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Offshore hubs

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Dr Birol: says the pathway to net zero by 2050 is "narrow but achievable"

IEA net zero roadmap lays out daunting pathway

A landmark report launched by the IEA gives a detailed roadmap on how to reach net zero emissions by 2050. But the pathway calls for unprecedented transformation. **Junior Isles**

The world has a viable pathway to building a global energy sector with net zero emissions in 2050, but it is narrow and requires an unprecedented transformation of how energy is produced, transported and used globally, according to a landmark report by the International Energy Agency.

The new report, 'Net Zero by 2050: a Roadmap for the Global Energy Sector' comes at a crucial time, as world leaders prepare for the COP26 climate talks in November this year. Climate pledges by governments to date – even if fully achieved – would fall well short of what is required to bring global energy-related carbon dioxide (CO_2) emissions to net zero by 2050.

According to the IEA, the scale and speed of the efforts needed to limit global warming to 1.5°C and thus avoid irreversible climate change, make this "perhaps the greatest challenge humankind has ever faced".

Launching the report, Dr Fatih Birol, the IEA's Executive Director said: "More countries are coming up with net zero commitments, which is very good, but I see a huge and growing gap between the rhetoric and the reality. Our Roadmap shows the priority actions that are needed today to ensure the opportunity of net-zero emissions by 2050 – narrow but still achievable – is not lost… Moving the world onto that pathway requires strong and credible policy actions from governments, underpinned by much greater international cooperation."

The Roadmap sets out more than 400 milestones to reaching net zero by 2050. These include, "from today", no investment in new fossil fuel supply projects, and no further final investment decisions for new unabated coal plants. By 2035, there are no sales of new internal combustion engine passenger cars, and by 2040 the global electricity sector to have already reached net zero emissions.

In the near term, the report describes a net zero pathway that requires the immediate and massive deployment of all available clean and efficient energy technologies, combined with a major global push to accelerate innovation. The pathway calls for annual additions of solar PV to reach 630 GW by 2030, and those of wind power to reach 390 GW. Together, this is four times the record level set in 2020. A major worldwide push to increase energy efficiency is also essential, resulting in the global rate of energy efficiency improvements averaging 4 per cent a year through 2030 – about three times the average over the last two decades.

Most of the global CO_2 reductions between now and 2030 in the net zero pathway come from technologies readily available today. But in 2050, almost half the reductions come from technologies that are currently only at the demonstration or prototype phase.

The special report is designed to inform the high-level negotiations that will take place at COP26 in Glasgow and was requested as input to the negotiations by the UK government's COP26 Presidency.

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G7 countries agree to end state financing for coal power plants

A recent decision by the Group of Seven (G7) wealthy nations to end state financing of coal fired power plants by the end of this year sends a clear signal that world leaders are treating the climate crisis with growing urgency.

Last month's move followed a recommendation from the International Energy Agency that all future fossil fuel projects must be scrapped if the world is to reach net zero carbon emissions by 2050 and limit warming to 1.5°C.

Reaffirming their commitment to keep temperature rises below 1.5°C by 2050, climate and environment ministers from the G7 (Canada, France, Germany, Italy, Japan, US and Britain) said fossil fuels should be mostly phased out from G7 countries' electricity supplies by the 2030s. The group also reiterated that it aimed to eliminate "inefficient fossil fuel subsidies" by 2025.

UK lawmaker Alok Sharma, who is president-designate of the COP26 UN climate summit to be held in Glasgow in November, said the consensus was "a clear signal to the world that coal is on the way out". Britain has also proposed that the G7 call for ending coal fired power generation as soon as possible in a joint statement when their leaders gather in June.

The UK government has said it will double its climate aid contribution and Prime Minister Boris Johnson has said he wants to secure a "substantial pile of cash" from leaders of major economies at the upcoming G7 meeting for climate finance.

UN Secretary General Antonio Guterres also urged members of the Organization for Economic Cooperation and Development to gradually abolish coal fired thermal generation by 2030 and for G7 members to present concrete plans for realising it by the time leaders gather for the meeting starting on June 11.

All G7 nations now have 2030 emissions reduction targets, aligned with 2050 net zero aims.

German Environment Minister Svenja Schulze called the agreement "an important step forward" that gave credibility to industrialised nations to urge others to follow suit.

The German government recently raised the ambition on its emissions reduction targets after a landmark ruling by the country's top court declared its existing climate protection law "insufficient", saying it placed too much responsibility for cutting carbon emissions on future generations.

Under the new targets, the government expects to slash emissions by 65 per cent by 2030 compared to 1990 levels, going further than the current 55 per cent reduction target. Germany is also aiming to be carbon neutral by 2045, five years earlier than previously planned.

Notably, the original law said that Germany's power plants must reduce emissions to 175 million tonnes of CO_2 in 2030. That target has now been cut to 108 million tonnes.

Commenting on the difficulties in meeting the new targets, Schulze said: "The expansion of renewables is now the bottleneck. We have to be able to do that more quickly, because that's the condition for us getting out of coal faster."

Meanwhile, the Asian Development Bank (ADB) is mulling over helping wean developing countries off coal while also supporting gas fired power generation as an insurance against the intermittent supply from renewables. The multilateral lender is currently updating its energy policy, which is scheduled for submission to the board of directors in the fourth quarter this year.

Sumitomo Mitsui Financial Group Inc. also said it will tighten its policy on financing coal fired power plants, halting new lending without exception from June 1st.

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"I welcome this report, which sets out a clear roadmap to net zero emissions and shares many of the priorities we have set as the incoming COP Presidency – that we must act now to scale-up clean technologies in all sectors and phase-out both coal power and polluting vehicles in the coming decade," said COP26 President-Designate Alok Sharma.

Sharma: We must act now to scale-up clean technologies

Financing the net zero pathway will call for total annual energy investment to reach $5 trillion by 2030, adding an extra 0.4 percentage points a year to global GDP growth, based on a joint analysis with the International Monetary Fund, said the report.

The investment will, however, deliver economic benefits. The jump in private and government spending creates millions of jobs in clean energy, including energy efficiency, as well as in the engineering, manufacturing and construction industries. All of this puts global GDP 4 per cent higher in 2030 than it would reach based on current trends, said the report.

A growing number of businesses are also making an increasingly important contribution to the drive towards net zero.

Last month more than 100 companies, governments and NGOs, including some of the world's biggest energy consumers, technology firms and utilities, publicly backed a world-first programme to improve transparency around renewable energy. The programme is being spearheaded by EnergyTag, the independent industry-led initiative to accelerate the shift to 24/7 clean power.

Although many organisations and individuals already buy energy, which is classified as renewable through current certification schemes, the consumption of this energy is only matched to production on an annual basis. The problem is that as more renewable power plants are built, the availability of clean energy becomes increasingly volatile, meaning overproduction at certain times of day and scarcity at others.

A report published by EnergyTag sets out how energy consumers and producers can use hourly certificates to verify that the energy they consume is green hour-by-hour.

EnergyTag also announced six projects to demonstrate how these more granular certificates can reward those that can provide renewable power at times of short supply, including storage and flexibility providers.

The projects, the first of up to ten planned this year, are in the US, Denmark, Netherlands, Sweden, Norway and Australia, and involve industry leaders Google, Microsoft, Vattenfall, Centrica, Energinet, Statkraft and Eneco. Initial results will be published by the end of 2021.

Shell ruling has ramifications for energy majors

A ruling ordering Shell to bolster its plans for cutting carbon emissions could have a huge impact on the oil and gas sector.

Junior Isles

A landmark court ruling ordering Royal Dutch Shell (RDS) to drastically deepen its planned greenhouse gas emission cuts could trigger legal action against energy companies around the world.

Last month a court in The Hague said the oil and gas major must reduce carbon emissions by 45 per cent by 2030 from 2019 levels in absolute terms. The ruling applies to emissions from operations, suppliers and customers and is to be implemented via a change in Shell's corporate policy, while Shell has complete freedom in how it achieves the target.

Earlier this year, Shell set out one of the sector's most ambitious climate strategies – to cut the carbon intensity of its products by at least 6 per cent by 2023, by 20 per cent by 2030, by 45 per cent by 2035 and by 100 per cent by 2050 from 2016 levels. The court said, however that Shell's climate policy was "not concrete and is full of conditions... that's not enough".

Reading the ruling, Judge Larisa Alwin said: "The conclusion of the court is therefore that Shell is in danger of violating its obligation to reduce. And the court will therefore issue an order upon RDS."

Shell said that it would appeal the court verdict and that it has set out its plan to become a net zero emissions energy company by 2050.

Commenting on the ruling, Dmitry Loukashov, Equities Analyst at VTB Capital said: "It is difficult for us to understand the grounds on which the ruling is based and how it might be implemented. However, one thing is certain for us: this event could have far-reaching consequences. Since the decision applies to emissions by customers (so-called Scope 3), over which Shell has little to no control, the chief option for implementing it is to cut the production of oil and oil products."

The lawsuit, which was filed by seven groups including Greenpeace and Friends of the Earth Netherlands, marks a first in which environmentalists have turned to the courts to try to force a major energy firm to change strategy.

The judgement is significant in that it emphasises that companies and not just governments may be the target of strategic litigation which seeks to drive changes in behaviour.

Michael Burger, head of the Sabin Center for Climate Change Law at Columbia Law School said "there is no question that this is a significant development in global climate litigation, and it could reverberate through courtrooms around the world".

It will certainly put the strategies of other oil and gas majors to cut emissions under the spotlight, and highlights the growing pressure on them to change course.

In April Chevron investors voted in favour of a proposal to cut its customer emissions, while shareholders at Exxon elected two climate activists to its board after months of wrangling over its business direction.

Total has begun to invest more in solar and wind power, but it is under pressure to do more as climate issues rise closer to the top of investors' agendas. Last month the group said it is preparing to change its name to TotalEnergies to signal its diversification towards cleaner energy sources.

"We think that these events are not isolated and are likely to be followed by further pressure on oil companies (especially those incorporated in Western countries and/or publicly traded) to decarbonise (maybe at a quicker pace), entailing a cut in their hydrocarbon production and a ramp-up in investments into new lines of business, such as renewables, hydrogen production and carbon capture. More broadly, if such sentiment on oil consumption persists, this might signify a bleak outlook for global oil demand in the not-so-distant future," said Loukashov.

The ruling follows a landmark United Nations Methane Report that states that drastically cutting emissions is necessary to avoid the worst impacts of global climate change.

Responding to the report, OGUK, the body representing the UK's offshore oil and gas industry noted that last year, flaring from the offshore oil and gas industry was down by 22 per cent but acknowledged, "there is always more work to be done".

OGUK Energy Policy Manager Will Webster said: "We're committed to taking action and driving change in this area – working with members on a progressive Methane Action Plan, a key deliverable of the recently agreed North Sea Transition Deal, that will drive industry efforts and reduce routine flaring and venting across the basin.

"We look forward to publishing this plan as another important milestone for our changing sector in the coming months."

Electrolyser projects to pass 200 GW by 2040

A new report by Aurora Energy Research highlights just how quickly companies are responding to the potential of low carbon hydrogen.

Drawing on its global electrolyser database, Aurora finds that companies are planning electrolyser projects totalling 213.5 GW for delivery by 2040 – of which 85 per cent of projects are in Europe.

Within Europe, there is a pipeline of over 9 GW in Germany, 6 GW in the Netherlands, and 4 GW in the UK, all scheduled to be operational by 2040. Current global electrolyser capacity is just 0.2 GW, mainly in Europe, meaning that if planned projects deliver by 2040, capacity will grow by a factor of 1000.

The success of green hydrogen from electrolysis will be driven by two key factors: the cost of the power – which makes up most of the cost, and the carbon footprint. For grid-connected electrolysers, France is expected to have the lowest grid power prices to 2040, followed by Germany. The countries with the lowest grid carbon intensity will be Norway, Sweden and France. To achieve the lowest carbon footprint, electrolysers can bypass the grid and connect directly with renewable power sources such as wind, solar and hydro. The European Union is starting to determine carbon footprint thresholds within their laws and policies, which will increasingly reserve the label of 'sustainable' hydrogen to renewable-connected electrolysers only.

A separate study conducted by Research partners IFP Énergies Nouvelles, SINTEF and Deloitte on behalf of the funding partners of Hydrogen4EU, found that total demand in 2030 could increase up to three times higher than the EU's Hydrogen Strategy projections.

Johannes Trüby, Director for Energy and Regulation at Deloitte Economic Advisory, explained: "Based on a comprehensive analysis of the European energy system, our models have shown that hydrogen will be essential for steel, chemicals and heavy-duty transportation, and that a mix of renewable and low-carbon hydrogen is best placed to deliver on the Climate Law's net zero target."

According to the Energy Transitions Commission, about $2.4 trillion ($80 billion per annum) will be required between now and 2050 for hydrogen production facilities and transportation and storage.

■ German chemicals producer BASF SE says it will be partnering with energy major RWE AG to realise a massive industrial plan that relies on offshore wind power generation and green hydrogen production. The plan calls for RWE to develop, build and operate a 2 GW, zero-subsidy offshore wind farm in the North Sea that will produce some 7500 GWh of electricity annually.

About 80 per cent of the generated electricity is expected to power innovative CO_2 reduction technologies, including electrically heated steam cracker furnaces, at BASF facilities in Germany. The remaining 20 per cent will be used to run a 300 MW electrolyser plant for green hydrogen production in northwestern Germany.

Spain passes climate change and energy transition bill

Spain's Congress has approved the country's Climate Change and Energy Transition Law, after almost a year in parliament.

