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Oil majors ramp up shift to low carbon energy

BP Chief Executive Bernard Looney: aiming for 50 GW of renewables by 2030

With falling oil prices and the pressure to meet emissions targets, oil and gas majors are accelerating the move to renewable energy and lowering their carbon footprints. **Junior Isles**

The shock to the global economy and energy markets from Covid-19, which saw a massive fall in oil prices, has caused several international oil and gas majors to rethink their future energy strategy.

In August, BP announced that it will need to invest tens of billions of dollars over the next decade and may have to accept lower returns than it can get from oil if it is to meet its target of becoming one of the world's largest renewable power generators. The oil and gas company wants 50 GW of renewables such as wind, solar and hydropower in its portfolio by 2030, up from just 2.5 GW now

In a strategy update on its 2050 net zero ambition, BP said it would cut its oil and gas output by 40 per cent by 2030 and spend $5 billion a year on low carbon projects. It is also planning to sell oil and gas assets that would not be economically viable with lower oil prices to raise $25 billion by 2025 to help fund its transition to cleaner energy.

It said in statement: "Within 10 years, BP aims to have increased its annual low carbon investment 10-fold to around $5 billion a year, building out an integrated portfolio of low carbon technologies, including renewables, bioenergy and early positions in hydrogen and CCUS. By 2030, BP aims to have developed around 50 GW of net renewable generating capacity – a 20-fold increase from 2019 – and to have doubled its consumer interactions to 20 million a day.

"Over the same period, BP's oil and gas production is expected to reduce by at least one million barrels of oil equivalent a day, or 40 per cent, from 2019 levels. Its remaining hydrocarbon portfolio is expected to be more cost and carbon resilient."

European oil majors are under pressure from activists, banks, investors and some governments to shift away from fossil fuels and are trying to find business models that offer higher margins than the sole production of renewable energy would generate.

Analysts say large offshore wind farms probably offer the quickest route for BP to scale up but as they can take years to develop, and have high start-up costs, it may have to turn to acquisitions. With renewable power companies trading at high price-to-earnings ratios, analysts say BP could

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UK offshore wind prices soon to undercut fossil generation

A dramatic drop in the cost of offshore wind power could soon see electricity from offshore wind projects in the UK being cheaper than fossil fuelled generation. Coupled with a slight rise in wholesale power prices, rapidly falling costs could mean the newest wind farms coming online in the UK will soon operate with negative subsidies, finds new analysis.

According to recent research by Imperial College London, published in the journal *Nature Energy*, record low prices of around £40/MWh agreed in contracts last year combined with expected electricity price rises mean that UK offshore wind providers will likely start passing on those gains to consumers in reduced energy bills by 2023.

Lead researcher Dr Malte Jansen, from the Centre for Environmental Policy at Imperial, said: "Offshore wind power will soon be so cheap to produce that it will undercut fossil-fuelled power stations and may be the cheapest form of energy for the UK. Energy subsidies used to push up energy bills, but within a few years, cheap renewable energy will see them brought down for the first time. This is an astonishing development."

The analysis examined the future electricity price trends and found that from the mid-2020s onwards, the contracted prices were likely to be below the UK wholesale price over the lifetime the latest wind farms would produce electricity.

Dr Iain Staffell, from the Centre for Environmental Policy at Imperial, said: "The price of offshore wind power has plummeted in only a matter of a decade, surprising many in the field. The UK auctions in September 2019 gave prices that were around a third lower than those of the last round in 2017, and two-thirds lower than we saw in 2015. This amazing progress has been made possible by new technology, economies of scale and efficient supply chains around the North Sea, but also by a decade of concerted policymaking designed to reduce the risk for investing in offshore wind, which has made financing these huge billion-pound projects much cheaper."

Researchers found decreasing costs when looking at a series of government auctions for offshore wind farms between February 2015 and September in the UK, Germany, the Netherlands, Belgium and Denmark.

The rapid fall in the cost of offshore wind has seen a dramatic rise in the demand for projects worldwide. New research published in late July by RenewableUK shows the global pipeline of offshore wind power projects which are either operational, under construction, consented or being planned, has soared by 30 per cent in the last twelve months from 122 GW to 159 GW.

Its latest 'Offshore Wind Project Intelligence' report shows that the UK has retained its top spot, dominating the market with a pipeline of 38.9 – a quarter of the global total. China has moved up from 4th to 2nd place with 19.3 GW – an increase of 7.3 GW, up 60 per cent.

The USA stays in 3rd place, up from 15.7 GW to 17.8 GW, an increase of 13 per cent, while Germany has dropped from 2nd to 4th place as its total of 16.5 GW has remained almost the same over the last 12 months, adding just 68 MW. Taiwan stays 5th with its project pipeline growing by 28 per cent from 8.9 GW to 11.4 GW.

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also build wind farms from scratch but they would come with high upfront costs.

Peter Atherton, associate at British strategy consultants Stonehaven told *Thomson Reuters*: "Getting value for that will be hard because these assets are very attractive and selling at very high prices."

BP Chief Executive Bernard Looney said on a conference call, however, that the company would only go after renewable capacity that came with the right returns – rather than chasing capacity for the sake of it.

In response to BP's net zero announcement, Mel Evans, senior climate campaigner for Greenpeace UK, said: "BP has woken up to the immediate need to cut carbon emissions this decade. Slashing oil and gas production and investing in renewable energy is what Shell and the rest of the oil industry needs to do for the world to stand a chance of meeting our global climate targets."

Several companies are already moving in this direction. Last month Equinor appointed a new CEO, with an increased focus on the energy transition.

Following the announcement Will Scargill, Managing Oil & Gas Analyst at GlobalData, a leading data and analytics company, said: "Equinor, like other major European oil and gas companies, has made a significant strategic shift in recent months to prepare for the energy transition. The company committed to halving its net carbon intensity by 2050 in February and has already made significant investments in this space.

"Equinor currently leads the oil majors in upcoming renewables capacity, with projects already in the pipeline set to contribute around 5 GW. The announcement of its new CEO's focus on the transition suggests an ambition to continue this leadership role."

Equinor and BP were not the only oil and gas majors to make significant announcements on future strategy in recent weeks. At the end of July, Chevron U.S.A Inc., a wholly owned subsidiary of Chevron Corporation, and Algonquin Power & Utilities Corp. signed an agreement seeking to co-develop renewable power projects that will provide electricity to strategic assets across Chevron's global portfolio. Under the four-year agreement, Chevron plans to generate more than 500 MW of its existing and future electricity demand from renewable sources.

Satterwhite: committed to lowering Chevron's carbon footprint

"Chevron intends to lead in the future of energy by developing affordable, reliable and ever-cleaner energy," said Allen Satterwhite, President of Chevron Pipeline & Power. "This agreement advances Chevron's commitment to lower our carbon footprint by investing in renewable power solutions that are reliable, scalable, cost efficient, and directly support our core business."

Utilities' H1 operating performance reveals impact of Covid-19

Renewables helped ease the impact of Covid-19 on utilities' H1 performance, says **Junior Isles**

Junior Isles

Several European utilities have reported robust first-half (H1) operating profits but performance has been dragged down by the impact of Covid-19 on the second quarter.

As lockdowns ease, utilities have now been able to better assess the impacts of the pandemic, with results showing that those with more renewables in their portfolio have generally been less affected.

In Germany, EnBW reported a 24.3 per cent year-on-year rise in adjusted earnings before interest, tax, depreciation and amortisation (EBITDA) for the entire group, thanks mainly to the company's Renewable Energies segment, which doubled its adjusted EBITDA contribution during the first half of 2020 compared to a year earlier.

As anticipated, the E.On Group's adjusted EBIT for the first six months of 2020 declined to roughly €2.2 billion ($2.59 billion) compared with €2.3 billion in the prior year. Adjusted net income decreased to €933 million from €1.05 billion in the prior year.

Announcing the results, E.On's CEO, Johannes Teyssen, said: "We can now see much more clearly than at the end of the first quarter and can look ahead to the second half of the current year with greater confidence. We delivered a strong first-half operating performance."

The company's CFO, Marc Spieker, added: "As anticipated, the Covid-19 crisis affected our EBIT in the second quarter. However, the decline relative to the first half of 2019, which resulted largely from the pandemic's repercussions, was comparatively mild.

Looking ahead, E.On revised its forecast for full-year 2020 to reflect Covid-19's technical earnings effects. The company noted that Covid-19's total unrecoverable adverse impact in 2020 is limited to only about 2 per cent of EBITDA.

Meanwhile, Uniper's positive earnings performance continued in the second quarter, albeit, as anticipated, not at the previous pace. Uniper posted adjusted EBIT of €691 million in the first half of 2020. Its earnings were thus significantly above the prior-year figure of €308 million. The first half benefited in particular from the optimisations achieved in the gas business in the first quarter.

Uniper CEO Andreas Schierenbeck said: "Despite Covid-19, our key performance indicators are right on schedule, enabling us to make our forecast for full-year 2020 more precise and to raise the mid-point of the forecast range slightly.

In Spain, meanwhile, Endesa posted a net profit of €1.128 billion for the first six months of 2020, up 45.4 per cent year-on-year. During the reporting period, Endesa formally disconnected 45 per cent of its coal-fired capacity on the mainland, leaving the company with 2523 MW. The utility generated 7396 GWh of electricity from renewables it has on the mainland, up 50 per cent on the year.

The first six months saw Iberdrola's EBITDA grow by 5.3 per cent on the year to €1.23 billion, largely underpinned by growth achieved in the US and the UK and capacity additions. However, the US and the UK were the only two Iberdrola markets in which the renewables business grew across the board, with EBITDA rising by 15.7 per cent and 54.6 per cent, respectively, due to wind power production both on- and offshore.

In native Spain, higher output and increased photovoltaic (PV) capacity failed to lift the renewables EBITDA, which came down 20.9 per cent year-on-year to €300.7 million due to lower sales price to the supply business.

In a separate announcement, the company said it has now taken over Australian renewables firm Infigen Energy after securing control of more than 50 per cent of the company's shares.

■ UK-based multi-national energy company Centrica will sell its US business to local group NRG Energy for $3.6 billion in cash, in a move aimed at reducing its debt. Centrica's earnings before interest, tax, depreciation and amortisation fell 19 per cent compared with the same period the year before, and adjusted operating profits fell by 14 per cent. In June the company announced 5000 job cuts and an overhaul of its staff contracts in an effort to achieve its £2 billion ($2.63 billion) cost-cutting target a year early in 2021.

Financial institutions to track climate impact of loans and investments

The Partnership for Carbon Accounting Financials (PCAF), a global collaboration of 70 financial institutions with financial assets of more than $10 trillion, is releasing a standard to provide financial institutions with shared methodologies and rules for measuring and disclosing the greenhouse gas emissions of their loans and investments.

Developed by a group of 16 banks and investors across the globe, the standard will ensure that there is a common set of carbon accounting methods that financial institutions can use to assess and track the carbon emissions financed by their loans and investments.

Carbon accounting of financial portfolios is the annual measurement and disclosure of GHG emissions financed by loans and investments at a fixed point in time in line with financial accounting periods. Carbon accounting methods are based on the Greenhouse Gas Protocol.

The Global Carbon Accounting Standard is based on carbon accounting methods already being used in several countries by banks and investors affiliated with the Partnership for Carbon Accounting Financials.

"The Standard is a key tool in the arsenal for financial institutions because it helps banks and investors measure their financed emissions, which is the starting point to the process of aligning financial flows with the goals of the Paris Agreement," said Ivan Frishberg, of Amalgamated Bank and Chair of PCAF North America regional team.

Beyond assessing, tracking and reporting financed emissions, a consistent and harmonised approach to portfolio carbon accounting gives financial institutions the information required to set climate targets and assess climate transition risks.

The announcement came just ahead of a letter sent out in mid-August by UNFCCC Executive Secretary Patricia Espinosa to all 197 parties in the Paris Agreement, urging them to send their national climate action plans at least "9-12 months" ahead of the COP26 summit. This is now set to take place in Glasgow next year.

Nationally Determined Contributions (NDCs) are emissions reduction and climate adaptation plans. Under the terms of the Paris Agreement, all member nations are expected to submit their NDC plans by the end of 2020.

NDCs form part of UNFCCC's Facilitative Sharing of Views (FSV) processes and Multilateral Assessment (MA), which are important transparency processes on countries' pre-2020 climate action.

The Multilateral Assessment allows countries from 10 August up until 7 September 2020 to pose questions to developed countries, namely: Australia, European Union, Finland, Germany, Italy, Netherlands, Norway, Portugal Sweden, and Switzerland. The FSV process allows Parties to submit written questions using an online platform. It is expected to start in September and be open for a month.

The MA and FSV processes facilitate the completion of the NDCs that are due in December.

Start of ITER assembly brings commercial fusion closer

An important milestone was recently reached on the long road to commercialising nuclear fusion with the start of assembly of the International Thermonuclear Experimental Reactor (ITER) in Cadarache, France.

The experimental plant's goal is to demonstrate that fusion power can be generated sustainably, and safely, on a commercial scale, with initial experiments set to begin in December 2025.

"With fusion, nuclear holds promise for the future," French President Emmanuel Macron said in a message to mark the official start of assembly.

As a technology, it promises "clean, no-carbon, safe and practically waste-free energy", added the President, who has long advocated nuclear power in the global fight against climate change driven by the greenhouse gases produced from the burning of coal, oil and natural gas.

Nuclear fusion, the process that powers the Sun and other stars, occurs when hydrogen atoms fuse together at intense temperatures to release huge amounts of energy. The process requires very small amounts of fuel – deuterium and tritium, which are abundantly available – and, unlike today's fission reactors, there is no physical possibility of a run-away accident with meltdown.

Dubbed as "the world's largest science project", the ITER project was launched in 2006 by 35 countries including the United States, Russia, China, Britain, Switzerland, India, Japan, South Korea and the 27 members of the European Union.

ITER's Director-General Bernard Bigot says if the technology proves feasible, future fusion reactors would be capable of powering two million homes each at an operational cost comparable to those of conventional nuclear reactors.

Rolling darkness in California

Blame game proceeds as power outages continue in California. **David Flin** reports.

The exact cause of California's rolling blackouts in August is still unclear as more power outages loom.

Experts have cited a number of potential causes for the outages that have hit the state, with every expectation that there may be further such incidents. Potential causes that have been put forward include: ballooning demand; inadequate transmission; over-reliance on renewable energy; and natural gas plant challenges during hot weather.

