half of the year as key mature and emerging wind markets began overcoming the impacts of COVID-19. Overall, 33.7 GW of new onshore wind power capacity was auctioned globally in 2020, of which China accounted for 67% of the global onshore wind power capacity awarded in 2020. Since the majority (96%) of the awarded onshore capacity in China last year was based on grid parity scheme, grid parity onshore wind can be expected to be a key element of new installations in next year's Global Wind Report.

Offshore Wind Market – Status 2020

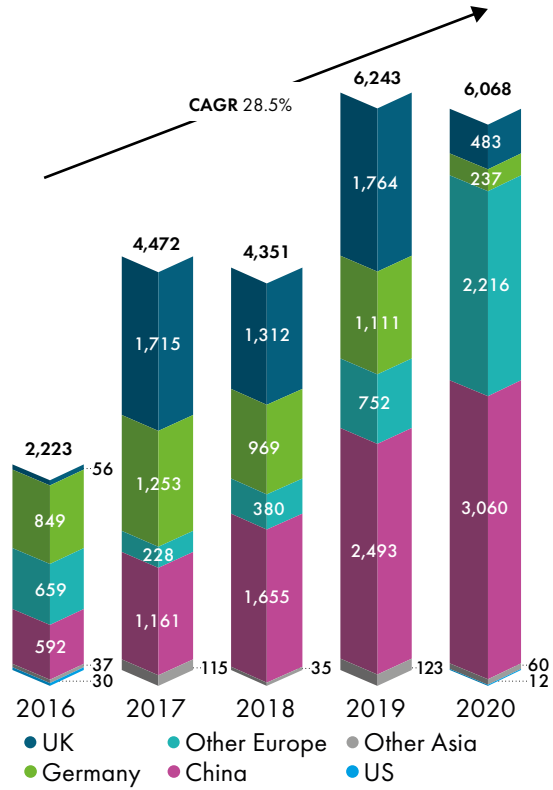
Despite the impact of COVID-19, the global offshore wind industry had its second-best year ever in 2020 installing over 6 GW of new capacity, keeping growth on track.

- China led the world in new annual offshore wind installations for the third year in a row with over 3 GW of new offshore wind capacity in 2020.
- Steady growth in Europe accounted for the majority of remaining new capacity, led by the Netherlands which installed nearly 1.5 GW of new offshore wind in 2020, making it the second-largest market in 2020, followed by Belgium (706 MW).
- The UK and Germany installed 483 MW and 237 MW respectively, making them the No.4 and No.5 markets in new installations in 2020. The slowdown of growth in the UK is due to the gap between the execution of projects in the Contracts for Difference (CfD) 1 and CfD 2 rounds. In Germany, the slowdown is primarily caused by unfavourable conditions and a lower level of short-term offshore wind project pipeline.
- Outside of China and Europe, two other countries recorded new offshore wind installations in 2020: South Korea (60 MW) and the US (12 MW).
- 2020 also saw Portugal commission two new floating offshore wind turbines, totalling 16.8 MW.
- The UK remains in the top spot globally in terms of cumulative offshore wind capacity, while China has now overtaken Germany to become the world's second largest offshore wind market.
- Last year, only 1,005 MW offshore wind capacity was awarded worldwide through auctioning, of which 759 MW is from the Netherlands and the remainder from China. A consortium of Shell and Eneco won the right to build the 759 MW Hollandse Kust North project in the Netherlands. The project is the third so called "zero-priced" bid, meaning that the project will only receive the wholesale price of electricity and no further support/payment.
- Although awarded offshore wind capacity was relatively low compared to 2019, more than 7 GW of offshore wind auction/tenders were launched in 2020, of which 5.5 GW is through state-issued solicitations in New Jersey, New York and Rhode Island in the US. The rest of the capacity is from Denmark (800-1000 MW) and Japan - representing its first auction for both floating and bottom-fixed offshore wind.
- Last year GWEC continued to provide guidance on offshore wind potential and technical development around the world and organise targeted advocacy and capacity building activities. Aside from the launch of a joint Japan Offshore Wind Taskforce with JWPA and the Floating Offshore Wind Taskforce, the Japan Cost Reduction Study conducted in 2020 informed the key findings and objectives of the Japanese government's "Offshore Wind Industry Vision" targeting 10 GW and 30-45 GW of offshore wind by 2020 and 2040 respectively.

The offshore wind market has grown from 2.2 GW in 2016 to 6.1 GW 2020, bringing its market share in global new installations from 4% to 7%, which is 3% lower than 2019 due to the strong growth spurt of onshore in 2020. GWEC Market Intelligence expects the global offshore wind market to continue to grow at an accelerated pace (for details, see Market Outlook).

New offshore installation

MW

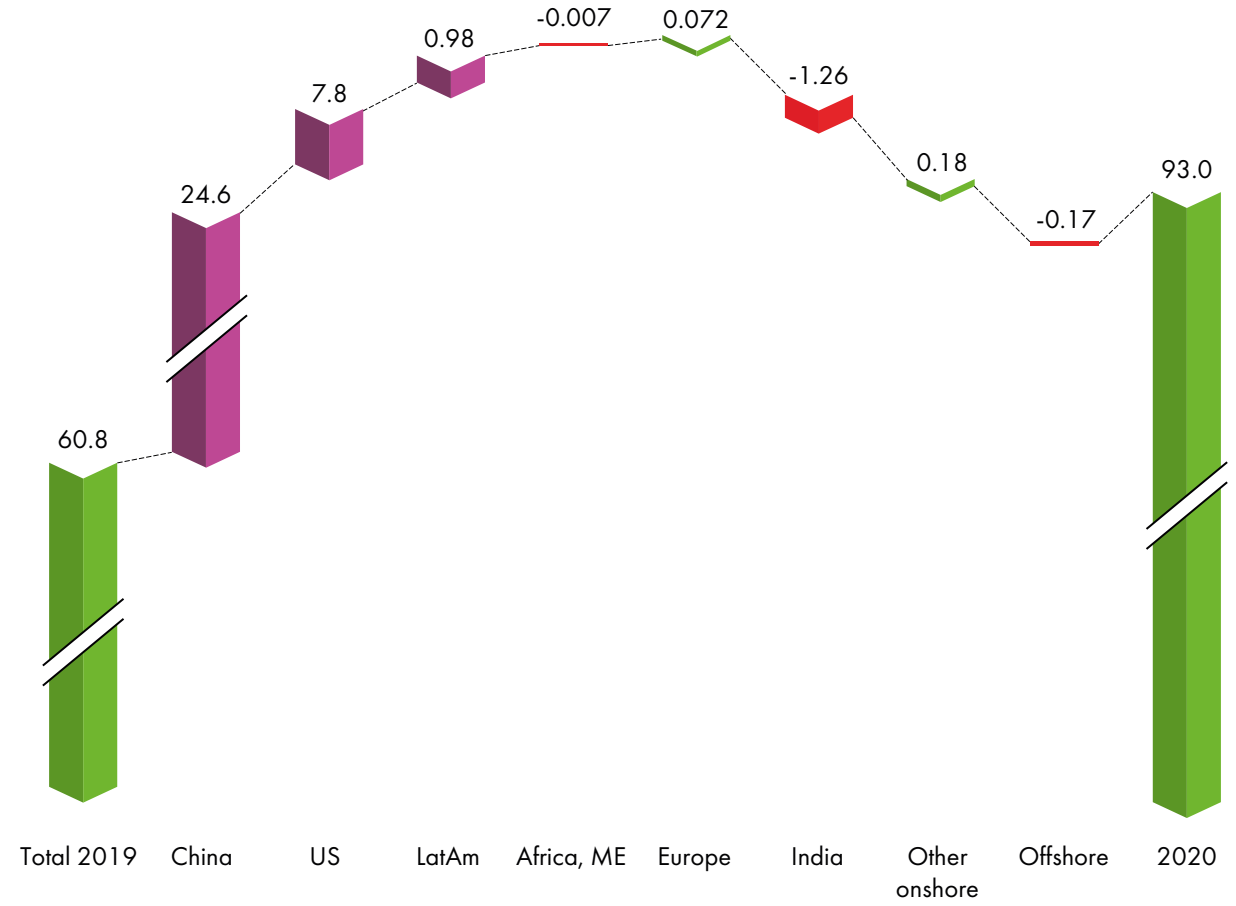


All regions increased new installations, except Europe and Africa & Middle East

2020 saw the annual wind market grow (with onshore and offshore combined) in all the regions except Europe and Africa & Middle East. All of the 32.2 GW YoY increase comes from onshore wind markets: China 24.6 GW, the US 7.8 GW, Latin America 1.0 GW, Europe 72 MW. However, 2020 was a challenging year for India's onshore wind market. Aside from the existing challenges of land acquisition, grid connection and permitting, the COVID-19 pandemic hit the market hard and caused delays in project construction execution. New installations in Africa & Middle East dropped by 7 MW compared to the previous year, primarily due to relatively low installations in North Africa, namely Egypt and Morocco. New offshore wind installations decreased slightly compared to 2019, which was mainly due to weak activity in the two largest European offshore markets: the UK and Germany.

Changes in new installations 2019 to 2020

GW, onshore and offshore



Actuals 2020 vs GWEC forecast

China onshore
An onshore installation rush in 2020 was expected, driven by the policy stating that onshore wind projects approved until the end of 2018 had to be grid-connected before the end of 2020 to receive the FiT. The fact that onshore wind installations doubled last year, however, was still a surprise considering that COVID-19 disruption was reported by the Chinese industry in Q1 2020.

US onshore
The US onshore wind industry achieved a record year even though the IRS extended the commissioning deadline from 2020 to 2021 for onshore projects that started construction in 2016 as well as the disruption of COVID-19 on global supply chains and project construction execution in the US

India onshore
Actual annual installations were not far from the Q3 forecast as the COVID-19 pandemic hit the market hard and GWEC Market Intelligence had already identified significant delays in onshore project construction execution as well as supply chain disruption in India from Q2 2020.

Germany onshore
A low level of onshore wind installations was already expected in Q1 2020 considering the ongoing challenging conditions around permitting. In addition, recognising the impact of COVID-19, Germany's federal network agency, BNetzA, has allowed onshore wind developers who were successful in previous auctions to delay project implementation.

Brazil onshore
No significant slowdown was reported in project construction execution during the pandemic in Brazil. The significant increase of new installations in 2020 was linked to projects being developed through private PPAs, which are quickly increasing in Brazil due to wind power's very competitive prices, while government auctions have slowed down in recent years.