Spain has now set itself an obligation to reach certain intermediate targets that are to help it fully decarbonise its economy by no later than 2050. The main targets include:

■ Cutting the total GHG emissions by at least 23 per cent compared to 1990 levels by 2030

■ Increasing the share of renewables in the final energy consumption to at least 42 per cent by 2030

■ The electricity system should produce at least 74 per cent of power using renewable sources by 2030,

■ Energy efficiency should be improved by at least 39.5 per cent.

The law leaves room for these targets to be revised up in line with scientific knowledge and the Paris Agreement obligations. The first such revision is due in 2023, according to the text of the bill.

Commenting on the bill, David Howell, SEO/BirdLife Climate and Energy Lead said: "SEO/BirdLife welcomes this law as an important milestone in Spain. It comes late and its content is insufficient in some respects, but it seems the best possible outcome given the current political situation in Spain and the inertias of its economy.

"Among many priority tasks now, it should ensure that the deployment of renewable energy is focused on the least environmentally sensitive areas: it is still too rare to see solar panels in cities and industrial areas and shopping centres."

He added: "The law establishes a new expert committee, a figure that has played a key role in other countries' announcements to accelerate decarbonisation, such as Germany and the UK. The Spanish government should not be afraid of a similar 'critical friend', with a strong independent role and the necessary resources to do its job. The government should clarify these two urgent issues with a royal decree and the expert committee should be up and running before the end of the year."

US government acts following 'ransomware' attack on pipeline

- Bipartisan approach to create cyber security programme
- Model exercises will give companies tools to self-test

Janet Wood

US lawmakers have responded to a recent cyber 'ransomware' attack that closed down the Colonial Pipeline, a key link in US energy infrastructure. Legislators have now joined forces in a bipartisan bill that would direct the Cybersecurity and Infrastructure Security Agency (CISA) to create a special cyber programme to test the nation's critical infrastructure defences. The Cyber Exercise Act would also require CISA to assist state and local governments and private industry to assess the safety and security of critical infrastructure.

It will evaluate the National Cyber Incident Response Plan, simulate the results of a shutdown at a critical network, develop action reports and plans and set out model exercises that industry can adapt for its needs.

CISA issued a security advisory on ransomware, in response to the DarkSide, the variant used in the recent attack on Colonial Pipeline. Recent research suggests these types of attacks continue to trend upward, with operational technology up 30 per cent in 2020.

"The federal government has been looking to address critical infrastructure cyber vulnerabilities for years. What has potentially shifted, however, is the ability and desire of criminal actors – as is allegedly the case with the most recent attack – to target critical infrastructure. Criminal actors have different motivations and pressure points than nation state actors, which may require a different deterrent approach," said John Dermody, Counsel in the Washington, D.C. office of international law firm O'Melveny & Myers and member of the firm's Data Security & Privacy Group.

Edgard Capdevielle, Chief Executive of Nozomi Networks, said the government now should do more to protect the country from ransomware gangs and other cyber criminals, adding "it is fair to criticize the government for not doing enough to help protect us when it comes to 'no dust' defensive actions, and offensive actions too to shut down threat actors and hold them accountable."

He proposed incentives to help critical infrastructure organisations strengthen their security including tax breaks for cyber security.

Terry Olaes, Technical Director (North America) of Skybox Security, said hackers now "see critical infrastructure as low-hanging fruit". He said industrial sensors coupled with outdated legacy IT systems "makes critical infrastructure a perfect target".

The company said device vulnerability scans and remediation often happen only once or twice per year, limiting visibility on the constantly evolving threats and leaving vulnerabilities unpatched for months.

Dermody noted that while the actors behind the Colonial Pipeline attack said that they chose the target solely because it had the resources to pay a large ransom, and not because it was critical infrastructure, "the notoriety and economic pain" the attack has caused will "undoubtedly lead to other, less scrupulous" cyber threat actors to take advantage of similar targets".

Covid in Chile delays power auctions but green hydrogen remains on schedule

Chile's National Energy Commission (CNE) has postponed a 2021 power auction because the capital Santiago and the region is in lockdown due to the Covid pandemic.

It was planned to open an auction for 2310 GWh of electricity per year in May, as announced by CNE in December, but recently CNE postponed the submission date for offers to June 25, to ensure more parties could take part, and rescheduled the rest of the timetable accordingly.

Power companies can offer electricity from any type of plant, including new-build and storage, for residential and SME customers between January 2026 and December 2040.

In contrast, a call for tenders for green hydrogen production projects of 10 MW and above opened before the lockdown and will remain open for applications until September.

The government has said it will fund one or more of the projects with the provision of up to $30 million, and says they should be operational by December 2025.

Energy Minister Juan Carlos Jobet explained that Chile has more than 40 green hydrogen projects in the pipeline. A first development phase would use them to help domestic industry to reduce its carbon footprint. In a later stage, Chile hopes to export green hydrogen, he said.

US's nascent offshore wind industry finds support

The recent final approval of the USA's first offshore wind project, Vineyard Wind, has won widespread support. As Secretary of the Interior Deb Haaland and Secretary of Commerce Gina Raimondo announced approval of the construction and operation of the project, they were joined by labour leaders.

The BlueGreen Alliance released the following statement from Executive Director Jason Walsh: "The nation's offshore wind industry holds massive but as of yet largely untapped potential for clean energy growth and job creation. Today's announcement signals that we are ready to embrace that potential for the good of our environment and the good of working families."

Opening up of the US seabed for wind has also been popular with major developers. The UK's National Grid recently announced a partnership with Germany's RWE to bid in offshore wind auctions off the northeast coast, including an upcoming seabed leasing round for rights to develop projects in waters in the New York Bight area, between Long Island and the New Jersey coast.

National Grid is not allowed to own generating assets in the UK, where it has subsidiaries that separately own the transmission network in England and Wales and (as NGESO) act as the transmission system operator. It also develops subsea interconnectors via its unregulated National Grid Ventures arm. But it has been building up solar and onshore wind assets in the US, where in 2019 it acquired renewables developer Geronimo Energy.

Mexico set to fall short of revised Paris targets

- Electricity sector reforms exclude private companies
- Wind investment falls dramatically

Janet Wood

Mexico will fail to meet its revised targets under the Paris Agreement, the Federal Competition Commission (Cofece) has admitted.

In new analysis, 'Transition to Competing Energy Markets: Clean Energy Certificates in Mexico's electricity industry', the agency said that prior to the reform of the Electricity Industry Act, Mexico had already admitted that it would fall short of its Paris Agreement target, to reach 35 per cent low carbon generation by 2035. It set a revised target of 29.8 per cent. However, recent energy sector reforms – currently suspended – will make it still harder to achieve the target.

President Andrés Manuel López Obrador has restricted private companies' activities, cancelled electricity auctions for new capacity and reformed the Law of the Electricity Industry to favour state-owned company Federal Electricity Commission (CFE).

Cofece said the clean energy deficit in 2024 would equate to approximately 6700 MW of wind power or 8300 MW of photovoltaic solar energy. The renewables sector believes that wind and solar power capacity could otherwise have reached 15 000 MW in this decade.

New figures from the Mexican Wind Energy Association (AMDEE) support Cofece's pessimistic stance. It said there had been a 61 per cent collapse in wind energy investments during 2021, falling from $1.3 billion in 2020, to reach barely $500 million. That had seen installation of 600 MW of wind generation.

"Maybe with work we'll reach 26 per cent, but we're no longer going to reach 35 per cent in 2024," said AMDEE President, Leopoldo Rodríguez.

Rodríguez said during a virtual press conference that the sector could double generating capacity, but it requires long-term legal certainty, clear rules, permit granting and long-term planning. "This could re-reactivate the projects, no doubt," he said.

Today, Mexico has 68 wind farms with a capacity of 7154 MW equivalent to 3100 turbines. Wind represents 7 per cent of the electricity generated in the country.

One of the reasons attributed by the representative of the private sector is that the authority, the Energy Regulatory Commission (CRE) is not giving the permits, but even if it does, the lack of investment in transmission prevents a benefit for the sector.

Rocío Nahle, Energy Secretary, previously justified the use of an oil waste, combustoleo, to produce electricity saying that Mexico is one of the least polluting countries in the world.

But Rodriguez said: "Using cars and electric vehicles with energy produced with combustoleo or diesel would be ridiculous."

FERC guidance opens the way for regional carbon markets in the USA

The US Federal Energy Regulatory Commission (FERC) has issued guidance on incorporating state-determined carbon pricing into markets operated by Regional Transmission Organizations (RTOs) and Independent System Operators (ISOs).

The new guidance comes in response to states taking an increased role in addressing climate change impacts from the electricity sector. FERC published a proposed policy statement on the topic in October last year and after a consultation it has now concluded that proposals to incorporate a state-determined carbon price into RTO/ISO markets could "potentially improve the efficiency of those markets". FERC added: "It is the policy of this Commission to encourage efforts of RTOs/ISOs and their stakeholders… to explore and consider the value of incorporating state-determined carbon prices into RTO/ISO markets."

FERC said states still have the authority to determine whether and how to address greenhouse gas emissions and that the ruling does not indicate a preference for one state's carbon pricing approach. Instead, the Commission clarified that the policy statement is intended to encourage discussion among RTOs/ISOs and their stakeholders regarding wholesale market rules and incorporation of state-determined carbon pricing.

Hydrogen use expands in Australia

- Horizon Power starts construction of Denham green hydrogen project
- Woodside, IHI and Marubeni study green ammonia export

Syed Ali

Australia is seeing an expanding role for hydrogen, with recent projects giving an indication of how the clean energy source will be an important part of the country's decarbonisation effort.

The Western Australian government-owned power company Horizon Power last month announced the start of construction of a green hydrogen project in the Gascoyne town of Denham.

The project will consist of a 348 kW electrolyser using power from a 704 kW solar farm. The facility will also include hydrogen compression and storage capacity and a 100 kW fuel cell.

Once operational, the remote microgrid will produce 526 MWh of power annually, or enough to cover the needs of 100 local homes, which will be fed into the Denham power system. Construction of the hydrogen power plant is expected to begin in August.

"Horizon Power's hydrogen plant will demonstrate how hydrogen can reliably produce power for towns currently dependent on diesel fuel power systems," said Horizon Power CEO Stephanie Unwin. "It will allow Horizon Power to transition our network away from higher emission generating sources and meet our target of no new diesel generation systems from 2025,"

Hydrogen could also have a role to play in decarbonising existing fossil fuelled generation in the country.

Last month it was announced that Australia's first power plant – capable of running on both hydrogen and natural gas – will be built in New South Wales, following an agreement between the private sector and both state and federal governments.

EnergyAustralia's new 300 MW Tallawarra B power station, which will sit alongside the existing Tallawarra A 435 MW gas fired plant, could begin using green hydrogen as early as 2025. The project will be fast-tracked to be operational by 2023-24 before the closure of the Liddell coal fired 1680 MW plant in the Hunter Valley.

In another development, Woodside Energy Ltd., IHI Corporation and Marubeni Corporation signed a Heads of Agreement to investigate the production and export of green ammonia produced from hydropower in the state of Tasmania.

Green ammonia produced from green hydrogen is a zero carbon emission fuel, which can be used to decarbonise coal fired power production, among other applications.

Initially, green ammonia would be produced at a small-scale hydrogen electrolysis plant using electricity generated from hydropower. Woodside is exploring options for production in the Bell Bay region in northeast Tasmania. The capacity of the proposed plant could eventually be scaled up to as much as 250 MW to produce green hydrogen as feedstock for green ammonia exports.

Opportunities to produce hydrogen will increase as Australia continues to drive renewables growth.

New figures released by Australian Energy Market Operator (AEMO) last month revealed 32 projects, totalling more than 3.3 GW of new renewable energy capacity, were registered for connection to the National Electricity Market (NEM) in 2020 and there are no signs of the growth in renewables slowing down.

Since March 1, 2021, the federal energy market operator has registered four new wind and solar generators in the NEM, with a total capacity of 226 MW while five generators, contributing a total of 383 MW, completed their commissioning and are in commercial operation.

■ Amp Power Australia Pty Limited, the Australian operating company of global developer Amp Energy has announced the establishment of the Renewable Energy Hub of South Australia (REHSA); a strategic portfolio of large scale integrated solar PV, wind and battery energy storage assets located in South Australia. The REHSA also includes the siting of the Spencer Gulf Hydrogen Energy Ecoplex, forming part of the South Australian Government's Hydrogen Action Plan.

Taiwan raises offshore wind ambition

Taiwan intends to increase its offshore wind additions in the period 2026-2035 from 10 GW up to 15 GW under draft plans revealed in May.

The country's Bureau of Energy (BoE) and Industrial Development Bureau (IDB) discussed the plans that call for annual additions of 1.5 GW over the period, up from a previous target of 1 GW per year. From 2026 to 2031, Taiwan would add a total of 9 GW of offshore wind and a further 6 GW from 2032 to 2035.

Taiwan has already awarded 5.5 GW of offshore wind capacity in two auctions held in 2018 and these projects have to be completed by 2025 at the latest. It has plans for new auctions to be held next year, including a first bidding round in June 2022, targeting power generation in 2026-2027. For offshore wind farms that would start operating in 2028/2029, Taiwan would launch bidding in 2023 and for projects that would enter operation in 2030/2031 an auction would be held the following year.

From 2026 to 2031, developers will have to go through a two-stage selection process. In the third phase, all developers must complete a two-stage process, in which they are first approved for technical competence, financial soundness and their level of localisation before being allowed to bid against each other.