California's Governor Gavin Newsom said reliability had been sacrificed in the complex power balance, noting: "We're going to be much more aggressive in focusing our efforts into ensuring reliability." He said that energy storage offered a potential solution, most likely in lithium-ion batteries, but utility-scale battery systems are not yet online in numbers in California.

"We're going to have to do more and be much more mindful in terms of our capacity to provide backup and insurance," he said.

California was hit by a combination of factors. There was a heatwave, causing demand to rise. This also affected neighbouring states, reducing energy imports into California. Normally, energy imports from other states account for around 25 per cent of California's energy mix. A 750 MW unit was offline, then two units, a 500 MW unit and a 470 MW power plant went offline, and 1000 MW of wind power dropped out of service due to lack of wind.

Steve Berberich, the CEO of the California Independent System Operator said: "What we have is a situation where the entire region is extremely hot ... We can't get the energy that we would normally get from out of state."

Renewables currently represent 32.4 per cent of California's energy mix. California has set targets to move to 60 per cent of electricity coming from renewable sources by 2030, and 100 per cent by 2045.

Bernadette Del Chiaro, Executive Director of the California Solar & Storage Association, said: "We have an evening electricity supply problem. Because we've been successful in building solar over the past 20 years, we have lowered overall demand and shifted a lower peak demand to later in the evening as the sun is setting. The answer to that problem is building more solar-charged batteries, not more fossil plants."

Construction has now started at what will be the world's largest battery storage plant in Moss Landing, Monterey, California. The battery park being constructed by Tesla and PG&E will be able to dispatch up to 730 MWh at a maximum of 182.5 MW for up to four hours, with the option of upgrading the system to 1.2 GWh. It will use 256 of Tesla's lithium-ion Megapacks. The facility is scheduled to come on line in 2021.

Chile on course to meet renewable targets

A spate of recent announcements in the renewable energy space indicate that Chile is well on course to meet its targets of renewable energy. Its National Energy Policy sets out targets of 20 per cent by 2025, 70 per cent by 2050, and to achieve 45 per cent of new build up to 2025 being renewable. It looks likely that the 2025 targets will be met.

First Solar recently announced that its 141 MW Luz de Norte solar power plant will be the world's first utility-scale solar facility licensed to deliver ancillary grid services commercially. The facility, located in Copiapó, Chile, is now being used to manage the frequency of the grid, ensuring its reliability and stability.

Carlos Barria, Head of Forecast and Regulatory Analysis at Chile's Ministry of Energy, said: "This is in line with our plans for integrating higher levels of renewable energy in our grid, which will enable us to achieve our goal to phase out coal-fired power plants by 2040 and to be carbon neutral by 2050."

Another example of activity pushing Chile towards its targets is that of Engie Energia Chile, which will expand its Vientos del Loa wind farm from 126.5 MW to around 204.6 MW. It is seeking to install 33 units of 6.2 MW wind turbines, with a total investment of $246 million.

Enel Generacion Chile also announced that it will install 2 GW of renewable energy by the time its Bocamina coal-fired plant goes offline. The company plans to end the use of coal-fired generation by May 2022, well ahead of the agreed date of 2040. It will disconnect unit 1 of the Bocamina coal-fired plant in December 2020, and unit 2 in May 2022.

Brazil should reach 20 GW of wind power by 2022

Wind power continues to grow rapidly in Brazil, with expectations that it will reach 20 GW by 2022, and 24.2 GW by 2024. This compares to 16 GW installed as of June 2020. Offshore wind in particular is likely to grow dramatically, with some estimates, such as those produced recently from EPE, the Brazilian state-owned energy research firm, that there is a potential 700 GW of offshore wind power that can be utilised.

As the first step in exploiting this potential, Brazilian firm BI Energia said in August that it will invest $4 billon to develop Latin America's first two offshore wind power projects, the 508 MW Caucaua wind farm and the 1.2 GW Camocim wind farm, both off the coast of Ceará state.

Luciano Bomfim, Executive Director of BI Energia, said: "We have a total of six projects under study, all of them located in Brazil's northeast region. Our analysis shows this is one of the best places in the world for this type of project." He added that four other sites, each with estimated capacity between 600 MW and 1 GW, were in the initial studies phase.

BI Energia is in talks with three trading firms interested in buying the electricity from the Caucaua and Camocim wind farms.

Onshore wind is also growing rapidly. Brazilian energy company AES Tiete Energia said in July that it will expand in the national wind market through acquisitions.

It will primarily target wind farms with contracts secured in past energy auctions and capacities between 250 MW and 350 MW.

At present, AES Tieste has 3.7 GW of renewable power in its generating portfolio, of which 2.7 GW are hydropower and the remainder are wind and solar.

USA to exploit up to 28 GW of offshore wind by 2030

- Investment will reach $17 billion by 2025
- Auctions in Gulf of Maine and California could happen in 2022

Up to 28 GW of offshore wind power in US waters off of four states (New York, California, North Carolina, and South Carolina) could be auctioned for development over the next two years, and be operational by 2030.

The Bureau of Ocean Energy Management (BOEM), which is in charge of offshore wind lease auction, was active under the Obama administration but has only completed two competitive leases sales during the Trump administration. However, total investment in the US offshore wind industry will reach $17 billion by 2025, $108 billion by 2030, and $166 billion by 2035.

In August the American Wind Energy Agency (AWEA) said that new offshore wind leases can be a short-term solution to jump-start recovery. "Based on existing activities and policy assumptions for future offshore wind development, around two million acres of federal waters in the New York Bight, as well as California and the Carolinas, could be auctioned for commercial leases as early as this year, as well as in 2021," it said. "Such leasing could support 28 GW of offshore wind development and generate $1.2 billion in US Treasury revenue. Other auctions for lease areas in the Gulf of Maine and areas in California could happen in 2022."

In support of this, the Brattle Group for Anbaric produced a report in August, 'Offshore Wind Transmission, An Analysis of Options for New York'. This report says that a multi-user planned transmission system for offshore wind in New York could save over $500 million, and significantly reduce environmental impacts and project risks.

The report evaluates the challenges of connecting each wind farm to shore individually compared to a high-capacity transmission system serving multiple wind farms. According to the study, a planned transmission approach would reduce cabling by almost 60 per cent, preventing 660 miles of seabed disturbance and reducing the impact on fisheries and marine ecosystems.

Kevin Knobloch, President of Anbaric's New York OceanGrid, said: "Developing a shared ocean grid is critical to achieving New York's ambitious offshore wind goals."

In another strand in the development of US offshore wind, the US Department of Energy's National Renewable Energy Laboratory (NREL) published a study in August on floating wind. It identified barriers that need to be overcome to bring down the overall cost, and outlined a vision for an integrated systems approach to improve the market feasibility of floating wind plants. The proposed approach aims to help the industry deploy cost-effective floating turbine systems by 2030.

Pakistan moves to bring down electricity costs

Pakistan is looking to reform its power sector while calling on the private sector in an effort to lower the cost of generation. **Syed Ali.**

In a bid to bring down the cost of electricity generation and reduce the circular debt, the Pakistani government has signed a new deal with a number of independent power producers (IPPs). The move comes ahead of a recently announced plan to reform the power sector.

According to government sources, in mid-August the government committee signed a Memorandum of Agreement with 13 wind power IPPs, with another six scheduled to sign soon after. Sources further said that these IPPs will receive profits in rupees and not dollars as underlined in the 1994 and 2002 power policies. The dollar to rupee rate has therefore been fixed at Rs148 ($0.88) for the duration of the agreement. This is expected to be the basis for buying electricity from power producers in the future and also fix tariff issues.

The agreement was signed as the government prepared to announce details of the savings in power generation costs through ongoing review of energy contracts. Federal Minister for Energy Omar Ayub Khan said full details would be announced in September.

Speaking at a press conference the minister said that with circular debt, estimated to rise beyond Rs2.7 trillion ($16.13 billion) by the end of the current fiscal year, the government would unveil a detailed reform plan for the power sector, including the expected reduction in the cost of generation through revised agreements with power producers and improvements in the transmission and distribution system. He said work and assessments were in progress, adding that no previous government has ever reviewed the power sector in order to solve its problems.

He said that most of the agreements with IPPs under the 1994 and 2002 policies and wind power plants built under the 2006 policy had been reviewed and the detailed calculations and savings would be made available along with similar revisions for projects owned by the government.

The Pakistan Tehreek-i-Insaf (PTI) government inherited a host of power sector challenges including system constraints, fast rising circular debts, inefficiencies driven by corruption, theft, growing burden of tariff, non-rationalisation and lack of policy decisions, which have all damaged the confidence of foreign investors.

Under the vision of Prime Minister Imran Khan, the government has devised a plan to ensure access to affordable, sustainable and indigenous electricity for all by 2030, while developing a more efficient and consumer-centric generation, transmission and distribution system. It also aims to achieve renewable energy targets of 20 per cent in the energy mix by 2025 and 30 per cent by 2030.

Japan to exceed renewables target but hydrogen more challenging

Over $100 billion of investment in wind and solar power plants between 2020 and 2030 is expected to push the share of renewables in Japan's generation mix to 27 per cent by 2030, exceeding the country's target, says Wood Mackenzie.

In its Fifth Strategic Energy Plan, Japan had aimed for between 22 per cent and 24 per cent of the country's generation mix to be attributed to renewables in 2030. Last year, renewables made up 19 per cent of the country's power generation, including about 8 per cent of wind and solar power.

Wood Mackenzie Research Director, Alex Whitworth, commented: "Even before recent announcements looking to accelerate retirements of coal power, Japan had a clear pathway to meet its 2030 renewable power target. Lower demand expectations are now aligning with falling renewables costs to accelerate Japan's shift away from fossil fuels."

In the next decade, Japan's wind and solar generation costs are expected to fall by over 30 per cent, further improving competitiveness against fossil fuels. This will lead to major investment opportunities in new energy even as subsidy levels decline.

Whitworth said: "The elephant in the room is coal power which currently supplies about a third of Japan's power and will continue to be the cheapest power supply option in Japan even beyond 2030. The next decade will be a balancing act to manage the growth of renewables to reach environmental and energy security goals while keeping end-user power tariffs stable.

Energy security concerns and a commitment towards lower carbon emissions have also driven Japan to become one of the first countries globally to announce its hydrogen strategy.

Currently the sixth largest hydrogen market globally, Japan's demand is expected to hit 4.02 million metric tonnes this year, with close to 90 per cent of demand coming from refineries, according to Wood Mackenzie.

However, the mobility sector forms a major portion of the country's hydrogen goals, where it plans 200 000 fuel cell vehicles (FCVs) by 2025 and 800 000 by 2030. The current fleet stands at 4000 FCVs.

Wood Mackenzie Research Director, Prakash Sharma, said: "Hydrogen fuel cell cars are 30 per cent more expensive than electric vehicles. Without rapid cost declines and continued government support in rolling out refuelling infrastructure, FCV targets seem challenging to achieve in the timeframe.

"Cost is the biggest challenge because green hydrogen currently costs 2-4 times more than fossil-fuel hydrogen. The focus on hydrogen adoption makes perfect sense though, because Japan has very few other options to reduce its non-power carbon emissions.

"Japan aims to lower green hydrogen price to $3/kg by 2030. This would require the levelised cost of renewable electricity to fall under $50/MWh, an additional 37 per cent reduction from the current forecast for domestic solar and wind plants."

■ At the end of July Mitsubishi Heavy Industries (MHI) and Copenhagen Infrastructure Partners (CIP) announced a 50:50 joint venture for the development of offshore wind projects in Hokkaido, where conditions are attractive for offshore wind.

China eyes subsidy-free wind and solar

- End of wind subsidies in 2021 could depress market
- Subsidy costs could reach $39 billion by 2020

China is looking to drive the implementation of subsidy-free wind and solar photovoltaic power projects in an effort to boost installed capacity and power output from renewables, according to a circular jointly released by the NEA and the National Development and Reform Commission.

New wind capacity connected to the grid is forecast to hit 11.4 GW in 2020, while 33.1 GW of new solar PV is expected, according to the circular issued in August. These projects will drive investment totalling about Yuan220 billion ($31.54 billion) and create new jobs, the NAE said.

To foster a sound environment for the industry, the administration said it will enhance cooperation with related authorities and strengthen monitoring of the development and construction of such projects.

Developers have rushed to complete projects this year before the subsidy for Chinese onshore wind is phased-out. From 2021, new wind farms will no longer be able to rely on subsidies, which could depress the market and affect developer profitability. This, however, will be a short-term effect, Wood Mackenzie said.

"The combined impact from coronavirus and the rush to install new wind capacity before the end of subsidies, could cause the LCOE for wind to rise 8 per cent to Yuan472/MWh in 2020 compared to 2019. This will prevent onshore wind from meeting the government's target for grid parity in 2021," explained senior consultant Xiaoyang Li.

Ending subsidies is, nevertheless, important for the government. According to Bloomberg reports, China may have amassed a debt pile of as much as $42 billion in renewable energy subsidies that have still gone unpaid to solar and wind power capacity developers.

Citing a BOCI Research analyst, Tony Fei, said recently: "Without structural change to address the issue, the subsidy receivables in the whole industry would continue to grow and drag companies' balance sheets and investment capabilities."

China announced last year that it would cut the size of its clean energy subsidies for 2020 to $806.5 million from an earlier plan for $1.15 billion. The departure from generous state support for renewable energy came after the subsidy bill began swelling as companies rushed to add solar and wind farms.

Due to this rush, in 2017, renewable subsidies hit $14.21 billion, and the government had still not paid these in full at the beginning of 2019. At the rate of new solar capacity approvals from the last few years, subsidy costs would have reached $39 billion by 2020, according to Wood Mackenzie estimates.

Analysts say there is also the problem with new capacity additions: these will start declining amid the uncertainty surrounding subsidy payments, and this will reverberate across the renewable energy industry.

"Without China's subsidies, the renewable industry wouldn't be in the position that it is today to compete with coal on price alone," Louis Sun, an analyst with BOCOM International Holdings, told Bloomberg.

Indonesia looking to gain investors' trust in clean energy

Indonesia is preparing a presidential regulation on renewable energy pricing to gain investors' trust in the clean energy sector. The move will benefit the Indonesian renewable energy landscape, particularly the geothermal sector, says data and analytics company, GlobalData.

According to GlobalData, renewables (including small hydro) formed 6.8 per cent of the overall installation in the country by the end of 2019, out of which geothermal accounted for 45.2 per cent with over 6 GW of geothermal projects in the pipeline in the nascent or advanced stages of the development.