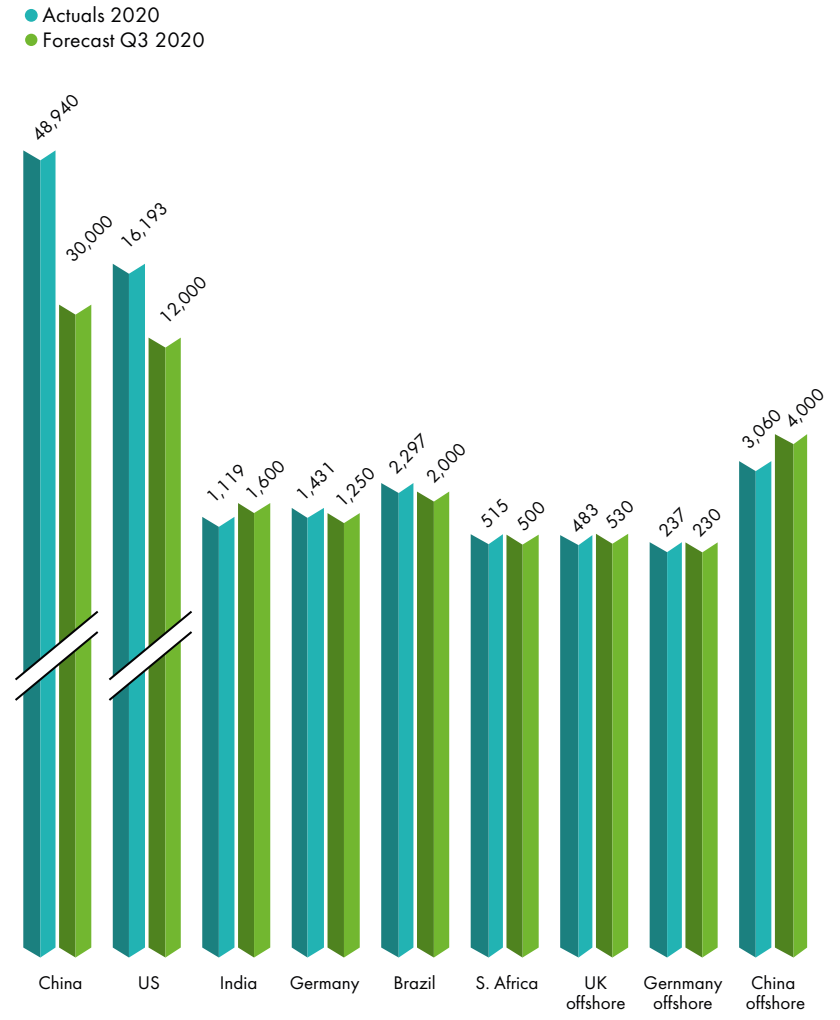
South Africa onshore
No auction was conducted in South Africa in 2020. Projects that came online last year were those awarded from the previous REIPPP rounds. This achievement was not easy as the country had some of the strictest COVID-19 lockdown measures globally. Projects under construction were declared non-essential, therefore sites were closed and construction was halted during the lockdown.

UK offshore
Last year, the UK only grid connected 69 units of 7 MW offshore wind turbines, which were the remaining turbines from the 714 MW East Anglia 1 offshore wind project. No floating turbines were commissioned in 2020 from the Kincardine floating wind farm that was expected to be online by the end of 2020.

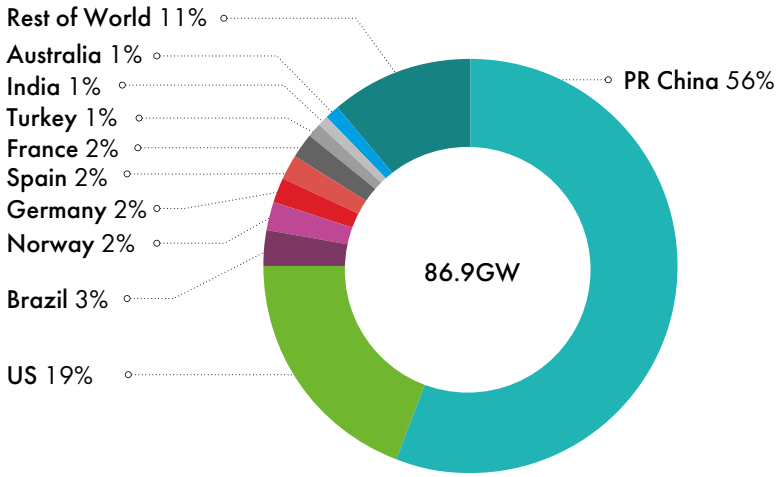
Germany offshore
Only 36 units of offshore wind turbines were grid connected and commissioned in Germany last year. All of those turbines, including 16 units of the Senvion 6.3 MW turbine were expected to be fully online before the end of 2019, but this slipped into to 2020.

China offshore
2020 is the second year of an offshore wind installation rush in China as project developers have to get their projects fully grid-connected before the end of 2021 in order to qualify the 0.85RMB/kWh FiT. However, only 3 GW was commissioned last year, mainly due to bottlenecks such as offshore wind turbine installation vessels.

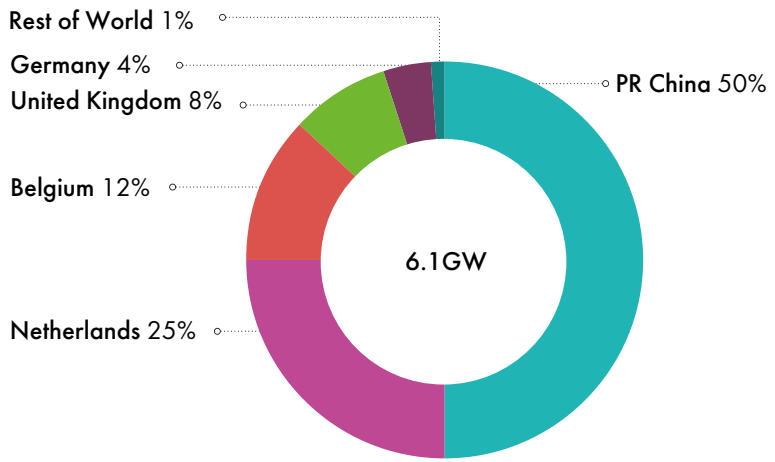
Actuals 2020 vs GWEC forecast



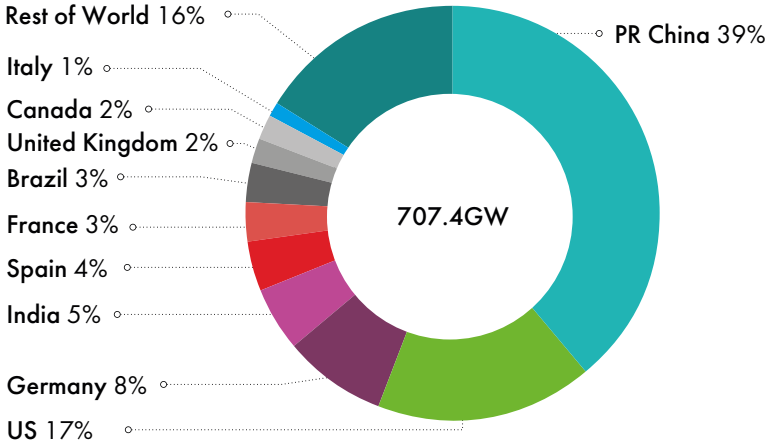
New installations onshore (%)



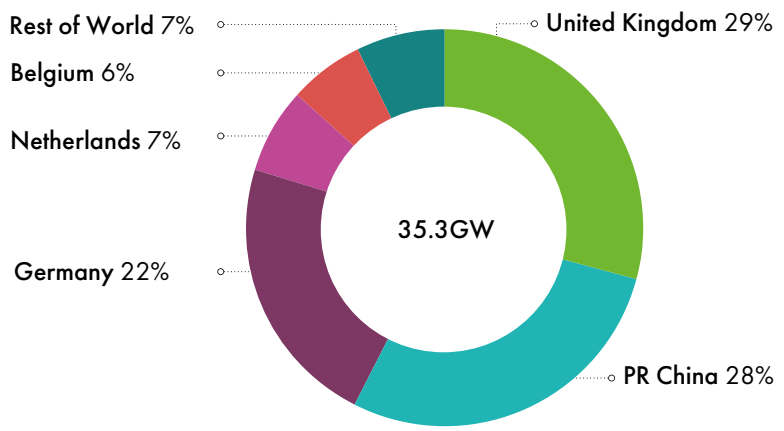
New installations offshore (%)



Total installations onshore (%)

