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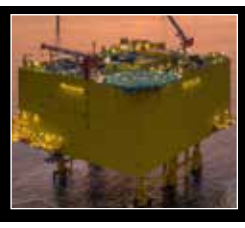
Special Technology Supplement

Recyclable blades and HVDC technology are crucial to Europe's offshore wind programme. *Page 8*



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Clean energy economy emerging "faster than imagined"

IEA Executive Director, Fatih Birol hailed solar as the "shining star"

Investment in clean energy is outstripping that in fossil fuels at an increasing pace, according to the International Energy Agency's latest World Energy Investment report. The agency notes, however, that oil and gas companies could do more. **Junior Isles**

The clean energy economy is emerging faster than expected, with investment in clean technology now almost double current spending on fossil fuels, according to a new report from the International Energy Agency (IEA).

According to the Paris-based agency's latest 'World Energy Investment' report, $2.8 trillion is set to be invested globally in energy in 2023, of which more than $1.7 trillion is expected to go to clean technologies – including renewables, electric vehicles, nuclear power, grids, storage, low-emissions fuels, efficiency improvements and heat pumps. The remainder, slightly more than $1 trillion, is going to coal, gas and oil.

Commenting on this trend, IEA Executive Director, Fatih Birol said: "I had the opportunity to address the G7 leaders in Hiroshima, Japan, with regards to energy and climate issues. We shared many things but the main idea was that a new clean energy economy is emerging, and emerging must faster than many realise. Five years ago, the investment in all energy sources was about 2 trillion – $1 trillion for fossil fuels and $1 trillion to clean energy. Five years ago the ratio of fossil fuels [investment] to clean energy was 1:1, this year it is 1:1.7 in favour of clean energy. In my view, this is a dramatic shift."

Driven by factors such as the falling cost wind and solar; government policies adopted as a result of the energy crisis brought on by the war in Ukraine; and industrial strategies around the world designed to boost home-grown manufacturing of clean equipment, the IEA expects clean energy investment to rise by 24 per cent between 2021 and 2023. Spending on fossil fuels is expected to increase by 15 per cent.

Low-emissions electricity technologies are expected to account for almost 90 per cent of investment in power generation. Consumers are also investing in more electrified end-uses. Global heat pump sales have seen double-digit annual growth since 2021. Electric vehicle sales are expected to leap by a third this year after already surging in 2022.

Solar was hailed by the IEA as the "shining star" of the global energy investment landscape. According to IEA forecasts, solar power investment is set to outstrip spending on oil production this year for the first time.

Spending on upstream oil and gas is expected to rise by 7 per cent in 2023, taking it back to 2019 levels. The few oil companies that are investing more than before the Covid-19 pandemic are mostly large national oil companies in the Middle East.

Birol expressed disappointment at the level of re-investment into clean energy by the oil and gas sector, despite them seeing record revenues last year as a result of high energy prices

Continued on Page 2

Prospect of deal on fossil fuel phase-out under threat

Talks aimed at setting a deadline to phase out fossil fuels at this year's UN COP28 climate change summit in Dubai in December look set to face serious headwinds under the UAE presidency.

Speaking at the recent Petersberg Climate Dialogue in Berlin, incoming COP28 President Sultan al-Jaber, who is also the head of the Abu Dhabi National Oil Company, said fossil fuels would "continue to play a role in the foreseeable future". He said the world should use all sources of energy while reducing emissions from power plants and other fossil fuel-reliant sectors by using carbon capture and storage (CCS).

"If we're serious about mitigating climate change and reducing in a practical manner emissions we must scale-up carbon capture technologies," he said, adding that in the United Arab Emirates "we have embraced a comprehensive, holistic approach to the energy transition."

His view on the continued use of oil and gas, however, differed from that of several other ministers.

During a press briefing at the event in Berlin, German Foreign Minister Annalena Baerbock, said: "We have to get out of fossil fuels, we have to dramatically reduce emissions."

The Danish Minister for Global Climate Policy, Dan Jørgensen, also told the *Financial Times* there were concerns "about making sure [CCS] does not become an excuse for not making the [energy] transformation we need".

"I don't think we should dismiss [CCS]. There are emissions that we are not able to phase out," he said, pointing to industry examples such as cement making. However, he added: "This should not be seen as something we do instead of replacing fossils with renewables".

The diverging views make for difficult talks later this year in Dubai. Also speaking in Berlin, Tina Stege, the climate envoy for the vulnerable Marshall Islands, and Maisa Rojas, Chile's Environment Minister, called for "honesty" at COP28 about the end of fossil fuel use.

"We…want the phase out. We want to make sure if we add new energy, we are taking the old dirty energy out of the system," said Rojas, while Stege added: "We need to really honestly look at where we are, what we haven't done and what we need to do. The fossil fuel era has to come to an end."

Last year at the UN COP27 climate change sunmit in Egypt, efforts to reach an agreement to phase out fossil agreement failed, despite the support of dozens of countries including the US and EU.

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brought about by the crisis. He noted that the majority of the $4 trillion generated by oil and gas companies has gone to dividends, share buybacks and debt repayment – rather than back into traditional supply.

"The oil and gas industry's capital spending on low-emissions alternatives such as clean electricity, clean fuels and carbon capture technologies was less than 5 per cent of its upstream spending in 2022," the IEA stated.

According to the report, the biggest shortfalls in clean energy investment are in emerging and developing economies.

"There are some bright spots, such as dynamic investments in solar in India and in renewables in Brazil and parts of the Middle East. However, investment in many countries is being held back by factors including higher interest rates, unclear policy frameworks and market designs, weak grid infrastructure, financially strained utilities, and a high cost of capital," it stated.

The IEA said "much more needs to be done" by the international community, especially to drive investment in lower-income economies, where the private sector "has been reluctant" to venture.

To help address this, the IEA and the IFC will on 22 June release a new special report on 'Scaling Up Private Finance for Clean Energy in Emerging and Developing Economies'.

The IEA report came just 10 days after another report by BloombergNEF (BNEF) estimated that Europe needs to invest more than €29 trillion ($32 trillion) in energy and related technologies between now and 2050 to transition to a net zero economy.

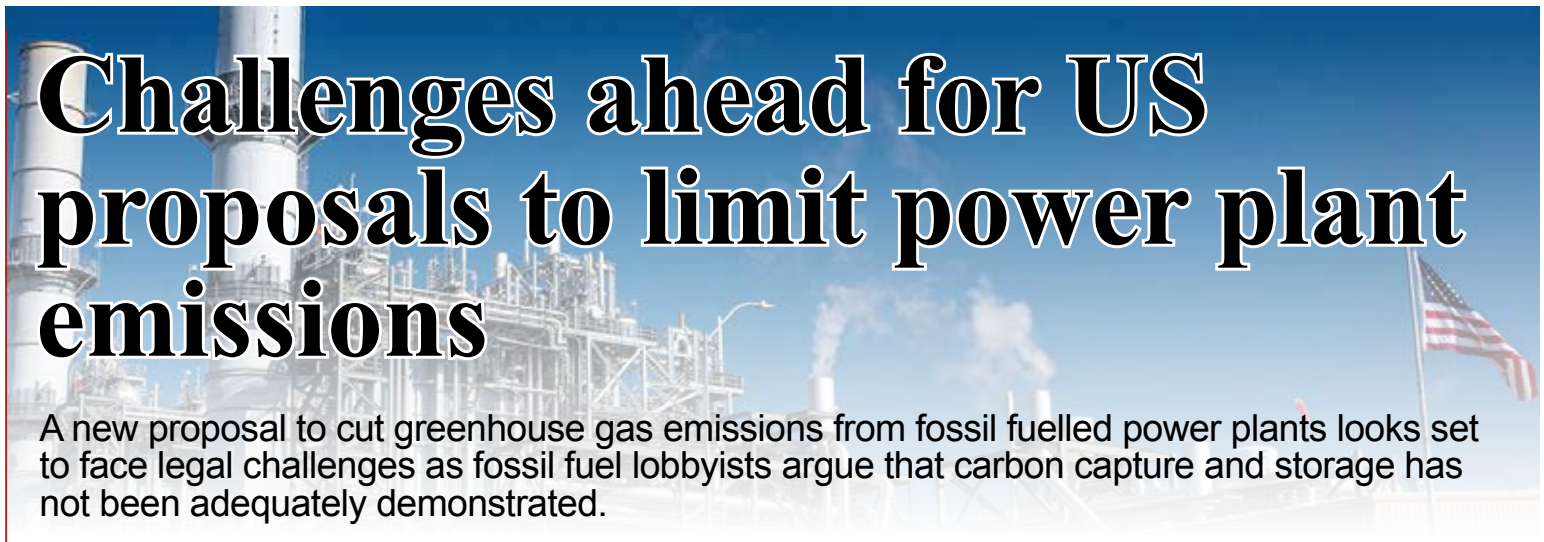
In 2022, the region's investment in low-carbon energy transition was $227 billion. To achieve the report's Net Zero Scenario, Europe has to increase its annual investments in clean energy supply, electric vehicles (EVs), heat pumps and sustainable materials to more than three times this level throughout the remainder of the decade and more than four times in the 2030s.

The IEA said the O&G sector re-invested less than 5 per cent of revenues in clean energy

According to BNEF's 'New Energy Outlook: Europe' report, more than two-thirds of the required investment is on the demand side, with EVs accounting for the biggest single portion – $21 trillion over 2022-2050, and heat pumps for another $1.4 trillion.

By 2050, Europe should also spend around $3.8 trillion on developing an expanded and digitalised grid that supports the integration of more renewables, EVs and heat pumps. A similar amount, more than $3.8 trillion, is invested in new clean power assets by 2050 under the Net Zero Scenario, a large part of which must be before 2030.

In that scenario, onshore and offshore wind capacity grows to 675 GW by 2030, up from 234 GW in 2022, while solar expands to 774 GW from 226 GW.



Challenges ahead for US proposals to limit power plant emissions

A new proposal to cut greenhouse gas emissions from fossil fuelled power plants looks set to face legal challenges as fossil fuel lobbyists argue that carbon capture and storage has not been adequately demonstrated.

Junior Isles

New proposals to limit greenhouse gas emissions from US power plants look set to face legal challenges from fossil fuel companies.

After being struck down almost a year ago by the Supreme Court, the Biden Administration has unveiled a plan to cut emissions from gas and coal plants through what would be the first-ever large-scale use of carbon capture and green hydrogen over the next decade.

According to the White House, the new plan, if successful, would put the US on track to reach net zero emissions from the power sector by 2035. Power plants are currently responsible for a quarter of the nation's greenhouse gases.

The new carbon pollution standards avoid up to 617 million metric tonnes of total carbon dioxide between 2028 and 2042.

The plan, however, could be open to legal challenges as fossil fuel companies and their representatives explore challenging it in court on the basis the technologies are unproven. A similar effort to clean up the power industry by the Obama White House in 2015 was hung up by legal challenges and ultimately repealed.

Michelle Bloodworth, President and CEO of America's Power, which represents utilities that burn coal, said: "The proposal raises a number of critical legal questions, including whether the EPA has the authority to force the use of technologies that are not economically or technically feasible for widespread use."

Jeff Holmstead, a lobbyist at Houston-based Bracewell LLC who formerly ran the EPA's air and radiation office during the Bush administration, said betting on carbon capture is risky.

"There isn't a single commercial-scale gas-fired power plant anywhere in the US – or as far as I know, anywhere in the world – that uses CCS to control its emissions," he said. "This fact alone could make it hard for EPA to convince the courts that CCS has been adequately demonstrated."

EPA officials and some environmental groups say the rule was designed to withstand legal challenges because it focuses on available technologies that can be applied directly at power plants, and because Congress affirmed the agency's authority to impose technology-based carbon standards.

They add that the Inflation Reduction Act, Biden's centrepiece climate legislation, offers billions in tax credits and incentives that make CCS and clean hydrogen economically feasible.

In its 651-page proposal, the EPA also cited SaskPower's Boundary Dam project in Canada as one that has demonstrated CO_2 capture rates of 90 per cent on an existing coal steam generating unit.

■ Lured by President Joe Biden's green energy tax incentives under the Inflation Reduction Act, UK power generation business Drax said it plans to spend $4 billion building two biomass power plants in the southern US. The plants are part of Drax's strategy to become a leader in "negative emissions", which can be sold in the form of credits to other companies looking to offset their emissions. The company's biomass power plants burn pellets made from organic matter such as wood chips to generate electricity.

Industry outlines urgent needs as Europe moves to scale-up offshore wind

The wind power industry has outlined key tasks for EU members if the bloc is to realise its offshore wind ambitions.

An Industry Declaration of more than 100 companies, representing the whole value chain of offshore wind and renewable hydrogen in Europe, recently outlined the urgent need for new investments in wind energy manufacturing capacity and supporting infrastructure.

The Declaration also warns that current policies do not underpin Europe's ambitions with adequate financing and funding mechanisms. In 2022 not a single offshore wind farm reached final investment decision. Uncoordinated market interventions, price caps and national claw-back measures deterred investments, it said.

Investment to get Europe where it wants to be is massive: the EU has calculated the cost of getting to 300 GW in offshore energy production by 2050 at €800 billion ($900 billion).

The Declaration came as nine Heads of State & Government – from Belgium, Demark, Germany, Netherlands, France, Ireland, Luxembourg, Norway and the UK – and the President of the EU Commission met at the North Sea Summit in Ostend, Belgium, to agree new commitments on the build-out of offshore wind in the North Seas.

The Declaration said expanding the offshore wind value chain is now primarily a volume game. Today Europe can manufacture 7 GW of offshore wind turbines a year. To meet the expansion path outlined in the Ostend Declaration Europe needs to manufacture 20 GW a year by the second half of this decade.

Importantly, it stressed that the expansion of offshore wind must be underpinned by investments in grids and ports. Europe needs to double its annual grid investments and channel €9 billion into the modernisation and expansion of its port infrastructure between now and 2030. It noted that if the UK is to meet its 50 GW target for 2030, significant acceleration is needed in grid development and supply chain investment.

Major European Transmission System Operator (TSO), TenneT, has already been making significant investments in developing a North Sea grid to handle the massive amount of wind power that is coming on line.

Early last month it concluded another framework cooperation agreement with NKT, Nexans and a consortium of Jan De Nul, LS Cable and Denys, for at least ten 525 kV HVDC cable systems with delivery until 2031.

In a separate move, offshore wind developers Cerulean Winds and Frontier Power International have unveiled plans for a £20 billion ($25 billion) floating wind-powered transmission network that will electrify North Sea oil and gas platforms.

The North Sea Renewables Grid (NSRG) project is touted as one of the UK's largest infrastructure developments backing the oil and gas sector's decarbonisation, Cerulean Winds said.

Offshore wind turbine scaling is creating unsustainable market risks

The offshore wind sector must act to address increasing mechanical breakdown issues, component failures and serial defects resulting from the deployment of ever-larger offshore wind turbines, according to renewable energy projects underwriter GCube Insurance.

GCube's new report, entitled 'Vertical Limit: When is bigger not better in offshore wind's race to scale?', is compiled from 10 years of the company's claims data and draws on evidence from experts across the offshore wind sector to demonstrate how offshore wind's risk landscape has significantly shifted, as manufacturers push to develop bigger machines, faster.