Ankit Mathur, Practice Head of Power at GlobalData, said: "There exists a large potential of power generation from geothermal energy in Indonesia, given the country's geographic location in the region with high tectonic activities. Much of the 29 GW+ estimated geothermal resources remain untapped and hence, with more structured policy initiatives and investments, the segment could witness rapid expansion.

"With an appropriate pricing, the interest of the developers would help expand the clean energy base, which in turn would lead the country to achieve a sustainable generation mix in the future."

However, considering the high risk and investment in the development of environmentally-friendly geothermal power plants, Indonesia plans to reimburse exploration costs and incentives for the advancement of geothermal infrastructure.

The government has provided incentives and emoluments, so the cost of renewable energy would likely be affordable for the public while still being economically feasible for the developer. Provisions such as price-competitive auctions, low local content requirement and US dollars indexation to the tariffs may further accelerate the renewable expansion.

UK nuclear plans unclear

■ Wylfa Newydd may be reinstated ■ Bradwell may be scrapped

David Flin

Indecision is hanging over the UK government's plans for nuclear power development, as uncertainty shrouds the future of both the Wylfa Newydd and Bradwell power stations.

Hitachi is currently in "detailed conversations" with the UK government over resurrecting plans for the proposed Wylfa Newydd plant in Anglesey, Wales, hoping to persuade ministers that the plant could be quickly re-mobilised if there is a new financing model for large nuclear power stations in Britain. Hitachi suspended the £20 billion Wylfa Newydd project at the start of 2019 after failing to reach an agreement over financing.

Hitachi has maintained a skeleton staff at Horizon Nuclear Power, a UK-based subsidiary of Hitachi, and continues to seek planning permission for the plant. A decision on the planning application is expected by the end of September. There have been discussions as to whether the government would take majority stakes in nuclear projects, enabling developers such as Horizon to become contractors.

In August, Duncan Hawthorne, Chief Executive at Horizon, said: "Our suspension has not in any way undermined our ability to restart quickly. We are ready to go, but the funding model needs to be in place."

Time is running out for Horizon, which has to submit a business plan to its parent company by December before its funding expires early next year. It wants clarity on the government's nuclear strategy and a potential funding model by the autumn.

On the other side of Britain, at Bradwell-on-Sea in Essex, there is uncertainty in parts of the British government concerning the proposed Chinese project to build a nuclear power station there.

There have been calls from some Conservative MPs to reject plans from the China General Nuclear Power Group (CGN) to build here using Chinese reactor technology.

This has increased fears that CGN would withhold further investment in Hinkley Point C, in which CGN is a joint investor with EDF.

These come at a crucial moment in Britain's nuclear programme. The UK's Committee on Climate Change has said that the country will need 38 per cent of its power from non-weather-dependent sources to achieve net zero carbon emissions by 2050.

Finally, the coronavirus pandemic forced EDF to contract rather than expand the size of its workforce on-site at Hinkley Point C. Productivity at the site is down by at least 20 per cent because of social distancing restrictions. In August, EDF warned that there was a "high risk" that first power generation would be pushed back to 2027.

Next steps towards commercial-scale hydrogen under way

Several European countries are making notable progress in their efforts to increase the production of green hydrogen.

Last month Germany, which has a goal of achieving 5000 MW of electrolysis capacity by 2030, started development of a 30 MW electrolysis plant. This is due for completion in 2025. A 700 MW electrolysis plant, which will follow if this is successful, is to be completed in 2030.

Companies building the 30 MW electrolysis plant, known as Westküste 100, see the project as the next step towards developing commercial-scale units.

The plant at the Heide oil refinery near Hamburg will use electricity from offshore wind turbines to electrolyse water and generate green hydrogen. EDF, Ørsted, and the Heide refinery will construct the plant in a joint venture partnership.

Jürgen Wollschläger, Managing Director of Raffinerie Heide and coordinator of the Westküste 100 project, said: "Our vision and the next milestone is developing an electrolysis plant with a capacity of 700 MW. The Westküste 100 partners will be working together to create this green future."

The Westküste 100 project will link different sectors within an existing regional infrastructure. Part of the generated hydrogen will be transported via a newly-built hydrogen pipeline to Heide's municipal utility for transfer to the natural gas grid. There are plans to supply a hydrogen filling station in a future stage.

All the milestones in the Westküste 100 project form the basis for the next scaling stages. The next stage is to build a 700 MW electrolysis plant, making use of the waste heat and oxygen arising during the electrolysis process. The electricity for the 700 MW electrolysis plant will also be generated by an offshore wind farm.

Alongside this German development, a group of Portuguese energy and industrial companies, along with their European partners, are assessing the feasibility of setting up a 1 GW green hydrogen cluster in Sines, Portugal. The first phase will install a 10 MW pilot electrolysis plant, and the partners say that capacity could grow to 1 GW by the end of the decade, along with 1.5 GW of renewables installed to power the electrolysers.

In Spain, Iberdrola announced in July that it will invest €150 million to construct one of the largest green hydrogen plants for industrial use in Europe. It will consist of a 100 MW solar plant, a lithium-ion battery system with a storage capacity of 20 MWh, and a 20 MW electrolysis hydrogen production system. It is scheduled to become operational in 2021.

The EU is targetting 33 per cent of its installed capacity from renewable sources, with a special emphasis on green hydrogen from offshore wind and solar power. Key EU countries are looking at green hydrogen to boost their renewable drive.

The EU is planning to allocate €3-5 billion towards green hydrogen, likely resulting in the production of one million tonnes per year, and large-scale deployment of solar PV could aid in bringing down the cost. However, some analysts believe the target capacity additions for solar PV set by some EU countries may be over ambitious.

Somik Das, Senior Power Analyst at GlobalData, said: "Countries such as Germany, France, Spain, Italy, and Portugal have shown their intent to use the opportunity provided by the Covid-19 pandemic to shift to renewables, but some have very ambitious targets. Germany will need to add 4.5 GW every year to 2030, and other countries have planned annual additions of around 2.5-2.8 GW. France, Italy, and Portugal may struggle to achieve these."

Das added: "Green hydrogen would enable EU countries such as Germany, France, and the Netherlands to incoporate seasonal energy storage and sector coupling, as well as develop an integrated energy system in the future."

France floats public consultation, as EU offshore wind expands

The growing importance of offshore wind in Europe was recently higlighted with the announcement that France is looking to build 750 MW of floating offshore wind projects off the southern coast of Brittany.

The government announced recently it will open a tender for 250 MW in 2021 with a 200 km² area, while a second tranche of 500 MW with a 400 km² area will be tendered from 2024. Both projects will be off the coast of Lorient.The two projects will be connected to RTE's transmission system.

Elsewhere, the European Investment Bank (EIB) has approved a €500 million financing for Ørsted's 752 MW Borssele 1 and 2 offshore wind project in the Netherlands. Borssele 1 and 2 will comprise 94 Siemens Gamesa 8 MW turbines located 22 km off the coast of Zeeland province. The wind farm is scheduled to be commissioned in October 2020.

In August during a ministerial meeting of the North Sea Energy Cooperation (NSEC), under German chairmanship, the Ministers for Energy and the EU Commissioner for Energy discussed the key role of offshore wind energy in achieving the goals for the expansion of renewable energies and the climate targets Europe agreed until 2050.

Germany's Federal Minister for Economic Affairs and Energy Peter Altmaier said at the meeting: "Joint and hybrid offshore wind projects are expected to play a key role in achieving the energy and climate targets by 2050." The potential European contribution from offshore wind energy by 2050 is more than ten times the current installed capacity of 22 GW. For this, the annual growth rate of the installed capacity of currently 3 GW would have to be increased considerably in the coming years.

UK eyes negative carbon emissions

The UK's electricity system could be negative with regard to carbon emissions by 2033 if carbon capture technology is used alongside renewable energy generation. This is the conclusion of a new report, 'Future Energy Scenarios', from the National Grid, published in late July.

Mark Herring, Head of Strategy at National Grid ESO, said: "This year's 'Future Energy Scenarios' paints an exciting picture of net zero Britain with electricity playing a crucial role in meeting the 2050 emissions targets. Although these are not firm predictions, we've talked to over 600 industry experts to build this insight and it's clear that while net zero is achievable, there are significant changes ahead."

The report says that fundamental changes are needed for energy consumers, particularly in transport, heating, and energy efficiency. The company predicts a revolution in consumer energy use, including a shift to energy efficient heat pumps.

National Grid expects a boom in renewable energy projects, including at least 3 GW of new wind power capacity and 1.4 GW of solar generation every year until 2050, alongside a widespread rollout of electric vehicles, which will effectively act as smart-charging batteries to help balance the electricity grid.

The report stated that without the use of carbon capture and storage, the UK would not meet the target of net zero by 2050.

It said that using carbon capture to trap bioenergy power plant emissions would save 62 million tonnes of CO_2 by 2050, equivalent to about 13 per cent of the UK's total greenhouse gas emissions in 2019.

Policy ambition and falling cost drive offshore wind

Offshore wind capacity will increase to over 234 GW by 2030 despite the slowdown caused by the global Covid-19 pandemic. **David Flin**

Between now and 2030, over 205 GW of new offshore wind capacity will be added globally, as a result of policy ambition, declining technology costs, and international commitments to decarbonisation.

In August, GWEC Market Intelligence predicted that, despite the impacts of the Covid-19 crisis, around 6.6 GW of offshore wind will be installed in 2020. Currently, around 29 GW is installed worldwide, with 6.1 GW of new capacity installed during 2019.

It is also highly likely that offshore wind will be a major contributor to post-Covid economic recovery, said GWEC as several governments are planning major efforts in the offshore market.

Europe is currently the leading region for installations, but the Asia-Pacific region looks set to show a tremendous increase in demand for offshore wind. China will become the global leader in new capacity, with Taiwan, Vietnam, Japan, and South Korea also set to become major markets, accelerating in installed capacity to 2030.

China is expected to have 52 GW of new offshore wind capacity installed by 2030. Taiwan will be the second largest offshore wind market, with a goal of 5.5 GW by 2025, and an additional 10 GW by 2035. Vietnam, Japan, and South Korea are expected to install 5.2 GW, 7.2 GW, and 12 GW of offshore wind capacity, respectively. North America currently has just 30 MW of offshore wind capacity in operation, but installation and deployment will accelerate, with 23 GW forecast to be installed by 2023.

Notably, floating offshore wind will reach full commercialisation by 2030, with at least 6 GW installed globally. Turbine technology will improve in both efficiency and resilience.

Feng Zhao, Strategy Director for GWEC, said: "The industry's outlook has grown more promising as more countries are waking up to the immense potential of offshore wind. Innovations in the sector such as floating offshore wind, larger and more efficient turbines, as well as power-to-X solutions, will continue to open new doors and markets for the sector and place the offshore industry in an increasingly better position to drive the global energy transition. Offshore wind has already proven itself as an affordable, scalable, zero-carbon technology. We are only beginning to unlock the full clean energy potential of offshore wind."

GWEC predicted that the top five markets for offshore wind installations in 2030 would be: China (58.8 GW); UK (40.3 GW); USA (22.6 GW); Germany (20 GW); and the Netherlands (11.4 GW).

Egypt cancelling solar power projects as demand falls

In a surprising move that is likely to have consequences in a post-pandemic recovery, Egypt is cancelling plans for the installation of several solar power projects. It says the cancellations are due to falling power demand resulting from actions taken to reduce the impacts of Covid-19.

In July plans for a 200 MW solar park due to be installed in Egypt's west Nile area were cancelled by the Egyptian Electricity Transmission Company (EETC). It cited falling power demand as the reason for the cancellation. EETC has also cancelled a tender for a 100 MW concentrated solar power (CSP) project in the same region.

EETC said that Egypt has achieved a surplus of capacity in the grid following the completion of a number of thermal and renewable energy projects over the last three years.

Egypt had been planning to develop a mix of solar, CSP and wind power in the west of Nile area, with bids first requested in September 2015. This drive came as a result of political unrest resulting from, among other things, power shortages and outages in 2014.

At present, with demand depressed by Covid-19, the west of Nile region has a generating surplus. However, prior to the pandemic, power demand was rising, with GDP growth consistently above 5 per cent.

Egypt set targets for renewable energy to contribute 20 per cent and 42 per cent of total energy produced by 2022 and 2035, respectively. Achieving these targets will require continual efforts to develop renewable schemes. Significant progress had been made, but this looks to be in danger of stalling.

However, wind projects are still being developed in Egypt. Egypt's New and Renewable Energy Authority (NREA) and a consortium led by Vestas have signed an agreement to develop a 250 MW wind project in the Gulf of Suez, costing $270 million. The wind farm should be operational by August 2023.

Turkey to export solar panels

As demand for solar power rises, Turkey will move from being a net importer of solar panels to a net exporter. The country plans to boost its wind and solar capacity by 10 000 MW each year over the coming decade, as well as becoming a net exporter of solar panels.

The first step in this process was carried out when it opened its first integrated solar panel facility in Ankara's Baskent Organised Industrial Zone on 19 August 2020. The $400 million Solar Technologies Factory was built by Kalyon Holding. The plant will manufacture ingot, wafer, module, and cell units with a capacity of 500 MW per year.

Fatih Dönmez, Turkey's Energy and Natural Resources Minister, said: "Our factory, which came to life with an investment of $400 million, will be the world's only fully-integrated solar panel plant operating under one roof." He added that following the commissioning of the plant, the share of solar energy in electricity production in Turkey will increase by 25 per cent. He emphasized that solar power was going to be an area of major growth, and that Turkey needed to be in the forefront of manufacturing panels.

Battery firms to quadruple output

Global lithium-ion cell manufacturing capacity will quadruple to 1.3 TWh by 2030, with China doubling pipeline capacity during this period.

Accordiing to a recent report from Wood Mackenzie, there are currently 119 battery manufacturing facilities that are operational, under constuction, or announced, with over 50 vendors. It says the growth is being driven by a demand for energy storage to balance out fluctuations in supply from variable renewable supply.

Mitalee Gupta, Senior Analyst with Wood Mackenzie, said: "Manufacturing capacity in Asia Pacific accounts for 80 per cent of global capacity pipeline. The region will remain as the leader of lithium-ion battery production for the next decade. Within Asia-Pacific, China dominates the pipeline capacity and is expected to double its capacity from 345 GWh in 2020 to over 800 GWh by 2030. In addition to local vendors' rapid expansion in China, foreign manufacturers such as LG Chem, Samsung SDI and SK Innovation have also been adding new lines after they became eligible for subsidies from the Chinese government in 2019."