"It is up to the developers to compete for the best locations," IDB Director Yu Chen-wei said as he presented draft regulations in Taipei. "We leave it up to them to decide what technologies to deploy," Yu added.

The long-awaited draft regulations have made the government's "local content requirement" more flexible, but the list of items that must be locally sourced is longer, the bureau said. Even the "mandatory" list, which has 26 items, would allow developers to source as much as 40 per cent from outside Taiwan, it said.

"Having been through the first two rounds of offshore wind farm development, we trust that our local suppliers have amassed a significant amount of experience," Yu said. "If they are competitive in the international market, they should be able to win 100 per cent of an order because they are the local supplier."

The bureau said that more importantly, generators and sea cables – which had been contentious because of doubts that they could be economically and technically feasible to manufacture locally – have been switched from the mandatory list to the "optional" list.

While the draft rules are not yet finalised, they came as a relief to many developers, who are eager to pin down the rules.

"I ask that the BOE make as few changes to the current draft rules as possible and that it releases the final version soon," JERA Energy Taiwan Co. Senior Development Manager Candice Wang said.

South Korea promises to deepen emissions cuts

South Korea's climate envoy has promised "bold" policy changes, following pressure to do more to tackle climate change.

President Moon Jae-in pledged in October that South Korea would achieve carbon neutrality by 2050, but has drawn criticism from environmentalists who claim that the administration has failed to present a robust plan for cutting coal and boosting renewables to the extent needed to meet its obligations under the Paris climate agreement.

Under South Korea's climate plan, last updated in December, the country is set to cut emissions 24.4 per cent from 2017 levels by 2030 – well short of the 50 per cent cut that researchers and environmental campaigners say is needed.

Yoo Yeon-chul, South Korea's ambassador for climate change, has now said Seoul is "making strenuous efforts" to draw up the "ways and means" for reaching the target. He told the *Financial Times*: "We will take bold measures in the end."

Yoo pointed to the government's record stimulus package in response to the coronavirus pandemic, which included funds targeted at energy efficiency, renewables and hydrogen technologies, and to Moon's decision in April to end state banks' funding for overseas coal projects.

He said an improved climate plan was being developed and would "most probably" be announced at COP26, the global climate conference set to be held in Glasgow in November.

The government made a significant move to boost its climate credentials last month with the news that will provide full support for a project to build the world's largest floating wind farm off the coast of Ulsan. The government will invest KRW1.4 trillion (about $1.25 billion) in the first phase of the 6 GW project.

The mammoth project will need a public-private investment of some KRW36 trillion, with the full commissioning expected in 2030.

Japan invests in sustainability

The European Bank for Reconstruction and Development (EBRD) and the Japan International Cooperation Agency (JICA) have unveiled plans to invest in sustainable energy and infrastructure.

The two organisations have also agreed to invest in sectors identified in the United Nations' 2030 Sustainable Development Goals.

EBRD Vice President Alain Pilloux said the agreement opens new co-financing opportunities in the areas of sustainable energy, green economy, infrastructure, financial inclusion, small and medium-sized enterprise (SME) support and many other areas.

The announcement demonstrates Japan's increasing shift of investment away from fossil fuelled energy.

In late April Kansai Electric Power and Marubeni reportedly scrapped their plans for a 1.3 GW coal fired power plant in Japan. Earlier Japan-based Electric Power Development similarly dropped plans to build a 1.2 GW coal fired power plant. Meanwhile in a separate development, Mitsubishi UFJ Financial Group it would stop financing the expansion of existing coal fired power plants, except those using emission reduction technologies such as carbon capture and co-firing.

UK opening puts spotlight on emissions trading schemes

- EU considering carbon 'border tax'
- International initiative would assure integrity of carbon markets

Janet Wood

Carbon prices surged beyond £50 before quickly slipping back to the £45 level as the UK opened its own Emissions Trading Scheme (ETS) after deciding to leave the EU's scheme when it left the European Union.

The EU's scheme has also seen emissions prices exceed €55 – a new record – and then fall to below €49.

Jonathan Marshall, head of analysis at the Energy and Climate Intelligence Unit, said the similarity between the two price levels "is going to make a lot of people pretty happy". Some had feared prices could diverge, creating the potential for arbitrage between the UK and EU systems. Since the UK market is smaller it is potentially more volatile than its European equivalent. The UK government has said that if the carbon price is consistently above £44.74 it will cool prices through a so-called Cost Containment Mechanism.

Ingvild Sorhus, Lead Analyst at Refinitiv Carbon Research, said that the early high prices had showed confidence in UK carbon allowances as "an attractive asset". Sebastian Rilling, EU Power & Carbon Markets Analyst at ICIS, said he expected UK prices to trade in line with EU prices following "an initial period of volatility".

Carbon prices have been rising as governments have been tightening emissions targets, with the EU ETS up from the €30 level in December. That has raised concerns in some sectors – EU steel producers, for example, warned that carbon price increases have put them at a competitive disadvantage against companies outside the scheme. The EU is considering whether to deal with concerns over 'carbon leakage' – when imports have a price advantage because they do not have to pay a cost for carbon emissions – with a carbon border tax. The UK is also mulling over a similar border tax.

Meanwhile a Taskforce on Scaling Voluntary Carbon Markets, set up last year by Mark Carney, UN Special Envoy on Climate Action and Finance, recently launched a consultation on a market governance body, legal principles of the market, and the definition of high-quality carbon credits, in a bid to ensure a high-integrity market for carbon trading.

Bill Winters, Chair of the Taskforce and Group Chief Executive, Standard Chartered commented: "A high-integrity carbon market, combined with emissions reduction and high standards of reporting, holds the key to accelerating progress.

"Today we are calling for the establishment of a new governance body, responsible for setting the Core Carbon Principles (a threshold standard for high quality credits), clear legal standards and uniting existing, fragmented carbon credit markets in one impactful, well-run system."

Offshore wind to lead Poland's energy transformation

- EC clears offshore wind regime
- Treasury set to take on coal assets

A milestone was reached recently when the European Commission approved Poland's plans for a Contracts for Difference (CfD) support scheme for offshore wind. Poland plans to implement it to bring forward offshore wind projects worth €22.5 billion.

During the first phase, offshore wind projects will not have to fulfil a requirement to auction the CfDs, because the number of projects will be very limited.

Instead they will have a reference price fixed based on their costs, with a maximum set at €71.82/MWh. But each project will have to be cleared by the Commission. CfDs for 5.9 GW of capacity may be offered by the end of June 2021 for projects that will come into operation from 2025.

From 2025, in the scheme's second phase, the reference price of projects will be fixed based on auctions, which will run in 2025 and 2027, each for 2.5 GW of additional capacity.

The scheme will run until 2030 and is also supported by an Offshore Act, recently signed into law, which regulates the development of offshore wind farms in the Polish Baltic Sea and allows for 10.9 GW of offshore wind capacity to be either operational or under development by 2027.

The Polish Energy Regulatory Office (ERO) has already awarded CfDs to the 1GW Baltica 3 and 1.5 GW Baltica 2 offshore wind power projects, developed by Ørsted and PGE, and to the 350 MW FEW Baltic II offshore wind project, developed by Baltic Trade and Invest Sp. z o. o., a subsidiary of the German energy company RWE.

The Polish government has allocated more than €4 billion for offshore wind, port development, and hydrogen production and distribution in its National Reconstruction Plan.

The plan has been submitted to the European Commission and Poland hopes to tap into the EU's €58 billion Reconstruction Fund.

Meanwhile the closure of Poland's coal industry also took a step forward recently as the Treasury announced plans to take over hard coal and lignite fired generation assets as well as lignite mines from power groups PGE, Tauron and Enea. All the assets will be held in a single entity, to be named National Agency for Energy Security, according to a statement from the State Assets Ministry.

Deputy Assets Minister Artur Sobon said: "… we decided to put on the government agenda the programme of spinning off coal assets to a separate entity… If the Council of Ministers makes a decision, we will launch the actual consolidation process; we would like to complete it towards the end of the next year."

Germany to speed path to net zero after court ruling

Germany is planning to set new stricter climate change targets for cutting emissions after a recent court ruling that said its current goals contravene the rights of children and young adults.

Federal lawmakers now want to bring forward the country's switch to net zero carbon emissions by five years to 2045. "We want to make our goals more precise," Finance Minister Olaf Scholz said.

The announcement, after the country's constitutional court described a flagship climate protection law as "insufficient", comes as the growing popularity of Germany's Green Party has increased pressure on the CDU party and its centre-left coalition partner the SPD.

With the general election imminent, in September, the government is under pressure to show it takes environmental issues seriously.

The court said that Germany's timeline for emissions reductions beyond 2030 did not have enough clarity and current measures could "irreversibly offload major emission reduction burdens" on to the period after 2030. It said that impeded the freedom of future generations.

The government now aims to reduce emissions to 65 per cent of 1990 levels by 2030 and 88 per cent by 2040. It will have to set annual emission targets for the period after 2030 in an improved plan to be put forward by December next year to comply with the court order.

'Far offshore' wind farm proposed for GB

Anglo-American joint venture company Hecate Independent Power Limited (HIP) has set out plans to install 10 GW of fixed and floating wind turbines in the North Atlantic, which would connect to the GB market via high voltage direct current (HVDC) submarine cables. The total project cost is estimated at GBP £21 billion ($30 billion).

The capacity is targeted entirely at the GB market. Each 1 GW tranche would have its own connection, sited in meteorological 'catchment areas' that differ from each other and current wind sites, with the aim of covering periods of low wind in those areas. HIP said it has lodged connection applications for an initial 4 GW of grid connections at four sites and the first 2 GW off the southern and eastern coasts of Iceland, could be commissioned in early 2025.

HIP chair Sir Tony Baldry, who served as UK energy minister in a previous government, noted: "HIP Atlantic fulfils the Prime Minister's vision of attracting investment and job creation in the North of England as part of this country's ambitious policy to make Britain the world leader in offshore wind energy.

"We will stretch the zone of British-operated wind generation outside of our traditional territorial waters, pushing the boundaries of existing cable technology to generate over 1000 km from our grid landfall points throughout England."

Poseidon split between fixed and floating sites

Sweden-based Zephyr Vind, a wholly owned subsidiary of the Norwegian company Zephyr, has announced plans to build a large-scale offshore wind farm in Sweden, which would use both floating and fixed foundations.

The offshore wind farm, named Poseidon, would consist of two sites – Poseidon North and Poseidon South – built some 40 km northwest of Gothenburg, within an area in the waters between Sweden and Denmark.

The location of the Poseidon project has been chosen based on the assessment of the most suitable grid connection area and good wind conditions, according to Zephyr Vind. Because of the water depth, the developer has opted for floating turbines for Poseidon North, while wind turbines at the Poseidon South site would be installed on fixed-bottom foundations.

The company has proposed two preliminary project designs: one with 61 wind turbines, each with a capacity of over 20 MW each, and one with 94 turbines each with a rated power output of 15 MW.

Zephyr Vind recently launched a public consultation, which runs until late June. It said it expects to submit permit applications in 2022, after further investigations and studies are carried out, and to have the project operational around 2031, subject to receiving all necessary permits.

Renewables must grow faster "to avoid fossil gas trap"

Coal generation falling to record lows, but fossil fuels continue to satisfy most of Africa's electricity demand growth.

Nadia Weekes

An analysis of global electricity markets by energy think-tank Ember has found that wind and solar generation grew to represent one-tenth of global energy production in 2020. But data for the previous five years reveals that only a third of the rise in Africa's electricity demand was met with renewables, and two-thirds with fossil gas.

Among Africa's leading economies, Morocco and Kenya had the highest levels of wind and solar, respectively generating 16 per cent and 15 per cent of their electricity from wind and solar in 2019. But many of Africa's leading economies have yet to harness the potential of wind and solar power, which are now amongst the cheapest forms of new electricity.

In 2019, Nigeria and Algeria generated less than 1 per cent of their electricity from wind and solar, while Egypt increased to 3 per cent in 2019 after recent growth in solar power. South Africa generated 6 per cent of its electricity from wind and solar in 2020, tripling since 2015, but still below the world average of 9.4 per cent.

Emerging economies such as India and Turkey have accelerated their deployment of wind and solar to reduce their dependence on fossil fuels. India's wind and solar generation tripled in five years to provide 8.9 per cent of total electricity production in 2020. The combined effect of lower electricity demand and wind and solar growth led to coal's market share falling by 5 per cent since 2015.

In Turkey, wind and solar provided 12 per cent of electricity generation in 2020 – three times the share in 2015. This helped to reduce the market share of gas and oil by 11 per cent over the same period. Coal's market share continued to grow, however.

Fossil fuels generated 61 per cent of the world's electricity in 2020, down from 66 per cent in 2015 when the Paris Agreement was signed. Coal was the single largest source, responsible for 34 per cent of global electricity in 2020.

Major African economies were significantly more reliant on fossil fuels for electricity than the world average of 61 per cent. Above-average levels of fossil fuels were observed in Nigeria (81 per cent) and South Africa (89 per cent) in 2020. South Africa stands out with by far the largest share of coal (86 per cent) in Africa, over double the world average.

However, some African countries had far higher shares of clean electricity than the world average in 2020 (39 per cent). Ethiopia, Kenya, Angola and Zambia all generated over 80 per cent of their electricity from clean sources in 2019.

