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It is often forgotten that the production of hydrogen-based fuels requires carbon. *Page 13*

V2G decarbonisation

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Technology Focus: New carbon capture technology can cut costs

A new process hailed as the next generation in carbon capture technology has been demonstrated. The novel process has the potential to cut costs and extend the breadth of applications for the technology. *Page 15*

The IEA's Keisuke Sadamori says CO_2 intensity will continue to decrease

Power sector set for 2025 'tipping point' on emissions, says IEA

With most new electricity demand set to be met by renewables and nuclear, the International Energy Agency says carbon emissions from the sector could be close to a tipping point. The report comes, however, as bp warns that the transition away from fossil fuels also needs to take account of the security and affordability of energy. **Junior Isles**

Significant rises in future carbon emissions from electricity generation are unlikely, suggesting the world is close to a tipping point for power sector emissions, according to the International Energy Agency (IEA).

In a new report, the Paris-based agency said renewables are set to dominate the growth of the world's electricity supply over the next three years and, together with nuclear power, will meet the vast majority of the increase in global demand through to 2025.

The IEA's Electricity Market Report 2023 finds that the growth in world electricity demand is expected to accelerate to an average of 3 per cent over the next three years, after slowing slightly last year to 2 per cent amid the turmoil of the global energy crisis and exceptional weather conditions in some regions. Renewables and nuclear power, however, are expected to meet more than 90 per cent of the additional demand.

Electricity generation from the burning of fossil fuels is one of the most significant contributors to the greenhouse gas emissions driving climate change.

"The world's growing demand for electricity is set to accelerate, adding more than double Japan's current electricity consumption over the next three years," said IEA Executive Director Fatih Birol. "The good news is that renewables and nuclear power are growing quickly enough to meet almost all this additional appetite, suggesting we are close to a tipping point for power sector emissions. Governments now need to enable low-emissions sources to grow even faster and drive down emissions so that the world can ensure secure electricity supplies while reaching climate goals."

Keisuke Sadamori, Director of the Office for Energy Security at the IEA, added: "CO_2 intensity of the world's power generation declined in 2022 and will continue to decrease as the share of renewables increases and the share of coal and gas fired generation falls."

The IEA says strong growth of renewables means their share of the global power generation mix is forecast to rise from 29 per cent in 2022 to 35 per cent in 2025. Separately, a new report from BloombergNEF finds that global investment in the low-carbon energy transition totalled $1.1 trillion in 2022 – a new record and a huge acceleration from the year before.

However, despite almost all new generation coming from renewables, forecasts show more still needs to be done to accelerate emissions cuts.

Commenting on what more can be done, Sadamori said: "To see a decline in CO_2 emissions, we need to accelerate the energy transition much faster. This means stronger policy interventions. First we need to accelerate investments in energy efficiency through government support, as this will lead to smaller requirements for new electricity capacity. We also need to accelerate renewables; we need to use all measures available to increase low carbon energy, including sources like nuclear and hydropower."

The IEA report came shortly after bp released its 'Energy Outlook 2023',

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Ministers discuss coordinated actions to limit impact of energy crisis on natural gas markets

Forty governments met last month at a Special IEA Ministerial meeting on natural gas markets and supply security to discuss additional ways to limit the impacts from the global energy crisis triggered by Russia's invasion of Ukraine and propose measures to support affected countries.

The virtual meeting of countries representing half of global gas demand also reviewed how such measures can contribute to momentum on clean energy transitions worldwide in line with the goal of limiting the rise in global temperatures to 1.5°C.

In a statement, ministers said they reached an agreement on the need to "coordinate response efforts" in order to mitigate the risks of Russia using energy "as a weapon of political coercion". There was acknowledgment that short-term measures such as the additional capacity in liquefied natural gas (LNG) had eased supply concerns. But a range of factors mean that uncertainty is likely to persist into 2023.

Measures to strengthen energy security were therefore welcomed by all the ministers. These include efforts to improve energy efficiency rapidly, speed up the deployment of renewables, and carry out targeted upgrades to grid infrastructure. In addition, coordinated actions are being prepared to support an orderly gas storage filling season in the Northern Hemisphere.

The meeting was held as the benchmark gas price in February fell below €50/MWh for the first time in almost 18 months, down to €48.90/MWh, as traders report growing confidence that European countries will avoid shortages this winter and next. The gas benchmark peaked at more than €300/MWh in August 2022.