Europe will increase capacity significantly over the next decade, reaching 25 per cent of global pipeline capacity in 2030, up from 7 per cent currently. Asian manufacturers are investing heavily in new plants in Europe: CATL's Erfut Plant, LG Chem's Wroclaw Plant, and Samsung SDI's Goed Plant. In addition, local manufacturers such as Northvolt and ACC have put forward ambitious plans to scale up production in Europe.

No end in sight for load shedding, says Eskom

South Africa will continue to face load shedding problems for the foreseeable future as it struggles to replace and upgrade its aged generation infrastructure. The country has been struggling with rotating blackouts for some years, as debt-laden Eskom deals with years of maintenance neglect at old plant.

At the time of writing, despite a drop in demand due to Covid-19, Eskom had implemented three rounds of load shedding since the Covid-19 outbreak in early March. The latest round was the result of breakdowns at four generating units, combined with a delay to the expected return to service of another unit under maintenance.

Eskom says it implements load shedding as a last resort to prevent the national grid from a total collapse and urged South Africans to help reduce electricity usage. Andre de Ruyter, CEO of Eskom, said that load shedding was likely to continue until September 2021.

To help with the post Covid-19 recovery, Eskom has floated a tender for a battery energy storage system (BESS) with a minimum 80 MW/320 MWh usable capacity at the Skaapvlei substation, near the 100 MW Sere Wind farm. Eligible bidders have seven months (extendible to a maximum of nine months) to submit bids.

Eskom said in a statement: "We have received financing for the project from the World Bank, as well as the African Development Bank and New Development Bank. The Skaapvlei project represents Eskom's first large-scale BESS project."

The plan is seen as part of plans to diversify the country's energy mix in a move away from coal, which is used for about 85 per cent of the country's power generation. Eskom is specifically considering green funding to offset debt and to re-purpose coal plants.

TenneT scaling up to connect offshore wind

- TenneT to invest €4-5 billion annually
- Scaling up for European energy transition

David Flin

TenneT, the transmission system operator in the Netherlands and parts of Germany, recently announced it will scale up its operations to invest €4-5 billion annually to connect renewable energy sources and develop a "borderless European electricity market.

TenneT currently has 14 offshore grid connections in operation, 12 in the German North Sea and two in the Dutch North Sea. The 12th offshore grid connection in Germany, Borwin 3, was completed in the first half of 2020, bringing the total connection capacity in the German North Sea to just over 7 GW, exceeding the German government's sustainability target of 6.5 GW by the end of 2020.

As offshore wind power grows, the investment required to bring the power onshore will also grow. Otto Jager, CFO, said: "We will connect growing amounts of renewable electricity to the grid while facilitating the development of a borderless European electricity market."

TenneT is also investing heavily in innovations to utilise the capacity and flexibility already present in existing electricity grids. In April, TenneT, along with Terna of Italy and Swissgrid of Switzerland, launched Equigy, a new European crowd balancing platform supported by blockchain technology.

This will enable millions of people to actively offer flexible capacity from their electric cars, domestic batteries or solar panels to grid operators to stabilise the electricity system and thus financially benefit from the energy transition.

Manon van Beek, TenneT's CEO, said: "On July 1st, we launched a new organisational structure with a new senior leadership team to support the company's growth and its role in the Netherlands, Germany, and neighbouring countries. New departments will further focus on strategic partnerships, digitalisation, and energy system planning."

Earlier this year TenneT raised €250 million of funding from the European Investment Bank. The financing is for TenneT's Southwest 380 kV west project, which will bring wind energy from the North Sea to the Netherlands.

GE changing strategic direction

In a re-emphasis of its activities, GE will sell its remaining 36.6 per cent stake in the oilfield services business Baker Hughes within three years for approximately $5.9 billion. At the same time, it will increase its activities in the field of decarbonising gas-fired power stations.

The redirection comes as a result of the impact of coronavirus on its aviation and power units, which caused a $2.2 billion quarterly loss. To improve its capital position, in July GE said it will make a public offering of 115 million Baker Hughes Class A shares priced at $21.50 each, and a private sale of $250 million Class B shares. It will continue to divest the remainder of its holding in Baker Hughes over the next three years.

Larry Culp, CEO of GE, said: "This allows us to be patient and disciplined while we divest this non-core piece of the portfolio, and that sets us up clearly to redeploy that capital. We're excited about the enhanced financial flexibility that it will give us."

At the same time, GE's Gas Power business will seek and develop opportunities to reduce carbon emissions from installed gas-fired power stations, seeing this as a major market opportunity. The company recently announced it is working with Uniper to explore, assess, and develop technology options to reduce carbon emissions from Uniper's fleet of gas-fired power stations and storage facilities.

A joint working group of both GE and Uniper representatives will produce a detailed roadmap by early 2021, which will assess potential upgrades and R&D programmes needed, including increasing use of hydrogen in GE's gas turbines and compressors.

Uniper has a gas turbine installed base of over 4 GW across Europe. It said this agreement would enable it to take a major step towards the decarbonisation of its natural gas assets. At the start of 2020, Uniper set itself the strategic goal of climate-neutrality in its European generation business by 2035.

Andreas Schierenbeck, CEO of Uniper, said: "From now on, our investments will focus on further decarbonisation of our gas assets, which could include post-combustion carbon capture, utilisation, and sequestration (CCUS) as well as blue or green hydrogen. Clean hydrogen will, as far as possible, replace the fossil components of the of the gas plants.

"If we also succeed in using our gas storage facilities to a large extent for hydrogen, we will be closer to a solution to the core problem of the European energy transformation: the lack of storage capacity for fluctuating renewable energies on an industrial scale."

Emerson and MHPS to collaborate

Emerson and Mitsubishi Hitachi Power Systems Americas (MHPS) are to collaborate on digital solutions to optimise performance and reliability, enable predictive and AI-driven maintenance strategies, and automate operational decision making.

The companies announced in August that they will build and deploy the next generation of total plant simulation for the Intermountain Power Plant Renewal project. Marco Sanchez, Vice President of Intelligent Solutions at MHPS, said: "This collaboration leverages Emerson's digital twin technology, MHPS' high-fidelity gas turbine and steam turbine models, and advanced analytics. The simulation solution will seamlessly receive data and operate in parallel with the plant's integrated control systems and other platforms to support commissioning and training."

The move is in preparation for a predicted increase in the use of digital solutions to optimise performance and reliability, especially with regard to remote activities, minimising contact time at the turbine. This has been driven by Covid-19, and will continue beyond the pandemic.

The two companies will explore: advanced sensing, thermal, process, and equipment modelling and diagnostics, advanced control; analytics; pattern recognition; remote monitoring; digital twin; automated workflows; and AI-driven predictive maintenance.

Separately, MHPS also announced that, as from September 1, 2020, it will change its name to Mitsubishi Power. This follows the decision by Hitachi to transfer the shares it held in MHPS to Mitsubishi Heavy Industries (MHI) Group.

Rolls-Royce remains cautiously optimistic

With signs of a recovery in some markets, Rolls-Royce says it is cautiously optimistic about the company's outlook despite being severely impacted by the Covid-19 pandemic.

At the end of August first-half financial results show Rolls-Royce's Power Systems division have been significantly impacted by the global Covid-19 pandemic, with adjusted revenue down 11 per cent to £1.25 billion (€1.43 billion). The division remains in the black, having generated £22 million (down 79 per cent) of underlying profit.

At the same time, Power Systems has been continuing to work hard on reinventing itself as a provider of sustainable, integrated total solutions for drive-power and energy needs, and is increasingly developing net-zero-carbon products.

Commenting on the impact of the pandemic, Andreas Schell, CEO of Rolls-Royce Power Systems said: "Despite the unprecedented scenario in which the global economy finds itself due to Covid-19, we have actively managed the economic impact on Power Systems in the first six months of 2020. We identified this problem at an early stage and took a number of countermeasures."

The company said it was cautiously optimistic about the outlook at present, noting that signs of recovery are now emerging in some applications and markets, for example in China.

"State rescue programmes and the easing of Covid restrictions, where feasible, will help bring about recovery. That said, whether and to what extent a recovery will occur also depends on what happens to the infection rate, and how that impacts the economy," said Schell. From today's perspective, Power Systems' end markets are expected to return to pre-Covid levels by the end of 2021.

Last month Rolls-Royce Power Systems and Shanghai Cooltech Power formed a 50/50 joint venture, MTU Cooltech Power Systems to produce backup generator sets powered by MTU Series 1600, 2000, and 4000 engines. Production will start in Shanghai by the end of 2020, with the purpose of establishing a stronger position in the backup power supply market, with a focus on data centres. The joint venture will start operating later this year.

Good post Covid-19 prospects for wind power giants

Wind power giants Nordex and Vestas are looking to a post-pandemic environment, positioning themselves to take advantage of the post-pandemic growth. Both have reported strong financial performance, despite the economic downturn.

In August, although posting a Q2 loss of €5 million, Vestas reported revenues for Q2 2020 are up 67 per cent on the comparable figure for Q2 2019. It took in firm and unconditional wind turbine orders amounting to 4148 MW, an increase of around 10 per cent on the comparable period last year. It is predicting a massive boom in work once the pandemic is over. The value of the wind turbine order backlog was €16.2 billion as at 30 June 2020.

Vestas says it is confident in its ability to ensure business continuity during the pandemic, and has very healthy prospects looking beyond this.

Meanwhile, the Nordex Group said its first-half sales doubled year-on-year to €2 billion, despite the pandemic. In the projects segment (excluding service), the group ended the first-half of 2020 with an order intake of 2531.9 MW valued at €1805.9 million.

Nordex also announced it will sell a 2.7 GW development pipeline of energy projects to RWE Renewables for $470 million. This will predominantly consist of its European onshore wind projects across France, Spain, Sweden, and Poland.

Completion of the proposed deal is subject to foreign investment approval in France as well as a French employee consultation process. The purchase price is approximately €402.5 million.

José Luis Blanco, CEO of Nordex Group, said: "Significant proceeds from this transaction will strengthen our balance sheet as we continue to build on our strong order book and capture market opportunities with our Delta 4000 product portfolio."

Americas

Elecnor to build 185 MW wind farm in Chile

Spanish renewable energy company Elecnor has won a contract to build a 185 MW wind farm in Chile. Located 50 km from Antofagasta, the Cerro Tigre wind farm will consist of 44 wind turbines each with a capacity of 4.2 MW and a height of 72 m.

Elecnor will also build a booster substation, 20 km of 220 kV transmission line, and the rest of the associated infrastructure. Work is expected to be completed by the end of 2021.

The company has also been contracted to expand the existing booster substation by building a 12 km long 220 kV transmission line.

Key Capture orders 200 MW of batteries

US battery supplier Powin Energy Corporation and Mitsubishi Hitachi Power Systems Americas (MHPS) will build 200 MW of utility-scale battery energy storage systems (BESS) for three projects in Texas, USA, for Key Capture Energy (KCE).

Powin will deliver a fully integrated battery along with a battery management system and long-term service for each of the three projects, including one of 100 MW and two 50 MW installations. MHPS will provide turnkey EPC plus long-term service support for all DC equipment, power conversion systems, and high voltage substations.

Construction work is due to be completed before summer 2021.

Asia-Pacific

GE supports 500 MW pumped hydro project

GE Renewable Energy has said it will help speed up development of a 500 MW pumped hydro storage project in the Australian state of New South Wales. The project is part of a larger 4 GW renewables complex.

The Walcha Energy project will combine solar and wind power generation with pumped hydro and battery storage to produce enough power to meet up to 15 per cent of NSW's electricity needs. GE Renewable Energy will provide technical and commercial support for the development of the Dungowan Pumped Hydro Storage Power Plant project under an agreement with Walcha Energy.

The Dungowan plant will provide firming and grid support services, making it easier for the state to add more renewables capacity.

Simon Currie, Managing Director at Energy Estate, said the facility is strategically located between coal plants about to retire to the south and emerging wind and solar capacity to the east, west, and north.

Turbine deals for Vestas in China and Vietnam

Vestas Wind Systems has won contracts to deliver turbines for a 50 MW wind farm in Vietnam, and an unspecified 150 MW project in China.

The Vietnamese order was placed by Phuong Anh Group and covers the second phase of the Hoa Binh 1 wind farm project. Vestas will supply and oversee installation of 13 V150-4.2 MW turbines. Ten units will be delivered in 3.8 MW mode and three in a 4 MW operating mode. A 20-year Active Output Management 5000 (AOM 5000) service agreement is also included. The machines will be erected in shallow waters close to the shore along the Mekong Delta. Turbine installation is scheduled to be completed in Q3 2021. The project is located in Hoa Binh district, Bac Lieu province.

The Chinese order includes 53 V120-2.2 MW machines in 2.4 MW power optimised mode and seven V155-3.3 MW turbines. The name of the customer and project has not been revealed at the request of the customer.

The contract includes a five-year service agreement.

Deliveries are due to start in Q3 2021, with the wind farm brought online shortly after.

MingYang wins 500 MW offshore wind farm order

MingYang Smart Energy has won a wind turbine order for the 500 MW Yangjiang Qingzhou III offshore wind farm in China. The project, developed by China Huadian Corporation, will feature 37 MySE6.8-158 turbines and 30 MySE8.3-180 turbines.

It will also comprise one 220 kV offshore substation, from which the power generated by the wind turbines will be transferred to land.

The project will be located off the coast of Yangjiang City.

Meghnaghat CCGT to get an upgrade

GE will install its Advanced Gas Path technology upgrade on the two GE 9F.03 gas turbines powering Reliance Bangladesh LNG & Power's upcoming 718 MW gas-fired power plant in Meghnaghat, Bangladesh.

The combined cycle power plant is scheduled to start operation in 2022.

Reliance Bangladesh LNG & Power is a joint venture between India's Reliance Power and Japan's JERA. The plant is being built by Samsung C&T, and will be powered by two GE 9F gas turbines, one GE D11 steam turbine, and three H53 generators.

GE's contract with Samsung C&T includes GE's AGP upgrade for two GE 9F.03 gas turbines, steam turbine refurbishment, along with control upgrade and parts supply.

Once implemented, the upgrade solution will help deliver up to 6.7 percentage points increase in power output, up to 3.3 per cent improvement in heat rate, up to 2 per cent increase in efficiency, enhanced operational flexibility, and extend the maintenance interval up to 32 000 hours.