Over the past five years, the race to scale turbine technologies has seen the leap from 8 MW to 18 MW turbines occurring in a fraction of the time it took to go from 3 MW to 8 MW. While this is an impressive technological achievement, GCube says such rapid commercialisation of 'prototypical' technologies is now leading to a concerning number of losses, and subsequently piling financial pressure on manufacturers, the supply chain and the insurance market.

Amongst the findings of the report, underwriters are concerned that 55 per cent of all claims by frequency come from component failures during construction from 8 MW+ machines, which now represent a larger share of Total Insured Values (TIVs).

This, combined with an increase in average offshore wind losses, up from £1million ($1.24 million) in 2012 to over £7 million in 2021, is creating unsustainable financial risk, right when scaling is needed to bring about the energy transition.

Another major finding is that 8 MW+ machines are suffering from component failures within the first two years of operation. This is juxtaposed against the significantly shorter timeframe (five years) for component failures during operation in the 4-8 MW category of turbines and points to the urgent need to address product quality and reliability – a key recommendation of the report.

Fraser McLachlan, CEO, GCube Insurance, commented: "The push to rapidly develop more powerful machines is piling pressure on manufacturers, the supply chain, and the insurance market.

"Scaling up is an essential part of driving forward the energy transition, but it is now creating growing financial risks that pose a fundamental threat to the sector." He added: "We advise manufacturers to focus on improving the quality and reliability of a reduced number of products to put themselves back on a sustainable path of development.

"At the same time, developers must support manufacturers by sharing the risk of larger machines more equitably and open their lending books to supply chain companies.

"Vessels are going to be one of the biggest bottlenecks in building offshore projects, and developers are in a powerful position to invest in supply chain companies at the benefit of the entire sector."

US battle lines drawn over fossil fuel generation

- Texas lawmakers propose to underwrite new gas fired stations
- New Federal rules likely to force carbon emission cuts

Janet Wood

Proposed state legislation in Texas would offer $10 billion to underwrite new gas fired power plants to meet the state's growing demand for electricity.

Filing a bill to support the measure, State Senator Charles Schwertner said: "We're willing to put resources, taxpayer dollars, citizen dollars to where we think there is a critical life and health and safety and obviously economic need."

Under the new legislation the state would offer companies interest-free loans for a 20-year period to build new gas fired power plants or to keep their older power plants online for five years, instead of closing them. The state will also pay a bonus if new plants became operational by 31 December 2026. The plants would be available in emergencies.

The bill was passed by the Senate but now has to be considered by the House. Around half of power in Texas comes from renewable energy, up from just two per cent in 2000.

Debate in Texas comes as federal agencies are acting to disincentivise states from relying on fossil fuelled plant like gas fired power stations, in line with the Biden administration's promise to decarbonise the power industry by 2035.

The Environmental Protection Agency (EPA) is shortly expected to publish new standards on carbon emissions for new and existing power plants that could force them to close, operate for fewer hours, or install carbon capture and storage. According to the Clean Air Act, the standards must be based on "best system of emission reduction" technologies, deemed affordable and technically feasible.

Data from the US Energy Information Administration shows fossil fuels accounted for more than 60 per cent of US electricity generation in 2022, with 60 per cent of that coming from gas and 40 per cent from coal.

Renewables accounted for around 20 per cent, with nuclear energy making up the rest.

South Korean company takes stake in green hydrogen project in Canada

South Korean company SK Ecoplant has signed up to participate in a $4.5 billion green hydrogen commercialisation project headed by Canada.

SK Ecoplant will partner with Canadian renewable energy company World Energy GH2 to participate in the first phase of the Nujio'qonik project – a green hydrogen project planned for Newfoundland in eastern Canada to use wind power to produce green hydrogen. Discussions are underway for SK Ecoplant to undertake the engineering, procurement, and construction responsibilities, it said.

The project will also include construction of green ammonia plants, which will turn 60 kt of green hydrogen into 360 kt of ammonia each year. Green hydrogen is expected to begin by March 2025 and green ammonia production is planned for March 2026.

Under the agreement, SK Ecoplant will make an investment worth $50 million in World Energy GH2 and take a 20 per cent stake in the project.

"As the first Korean company to participate in an intercontinental green hydrogen commercialisation project, we have gained a competitive advantage in acquiring diverse overseas business opportunities," said SK Ecoplant CEO Park Kyung-il.

"SK Ecoplant's rapid execution ability and extensive experience will help us become a prominent leader in the global green hydrogen and green ammonia market in the future," he added.

Brazil to auction contracts for massive expansion of transmission network

Brazil has announced plans to auction contracts for new transmission lines that will enable the installation of 30 GW of renewable energy generation and production of green hydrogen.

Alexandre Silveira, Minister of Mines and Energy said the Electricity Transmission Grants Plan (POTEE) would see investment of $11.2 billion in transmission infrastructure in the Northeast region. The government intends to hold a total of three auctions, two in 2023 and the third in 2024. The first is planned for June.

Meanwhile Spanish utility Iberdrola has joined forces with Singaporean institutional investor GIC to invest $475 million in Brazil's existing transmission networks. The two companies will co-invest in 1865 km of operational assets for an average concession term of 25 years. Iberdrola will invest through its Brazilian subsidiary, Neoenergia, which already operates has over 710 000 km of power lines in Brazil.

In addition, the companies have signed a framework agreement for the joint participation in future tenders for electricity transmission assets in Brazil, including the auction scheduled for June.

With this, GIC became a preferred partner of Iberdrola for assets under construction and upcoming auctions. The alliance includes the right to acquire a 50 per cent stake in other assets under construction and operation, which encompass 6279 km of transmission lines.

East coast leads in growing US offshore wind pipeline

- Massachusetts promises largest Request for Proposals yet
- Californian industry urges quick decisions on floating projects

Janet Wood

The Massachusetts Department of Energy Resources (DOER) and local distribution companies have submitted their largest Request for Proposals yet for offshore wind farms.

If approved, the state will procure up to 3.6 GW of offshore wind – 25 per cent of the state's annual electricity demand and a significant increase over the previous procurement, which was for 1.6 GW.

"We are excited to announce the first offshore wind procurement of our administration – the biggest in our region's history," said the Governor of Massachusetts, Maura Healey.

"This draft RFP is a signal to the rest of the world that Massachusetts is all-in on offshore wind and ready to be the industry's hub."

Meanwhile New Jersey is preparing to kick-off its second offshore wind transmission solicitation. The state recently increased its offshore wind target from 7.5 GW to 11 GW of offshore wind by 2040.

The New Jersey Board of Public Utilities said recently that it has formally requested PJM to include the new offshore wind goal into PJM's Regional Transmission Expansion Planning.

The two states are not the only ones seeking to increase their offshore wind pipeline.

The American Clean Power Association (ACP) recently released a report on the market that showed a rapidly growing pipeline of projects across 32 leases totaling 51 377 MW and outlines the crucial role that states are playing in driving US offshore wind procurement.

The Offshore Wind Market report said the East Coast dominates with 84 per cent of the development pipeline across 32 leases, accounting for 43.1 GW. It discussed the supply chain development that would follow the US offshore wind investment.

West Coast states have also recently stepped up plans for offshore wind. In December, the Bureau of Ocean Energy Management (BOEM) held its first-ever federal auction for California offshore wind, identifying five provisional leaseholders to deploy an initial 5-7 GW at Morro Bay and Humboldt off the state's Central and North Coasts.

California also recently affirmed plans to focus on floating wind with the aim of deploying 25 GW by 2045. Speakers at a summit hosted by Offshore Wind California (OWC), urged the state to move with speed and scale on next steps to bring offshore wind online – including transmission and port upgrades, procuring at scale, a permitting roadmap, supply chain, workforce training, and suitable sea space to reach the state's goals.

"It's amazing in less than five years how far offshore wind has advanced in the Pacific," said Tommy Beaudreau, Deputy Secretary, US Department of Interior. "We're laser-focused on building our nation's domestic offshore wind economy."

Colombia announces plans for offshore wind auction

Colombia has announced that its first auction for offshore wind energy generation projects, will be ready in August. The country already has one offshore wind farm in the pre-feasibility stage: Vientos Alisios, the country's first offshore wind farm, was announced, which will have 35 wind turbines in the Caribbean Sea. That project, led by the Spanish company BlueFloat Energy, is planned to go into operation by 2027.

On the new auction plans, Irene Vélez, Minister of Mines and Energy, said: "The important thing is to tell investors that this is Colombia's moment."

He explained that the area will be in the department of Atlántico and believed "that between four and six wind generation projects will be able to fit there". A 2022 roadmap for offshore wind in Colombia identified three zones in the Caribbean Sea that have a potential of up to 100 GW. At that time the then Minister of Mines and Energy, Diego Mesa, said: "Portugal thinks of itself as the green hydrogen producing region for Europe and also wants to be the port where green hydrogen imports arrive to distribute in the rest of the European continent. We can be, on the other hand, that place where green hydrogen is exported."

Wind to play major role in Vietnam Power Development Plan

■ Generating capacity to reach 150 GW by 2030 ■ Offshore wind to grow from zero to 6 GW

Syed Ali

Vietnam has approved its National Power Development Plan VIII (PDP8), notably including big plans for wind power generation.

Under the Plan, the country's power generation capacity is set to reach around 150 GW by 2030, up from 69 GW in 2020. Requiring $134.7 billion of investment for the development of power sources and grid infrastructure this decade, the Plan sets a target of 6000 MW of offshore wind by 2030. Onshore wind is planned to reach 21 880 MW, representing 14.5 per cent of the power mix.

A key goal of PDP8 is to ensure energy security in view of a projected GDP growth of an average 7 per cent a year between 2021 and 2030. The government says that with the Plan, it aims to put Vietnam in the top four countries in ASEAN in terms of power reliability.

This will be helped by a programme to install rooftop solar panels on half of the country's office buildings and homes by 2030. Overall, solar PV capacity will account for 12 836 MW, or 8.5 per cent of the generating mix at the end of the period.

The government's PDP8 for the period 2021-2030, with a vision to 2050, seeks to increase the share of renewable energy in the country's power mix to between 67.5-71.5 per cent by mid-century.

The development plan is important to unlock $15.5 billion of green-transition funds pledged to Vietnam in December by the Group of 7 nations and other wealthier countries, but its approval had been delayed for years amid internal squabbles and complex reforms.

The 6 GW 2030 target for offshore wind capacity, from zero today, is expected to attract billions of dollars of foreign investments. Capacity could soar to over 90 GW by 2050, according to the targets indicated by the Vietnamese government.

■ Construction has been launched at the 600 MW Monsoon cross-border wind project in Laos, set to create Southeast Asia's largest onshore wind turbine complex, which will export electricity to Vietnam. The wind park, together with a dedicated 500 kV transmission line, will be built in the Sekong and Attapeu provinces and will sell its electricity to Vietnam Electricity (EVN) under the 25-year power purchase agreement.

India's pledge to stop new coal power plants could hit key states

India's plans to stop building new coal fired power plants, beyond those already under construction, could pose a serious challenge to several key states that are major contributors to the national economy and remain overwhelmingly reliant on coal for electricity generation.

The new proposals make clear that whatever coal capacity is already under construction will proceed. A total of 32 000 MW of new coal power is currently being built in India, according to the Global Energy Monitor (GEM). Once completed, that would boost current operating capacity by close to 14 per cent, and lift total Indian coal capacity to beyond 266 000 MW, GEM data shows.

The new draft policy, which still has to be approved by the federal cabinet, would affect India's three largest states by gross domestic product (GDP) – Maharashtra in the west, Tamil Nadu in the south, and Uttar Pradesh in the north. According to think-tank Ember, the states relied on coal for over 75 per cent of their collective electricity generation in 2022. Several other major states, including West Bengal and Telangana are even more reliant.

The findings highlight the scale of India's task as it tries to plot an effective national decarbonisation roadmap that does not jeopardise economic momentum and job growth.

As the majority of developing nations reduce coal capacity to fulfil climate commitments, India and China account for nearly 80 per cent of all coal projects that are now under construction.

Clean energy investment flows into Philippines

The Philippines is proving increasingly attractive for clean energy investors, as highlighted by several significant announcements last month.

In mid-May Singapore-based Blueleaf Energy of the Macquarie Group said it plans to aggressively expand its portfolio of renewable energy projects in the Philippines in the next five years, with its sights set on developing solar, wind, and battery energy storage facilities.

Blueleaf Energy CEO Raghuram Natarajan said the company intends to build 2-3 GW of renewables in the Philippines over the next five years. "That's roughly 2000 MW at least in the next five years. And that would translate to an investment commitment in excess of $2 billion," Natarajan said.

The news follows another announcement earlier in the month, with ACEN Corp. saying it plans to spend up to around $8 billion for the rollout of its 8 GW portfolio of clean energy projects in the Philippines by 2030.

"If you look at the rough average cost of solar and wind, it is about $1 million per MW, approximately. Solar is about $700 000/MW at least in the Philippines, then wind is in the $1.4 -1.6 million/MW range," Eric T. Francia, President and CEO of ACEN, said during a media briefing.

The announcements came as President Ferdinand Marcos, Jr. inaugurated the 160 MW Peso11.4 billion ($204 million) Pagudpud Wind Project. The project was started in 2021 and will reach full capacity by the end of this year.

Marcos said the Philippines had the potential to be a "major wind power producer" in the world. "Our unique topography is very suitable for building offshore wind farms, and we should take advantage of it to produce cheap electricity," the President said in a statement.

"If optimally developed," he noted, "offshore wind will play a major role in our country's goal for a low-carbon future, improved energy security and reduced dependence on import fuels."

The government's desire to use low-carbon, secure energy has also led to nuclear being considered.

In a recent meeting with President Marcos in the US, NuScale Power, a publicly traded American company that designs and markets small modular reactors (SMRs), relayed its intentions to build SMRs worth up to $7.5 billion in the Philippines.

During a five-day visit to the US in early May, Marcos said: "We need everything (to address the energy problem)… and this new technology is something."

Last September, Marcos met NuScale executives during a working visit to New York.

Philippine presidential communications secretary Cheloy Garafil said the project was an unsolicited proposal of NuScale and its Philippine partner, Prime Infrastructure Capital, controlled by tycoon Enrique Razon Jr. Razon was among a group of business leaders accompanying President Marcos on his first official trip to Washington.

Thailand ramps up shift to renewables

Thailand, which has so far been slow to embrace renewables, is being forced to ramp up its wind and solar ambitions as a result of the energy crisis, according to a government official.

Wattanapong Kurovat, Director-General of the Energy Policy and Planning Office has now said the country must reduce dependence on imported fuel and rethink its renewable energy strategy following last year's surge in natural gas prices sparked by Russia's invasion of Ukraine.

"When we called on renewables plants to sell us more energy last year, we found that what we had was really all there was," Wattanapong said. "We couldn't call for more when we needed it."

As part of an energy security push, the government in April announced winners for a power purchase plan covering roughly 5 GW of renewables – the biggest feed-in-tariff programme to date – that is set to essentially double wind and solar capacity by 2030. On top of that, authorities are now also planning another round for 3.67 GW later this year, Wattanapong said.