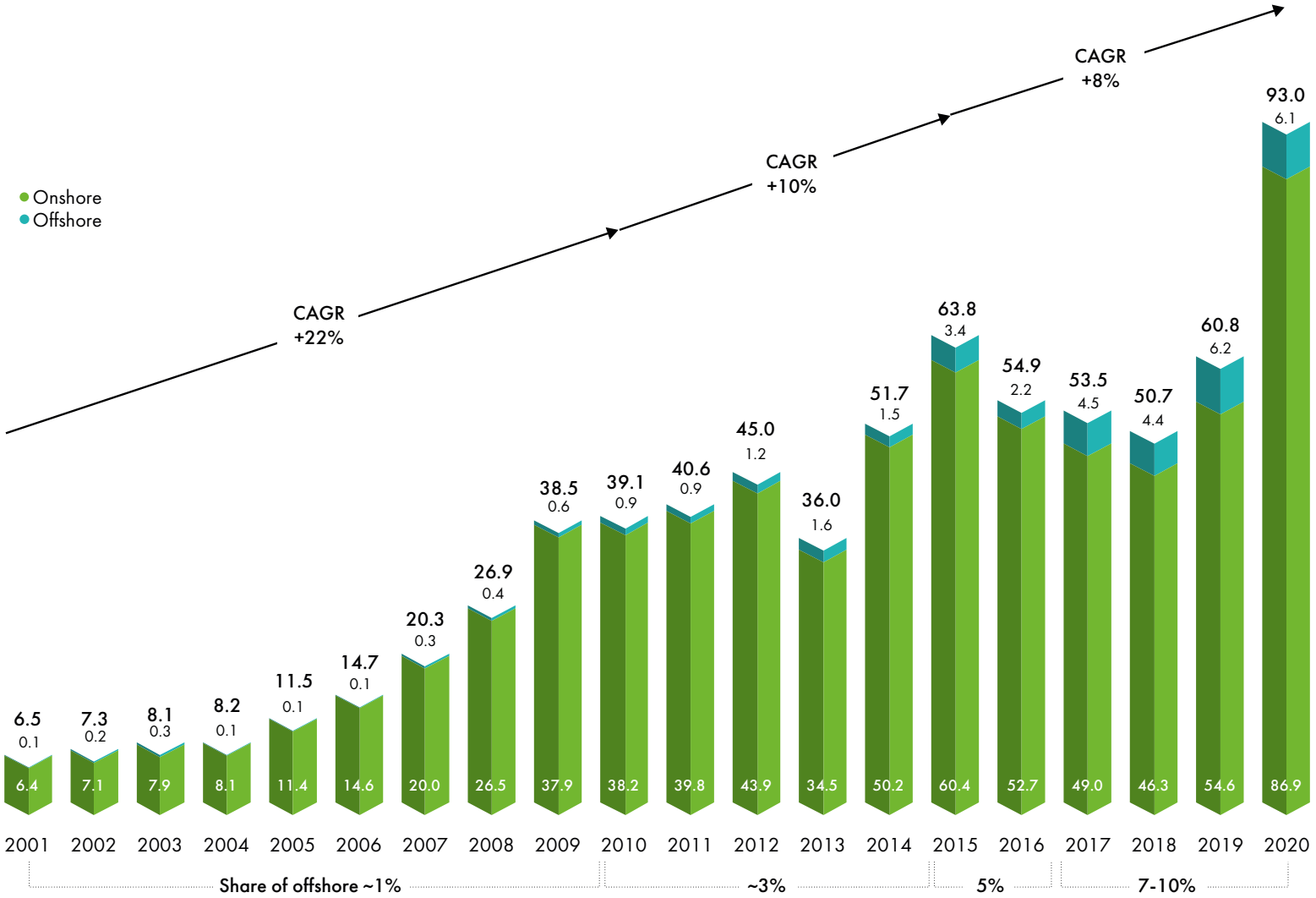


Total installations offshore (%)

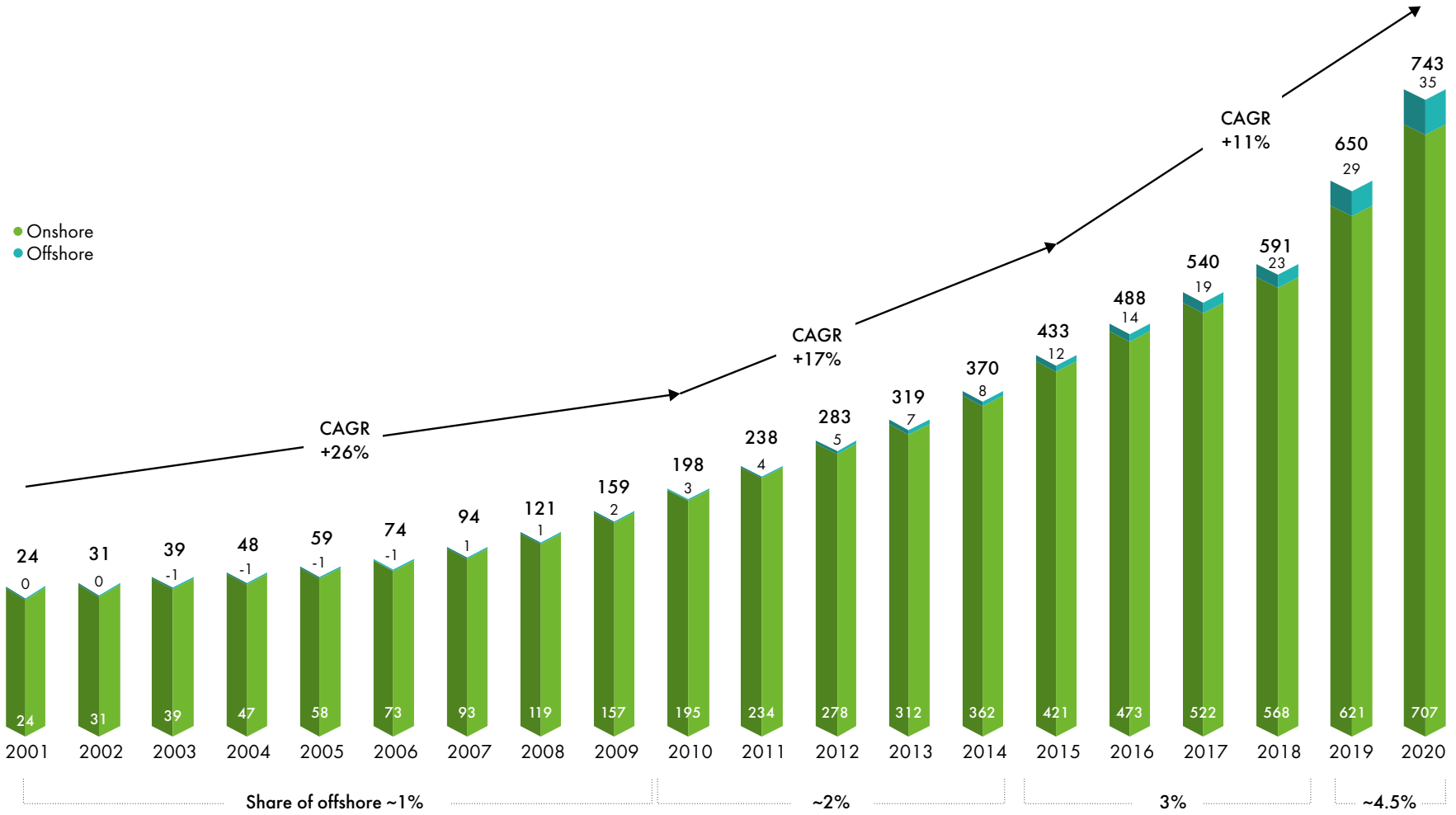


Detailed data sheet available in GWEC's member only area. For definition of region see Global Wind Report – Methodology and Terminology (Link to page)

Historic development of new installations (GW)



Historic development of total installations (GW)



MW, onshore	New installations 2019	Total installations 2019	New installations 2020	Total installations 2020
Total onshore	**54,634**	**620,967**	**86,932**	**707,396**
Americas	**13,437**	**148,081**	**21,750**	**169,758**
USA	9,143	105,436	16,193	122,275
Canada	597	13,413	165	13,577
Brazil	745	15,452	2,297	17,750
Mexico	1,281	6,215	574	6,789
Argentina	931	1,604	1,014	2,618
Chile	526	2,145	684	2,829
Other Americas	214	3,817	823	3,920
Africa, Middle East	**830**	**6,454**	**823**	**7,277**
Egypt	262	1,452	13	1,465
Kenya	0	338	0	338
South Africa	0	1,980	515	2,465
Other Africa	568	2684	295	3009
Asia-Pacific	**28,626**	**283,780**	**52,546**	**336,286**
China	24,292	229,384	48,940	278,324
India	2,377	37,506	1,119	38,625
Australia	837	6199	1097	7296
Pakistan	50	1,239	48	1,287
Japan	274	3857	551	4,373
South Korea	191	1,420	100	1515
Vietnam	160	388	125	513
Philippines	0	427	0	427
Thailand	322	1538	0	1538
Other Asia	123	1,822	566	2,388
Europe	**11,741**	**182,651**	**11,813**	**194,075**
Germany	1,078	53,913	1,431	55,122
France	1,336	16,643	1,318	17,946
Sweden	1,588	8,804	1,007	9,811
United Kingdom	629	13,617	115	13,731
Turkey	686	8,056	1,224	9,280
Other Europe	6,424	81,618	6,718	88,185

MW, offshore	New installations 2019	Total installations 2019	New installations 2020	Total installations 2020
Total offshore	**6,243**	**29,232**	**6,068**	**35,293**
Europe	**3,627**	**21,901**	**2,936**	**24,837**
United Kingdom	1,764	9,723	483	10,206
Germany	1,111	7,491	237	7,728
Belgium	370	1,556	706	2,262
Denmark	374	1,703	0	1,703
Netherlands	0	1,118	1493	2,611
Other Europe	8	310	17	327
Asia-Pacific	**2,616**	**7,301**	**3,120**	**10,414**
China	2,493	6,936	3,060	9,996
South Korea	0	73	60	136
Other Asia	123	292	0	282
Americas	**0**	**30**	**12**	**42**
USA	0	30	12	42

MARKETS TO WATCH

Chile

As electricity demand falls at an unprecedented rate due to the impact of COVID-19, the unfolding energy crisis will test the commitment of both industry and the government to their renewable energy agendas.

Ambitious plans to harness more wind energy in conjuncture with the commitment to putting sustainability and decarbonisation at the heart of COVID-19 recovery plans make Chile's wind market a challenging yet attractive proposition for international companies and investors.

Chile's exceptional natural resources make it attractive for wind energy investment and development. In 2020, wind energy capacity expanded by more than 30%, with new installations of 683.5 MW. Chile now has 2.83 GW of wind capacity in operation and a further 1.5 GW of capacity under construction, which was delayed in 2021 due to Covid-19. More than 6 GW of approved wind projects were awarded PPAs in Chile's 2015 power auction but are still pending, while others will deliver power to corporations via bilateral agreements.

While the drying up of the wind installation pipeline is a worrying issue, Chile's wind market may, on the other hand, be spurred on by government plans to deploy storage solutions to balance demand and supply. That the government acts on these plans, as yet, remains to be seen.

Signs of Chile's resiliency for green recovery adoption

Against a backdrop of COVID-19 and social tensions, the government updated its NDC as a step up on its climate policy. It now aims for GHG emissions to peak by 2025 at the latest; to phase out coal power by 2040; and to become the first country in the Americas to formally commit to net zero emissions by 2050.

Coal is still heavily relied on to power Chile's energy needs, meeting 37% of total consumption in 2020. Despite this, Chile has deepened its commitment and acted on a progressive retirement of coal-powered generation.

Chile's exceptional natural resources make it attractive for wind energy investment and development

As part of the state policy to combat climate change, Enel and AES, among others, voluntarily announced the retirement of their coal plants earlier than planned, equivalent to more than 20% of current coal capacity. These closures demonstrate a proactive move by private corporations to support Chile's policy towards transitioning into renewable energy, including the production and exportation of green hydrogen.

Near-term installations may be constrained

Chile postponed its 2020 planned electricity auction after downward revisions to GDP, with the auction for 2.3 TWh/year of renewable energy to be held in June this year. Projects awarded contracts under

the auction will supply electricity under 15-year PPAs for 2026-2040 to distribution companies.