According to Moody's, companies' resilience, mild weather and policy effectiveness (to replace Russian gas) have been key to keeping the energy situation safe. It estimates that policy effectiveness and companies' resilience contributed to around 75 per cent of the improvement in the energy situation in 2022. European gas storage at the end of 2022 stood at 82 per cent (around the highest level since 2015).

Moody's warned, however, that energy supply in the winter of 2023-24 will be tight since Russian gas flows will be, at best, around 20 per cent of 2022 energy flows assuming no further cuts.

A new report by energy and sustainability consultancy Advantage Utilities, said the UK and the rest of Europe may never return to its reliance on Russian gas and oil thanks to increased global imports of LNG, new LNG terminals as well as storage coming online. Greener options such as solar, wind and hydro have also aided in this transition, it said.

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which explores key trends and uncertainties surrounding the energy transition out to 2050.

The three main scenarios considered in the Outlook – Net Zero, Accelerated, and New Momentum – have been updated to take account of two major developments over the past year: the Russia-Ukraine war and the passing of the Inflation Reduction Act (IRA) in the US.

Dale says the transition needs to address all three elements of the energy trilemma

bp's chief economist, Spencer Dale, said: "Global energy polices and discussions in recent years have been focused on the importance of decarbonising the energy system and the transition to net zero. The events of the past year have served as a reminder to us all that the transition also needs to take account of the security and affordability of energy. Any successful and enduring energy transition needs to address all three elements of the so-called energy trilemma: secure, affordable and lower carbon."

The Outlook stressed that "the carbon budget is running out", noting that despite the marked increase in government ambitions, CO_2 emissions have increased in every year since the Paris COP in 2015 (with the exception of 2020). "The longer the delay in taking decisive action to reduce GHG emissions on a sustained basis, the greater are the likely resulting economic and social costs," it stated.

It also said government support for the energy transition has increased further in a number of countries, including the passing of the IRA in the US. The scale of the decarbonisation challenge, however, suggests greater support is required, said the Outlook, including policies to facilitate quicker permitting and approval of low-carbon energy and infrastructure.

The Outlook for natural gas going forward appears uncertain. According to bp, its prospects depend on the speed of the energy transition, with increasing demand in emerging economies as they grow and industrialise offset by the transition to lower-carbon energy sources led by the developed world.

"The recent energy shortages and higher prices highlight the importance of the transition away from hydrocarbons being orderly, such that the demand for hydrocarbons falls in line with available supplies. Natural declines in existing production sources means there needs to be continuing upstream investment in oil and natural gas over the next 30 years, including in Net Zero," bp stated.The IEA, meanwhile, noted that sharp spikes in natural gas prices amid the energy crisis have fuelled soaring electricity prices in some markets, particularly in Europe, prompting debate in policy circles over reforms to power market design.

According to the IEA, the Iberian model has succeeded in lowering electricity prices in Spain but, at the same time, it has increased gas consumption.

EU seeks to boost competitiveness through Green Industrial Plan

In an attempt to maintain competitiveness in the burgeoning clean energy sector, the EU is proposing an industrial plan that will boost domestic manufacturing and stave-off the growing shift of investment to the US. **Junior Isles**

Junior Isles

The European Commission has outlined its Green Deal Industrial Plan in a move to enhance the competitiveness of Europe's net zero industry and support the fast transition to climate neutrality. The move comes as pressure mounts on the bloc to respond to the US Inflation Reduction Act (IRA) launched by US President Joe Biden in August last year.

The Plan aims to provide a more supportive environment for the scaling up of the EU's manufacturing capacity for the net zero technologies and products required to meet Europe's ambitious climate targets. It builds on previous initiatives and relies on the strengths of the EU Single Market, complementing ongoing efforts under the European Green Deal and REPowerEU.

The Plan is based on four pillars. The first pillar of the plan is about a simpler regulatory framework. The Commission will propose a Net Zero Industry Act to identify goals for net zero industrial capacity and provide a regulatory framework suited for its quick deployment, ensuring simplified and fast-track permitting, promoting European strategic projects, and developing standards to support the scale-up of technologies across the Single Market.

The second pillar will speed up investment and financing for clean tech production in Europe. Public financing, in conjunction with further progress on the European Capital Markets Union, can unlock the huge amounts of private financing required for the green transition.

Under competition policy, the Commission aims to guarantee a level playing field within the Single Market while making it easier for the Member States to grant necessary aid to fast-track the green transition.

As between 35 per cent and 40 per cent of all jobs could be affected by the green transition, developing the skills needed for well-paid quality jobs will be a priority for the European Year of Skills, and the third pillar of the plan will focus on it.