Five G20 countries had over three-quarters of their electricity supplied from fossil fuels in 2020, ranging from Saudi Arabia's 100 per cent, through South Africa, Indonesia and Mexico to Australia's 75 per cent. In comparison, France and Brazil only generated 9 per cent and 14 per cent of their electricity from fossil fuels, respectively.

In Africa, renewable energy growth has been accelerating since 2015, but it has not yet been fast enough to meet all of the rising demand. The rise in gas was particularly marked in North Africa, where there were the biggest increases in electricity demand, and very little build-up of renewable electricity generating capacity.

Africa, unlike Asia, has avoided a coal-reliant electricity grid. There has been no growth in total coal generation since 2014, with South Africa's falling coal generation being cancelled out by increases in Morocco and Zambia. There is very little coal capacity under construction or planned in Africa – only South Africa and Zimbabwe are building new coal power plants.

"The challenge remains to build renewables fast enough to keep up with rising electricity demand, not just for Africa, but across the world," said Peter Tunbridge, analyst at Ember. "Wind and solar have the potential to power Africa's electric future, and rapid deployment of these technologies will be essential for African countries to meet their rising demand for electricity, whilst avoiding a fossil gas trap."

"Solar and wind energy are now the cheapest sources of new power generation in Africa. Countries such as Morocco and Kenya have made impressive progress. Other countries, including South Africa, will add significant new investments in these technologies in 2021 and beyond," said Professor Anton Eberhard, Power Futures Lab, University of Cape Town. "As the share of these variable energy sources grows, there will be new challenges for power systems in Africa, especially for system operators who will have to procure and manage complementary flexible resources to ensure supply security and stability," he added.

Oman to produce hydrogen from 25 GW wind-solar complex

- Export of green hydrogen and ammonia planned
- High-value jobs and supply chain created

Nadia Weekes

An international consortium comprising Oman's national energy company OQ, green fuels developer InterContinental Energy and Kuwait government-backed investor Enertech have laid out plans to build a 25 GW wind-solar complex in Al Wusta governorate, central Oman, that will power the production of "millions of tonnes" of green hydrogen each year.

Although the exact location of the project was not specified, the partners said the site has an "optimal profile of strong wind at night and reliable sun during the day", while its proximity to the coast will enable seawater intake for the electrolysis.

The green hydrogen could be used on-site, exported directly or converted into green ammonia for international export. According to the partners, the proposed facility is "well positioned" to offer a secure and reliable supply of green fuels globally at a highly competitive price.

The consortium has been collaborating on the project for more than three years. The consortium partners say they will leverage their broad existing commercial relationships and partnerships to secure long-term product sales agreements.

Demand comes from the shipping sector, which requires green ammonia for its significant decarbonisation needs and the aviation sector, which will utilise synthetic fuels made from green hydrogen.

Parts of the ground transportation sector, such as rail and trucking may also adopt green hydrogen as a fuel source, and heavy industry will look to use green hydrogen to fuel energy-intensive industrial processes such as steel manufacturing.

The consortium has been conducting wind and solar monitoring analysis in Al Wusta since 2019. Renewable power generation will benefit from the very high and stable levels of solar irradiation and wind resources the site offers.

The project will provide a significant number of high-value jobs during site construction and operation. It could also support the development of Oman's renewable energy supply chain manufacturing and expertise, given its scale.

"OQ is proud to announce our biggest project in this field, which aims to maximise utilisation of Oman's natural resources of wind and solar to produce green hydrogen. Alternative energy is a key driver for OQ's long-term growth and a cornerstone of its strategy," said Salim Al Huthaili, CEO of Alternative Energy at OQ.

Alicia Eastman, Co-Founder and President of InterContinental Energy said: "This is a huge milestone in our mission to deliver cost-competitive zero-carbon fuels at an unprecedented scale to meet rapidly growing global demand across sectors."

Malawi's first solar-plus-storage project planned

Leading global solar PV supplier Sungrow has partnered with JCM Power, InfraCo Africa, RINA and Innovate UK to construct the Republic of Malawi's first utility-scale solar-plus-storage project.

The inclusion of lithium-ion batteries behind the meter at this scale will be a first in sub-Saharan Africa.

Located in the Dedza district of Malawi, near the town of Golomoti, the 20 MW solar PV facility and 5 MW/10 MWh battery energy storage system (BESS) will use a PV inverter, MV station, all-in-one power conversion system, battery container, and energy management system (EMS).

The project aims to help improve the availability and reliability of Malawi's power supply through its frequency and voltage regulation, peak shaving, and reactive power support capabilities.

JCM Power will manage all engineering, procurement and construction activities for the Golomoti project, which is expected to enter commercial operations at the end of this year.

Meanwhile, renewables developer Lekela Power has hired assurance and risk management expert DNV to carry out a feasibility study for a 40 MW/175 MWh BESS next to a wind farm in Senegal.

The project will lead to the construction of West Africa's largest grid-scale BESS at the 158.7 MW Parc Eolien Taiba N'Diaye wind farm. When fully charged, the battery will be able to discharge its fully rated capacity for more than four hours.

DNV's study will focus on how to provide increased grid stability and integrate intermittent renewable energy into the electricity grid of national utility Senelec, which is expected to sign the nation's first off-take agreement for energy storage in relation to this project.

The project is funded through a grant provided by the US Trade and Development Association (USTDA). Construction work is expected to kick-off next year.

Lekela is a renewables platform owned 60 per cent by Actis. The remaining shares are held by a consortium led by Mainstream Renewable Power.

Vestas eyes UK offshore growth

- Expanded facilities would accommodate Round 4 contracts and handle new blade production
- New credit facility will accelerate renewables and innovation

Junior Isles

Following its recent re-entry into offshore wind, Vestas is planning to further expand its UK offshore wind turbine production footprint.

Confident of securing sufficient project volume in the upcoming Contracts for Difference (CfD) Allocation Round 4, the Danish wind turbine manufacturer Vestas is now investigating the potential of expanding its UK footprint through additional manufacturing and supplier sites across the UK.

Henrik Andersen, President and CEO of Vestas, said: "We are extremely proud of the onshore and offshore wind expertise that we have built up in the UK and are positive about the market potential being created from the CfD Rounds. If successful in securing enough turbine orders from CfD Allocation Round 4, which includes a strengthened Supply Chain Plan policy for project developers, Vestas is intent on expanding its already sizeable UK footprint. We are in discussions with a number of potential partners and look forward to securing competitive solutions that augment Vestas' activities in the UK, for delivery of future UK projects."

The company says it is currently in discussions with potential partners that can competitively supply towers and additional blade manufacturing in the North East of the UK, and has signed Memoranda of Understanding (MoUs) with several potential partners.

Vestas produces more than 1000 V164 blades from the Isle of Wight for UK and European markets and the need for new blades for bigger turbines will require expanded production capacity.

The company recently announced its next-generation turbine, the V236-15.0 MW turbine, which is due to be powered by 115.5 m blades. The Isle of Wight manufacturing facility has the potential to be expanded for serial production of these blades, enabling Vestas to leverage the wind expertise it has built up in the UK.

Alongside existing and potential future manufacturing and supplier activities, Vestas has also carried out blade technology research and development (R&D) for its latest turbine blade models on the Isle of Wight for the past 20 years, at a blade technology R&D centre located in West Medina Mills. This centre has been essential in the design and testing of eight different blade types, including its latest onshore and offshore turbine platforms.

Vestas' efforts to drive technological innovation and accelerate renewables development received a boost in late April when it signed a €2 billion revolving multi-currency credit facility with a group of leading banks. The facility's margin will also be closely linked to Vestas' sustainability KPIs (key performance indicators).

The credit facility, which is available for general corporate purposes, including guarantees issuance in relation with wind power projects, carries a five-year tenor with two one-year extension options, replacing Vestas' undrawn €1150 million revolving credit facility signed in 2017.

Directly linked with Vestas' sustainability strategy, the facility's interest rate margin will be adjusted based on sustainability-linked performance targets, marking this the first time Vestas has engaged with sustainability-linked financing.

These targets measure Vestas' ability to reduce its own carbon footprint and enhance workplace safety while subsequently adding ambitious targets to improve the carbon footprint across its supply chain. Performance targets will also cover ambitions around more sustainable materials use, and increased recyclability across the turbine value chain.

Lisa Ekstrand, Senior Director and Head of Sustainability at Vestas said: "With this sustainability linked loan agreement, Vestas is demonstrating the inherent value in combining our commercial and sustainability strategies. We can now further strengthen our ability to improve sustainability performance, both across our direct operations, and across our indirect footprint. This journey is crucial to achieving Vestas' vision: to build sustainable energy systems through our growing leadership position within renewables."

GE and Toshiba to cooperate on Haliade-X roll-out

A strategic partnership agreement recently signed between GE Renewable Energy and Toshiba Energy Systems and Solutions will localise critical phases of the manufacturing process of GE's Haliade-X offshore wind turbine and support its deployment in Japan.

Financial terms and specific details were not disclosed but the companies claim the agreement will help GE's offshore wind technology to be more competitive in upcoming auctions in the countrty.

The two companies said that they will leverage their collective technology, manufacturing facilities and skills, construction, operation, and maintenance expertise as part of the agreement. Toshiba brings local manufacturing capabilities, a highly skilled workforce, strong energy domain expertise including in wind power, and an in-depth knowledge of the Japanese offshore market.

As part of the strategic partnership, GE will provide the Haliade-X technology, provide parts and components for nacelle assembly, and support Toshiba in jointly developing a local supply chain as well as completing assembly of the nacelles with "best-in-class quality standards".

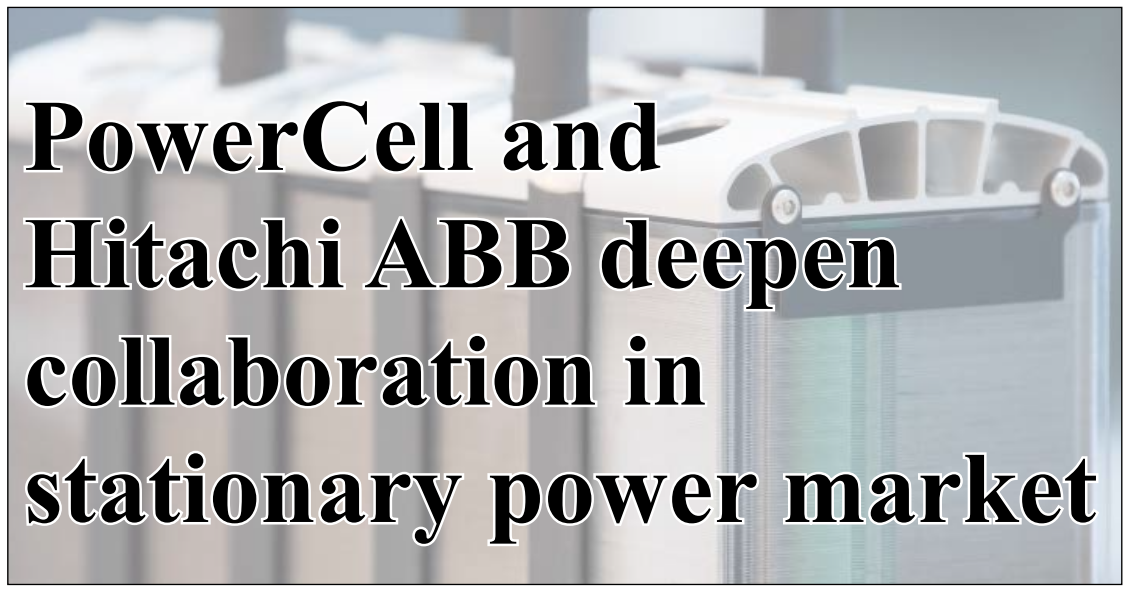
Toshiba will assemble, warehouse, transport Haliade-X nacelles, provide preventative maintenance services and have critical sales and commercial responsibilities for the Japanese market.

John Lavelle, President & CEO, Offshore Wind at GE Renewable Energy, said: "Toshiba is the strategic partner to help us bring the benefits of offshore wind to Japan. Their local manufacturing capabilities, experience in the energy sector, and outstanding reputation in the market make them an invaluable strategic partner. Together, we are well positioned to support Japan's ambitions to be a leader in renewable energy and offshore wind in particular."

Mamoru Hatazawa, President & CEO of Toshiba Energy Systems and Solutions Corporation, said: "We are pleased to announce this partnership with GE. As a long-lasting business partner of GE for decades on power systems businesses, Toshiba is best suited to support GE to create another global leader in offshore wind market.

"GE's Haliade-X is the most powerful offshore wind turbine built and helps to make offshore wind a more cost-effective and competitive source of clean energy. Through this strategic alliance, Toshiba will actively participate in offshore wind projects by supplying reliable products and contribute to the spread of renewable energy in Japan."

As part of its green growth strategy for becoming carbon neutral by 2050 the Japanese government plans to award 10 GW of offshore wind capacity by 2030 with tenders of 1 GW per year. The plan's calls for installing 30 to 45 GW of offshore wind turbines, including floating offshore wind turbines, by 2040 in part through the development of a competitive domestic supply chain.



PowerCell and Hitachi ABB deepen collaboration in stationary power market

Against a background of increased demand for hydrogen-electric stationary power solutions that can complement renewable and volatile energy sources, PowerCell Sweden AB and Hitachi ABB Power Grids have agreed to combine their fuel cell-based stationary power technologies and market fuel cell-based solutions.

The two companies say they will initially focus on complete, mobile container-based solutions with a power of up to 600 kW, and on module-based stationary megawatt solutions. The generic fuel cell-based complete solutions, including service offers, will be marketed and sold jointly by the companies.