The move marks a change in direction for Thailand, which had stalled new wind and solar in preference for natural gas for years as a transition fuel, to now adopt cleaner sources. Renewable projects in emerging countries like Thailand often struggle to gain a foothold due to grid constraints, red tape and a lack of funding.

Thailand has, therefore, historically depended heavily on LNG imports for power generation, resulting in sky-high costs after spot prices surged last year. The Electricity Generating Authority of Thailand (Egat) was saddled with roughly Baht150 billion ($4.32 billion) in costs to curb utility bill hikes last year.

The government's next power development plan, which is expected to be proposed later this year to a new cabinet, will have more ambitious renewable energy goals, said Wattanapong. The revisions are also aimed at helping Thailand reach its climate goals to cut emissions by 30-40 per cent by 2030, on a path to reach net zero by 2065.

Renewables will account for more than 50 per cent of the power generation mix by 2037, up from about 20 per cent in the current plan, said Wattanapong. Falling domestic gas production is also driving the urgency.

Egat said it would invest almost Baht300 billion to increase its power generation capacity from floating solar farms at its nine hydropower plants to 10 GW by 2037. The government has already approved its plan to develop 2725 MW from floating solar farms at the nine dams.

Offshore wind tenders continue to roll out across Europe

- Multiple areas of Adriatic and Aegean seas set aside
- Baltic Sea tenders expected this year

Janet Wood

The European Union has granted €252 000 ($270 000) of funding, as part of its Connecting Europe Facility (CEF), for feasibility studies for a 300 MW offshore wind farm in the Northern Adriatic coastal zone near Croatia and Italy.

The initiative is one of many offshore wind projects being progressed across Europe, despite pressure on the industry's supply chain, concerns over scaling up of offshore wind turbines and a wish list for government support.

The EU's current targets for offshore wind – which call for 60 GW by 2030 and 300 GW by 2050 – are in addition to those set by countries outside the EU such as the UK and Norway. The continent could have up to 450 GW of offshore wind in operation by 2050.

As projects continue to be delivered in the southern North Sea, attention has also turned to other offshore areas. The CEF funding for Croatia's initial offshore wind farm will tap just a small part of the potential resource in the area. Croatia's offshore wind potential is seen at up to 25 GW, according to a new report funded by the European Bank for Reconstruction and Development (EBRD).

"The identified potential of up to 25 GW of offshore wind capacity in low-impact areas alone could turn Croatia into a major European player in the renewable energy sector over the next decade," said Victoria Zinchuk, EBRD Director for Central Europe. The study identified more than 29 000 km^2 of offshore area available for renewables, including offshore wind, both bottom-fixed and floating.

Elsewhere, Greece has recently selected five areas to accommodate 2.1 GW of offshore wind turbines in the north and central Aegean, according to recent reports, in what will be the first phase of its offshore wind deployment programme.

In the north, a site off Alexandroupoli has been designated as suitable to become home to pilot projects totalling 600 MW. Three areas in the central Aegean could each accommodate a 300 MW wind farm while a location off eastern Crete could host a 600 MW complex.

Greece is targeting at least 2 GW of offshore wind by the end of the decade, most of it floating wind.

In the Baltic Sea European Energy and Vårgrønn have announced a long-term strategic partnership to pursue opportunities off Lithuania, Estonia and Latvia. The three states are considered to have 15.4 GW of possible capacity and tenders are expected in Lithuania and Estonia this year.

Solar expansion seeks new options

- Major push on rooftop PV in Germany
- Offshore solar and co-location with agriculture under investigation

Janet Wood

Germany is about to accelerate the deployment of solar energy across the country.

It recently proposed a new strategy after consultations in March and April. It promised: faster approval procedures for ground-mounted solar farms; a boost for rooftop commercial and industrial solar installations; measures to speed up and simplify grid connection; actions to build industrial production capacity; skills investment; and removal of tax hurdles.

Economy Minister Robert Habeck said that Germany is well on track to meet its 2023 target of 9 GW of new solar capacity. The country's Federal Network Agency also recently opened a new rooftop solar tender looking for 190 MW of capacity. It hopes to reach 650 MW in three calls this year.

European countries have redoubled their efforts to install solar PV on rooftops and co-locate it with other activities as the solar industry encounters push-back over large-scale use of agricultural lands.

A recent report from McKinsey & Company highlighted land availability as a major constraint in expanding both wind and solar capacity. The report, 'Land: A crucial resource for the energy transition' said new renewable installations in France, Germany and Italy alone would affect an area the size of Belgium (up to 35 000 km^2) by 2040. McKinsey notes that technical and environmental constraints place limitations on the land available.

Raffael Winter, Partner at McKinsey said: "Land availability is crucial to other societal and environmental objectives, such as agriculture and biodiversity conservation. This creates increased competition for what are all extremely important issues. It's vital for businesses and regulators across Europe to act hand-in-hand to ensure that RES development is land-efficient and biodiversity-enhancing by harnessing deployment strategies that can ensure sustainability and promote a comprehensive approach."

The pressure on land has prompted research into solutions like Agri-PV, a multi-functional agricultural system that combines crop production with solar energy production. The Danish government-funded project will be developed in collaboration with European Energy, Aarhus University, Copenhagen University, and Slagelse Municipality.

The project will explore intensive use of field robots, increased biodiversity, the technical and economic viability of the system, and the acceptance of farmers and the surrounding community.

"We are excited to participate in this project to develop and mature the potential of agricultural and energy production, thus establishing a solid foundation for future larger projects," said Mads Lykke Andersen, Head of Solar Energy Innovation at European Energy.

Other options are also under investigation. The Netherlands recently announced a €28 billion ($30 billion) package to achieve its climate goals in 2030 that included building 3 GW of offshore solar by 2030.

Sharing 'cuts costs for wind and wave'

Wind and wave energy projects can reduce their levelised cost of energy (LCOE) if they share infrastructure, services and a supply chain, according to a new report produced for Wave Energy Scotland.

'Wave and Floating Wind Energy – Opportunities for Sharing Infrastructure, Services and Supply Chain', investigated a range of sharing opportunities. It found LCOE savings of up to 7 per cent for wind power and up to 40 per cent for wave energy, while the combined LCOE of a shared project can be up to 12 per cent lower than in separate developments.

Cost reductions are shown to be available to both wind and wave technologies without needing to consider fully hybrid wind/wave platforms – an option considered to be too high-risk at this stage.

Wave energy can be integrated by placing individual megawatt-scale devices in clusters between floating wind turbines or by mounting numerous wave devices on floating wind substructures, sharing their supply chain and manufacturing processes.

WES Managing Director Tim Hurst said: "The conclusions from this report provide a promising starting point for cross-sector discussions, supporting the launch of a more detailed optimisation and feasibility study, and WES looks forward to progressing this development for the sector."

Scotland is already creating a huge supply chain and services network to satisfy the massive offshore wind capacity leased through the ScotWind programme.

EU cuts both demand and fossil fuel use last winter

Nearly every EU state reduced energy demand last winter and renewables generated more than fossil fuels for the first time ever, according to energy think-tank Ember – despite extended outages in France's nuclear power plants.

Overall energy demand fell by seven per cent. But fossil fuel generation dropped by 12 per cent compared to 2021 – coal power was down 11 per cent and gas was down 13 per cent.

Fifteen of the 18 coal-using EU countries reduced coal use, with the biggest users – Poland and Germany – making up 70 per cent of the reduction.

Ember's analysis found that between October 2022 and March 2023 renewables provided 40 per cent of the EU's electricity compared to 37 per cent from fossil fuels.

Although most EU states reduced electricity demand over the winter, only Romania, Slovakia and Greece achieved a voluntary target of 10 per cent. On average, demand fell by 6.2 per cent between November and March.

"Europe faced a crisis winter, with spiralling energy costs and supply concerns triggered by Russia's invasion of Ukraine," said Ember analyst, Dr Chris Rosslowe. "The EU got through those difficult months, but it can't rely on emergency demand cuts and mild weather for future years."

Lithuania follows Ukraine to synchronise with Western Europe grid

Lithuanian grid operator Litgrid says successful test operations in which it cut connections with the Russian power grid have paved the way for plans to synchronise Lithuania's grid with Western Europe.

Lithuania halted energy imports from Russia last year but it is still part of a common synchronised electricity grid with Russia and Belarus dating back to the Soviet era.

Lithuania's electricity needs were fully secured by its own generation and imports from Poland and Sweden.

"Another and extremely significant step closer to the day when we will be where we belong – in the European grid!" wrote head of government Ingrid Simonyte on Facebook after the successful test, while Energy Minister Dainius Kreivys spoke of a "big step towards energy independence". Lithuania is also set to be further connected to Estonia and Latvia via offshore wind connections.

Estonia and Latvia have also halted imports from Russia, but are not technically ready to synchronise with the Western European grid. Meanwhile, Ukraine has increased exports to Western Europe after a six-month gap. The country's electricity network was synchronised with Western Europe immediately after Russia invaded, after plans to switch it away from the Russian grid were brought forward. It is currently able to export power via a 400 MW link.

High cost 'main hurdle' for nuclear in growth trajectory to 2050

- Cost of new nuclear and SMRs principal obstacle to adoption
- Next decade will be critical to long-term success

Nadia Weekes

Global nuclear capacity is projected to increase by 280 GW by 2050 as countries look to boost decarbonised sources of electricity, according to a report by consultants Wood Mackenzie, provided costs are reduced.

David Brown, Director of the Energy Transition Practice at Wood Mackenzie and lead author of the report, said the nuclear industry must address the cost challenge urgently if it wants to capitalise on the significant growth potential offered by low-carbon power.

The high cost of new nuclear and small modular reactors (SMRs) is likely to remain a major obstacle to their adoption, despite policy support and market growth. Currently, the cost gap between nuclear and other forms of low-carbon power generation is too substantial for nuclear to experience rapid growth.

SMRs are designed to be modular, assembled in factories and scalable. They are expected to reach the market faster, with a target construction time of three to five years compared with the ten years needed for a large pressurised water reactor (PWR).

Wood Mackenzie's modelling indicates that if costs can drop to $120/MWh by 2030, SMRs will be competitive with nuclear PWRs, gas and coal (both abated and unabated) in certain regions around the world. Further price reductions are anticipated between 2040 and 2050 as SMRs benefit from economies of scale and improved market economics.

The rate of expansion for SMRs will depend on how quickly costs can be reduced. Wood Mackenzie estimates that conventional nuclear power currently has an electricity cost that is at least four times higher than wind and solar power when considering the levelised cost of electricity (LCOE).

Up until 2030, SMRs are projected to have a limited presence in the power market due to high costs impeding their rapid deployment. With the decade already progressing and the time required for construction, it is now evident that only a few plants can be built at best.

According to industry estimates, the cost of a first-of-a-kind (FOAK) SMR could range from $6000/kW to $8000/kW, with Wood Mackenzie analysts expecting FOAK costs to be on the higher end or even above, as developers undertake early-stage projects.

Wood Mackenzie's tracking of the SMR sector indicates that there are only six potential FOAK SMR projects in the pipeline between 2023 and 2030, with the capacity of each facility ranging from 80 MW to about 450 MW.

The amount of investment in FOAK SMRs remains uncertain and will be influenced by factors such as financing terms, commodity costs, uranium availability and political support.

Wood Mackenzie estimates that, between 2030 and 2040, it will be necessary to have 10-15 projects with a combined capacity of 3000- 4500 MW to support reduced SMR costs.

Nuclear must compete with a number of electricity decarbonising technologies including hydrogen-fired power, gas or coal with carbon capture and storage, geothermal and long-duration energy storage. All of them are expensive and require technological advancements to establish a strong foothold in the market, the report finds.

- Korea Hydro & Nuclear Power, Samsung Heavy Industries and Seaborg Technologies have formed a consortium to develop floating nuclear plants with Seaborg's innovative molten salt reactor technology.

Israel launches national hydrogen integration plan

Israel has launched a comprehensive national plan to integrate hydrogen into the country's energy landscape as part of the Ministry of Energy's efforts to decarbonise the economy.

The ministry estimates that hydrogen demand for electricity, heavy transport, industry, aviation and shipping could reach 5.2 million tonnes in Israel in 2050.

The multi-year plan includes the promotion of research and development (R&D), regional hydrogen valleys and other infrastructure. It also proposes the introduction of flexible regulation for integrating hydrogen into the energy sector.

R&D and demonstration projects are intended to provide solutions to major challenges such as high costs, logistical and safety issues, and the efficiency of hydrogen production, storage and use.

The hydrogen valleys will cover the entire value chain, from production technologies, through storage and transport to final use in industry, transport and energy.

The promotion of the necessary infrastructure will include the setup of dedicated fuelling stations, underground hydrogen storage, and testing the feasibility of transporting hydrogen in natural gas pipelines.

The ministry also intends to promote international collaboration to help develop technologies, reduce costs, create new trade relations and diversify available energy sources.

Kazakhstan forges international hydrogen and renewables partnerships

Kazakhstan's Prime Minister, Alikhan Smailov and the European Commission's Executive Vice-President, Valdis Dombrovskis, approved a roadmap for the secure and sustainable supply of raw and refined materials and the development of renewable hydrogen and battery value chains, with the aim of promoting the green and digital transformation of both economies.

The document addresses crucial topics such as the modernisation and decarbonisation of the Kazakh mining industry, while foreseeing closer cooperation on geological exploration, research and innovation.

In a separate development, Kazakh government officials and representatives from Chinese companies State Energy Investment Corporation of China (CPIH) and SANY Renewable Energy signed a memorandum of understanding on the building of a 1 GW wind farm complex in the Jambul region of Kazakhstan.

An energy storage facility will be built next to the wind farm to smooth out fluctuations in wind generation. CPIH intends to build factories in Kazakhstan for the production of wind turbine towers, blades and other components.

Wave energy technology could support Namibia's decarbonisation

- Strong wave resource makes of Namibia an ideal location
- Ambition to become a leading green hydrogen exporter

Nadia Weekes

Finnish AW-Energy, a player in nearshore wave energy technology, has signed a memorandum of understanding with Namibian company Kaoko Green Energy Solutions for the development of renewable energy and the production of green hydrogen from renewable sources including wave energy.

AW-Energy is behind WaveRoller, a commercial-scale wave energy converter unit that is submerged nearshore and generates electricity from the movement of the waves through the surge phenomenon.

Christopher Ridgewell, CEO of AW-Energy, said: "With an energetic and consistent wave resource Namibia is very well positioned to utilise the benefits of wave energy to enable sustainable industries and jobs."

Sacky Nalusha, a director for Kaoko Green Energy Solutions, said that creating opportunities for innovative solutions and partnerships could grow the energy sector, which is currently underdeveloped in southern Africa. "Ocean waves have the potential to provide a sustainable solution to our energy needs and demands," he added.

Phase 1 of the collaboration will include a detailed site design and the fabrication and deployment of a WaveRoller wave farm on the coast of Swakopmund to deliver renewable power to the area. Phase 2 will assess the capacity for wave farms in other Namibian locations. Finally, Phase 3 will expand wave energy plants to deliver power to the grid and explore options to support desalination and green hydrogen projects.