While a rebound in the build is expected over 2021-22, the postponed auctions of 2020 suggest that energy supply might emerge an issue post-2024. However, this will not equate to a lack of appetite for wind in Chile. Chile became the second-largest destination for new wind investment in Latin America with US$2 billion and the uptake of bilateral renewables PPAs in 2020, exemplifying investor and corporate confidence in Chile's wind potential.

Lack of interconnection from world-class wind spots in the centre of the country, where population and demand are concentrated, have resulted in curtailment of wind generation as well as wholesale price volatility. While the bottleneck situation has already been eased after important transmission lines were commissioned in 2017 and 2019, both lines have quickly reached full operation capacity.

In September 2020, a long-awaited Power System Flexibility Strategy was revealed, with focus on: (i) market design to allow the development of a flexible grid, (ii) changes in regulation for energy storage systems and other new technologies that provide flexibility and (iii) optimisation of system operation. Earlier this year, positive news of a US$717 million transmission system expansion proposal was announced by the National Electric Coordinator (CEN) of Chile. This was translated into a call for transmission projects to be awarded later this year.

Chile unveils hydrogen ambitions

As the world's largest copper exporter with energy-intensive mining processes, ramping up Chile's green hydrogen production is an inevitable move to support the switch to cleaner fuel.

For this reason, Chile presented its National Green Hydrogen Strategy in November 2020. An action plan was drafted to accelerate green hydrogen production to 5 GW by 2025, produce the world's cheapest green hydrogen by 2030 and make the country one of the top three exporters of the fuel by 2040.

Copper producer Antofagasta PLC announced that it is considering changing to hydrogen-powered trucks. This was followed by Enel Green Power Chile and Andes Mining & Energy SA unveiling a plan to install a pilot production project in the country's south. Another initiative came from major mining company BHP, which began a pilot project in its Spence copper mine to replace the diesel and natural gas used for its copper obtaining process.

While most of the projects so far are pilots, that could change as hydrogen gets cheaper and the pressure to decarbonise increases. More hydrogen-related announcements from Chile in 2021 would not be a surprise.

Green growth: Key to Chile's recovery from the social, health, and climate crisis

Chile's commitment towards a net zero economy is in motion under the consensus that a fundamental transition to renewables is inevitable, with transmission upgrades and green hydrogen as enablers. As well, the World Bank and the NDC-SF are currently supporting the Ministry of the Environment to develop a participatory mechanism for a large and inclusive consultation of Chile's long-term climate policy.

Saudi Arabia

The Kingdom of Saudi Arabia (KSA) is in the midst of a historic shift. Over the last decade, KSA launched an ambitious, multi-faceted plan to transition from reliance on hydrocarbons. Development of hydrocarbons in the 1930s ushered an isolated desert kingdom into modernity. Vision 2030, launched in 2016, is the blueprint for this ambitious national development program, based on KSA's investment power to create a more diverse and sustainable economy. The sheer scale and scope of KSA's vision has attracted global attention, leaving observers to wonder what can be realised within proposed timelines. A key part of Vision 2030 is the King Salman Renewable Energy initiative.

Sound fundamentals for wind power

Sound fundamentals for wind power

In 2010 KA-CARE was launched which set KSA's first targets for 54 GW of renewables by 2032 including 9 GW from wind. KA-CARE undertook wind assessments, identified 40 sites with promise and selected more than 35 sites to be developed by 2030. KA-CARE called for 1.7 GW of wind to be procured via auctions and for wind to help satisfy electricity needs in desalination plants. By 2014 KA-CARE's efforts stalled and no auctions were held. In 2016 Saudi Aramco launched KSA's first utility-scale wind turbine, a GE 2.75-120 single WTG demonstration project, at the Turaif Bulk Plant inland and a second identical WTG in Huraymila, near Riyadh.

Sound fundamentals for the market to scale exist. KSA is a wind market to watch, despite the global attention focused on solar, due to abundant insolation. KSA is ranked 13th globally among countries with highest potential for onshore wind production. Annual average onshore wind speeds at good sites are between 6-8 m/s with strong winds through most of the year. KSA's renewables sector could create up to 750,000 jobs over the next decade. Realising this employment goal helps create the knowledge-based economy which Vision 2030 foresees.

Frameworks steering renewable energy growth

By 2016 a new approach for the King Salman Renewable Energy Initiative started. The National Renewable Energy Programme (NREP) was launched as part of Vision 2030. An integral part of NREP was creation in 2016 of a new Renewable Energy Project Development Office (REPDO), made up of procurement specialists. After Ministry of Energy's recent 're-brand' to emphasize KSA's energy transition, other agencies will likely follow suit. In 2018 Saudi Electricity Company (SEC) created a new subsidiary, Saudi Power Procurement Company (SPPC), to issue 20-year PPAs for REPDO awarded wind projects. These are for competitively awarded Build-Own-Operate (BOO) independent power producer (IPP) projects.

REPDO's approach involves tendering projects with much pre-development completed: site selection and land lease agreements, two-year wind resource data, environmental and social impact assessment, and grid integration studies. In addition,

SEC is responsible for building needed substations.

NREP's new target is for 58.7 GW of renewables by 2030 of which 16 GW is wind. The interim target is for 27.3 GW by 2023 of which 7 GW is wind. REPDO will make 30% of KSA's capacity additions via IPP auctions. REPDO's first wind auction in 2018 awarded the 400 MW Dumat al-Jandal wind project to Masdar (UAE) and EDF-EN (France) using Vestas V150 4.2 WTGs (99 x 4 MW). The $500 million project – the most cost-efficient wind energy project in the world and largest Middle East wind farm – is a big step for the sector. The project's tariff of $19.9/MWh attracted considerable attention, turbine erection is underway, with commercial operations expected Q1 2022. REPDO announced plans for an 850MW wind farm in Yanbu, as part of NREP's fourth round, and plans to build 35 more wind farms by 2030. Saudi National Grid Company's CEO recently stated that KSA expects to attract more than $20 billion in renewables investments by 2030.

Developing the local wind industry

Doing business in KSA has conditions, known as "Saudization", aimed at increasing private sector employment of Saudi nationals. This is understandable as 50% of KSA's population is under 30. However, in late February 2021, Investment Minister and Aramco former Chairman Khalid Al-Falih, announced that Saudization would still be encouraged but is no longer required so long as companies doing business in KSA establish a global or regional headquarters there.

Still, the Saudization principle informs Vision 2030's plan for localisation of renewables manufacture. REPDO's first round of competitive tenders included a capex-based 30% local content requirement. However, second and third rounds moved to a new mechanism where KSA's local content agency 'scores' suppliers and manufacturers to reach similar levels as for round one. These localisation targets are expected to increase in later bid rounds.

Initially, towers, nacelle and hub assembly, and rotor blades are targeted for local manufacturing. In the medium term, nacelle housing, and in the long term, nacelle electricals, generators, and drive train gearboxes may be included. Two or three OEMs are expected to commit to localise.

New growth opportunities for wind

A new $5 billion green hydrogen project in Neom, the 100% renewables "smart city" in Tabuk Province, is a case in point. This is the world's largest green hydrogen project powered by 4 GW of wind and solar. It involves a partnership between ACWA Power, the Kingdom's largest IPP and national renewables champion, and Air Products and Chemicals (US).

Plambeck Emirates (UAE) signed an MOU with Saipem to design and develop a 500 MW floating offshore wind farm to propose to the Saudi government.

Still, crucial questions remain about the Saudi wind market. Will new thinking on Saudization pose barriers for global wind players to enter KSA? Will solar's development eclipse wind's envisioned role? Will hydrocarbon-based energy generation persist longer than expected? Only time will tell, but Saudi Arabia is certainly a market to watch and one too large to ignore.

Vietnam

Vietnam's wind market is at an inflection point. The opportunity ahead is to accelerate into a phase of rapid growth to meet the country's increasing electricity demand, ensure energy security and deliver socio-economic benefits in pursuit of a renewables-led pathway.

Over the past five years, giant turbines churning in windy sites have become more common, mainly spurred by a staggering increase in electricity demand at an average of about 10% annually and the dramatic 30% decline in the capital cost of wind turbines, according to McKinsey. Today wind makes up roughly 1% of electricity production, or just 597 MW, which falls short of the 800 MW wind target set by PDP 7 (revised) back in 2018, largely due to permitting postponements caused by the impact of COVID-19 and its recent 2021 national assembly election.

GWEC welcomed the approval of an additional 7 GW of wind projects by the Prime Minister in June 2020, in Document No. 75. Soon after, the Ministry of Industry and Trade (MOIT) proposed to add 6.4 GW of new wind projects to the power plan in Document No. 7201/BCT-DL, bringing the total existing and approved wind power capacity to the current power plan to 18,200 MW.

These timely announcements, along with the issuance of Resolution 55 early last year to open up opportunities for the private sector to participate in energy development, demonstrated Vietnam's clear commitment to be a leading market for wind energy development in Asia.

Policy stability needed to sustain wind growth

A shift towards renewables was confirmed by the recent draft release of the Power Development Plan VIII (PDP8), which awaits commentary and finalisation at the time of writing. In February 2021, the MOIT issued Document No. 828/BCT-DLL detailing the implementation of the law on the national sector planning, including the long-term wind energy targets and interconnection development strategies:

While the target is significantly higher than the revised PDP7 of 2016, the realisation of this ambition is challenged by the nearing expiry of the wind Feed-in Tariff (FiT) at the end of October 2021 and the pandemic-related delays of 2020.

Towards late 2020, the MOIT issued Document No. 8159/ BCT-DL for comments and revealed a proposed extension of the onshore wind FiT at a slash of 17% – one of the most dramatic reductions seen in any wind power market globally to date, for projects commissioned from late 2021 to the end of 2023. Such a drastic reduction in an early-stage market risks slowing down growth and investment in Vietnam's promising wind power sector. The industry is awaiting a decision on FiT expiry/extension in the coming months, ahead of the current FiT's expiry in November 2021.

The global trend is widespread transitions from FiTs to competitive bidding schemes, and the wind industry is positive about declining LCOE through increased competition and price transparency. But this transition

Photo Credit: Vestas

needs to be carefully studied and adapted to the local context to ensure a smooth transition.

The grid playing catch-up with renewables

Critical to the steady progression of the wind market will be the ability to successfully integrate renewables into the heavily burdened and overloaded transmission network. Interconnection availability has become the primary concern for wind developments in Vietnam, particularly following the influx of 11 GW of solar supply to the grid in 2020, compared to the 850 MW expected in the revised PDP7, due to an installation rush ahead of a FiT expiry.