Siemens to build 473 MW Indian wind project

Siemens Gamesa has won an order from Adani Green Energy for one of the largest wind power projects in India. The company will deliver 215 SG 2.2-122 wind turbines, totalling 473 MW. Siemens Gamesa will manufacture, supply, install, and pre-commission the wind turbines for the project in Fategarh, Rajasthan, India. The project is scheduled to be commissioned by September 2021.

Navin Dewaji, India CEO, Siemens Gamesa, said: "We are happy to announce this new deal with Adani Green Energy, and we thank them for placing their confidence in our capabilities. Growing partnerships with leading IPPs like Adani encourage us to enhance our efforts in developing innovative technologies to deliver more value for our customers."

Europe

HVDC connection for NorthSea wind farm

Siemens Energy will supply the HVDC power transmission technology for an offshore connection in the German North Sea. A contract was signed by the German-Dutch network operator TenneT and the BorWin5 Offshore Consortium, consisting of Siemens Energy and Dragados Offshore.

The project scope includes the turnkey construction and installation of the offshore platform in the North Sea and the converter station on land. The offshore converter station will convert the three-phase AC produced by the wind turbines into ±320 kV DC for low-loss transmission to land. The shoreside converter station in Garrel/Ost will convert the electricity back into 3-phase AC to feed into Germany's power grid.

Siemens Energy will supply the HVDC technology and build the shoreside station, while Dragados will be responsible for the design, procurement, construction, and installation of the offshore converter platform.

The capacity of the transmission link will be 900 MW. Transmission from the project is due to start in 2025.

Hitachi ABB Power Grids to link Shetland and UK

Hitachi ABB Power Grids has won an order from Scottish and Southern Electricity Networks (SSEN) Transmission to enable Europe's first multi-terminal HVDC interconnection. The link will connect the Shetland Islands to the UK transmission system for the first time, and will enhance security of power supply and help transmit wind power generated on the islands.

Hitachi ABB Power Grids will deliver and commission an HVDC system facilitating a multi-terminal link, providing flexibility to transfer power in multiple directions with minimal power losses.

The HVDC system will transmit DC power via underground and subsea cables to an HVDC switching station at Caithness in the north of Scotland. It will then be transferred via the already installed Caithness Moray HVDC link, before being converted back to AC for onward transmission, forming a three terminal DC system.

The project is scheduled for completion in 2024.

In a seperate deal SSE Renewables, the owner and developer of the Shetland-based Viking Wind Farm, named Vestas as supplier of the turbines for the project. The deal means Viking will be Vestas' largest stand-alone onshore wind farm order in Europe to date.

CrossWind secures Hollandse Kust contract

The CrossWind consortium, a joint venture of Shell and the Dutch energy supplier Eneco, has won a contract to build a 759 MW subsidy-free offshore wind farm Hollandse Kust (noord) in the Netherlands. The wind farm is 18.5 km off the coast of the Netherlands, near the town of Egmond aan Zee, and is scheduled to be operational by 2023. Once operational, the wind facility will generate 3.3 TWh of energy annually.

Both Shell and Eneco have taken final investment decisions on the project.

Maarten Wetselaar, Integrated Gas and New Energies Director for Shell, said: "It will be an important step in our ambition to become a net-zero emissions energy business by 2050 or sooner. This wind farm is a crucial part of a new value chain – from wind to hydrogen – with our ambition to build a green hydrogen plant in rotterdam and with NortH2."

Marine installations company Van Oord confirmed it will construct and install the turbine foundations and cables.

In May this year, Eneco and Shell Nederland partnered to bid for the 700MW tender for the Hollandse Kust Noord offshore wind farm.

Statkraft and GE to stabilise UK grid

Statkraft UK will install GE's Rotating Stabliser technology at its stability project at Keith in the northeast of Scotland. GE Power Conversion will manufacture and install two Rotating Stabiliser synchronous machine's at the Statkraft site.

Statkraft had been awarded four stability contracts (two at Keith, two at Lister Drive) by National Grid ESO earlier this year.

This project will provide stability services to the grid, including inertia, short circuit level, and frequency response. GE's Rotating Stabiliser provides a way of replacing the stability services provided by traditional thermal plant generation, but without CO_2 emissions. As a result, fossil fuel-powered generation does not need to run, allowing more renewable generation to operate.

Doosan to build Polish waste-to-energy plant

South Korea's Doosan Heavy Industries & Construction has won a $185 million waste-to-energy project in Poland. It will build the plant in consortium with its German subsidiary Doosan Lentjes.

The plant will be located in Olsztyn, 200 km away from Warsaw. It will provide 12 MW of electricity and heat for the region from 300 tons of waste. Construction of the plant is scheduled for completion by 2023.

Doosan Heavy I&C expects the contract will help pave the way for additional waste-to-energy orders in Europe.

International

JinkoSolar signs 1 GW solar farm contract

JinkoSolar Holding has signed a contract with Shanghai Electric to provide nearly 1 GW of solar modules for a solar facility in Dubai, UAE.

The modules will be used for Phase V of the Dubai Electricity and Water Authority's Mohammed bin Rashid Al Maktoum solar complex. JinkoSolar will supply its Swan series modules for the project. Shanghai Electric won the EPC services contract for the project.

JinkoSolar and Shanghai Electric have reached a strategic partnership agreement to cooperate in the development, bidding, investment, and construction of overseas solar projects.

EPC contract awarded for huge solar complex

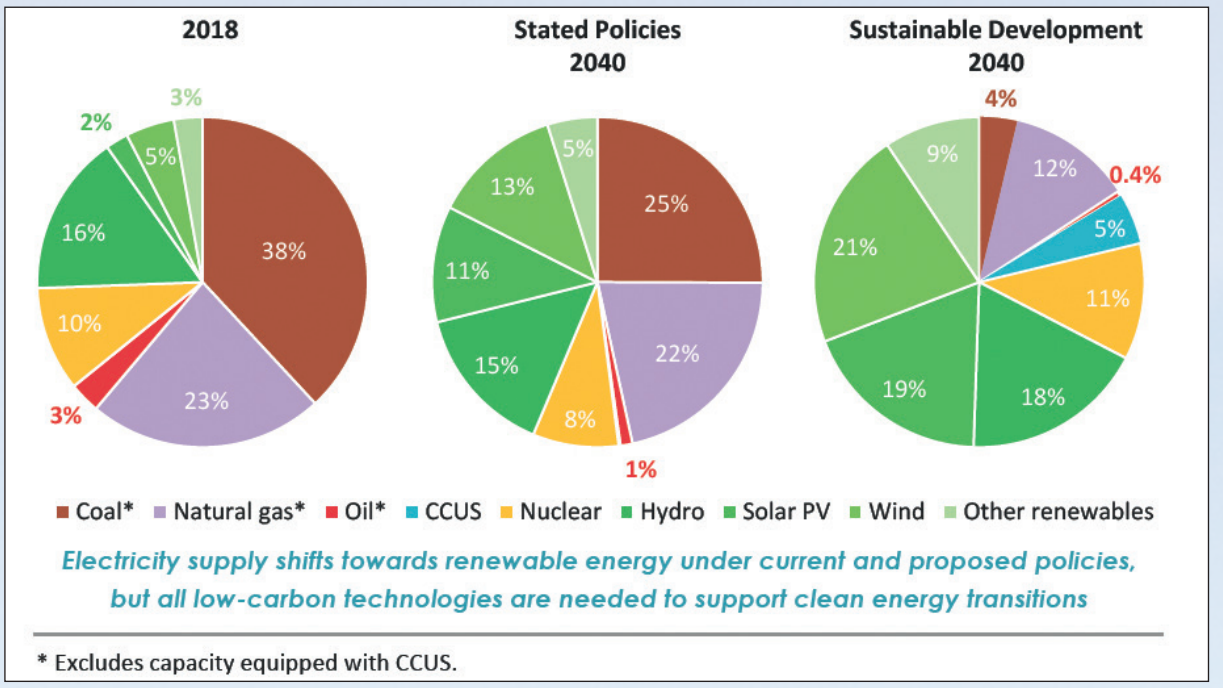
ACWA Power has selected Shanghai Electric as the EPC contractor for the fifth phase of the 5 GW Mohammed bin Rashid Al Maktoum solar complex in Dubai.

The contract for the 900 MW solar facility was won by ACWA Power and Gulf Investment Corporation (GIC) in a tender held by the Dubai Electricity and Water Authority (DEWA).

The $560 million solar plant will be built in three stages. The fifth phase is 40 per cent owned by the ACWA-GIC consortium, while DEWA holds the remaining stake.

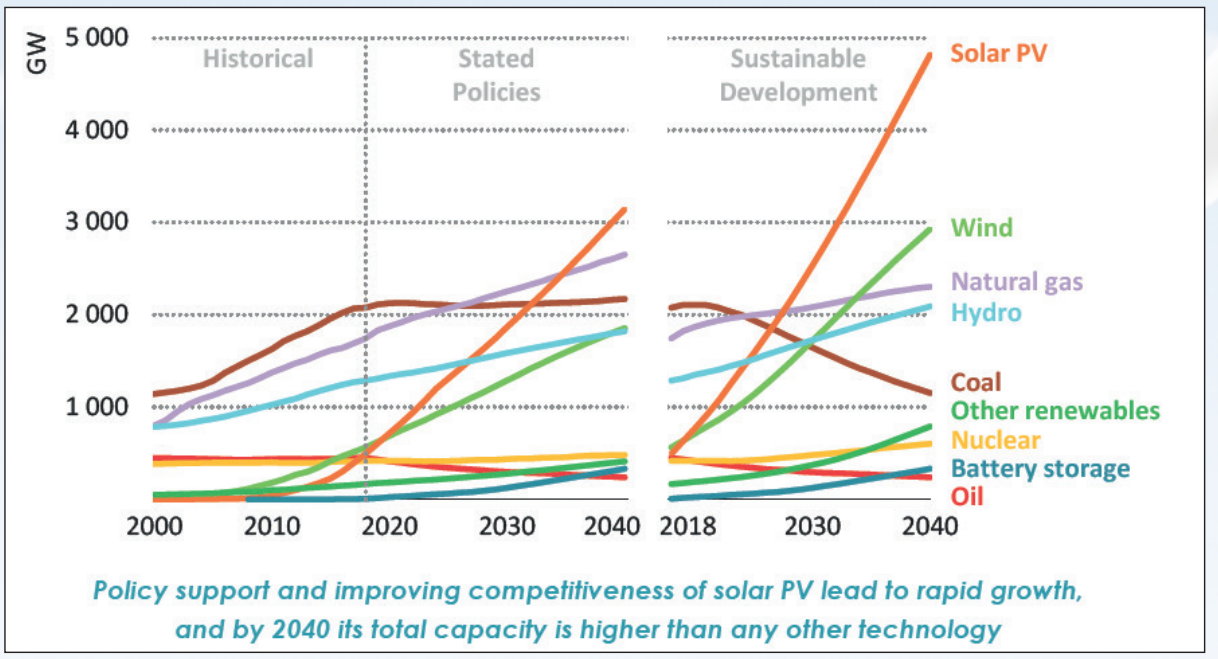
DEWA will buy power from the facility at $16.95/MWh for 25 years.

Global electricity generation mix by scenario



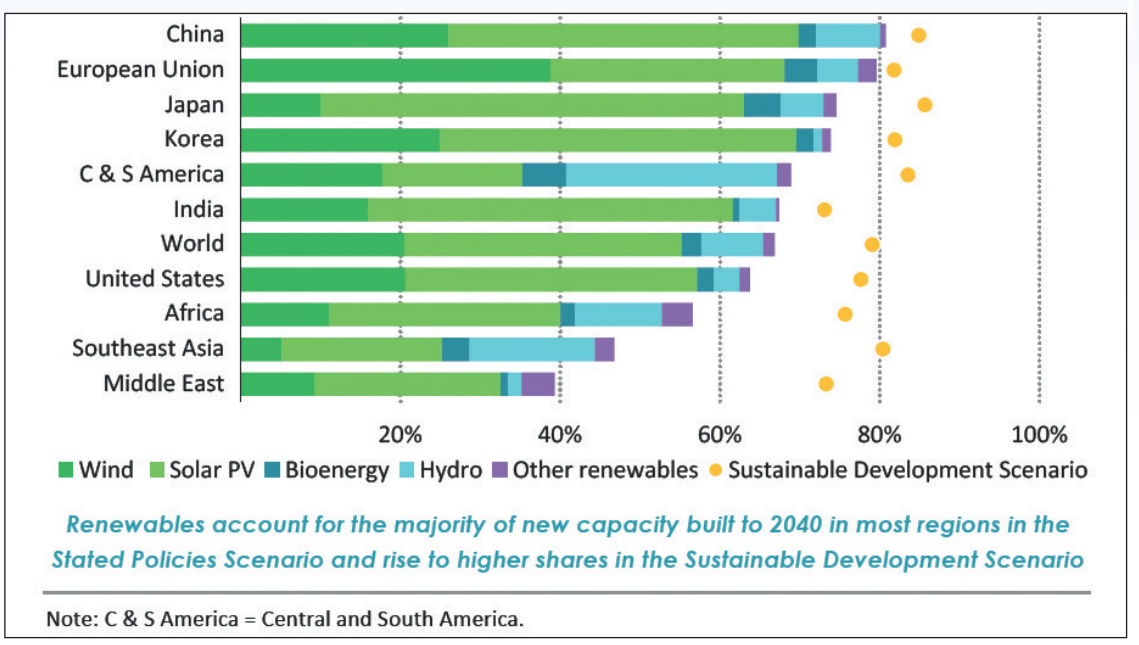
World Energy Outlook 2019, © IEA/OECD, Figure 6.4 , page 265

Global power generation capacity by source and scenario



World Energy Outlook 2019, © IEA/OECD, Figure 6.5 , page 266

Renewables share in capacity additions by region in the Stated Policies and Sustainable Development scenarios, 2019-2040



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Hydrogen

Hydrogen gains momentum as Europe makes serious plans for implementation

For hydrogen to contribute to climate neutrality, it needs to achieve a far larger scale and its production must become fully decarbonised but the list of planned global investment in projects is growing on a weekly basis.

Gary Lakes

There are plenty of skeptics and hydrocarbon industry diehards, but hydrogen is a hot word in energy circles as the world plans an economic rebound from the consequences of Covid-19.

Over the course of 2020, the focus of concern has not only been about improving the health of the human population, but improving the health of Planet Earth as well, and this has brought much discussion on the pluses of moving away from carbon and implementing a hydrogen economy.