Namibia's Green Hydrogen Council launched its green hydrogen strategy at COP27 in Sharm El-Sheikh, Egypt. The strategy sees Namibia become a net exporter of hydrogen.

"Combined with other renewable energy sources such as solar, WaveRoller enables significant cost reductions in green hydrogen production and represents a viable solution in the drive to execute the world's clean energy hydrogen roadmap," according to Ridgewell.

Green shoots for wind turbine manufacturers?

- Vestas reports €15 million Q1 profit
- Nordex grows sales revenues due to higher installation output

Junior Isles

Wind turbine manufacturers are beginning to see improved financial results as the impact of global headwinds appears to be easing.

Last month leading wind turbine manufacturer Vestas said it returned to profit in the first quarter, reporting a net profit of €15 million ($16.4 million) in the first three months of the year. By comparison, the group had posted a loss of €765 million in the first quarter of 2022.

The results mark a return to profit after a year that resulted in the Danish company recording a loss of €1.2 billion in 2022 after Russia's invasion of Ukraine impacted the group's business. The company, which announced in April last year that it was leaving Russia following its invasion of Ukraine, cited the fallout from the war and supply chain disruptions for last year's losses. Like other manufacturers, it was also affected by increased competition and soaring metal prices.

"Vestas has had a good start to 2023," said Chief Executive Henrik Andersen.

The first quarter got a boost from the sale of the company's converter business, lower warranty provisions and "solid profitability" in its service division, he said.

Wind turbine orders rose by 12 per cent in the first quarter and revenue was up 14 per cent to €2.8 billion as deliveries increased.

But Andersen cautioned that there was still "a long way to go" for the full year. "The wind industry remains challenged by political uncertainty, slow permitting processes, and high inflation, which we expect to continue throughout 2023," he said.

The group maintained its 2023 forecast unchanged, with sales ranging between €14 billion and €15.5 billion with an operating margin of three per cent.

Germany's Nordex Group also saw promising Q1 results, reporting sales of €1217 million. It said this growth in the first three months of the year is attributable to higher installation output than at the start of the previous year. Both the average installed capacity (in MW) per turbine and the number of installed wind turbines increased.

Nordex erected 276 wind turbines in 19 countries with an aggregate output of 1319 MW in the first quarter of 2023. In the prior-year quarter, 197 wind turbines with an aggregate output of 867 MW were installed in 12 countries.

"Overall, the year began as expected and we increased our installation output in the first quarter," said José Luis Blanco, CEO of the Nordex Group. "We are still focused on processing our order book efficiently, as the high costs associated with old projects are still adversely impacting our margins. In this respect, we expect to steadily improve our profit margin over the course of the year due to our revised pricing and contract arrangements. Overall, we continue to see improving volumes in our key markets, on the back of positive political momentum."

Companies seek electrolyser opportunities

The growing market for hydrogen production equipment is spurring electrolyser manufacturers to explore new opportunities.

US turnkey hydrogen solutions provider Plug Power Inc announced in May that it is in the final stages of negotiating large-scale project opportunities for its electrolyser business in the US, Europe and Asia-Pacific, representing potential bookings surpassing 1 GW.

In a letter to investors the company's President and CEO Andrew Marsh and CFO Paul Middleton, said the "sales funnel" for electrolysers exceeds $30 billion and about half of it relates to e-fuels, including green ammonia and methanol. Its backlog tops 2 GW across large-scale projects and 1 MW to 5 MW containerised solutions.

Plug also said it expected its Gigafactory in Rochester, New York, to reach its 100 MW/month target for electrolysers by the end of May. The facility is ramping up production towards its annual run rate of 2.5 GW of total capacity, with 1.5 GW dedicated to electrolysers.

Elsewhere, French oil and gas services group Technip Energies announced a hydrogen green solutions joint venture (JV) with Belgian group John Cockerill. The JV, named Rely, will be 60 per cent owned by Technip Energies and 40 per cent by John Cockerill, and aims to reach revenues of more than €1 billion by 2030, the group said.

Rely will offer end-to-end solutions, from pre-final investment decision services through to proprietary products, project execution and operation and maintenance, Technip said.

Technip, which specialises in engineering and technology for the energy industry, also posted stronger-than-expected first-quarter core profit, citing strong performance in the segments and an order intake benefitting from important awards in ethylene, carbon capture and sustainable fuels.

Technip's Project Delivery segment, supported by a robust LNG and customer spending cycle, should see a significant improvement in order intake during 2023 and 2024, the company said.

Trina Solar reports increase in revenues, as solar market soars

- Annual revenues up 83 per cent
- Investment in solar to hit $382 billion this year, says IEA

Junior Isles

Trina Solar has seen an increase of 83 per cent in year-on-year revenues, as it reported its full year 2022 results.

The company recorded an annual global revenue of $12.645 billion (RMB 85.052 billion), representing an increase of 83.41 per cent on 2021. Trina Solar's main businesses – including PV products, PV systems and smart energy – all registered strong growth.

The company also said that its module shipments in 2022 totalled 43.09 GW and cumulative module shipments exceeded 140 GW by the end of March 2023.

Gonzalo de la Viña, President EMEA at Trina Solar, said: "Our strong growth was driven by increase across all our product and solution lines, infrastructure, and applications. Trina Solar's business now exceeds $12 billion in annualised revenue. We remain the overwhelming market leader in a number of market categories and our technically advanced and highly differentiated business is driving the net zero revolution throughout the region."

The impressive results reflect strong growth in the global solar PV market. According to the International Energy Agency (IEA), total spending in solar was around $325 billion in 2022 and is forecast to hit $382 billion this year.

In its 'World Energy Investment 2023' report, the IEA said China alone added over 100 GW of solar PV capacity in 2022, almost 70 per cent higher than in 2021, and annual installations increased by 40 per cent or more in Europe, India and Brazil, despite inflation and supply chain issues.

The report noted that module prices were around 20 per cent higher in early 2022 y-o-y, but started to come down in early 2023 as input costs declined (solar grade silicon and wafers) and manufacturing capacity expanded (largely in Asia).

SSE ploughs investment back into clean energy as profits soar

UK power group SSE says it plans to ramp up investment in clean energy projects and networks following an almost 90 per cent increase in full-year profits.

With profits boosted by high electricity and gas prices over the last year, the company now plans to invest £18 billion ($22.2 billion) by 2027 and potentially as much as £40 billion through to 2030. This is around 40-50 per cent higher than under previous plans outlined last year.

Alistair Phillips-Davies, SSE's Chief Executive, said the upgrade followed "strong financial performance" over the year as well as the resilience of its business and balance sheet.

He warned, however that the increased investment would require the right policies and commitments from government.

"We have lots of shovel-ready projects, what we're encouraging government and policymakers to do now is get into delivery mode," Phillips-Davies told the *FT*.

SSE also said it had abandoned moves to sell a minority stake in its UK electricity distribution network, having concluded the sale was not needed "at this point in time".

The company's adjusted pre-tax profits for the full year ending March 2023 climbed 89 per cent from £1.16 billion to £2.2 billion. The biggest increase came from its gas assets. Adjusted operating profits from its gas fired power plants soared 244 per cent to just over £1 billion.

SSE's announcement came as European gas prices fell to their lowest level since the start of the energy crisis. The European TTF benchmark hit a low of €35.20/MWh in early May, a level last seen in July 2021, as mild weather destroyed demand and alternative LNG gas sources hit the market.

Gas prices still remain elevated compared to historical levels, however. In 2019 TTF averaged less than €15/MWh and the pre-crisis peak for prices was €29.17 in 2018, which even adjusted for inflation is still slightly below where prices are trading today.

Closing the circle on offshore wind

Offshore wind is central to the EU meeting its renewables and decarbonisation targets. Meeting those targets is a huge task in terms of building and connecting wind farms at the necessary pace. And when those targets are met, there is the question of what to do with the masses of old, end-of-life turbine blades that are currently destined for landfill or other processes that emit CO_2 and jeopardise the circular economy. **Junior Isles** speaks to experts from Siemens Energy and Siemens Gamesa about these pressing issues.

In January this year, the EU agreed on new, ambitious long-term goals for the deployment of offshore renewable energy up to 2050, with intermediate objectives to be achieved by 2030 and 2040.

According to the European Commission's calculations, the region will need to install about 111 GW of offshore renewable generation capacity by the end of this decade – nearly twice as much as the objective of at least 60 GW set out in the EU Offshore Renewable Energy Strategy in November 2020. And beyond 2030, the sector must add 215-248 GW by 2040, and 281-354 GW by 2050.

Starting from an installed base of 16.4 GW in 2021, it is a huge task. Connecting thousands of turbines each year to meet climate change targets will be a monumental challenge but looking further ahead, there is also the question of tackling the impact of these turbines on the environment at the end of their life. What to do with wind turbine blades from decommissioned wind farms is now increasingly being recognised as a looming environmental problem.

According to Siemens Gamesa estimates made in 2021, there could be as much as 200 000 offshore wind turbine blades in Europe that will be installed for offshore use by 2050. This means there could be more than 10 million tonnes of recyclable material that could be reclaimed.

Commenting on the scale of the problem, Jakob Mænnchen, Head of Casting at leading offshore wind turbine supplier, Siemens Gamesa, said:

Mænnchen was part of a multi-disciplined team that developed the RecyclableBlade

Siemens Gamesa RecyclableBlades leaving the blade factory in Hull (UK) for the Kaskasi offshore development (Germany)

"Of course targets have shifted a bit over the last few years, so I imagine it could be more. But regardless, the sheer size of the number is absolutely huge. There are some energy intensive and costly ways of getting rid of the blades; and other things have been tried, such as mixing them in cement kilns. But normally, blades are sent to landfill at the end of their life. But because the materials they are made from are quite stable, they just remain there. This doesn't send the right message."

Not to mention that the disposal of such quantities of blade material would likely call for the creation of new landfill sites.

To address the problem, Siemens Gamesa launched its RecyclableBlade product in September 2021. Just ten months later, the world's first commercial recyclable blades entered operation at the Kaskasi offshore wind farm in German waters.

The wind farm will operate at a nominal output of 327 MW and, in boost mode, at a maximum capacity of 342 MW – generating enough clean energy for up to 400 000 homes across Germany. Kaskasi features 38 SG 8.0-167 DD offshore wind turbines, with each blade measuring 81 m in length. Thanks to the use of the RecyclableBlade at this project, further significant CO_2 reduction will be achieved using the recycled blade materials in new products.

The blades are the result of a development process that has lasted about five years. Explaining the thinking behind it, Mænnchen said: "Because wind turbine blades are very strong composite materials, they are hard to breakdown; it requires a lot of energy or costly applications to dispose of them afterwards. That's why they are disposed to landfill. Some ask why there hasn't been a solution until now but you must remember that we are still quite a young industry."

He added: "But because Siemens Gamesa is a company that wants to create green, sustainable solutions, it was very important for us to look into this. So we decided to develop this new composite blade with a more circular approach."

Siemens Gamesa developed a multi-generation plan that contained its ideas for materials to be used in the blade. This laid down a path to begin discussion on what the technical properties and sustainability requirements were for its development in the short-, mid- and long-term. While the company shared its proposal with all its resin suppliers, it was Indian-based

Aditya Birla Advanced Materials, an expert in epoxy resins, that was able to come up with an idea that met the requirements.

The research and development team at Aditya Birla worked in close co-ordination with Siemens Gamesa's technology team to develop a novel recyclable epoxy resin system, leveraging the company's proprietary Recyclamine technology.

Essentially, the blades use a recyclable resin system that enables recovered blade materials – the resin, fiberglass, and wood, among others – to be reused and repurposed, bringing them back into the system and closing the loop. The resin has been designed for extra slow reactivity to enable improved processability and to cure faster than conventional materials, thereby contributing towards lowering cycle time in wind turbine blade manufacturing.

Importantly, the blade is also produced the same way as a standard blade and is based on Siemens Gamesa's existing IntegralBlade manufacturing process. This means there is no increased implementation risk associated with the new resin system.

Mænnchen was part of a multi-disciplined team that worked on the technology in the early stages. Explaining how it works, he said: "Composite blades consist of a 3D matrix chemical structure, where everything is bound together to make it incredibly strong. The technology we use introduces a new linkage in the chemistry of this backbone that can only be separated under certain specific conditions. But they are conditions that are quite easy to achieve."

By using a common acetic acid and raising the temperature to 80°C, this link can be activated in order to separate the composite's base materials. "It is an innovation in adapting common products and well-known chemistry to break this small linkage," said Mænnchen. "Basically, you take down the blade, cut it into pieces, place it in a tub of acid and boil it for 3-4 hours.

"It's one of those things that sounds really simple once you've done it, but getting to that point takes a lot of research and development.."

Although the wind industry represents only about 10 per cent of the total composite waste, European project developers were quick to embrace and drive the technology.

"Talks and initial development began about five years ago. As soon as we actually started producing the blades and doing the initial testing of the recycling, things moved very quickly. Taking just a few years for development is a very short time in our industry. We were the first to go out with a solution like this", noted Mænnchen.

"When we announced the blades and went to project developers, they were very eager to learn about this solution. It's really about having the same mindset across the board – from OEM to developer – to foster an innovation like this."

With the Kaskasi project already up and running, it was not long before RWE again opted for Siemens Gamesa's RecyclableBlades for 44 of 100 SG 14-222 DD offshore wind turbines to be installed at the Sofia offshore wind power project off the east coast of the UK. This project will utilise RecyclableBlades measuring 108 m long, representing the first deployment of this variant.

When these blades do eventually reach the end of their life, Siemens Gamesa says it will advise on the recycling process.

"Although we produce and service the products, after they are in place, we do not own them and are not responsible for decommissioning them and doing the recycling; that's down to the project owner and whichever recycling companies that will be handling it," said Mænnchen. "But of course we have a vested interest in ensuring it's done right. It can of course be done in different ways, depending on what you want out of it, but we will advise on how to do it when we deliver products."

Mænnchen confirmed the process and RecyclableBlades have been tested to ensure they are not affected over their lifetime by environmental conditions such as acid rain, and that when the blades are decommissioned, the reinforcements, core materials, plastics and metal parts can be easily recovered in good quality and value.

He noted, however, that the "process design" of the recycling facility, needs to be refined. "After the recycling process is complete, you will have a mix of your fibres, core material, and thermoplastic material. The core material and fibres can be removed, cleaned and used for other purposes. The thermoplastic material then has to be filtered out from the acidic solution. This can be done by centrifuge or neutralisation of the solvent; it can be done in different ways. It just depends on what is the most efficient path, and the expertise of the recycling facility."

One notable point, he adds, is that there will be a big industry using materials from the RecyclableBlade for other things such as printed circuit boards, and consumer electronic devices.

Mænnchen noted: "This means there will be recycling techniques and facilities that are accustomed to using materials like this. We can draw on existing experience."

Although there is a slight premium on the price of the RecyclableBlade compared to conventional blades, Siemens Gamesa notes that this is mitigated by the fact that project owners can use and sell recycled materials and also avoid paying for landfill.