The fourth pillar will be about global cooperation and making trade work for the green transition, under the principles of fair competition and open trade, building on the engagements with the EU's partners and the work of the World Trade Organization. To that end, the Commission will continue to develop the EU's network of Free Trade Agreements and other forms of cooperation with partners to support the green transition.

The draft proposal stated Brussels would aim to set up a European sovereignty fund by the middle of this year to allow all 27 governments to fund state aid.

The proposed measures, which have yet to be finalised are part of a comprehensive Brussels plan to respond to the US' IRA legislation, which many European leader say will lead to European companies shifting clean sector investment from Europe to the US.

The Commission's Executive Vice-President for Competition Margrethe Vestager said when combined with stable, cheap energy prices in the US, the IRA could have a "toxic" effect on some European industries. Thierry Breton, the EU commissioner for the internal market accused the US of starting a "subsidy race".

More than $90 billion in green investment has poured into the US since last year's passage of the IRA, which provides $369 billion worth of tax credits, grants and loans to boost renewable energy and slash emissions.

In an interview with the *Financial Times*, John Podesta, President Biden's senior clean energy adviser, pushed back at criticism that the IRA would divert investment and undermine the EU economy. He said Europe must take responsibility for developing its own clean energy sector.

"We hope that the European industrial base will succeed, but it's up to Europe to do some of the work," he said. "We're not going to do that all for them."

Hydrogen central to Green Deal Industrial Plan, as EU adopts delegated act on additionality

The EU's proposal for a Green Industrial Plan has reinforced that hydrogen is now a strategic technology for reaching the EU's net zero target by 2050.

Under the Plan, the Net Zero Industry Act will establish concrete shared EU objectives for hydrogen technology by 2030 and speed up permitting processes,which will be vital for meeting its targets.

According to Hydrogen Europe The Temporary State Aid Crisis and Transition Framework are also "headed in the right direction", providing direct support for renewable hydrogen production and storage, the use of renewable hydrogen in industry, and the production of electrolysers and related critical raw materials.

Jorgo Chatzimarkakis, CEO of Hydrogen Europe, the European association representing the interest of the hydrogen industry, said: "We very much welcome President Ursula von der Leyen's announcement, which reaffirms what she said in Davos confirming hydrogen as a key strategic technology in the energy transition. We hope this type of support will be extended to the entire hydrogen ecosystem."

The proposal for the Green Industrial Plan came as the European Commission finally published the long-awaited delegated act on additionality. The definition is key for determining compliance with the proposed targets in the Renewable Energy Directive, targets that would see the industry and transport sectors progressively replace grey hydrogen with green hydrogen as well as creating new markets for the commodity.

It has taken over three years for the European Commission to provide a framework that defines renewable-based hydrogen and hydrogen-based fuels. Hydrogen Europe said the process has been "lengthy and bumpy, but the announcement is welcomed by the hydrogen sector", which has been eagerly waiting for the rules to be set so that companies can finalise investment decisions and business models.

Chatzimarkakis said: "A far-from-perfect regulation is better than no regulation at all. At last, there is clarity for industry and investors and Europe can kick-start the renewable hydrogen market.

"This comes at a critical time, with the USA setting a very high benchmark with their Production Tax Credits, offered under the Inflation Reduction Act, attracting more and more investments towards their clean hydrogen market".

This new regulation mandates that renewable hydrogen be produced exclusively with additional renewable power plants, and that the hydrogen only be produced during the hours that the renewable energy asset is producing electricity (hourly temporal correlation), and only in the area where the renewable electricity asset is located (geographical correlation).

These strict rules can be met but will inevitably make green hydrogen projects more expensive and will limit its expansion potential, reducing the positive effects of economies of scale and affecting Europe's capacity to achieve the goals set in REPowerEU.

The role of governments will be crucial in supporting this sector and closing the price gap between renewable and conventional hydrogen.

Early last month the EU also announced plans for a pilot EU auction this autumn. The EU Innovation Fund has committed an initial €800 million, with the precise terms and conditions of the auction expected to be announced in June.

The pilot is part of the bloc's broader Hydrogen Strategy – under which green hydrogen has been cited as a key priority for the EU to achieve the European Green Deal.

Industry players weigh-in ahead of EU proposal for electricity market reform

Europe's largest electricity and gas companies have come together to make proposals in relation to the upcoming reform of the EU Electricity Market Design.

The European Commission is expected to publish its proposal, which comes in response to the energy crisis, by March 14.