The energy transition as currently planned may not happen as quickly as many would like, but the European Commission in July adopted a hydrogen strategy for a carbon neutral Europe by 2050. Hydrogen is the most abundant element in the universe and once harnessed and produced in large quantities, it will be applied to transport, industry, power generation and other sectors of human activity.

In the paper outlining its hydrogen programme, the EC noted that only small amounts of hydrogen are currently produced, and that is made by using coal and natural gas as feedstock for the electricity needed for the electrolysis process, which according to the EC, results in the production of 70-100 tons of CO_2 emissions annually.

"For hydrogen to contribute to climate neutrality, it needs to achieve a far larger scale and its production must become fully decarbonised," the EC paper states, and it pointed out that the list of planned global investment in hydrogen production projects is growing on a weekly basis and the number of companies joining the International Hydrogen Council is steadily increasing.

The European Union is expected to invest between €180 billion to €470 billion in hydrogen by 2050.

This summer Germany announced a €9 billion investment in a National Hydrogen Strategy and the UK launched the Hydrogen TaskForce. Meanwhile, Russia is also looking at investment in hydrogen to meet future European market demand.

Germany plans to have 5 GW of hydrogen production capacity by 2030 and another 5 GW added to this by 2040. The programme is part of a €130 billion stimulus designed to contribute to economic recovery from the coronavirus pandemic. The investment in hydrogen production is part of €40 billion marked for climate-related spending and could result in providing hydrogen to produce 10 per cent of Germany's total electricity capacity.

The technical methods of producing hydrogen are colour-coded: brown and grey hydrogen come from hydrogen that is produced by coal and natural gas. These produce about 95 per cent of the world's hydrogen. Blue hydrogen is produced from natural gas, using carbon capture and storage (CCS) to capture and store the CO_2. Green hydrogen is produced by renewable energy sources and emits no carbon during production. The process separates hydrogen from water using electrolysis and ultimately is the stage that the world wants to reach.

Germany is looking to accelerate green hydrogen production but the technology requires a huge ramp-up in wind and solar energy output. Once renewable energy production is solidly established and widespread, green hydrogen will be available for power stations, heavy industry and to replace fossil fuels for home heating and transportation.

The UK's Hydrogen Taskforce anticipates the release of a government hydrogen strategy in 2021 in which the production target for 2035 will be 125.3 TWh, 80 per cent of which will be blue hydrogen and 20 per cent green. The Taskforce further argues that moving to hydrogen will not only reduce carbon emissions but also boost the economy through the creation of new jobs. It projects that by 2035 the UK's hydrogen economy will be worth £18 billion and create 75 000 jobs. Furthermore, it states that much of the infrastructure currently used in the natural gas industry can be adapted to transport hydrogen and that many jobs within the oil and gas industry can easily fit into hydrogen operations.

Russia's Ministry of Energy announced in July that it will produce 'clean' hydrogen in 2024 by using nuclear energy in a partnership between gas company Gazprom and nuclear energy firm Rosatom. Gazprom has forecast that the EU hydrogen market will be worth €153 billion by 2050 and wants to participate in supplying the new fuel. The company has suggested that it will be able to supply a gas mixture containing 70 per cent hydrogen to Germany using the yet to be completed Nord Stream 2 pipeline.

Russian sources report that the country wants to be capable of supplying 15 per cent of global hydrogen production by 2035 by using its huge hydrocarbon resources as a bridging technology for hydrogen production.

Gas

Turkey discovers gas in Black Sea but challenges remain

The huge natural gas discovery at the Tuna-1 well could have a massive impact for the Turkish economy but the investment that will be needed, combined with political tension in the region, means it could be some time before it reaps the potential rewards.

Gary Lakes

The Republic of Turkey on August 21 announced the discovery of a natural gas resource in the Black Sea and estimated its size at around 320 billion cubic metres (around 12 trillion cubic feet). The discovery, located near the exclusive economic zones (EEZs) of Bulgaria and Romania, is significant for Turkey, which until now has had no sizeable oil or gas discoveries in its territory.

The discovery at the Tuna-1 well, if developed, could have an important impact for the Turkish economy, which relies on energy imports. Turkey uses 45-50 bcm annually of natural gas, virtually all of which is imported from Russia, Iran and Azerbaijan. The country imports LNG from Algeria and Nigeria, and with the price of LNG currently low on the global market, it has been importing LNG from the spot market through four Floating Storage Regasification Units (FSRUs) installed at various locations along its coast. Gas imports last year cost Turkey some $40 billion.

Turkish President Recep Tayyip Erdogan announced the gas discovery on Turkish TV signifying the importance of the discovery to Turkey, and validating his efforts to push Turkish Petroleum (TPAO) to discover anything, anywhere.

Erdogan's policy of encroaching on the internationally recognised territory of littoral countries in the East Mediterranean has seriously ratcheted up tensions with Greece, Cyprus, Egypt and even Israel.

Turkey's claim to a continental shelf in the East Mediterranean and a 'Blue Homeland' that includes half of the Aegean Sea and vast expanses of the Mediterranean as far as the coastlines of the Greek islands of Rhodes and Crete, and to the edge of Libyan territorial waters has led to diplomatic alarm within the European Union and with France in particular.

Turkey has long claimed most of the Cypriot EEZ and frequently interfered with exploration efforts there by France's Total and Italy's Eni. Turkish drillships, including the Fatih, which made the Tuna-1 discovery, drilled several wells in the Cypriot EEZ over the last year and currently the Yavuz drillship and a seismic vessel are in the area.

Turkey stated recently that it will send its third drillship into the East Mediterranean soon, but has not said where. If the ship should enter Greek territory, then tensions are expected to reach a tipping point. The EU has already warned Ankara to remove its ships from Greek and Cypriot waters, but Turkey has chosen to ignore the warning.

Gloating over the gas discovery, which has been renamed 'Sakarya', Erdogan said that Turkey hoped to bring the resources into development by 2023, the centennial of the founding of the Turkish Republic. Erdogan called it an "historic day" saying: "Turkey has made its biggest natural gas discovery," adding that it gives Turkey a "new era."

Certainly, once the gas is flowing it will contribute significantly to Turkey's energy security, but it will not solve all the country's problems.

Some in Turkey have already fallen into the gas dreams scenario that a new discovery often conjured up. Turkish Finance Minister Berat Albayrak, Erdogan's son-in-law, called it a financial game changer. "It will remove the current account deficit," he said. "We will be soon talking about current account surpluses."

Bringing the field on-stream will require many more appraisal and development wells and billions of dollars in investment. Also, the deep-water environment will pose challenges of its own. It is unclear if TPAO actually has the expertise to bring a project like this into operation, since it has not done this before, and will likely require a partner. Considering the fact that a huge market for the gas is already there in Turkey, a partner or two might not be hard to find.

But with gas prices so low amid global oversupply, it may be some time before developing the field would be worth the investment. Some analysts have said that it could take seven to 10 years to develop the field. In the region, only two reservoirs have been fast-tracked: the Tamar field offshore Israel and the giant Zohr field offshore Egypt. In both cases it was because the countries were in dire need of gas supplies.

One thing is certain, Turkey will continue its neo-Ottoman approach to gas exploration in the East Mediterranean, where most exploration – with the exception of Turkey – has stopped due to the coronavirus pandemic.

However, Total and Eni, which in partnership hold seven licenses in the Cyprus EEZ, are due to resume drilling some time in 2021. So too will ExxonMobil, which holds the license to Cyprus Block 12, where in January 2019 it announced the Glaucos-1 discovery. Chevron Corp in July purchased Noble Energy, which includes Israel's 22 tcf Leviathan field and Cyprus's 4.5 tcf Aphrodite field.

Those companies cannot be expected to be held at bay by Turkey forever.

Meeting the challenge of integrating renewables

With the increasingly urgent drive to decarbonise the power system, renewable energy will play an ever expanding role. However, we need to ensure that the renewables integration is as environmentally-friendly and efficient as possible in order to fulfil our vision of ensuring affordable and clean energy, sustainable living and a world fit for all our next generations. **Andreas Berthou**

As more renewable power sources join to gradually replace carbon-based energy, we need to ensure our grids remain resilient and become more flexible as they adapt to fast-changing demands and increasing decentralisation. While the growth of renewable energy must be celebrated, there's no denying it will add to the challenges of managing what is mostly a legacy grid and will therefore require some changes in how power is transmitted and distributed in the future.

The challenges faced by grid operators vary depending on if the renewable power enters the grid at the distribution or the transmission level. The big offshore wind farms are usually integrated at the transmission level with a single point connection, meaning there is less redundancy in the setup with potentially a long connection line in between load centres. Onshore wind farms are in the range of hundreds of megawatts so they can connect in the distribution grid where the controllability is not ensured; it is a stochastic fluctuation of the loads that makes ensuring stability a challenge.

The interconnected continental system is well matched during regular operations. When you have a weakened operation because of line outages or splits of the system, it can potentially be a big challenge and with increased renewables will be almost unmanageable in the future.

With the digital transformation having a positive impact on the power sector, as it is throughout the rest of the industrial world, there are numerous technology solutions available. These include high voltage direct current (HVDC), thyristor-controlled series compensation (TCSC), phase-shifting transformers (PST), distributed series compensation and even unified power flow controllers (UPFC); with the best solution being dependent on each particular challenge.

The PST is well established in the continental system, particularly around the Benelux regions where they need to cope with the high power flows from north to south. They are inexpensive compared to other options, but they are only suitable for steady-state control. If you go more into dynamic response of the grid where you require a response in under a second, then they are not sufficient. In those instances, you need series compensation of lines with TCSC or UPFC; however, market acceptance of the latter solution is not high. When it comes to UPFC, there is no market for this kind of innovation in the European system, so you will not find it installed anywhere.

At the same time, TCSC is not the answer when it comes to managing an increased load of renewable energy to the grid. Instead, it is a method of optimising what is already available, with lower gains. For the coming years, we need to build up capacity in the grid.

The HVDC option, pioneered by Hitachi ABB Power Grids, is more attractive because it allows you to introduce new lines that are more controllable and will increase the transfer capacity. It is also the most environmentally-friendly technology as it can provide more power per square metre over greater distances with lower losses, meaning that more power reaches the consumer more efficiently. Another significant advantage is that you can modulate the active power transmitted.

What we see as a big market for HVDC is the integration of offshore wind, a role that it is already filling. The next step will be to combine interconnections and offshore wind connections with building up connecting networks such as the UK to the Continental system or Scandinavia. This will be the next growth area for HVDC as hybrid interconnectors or multi-purpose systems.

The biggest drawback for HVDC lines, as is also true for AC lines, particularly onshore, is the lengthy planning processes with the associated environmental concerns and public opposition involved in getting new lines constructed. This can sometimes be mitigated by clever routing. For example, the connection between Italy and France runs in parallel with a motorway. However, the distances involved there are short compared to the north-south corridor required in Germany. The systems and procedures for planning are there in Europe in its Ten Year Network Development Plan, but it takes a long time to build up this new infrastructure. When you work within an existing substation, you do not have all these issues, but when you want to touch a line or build up a new line, it can be a lengthy process.

Theoretically, you can transform an existing overhead line for use with HVDC; there is one reference case within Europe which is now in execution. The problem, however, is the reason to do this is to increase capacity on a line that is fully loaded but to carry out this work you have to cease operation for some time. The challenge is how to schedule that within the operational constraints that you may have.

There was a push in 2016 with a so-called network code for HVDC from the European Commission. The Network Code on HVDC specifies requirements for long-distance direct current (DC) connections. The idea behind that network code was to harmonise their requirements for HVDC systems, no matter what country they are connecting, promoting interconnections. Unfortunately, what we could see afterwards was that during national implementation these codes diverged again. This is increasing the risk for the technology moving ahead with multi-terminal systems or even HVDC for offshore wind connection. Grid codes must be developed soon to close this gap.

A good example of the benefits of HVDC is in the Baltic Sea. The 600 MW Danish Kriegers Flak offshore wind farm, which comes online in 2022, will consist of two parts: the western Kriegers Flak A (KFA) with a total capacity of 200 MW and the eastern Kriegers Flak B (KFB) with a total capacity of 400 MW.

The Kriegers Flak combined grid solution project will connect the Danish region of Zealand with the German state of Mecklenburg-Western Pomerania via two offshore windfarms – German Baltic 2 and Danish Kriegers Flak. It is an innovation in the context of the energy transition, as it is the world's first project combining grid connections to offshore wind farms with an interconnector between two countries.

The interconnector will allow electricity to be traded in both directions – from Denmark to Germany and from Germany to Denmark. Energinet is currently building the grid connection of the future Kriegers Flak offshore wind farm (600 MW). The Kriegers Flak (Denmark) and Baltic 2 (Germany) wind farms are less than 30 km apart, and both wind farms are linked through two sea cables with a transmission capacity of 400 MW, forming the interconnector.

The frequencies of the Danish and German transmission systems use a slightly different phase, which means they need to be matched at the interface. This will be enabled by two serially connected voltage source converters (VSC). One converter transforms the alternating current (AC) from the Nordic interconnected system to direct current (DC). The other converter transforms this direct current back to alternating current – only now adapted to the Continental Europe Synchronous Area. This so-called back-to-back converter will be installed in Bentwisch, near Rostock in Germany.

With the provision of reactive power, you can also make sure that you have voltage support at the point of connections. However, this is a bit limited because the further away you get from the node the HVDC converter is connected, the less effective such reactive support is. Overall, we believe that the setup in the future for maximum renewables integration is going to be a combination of HVDC, TCSC for optimised line loading, Static Synchronous Compensators (Statcoms) for voltage control, and PSTs for steady state optimisation of power flows.

In terms of the next challenges, it is about managing the longer power flows. The market will become more volatile with more renewables, which is where HVDC came into its own from the beginning. HVDC plays a crucial role in the transition to a stronger, smarter and greener grid powered by renewable energy sources, which typically require long distance transmission. It is particularly effective, for example, for bringing wind power from remote offshore wind farms to mainland grids. With WindEurope estimating that Europe's offshore wind capacity will reach 450 GW by 2050, HVDC technology will be instrumental in efforts to keep the extent of global warming below 1.5°C.

Andreas Berthou is Global Head of HVDC of Grid Integration business, Hitachi ABB Power Grids.

Berthou: The challenges faced by grid operators vary depending on if the renewable power enters the grid at the distribution or the transmission level

Green ammonia: the answer to a carbon free future?