Arguably, these considerations should be rewarded in the auction process if the industry is to continue developing innovations that protect the environment. The circular economy is vital to a sustainable future and, argues Siemens Gamesa, when making the decision on a project-winning developer, it should not come down

The RecyclableBlades being transported from Hull to the Kaskasi offshore development

Converter platform of the BorWin3 grid connection in the German North Sea. The grid connection system BorWin3, which can bring 900 MW of wind energy onshore, began operation in August 2019

Inside a high-voltage direct current converter hall

just to price. Additional qualitative criteria can include but are not limited to recyclability.

The company stated: "Today, most auction processes in Europe and across the world are only focused on price. This makes it difficult for new products – which are more expensive because they are new – to penetrate the market as fast as we'd like to see them. If we want the world to have sustainable products, the system has to appreciate the effort needed to develop and manufacture them."

As the number of offshore wind farms grows in European waters, policies that reward such innovation and encourage technology that makes turbines sustainable, is not the only challenge.

With the need for around 90 projects to meet 2030 targets, Siemens Energy stresses that developments in technology to connect offshore projects like Kaskasi to the onshore grid will be key.

The three-phase current generated by the Kaskasi wind farm is transported to the HelWin Beta high-voltage direct current (HVDC) platform, which is at the heart of the HelWin2 HVDC offshore grid connection in the German North Sea.

HelWin2 uses symmetrical monopole technology, operating at 320 kV direct current for a capacity of 690 MW. It uses Siemens Energy's HVDC PLUS technology to convert power from AC to DC for transport to shore. An onshore HVDC station converts the power back into AC to feed it into the grid. The technology is based around the Modular Multi-level Converter (MMC) for, voltage source converter (VSC) applications.

Outside of Germany the same technology is used to provide higher power capacity, depending on the voltage. In the UK, where the voltage is 420 kV, the power capacity is just over 1.3 GW.

For the EU to reach its ambitious targets for offshore wind, a new standard for connecting wind farms to shore is being adopted. Going forward, there will be more and more bipole systems that also operate at a higher voltage.

The new standard, which has already been adopted by transmission system operators (TSOs), TenneT and Amprion, will see HVDC offshore platforms operate at 525 kV for a capacity of 2 GW.

Andreas Barth, Vice President Tender and Projects Grid Solutions at Siemens Energy, noted: "We will be able to supply more power via a single HVDC connection. The big advantage of a bipole system is that you can even operate the system with half the power in case there is a failure in one of the poles. This gives a much higher availability of the system, since the operator does not run the risk of fully dropping the wind farm from the grid."

One challenge with the higher voltage is the requirement of a larger platform but rather than only optimising the design to reduce platform size, the focus is also shifting to building identical platforms in an effort to speed up the build-out programme.

In April the TSO, in a move that will go a significant way to helping the EU realise its ambition for offshore wind, signed contracts worth €30 billion with four cooperation partners to develop the North Sea as a hub for sustainable and independent European energy production.

With the signing, TenneT has now completed the process of awarding contracts for the sea- and land-based converter stations for a total of 14 offshore grid connection systems, which was launched in August 2022. TenneT had already awarded 11 of these systems at the end of March, eight of them in the Netherlands and three in Germany. Three more systems in Germany were added with the April deal. These 14 systems, each of 2 GW, are to be connected by 2031.

One of the deals will see Siemens Energy in a consortium with Dragados Offshore execute the German projects BalWin3, LanWin4 (both with a connection to the onshore grid in Wilhelmshaven) and LanWin2 (with a connection near Heide). In December 2022, the same consortium was awarded acontract by Amprion to build the converter stations for the German projects BalWin1 and BalWin2 offshore grid connection systems.

Commenting on the German TSO's approach to allow consortiums to employ repeat designs for their platforms, Barth said: "The question of faster implementation and the securing of production capacities has gained in significance in the award decisions. The focus is on being able to connect to the grid on schedule with the expansion targets.

He says that standardisation is key to building and connecting the platforms within what is a relatively short timeframe. "The fact that we have identical designs for all our platforms is a big step forward. We are using identical equipment for all our platforms and therefore only have to design the platforms only once for all 2 GW standard projects. Additionally, we will use the same platform partner, Dragados Offshore, for all our five 2 GW projects in the German North Sea and will build them one after another. This well established partnership allows for faster implementation of the projects."

Work is already well underway on the new platform standard. Based on TenneT's standard design for the platform, Siemens Energy started the detailed design at the beginning of the year and is also optimising it to meet Amprion's requirements.

Platform design work started with system design – the basic design of the electrical grid connection. This involves a study of the offshore grid and which turbines will be used; and onshore network studies to identify where the grid will be connected to the different onshore locations. These network studies provide the basis to the design of high-voltage equipment.

Barth added: "Once the design of transformers, converters, reactors, switchgear, etc., is complete, this is then incorporated into a platform and civil design – a platform design for the offshore and a civil design for the onshore side. This is the moment when we really partner, working with Dragados Offshore on the final design for the offshore platform. The first platform will take more time since the platform design has to be well-thought-out. Subsequent platforms are considerably faster to build since they are based on the same design. We have more time to begin the civil design since this is not on the critical path; and will only take about two years to build."

Siemens Energy is very confident it will meet the necessary schedule. "We have substantial experience. We've already built five HVDC platforms and another 11 are in progress, with DolWin6 soon to be finished," said Barth. "Once that first 2 GW project is complete, the next question is how much more speed can we gain by working with the TSOs. We are now designing the platform, which will take 18-24 months to finalise. However, as implementation continues, there will certainly be more optimisations in the new standard, and as our partner gains experience with manufacturing, logistics, supply chain, manufacturing methodology, etc., these can also be optimised."

The type of framework agreement that TenneT has signed with the consortiums not only helps accelerate the offshore build programme but also provides certainty for equipment suppliers in what has been a volatile market.

"If we need to build four or five platforms, each time we have to book resources in terms of materials as well as people and probably partner with yards to increase our capacity. We also have to think about partnering with civil contractors, installers and staff that can do the commissioning," said Barth. "More certainty through this type of framework agreement allows us to book what we need for the next five platforms. For example, it makes it much easier to go to market to book a jack-up barge and make sure we have the necessary resources when needed."

He stressed that eventually, building HVDC networks will have to be handled similar to how AC grids have been built for decades. "For AC grids, it is straightforward because grid codes are available and control and protection mechanisms are all already defined, etc. For DC, this is not the case because at the moment we just transmit from one point to another. But this will have to change as we are just starting a new type of grid."

The goal is to build DC grids – both onshore and offshore. Although the 2 GW standard is for point-to-point connections, they will also be 'hub-ready' so that at a later stage they can be connected to a meshed grid. This will call for multi-terminal operation.

Barth said: "In the next step the offshore platforms, and even the onshore side, will be connected to each other. This will give the operators even more flexibility, as it will allow them to route energy not only from point-to-point, but also to different locations in the grid."

The cooperation seen for the 2 GW standard will be important in realising the ultimate DC meshed grid.

"It will need alignment between different transmission system operators as well as between the different HVDC suppliers; if they each have their own standard, the DC meshed grid will never work. Aligning on the 2 GW standard was a good first step towards the DC meshed grid. It gives all involved parties more planning certainty so everyone can be aligned for the next step. The alignment must be approached internationally, i.e. it must not only take place within Germany, but also, for example, Germany with UK, France Norway and Sweden. This will allow energy to be exchanged between locations and be used more efficiently."

The ability to shift wind energy to any country at any time is crucial for the proper utilisation of the region's wind resources.

Barth explained: "For example, there is a one hour time difference between Germany and the UK. You may need the energy at 6 pm in Germany but one hour later, it might be better used in the UK. So you would need to flexibly transport the energy from one point to another."

He concluded: "Building this DC grid will be the big challenge for the next ten years and it will require standardisation, certainty, the right regulatory schemes and innovation."

Barth says in the next step the offshore platforms will be connected to each other

Americas

Largest HVDC wind energy project in USA

Hitachi Energy has won a contract from Pattern Energy to supply its HVDC and other technologies for the SunZia Transmission Project, a 3000 MW HVDC link between Corona, New Mexico and Pinal County, Arizona.

When complete, the link will connect the 3500 MW SunZia Wind project in New Mexico to the electricity grids in Arizona and Southern California.

The HVDC Light system will be the largest voltage source converter (VSC) installation in the US and one of the largest worldwide. At more than 880 km, it will also be one of the country's longest HVDC transmission links.

Hitachi Energy has partnered with Quanta Services to provide a turnkey project solution for the SunZia project, including managing the HVDC construction and building installation at the associated project sites.

The HVDC converter stations are expected to be in service by the end of 2025 to support final testing and commissioning of the SunZia Wind facilities in 2026.

Westinghouse to replace Surry steam generators

Dominion Energy has awarded Westinghouse Electric a contract for six replacement steam generators for its Surry Nuclear Power Station in Virginia, USA.

The steam generators will be fabricated at the Westinghouse Italy facility in Monfalcone, Italy. They are based on Westinghouse's original F-Series units with multiple enhancements to maintain top performance. Delivery will start in 2028, with installation beginning in 2029.

Dan Sumner, President of Operating Plant Services for Westinghouse, said: "These industry-leading steam generators will help Dominion deliver safe and efficient nuclear energy into the middle of the 21st century."

This agreement follows a contract signed in 2021 between Westinghouse and Dominion for a major instrumentation and control (I&C) system upgrade.

CANDU refurbishment at Bruce Power

SNC-Lavalin Nuclear, Aecon, and United Engineers & Constructors, forming a consortium called Shoreline Power Group, has signed a 10-year, $1.3 billion agreement with Bruce Power in Ontario, Canada.

The contract is to extend the life of four of Bruce Power's CANDU reactors to 2064. SNC-Lavalin's Canadian nuclear division will provide project management services associated with the reactor refurbishment of Units 4, 5, 7 and 8, the remaining units at Bruce Power that have yet to undergo a life-extension process.

Shoreline Power Group has worked on the successful life-extension of Bruce Power's Unit 6, which is being returned to service later in 2023. Bruce Power's Units 1 and 2 were refurbished in 2012.

The scope of work for the latest agreement includes the overhaul of the core reactor components of the CANDU units. Preparatory work is expected to commence in 2023, with completion anticipated in 2032.

Mitsubishi-CONSAG wins Portocem contract

A consortium of Mitsubishi Power Americas and CONSAG has signed an agreement with Portocem Geracão de Energia for the EPC of the Portocem Thermoelectric Power Plant in Brazil.

Mitsubishi Power will supply four M501JAC enhanced air-cooled gas turbines, while CONSAG will be responsible for supplying the balance-of-plant, utilities, civil works, assembly, and commissioning of the plant as well as implementation of transmission lines and substations.

The four M501JAC gas turbines will operate in simple cycle mode. It will be one of the largest power plants in Latin America with an installed capacity of 1.6 GW. It will be constructed in the Pecém Industrial and Port complex in Fortaleza.

A 6 km transmission line will connect the plant to the National Interconnected System (SIN) through the Pecém 2 substation.

Asia-Pacific

SJVN wins Gujarat 100 MW wind project

SJVN has been awarded a 100 MW grid connected wind power project in Gujarat, India following an open competitive tariff bidding process followed by an e-Reverse Auction.

Japanese offshore wind farm order for Vestas

Hibiki Wind Energy has awarded an order to Vestas for the supply of turbines for the Kitakyushu-Hibikinada offshore wind project, located off Japan's Fukuoka prefecture.

The order includes the supply and installation of 25 V174-9.5 MW wind turbines as well as a long-term Active Output Management 5000 service agreement for the wind farm.

Plafinger Marine was commissioned to deliver 25 of its stiff boom cranes for the Kitakyusyu-Hibikinada offshore wind farm.

Japan's Penta-Ocean Construction was selected as the preferred bidder for the construction of wind turbine foundations and marine civil engineering works for the project.

Suzlon to supply Tamil Nadu wind turbines

Suzlon has won a 39 MW order in India from First Energy 5 Pvt Ltd, part of Thermax Group. Under the contract, Suzlon will supply 13 units of its 3 MW series turbines for a project at Thalaikattupuram, Tuticorin, in the southern Indian state of Tamil Nadu. The wind park is scheduled to be completed next year.

Suzlon will also oversee the erection and commissioning of the turbines, which will use a hybrid lattice tubular tower. It will further provide O&M services once the project is completed.

The wind park is part of a 100 MW wind-solar hybrid project by First Energy.

In addition, Torrent Power has awarded a contract to Suzlon Energy to develop a 300 MW wind power project in Karnataka, India. Suzlon will install 100 wind turbine generators, each with a hybrid lattice tubular tower and a rated generating capacity of 3 MW. The project is scheduled to be commissioned in 2025. Suzlon will also provide O&M services after commissioning.

Europe

TenneT awards 525 kV HVDC system contract

TenneT has awarded a 525 kV HVDC a offshore and onshore cable system portfolio for connecting offshore wind farms to the German electricity grid to Jan De Nul Group, LS Cable & System, and Denys NV.

The combined DC cable length of the awarded portfolio is almost 2000 km. BalWin 4, LanWin 1, and LanWin 5 are cable systems consisting of both offshore and onshore sections, while the NordOstLink is an onshore cable system. BalWin 4 and LanWin 1 will connect to the Unterweser area, and LanWin 5 to Rastede. All grid connections will have a capacity of 2 GW each and will be operational by 2029, 2030, and 2031, respectively.

Polish nuclear power plant agreement

Westinghouse Electric, Bechtel, and Polskie Elektrownie Jadrowe (PEJ) have signed an agreement for the design and construction of Poland's first nuclear power plant.

The Polish Government selected the Westinghouse AP1000 reactor technology in November 2022. Licensing and engineering work is already underway. This agreement enables design activity to start, with a view to enabling the construction contract to start in 2025.

Sweden's Ringhals reactor systems to be upgraded

Vattenfall has awarded new contracts to modernise its Ringhals nuclear power plant in Sweden to Framatome. Under the terms of the contract, Framatome will update reactor control systems using its digital I&C Teleperm XS platform and refurbish the reactor coolant pumps for Units 3 and 4. The modernisation also includes upgrade of the KSU Simulator.

The new reactor control system will be installed and commissioned in 2026 for Unit 3 and 2027 for Unit 4.

In addition to the control system upgrades, Framatome will also refurbish six reactor coolant pumps (RCPs). The RCP internals and motors will be transported to Maubeuge, where they will be inspected and refurbished, including the installation of new stators and the replacement of thermal barrier covers. The refurbished elements will then be shipped back to Sweden to progressively replace the current operating equipment starting 2025 through 2031.

Voith to expand Kruonis pumped storage plant

Ignitis Gambya is investing €150 million in the expansion of the Kruonis pumped storage hydropower facility in Lithuania, with the addition of a fifth unit.

Voith Hydro has been selected to install a pump turbine unit with an output of 110 MW for the project.

Voith Hydro's scope of supply includes pump turbine and motor-generator, converter, transformer, penstock, auxiliary equipment and the necessary civil works to integrate the unit optimally into the existing power plant. Voith Hydro will act as general contractor and is therefore responsible for design, manufacturing and transport, as well as assembly and commissioning of the unit on site.