In June last year, PowerCell Sweden and Hitachi ABB Power Grids signed a memorandum of understanding regarding a collaboration around fuel cell-based stationary power solutions.

The companies have since evaluated how to best combine tehir respective technologies into attractive complete solutions within hydrogen-electric stationary power. PowerCell's fuel cell systems and Hitachi ABB Power Grids' total solutions for grid connection will be the main building blocks.

PowerCell Sweden develops and produces compact, modular and scalable fuel cell stacks and systems for stationary and mobile applications with high energy density. The fuel cells are powered by hydrogen, pure or reformed, and produce electricity and heat with no emissions other than water.

Synhelion and Wood tie-up accelerates market entry of solar fuels

A recent partnership between Swiss solar fuel pioneer Synhelion and consulting and engineering company, Wood, looks set to accelerate the commercialisation of solar-based synthetic fuels.

Synhelion has developed a solar thermal process for the production of synthetic fuels. The process of the ETH Zurich spin-off is based on a technology to efficiently convert concentrated sunlight into process heat. In 2019, Synhelion produced the first-ever solar fuel from air and sunlight under real field conditions.

Since then, the company has scaled up the individual components of this technology to industrial size and developed further processes for the production of synthetic fuels. The partnership with Wood will bring together Synhelion's solar technologies with Wood's own novel hydrogen reforming reactor technologies further accelerating the path to market maturity.

In 2021, Synhelion and Wood will jointly design, build, install and commission a complete system on the solar tower at the Jülich site of the German Aerospace Center.

This plant will demonstrate the production of syngas – a mixture of hydrogen and carbon monoxide – on an industrial scale. The syngas can then be refined into liquid fuels such as gasoline, diesel, or kerosene using established industrial processes. The plant will also be used to produce solar thermal hydrogen.

Americas

Transmission lines for Peru wind farm

Abengoa of Spain has recently announced that it will build transmission lines to transport electricity from the future 260 MW Punta Lomitas wind farm in Peru. It was selected by power generation company Engie Energia Peru, part of the French utility group Engie.

Abengoa will supply detailed engineering and construction of the 63 km 220 kV double ternary transmission line, along with duties such as procurement, civil works, electromechanical assembly, and commissioning of different sections.

Punta Lomitas is Engie's first wind power project in Peru. Engie was granted a definitive concession in March 2021 from the Peruvian government to build and operate the wind farm. Siemens Gamesa Renewable Energy was selected in April as the wind turbine supplier.

The Punta Lomitas wind farm is scheduled to begin operation in the first quarter of 2023.

Lincoln Land Wind strikes turbine deal

GE Renewable Energy has been awarded a contract to supply turbines to the 302 MW Lincoln Land Wind project in Illinois, USA. GE will supply 107 units of its 2.82-127 onshore wind turbines for the project. It will also service the machines for 20 years.

GE Energy Financial Services is providing tax equity for the project, scheduled for completion by the end of 2021.

Lincoln Land Wind was initially developed by Apex Clean Energy. It was acquired by Ares Infrastructure and Power (AIP) earlier this year. The plant will sell power totalling 126 MW of its total capacity to McDonald's, and about 175 MW to Facebook.

Together, GE and Ares have announced more than 800 MW of new onshore units over the last 12 months.

Energy storage order for California

Southern Power, a subsidiary of Southern Company, has awarded an order for two energy storage projects in California with a combined capacity of 640 MWh to Mitsubishi Power Americas, a subsidiary of Mitsubishi Heavy Industries (MHI) and US energy storage company Powin.

Southern Power wants to add energy storage to two of its solar facilities; 88 MW/352 MWh to its 205 MW Garland solar park in Kern County and 72 MW/288 MWh of storage to its 204 MW Tranquility solar facility in Fresno County. AIP Management and Global Atlantic Financial Group have stakes in the two solar power projects.

The energy storage facilities are due to start operations this year. The systems will use lithium iron phosphate technology and are designed for a 20-year life cycle.

Vestas wins 212 MW wind project in Brazil

The Brazilian renewable energy company Omega Energia has awarded an order to provide turbines for a 212 MW wind project in the eastern Brazilian state of Bahia to Vestas Wind Systems.

Under the contract, Vestas will supply 47 units of its V150-4.2 MW turbine in 4.5 MW power optimised mode for the Assurua 4 project, located in the cities of Gentio do Ouro and Xique-Xique.

Turbine delivery is scheduled for the second half of 2022, with commissioning expected in the first quarter of 2023.

The agreement with Omega Energia includes a 10-year Active Output Management 5000 turbine service contract.

Asia-Pacific

K2M to design Taean offshore wind farm

Danish consultancy firm K2 Management (K2M) has been selected to provide design and owner's engineering services for the 504 MW Taean offshore wind project off the South Korea coast.

K2M successfully delivered the preliminary feasibility study as well as site screening during the initial stages of project development in partnership with South Korea's Dohwa Engineering.

In the next stage, K2M will deliver the design of the turbine foundations, inter-array and export cables and the offshore substation. K2M and Dohwa will also carry out energy yield assessment and manage the invitation to tender and permitting processes.

Construction of the wind farm is scheduled to commence in July 2023. Completion date is set for 2026.

Order placed for Hyuga 50 MW biomass plant

Mitsubishi Power, a subsidiary of Mitsubishi Heavy Industries Group, has been awarded a contract to supply a 50 MW woody biomass fired power plant planned for development in Hyuga in Miyazaki Prefecture, Japan. Mitsubishi Power will provide the full turnkey solution for the plant, handling EPC. Commercial operation is scheduled to commence in November 2024.

The project comprises delivering a steam turbine, CFB boiler, generators, and other equipment. Under the contract, Mitsubishi Power will build and supply the key power generating equipment. Mitsubishi Power Environmental Solutions will provide air quality control systems, Mitsubishi Electric Corporation will supply generators and electrical components, while Fujita Corporation will handle civil engineering and construction.

Taiwan selects preferred supplier for Hai Long

Hai Long Offshore Wind Project (Hai Long) has selected Siemens Gamesa Renewable Energy for preferred supplier status for both the 232 MW Hai Long 2B and 512 MW Hai Long 3 offshore wind projects.

The agreement includes supply of SG 14-222 DD offshore wind turbines and service for the full volume of the project. The agreement is subject to contract and final investment decision from the Hai Long consortium partners, expected in 2022.

Siemens Gamesa will deliver SG 14-222 DD offshore wind turbines to all the Hai Long power projects, the exact number yet to be determined. The turbines will be installed 50 km off the coast of Changhua County. Each turbine will have a capacity of 14 MW and a rotor diameter of 222 m, with 108 m long Siemens Gamesa Integral-Blades.

Siemens Gamesa is currently constructing a Nacelle Assembly Facility in Taichung, with production due to commence later this year. A factory expansion will start in 2022, subject to a final investment decision by the project partners.

Europe

GE closes Dogger Bank C deal

Dogger Bank Wind Farm and GE Renewable Energy have finalised contracts for the supply of 87 GE Haliade-X 14 MW turbines, along with a five-year service and warranty agreement for Dogger Bank C, the third and final phase of what will become the world's largest offshore wind farm.

GE Renewable Energy secured a preferred turbine supplier agreement for the third phase of the Dogger Bank offshore wind project in December 2020. GE has been confirmed to deliver a total of 277 units of its Haliade-X turbine for the entire 3.6 GW project located off the northeast coast of England.

The contracts are still subject to Dogger Bank C reaching financial close, expected in late 2021.

Upgrades at Krško Nuclear power plant

Framatome has signed two contracts to upgrade systems and equipment used to manage operations at the Krško Nuclear Power Plant in Slovenia. The company will design, deliver, and install new I&C systems and replace the thimble tubes, an important part of the plant's in-core neutron flux measurement system.

It will replace the plant's existing I&C system, and will also design, supply, and replace 36 thimble tubes, including thimble tubes with a new nitriding surface hardening process designed for increased longevity, and a complete study on tube wear behaviour.

Framatome will complete these upgrades during the plant's outage in autumn 2022.

Terna orders STATCOMs for Italian grid

Italian transmission system operator Terna has ordered two static synchronous compensator (STATCOM) systems for grid stabilisation from Siemens Energy.

The two new STATCOM systems, part of Siemens Energy's SVC Plus series, will be built in Villanova in the Abruzzo region, and Latina, in the Lazio region. They will be delivered as a space-saving containerised solution, which also reduces project execution time by avoiding building approval procedures.

The STATCOM systems operate with 125 MVAr each at 400 kV and will be the first completely containerised STATCOM solution at this voltage level. The systems will stabilise voltage fluctuations by acting as either a source or sink of reactive power depending on the requirements of the Italian grid. They will significantly reduce the risk of voltage drops and blackouts. In addition, the synchronous condensers will also provide short circuit power and inertia.

The first synchronous condenser in Fano is planned to be commissioned at the end of 2021, and the second in Rosara in October 2022. The two STATCOM systems will be commissioned in June 2022.

Highview Power to deploy MAN turbomachinery

Highview Power has selected MAN Energy Solutions to provide its Liquid Air Energy Storage (LAES) turbomachinery solution for Highview's CRYOBattery facility, a 50 MW liquid air energy storage facility with a minimum of 250 MWh located in Carrington Village, Greater Manchester, UK.

The liquid air energy storage plant uses cryogenically-liquefied air as a medium for storing energy. It is especially suitable for special applications that require large amounts of energy over a discharge time of several hours, and enables fluctuating, renewable sources to bear baseloads.

The MAN turbomachinery train will be a key part of the CRYOBattery facility that, upon completion, will form one of Europe's largest battery-storage systems.

Construction of the CRYOBattery began in late 2020 with commercial operation scheduled to start during 2022. Highview Power will operate the facility in partnership with Carlton Power.

Construction will proceed in two phases. Phase 1 will involve the installation of a 'stability island', to provide near-instantaneous energy grid stabilisation. This will be achieved using a generator and flywheel, among other components. Enabling short-term stabilisation will provide the basis for Phase 2 and the completion of the more complex liquid air energy storage system that includes various compressors, air expanders and cryogenic equipment.

International

Sungrow wins Egyptian 200 MW solar contract

Sungrow Power Supply signed in May a contract for an inverter supply for the 200 MW Kom Ombo solar project in Egypt. Under the terms of the contract, Sungrow will supply its 250 kW inverter solution for the facility. The facility will be located in the desert area near Kom Ombo in the Aswan Governate.

The $160 million project is being developed by ACWA Power, and it will be built by Sterling and Wilson Solar. The power plant is scheduled to start operations in Q3 2022 and will sell the output to the government of Egypt.

Côte d'Ivoire orders Siemens GTs

Siemens Energy has recently signed an agreement with Spanish EPC contractor TSK to supply technology and services to Atinkou, a new combined cycle gas turbine (CCGT) power plant to be built in Jacqueville, Côte d'Ivoire. Owned by Atinkou, a subsidiary of Eranove, the power plant will have an installed capacity of 390 MW in combined cycle. The plant is scheduled to start operation in late 2022.

Siemens Energy's scope of supply includes one SGT5-4000F gas turbine and one SST5-3000 steam turbine, each along with a generator, condenser, and an SPPA-T3000 control system. In addition, Siemens Energy has signed a 12-year long-term service agreement with the end customer Atinkou.

Karim Amin, Executive Vice President of Siemens Energy's Generation Division, said: "Siemens Energy is proud to be supplying the very first F-class gas turbine to the Sub-Saharan region, thereby continuing our commitment to improve access to reliable and affordable energy in West Africa. This power plant will be the most efficient natural gas fired power plant in Côte d'Ivoire and in the region. It will help to reduce the area's carbon footprint from power generation and support Côte d'Ivoire in its efforts to become a regional energy hub."

For more information, please contact:

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Key milestones in transforming global electricity generation

Category	
Decarbonisation of electricity sector	• Advanced economies in aggregate: 2035. • Emerging market and developing economies: 2040.
Hydrogen-based fuels	• Start retrofitting coal-fired power plants to co-fire with ammonia and gas turbines to co-fire with hydrogen by 2025.
Unabated fossil fuel	• Phase out all subcritical coal-fired power plants by 2030 (870 GW existing plants and 14 GW under construction). • Phase out all unabated coal-fired plants by 2040. • Phase out large oil-fired power plants in the 2030s. • Unabated natural gas-fired generation peaks by 2030 and is 90% lower by 2040.

Category	2020	2030	2050
Total electricity generation (TWh)	26 800	37 300	71 200
Renewables			
Installed capacity (GW)	2 990	10 300	26 600
Share in total generation	29%	61%	88%
Share of solar PV and wind in total generation	9%	40%	68%
Carbon capture, utilisation and storage (CCUS) generation (TWh)			
Coal and gas plants equipped with CCUS	4	460	1 330
Bioenergy plants with CCUS	0	130	840
Hydrogen and ammonia			
Average blending in global coal-fired generation (without CCUS)	0%	3%	100%
Average blending in global gas-fired generation (without CCUS)	0%	9%	85%
Unabated fossil fuels			
Share of unabated coal in total electricity generation	35%	8%	0.0%
Share of unabated natural gas in total electricity generation	23%	17%	0.4%
Nuclear power	*2016-20*	*2021-30*	*2031-50*
Average annual capacity additions (GW)	7	17	24
Infrastructure			
Electricity networks investment in USD billion (2019)	260	820	800
Substations capacity (GVA)	55 900	113 000	290 400
Battery storage (GW)	18	590	3 100
Public EV charging (GW)	46	1 780	12 400

Note: GW = gigawatts; GVA = gigavolt amperes.