The solar boom in 2019 and 2020 has clearly highlighted outdated and poor grid infrastructure, and the heavy investment needed to avoid power shortages and excessive curtailment in coming years. The question remains whether Vietnam can provide the policy and regulatory clarity needed to spur sufficient capital investment to upgrade its grid infrastructure.

A new law on public-private partnerships (PPP) in Vietnam took effect in January 2021, opening opportunities for greater private and foreign investment into transmission grid projects. Investing in upgrading Vietnam's transmission grid, including additional domestic and international interconnections, will increase overall system flexibility and the integration of strategic and cost-competitive renewables.

The tailwinds for offshore wind

Among other technologically mature renewable energy technologies, offshore wind offers Vietnam a scalable, indigenous, clean, and affordable electricity source. For its tremendous natural endowment of 3,000 kilometres of coastline translating into 475 GW of offshore wind technical resource potential, there is enormous opportunity for scaling up the burgeoning nearshore projects into a thriving offshore wind sector in the coming years.

The time is now for Vietnam to recognise that offshore wind can play a significant role in its future energy system and its economy, delivering clean energy jobs, sustainable growth and a cost-competitive supply chain that can serve the wider region in Asia.

How Vietnam will take advantage of this potential via clear policy ambitions in the finalised PDP8, regulatory certainty and grid upgrades remains to be seen. But capitalising on the wind market growth potential in the next few years will have far-reaching consequences for GDP growth, trade balance, environmental performance and energy security in the long term.

Vietnam's wind energy targets, based on draft PDP8 (at time of writing)

	2020	2025	2030	2035	2040	2045
Onshore wind and near shore wind (MW)						
High scenario	630	12,280	16,080	25,880	34,680	40,080
Base scenario	630	11,320	16,010	23,110	30,910	39,610
Offshore wind (MW) (in the sea area with the depth of more than 20m)						
High scenario	0	0	3,000	11,000	23,000	36,000
Base scenario	0	0	2,000	9,000	15,000	21,000

Colombia

Currently, more than two-thirds of Colombia's energy demand is met by hydropower, around 1% by non-hydro renewable energy and the rest by fossil fuel sources. While electricity supply in Colombia is dependent on hydropower, the country is prone to El Niño conditions and long periods of low rainfall. For firm and sustainable power supply, hydropower needs to be complemented with a higher share of wind or other suitable renewable energy.

As of 2020, Colombia has 19.5 MW of wind installed capacity in the Jepírachi Wind Project. Wind project installation is expected to take off from 2022, as the country awarded 2.27 GW of wind capacity across two auctions in 2019. After a reliability charge auction, 1.07 GW of wind capacity was awarded in the country's first large-scale renewable energy auction in October 2019.

In early 2020, Colombia's national energy planning unit UPME approved grid connection for 2.53 GW of wind projects. As of December 2020, UPME has 322 active projects of 16.02 GW, including 3.16 GW of wind capacity in the pipeline.

The COVID-19 crisis significantly lowered energy demand in the country, and as a result Colombia did not issue any tenders in 2020. The Ministry of Mines and Energy (MME) has revised its short-term energy forecast, and in a best-case scenario demand is averaging 72.10 TWh in 2021 and 79.74 TWh in 2026. However, long-term energy demand is still expected to grow by more than 60% to 2050, at an annual rate of around 1.5%.

A net zero pledge with support for renewable energy

Colombia is driving the RELAC initiative (Renewable Energy for Latin America and the Caribbean) and has committed to the regional goal of increasing renewable energy share to 70% by 2030. Domestically, it intends to achieve a goal of at least 4 GW by 2030 from non-conventional renewable energies. By the end of 2020, the government had announced that it plans to reduce 51% GHG emissions by 2030 as part of its long-term strategy to reach net zero by 2050. Under this forward-looking plan, the country's enormous and untapped wind potential needs to be realised for resilient energy system transformation and socio-economic benefits.

A series of regulatory proposals has been made to grow non-conventional energy sources:

- First, the MME published a draft resolution setting minimum favourable requirements for sale of renewable power by wholesale market participants. To increase renewable power purchase swiftly, it also stipulates that at least 10% of annual energy sales to end-users should come from non-conventional sources, both in the regulated and free markets. Its annual obligation will come into force from 1 January 2022.

- Second, new rules and procedures for transmission capacity assignment on the national grid published by power sector regulator CREG would relax connection bottlenecks by re-allocating rights for the use of

Photo Credit: Mainstream Renewable Power

idle capacity to new power plants. Further, grid capacity utilisation of other provinces in the country can push feasible development of wind projects to these potential regions.

While these policies would foster the renewable power purchase, Colombia needs to address short to medium-term challenges which hinder wind project development and grid connection timelines. Considering the market challenges, GWEC Market Intelligence forecasts that 2.2 GW of new wind capacity could be installed from 2022 to 2025.

Colombia has several areas with high wind power potential. Its La Guajira area stands out as one of the most favourable sites in Latin America, with Class 7 annual average wind speeds that near 10 m/s. As per World Bank data, this area has up to 18 GW for power generation potential - enough to cover national demand twice.

Current and near-term challenges to the pace of wind growth

But for existing wind projects, developers and investors are facing logistical issues due to the unavailability of suitable land-based infrastructure to transport longer and larger wind turbine components via roads, such as blades and towers. Additionally, wind turbine components are imported via shipping to nearest ports. Since most of these port facilities and vessels are privately owned or operated, robust agreements to regulate the use of ports is required. This will not only help to safeguard wind components but will address project execution timelines and expenditures.

Aside from logistical challenges, there is continued delay in the construction of the 470 km 500 kV Colectora transmission line, as the construction company must advance social impact assessments and EIAs as part of the licensing procedure.

This line will dispatch the energy generated by six wind farms of more than 1,000 MW, awarded in the La Guajira area. Although some communities have already signed agreements, certificates have to be issued as the next step for licensing. Moreover, the physical meetings of this process have been delayed due to the pandemic. These wind projects have execution commissioning guarantees up to 31 December 2023 and the situation will be critical if the Colectora transmission line fails to be operational by this deadline.

Colombia's president has announced that a second large-scale renewable energy auction with long-term PPAs will be conducted during the first semester of 2021. The rules for the tender are currently in the public hearing process. The MME also intends to cover power retail companies serving households, commercials and small industrial businesses in this auction.

Notably, eligible projects will need to be operational before December 2022, in an effort to consolidate the country's position in the diverse and non-conventional energy space. In this case, challenges related to environmental licensing, insufficient infrastructure for power evacuation and unsuitable transportation networks should be resolved through solutions such as single window clearance, virtual public hearings and strategic long-term infrastructure planning. Preparation of a long-term auction pipeline can further provide visibility to investors and developers in the market.

La Guajira area stands out as one of the most favourable sites in Latin America, with Class 7 annual average wind speeds that near 10 m/s

Reportedly, the Vientos Alisios consortium is planning to conduct pre-feasibility studies for Colombia's first 200 MW offshore wind farm, 15 km off the coast at the Port of Cartagena. Developers intend the project to enter construction in 2024 and come online by December 2025.

Mozambique

Mozambique is well-endowed with natural resources and has the largest power generation potential in Southern Africa. Its population of 30 million is spread over a large area with a dispersed rural population and limited grid infrastructure. Until recently, the country's primary energy resource potential has been hydropower, which represents roughly 80% of installed power generation capacity, as well as proposed development of its substantial offshore natural gas reserves through floating LNG infrastructure.

However, over the last decade, the Mozambican government has started to adopt non-hydro renewable energy sources to diversify its electricity mix. The country has areas with excellent wind resource potential, and wind is being incorporated into centralised electricity planning in the Integrated Master Plan of Energy Infrastructures (PDIE).

Expanding electricity access while diversifying the power mix

Due to its dependence on hydropower, Mozambique is vulnerable to drought, but produces sufficient electricity to provide bulk exports to South Africa via existing interconnections through the regional South Africa Power Pool (SAPP). While Mozambique's power generation potential is generally estimated to be more than 185 GW, its installed capacity is currently less than 3 GW.

Access to the power grid has tripled in Mozambique over the last decade and is forecast to continue growing at an annual rate of 7-8%. This is driven by the government's National Electrification Strategy (ENE) to achieve universal access by 2030 for the more than 4 million households without electricity, a large increase from the current access rate of about 40%. The National Energy Regulatory Authority (ARENE) and state-owned utility Electricidade de Mocambique (EDM) are also developing a sustainable energy strategy to significantly reduce GHG emissions while supporting the growth of electricity demand.

According to the latest wind resource measurements from 2020 developed by consultants to the IFC, Mozambique has technical potential to achieve up to 681 GW installed capacity and 1,570 TWh/year of net wind energy generation. Beyond its excellent wind resource, there are other favourable conditions for wind development, including complementarity with the country's well-developed hydropower capacity and its peak energy demand in the evening.

Mozambique's government and EDM also have a track record, albeit limited, of working with renewable energy IPPs. In 2016, Scatec Solar and Norfund signed a PPA for the country's first large-scale renewable energy IPP project – the Mocuba solar PV plant, built in the north-central province of Zambezia, which secured a 25-year PPA with EDM and involves IFC-led financing. As has been the case in many emerging markets in Africa and globally, Mozambique's first wind projects parallel its solar development.

Increasing momentum towards competitive procurement

The Namaacha region in the south of the country hosts Mozambique's

Photo Credit: Mainstream Renewable Power

two most advanced wind projects, each with 60 MW capacity. One is being developed by EleQtra and the other by Globeleq in partnership with local developer SourceCapital. Both projects received approval in 2018 following an agreement signed between each developer and the Mozambique Energy Fund. The United States Trade and Development Agency has awarded several grants for wind project feasibility studies, including to EleQtra's project and to a Globeleq subsidiary's wind/storage project in the Manhiça district.

While the Namaacha and Manhiça projects were developed on a bilateral basis, there is a clear trend in Mozambique to move towards a competitive procurement framework – driven by the PROLER (Project for Promotion of Auctions for Renewable Energies) programme. Supported by the Agence Française de Développement (AFD) and EU, PROLER assists EDM in setting up calls for tenders and conducting preliminary environmental and social studies. In additional, the AFD has proposed a guarantee mechanism to mitigate offtaker risk around the buyer, EDM. To date, three solar projects are planned in the north, while a fourth wind/storage project is being planned in Inhambane, on the coast just north of the capital Maputo.

Mozambique can become a leader in the next wave of wind energy markets in Sub-Saharan Africa

Medium-term potential for wind in Mozambique

The Mozambican energy system has the potential to implement up to 200 MW of wind projects in the medium term, depending on government energy planning decisions, construction of adequate complementary infrastructure and execution of PPAs at suitable long-term tariff rates. More wind energy capacity could also be developed based on opportunities to export power to neighbouring South Africa and Zimbabwe via the SAPP.