The facility is set to go into operation by the end of 2026.

North Sea floating solar array

The Dutch startup Oceans of Energy has been awarded a contract to install floating solar panels at an offshore wind farm in the North Sea. It won a contract from CrossWind, a joint venture between Shell and Eneco, to build a 0.5 MW floating solar array between wind turbines at the 750 MW Hollands Kust Noord wind farm, located 18.5 km off the coast of the Netherlands.

The solar panels will be situated in between the offshore wind turbines, providing backup power on sunnier but less windy days.

The panels will be moored to the wind turbines and connected to the same cables, transporting energy efficiently to end-users.

Axpo to build 10 MW solar plant

Axpo will build a 10 MW alpine solar plant in the Disentis ski area in the Swiss canton of Grisons. The plant will provide power for the mountain railway to the area.

The alpine solar plant Ovra Solara Magriel will be built on an area of 80 000 m^2 at an altitude of 2100 m near the La Muotta peak. The plant will have an installed capacity of 10 MW and produce 17 GWh of electricity annually.

Construction is scheduled to start in spring 2024. The first section will be commissioned in autumn 2025 and full commissioning is due in autumn 2026.

International

Mitsubishi wins Sabiya power and water contract

Mitsubishi has been awarded a long-term contract by the Kuwait Ministry of Electricity & Water & Renewable Energy to optimise the performance of the Sabiya power and water distillation station and boost its efficiency, in line with Kuwait Vision 2035 to meet the country's growing power needs and goals for a decarbonised energy future.

Mitsubishi Power will upgrade eight units of steam turbines, generators, and control systems, as well as introducing Digital Electronic Hydraulic (DEH) systems, new Turbine Protection System (TPS) and Turbine Supervisory Instruments (TSI).

The upgrade services will extend the lifetime of the Sabiya Power and Water Distillation Station by 20 years.

Valmet to deliver Sabiya automation retrofit

Valmet will deliver a Valmet DNA Automation System retrofit to Sabiya Power and Water Distillation Station in Kuwait, owned by the country's Ministry of Electricity & Water & Renewable Energy. The new system will replace an existing control system in distillation units 1-8.

Valmet's delivery scope consists of Valmet DNA Automation System including Valmet DNA User Interface (DNA UI) and support services. The system withstands the harsh weather, dust and moisture typical of the region.

The value of the order has not been disclosed. The system delivery will take place in November 2023, the first commissioning phase in spring 2024 and the second commissioning phase in autumn 2024.

6 MW wind turbine prototypes for Türkiye

Enerjisa Uretim of Türkiye has awarded a contract to Enercon for the delivery of two wind turbine prototypes. Enercon will supply two of its 6 MW E-175 EP5 units, scheduled for delivery in 2024.

The prototypes will be installed at the Enerjisa Uretim Balkesir Wind Power Plant and Enerjisa Uretim Bandrma Energy Base. Both of these are located in Balkesir province in northwest Türkiye.

An IEA report says that Türkiye's renewable energy capacity is expected to grow 64 per cent or 33.8 GW over the next five years, and it will be one of the top 10 renewable energy markets in the world.

Hydrogen

EU taking steps to building hydrogen infrastructure

Oil and gas continue to hog the energy headlines and will certainly do so for the next decade, but as in many developed economies, European countries are pushing forward with plans to shift to hydrogen and other renewables fuels before 2030. Key components of the energy transition will involve infrastructure and transport, tangible matters the European states are beginning to focus on.

Gary Lakes

Ministers from EU members Germany, Italy and Austria and their transmission system operators (TSOs) last month petitioned the European Commission to provide special status to hydrogen transport projects designed to deliver hydrogen produced by renewable sources (green hydrogen) in North Africa among those countries.

The countries are calling for the SoutH2Corridor to be placed on the list of Projects of Common Interest (PCI), which provides special funding and enables faster permitting. The group is backing other hydrogen infrastructure projects such as Austria's proposed link between it and Germany and Slovenia. Another proposal calls for a gas pipeline owned by Italy's Snam to be converted to carry hydrogen to Austria and Slovenia.

The infrastructure links are designed to transport hydrogen to industrial regions that will be the focus of transitioning away from heavy fossil fuel usage.

SoutH2Corridor would have a capacity to transport 4 million tons/year, the equivalent of 133.2 TWh/year and ensure access to green hydrogen at a time when the market is expected to be tightening as demand expands.

According to a forecast for 2030 made by ICIS, Germany, Italy and Austria could see a combined domestic demand for hydrogen amount by that time to the equivalent of 124 TWh/year. Those states could produce 80 TWh domestically, while the SoutH2Corridor would be able to fill the gap.

ICIS data suggests that by 2050, the North African states of Morocco, Algeria and Tunisia will be producing hydrogen for export to the equivalent of 363 TWh/year that will go by pipeline to Italy and Spain, of which 213 TWh would be transported to Italy.

In their letter to the EC, the ministers said "the development of the project candidates will contribute to security of supply and greater diversification of import sources, while at the same time reducing fossil dependencies."

Earlier this year, the TSOs of Spain, Portugal and France launched an initiative called Green2TSO that will guide the conversion of their gas infrastructure network into a hydrogen system. Through 'open innovation' the plan calls for the incorporation of new technologies that will allow for hydrogen development in the transport grids.

Priority will go to technologies for the development of hydrogen detection and measurement systems, compression and above-ground storage and alternatives for coating and cleaning pipelines. The EC has already agreed to provide funding for a technology called Green2TSO OPHTYCs, which detects and measures hydrogen.

The Green2TSO partnership is aligned with programmes backed by the EC including the Green Deal, Fit for 55 and REPowerEU, which set safe, efficient and clean guidelines for the future carriers of hydrogen.

All measures undertaken by EU members for the hydrogen conversion are guided by the Hydrogen Backbone Initiative, which was launched a year ago with the aim to accelerate Europe's decarbonisation by defining the critical role of hydrogen infrastructure based on existing and new pipelines. The initiative seeks to enable the development of a competitive, liquid, pan-European renewable and low-carbon hydrogen.

The TSOs of Spain (Enegas), Portugal (REN) and France (GRTgaz and Terega) are partnered in Green2TSO and are behind the H2Med subsea hydrogen pipeline that will connect Barcelona with Marseille (known as the Bar-Mar Pipeline), which was first proposed in October last year. It too is part of the Hydrogen Backbone Initiative. Earlier this year, Germany announced that it would join H2Med.

Also during April, TSOs in the Nordic and Baltic countries launched a feasibility study for the Nordic-Baltic Hydrogen Corridor. Six EU member states are involved in the study for a pipeline system that will connect the green energy production regions in northern Europe with the major hydrogen consumption regions of the EU.

Finland, Estonia, Latvia, Lithuania, Poland and Germany are participating in the study, which is led by Latvia's Amber Grid TSO. The initial results are due to be complete by the end of this year and the project could be completed and in operation by 2030.

Meanwhile in May, Australia's Provaris and Norway's Hydrogen AS completed a pre-feasibility study on exporting hydrogen from Norway to Europe by 2027. The study is reported to demonstrate the potential for low-cost delivery of green hydrogen.

Provaris said the scope of the study includes the selection of a preferred coastal site in Norway, renewable power supply, production of hydrogen, compression facilities, and infrastructure requirements for jetty loading. The project would employ Provaris' H2Leo storage technology and two H2Neo carriers.

Gas

New gas infrastructure shapes energy security for southeast Europe

EU members in the group's southeastern corner are no longer at the mercy of gas supplies from Moscow. Gas is arriving in the region by pipeline and from LNG terminals, putting the Balkans on a path to energy inter-independence with neighbouring countries and in business partnerships with numerous gas suppliers.

Gary Lakes

Energy security in Southeast Europe has been an issue for decades. One question in the late 1990s was how to get the oil and gas resources in the newly independent republics of the Caspian region to the European market. Another issue was linking the existing gas grids throughout the entire region.

In 2006 and again in 2009, the point of European energy security was driven home when disputes between Russia and Ukraine led to temporary stoppages in Russian gas deliveries to Europe.

Years of legislation within the European Union and its members, infrastructure construction, and big investment has now placed eastern and southeastern European countries in a vastly improved situation as new infrastructure is completed and gas supplies are moving at a time when the EU is clearly cutting its energy connections with Russia.

The Caspian oil question was settled in 2006, when the BP-led Baku-Tbilisi-Ceyhan (BTC) opened and delivered Azeri crude to the Mediterranean Sea, but Caspian gas took longer to arrive. The Southern Gas Corridor (SGC), stretching from Baku to southern Italy, came into operation in 2020 with its first delivery of Azeri natural gas to southern Europe.

Azerbaijan supplies gas to the EU members from its Shah Deniz gas field in the Caspian Sea. The gas is transported through Azerbaijan and Georgia via the South Caucasus Pipeline (SCP) to Turkey where it links to the Trans-Anatolian Natural Gas Pipeline (TANAP) that stretches to northern Greece and connects to the Trans-Adriatic Pipeline (TAP), which runs across Greece to Albania and to Italy.

The Interconnector-Greece-Bulgaria (IGB), which became operational in October 2022, intersects TAP in northeastern Greece and delivers gas from the DESFA system to Bulgaria, from where it is transported to other countries.

"Do you remember the state Bulgaria and the Bulgarian energy industry was in until August of last year?" Bulgarian President Rumen Radev asked delegates at the Delphin Economic Forum in Greece in April. "No supplies, no gas, no contracts, no auctions, no slots, no terminals, no interconnector and with fuel and prices in the sky?"

Greece's LNG terminal at Revithoussa in southern Greece is connected to the DESFA system as will be the Alexandroupolis terminal. Both terminals will send gas into Bulgaria and beyond through the IGB. Pipeline connections are now being established throughout the region. Moldova has been receiving gas through the vertical corridor since December. Interconnecting pipelines are being built between Bulgaria and Serbia and Greece and Macedonia. Albania will serve as a hub that will send Azeri gas north along the Adriatic coast to Croatia, where there exists the Krk LNG terminal, which has recently signed an agreement to increase its capacity. Meanwhile, TAP is moving ahead with plans to expand its capacity from 10 bcm/year to 20 bcm/year.

The developments will lead to not only Bulgaria and Greece being gas hubs, but other hubs will form in the years ahead as new interconnections throughout the region are made.

"Bulgaria is no longer passive," Radev said, emphasising the role he wants his country to play, "but a partner that realises its own interests and that of its partners in the best possible way," pointing to transparent gas tenders, the use of LNG terminals in Greece and Turkey, and the 'Solidarity Ring' initiative, known also as the EastRing, through which Azeri gas will be transported throughout southeastern Europe.

In late April, four EU members in southeast Europe strengthened their energy security futures with the signing in Sofia of a memorandum of understanding (MOU) that included Azerbaijan.

The MOU focused on future cooperation regarding the distribution of Azeri gas throughout the countries participating in the EastRing bi-directional pipeline project. Bulgaria's Bulgartransgaz, Romania's Transgaz, Hungary's FGSZ, and Slovakia's EURSTREAM signed the document along with Azerbaijan's state-owned oil and gas company Socar.

The latest agreement follows a similar gathering in December last year in which Greece's transmission operator DESFA and those of Bulgaria, Romania and Hungary signed an MOU concerning cooperation on the so-called 'Vertical Corridor', which will see the development of a bi-directional gas pipeline stretching from Greece to Hungary and further. Gastrade, the Greek company behind the development of the LNG regasification terminal at Alexandroupolis, also signed the MOU. That LNG terminal will be operational by the end of this year.

Turkey also sends natural gas into Bulgaria through a connector pipeline with its own network. It recently delivered gas to Bulgaria from an LNG terminal near Izmir on the Aegean coast.

The EU is supporting the expansion of gas exports from Azerbaijan to Europe. Azerbaijan made its first deliveries via TAP in 2020 with a capacity of 8 bcm/year. That is soon to rise to 12 bcm annually and could reach 20 bcm by 2030. The IGB is planning to expand its capacity from 3 bcm/year to 5 bcm/year in the near future.

Energy security vs decarbonisation: *challenge and compromise*

The energy industry is on the vital journey from reliance on fossil fuel to the development of a sufficient global supply of clean energy. At the same time, it faces significant geopolitical pressures caused by, among other things, the Covid pandemic and the Ukraine war. Those pressures have increased governments' focus on achieving energy security (and preferably, energy independence). The result of these converging and conflicting challenges seems to be compromise in the short-term – but it is encouraging to see signs of medium and longer term solutions emerging. HFW's **Brian Perrott** and **Amanda Rathbone** explain.

It would be fair to say that the focus on net zero seems to have faltered somewhat, as progress towards decarbonisation has butted up against the urgency of immediate energy security needs. Indeed, it was evident at the 2023 FT Commodity Global Summit in Lausanne, Switzerland, that the drive to net zero was a more muted objective in the short-term amongst a galaxy of competing challenges.

The geopolitical pressures are well illustrated by Germany's dilemma: at the recent Petersberg Climate Dialogue, the German Foreign Minister called for the introduction of a global renewable energy target to reduce emissions and limit global warming. But faced with the recent energy crisis caused by the war in Ukraine, the German government voted to prolong the operation of hard coal fired power generation plants to March 2024 and to bring back brown coal capacity until June this year.

It remains the case that there are not currently sufficient commercially viable clean or renewable fuels available to meet global energy demands. To bridge that gap, countries continue to use fossil fuels. The widespread use of LNG as a "transitional" fossil fuel is perhaps the ultimate symbol of compromise in the stand-off between decarbonisation and energy security.

Geopolitics plays a role here too: the war in Ukraine led to price spikes and a huge increase in European demand for LNG, causing other regions to lose out, particularly in the global south. Pakistan is a good example: last year, Pakistan LNG issued a tender and received not a single bid. To maintain security of supply, Pakistan is now shifting away from gas, which once accounted for more than a third of its power output, towards coal and oil.

The legal sector often acts as a barometer and that has never been truer than in the LNG market in recent months. We saw a significant uptick in the number and scale of contracts agreed, price renegotiations, disputes and declarations of *force majeure* as the scramble to secure supply created volatility. The LNG infrastructure sector also saw increased activity, including in the construction of new receiving terminals and floating storage regasification units (FSRUs). This investment in expensive and complex LNG infrastructure in both Europe and Asia indicates that LNG is expected to be a major global source of energy for at least the medium term.

Legislation has also reflected the LNG compromise – in July 2022, the EU passed a law designating gas and nuclear as sustainable energy sources in the EU taxonomy. They were originally omitted and their inclusion has proved controversial.

The European Commission is now facing legal challenges to the designation, including from various environmental groups. In October 2022, Austria submitted a complaint to the Court of the European Union, arguing that gas and nuclear do not fulfil the requirements of the taxonomy not to cause significant environmental or climate-related harm and that the last-minute nature of their inclusion was unlawful. The law came into force on 1 January 2023 and the legal challenges are likely to take several years.

There is also concern surrounding the supply of critical minerals. In May 2021, a report by the International Energy Agency on the role of critical minerals in the clean energy transition referred to a "looming mismatch" between the world's climate ambitions and the supply of the minerals critical to achieving those ambitions.