Source: IEA Net Zero by 2050: A Roadmap for the Global Energy Sector (Table 3.2, page 117). All rights reserved.

Hydrogen

Climate pressure drives hydrogen and ammonia developments

Recent events in the oil and gas sector are a clear signal that more and more thought – and more investment – is going to be put into renewables, and ultimately products like hydrogen and ammonia.

Gary Lakes

With last month's ruling against Royal Dutch Shell to cut carbon emissions faster and the shake-ups at ExxonMobil, Chevron and ConocoPhillips, pressure is mounting on oil and gas majors to recognise climate science and the expanding social consciousness of the dangers to the planet if they drag their feet in addressing global warming.

Commenting on the events that took place on May 26 to the *Wall Street Journal*, Amy Myers Jaffe, an energy expert and professor at Tufts University's Fletcher School said: "The events of today show definitively that many leaders in the oil and gas industry have a tin ear and do not understand that society's views and the legal and political environment in which they operate are changing radically."

The Dutch court ruling and US shareholder shake-ups follow a report released by the International Energy Agency (IEA) in mid-May that concluded that investment in fossil fuel exploration and development needs to stop immediately if the world is to comply with CO_2 emissions reductions set by the Paris Agreement.

While the fossil fuel industry will not be pleased with these developments, it is a clear signal that more and more thought – and more investment – is going to be put into renewables, and ultimately products like hydrogen and ammonia. Many entrepreneurial firms, laboratories and energy companies are working on alternative energy sources and reporting important advances.

Billions and trillions of dollars will be needed to finance the energy transition, and eventually all of these quantitative innovations will result in a qualitative leap that significantly changes the energy sector and subsequently just about everything else.

A very interesting development was announced last month by an Israeli firm that said it had invented an engine that runs directly from hydrogen. Aquarius Engines said that its hydrogen-fuelled linear engine had successfully underwent a test carried out with Austrian company ALV, which specialises in propulsion systems and their integration in different vehicles.

"In the trial, the engine ran on hydrogen only with no assistance whatsoever from fossil fuels. The results of the tests indicate that the company's engine can be operated using hydrogen only (100 per cent), emitting gases at negligible to zero levels," Aquarius said in a statement.

"Aquarius's engine is a small, light engine with just one moving part, with very high output and fuel efficiency that represents a significant, competitive player in generators, and later for power units for trucks, and for propulsion solutions for aviation, ships, and security vehicles, and range extenders for the car market," the company said.

In Norway, the carbon tech company Horisont Energi expects to make a final investment decision on its Barents Blue project by the end of 2022. Barents Blue is a project located in northern Norway that will produce blue ammonia using natural gas. The project will capture the carbon involved in the process and store it in rocks beneath the Barents Sea. The project so far is the largest ammonia project planned for Europe, capable of producing 1 million tons per year. Two million tons annually would be captured and stored in the offshore Polaris project. Eventually, Horisont intends to produce green ammonia at the plant. The company said it intends to set the standard for large-scale clean ammonia production.

China's state-owned Sinopec has announced its plans to begin construction of a green hydrogen plant in Inner Mongolia in 2022. The plant will produce 20 000 tons of hydrogen a year through the use of solar power. An investment of $408.5 million will be made in the plant. The first phase will see 10 000 tons of hydrogen produced, supported by a 270 MW solar power station and a 50 MW wind farm.

The oil-producing centre of Abu Dhabi is also planning to move into ammonia in a big way. Helios Industry, a privately-owned company, will invest $1 billion in a green ammonia production facility at the Khalifa Industrial Zone Abu Dhabi with a capacity of 200 000 tons using 40 000 tons of hydrogen and an 800 MW solar power facility.

Abu Dhabi National Oil Company (Adnoc) plans to move forward with a blue ammonia plant that will have a 1 million t/year capacity. The plant will be located in the TA'ZIZ industrial park in Ruwais with plans to start production by 2025. Adnoc currently produces 300 000 tons per year of hydrogen and intends to boost this to more than 500 000 tons annually by 2030.

Gas

World Bank initiates global movement to halt routine gas flaring

Despite pledges by a number of countries to reach net zero by 2050 in line with the Paris Agreement, the IEA says there will still be 22 billion tons of carbon dioxide entering the atmosphere. Putting a halt to gas flaring is one of those key buttons that needs to be pushed to stop the rise in emissions.

Gary Lakes

The International Energy Agency (IEA) last month laid out the route to net zero emissions by 2050 in a report stating that there should be no further investment in new oil, gas and coal projects that are not already underway. Given the size and strength – and the importance – of the hydrocarbon industry, that is going to be a challenge that it will face reluctantly, but face it, it must.

Despite pledges by a number of countries to reach net zero by 2050 in line with the Paris Agreement, the IEA says there will still be 22 billion tons of carbon dioxide entering the atmosphere, a level that will continue to contribute to global warming and climate change.

Where to begin with the massive changes that are necessary?

Putting a halt to gas flaring is one of those key buttons that needs to be pushed. A new report issued in April by the World Bank stated that enough gas was flared during 2020 to power all of sub-Saharan Africa. To emphasize and address the problem of flaring, the World Bank has introduced the Zero Routine Flaring by 2030 Initiative. Meeting this goal by putting an end to flaring by the end of this decade would be a considerable contribution towards reaching net zero emissions.

The report stated that some progress has been made in damping down this wasteful and highly polluting practice. Routine flaring of natural gas during 2020 amounted to 142 billion m^3 (bcm), down from 150 bcm in 2019 due to the corona virus pandemic, but that is still enough to meet the annual energy needs of two-thirds of Africa. And while the report noted that the oil and gas industry saw a decline in production by 8 per cent during 2020, gas flaring decreased by only 5 per cent. According to World Bank data, oil output fell from 82 million b/d in 2019 to 76 million b/d in 2020 as economies shut down in response to the pandemic and demand shrivelled.

According to the World Bank, the 142 bcm of gas that is flared annually amounts to more than 400 million tons of carbon dioxide equivalent being emitted into the atmosphere. That amount of gas could theoretically produce 750 billion kWh of electricity and help economies move in the direction of sustainable development this decade.

With the UN Climate Change conference in Glasgow not far away, World Bank officials are calling for gas flaring to stop.

"Awareness of gas flaring as a critical climate and resource management issue is greater than ever before," Zubin Bamji, Program Manager for the World Bank's Global Gas Flaring Reduction Partnership (GGFR), said in the report. "Almost 80 governments and oil companies have committed to Zero Routine Flaring within the next decade and some are also joining our global partnership, which is a very positive development."

He added that gas flaring reduction requires significant investment and time, but he called on countries and companies to place gas flaring at the centre of their climate action plans. "To save the world from millions of tons of emissions a year, this 160-year-old industry practice must now come to an end," he said.

Seven countries – Russia, Iraq, Iran, the US, Algeria, Venezuela and Nigeria – account for 65 per cent of gas flaring, although they produce only 40 per cent of the world's oil. Yet reducing flaring comes with its own set of problems.

In the US, which accounted for 70 per cent of the 5 bcm decline in flaring during 2020, companies, especially those involved with fracking, are faced with the challenge of connecting thousands of flare sites to a grid whereby the gas can be connected to a market. Russia's oil fields in the remote regions of Siberia have no infrastructure to capture and transport gas. In many cases, the gas is re-injected back into the oil field in order to maintain field pressure, but in some situations, technical solutions like that are not feasible.

However, the World Bank reported that progress had been made in Russia and Nigeria, saying that both countries have "achieved significant progress" over the past 15 years. Iraq, Iran, Venezuela and Algeria could all see vastly improved circumstances for their domestic economies by harnessing their flared gas, by using it to generate electricity or by exporting it to foreign markets, but their financial circumstances leave flaring far down the list of priorities.

Through the GGFR, a multi-donor trust fund, the bank is working with governments, oil companies and multilateral organisations to end routine gas flaring. The GGFR is identifying solutions to technical and regulatory obstacles by developing country-specific programmes aimed at putting flared gas to practical use for the sake of economic and environmental improvement.

Offshore wind at the hub of EU carbon neutrality

The hub-and-spoke concept connects offshore wind farms to one or several hub islands

The North Sea is seen by many as the powerhouse of Europe, but realising its potential is not without its challenges. **Junior Isles** hears how the region might achieve its goals for offshore wind.

Europe's offshore wind power potential is large enough to meet its growing electricity demand and is central to helping the bloc achieve its carbon reduction targets. In its 'Our Energy, our future' report, WindEurope concluded that to reach carbon neutrality by 2050, 212 GW should be deployed in the North Sea, 85 GW in the Atlantic (including the Irish Sea), 83 GW in the Baltic, and 70 GW in the Mediterranean and other Southern European waters.

Today the EU's offshore wind capacity, however, stands at just over 25 GW. This is a long way short of the 111 GW that European countries plan to deliver by 2030 under their National Energy and Climate Plans, and even further from the EU's ambition of building 300 GW of offshore wind by 2050.

It is clear that plugging the gap will call for a different approach to what has been used thus far. As one of Europe's major investors in national and cross-border grid connections on land and at sea, electricity transmission system operator (TSO) TenneT has a key role to play in Europe's effort to realise its offshore wind ambition.

Commenting on the task at hand, Tim Meyerjürgens, TenneT's Chief Operations Officer, said: "It's clear that the North Sea will be the powerhouse of Europe in the future – something that is increasingly being recognised by politicians. But we saw very early on, when the Paris Climate Agreement was made, that the way offshore wind is being added will not be sufficient to meet the target. So we looked at what was needed at the end and then analysed what was necessary to get there."

Together with Energinet and Gasunie, TenneT looked at the potential of the southern part of the North Sea to see what was needed in terms of meeting climate goals for the energy sector. They calculated that 180 GW was necessary and feasible in the southern area.

Meyerjürgens noted: "It was clear from the very beginning that the point-to-point connection approach that is being used – because we are mainly building DC (direct current) connections – will not be sufficient and will also not be efficient."

TenneT, Energinet and Gasunie, together with Port of Rotterdam, under a consortium known as the North Sea Wind Power Hub (NSWPH), therefore came up with what they call the 'hub-and-spoke' concept, which takes a more integrated and long term approach to the energy transition.

The idea is to shift focus from using the point-to-point offshore converter platforms commonly used at the moment and instead build modular, connected, hubs in the North Sea. The hub-and-spoke concept connects offshore wind farms to one or several hub islands via alternating current cables (AC). Power is then converted to DC electricity by converters on the hub islands, before being exported by a series of interconnectors (the spokes) to the linked North Sea countries.

Projects may also utilise power-to-gas technologies on the hub islands to convert offshore wind-generated power into hydrogen, which would then be exported via new and existing gas pipelines.

The consortium believes internationally coordinated roll-out of offshore wind energy, supported by one or more hub-and-spoke projects, is technically feasible, reduces system cost and provides long term security of supply. Further, the coordinated development of wind farm connections and interconnections reduces the need for onshore grid reinforcements.

"We will start with a first island in the North Sea connected to Denmark, the Netherlands and Germany, and later, when further hubs are built, we connect them to all the countries around the North Sea. We think the optimum size of such hubs is around 12-15 GW," said Meyerjürgens. "Our studies show that this concept, compared to the point-to-point networks being built at the national level, is about 30 per cent more efficient since combining offshore wind connections with interconnections makes much better use of the cables. The average full load [of a cable] in the North Sea is around 4500 hours, so the cable is not used half of the time.

"Also, the more renewables that come on the grid, the more important it is to connect larger areas in Europe together. When there's a lot of wind in the UK, it does not mean there is a lot of wind in Germany at the same time. So connecting markets together gives you more flexibility and ultimately greater resilience."

A few national hubs are already being planned. The Danish Energy Island project, which was given the go-ahead by the Danish government in February, is planned to be up and running by 2033, and there are discussions for a similar project in the Netherlands.

Meyerjürgens says the NSWPH is preparing its 12 GW international hub with a view to being operational around 2035. He notes, however, that the concept is "not feasible without hydrogen" and says some innovations are still needed to make it cost efficient.

TenneT is developing a new 2 GW standard for greater transmission capacity for point-to-point connections, and says this standard will also be used for the North Sea hubs. The new standard will be based on a voltage level of 525 kV to achieve the increased power.

"This will be the new voltage standard for a number of years… and will be now used for all our future offshore connections. We are designing them to be 'hub-ready', so that at a later stage we are able to connect them to a meshed grid. This is not completely feasible yet since DC circuit breakers are still an issue. However, today you can already connect an offshore connection with an onshore corridor by using technology that allows you to connect three converters to one cable without a circuit breaker. So we are making decisions today that keep a lot of options open for the future."

Siemens Energy, which is a key technology partner of TSOs such as TenneT, says a multi-terminal concept operating at 525 kV requires some development work in the system's protection and controls.

Siemens Head of Grid Access, Andreas Barth, said: "Today we have a point-to-point connection; tomorrow in the hub-and-spoke we need to be able to feed-in from all directions and export to all directions. That will require developments in the control and protection system so we can ensure the system integrity of the network is secure. We are working on this in a preferred partnership arrangement with TenneT… multi-terminal and 525 kV is the future; that's the storyline for the next 5-7 years."

Nexans has also been playing an instrumental role in developing the new 525 kV system for offshore wind. Having already qualified 525 kV HVDC onshore cables with a power rating of 2 GW for Germany's TSOs, the company is now in the process of qualifying a cable system at this voltage to meet offshore requirements.