The growth of the Mozambican wind energy market is closely tied to the success of the projects currently in the pipeline, and the demonstration effect they will have on industry and government stakeholders. Early signals from EDM are positive, but the technology still has much to prove before it can be more heavily relied upon in Mozambique's energy mix.

Competition from gas-fired thermal power plants, based on supplies from the massive LNG projects under development, still poses a threat to renewable energy's growth. However, unfavourable market conditions stemming from the pandemic, coupled with the evolving armed conflict in the north, are casting uncertainty over the first proposed LNG project.

Despite a variety of market challenges, Mozambique can become a leader in the next wave of wind energy markets in Sub-Saharan Africa. With the necessary elements to spur wind energy development into a significant element of the generation mix, Mozambique is an important wind market to track on the continent.

Photo Credit: Mainstream Renewable Power

Exploring new markets

From the perspective of GWEC Market Intelligence, it is important to highlight the development for wind in emerging markets. The four selected markets, Thailand, Philippines, Ethiopia and Uzbekistan, are representative of markets with high wind potential but varying political support and targets to date. Still, in all four markets there is an increasing awareness that wind can provide a scalable, cost-competitive and efficient solution for renewable energy.

GWEC Market Intelligence is monitoring activities in 46 markets on a regular basis to document the opportunities and progress of taking wind global.

Thailand

Development stage
Limited wind capacity in the pipeline. There may be new opportunities in 2021 if the proposed revision for PDP 2018 is adopted, calling for at least 90 MW of new wind capacity annually between 2022 to 2024.

Political support
The proposed revision of its PDP 2018 can accelerate some of the developments allowing for 90 MW of new wind capacity per year between 2022-24. Although limited in size, it's the first wind-specific target, and new tenders could be issued within the next year.

Challenge
Thailand currently faces overcapacity with a reserve margin of 47% (including imports) in 2019. The commissioning of the new hydropower plants in Laos last year, for which Thailand has a long-term purchase commitment, further exacerbated the overcapacity challenge.

Next milestone
Steps towards policy certainty and implementation of the PDP revision need to happen in 2021. The transformation of Thailand into a power trading hub presents a future prospect for wind developers.

Philippines

Development stage
Despite the wind industry being stagnant for the last four years, the Philippines has a large pipeline of almost 5 GW of proposed wind projects.

We can expect some momentum brought in by a 132 MW wind plant in 2021 and by the beginnings of discussions around offshore wind development in the country.

Political support
The draft Philippines Energy Plan for the period 2018-40, published in 2020, falls short on its 2030 renewables target. However, the launch of a green energy auction in 2021, moratorium on greenfield coal plants and development of the Green Energy Option Program for large power consumers will promote growth of renewables.

Challenge
Lack of incentivisation under the current FIT, long permitting process, legal obstacles along with limitations on transmission capacity have made it difficult for wind development thus far.

Next milestone
GWEC expects that improving economics of wind development and green energy auctions could help materialise some of these pipeline projects. However, the future of wind is still dependent on the type of supply requirement called for through the annual auctions.

Ethiopia

Development stage
Since the 320 MW installations of wind by 2015, there have not been further developments. However, momentum is growing with its 120 MW Aysha-II and 100 MW Asella-I wind farms in development, 300 MW wind project under negotiation phase and 2x 125 MW projects under feasibility study along with wind speed measurement across 18 sites clearly depicts a strong wind pipeline in years ahead.

Political support
As per draft Ethiopian Electric Power System Development Plan for the period 2021 – 2030, published in January 2021, aims for the commissioning of 24 wind farms that will increase wind capacity in the generation mix from current 7% (324 MW wind / 4,505 MW total) to 15% by 2030 (2570 MW wind / 17,056 MW total).

Challenge
Financing in general is a big challenge in Ethiopia. The rapid devaluation of the Ethiopian birr has led to currency convertibility risk, as IPPs are paid in birr, as well as uncertainty around the credibility of Ethiopia Electric Power as an offtaker. Furthermore, there is a general lack of a domestic and foreign commercial banking presence.

Additionally, the process of competitive bidding for wind IPP projects is long and time intensive which needs improvement to grow the country's wind market.

Next milestone
Adopting the currently being considered auction system (similar to South Africa) together with the strengthened institutional framework and provision of risk mitigation measures for currency convertibility, transferability and availability would significantly help the country in achieving its ambitious plan for wind development.

Uzbekistan

Development stage
Soon after the raised renewables target, in June 2020, Uzbekistan sealed the deal for its first wind farm of a 500 MW capacity, shoring up its wind power ambitions..

At the start of this year, another 2 PPAs were signed with ACWA Power for two separate wind farms that aim to connect 1 GW of wind, powered by approximately 200 wind turbines, to supply 2.7 million households in the country.

Political support
In May 2020, the Uzbekistan Ministry of Energy announced a goal to source 25% of its power from renewables by 2030, which would require an estimated 5GW of solar and 3GW of wind.

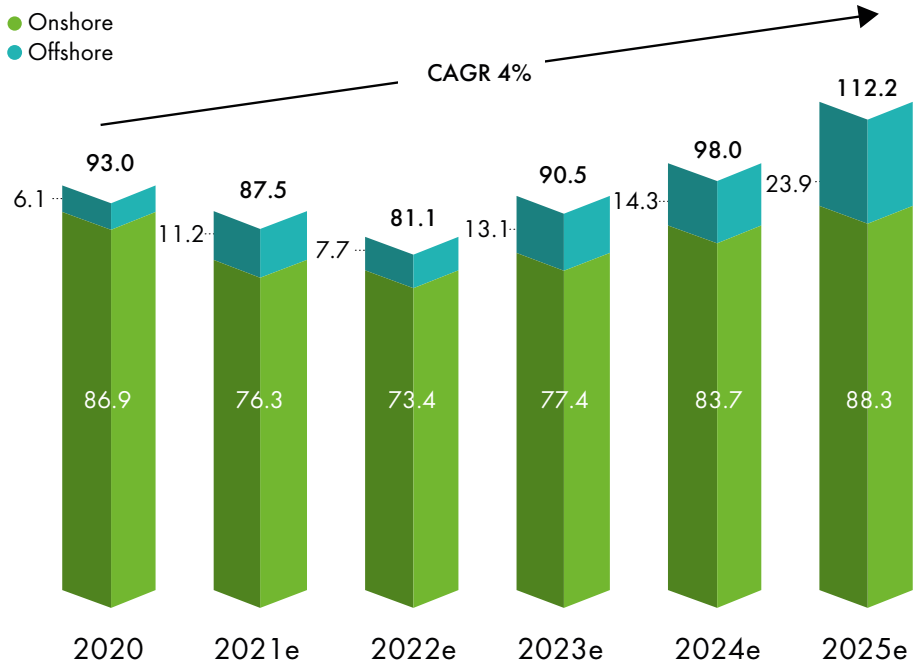
The country has also devised a low-carbon energy strategy to aid renewables transition.

Challenge
The lack of utility-scale renewables projects to date makes it hard for companies to gauge development barriers ahead, with challenges working with a utility integrating wind power into the country's grid for the first time. In addition, materials used for large-scale renewables are not specifically exempted from import duties, which raises uncertainty among developers as they consider developing a project in Uzbekistan.

Next milestone
For a country with wind capacity potential estimated at more than 520 GW, proper plans for the tender of the first projects, possibly beginning with a demonstration scale project will be crucial to kickstart the industry.

MARKET OUTLOOK 2021 – 2025

New wind power installations outlook 2020-2025 (GW)



Global wind energy market expected to grow on average by 4 per cent each year

GWEC's Market Outlook represents the industry perspective for expected installations of new capacity for the next five years. The outlook is based on input from regional wind associations, government targets, available project information and input from industry experts and GWEC members. An update will be released in Q3 2021. A detailed data sheet is available in the member only area of the GWEC Intelligence website.

Global outlook

- The market outlook for the global wind industry remains positive. The CAGR for the next five years is 4.0%, even though the installed capacity for 2020 marked a new high.

- GWEC Market Intelligence expects that over 469 GW of new capacity will be added in the next five years. That is nearly 94 GW of new installations each year until 2025.

- Growth at the beginning of the next five-years will continue to be driven by government policy, including FiT, PTC, ITC, Green Certificates and renewable or technology-neutral auctions and tenders. New installations are expected to drop slightly in 2021, but it is still possible to make it the second-best year in history, taking into account the ongoing installation rush in the world's two largest markets, China (offshore) and the US (onshore), driven by the cut-off of FiT and the deadline to qualify the full PTC value respectively.

- From 2022 onward, although the PTC will remain as the main driver for installations in the US (where the one extra year PTC extension passed the senate last December can prevent the US onshore market from a cliff drop

in 2025), the rest of world is expected to operate based on wind-only, hybrid, and technology-neutral auctions or on the grid-parity scheme (mainly China). To ensure stable growth in Europe, Latin America, Africa & Middle East and South East Asia, lessons shall be learnt from the previous auction market design failures in countries like Germany and India.

Global onshore outlook

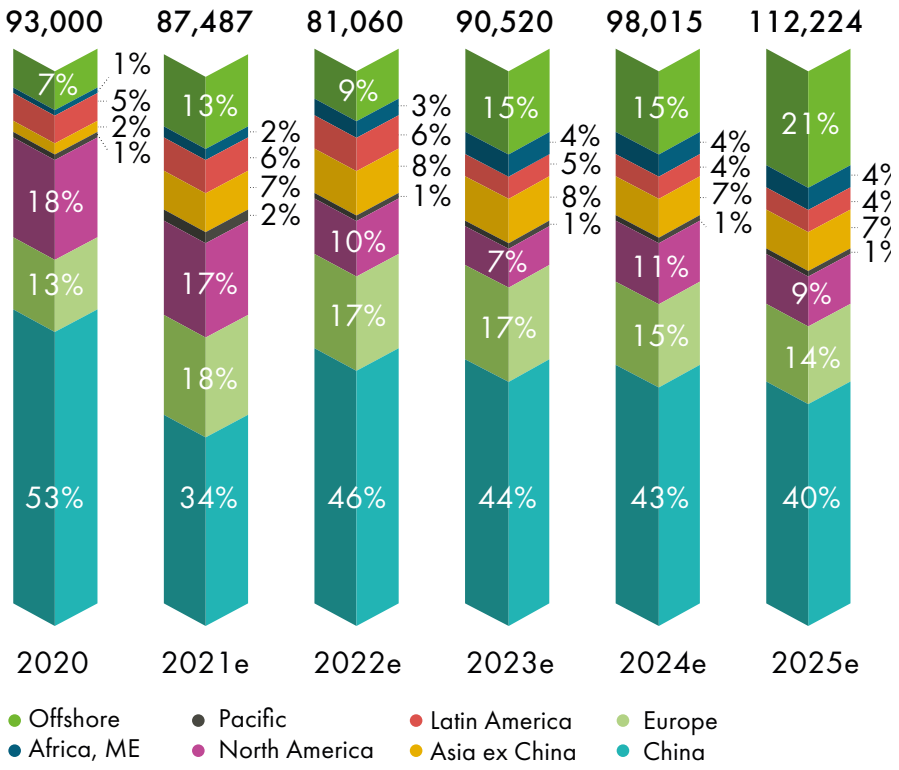
- The CAGR for onshore wind in the next five year is 0.3%. The average annual installation is 79.8 GW. In total, 399 GW is likely to be built in 2021-2025. In China, from 2021, onshore wind has entered a new era: subsidy-free. Although the expected drop in the Chinese onshore market in the near-term will slow down global onshore growth, the net zero targets declared by the Chinese government and the implementation plans of provincial governments and corporates are likely to accelerate the new installations from 2022(for details, see the China net zero case study).