An open letter, published by Sweden's Vattenfall AB and signed by many of its European peers, states that the planned reform of the market is a "great opportunity" to foster investments in renewables and low-carbon power, but warned that it should be handled with caution in order to avoid fragmentation of the internal energy market.

The companies therefore say in the letter that "certain elements should be considered", such as the need to properly assess a reform with a future-proof design rather than "urging structural corrective measures that would not deliver the expected outcomes".

With regard to renewables and low-carbon power generation, the companies believe that "long-term commitments should be incentivised to de-risk the investments and hedge final customers against price volatility". They also pointed out regulatory stability and long-term price signals are essential.

Another area of concern is the need for improved short-term markets. Some initiatives given as examples include flow-based day-ahead market coupling, maximising cross-border trade, and demand response participation in markets. The establishment of grids to enable the green transition is also crucial, they said.

Several of these recommendations were echoed by Dutch-German grid operator TenneT, which added in a separate statement that market design also needs to properly reflect grid constraints and operational challenges to ensure system resilience and efficient use of infrastructure.

The energy companies' letter also warned that the exceptional emergency measures adopted some months ago by the European Council should not be confused with structural market reform.

Germany, Denmark, the Netherlands, Luxembourg, Finland, Lithuania and Slovenia also distributed a joint letter in which they position themselves in favour of a mild reform of the wholesale electricity market as opposed to approaches such as that by Spain. The countries said they believe such approaches are much more ambitious and interventionist.

Small modular reactors move towards deployment

- Ontario will see first unit at Clarington
- NuScale wins US approval

Janet Wood

Small modular nuclear reactors (SMRs) are set for deployment at two sites in Canada and the USA, which could kick-off orders from other customers for this new technology.

GE Hitachi Nuclear Energy, Ontario Power Generation (OPG), SNC-Lavalin and Aecon Group recently signed a contract to build a BWRX-300 at OPG's Darlington New Nuclear Project site in Clarington, Ontario. OPG will be the licence holder, GEH will design the reactor and provide engineering licensing support, construction, testing, training and commissioning, while SNC-Lavalin is the architect and engineer and Aecon Group will provide construction services, including project management.

Site preparation and related work have begun and the SMR is expected to be completed in the fourth quarter of 2028, Aecon Group said.

Sean Sexstone, Executive Vice President for advanced nuclear at GEH, said this first commercial contract for an SMR in North America is a "significant milestone in deploying SMRs in Canada and across the globe".

"Following our on-time, on-budget success working with OPG on the refurbishment of Darlington's existing CANDU reactors, we are very pleased to contribute our expertise with our alliance partners on this exciting new build," said Joe St. Julian, President, Nuclear, SNC-Lavalin.

"SMRs will play a key role in helping to reinvigorate Ontario's economy and further support the province and Canada as we work toward meeting our climate change targets of zero-emission electricity," said Ken Hartwick, President and CEO of OPG.

Saskatchewan Power Corp said last year that it had selected the BWRX-300 for possible deployment in Saskatchewan in the mid-2030s.

In January the US Nuclear Regulatory Commission certified NuScale Power's 50 MW SMR, the first of its type to win federal approval.

"SMRs are no longer an abstract concept," said Kathryn Huff, Assistant Secretary for nuclear energy at the Department of Energy. "They are real, and they are ready for deployment thanks to the hard work of NuScale, the university community, our national labs, industry partners, and the NRC."

NuScale plans to build six units at Idaho National Laboratory by 2030.

Huff added: "Canada was the second country in the world to ever generate commercial nuclear power. Together with our alliance partners, we will ensure Canada again leads the way to advance an exciting new frontier in nuclear energy. We continue to work with SMR vendors in Canada and around the world to bring more of these reactors online, coinciding with a rise in interest from jurisdictions looking to use nuclear power to decarbonise their energy mix, while maintaining their energy self-sufficiency."

EDPR's 'biggest' wind complex the start of a potential record-breaking year in Brazil

EDP Renovaveis has celebrated the startup of a 580 MW wind 'complex' in Brazil's Rio Grande do Norte state. The complex is made up of 14 wind farms totalling 138 turbines, in three clusters – Monte Verde (319.2 MW), Boqueirao (79 MW) and Jerusalem (180.6 MW).

At present, the new complex is the Portuguese firm's largest renewable energy park, although the company has more than 7 GW of wind and solar assets in Brazil in different stages of development.

But the wind complex represents just a small part of Brazil's new power capacity in 2023. It is expected to add 10.3 GW of new capacity this year in 238 projects, with over 90 per cent of it coming from centralised wind and solar, according to a forecast by Brazilian power sector regulator Aneel.