Maxime Toulotte, Head of Technical Marketing for the Subsea & Land Systems (SLS) business unit in Nexans, said: "For the future connection of offshore wind farms in Germany and the Netherlands, TenneT is asking a number of cable manufacturers, including Nexans, to qualify 525 kV HVDC technology according to their requirements. This will finish approximately by the middle of next year. While 525 kV cables have been used for interconnectors, TenneT has requested a complete cable system be developed with cables that use XLPE insulation. The first project with the new technology is expected to be in the Ijmuiden Ver wind energy area in the Netherlands by 2030."

While these developments show there are no insurmountable technology obstacles, Meyerjürgens believes there has to be a change in political approach and planning if Europe is to meet its offshore wind target.

"The regulation and market models always take a national approach, which is limiting us in speed. It would be better to have one [European] regulatory framework or market model. It's a European task and we need to collaborate much more closely because we only get there when we all get there."

Meyerjürgens said "it was clear from the very beginning" that the point-to-point connection approach "would not be sufficient or efficient"

China's unseen decarbonisation tool

China has added huge amounts of wind and solar. Nuclear has been less publicised but will be key to the country achieving its carbon emission targets.

Joseph Jacobelli

Much has been broadcasted about China's clean energy exploits. In just a few years it added massive amounts of solar and wind generation capacity. The nation's clean energy equipment manufacturing sector also proved its prowess.

The growth of its nuclear power industry, however, is less publicised. Yet China regards nuclear as an important clean energy source, which plays a highly pivotal role in the country's emissions reduction plan – also known as the "30-60 goal" – over the next several decades.

Since the first unit came online in 1994, nuclear has generated 4630 TWh and resulted in a cut in carbon dioxide (CO_2) emissions of about 2.1 billion tons, according to China Nuclear Energy Industry Association (CNEIA). Installed nuclear electric capacity amounts to a little over 51 GW at 49 generating units, with a further 21 GW under construction as of March 2021 based on data from CNEIA.

Nuclear power was responsible for over 2 per cent of the nation's capacity and a little under 5 per cent of total electricity output, as at the end of 2020. This is a relatively small contribution to the overall national electric power generation mix given that hydroelectric output was responsible for almost 18 per cent, wind power for about 6 per cent, and solar power for over 3 per cent.

Nevertheless, the historical growth of nuclear has been massive albeit this is not yet reflected in its contribution to the electricity mix – merely about 5 per cent in 2020. Nuclear output growth substantially outperformed that of total electricity in four of the past Five Year Plans (FYPs).

The compound annual growth rate of nuclear generation was 18.1 per cent and 16.4 per cent versus 6.7 per cent and 5.6 per cent for electricity as a whole in the 12th FYP, through 2015, and 13th FYP, through 2015, respectively. The only exception was during the 11th FYP, through 2010, when the nation was more focused on adding coal fired generation at a fast pace to power the extraordinary GDP increase. Coal was a generation type it had learned to build efficiently, quickly, and cheaply.

Year to 31 December 2020	GW	Mix	TWh	Mix
Hydro	370	16.8%	1,360	17.8%
Thermal	1,250	56.8%	5,170	67.8%
Coal	*1,080*	*49.1%*	*4,630*	*60.7%*
Ex-Coal	*170*	*7.7%*	*540*	*7.1%*
Nuclear	50	2.3%	366	4.8%
Wind	280	12.7%	467	6.1%
Solar	250	11.4%	261	3.4%
Total	**2,200**	**100.0%**	**7,624**	**100.0%**

China Nuclear Electric Power Generation Growth in Past Five Year Plans
Sources: bp plc, "Statistical Review of World Energy 2020" (https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html, 2020) accessed May 15, 2021. "Report of China Power Council: Rapid Growth of Wind Power and Solar Power Generation in 2020" (guangfu.bjx.com.cn February 2, 2021). Author calculations.

The principal motivation to promote nuclear energy in China is similar to that of other jurisdictions. Domestically generated nuclear energy reduces reliance on imported fuels, namely oil and natural gas, and is an ideal substitute for polluting base load coal fired generation. The nation could have built even more capacity in the past decade, but authorities have taken safety extremely seriously.

This is particularly evident from actions taken in the early 2010s. China temporarily stopped its nuclear generators as well as the construction of new ones for enhanced inspection as well as placing a moratorium on approval of new ones following the disaster caused by the accident at the Fukushima Daiichi nuclear power plant in Japan on March 11, 2011 in the wake of an earthquake and tsunami.

Also, the State Council, China's most powerful decision-making body, decided to fully incorporate the International Atomic Energy Agency's (IAEA) safety standards into its national nuclear safety rules. This very strict approach has resulted in the industry never experiencing an operational event of International Nuclear and Radiological Event Scale Level Two or above. INES Levels 1-3 are considered incidents, Levels 4 -7 are classified as accidents.

The Chinese leadership has for now declared that it targets for CO_2 emissions to peak by 2030 and for the nation to reach carbon neutrality by 2060 – its "30-60 Goal".

These targets are likely to be adjusted and we will see CO_2 peaking and a net-zero economy much earlier. This is, in part, because of pollution's high cost to the environment, economy and population, the strong commitment to decarbonisation in the past decade, the track growing record in cutting emissions in the electricity and transportation sectors, the economic value-add (i.e., the jobs and industry creation prospects), and the aspiration to be a global leader in decarbonisation.

The country missed its 58 GW target of operational nuclear capacity by 2020 by 16 per cent. Post Fukushima, authorities became extremely cautious in the approval of new nuclear generation units, especially of units using new technologies. Going forward, approvals should become more regular and the nation's official capacity targets for 2025 and 2030 should be easily achieved.

It aims at raising capacity by 40 per cent during the 14th FYP to 70 GW in operational capacity and 40 GW under construction by 2025. It also aims at further increasing by 187 per cent in the 15th and 16th FYPs (through 2035) to a total of about 200 GW. By that time the nation's total should reach about 4000 GW, with nuclear accounting for 5 per cent of capacity and 10 per cent of generation, according to Tingke Zhang, Vice President and Secretary General of CNEIA.

There are a great variety of forecasts as to how much upside there will be to the nuclear power capacity after 2035. Most estimates range between 300 and 600 GW.

The key variable revolves around technology. If the domestic manufacturers' next generation nuclear technology can ensure that even in the unlikely event of an accident higher than INES Level 3, there will be no environmental damage, then probably the upper end of the forecasts can be realised.

Nuclear energy is at the absolute centre of China's energy complex and a pivotal tool for the nation to meet the declared "30-60 Goal", which is likely to become more aggressive over the next few years.

The support of the central government toward this energy source has repeatedly been publicised in the Chinese media. Premier Li Keqiang also specifically mentioned nuclear energy's importance in a key document, the '2021 Work Report' presented on 5 March 2021, stating:

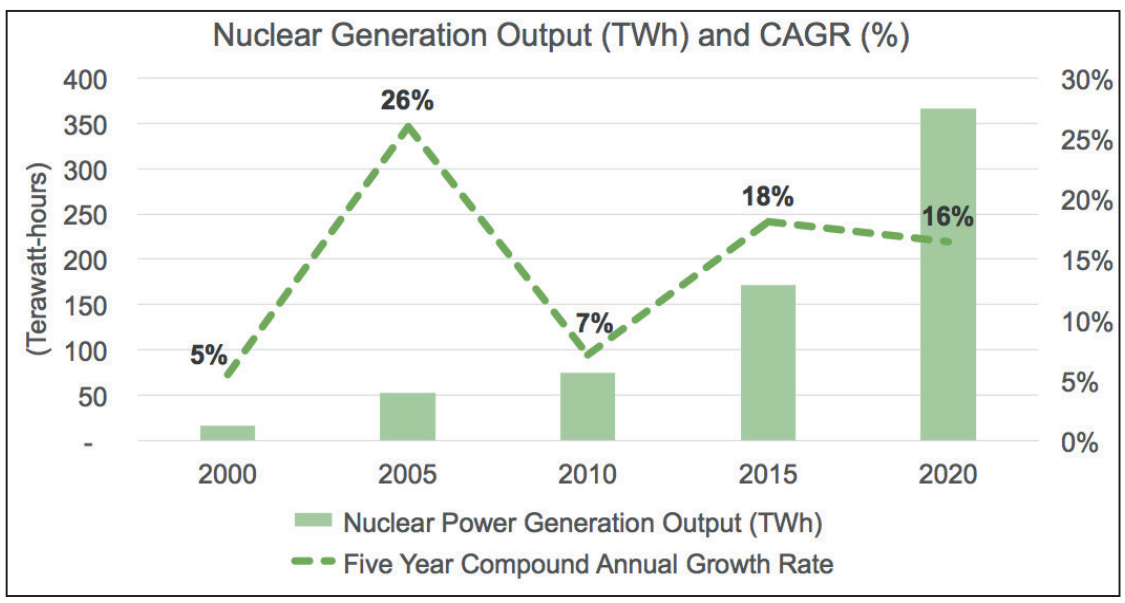
"We will take solid steps toward the goals of achieving peak carbon dioxide emissions and carbon neutrality. We will draw up an action plan for carbon emissions to peak by 2030. China's industrial structure and energy mix will be improved. While promoting the clean and efficient use of coal, we will make a major push to develop new energy sources, and take active and well-ordered steps to develop nuclear energy on the basis of ensuring its safe use."

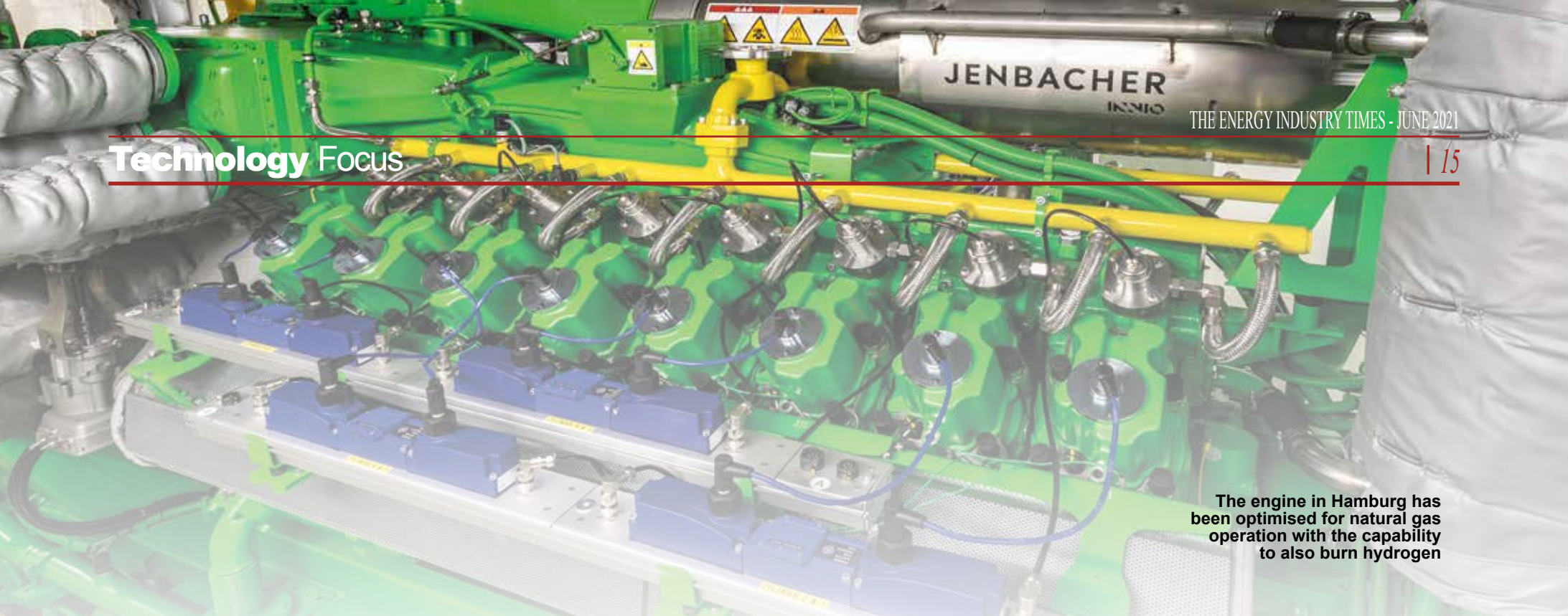
Specifically on thermal coal, it is worth noting that the Chinese President Xi Jinping himself declared to a global leaders' forum in April that China will slow coal consumption during the 14th FYP period and phase it down during the 15th FYP period, through 2030.

Given the intermittent nature of some renewable energy sources, especially solar and wind, and also given the high cost of energy storage and gas generation, two tools to optimise power from renewables, one can be confident that China is most likely to raise future install capacity targets for nuclear power generation over the next several decades.

Giuseppe (Joseph) Jacobelli is a business executive, analyst, and author with over 30 years' experience in energy and sustainability in Asia. He is author of 'Asia's Energy Revolution: China's Role and New Opportunities as Markets Transform and Digitalise', De Gruyter, 2021, available June 7.

China Electric Power Industry Statistics for 2020
Source: "Report of China Power Council: Rapid Growth of Wind Power and Solar Power Generation in 2020" (guangfu.bjx.com.cn February 2, 2021) accessed May 15, 2021. Author calculations.





The engine in Hamburg has been optimised for natural gas operation with the capability to also burn hydrogen

Warming up to hydrogen

A gas engine now operating on green hydrogen at a combined heat and power plant in Hamburg, Germany, is a significant milestone in the development of reciprocating engines for burning the carbon-free fuel. **Junior Isles** reports.