Global offshore outlook

- The CAGR for offshore wind in the next five year is 31.5%. New installations are likely to quadruple by 2025 from 6.1 GW in 2020. In total, more than 70 GW offshore is expected to be added worldwide in 2021-2025. This positive global offshore wind market outlook is supported by: 1) the sharp drop of offshore wind LCOE, 2) increased offshore wind targets in Europe, the United States and key markets in Asia such as Japan and South Korea, 3) the expected commercialisation and industrialisation of floating wind, and 4) offshore wind's unique role in facilitating cross industry cooperation and accelerating the global energy transition from fossil fuel to renewables.

Developing markets and offshore likely to take bigger role to drive global growth

New wind power installations outlook 2020-2025 by region
MW and per cent, onshore and offshore



Offshore wind
The volume of annual offshore wind installations is expected to quadruple from 6.1 GW in 2020 to 23.9 GW in 2025, bringing its share of global new installations from today's 6.5% to 21% by 2025. In Asia, China will remain the largest contributor in the next five years, followed by Taiwan, Vietnam, Japan and South Korea. In Europe, offshore wind will continue to grow, especially when the big CfD 3 projects come online in the UK from 2023 and with new projects to be installed by Eastern European countries from 2024. In the US, under the support of the Biden Administration, commissioning the first utility-scale offshore installations (more than 800 MW) by 2023 is becoming feasible and multi-GW level of new installations are expected to be built thereafter.

Africa & the Middle East
New installations in this region will double in 2021 and then triple in 2022 compared with 2020. Such growth momentum is unlikely to stop during the rest of the forecast period. On average, 3.2 GW of new capacity is expected to be added each year in Africa/Middle East in the next five years (2021-2025), which is primarily driven by growth from South Africa, Egypt and Morocco in Africa and Saudi Arabia in the Middle East.

Asia excl. China
The COVID-19 pandemic coupled with the existing challenges with land acquisition, grid connection and permitting made 2020 a tough year for India. However, the situation is expected to improve and more capacity will come online starting from 2021, with annual installations reaching a new peak in 2023 due to the retirement of the ISTS waiver. Aside from India, Vietnam is expected to be a key driver in this region considering the ongoing installation rush driven by the

planned expiry of the FiT as well as the highly awaited Power Development Plan VIII (PDP8). Additionally, sizable volume is also expected to come from emerging markets in southeast Asia, such as the Philippines and Indonesia, and in central Asia namely Kazakhstan and Uzbekistan.

Pacific

After a four-year break, new capacity was commissioned in New Zealand in 2020 and more projects are expected to be built in the next five years. However, the majority of demand in this region in 2021-2025 will still come from Australia. State level support and auctions together with new solutions like hybrid power plants and Power-to-X will continue to generate opportunities in region's largest market, but grid transmission challenges will need to be addressed to accommodate such growth.

Europe

Driven by expected growth from established markets in Western Europe, including Germany, France and Spain, the Nordic countries, especially Sweden and Norway, and non-EU 27 markets such as Turkey and Russia, a new onshore installation record is likely to be achieved in 2021. After that, annual installations will remain stable in the remainder of the forecast period. However, as WindEurope has flagged, to ensure 15 GW/year onshore growth in Europe in the next five years, issues such as permitting, re-powering and pandemic associated restrictions will have to be addressed.

GWEC Market Intelligence expects that over 469 GW of new capacity will be added in the next five years.

The Americas

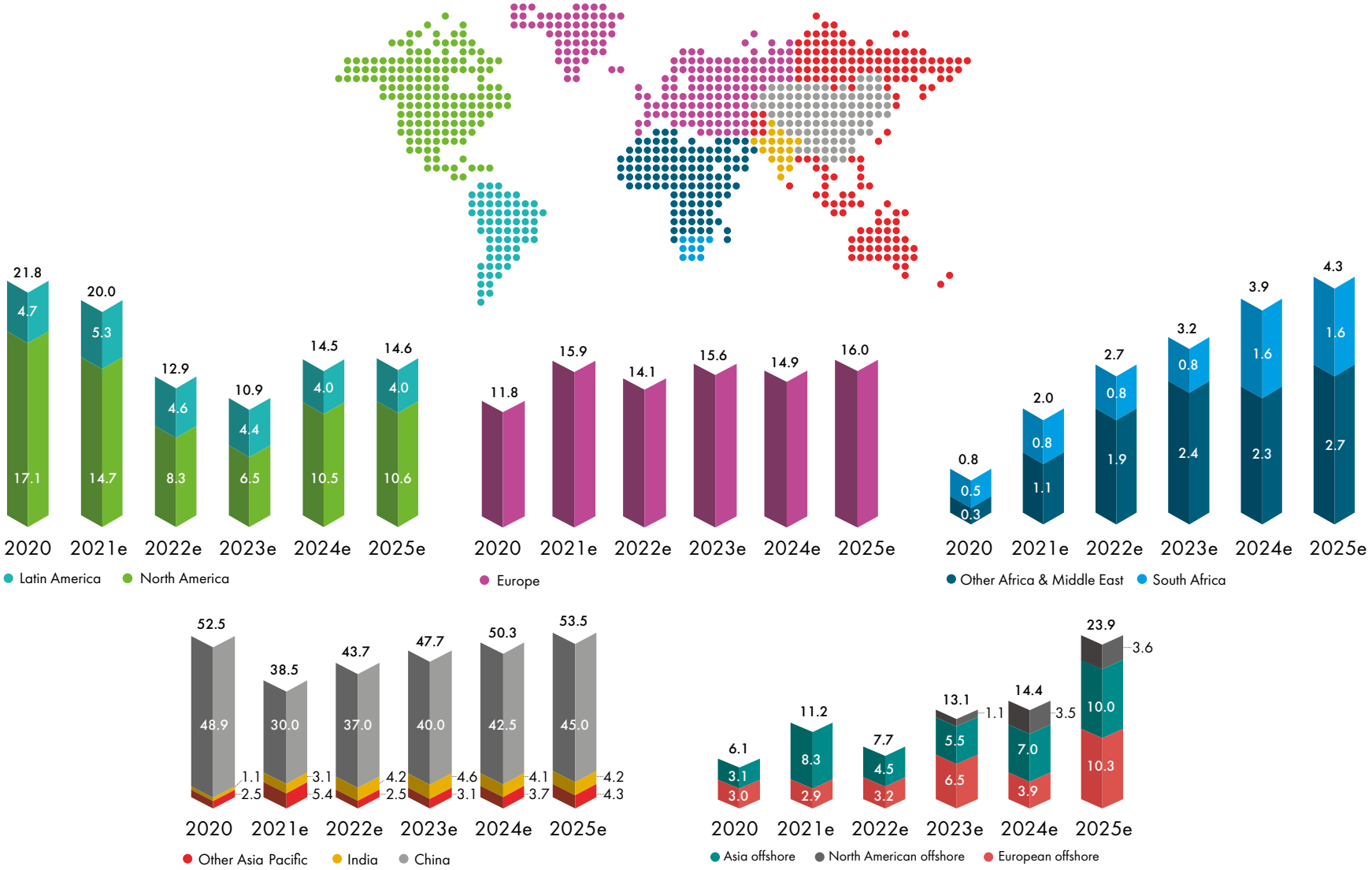
A new installation record is expected in Latin America in 2021, but the region is still a mixed picture in terms of government support, economic stability and grid capability on a country level, and annual growth in this region is likely to drop back from 2022. Brazil, Chile, Mexico, Argentina and Colombia are expected to be the top five contributors to regional growth in the next five years. In parallel to existing auction schemes, private auctions or bilateral PPAs have emerged as an alternative to drive the growth in this region. In North America, the PTC will remain as the primary driver to support the US onshore wind growth in the next five years. Onshore wind installations in the US are likely to decline in 2022 and 2023 but can be expected to bounce back in 2024 and 2025, driven by the PTC extension enacted in both 2019 and 2020.

China

After explosive growth in 2020, GWEC Market Intelligence believes Chinese onshore wind installations in 2021 will decline significantly. This is because most of the project pipelines approved before the end of 2019 have already run their course and starting from 2021 all onshore projects have to be subsidy-free. Nevertheless, onshore wind installations are expected to gradually ramp up again to support China's carbon neutrality target in the coming years to reach new record levels.

Regional onshore wind and offshore wind outlook

New installations (GW)



APPENDIX

Global Wind Report - Methodology and Terminology

Data definitions and adjustments

GWEC reports installed and fully commissioned capacity additions and total installations. However, considering the delay of grid connection in China, GWEC uses installation data from the Chinese Wind Energy Association (CWEA) for China instead of grid-connected data.

New installations are gross figures not deducting decommissioned capacity. Total installations are net figures, adjusted for decommissioned capacity.

Definition of regions

GWEC adjusted its definition of regions for the 2018 Global Wind Report and maintains these in the 2021 edition, specifically for Latin America and Europe.

Latin America:
South, Central America and Mexico

Europe: Geographic Europe including Norway, Russia, Switzerland, Turkey, Ukraine

Sources for the report

GWEC collects installation data from regional or country wind associations, alternatively, from industry experts.

Historic installation data has been adjusted based on the input GWEC received. The 2021 Global Wind Report shows the accurate current and historic data.