This has prompted a global race to secure sufficient supply. Geopolitics is a major factor here too. China is currently the biggest producer of 12 out of the 18 minerals identified by the UK as critical and it is estimated that 75 per cent of the world's current supply of the most important minerals is concentrated in three countries, two of which are China and the DRC. ESG-related issues pose another difficult challenge in this sector.

Governments are responding to these challenges in a number of ways. Partnerships between countries are emerging as a key feature. These represent a compromise between energy independence and energy security.

A high-profile example is the Minerals Security Partnership between 10 countries, including the US, Australia, the UK, Japan, Canada, France and Germany but smaller partnerships are springing up regularly. Conversely, nations rich in critical minerals, including Indonesia and Chile, are starting to use legal tools such as export controls to ensure security of supply and maximum return on their natural resources. There is also an increase in funding for domestic exploration projects for critical minerals.

The response is not just apparent at government level. We are seeing companies, particularly car manufacturers, invest in mineral producers and then enter offtake arrangements with them directly, in order to ensure security of supply for their EV battery production needs. A recent example is Ford's investment in the Indonesian $4.5 billion Pomalaa nickel facility.

Applying the legal barometer, the rise in legal activism reflects the faltering progress towards net zero. In the UK, the environmental law charity Client Earth has launched a variety of claims. These include a successful action against the UK government over gaps in its net zero strategy, which Client Earth argued breached the Climate Change Act 2008.

As companies grapple with the tension created by the need for both energy security and decarbonisation, we are seeing an increase in enquiries and activity relating to both the trading of voluntary carbon credits and carbon capture and storage as alternative ways to move towards net zero emissions, whilst the development of sufficient clean fuel resources continues.

There is recognition from the financial sector of the role carbon trading has to play here. In May 2023, the International Swaps and Derivatives Association (ISDA) issued a report from its 'Future Leaders in Derivatives Group'.

This acknowledged the conflict between on the one hand, the need to generate both public and private funding in order to achieve long-term energy security and on the other, the damaging impact of the recent volatility and geopolitical pressures on sustainability investment. It advocated the scaling up of the voluntary carbon credits market to help generate funds for investment in projects aimed at carbon reduction or neutralisation. It also called for both quality and legal standardisation to help investors better assess risks and to avoid greenwashing.

Ultimately, sufficient supply of clean renewable fuels should allay energy security concerns and long-term indications are positive. The massive, $370 billion package of investments and tax credits offered by the Inflation Reduction Act in the US and the announcement of the strategically significant policy initiatives in the EU Green Deal are clear indicators of the longer-term direction of travel for governments.

Investment in and support for the scaling up of new fuels are also growing: for example, the Australian government recently announced a A$2 billion ($1.3 billion) Hydrogen Headstart programme to "bridge the commercial gap" in the development of some major hydrogen projects.

At the end of 2023, the COP 28 climate conference will see the conclusion of the first global stocktake since the Paris Agreement was reached. This is a process evaluating the degree to which nations are succeeding in meeting their objectives to reduce greenhouse gas emissions. Current signs suggest that the urgency of the need for energy security, particularly in the wake of Covid and the Ukraine war, has prevailed over the importance of decarbonisation in the short-term. Supply remains a key challenge to be addressed. But there are causes for optimism looking forward.

Brian Perrott and Amanda Rathbone, are Partner and Knowledge Counsel, respectively, at HFW.

Rathbone: significant policy initiatives are clear indicators of the longer-term direction of travel for governments

Perrott: the rise in legal activism reflects the faltering progress towards net zero

Offshore wind: different strokes for different folks

Offshore wind is one of the fastest-growing forms of clean energy globally but different regions are on different paths. While the US capacity is expected to grow, the outlook is uncertain due to politics. Europe, on the other hand, should see consistent development. Asia's additions will outstrip that of the other two markets substantially. Furthermore, linkages between Europe and Asia should rise exponentially, says **Joseph Jacobelli**.

The global wind power profile is impressive. Generation capacity has been growing at a fast pace globally. It jumped to 832 GW in 2021 from 181 GW in 2010, a share of about 10 per cent of the world's total, according to the International Energy Agency (IEA), generating over 1870 TWh. About 93 per cent was onshore wind capacity and 7 per cent was at offshore wind farms. Asia was 48 per cent of the total, Europe 28 per cent and North America 19 per cent; China alone had a 40 per cent share, according to BP's '*Statistical Review*'.

Global offshore wind is increasingly becoming prominent. Capacity was 63.2 GW in 2022 vs. 12.2 GW in 2017, according to the Global Wind Energy Council (GWEC), or a five-year compound annual growth rate of almost 40 per cent. The bulk of the installed capacity was in the UK (33 GW) and other northern European countries, including Germany (9 GW), Denmark (7 GW) and the Netherlands (5 GW).

The outlook through 2050 for global offshore wind ranges from 1500 GW to 2400 GW. The low end of the range would mean an annual addition of at least 50 GW or 12 per cent per year. The consensus forecast view is that over half will be built in the Asia Pacific region. China has the leading role in the region. The nation has the potential for technological development of offshore and deep offshore wind power resources of about 2250 GW, a number quoted in 2022 by many domestic news sources such as the China Electrical Equipment Industry Association. Western Europe should become the second largest market for offshore wind power, with a forecast by WindEurope of 300 GW, including 100 GW in the UK. North America would be a distant third with expectations ranging between 40 GW to 50 GW, although this should have significant upside given the region's offshore and deep offshore wind resources.

The challenges to more additional capacity are well publicised and understood. Chief among these are national policy frameworks, infrastructure bottlenecks, and high generation costs. In some jurisdictions public and environmental concerns also feature. Policy, infrastructure, and cost issues are interdependent factors and impact each other. The absence of government policy, or a lack in clarity in the policy, prevents or discourages investment in the sector and raises the risk premium. This also negatively impacts investments in electric power distribution infrastructure which in turn also increases the cost of capital. These two factors in turn impact additional capacity, translating in higher generation costs. Fortunately, the cost per unit generated by offshore wind farms has been falling and is expected to continue to decline. The IEA and the International Renewable Energy Agency (IRENA) expect that between 2021 and 2050, it will drop at least 50 per cent in the US and in India to $60/MWh, 33 per cent in the EU to $60/MWh, and 65 per cent in China to $35/MWh.

Ample funding availability is another bullish factor for offshore wind globally. There seems to be no shortage of capital. Recent news flow on the sector shows that key finance providers and investors are keen. Governments are willing to provide some funding and/or funding support. One example is the UK government is committed to supporting investments in clean energy. In March, it published a Green Finance Strategy and is providing funding for a variety of projects, including a £160 million ($198 million) investment scheme for floating offshore wind manufacturing.

Commercial banks and multilateral financial institutions are also increasingly willing to lend. Three of the many examples are the US Department of Energy loan guarantees for offshore wind projects, the European Investment Bank €210 million ($225 million)financing of three floating offshore wind farms, and Mizuho, MUFG and DBJ's joint financing of the ¥175 billion ($1.3 billion) Kitakyushu-Hibikinada Offshore Wind Farm in Japan.

Insurance companies, pension funds, private equity firms, and corporate investors and other hopeful investors are aggressively looking for opportunities too. For example, on the Asia private equity side, Bain & Company evaluated that while deal value fell 44 per cent year-on-year in 2022, utilities and renewables deals rose 47 per cent year-on-year, including a Macquarie Group offshore wind investment of over $1 billion.

US offshore wind development has been slower than Europe and Asia. This is despite an offshore wind energy development resource of as much as 4250 GW according to The National Renewable Energy Laboratory. Policy inconsistency, partisan politics, and interest groups have slowed the development of clean energy in the country. At the executive level, the federal government's implementation of climate laws and policies is strongly affected by the party in power. This dynamic continues in the legislature at both the national and state level, with inclination towards climate action divided along party lines. The fossil fuel industry is a major interest group with significant influence over politicians. It spends huge amounts of money lobbying against clean energy policies and pro-climate politicians. President Biden's Inflation Reduction Act, which in significant part aims to promote clean energy, could be diluted in the coming years due to these three hurdles. It could ease in the future, but change may be slow.

Europe's consistent and robust rate of increase should remain consistent. In fact, Europe has more than doubled down when it comes to its commitment to reduce emissions despite the massive political, economic, and cultural variances.

The latest major climate action from the bloc was the European Green Deal. It aims at ensuring "no net emissions of greenhouse gases by 2050" and "economic growth decoupled from resource use". The European Commission has stated that offshore renewable energy plays a key role in reaching its ambitious energy and climate targets. It set out a clear roadmap for how to achieve this goal including increase its offshore renewable energy capacity from 12 GW to 60 GW by 2030 and 300 GW by 2050.

Asia's offshore wind construction has outstripped the rest of the world. The region's efforts may not be as coordinated as those in Europe but growth in the region should continue to be faster than the rest of the world. Just five years ago offshore wind was a topic in only a few Asian power markets – mainland China, Taiwan and Japan. Today, there are plans of active projects in a myriad of other markets, including Australia, India, the Philippines, South Korea, and Vietnam.

IRENA and other institutions expect Asia to account for 50 to 60 per cent of global offshore wind installed capacity in the coming one or two decades. Experts are generally bullish. The offshore wind resource and financing availability in the region is plentiful and, crucially, more governments are setting facilitating policy frameworks. One expert, GWEC's Mark Hutchison, an Asia energy industry veteran, believes that the region is seeing positive change (listen to 'The Asia Climate Finance Podcast' Ep.29 for details).

Improving policy frameworks by some electricity market regulators in Asia have cut the risk premium. Coupled with the massive growth potential, better policies have made some of these markets highly attractive to foreign investors, especially from Europe. They include investors and equipment suppliers such as Copenhagen Infrastructure Partners, EDP, ENGIE, ENI, Equinor, Iberdrola, Mainstream Renewable Power, MHI Vestas, Ørsted, RWE, Siemens Gamesa, TotalEnergies, and Vattenfall.

The current or planned investment by European companies also means knowledge transfer, and building long-term links between the two regions in offshore wind projects. Long term, this linkage could include China. The nation has much to offer especially in its expertise at reducing offshore wind cost given the sheer size of its investments domestically. At the moment though, unfavourable geopolitics prevent offshore wind investments in both directions.

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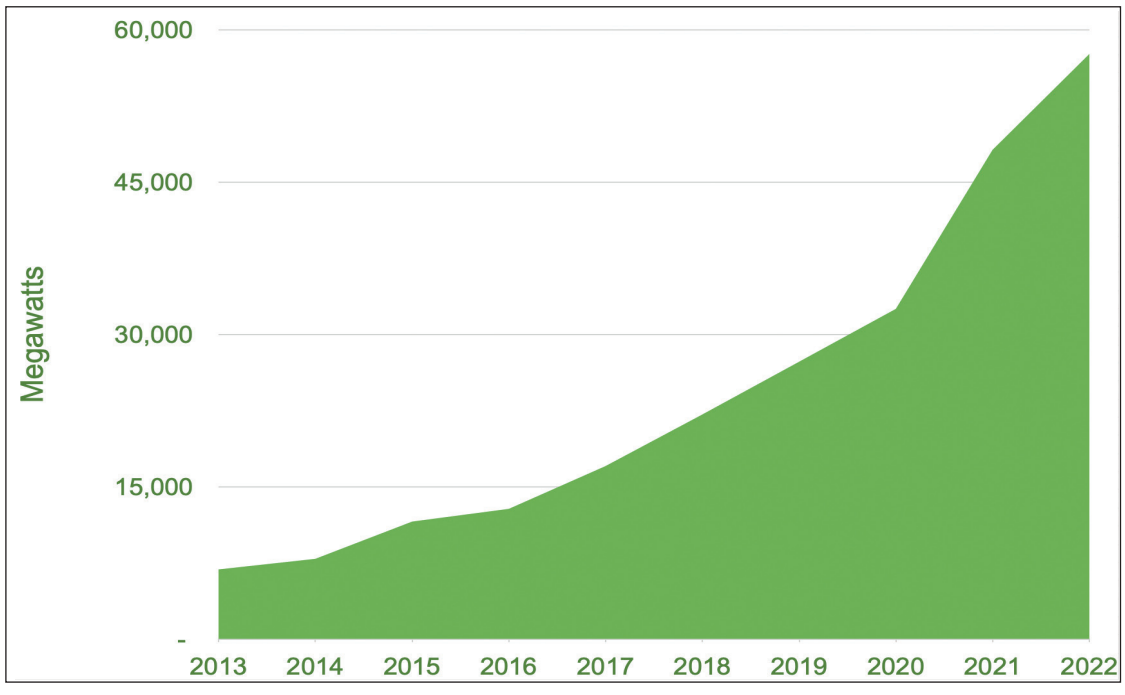
Global offshore wind capacity in operation (cumulative)
Source: Global Offshore Wind Report 2022, World Forum Offshore Wind, 20 February 2023



Saving geothermal from remaining a renewable energy afterthought

Although geothermal energy has long held the promise of baseload carbon-free energy, it has failed to make any real inroads in the global power mix. New geothermal technologies, however, are driving renewed interest. Roleva Energy's **Bart Lucarelli**, PhD, highlights one that looks particularly promising – a deep-well, closed-loop geothermal energy transfer system developed by Eavor Technologies.

For the past 25 years, proponents of geothermal have argued that geothermal energy offers a vast, largely undeveloped resource for transitioning the global power sector away from fossil fuels and toward a renewable energy future based on reliable, 24/7 base load power supply. In practice, however, the results have been underwhelming at best.

The installed base of geothermal power plants was estimated, as of December 31, 2021, to be 15.85 GWe or 0.5 per cent of total renewable energy installations worldwide. While this small total can be partly attributed to the huge decline in costs of solar PV and wind power plants over the past decade, a lack of commercially available technology for bringing geothermal resources into production everywhere, is also a major factor.

Yet a new enthusiasm is starting to emerge. IRENA, for example, believes that "geothermal energy holds a unique place in the renewable energy ecosystem" offering sources of heat for generating electricity and meeting space and water heating needs at high efficiency with low-to-no GHG emissions. It is also credited as "a long-lasting sustainable source when properly managed" that can meet power demands as a base load plant with load following capabilities.

The main reason for the latest surge in interest in geothermal power is the development of new geothermal technologies that have either recently entered into commercial operation or are on the cusp of doing so.

One of the most exciting developments over the past five years has been the demonstration of a deep well, closed loop geothermal energy transfer system developed by Eavor Technologies (Eavor), a small Canadian start-up company based in Calgary, Alberta.

With support from the Canadian government and the provincial government of Alberta, Eavor demonstrated the technical feasibility of Eavor-Lite, a pre-commercial, proof-of-concept closed-loop plant, which was installed and commissioned between September and December 2019 and then operated for a 16-month period to confirm that key technologies worked as expected.

Eavor-Lite consists of two boreholes located 2.5 km apart and drilled to a depth of 2.4 km. Each borehole is connected to two horizontal legs, known as multilaterals. The Eavor-Lite project has notably successfully demonstrated several key technologies:

- Magnetic ranging technology, which allowed the precise intersection of each borehole with the two multilateral legs;
- Rock-Pipe sealant system used to seal the multilateral legs to the boreholes and then seal the inside walls of each multilateral, minimising the intrusion of the Eavor-Loop working fluid into the rock formation and debris from the rock formation into the working fluid. Eavor claims Rock-Pipe will provide a secure and robust seal for a 30-year operating life;
- Using a natural thermosiphon process to continuously circulate a proprietary working fluid through the closed loop system without the need for any mechanical pumping while achieving close to 100 per cent of the expected heat transfer by conduction alone.