As global pressure to decarbonise continues to grow, an increasing number of utilities are exploring how hydrogen can be utilised as a zero carbon energy source in their existing operations.

In November HanseWerk Natur GmbH– a subsidiary of German energy service provider HanseWerk AG – together with INNIO Jenbacher began field testing on a converted combined heat and power (CHP) plant in the Othmarschen area of Hamburg. The project marks a significant milestone in the development of gas engine technology for burning hydrogen – being claimed as the world's first large-scale gas engine in the 1 MW range that can be operated either with 100 per cent natural gas or with variable hydrogen-natural gas mixtures up to 100 per cent hydrogen.

Announcing the start of field testing, Carlos Lange, President and CEO of INNIO said: "Our joint project with HanseWerk Natur is a key milestone on the path toward climate neutrality since green hydrogen is an important part of the solution. A particularly attractive aspect of our gas engine technology is that existing natural gas engines can also be converted to run on hydrogen. This offers operators security of investment, with the added benefit that the existing infrastructure can not only be utilised in the longer term, but also deployed in a way that is environmentally sound."

Demonstrating the feasibility of a hydrogen-fuelled engine in a CHP plant has long been on the company's agenda so it decided to see how it could take advantage of its long-standing relationship with Hanswerk Natur to realise its goal.

"We have realised a number of projects with them over the years, a lot of them being very innovative in terms of heat use, etc. They are an excellent partner," said Carl Richers, VP Product Management and Marketing at INNIO Jenbacher. "It was not only important to demonstrate that we could build a hydrogen power plant but that we could realise two firsts – a megawatt-scale, 100 per cent hydrogen unit, and the first conversion of an existing natural gas unit to hydrogen operation."

The project is the latest in Hanswerk Natur's drive to "green" its operations. Many of its units already run either on biogas or on biomethane and the company is keen to show that existing CHP plants – with their high fuel conversion efficiency and ability to stabilise the grid – not only have a role to play today in decarbonisation but also in a future where the energy landscape is dominated by renewables.

Richers noted: "It was important to show the different use cases for our engines going forward. That means operating on natural gas today and then as increasing amounts of hydrogen is injected into the gas grid, the ability to operate on hydrogen-natural gas mixtures, and ultimately on 100 per cent hydrogen as the gas system is fully decarbonised."

At the moment, certified green hydrogen for the engine – which is housed in a car park area of a leisure complex – is delivered in bottles. The main challenge in developing or converting a gas engine to burn this hydrogen is the different combustion behaviour of the two fuels and their volumetric energy densities.

Richers explained: "This means you need a greater volume of hydrogen. Hydrogen also burns much faster than natural gas, and is more 'ignition friendly', i.e. it has a lower knocking resistance. These are things that had to be addressed in the engine development."

The design team therefore focused on modifications to the engine control system, fuel supply system and turbocharger.

"Pressure monitoring of each cylinder is needed to optimise combustion in each cylinder, noted Richers. "Also, gas and air are normally mixed before it enters the turbocharger but with hydrogen, port injection valves are needed to deliver the fuel to each individual cylinder. And to control the different air/fuel mixture, we had to modify the turbocharger and install a waste gate to have more flexibility in adjusting the engine to the two fuels used."

Initial testing of the components began on a test bench engine in Jenbach, Austria, during the spring-summer of 2020 in order to optimise load points, parameters for emission compliance and load acceptance behaviour of the unit. Conversion of the engine at the Hamburg plant then began in September last year.

Richers notes that this short development time was possible because of the company's experience of burning gases with hydrogen content. "We have a significant fleet running on wood gas, coke gas, syngas and various process gases – some of these have a hydrogen content of up to 70 per cent. We were able to leverage this experience for the latest development."

INNIO Jenbacher has also been running engines on hydrogen and hydrogen/natural gas mixes since the early 2000s in Argentina and Germany. Now on the engine in Hamburg, the first period of operation has demonstrated that it can operate reliably on varying degrees of hydrogen in a typical CHP use profile with no technical restrictions.

"It has shown that the engine can run continuously or balance the grid with frequent starts and stops," said Richers. "From a hardware perspective, the use of port injection means they are already prepared for extremely fast starting."

Because the Hamburg engine has been optimised for natural gas operation with the capability to also burn hydrogen, Richers says there had to be a "couple of compromises" in terms of performance.

"We have to de-rate the engine when running on 100 per cent hydrogen operation, so that power output is reduced by roughly 40 per cent. Electrical efficiency also drops very slightly; it's 42 per cent on natural gas but still above 40 per cent on hydrogen. The overall efficiency, when including heat, is almost identical: around 93 per cent."

The slight reduction in electrical efficiency is driven partly by the different combustion and partly by the de-rating. "Because the mechanical friction in the engine remains identical and there is less power output, the efficiency drops; it's mathematics," said Richers.

Going forward, the plan is to have shorter test periods to achieve smaller optimisations in order to deliver, for example, higher power output when running on hydrogen.

The HanseWerk Natur engine is an important piece of INNIO Jenbacher's technology roadmap. "It's important to be ready for the future," said Richers. "Developments are happening quickly and we want to be able to convert our existing installed units to hydrogen, or install new units based on hydrogen. So we are ready and just waiting for hydrogen to be available on a broader scale."

INNIO is in discussions with several customers on potential projects, and investigating opportunities; notably, one that could materialise in Austria with Verbund. The Austrian energy company operates two gas turbine at a site in Mellach and is planning to install electrolysers. Here, there is the possibility to install an engine-based CHP unit that would run on hydrogen.

Commenting on the future, Richers said: "The bottleneck today is availability and price of green hydrogen. That's what is limiting the number of projects to a couple of demonstrator projects."

With regards to conversion of its product portfolio, INNIO Jenbacher says it has a commercially available solution today and will continue development to minimise the power reduction on hydrogen operation.

"The focus is on our Jenbacher Type 4 (up to 1.5 MW) and Type 6 (2-4.5 MW) platforms and I would expect that we have serial release of engines with minimised impact on the power output by around 2025," said Richers. "This would also be for retrofit kits for installed units."

Retrofits would require installation of a new fuel injection system, changes to the cylinder heads, new waste gate and changes to the control system. Depending on the configuration, changes to the piston might also be required. "These are the major equipment changes needed in order to adjust the compression ratio for hydrogen operation. Sometimes the fire protection concept of the engine room or plant also has to be revised."

He added: "The price of the conversion could be reduced if it is combined with a scheduled overhaul where many of the components have to be touched anyway."

In the long term, Richers believes there will be a good market for installing its hydrogen fuelled CHP plants in a number of regions but especially in Europe and the west coast of the US for his company. In an energy landscape that is 100 per cent renewables, he says, these will be driven by the hydrogen produced from excess electricity and from hydrogen that will be imported to compensate for a seasonal under-supply of electricity in the system.

He noted: "In a scenario where we need green heat as well as green electricity, we will require significant amounts of chemically stored energy. Hydrogen would either come from locally run electrolysers or imported from other parts of the world."

He concluded: "We are positive about the future. CHP natural gas engines are important today in supporting the transition to a low carbon future, as they have the flexibility to support the growth of renewables by compensating for the fluctuations caused by renewables, and because of their high overall energy efficiency since they provide both electricity and heat. And in the future, they can be converted to green hydrogen operation to be an integral part of a fully renewable energy landscape."

Richers: We are ready and just waiting for hydrogen to be available on a broader scale

Junior Isles

Roadmaps and disappearing pathways

The International Energy Agency's recent net zero roadmap is certainly a comprehensive piece of work. It prompted a long-time friend and fellow journalist to quip: "That IEA roadmap was really something. I wonder if anyone will pay attention to it?" Plenty paid attention (the website reportedly crashed for hours on its publication) but perhaps the real question is: how much difference will it make?

Titled: 'Net Zero by 2050: a Roadmap for the Global Energy Sector', the report is hailed by the IEA as "the world's first comprehensive study of how to transition to a net zero energy system by 2050 while ensuring stable and affordable energy supplies, providing universal energy access, and enabling robust economic growth".

It sets out clear milestones – more than 400 in total, spanning all sectors and technologies – for what needs to happen, and when, to transform the global economy from one dominated by fossil fuels into one powered predominantly by renewable energy like solar and wind.

Launching the report, the IEA said that the world "has a viable pathway" to building a global energy sector with net zero emissions in 2050, "but it is narrow" and requires an unprecedented transformation of how energy is produced, transported and used globally.

"Our Roadmap shows the priority actions that are needed today to ensure the opportunity of net zero emissions by 2050 – narrow but still achievable – is not lost. The scale and speed of the efforts demanded by this critical and formidable goal – our best chance of tackling climate change and limiting global warming to 1.5°C – make this perhaps the greatest challenge humankind has ever faced," said Dr Fatih Birol, the IEA Executive Director.

Certainly anything is achievable but what is the likelihood? To say the pathway remains narrow and extremely challenging is perhaps an understatement of what needs to be done.

Based on the study, Dr Birol said he sees three big pieces of "homework" for everyone – governments, industries, citizens, academics, etc. Firstly, make the most of existing clean energy options including energy efficiency and electric cars. Number two, "push the magic button of innovation"; i.e. incentivise technologies such as advanced batteries, hydrogen applications and direct air capture so they are ready for the market to help reduce emissions after 2030. And thirdly, substantially reduce the use of fossil fuels.

Looking at the IEA's stipulations for the third task, however, it would appear that we have failed even before we start. The press release for the Roadmap states that, "from today", there must be no investment in new fossil fuel supply projects, and no further final investment decisions for new unabated coal plants.

Clearly, that will not happen. In April China said it would not start phasing down coal use until 2026. Speaking via video link at the Leaders Summit on Climate hosted by US President Joe Biden, Chinese President Xi Jinping said: "We will strictly limit the increase in coal consumption over the 14th five-year plan period (2021-2025) and phase it down in the 15th five-year plan period (2026-2030)."

Although Su Wei, Deputy Secretary-General of the National Energy Administration (NEA), China's state planning agency, said the country would aim to reduce the share of coal in its total energy mix to less than 56 per cent this year, China remains one of the only major economies to approve new coal projects. "For the moment we don't have another choice," said Su. The NEA also said it will continue to "moderately and rationally" push the launch of coal fired power plants alongside China's major power transmission lines.

Meanwhile, a draft electricity document seen by *Reuters* in April, also shows that India may build new coal fired plants, as they generate the cheapest power. The fuel still accounts for nearly three quarters of the country's annual power output.

This does not align with some of the key milestones set out in the IEA roadmap: the phase-out of all subcritical coal fired plants by 2030 (870 GW existing plants and 14 GW under construction) and the phase out of all unabated coal fired plants by 2040.

Then there is the question of what happens to coal fired plants already under construction in China, India and other places like Vietnam and Indonesia, which are not due for completion for several years? It is highly unlikely they will be decommissioned so early on in their 30+ year lifespan, or retrofitted with carbon capture technology any time soon.

The IEA also noted that annual solar and wind capacity additions would have to quadruple this decade, compared to the record level set in 2020. Realising this degree of acceleration is another huge task.

Sandrine Dixson-Declève, Club of Rome President and Chair of the new DG R&I Think Tank ESIR (Economic and Societal Implications of Research and Innovation) within the European Commission offered her thoughts on how the energy transition could be accelerated, at least in European electricity sector.

Speaking at the recent virtual annual Eurelectric Power Summit on how Europe could meet its more ambitious targets, she said: "There are a variety of ways to accelerate but first we need to ensure that we're not just thinking about technology. Acceleration means thinking about how to get technology to where it needs to be. If we could set a 30gCO_2/kWh for emissions to ensure that by 2030 we are down in terms of carbon emissions and ensure that we drive the link towards clean electrification, that is exactly what we would need.

"There are already calls by the UK government to shift out of internal combustion engines. Why can't we do the same in terms of clean energy? We also need to triple our investment in renewables, as outlined in the Accenture ('Electric Decade') report; and this needs to be done not just across developed regions but also in developing regions." She added that the right signals would also have to be in place in terms of policy, with the elimination of tax incentives and subsidies for fossil energy, as well as the removal of "perverse market indicators" for fossil fuelled power generation.

Laurence Tubiana, CEO, European Climate Foundation also commented on how to accelerate the growth in renewables. Notably she said it was important to share discussions related to the transition with citizens, especially when it comes to integrating clean energy infrastructure into their communities.

The IEA roadmap stressed that citizens must be active participants in the entire process, making them feel part of the transition and not simply subject to it. As Dr Birol pointed out: "The clean energy transition is for and about people."

It all amounts to an unprecedented challenge that will require global collaboration between all countries and between sectors. It calls for trillions of dollars in financing, and concessions will have to be made all around to navigate the pathway to net zero. As the report, states: "... advanced economies have to reach net zero before emerging markets and developing economies, and assist others in getting there."

Dr Birol noted that different countries in the "race to zero" are starting from different starting points. And while this is an important point that has to be acknowledged and accounted for, the over-arching issue is that the finish line is still the same for everyone. As Birol said: "The race is not between countries but is against time and unless all governments finish the race, nobody can win."

The pathway to meeting that 2050 deadline may have already disappeared. Nevertheless, the attempt must still be made. Even if the world does not find a way to net zero by 2050, transitioning to cleaner, greener energy offers a pathway to the global economic recovery the world needs right now. And as the legendary heavyweight boxer Muhammad Ali once said: "Impossible is nothing."

Cartoon: jemsoar.com