Used terminology

GWEC uses terminology to the best knowledge. With the wind industry transitioning certain terminology is not yet fixed or can have several connotations. GWEC is continuously adapting and adjusting to these developments.

Acronyms

BESS	Battery Energy Storage Systems
BNEF	BloombergNEF
CAPEX	Capital Expenditures
CCS	Carbon Capture and Storage
CCUS	Carbon Capture, Utilisation and Storage
CfD	Contract for Difference
CO_2e	Carbon Dioxide Equivalent
COP26	26th UN Climate Change Conference of the Parties
DFIs	Development Finance Institutions
DISCOMs	Distribution Companies
EJ	Exajoules
EO	Executive Orders
ESG	Environmental, Social and Corporate Governance
ETFs	Exchange Traded Funds
ETS	Emissions Trading Scheme
EU	European Union
FiT	Feed-in Tariff
GDP	Gross Domestic Product
GHG	Greenhouse Gases
GW	Gigawatt
IEA	International Energy Agency
IMF	International Monetary Fund
IPP	Independent Power Producers
IRENA	International Renewable Energy Agency
IRP	Integrated Resource Plan
ISTS	Inter-state transmission System
ITC	Investment Tax Credit
KEPCO	Korea Electric Power Corporation
LCOE	Levelised Cost of Energy
LTES	Long Term Energy Scenarios
MDBs	Multilateral Development Banks
MOIT	Vietnam Ministry of Industry and Trade
Mt	Metric Tonnes
MW	Megawatt
NDCs	Nationally Determined Contributions
O&M	Operation and Maintenance
OEMs	Original Equipment Manufacturers
PDP	Vietnam Power Development Plan
PPA	Power Purchase Agreement
PV	Photovoltaic
R&D	Research and Development
REIPPPP	Renewable Energy Independent Power Producer Procurement Program
RPS	Renewable Portfolio Standard
SMEs	Small and Medium Enterprises
TEPCO	Tokyo Electric Power Company
TWh	Terawatt Hour
UK	United Kingdom
UN	United Nations
US	United States

About GWEC Market Intelligence

GWEC Market Intelligence provides a series of insights and data-based analysis on the development of the global wind industry. This includes a market outlook, country profiles, policy updates, deep-dives on the offshore market among many other exclusive insights.

GWEC Market Intelligence derives its insights from its own comprehensive databases, local knowledge and leading industry experts.

The market intelligence team consists of several strong experts with long-standing industry experience across the world.

GWEC Market Intelligence collaborates with regional and national wind associations as well as its corporate members.

About GWEC Market Intelligence

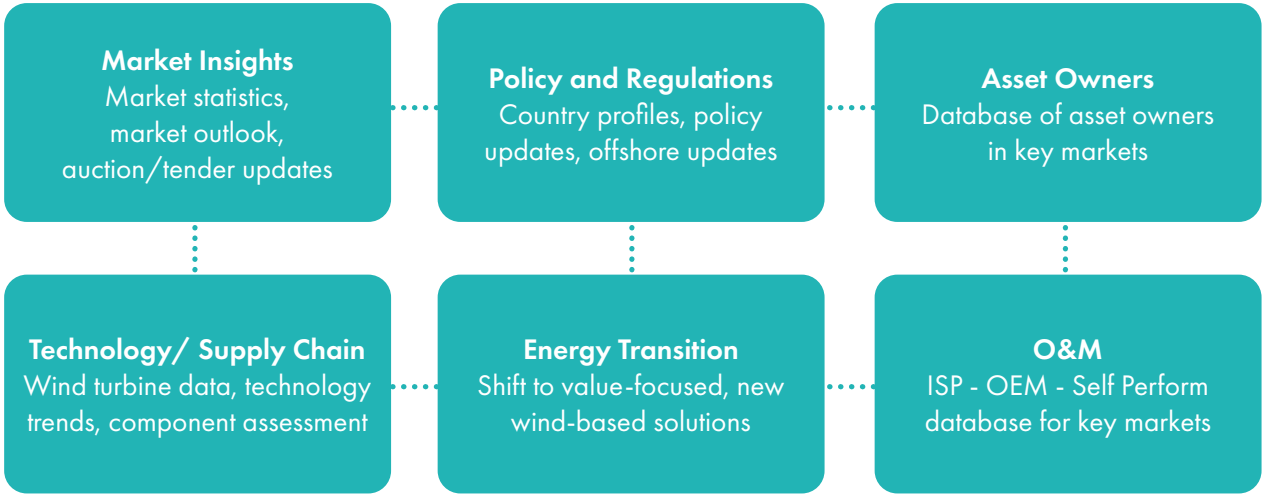
How to access GWEC Market Intelligence

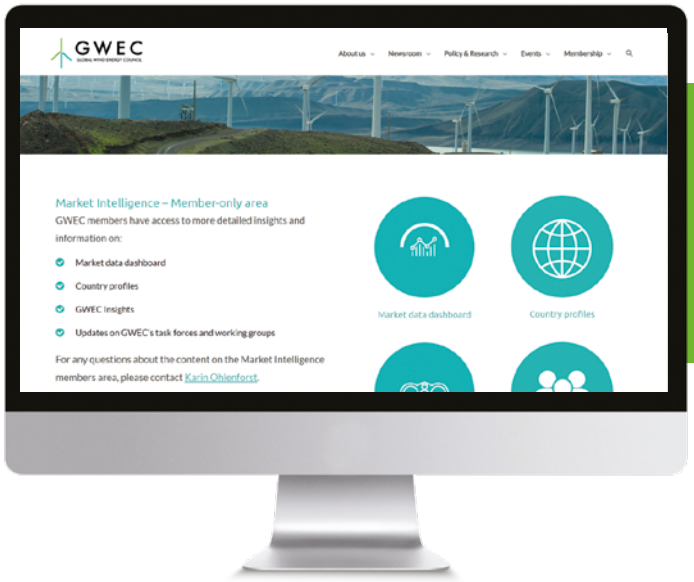
- Corporate GWEC Members
- Wind energy associations
- Market Intelligence subscription

Subscription

Contact Feng Zhao feng.zhao@gwec.net

GWEC Market Intelligence Areas





GWEC Market Intelligence created a Member-only area to provide more in-depth market intelligence to GWEC's members and their employees.

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GWEC Market Intelligence Products in 2021

Product	Frequency
1. Wind Energy Stats/Market Data	
Wind Stats 2020 (and historic)	Annual
Global Wind Report 2021	Annual
Wind Energy Statistics (wind energy pentration rate, jobs)	Annual
2. Country Profiles/Policy Updates	
Country Profiles Onshores/Country Profiles Offshore	Quarterly/Ad-hoc
Ad-hoc policy updates	Ad-hoc
3. Market Outlook	
Global Wind Market Outlook 2021-2025 (Q1 and Q3)	Semi-Annual
4. Supply Side Data	
Global Wind Turbine Supply Side Data Report (by market, technology, turbine size and numbers)	Annual
5. Auctions/Tenders	
Auction Trends and Learnings	Annual/Quarterly
Global Auction Results (database)	Quarterly
6. Offshore Wind Market	
Global Offshore Wind Report 2021	Annual
Market Entry Opportunities Database	Annual/Quarterly
Global Offshore Project Pipeline (database, in operation and under construction)	Annual/Quarterly
Global Offshore Turbine Installation Vessel Database	Annual/Quarterly
7. Components Assessment	
Gearbox (2019), Blade (2020), Generator (2021), followed by other components	Special Report
8. Wind Asset Owners/Operators	
Ranking of Wind Asset Owners and Operators Globally (Onshore and Offshore)Annual	
9. O&M	
O&M Service Provider Database (ISP- OEM - Self-perform	Annual
10. Energy Transition, Digittalisation, Hybrid, Hydrogen	
Position papers/studies - Value shift, Corporate PPAs	Special Report
New solutions, GWEC policy recommendations	Special Report

WOMEN IN WIND GLOBAL LEADERSHIP PROGRAM

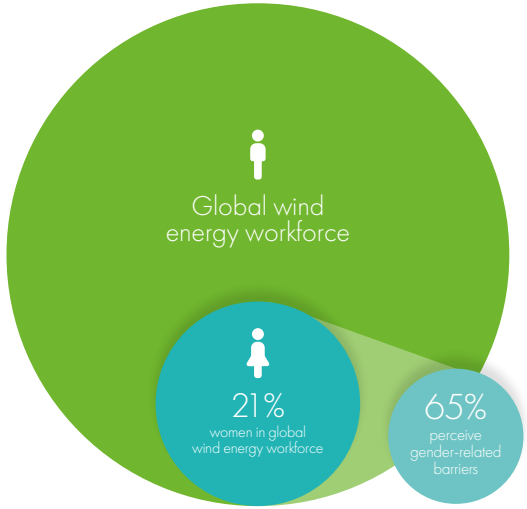
2020 was a year of disruption, loss and adaptation. The pandemic deepened pre-existing inequalities and exposed the vulnerabilities of our social, economic and political systems. As the global community examines the path to green recovery and sustainable growth, diversity and inclusion must be mainstreamed as a priority. Gender equality is crucial to the design of effective climate policies, and national and international efforts to tackle climate change must address the need for shared empowerment and innovation to be successful.

In 2019, the Global Wind Energy Council (GWEC) and the Global Women's Network for the Energy Transition (GWNET) jointly launched the Women in Wind Global Leadership Program. The program is designed to accelerate the careers of women in the wind industry, support their pathway to leadership positions and foster a global network of mentorship, knowledge-sharing, and empowerment.

Women's contributions – their talents, skills and views – are critically important in supporting the growing industry during a momentous transition towards a more sustainable energy system benefiting all of humanity. However, a study by IRENA and Women in Wind published in 2020 found that women currently make up only 21% of the global wind workforce, and the majority of women in the sector perceive gender-related barriers to their retention and/or advancement.

GWEC and GWNET call on stakeholders across the wind and renewables industries to recognise the importance of equal participation in the fight against climate change. In uplifting the next generation of stewards for a sustainable energy system, we affirm that our efforts are in alignment with UN Sustainable Development Goal 5 (achieve gender equality and empower all women and girls) and UN Sustainable Development Goal 7 (ensure access to affordable, reliable, sustainable and modern energy for all).

Find out more and join us: https://gwec.net/women-in-wind/about-the-program/
Instagram: @WeAreWomenInWind



Women make up 21% of the global wind energy workforce, and 65% of them perceive gender-related barriers in the sector
Source: 2019 study by IRENA and Women in Wind, with nearly 1,000 respondents from 71 countries

Jointly organised by:

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