Power-to-X city: synthesising a carbon-free fuel using renewable energy. *© Siemens Energy*

Siemens Energy Green Ammonia demonstrator plant at the Rutherford Appleton Laboratory, Oxfordshire, UK. *Image courtesy of the Science Technology Facilities Council*

Green ammonia offers the prospect of reducing carbon emissions, not just in electrical power generation but also other sectors such as transport and industry.
Steve Scrimshaw

The coronavirus pandemic has been a hard time for everyone across the globe, and as things begin to return to a new state of 'normal', there are some lessons we should take from our time in lockdown. Because of the restricted movement, shutting down of buildings and remote working policies forcing most of us to stay within the confinements of our own homes, our carbon emissions have rapidly depleted. In fact, the UK reached the milestone of not having used coal-powered electricity for two whole months for the first time in 140 years during the lockdown.

Statistics already suggest that as restrictions are easing, and the population is beginning to get back to normality, carbon emissions are rising once again. Although it's been reported that they're 5 per cent lower than they were during the same time in 2019, the rapid return of such high levels of carbon emissions is extremely worrying. If the government is to reach its target of zero carbon emissions in the next 30 years, there is still some way to go.

While the move away from coal represents good progress in reducing carbon emissions from the power sector, renewable sources still only account for around 20 per cent of our electricity generation. And similar progress in other energy-intensive sectors such as industry, transport and heat remain, as yet, elusive. This brings about the questions of what exactly our future energy systems look like? How will we continue to provide easy access to affordable energy, and avoid the causes of climate change? This is where green ammonia comes in, offering a low cost, carbon free solution to help battle the global fight against climate change.

Scrimshaw: the technology required to begin to implement and use green ammonia already exists

Some of the most popular and well-known renewable power sources offer carbon-free energy, but the problem is their intermittency. We can't control when the sun shines, or when the wind blows – yet we want (and are used to) the freedom to choose when we use this energy.

Recent analysis from the Department for Business, Energy and Industrial Strategy shows that in 2019, 37 per cent of the UK's electricity generation came from renewable sources such as wind turbines and solar, four percentage points higher than 2018. However, this is still not enough to reach net zero using renewables alone, so a reliable storage technique is needed.

Energy storage is often presented as the solution to this intermittency problem, but the challenge is to store energy in sufficient quantities – and at low enough costs – to meet our needs which are growing all the time. Energy is, of course, already stored in vast quantities today – it is just that the energy stores we are used to come in the form of fossil fuels such as oil (and its derivatives) and natural gas. These chemical energy vectors are ubiquitous for a reason – carbon-based fuels are stable, energy dense, and are easy to store and transport.

The issue lies with the CO_2 emitted when we burn them. So, what if there was an alternative? What if we could synthesise a carbon-free fuel using renewable energy, which could be used to store and transport that energy in bulk, without the carbon emissions associated with its fossil-based counterparts?

Ammonia (NH_3) is a promising candidate for just such a carbon-free, synthetic fuel. An ammonia molecule is made up of one nitrogen atom and three hydrogen atoms – in some ways similar to natural gas (methane, CH_4) which has one carbon atom plus four hydrogen atoms – and can be synthesised from abundant raw materials, namely air and water.

Nitrogen comprises 78 per cent of the atmosphere, and may be readily separated out from air; water may be split back into its constituent elements via an electrochemical process called electrolysis.

Once the hydrogen and nitrogen are produced, they can be combined in a reaction called the Haber-Bosch process to produce ammonia. If renewable energy is used to power these processes, then that energy becomes locked up in the ammonia molecule, without any direct carbon emissions.

The final step, energy release from this "green ammonia", can be achieved by cracking the ammonia back into nitrogen and hydrogen, and then using the hydrogen in a fuel cell – such as in a fuel cell electric vehicle. Another way is to use it in combustion – in exactly the same way as we burn carbon-based fuels today – such as in a gas turbine, for example.

In this way, green ammonia offers the enticing prospect of reducing carbon emissions not just in electrical power generation, which has so often been the limit of our current best efforts to decarbonise, but also other sectors such as transport and industry.

By switching to renewable electricity to make ammonia, it's possible that we could save more than 40 million tonnes of CO_2 each year in Europe alone, or over 360 million tonnes worldwide. With the government's continued commitments to meet net zero emissions targets by 2050 and the recent announcement that they are set to invest a further £350 million to fuel green recovery, new carbon free fuels such as green ammonia and green hydrogen will be needed to decarbonise energy generation, heat and transport and industry.

The latest government announcement, and the clarification that £139 million of that budget will be spent on cutting emissions in heavy industry by supporting the transition from natural gas to clean hydrogen power is definitely a step in the right direction. But the pace of change is still slow for a solution that is readily available.

Siemens has shown this process is possible at the Rutherford Appleton Laboratory in Oxfordshire, where, with the Science and Technologies Facilities Council, the University of Oxford and Cardiff University, it developed the world's first Green Ammonia Demonstrator.

The beauty of this is that the technology required to begin to implement and use green ammonia already exists. Industrial air separation processes to produce nitrogen are routine; water electrolysis was performed on an industrial basis before steam methane reforming became a cheaper source of hydrogen.

Fritz Haber won his Nobel Prize "for the synthesis of ammonia from its elements" in 1918, and today the Haber-Bosch process accounts for 180 million tons of ammonia production each year. The infrastructure required to store and transport it safely is already widespread and would make the transition to using renewable energy sources simpler, quicker and cheaper than previously predicted. Green ammonia has the opportunity to play a vital part in a future, low-carbon energy system.

Understandably, the pandemic has meant we are not dealing with "business as usual" and it's right that the government's time is dedicated to this unprecedented issue, especially as it doesn't look like it'll be going away anytime soon. However, the need for a climate strategy that is able to avert the risks of irrevocable climate change aren't changing and cannot be pushed to the side. The solution has already been found; it just needs to be invested in.

Steve Scrimshaw is Vice President, Siemens Energy UK&I.

Digital transitions

Energy companies face a number of challenges as they continue to reinvent themselves in response to the changing energy landscape. Linda Rae, General Manager for the Power Generation and Oil & Gas businesses for GE Digital, says digitalisation is the key. **Junior Isles**

Navigating the changing energy landscape is no easy task. In a world where access to electricity is still not a given for more than a billion of the world's population, ending ongoing energy poverty is still a challenge. Renewables and distributed energy sources have a role to play here. Renewables are also key to making the all-important transition to a low carbon economy.

The transition and the inexorable rise of renewables, however, has seen utilities and energy companies having to develop new business models and draw on new tools to ensure they continue operating efficiently while delivering reliable, affordable and cleaner electricity to consumers.

As a major technology partner to energy companies around the world, GE Digital sees digitalisation as an integral part of making that shift.

Linda Rae is General Manager for the Power Generation and Oil and Gas businesses for GE Digital. Having taken up the position in January this year she is responsible for running a segment of the GE Digital business that is seeing an increasing reliance on digital solutions to meet the demands of the industry.

She identified availability of electricity across the globe, integrating renewables, and meeting global climate change targets as the top three issues driving today's power generation sector and outlined the importance of technology in addressing those drivers.

Rae noted: "Many corporations have committed to achieving net zero emissions by 2050 or earlier. Trillions of dollars have flowed into low carbon technology since 2010. Solar and wind are now quite competitive in most markets but with the majority of the world's power still coming from fossil fuels, getting to zero emissions in 30 years is a tremendous challenge.

"It will require tremendous innovation in renewables and in smart grids, and we believe that digital will play an important role in that trend."

Digitalisation is taking place across the entire power sector value chain – from generation, through transmission and distribution, to consumption.

Highlighting some of the key areas, Rae said: "On the generation side, we have been working with customers to help them stay profitable in a competitive environment. Many are embracing digitalisation to drive operational excellence. Operation and maintenance (O&M) cost reduction continues to be a major imperative for our generation customers, and software-driven reliability and maintenance is a principle means of driving O&M costs down. This is not just for critical assets but also for the balance-of-plant; so it's really enterprise-wide leverage of digital tools and predictive analytics to drive O&M costs down.

"They're also looking at opportunities for business process automation. This all helps to avoid unforeseen outages and enable smarter choices about how to maintain and operate their assets."

The New York Power Authority (NYPA) is America's largest state power organisation, with 16 generating facilities and more than 1400 circuit-miles of transmission lines. GE Digital has partnered with NYPA to enable an innovative energy infrastructure to forecast and prevent equipment failures and significant outages with its predictive analytics software. Online remote monitoring of power plants, substations and power lines is increasing plant efficiency and productivity, reducing unplanned downtime, lowering maintenance costs and minimising operational risks.

Rae says capacity forecasting and planning is another way in which digitalisation is helping utilities. "Today's energy market is pretty complicated; daily decisions have to be made by generators about what they will produce and during which period of time. Digitalisation helps them understand how they will deal with trading surpluses and pricing maximisation over time."

And at the cutting-edge, GE Digital says it is seeing greater digitalisation in areas such as control technologies, drones and augmented reality for remote maintenance and operation. This is something that has certainly been seen more since the Covid-19 pandemic. "Digitalisation is a way for them to maintain operations with reduced staffing in their facilities," said Rae.

In transmission and distribution, most digitalisation efforts have been in making grids smart to allow more efficient transmission of electricity, smart communications between utilities and consumers, as well as in the integration of renewables.

Rae said: "Digitalisation enables smarter decisions about when renewables are utilised versus more traditional sources of energy, as well as how that energy is passed through the grid to optimise supply and demand. And on the consumption side, digital capabilities help to ensure energy efficiency at the end-point as well as enabling a potential reduction in peak load demand."

With such benefits, it's clear why digitalisation is big business and continues to grow. According to 2020 research carried out by Harbor Research, the total Industrial Analytics Software & Services market (including manufacturing & resources segments) will grow to more than $80 billion by 2025 at a 24 per cent CAGR. "We expect Power Generation Software and services to grow to $6.7 billion by 2025 at about 17 per cent CAGR," Rae said.

She added: "We account for factors such as capacity retirements. We also look at generation and consumption patterns and broader factors, such as GDP growth, that impact consumption of energy over time, and of course digital penetration. We look at customer trends, behaviours and pain points that can be addressed through digital solutions."

Rolling out digital solutions requires an understanding of the utility's needs and emerging trends. For GE Digital, this starts with the deep relationship it has with the customer, as well as having the expertise that comes with being a sister company to GE Power.

"Because we work with customers as both an OEM and digital provider, we understand the issues around reliability, availability of equipment, O&M costs, worker safety, mobility, etc. These are all factors in which we are deeply entrenched with our customers," said Rae.

"We help them understand what the right scope and approach is for them. In some instances, it's a very small pilot to get them started. In other cases, some are able to take on a whole plant or critical assets. We have a team of experts that works with the customer through the entire implementation process.

"We configure a software and services portfolio that enables the digitisation of those assets and the plant operations to optimise the utilisation and minimise risk."

Through its long-term R&D investments and long history in the power industry, GE Digital has developed a broad library of digital twins and equipment blueprints covering about 50 per cent of failure modes and equipment sites today, and continues to add to those libraries. "Our strategy is to maximise the ROI for the customer by leveraging the deep expertise that we have," said Rae.

Digitalisation is certainly proving its worth in the current pandemic, which has brought home the importance of remote operations.

Rae said: "Most of the customers I've talked to during the pandemic have been operating with skeletal staff… the indispensability of digital solutions to ensure business continuity while working with a skeletal and largely remote staff has been eye-opening to our customer base and to us."

She says there has been a sharp uptick in demand for GE Digital's Remote Operations digital solution, which allows plant operators to access the plant and fix issues in a remote and secure manner.

But implementing digital solutions does not come without its challenges. According to Rae the biggest of these is the change management that utilities have to go through as they adapt their business processes to take advantage of the digital solutions that they have adopted.

"There are years of entrenched manual practices and ultimately we are trying to automate those practices and ways of doing business. This requires a proactive approach to change management and helping employees get through that transition."

As examples she cited: the challenges around gathering and understanding of data; making decisions around capital allocation; and decisions around risk versus cost.

"There are cultural challenges as well as multi-generational challenges. Many facilities have an older workforce that aren't as comfortable with leveraging digital tools to make decisions, juxtaposed with an influx of millennials who are naturally tuned to using digital. This can add to the cultural challenge that customers are facing.

"Also, the general shift from reactive methods to condition-based monitoring and maintenance can take time for users to adapt to."

Apart from the technology concerns – the main one probably being cyber security – Rae adds that a common concern she hears, is "time to value".

"It's a fairly intense investment in terms of resources and time and money to undergo a digital transformation. So the question is always: 'how do I know I will get the value to justify this big investment?' We help customers understand how they can shorten their time to value."

The final concern, she says, relates to data – its availability, cleanliness and the ongoing data maintenance requirements. She assured, however: "We work with them to help them address all of these things.

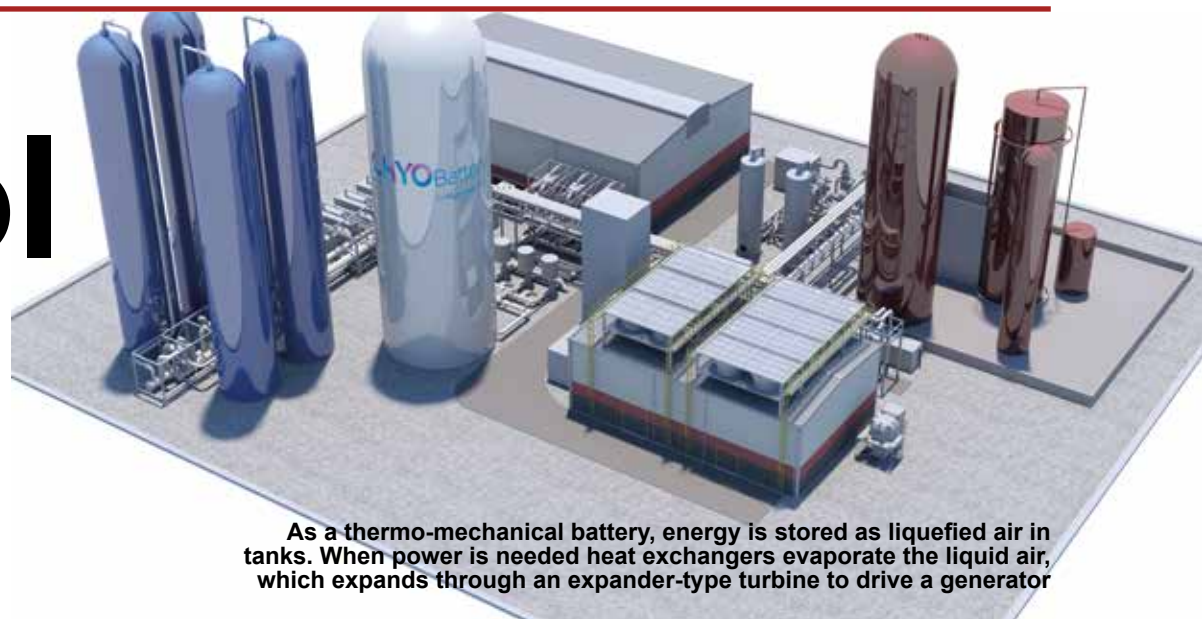
"And of course we have a customer success organisation that works with customers throughout their subscription to make sure they have ongoing support and access to further expertise and training if they need it. Our commitment is to ensure customers get the value they signed up for."