According to Eavor, the Eavor-Lite project was "executed successfully, on-time and on-budget, demonstrating that a commercial-scale Eavor-Loop can be drilled, sealed, and operated purely by a thermosiphon effect with thermodynamic results in agreement with the predicted output from simulations."

Although the Eavor-Loop system is capable of also meeting the hot water requirements of district heating centres and large commercial/industrial end users, Eavor's priority is to produce medium to high temperature steam for generating base load power from dispatchable geothermal power plants "almost everywhere".

A number of other start-up companies claim to be developing advanced geothermal systems. Some of them are also applying closed-loop systems. However, none have progressed toward commercialisation at the pace that Eavor has. Nor have these other companies solved the many technical issues such as operating under natural thermosiphon and developing a sealant system that avoids the necessity of casing the multilaterals, as Eavor has.

The generic commercial version of the Eavor-Loop system is similar to Eavor-Lite in a number of important ways. However, the boreholes of the commercial Eavor-Loop systems will be drilled to much deeper depths, ranging from 4 to 8 km and will be positioned only 50-100 m apart, not 2.5 km as adopted for Eavor-Lite. Also, the radiator-like multilaterals will have up to 12 legs versus two multilateral legs for Eavor-Lite.

The complete Eavor-Loop system resembles two vertical pipes connected to two or more sealed radiators. Eavor uses a proprietary working fluid, which it injects at the surface into the inlet borehole. The working fluid circulates continuously through the Eavor-Loop system where it absorbs heat via conduction from the rock formation that the radiator-like multilaterals have been drilled into. Then, through a natural thermosiphon mechanism, the heated working fluid rises to the surface without the need for any mechanical pumping.

The working fluid is then passed through a heat exchanger at the surface where the absorbed heat is released and used to convert a second working fluid in a separate closed loop system to generate steam for driving a steam turbine-generator set and producing electricity. Depending on the temperature of the steam coming from the surface heat exchanger, the project owner will decide among three options for generating electricity (a) flash cycle steam plant, (b) a dry steam cycle power plant, or (c) a binary cycle plant. These three power plant options are commercially available and not considered as part of the Eavor-Loop system.

The Eavor-Loop system also has other benefits. Notably, according to Eavor there is no induced seismicity that fracking or reinjection of brines back into the inlet borehole might cause. Environmental impact is also limited – there are zero emissions of subsurface CO_2 or other GHGs into the atmosphere, and no environmental impact on subsurface water resources. The system has a very small surface footprint.

Eavor plans to install its Eavor-Loop system in both sedimentary (sandstone or limestone formations) and igneous (basalt or granite formations) rock. The specific layout of the system will vary somewhat by project according to geological conditions and whether the project will be for direct heat utilisation or the supply of base-load electricity.

With the successful completion of its Eavor-Lite demonstration project, Eavor has significantly de-risked its Eavor-Loop system. New projects (and funding) appear to be flowing and that will de-risk Eavor-Loop 2.0, the most advanced of two commercial versions and the preferred option for power generation.

Eavor's first commercial project is under construction at a site near Geretsried, a small town in Bavaria, Germany. After another company failed to tap into the low temperature geothermal heat at the Geretsried site, Eavor was solicited to complete the project using its Eavor-Loop system. For this project, Eavor will drill its multilaterals into a sandstone sedimentary formation at a depth of around 2.5 km. Construction started in October 2022 and drilling of the new wells will start in July 2023 with first energy production expected in Q4 2024.

As part of the commercial terms of its Geretsried project, Eavor has been awarded a feed-in-tariff of €22.4 cents/kWh (~US21 cents/kWh). It has also been awarded a grant of €91.6 million from the European Innovation Fund. The project will produce 8.2 MWe, with a direct heat utilisation component waiting in the wings.

It is reported that Eavor is assessing other projects in northwest Europe, perhaps up to 50 projects according to one article. Success appears to breed more success for Eavor.

In the US, Eavor has successfully demonstrated its Eavor-Lite proof of concept system at a high geothermal gradient site near Animas, New Mexico (NM), which Eavor refers to as Eavor-Deep. For this proof of concept project, Eavor drilled a single borehole to a true vertical depth (TVD) of 5480 m. The temperature of the basement rock at 5480 m TVD was 250°C, a much greater depth than experienced during the Rocky Mountain House demo.

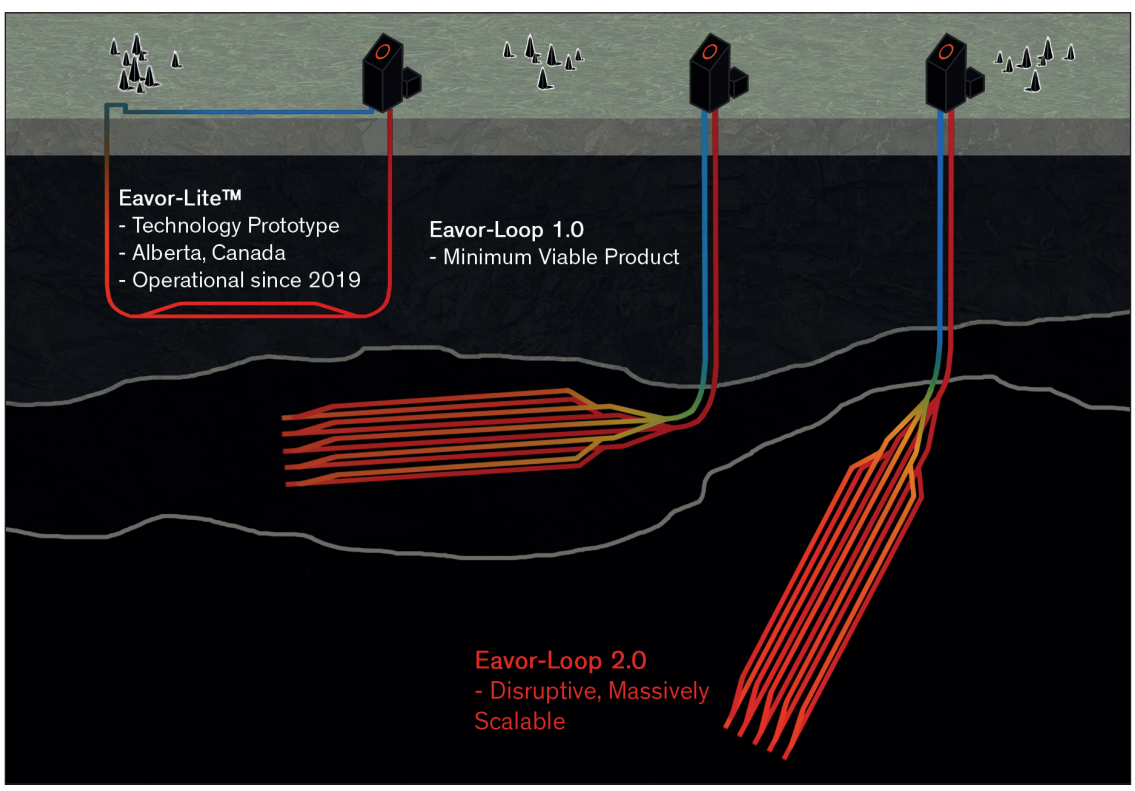
Eavor used the project to demonstrate its advanced drilling technologies and at a much greater depth and basement rock temperature than its Eavor-Lite project in Alberta. The company says it successfully demonstrated its drilling methods and technologies at 5480 m TVD.

The successful demonstration of Eavor-Lite at Rocky Mountain House in Alberta, the start of construction on Geretsried project, and the completion of Eavor-Deep in January, have "put the wind at Eavor's back". To the extent that its financial backers – Chevron, BP, Vickers, Temasek, and others – are willing to provide financing to support the implementation of new Eavor-Loop projects on commercial terms, Eavor can now claim that its Eavor-Loop system is commercially available.

It may take a bit more time before the Eavor-Loop system can be declared as commercially proven, as additional operating experience is required in some key areas.

However, based on evidence to date, the smell of success is in the air and with it the prospect that geothermal energy may finally play its long promised role as supplier of base load, dispatchable power that will lead to a significant decarbonisation of the power systems of the World – anywhere and everywhere.

Bart Lucarelli, PhD, is Managing Director, Roleva Energy.



Evolution from Eavor-Lite to Eavor-Loop 1.0 and Eavor-Loop 2.0.
Source: Matthew Toews and Michael Holmes, Eavor-Lite performance update and extrapolation to commercial projects (Eavor Technologies Inc.), 2021

Junior Isles

Poetry not in motion

I have not yet had the opportunity to peruse the International Energy Agency's recently launched 'World Energy Investment 2023' report but the180-page tome is on my 'must read' list. Congratulating his staff on the report, IEA Executive Director Fatih Birol said: "It reads so well, it doesn't seem like a report on energy; it reads like a poem."

The headline takeaway from the report is that there has been a "dramatic shift" in the ratio of fossil investment versus clean energy. According to the IEA, just five years ago, which Birol says "is like yesterday in the energy world", total energy investments equalled about $2 trillion with an even split between fossil fuels and clean energy. Today, that ratio is 1:1.7, i.e., while investment in fossil fuels has remained at about $1 trillion, investment in clean energy has surged to $1.7 trillion.

This, says the IEA, can be attributed to three key drivers: the falling costs of wind and solar, which the IEA says are now competitive almost everywhere; government policies in reaction to the energy crisis, exacerbated by Russia's war on Ukraine; and thirdly, global industrial strategies such as the US Inflation Reduction Act, the EU Green Deal Industrial Plan and Japan's Green Transformation strategy, aimed at fostering domestic clean energy technology manufacturing capacity.

Clearly the new clean energy economy is emerging, and much faster than many realise. Birol noted that at last month's G7 Summit in Hiroshima, Japan, leaders from the world's seven wealthy nations plus leaders from several other countries including Brazil, India and Indonesia, all agreed that clean energy is the way forward.

But with the direction of travel widely agreed, in the face of an imminent existential climate crisis, speed is now the order of the day. While the IEA's investment report may read like a poem, there was nothing poetic about the remarks from the opening session at the recent Innovation Zero conference in London, UK.

Prof. Johan Rockstrom, Director, at Potsdam Institute for Climate Impact Research (PIK) and Prof. Sir David King, Founder and Chair of the Centre for Climate Repair at the University of Cambridge, described a chilling picture of a world that has failed to keep global warming below the 1.5°C limit stipulated in the 2015 Paris Agreement.

Rockstrom stressed that 1.5degC was a limit that the world will "begin touching" next year. He also warned that it was not a target but a tipping point, beyond which the effects of climate change would be irreversible.

Commenting on the UN assessment that there was no credible pathway to 1.5°C in place, and that even if current pledges for action are delivered in full by 2030, there could still be a rise in global temperatures of 2.5°C by the end of the century, Rockstrom said: "Once we go beyond 1.5°C, we go from moderate risk to high risk that the impacts on humans and the economy will be permanent and irreversible, causing self-reinforced warming. We are at 1.2°C today and are on a pathway that will take us way beyond 1.5°C.

"Science advances with a lot of uncertainty and the climate system is very complex, but there is one conclusion that is without any uncertainty and it's that a 2.5°C surface temperature rise is a disaster. It would exceed the warmest temperature on Earth over the last four million years. It would lead to a complete melting of the big ice sheets and at least a 10 m sea level rise, a collapse of the rain forests and marine biology… and over one third of the equatorial regions would be uninhabitable."

Prof. King added: "We know the Arctic Circle is heating up at 4-5 times the rate of the average for the planet. Today it's over 3°C above the pre-industrial level. This means the ice on Greenland is now melting – it could be irreversible without human intervention. That alone is a 7-8 m sea level rise."

Later in the conference, Dr Nina Seega, Director, Centre for Sustainable Finance at Cambridge Institute for Sustainability Leadership (CISL), spelled out what this means at the local level. She said: "1.5 degrees in the UK means a 0.5 m rise in sea level. That means my home in Cambridge becomes a seaside destination; I don't have to move, the sea will come to me."

According to Prof. Rockstrom it is still just about possible to hold 1.5°C, although the window is rapidly closing. Scientists say there is a global carbon budget of around 300 billion t of CO_2. With the world emitting over 40 billion t of CO_2 every year, the world is expected to permanently pass the 1.5°C limit somewhere around 2030-2035. The next decade is therefore critical.

Prof King said: "Greenhouse gas levels in the atmosphere are close to double what they were in the pre-industrial period. For you and I, that's like putting a second duvet on your bed. You will get too hot. We have just put a second duvet on our planet."

Clearly deep and rapid emissions reduction is absolutely vital. "We are doing good things but we must do it 5-10 times faster," said Prof. King.

For this to happen everyone needs to play their part. Innovations in carbon removal technologies will be necessary and such technologies will have to go from lab to commercial roll-out faster. One speaker at Innovation Zero said: "You need to get innovations out of the lab as soon as you can… spend less time planning and more time doing. Do six months of experiments and then iterate."

Governments will also need innovative policies to accelerate the shift to clean technologies across all sectors. Norway is an example of where policy has resulted in nine out of ten cars now sold in the country being either electric or hybrid.

The continued reduction of fossil fuels in the energy mix will also need to go faster. And here is where many of the oil and gas majors can arguably do more. They can certainly be leaders in technologies such as carbon capture utilisation and storage, low emissions hydrogen and biofuels.

The IEA notes that by 2030, for a 1.5°C scenario, for every $1 invested in fossil fuels, there will be $9 going into different aspects of clean energy. It notes, however, that many oil and gas majors are typically investing less than 5 per cent of profits in clean energy.

This is particularly worrying when considered in the context of recent comments from BP's Chief Executive Bernard Looney. In February BP scaled back its climate ambitions and last month Looney told the Economic Club of Washington, DC, that halting oil production now would be "simply impractical". He noted, however, that "with that said, there is an issue called carbon… It's a real issue. It needs to be tackled, and that's why we want to transition."

Although there is variation in investment in clean technology across different oil and gas companies, the IEA believes there is scope for clean investment to be higher than the 5 per cent. Birol said that more than half of the $4 trillion generated by oil and gas companies last year – which is more than twice their average – went to dividends, share buybacks and debt repayment.

"Less than half went to investments, and this is something we all need to highlight. If we hear companies are not investing because of a lack of money, this is not true… many have announced they would like to be part of the solution to the climate change problem, which is very welcome. We would like to see all energy stakeholders be part of the coalition to address the common challenge of climate change.

"But when we look at the numbers, we see that the amount of money going to clean energy investments in the total investment of the oil and gas industry is less than 5 per cent today. So there is a need [for them] to elevate either the numbers or calibrate the statements."

Unfortunately, as is often the case, when all is said and done, there is usually a lot more said than done. And in the current climate crisis, beautiful words are not enough.

Cartoon: jemsoar.com