Looking ahead, digitalisation will no doubt grow as current trends continue to play-out, although a great deal of policy and government intervention work has to happen for sustained progress.

Rae concluded: "The influx of renewables will continue to grow over the next 10 years to the point that we will see a fundamentally different business model around producer and consumer – the 'prosumer' – that will dramatically change the whole energy marketplace. The impact of decarbonisation will radically change the sources of energy as well as the optimisation of capacity and efficiency. There will also be faster growth in microgrids, more utilisation of data over time, integration of data throughout the entire value stream and ultimately we will see a much more digitally mature energy sector."

Rae: Many corporations have committed to achieving net zero emissions by 2050 or earlier… It will require tremendous innovation in renewables and in smart grids, and we believe that digital will play an important role

Really cool storage



As a thermo-mechanical battery, energy is stored as liquefied air in tanks. When power is needed heat exchangers evaporate the liquid air, which expands through an expander-type turbine to drive a generator

Liquid air energy storage, a large-scale form of long duration storage that some call "pumped hydro in a box", is preparing for the first commercial project. **Junior Isles** reports.

Outside of pumped storage and compressed air energy storage, options for long term storage of electricity produced from wind and solar are limited. But an exciting technology development, which began to take shape about 15 years ago, is now moving into a commercial setting.

In June this year, Highview Power announced the award of a £10 million grant from the UK Department for Business, Energy & Industrial Strategy (BEIS) for a cryogenic energy storage facility to help the country achieve its decarbonisation goals. Known as the CRYOBattery, the 50 MW storage facility (with a minimum of 250 MWh) located in Carrington Village, will be one of Europe's largest battery storage systems.

The news marks a significant milestone in the commercialisation of a technology with its roots dating back as far as 2001. That was the year British inventor Peter Dearman developed and patented the Dearman Engine.

The key to Dearman's breakthrough was the realisation that liquid air could be vaporised inside an engine cylinder using heat supplied by a thermal fluid mixture such as water and glycol, eliminating the need for the bulky and inefficient external heat exchangers of traditional cryogenic engines.

It was not until 2006, however, that the possibilities for Dearman's technology in the power sector began to take shape when Highview Power began to develop its cryogenic technology. Working with the University of Leeds, Highview developed a series of efficiency enhancements to the liquid air cycle by integrating the production and expansion processes to make use of waste heat and cold, so making the concept of a grid scale energy storage system economically viable.

But it was a concept ahead of its time. Commenting on its development, Javier Cavada, Highview Power's CEO, said: "The technology was ready before the market was really demanding it. With thermal generation, you didn't need this kind of storage or [grid] stability services. But we all know that now [with wind and solar] the time is here."

The first pilot was built in 2011. This was followed by a 5 MW/15 MWh demonstration plant co-developed with Viridor, which has been connected to the grid at a site in Bury since June 2018. These projects, however, are too small to showcase the real benefits that the technology can bring.

"The technology offers storage more on the pumped storage scale," said Cavada. "It's not only long duration but also large megawatts. In addition to this, it can ease congestion and help stabilise the grid. It will show that this kind of infrastructure asset can deliver multiple revenues."

The project is being developed by Highview Power and UK independent power station developer Carlton Power, at the Trafford Energy Park, just outside of Manchester. It will use existing substation and transmission infrastructure and will allow Carlton Power to derive income from several markets. According to Cavada, government involvement through the grant makes the project even more attractive.

Carlton Power has been permitted to build a gas fired combined cycle plant at Trafford, which would operate according to demands from National Grid. However, the impact of increasing wind on the grid could make its operating regime increasingly expensive for National Grid. The storage project would help control these costs.

"Gas plants are operating for less and less hours," said Cavada. "When National Grid calls on gas fired plant to provide grid support services, it is forced to curtail wind power. So it ends up paying twice – for the wind it does not use and for the gas plant needed to balance the grid. So gas is not offering good value to the consumer… bringing in storage will help Carlton Power to maximise the value of its existing assets and leapfrog into hi-tech, innovative technology."

As a thermo-mechanical battery, energy is stored as liquefied air in tanks. Because the energy is stored in large tanks, which are relatively low in cost, the larger the energy capacity (more MWh stored), the more competitive the cost of the facility per MWh (capex).

"We are looking at a minimum of five hours and potentially six. That's 250-300 MWh. But the important point is, it can be expanded just by adding more tanks. It can be expanded to 100 MW, 500 MW or 1 GW power, etc., with very little extra investment.

"For a lithium battery, going from 50 MW to 100 MW, you would double the cost. In our case you just get a bigger turbine and generator, so you would increase cost by just 40 per cent instead of 100 per cent. So the larger, the better."

At approximately £110/MWh for a 10-hour, 200 MW / 2 GWh system, Highview Power says the CRYOBattery offers a competitive levelised cost of storage for large-scale applications. For the 50 MW/250 MWh block, the total investment is about £85 million.

Like a battery plant, each CRYOBattery block consists of a 'charging station', 'storage' and a 'discharging station'. But crucially each section can be sized independently.

Charging is provided by a liquefaction system, which uses electricity from the grid. This predominantly comprises an air separation unit, heat exchangers and compressors to separate air from the atmosphere, cool it, and compress it by a factor of 700. The liquid air is pumped to storage tanks, which essentially act as the battery cells. When power is needed heat exchangers evaporate the liquid air, which expands through an expander-type turbine to drive a generator.

The project is now in the execution phase with construction of the discharging station now under way. Sumitomo Heavy Industries, which recently invested $46 million in Highview, will support the project with engineering and execution services.

Cavada notes that the entire installation is "pretty compact". He said: "If you used Li-ion batteries, the size would be at least double."

The ability to have large amounts of compact, long term energy storage that can be located anywhere is a huge selling point for the technology. Unlike pumped storage and compressed air it is not dependent on geography. Cavada says it's like "having pumped hydro in a box".

And like pumped hydro, running costs, says Cavada, are very low. "It is very low maintenance. You don't need to do anything until you need to make an intervention. If you maintain it well, the lifetime is 30-40 years – like a traditional power station." He also noted that the cryogenic system is inexpensive to run and maintain. "It is the same technology that's used in LNG terminals, so it's very well known."

In addition to its large, long-term storage capability, the CRYOBattery can also provide grid balancing, and ancillary services such as frequency response and voltage support. While not in the millisecond range of Li-ion batteries, power can be delivered to the grid in a matter of seconds.

"In normal operation, we can do it in less than 10 seconds from the time of receiving the signal to providing to the grid; below one minute is fine for the grid. And I believe if there was ever a need for less than 1 second, we could hybridise with a flywheel. But this is not the main reason for this technology; it's about shifting energy to another time in the future."

Another key benefit is the CRYOBattery can also provide synchronous inertia to the grid, like rotating turbines at thermal or nuclear power plants. This provides voltage support and reactive power to the grid – something that has been disappearing as coal and gas plants are displaced by solar and wind.

Cavada noted: "Last year National Grid identified it was losing inertia and reactive power, which is increasing the potential for blackouts. But the goal is to maximise the use of wind and solar. We can provide rotating inertia without providing electricity, so you get fully renewable inertia and reactive power."

Balancing how the CRYOBattery delivers such ancillary services versus pure storage capability is achieved through the use of clever software.

"It's an extremely flexible asset. Unlike other batteries which can only be charged and then discharged, we can charge and discharge at the same time. This means you can provide both storage and system services at the same time, in the same second or you can do it shifted in time. You can provide system services without storage, or storage without system services, or you can do both at different power outputs. You can even provide inertia to the grid without having any power in the tanks."

With completion of the discharging station scheduled for next summer and commercial operation slated for early 2022, it will not be long until Carlton Power is able to offer the grid the various benefits its newest installation can provide.

It is one of four projects that the developer plans to roll-out with Highview, totalling over 1 GWh.

"Before the end of this year we will decide whether we go with the second or second and third at the same time, etc., because there are big economies of scale to be gained," said Cavada.

He concluded: "We will make some big announcements before the year is over for projects both in the UK and the US. This UK project is a landmark, flagship project, as it's the first and the biggest but it will not be the largest for very long."

Cavada: It's an extremely flexible asset. Unlike other batteries which can only be charged and then discharged, we can charge and discharge at the same time

Junior Isles

Still star gazing

We always tell our children: "Never give up on your dreams." After all, humankind would not progress without the stuff of dreams and the pioneers with the unwavering determination to chase them. But the art of balancing pragmatism versus aspiration is a tricky one.

Five years ago in an interview with *The Guardian* newspaper Steven Cowley, who was then leading the UK's participation in ITER (the International Thermonuclear Experimental Reactor) said the experimental fusion reactor being built in Cadarache, France, is "going to show that man can make a star".

As ambitions go, they don't come much bigger. Yet this incredible dream took a big step towards reality with the official start of assembly of what has been called "the world's largest science project".

ITER (pronounced "eater") – Latin for "the way" – is an international project with components coming from 35 partner countries. It will be the world's largest nuclear fusion device, designed to show that fusion can generate power sustainably, and safely, on a commercial scale. Crucially, it is intended to be the first fusion reactor to produce more power than it consumes. ITER is meant to produce about 500 MW of thermal power but as an experimental project, it is not designed to produce electricity.

Cartoon: jemsoar.com

John Smith, Director of magnetic technology at General Atomics says it will try "to run a fusion experiment for several hundred seconds, which has never been done at the power levels talked about". He added: "And then most importantly, they're going to show what they call the 'fusion gain'. That's where the power that it takes to create the fusion reaction, they'll actually get 10 times more power out of the reaction than what they put in."

Nuclear fusion has long been the holy grail of energy production – almost limitless power without any carbon emissions and very little radioactive waste. Yet, as with all holy grails, it always seems to be just out of reach – fusion has long been dubbed as a technology that is "always 30 years away".

Fusion happens in our sun and every star, where, under immense temperature and pressure the nuclei of hydrogen atoms, which are protons, fuse to form a nucleus of helium, releasing energy. But, due to the repulsive forces between the protons, it is a process that takes millions of years before a star can be born.

To replicate the process on Earth, scientists therefore usually use two hydrogen isotopes instead – deuterium and tritium – that contain one and two extra neutrons in their nuclei, respectively. Deuterium is abundant in seawater and tritium can be made by the fusion reactor itself. By heating the deuterium-tritium mixture to well over 100°C million inside a ring-shaped vessel, the two elements fuse to form helium, energy and fast-moving neutrons. The neutrons will be absorbed by shielding around the reactor vessel that contains lithium, and the interaction will create more tritium.

There is a virtually limitless source of fuel in the world's oceans to feed future nuclear fusion reactors. According to the project's partners, "a pineapple-sized amount of fuel is the equivalent of 10 000 tons of coal". And though the process produces some radioactive waste products, they all have short half-lives and will become inert within a few hundred years, as opposed to the thousands of years for the radioactive waste from today's fission reactors.

In a statement, the partners said: "Fusion is safe, with minute amounts of fuel and no physical possibility of a run-away accident with meltdown" as with traditional nuclear power stations.

At ITER a doughnut-shaped chamber called a Tokamak will heat the hydrogen mixture until it becomes a cloud-like ionized plasma, which is then shaped and controlled by superconducting magnets. These magnets create an overlapping set of fields that keep the electrically charged gas inside from touching the sides of the Tokamak and thereby losing energy. Fusion occurs when the plasma reaches in the region of 150°C million – 10 times hotter than the sun's core.

The size and complexity of the facility is staggering. The main fusion reactor will be built on a flattened area of concrete that would cover 60 football pitches. The Tokamak vessel will comprise about a million components, with some, like the superconducting magnets, standing as high as a four-storey building and weighing 360 tons each. When the main building containing the reactor is complete, it will be 60 m tall and extend 10 m below the ground.

As the components arrive from the project's partners all over the world, the task of putting together what is described as the world's largest puzzle begins. Some 2300 people are at work on site to put the machine together.

ITER's Director-General Bernard Bigot, said: "Constructing the machine piece by piece will be like assembling a three-dimensional puzzle on an intricate timeline. Every aspect of project management, systems engineering, risk management and logistics of the machine assembly must perform together with the precision of a Swiss watch. We have a complicated script to follow over the next few years."

ITER's initial demonstration of its functionality, called "first plasma" is scheduled for December 2025 and could reach full power by 2035. Whether that timeline will be met is anyone's guess. The project is already running five years behind schedule and has seen its initial budget triple to some €20 billion ($23.4 billion).

Yet I have every confidence that scientists will get there eventually; the desire is too great. As Smith noted: "Maybe 15 years ago, I might have had my doubts about coordinating such a complex effort. Now that I've seen it being brought together and then working intimately with the worldwide group, I have no doubt that it will come together."

Nonetheless, ability and determination is not the problem here. Commenting on the potential impact, Smith added: "It changes, I think, the whole world's energy economics entirely if fusion goes forward."

'If' is a big word. And fusion will not get the chance to change the world's energy economics. Long before we get there, it's more likely energy economics will change the prospects for fusion.

ITER will continue and most likely eventually succeed; and no doubt the various national plans to build commercial reactors will build on its success. At the same time dozens of private companies will carry on pushing forward and raising funds to develop fusion reactors based on different approaches to ITER. This work is mostly due to a genuine belief that fusion will play a part in the future energy mix but I suspect that some national projects may be more about earning bragging rights.

The challenge will be economics and urgency. Some argue that with the climate crisis, fusion has to happen. The technology, however, will not be commercial before the crisis is upon us. And further, where is the incentive when there are available technologies and strategies that can do the job at a fraction of the cost?

Five years ago, Cowley said: "There are probably, over history, a handful of historic moments where in a flash the future changed. In a flash the future will change with this machine…"

This is certainly true. I fear, however, that Cowley may not be around long enough to see it happen. Man may indeed be capable of making a star but if the cost of wind and solar keep falling, this "sun in a box" may never see the light of day.