The regulator said it would be the largest capacity expansion in a single year since Aneel started tracking in 1997. In 2022, Brazil added roughly 8.5 GW of new capacity, with non-hydro renewables representing 6.5 GW. Previously the biggest addition was 9.5 GW in 2016.

Bahia, Rio Grande do Norte and Minas Gerais will host over 70 per cent of the new capacity. Minas Gerais is forecast to add 1.8 GW of solar PV.

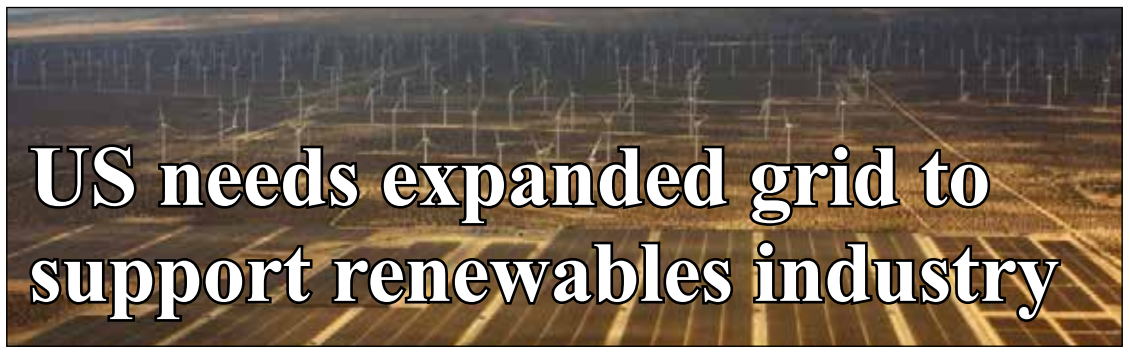
US-Mexico partnership to see four wind farms built

Mexico's President Andres Manuel Lopez Obrador announced recently that he expects the US government or US banks to finance four wind farms to be installed in the Isthmus of Tehuantepec.

López Obrador said the finance, which he said would be on 'comfortable terms' followed agreements reached with Washington to confront climate change. He was quoted as saying the four wind farms will be built by Mexican and US companies and managed by the state-owned Federal Electricity Commission (CFE), which will have financing from "the United States or US banks at very low, zero rates".

US legislators and US Climate Envoy, John Kerry, are expected to visit Mexico in March to kick-off the project, he said. The wind farms are part of López Obrador's plans to build ten industrial parks in the region, said to be one of Mexico's least developed regions. That may include a facility to manufacture electric vehicles.

Mexico has plans to add 30 GW of new wind, solar, geothermal, and hydroelectricity capacity by 2030, as part of a new ambition to raise its greenhouse gas emissions reduction target from 22 per cent to 35 per cent over the next eight years.



US needs expanded grid to support renewables industry

- New renewables outpace gas plants
- Strategic approach needed to expand grid most efficiently

Janet Wood

New data from the US Federal Energy Regulatory Commission (FERC) reveals that renewable energy sources (biomass, geothermal, hydropower, solar, wind) provided nearly three-quarters of new utility-scale generating capacity in the US last year. That rise is set to continue, but the industry has warned that new transmission network construction must keep pace with the renewables rollout, or targets will be at risk – among them the US government goal of adding 30 GW of offshore wind capacity by 2030 from just one wind farm currently in operation.

New utility-scale solar capacity of nearly 10 GW and 8.5 GW of wind capacity – almost all onshore – each comfortably surpassed the 5.5 GW of new natural gas capacity in the USA last year and nearly doubled a FERC forecast three years ago. There were also smaller amounts of geothermal (90 MW), biomass (31 MW) and hydropower (24 MW).

By the end of 2022, renewable energy sources collectively provided 27.3 per cent of the total available installed generating capacity in the US.

FERC is now projecting that to December 2025, solar capacity additions could total 76 GW and new wind is likely to total 18 GW.

However, that increase requires 'unprecedented' cooperation between grid operators and federal and state agencies to build new transmission lines.

The warning over a bottleneck in offshore wind came in a recent report from the National Renewable Energy Laboratory, which said coastal states need more export links as well as an expanded supply chain.

"Ambitious global offshore wind energy deployment targets will create substantial demand for the components needed to build these wind turbines and balance-of-system components such as foundations and cables," said the report.

The report proposed 34 new US wind turbine component manufacturing facilities, eight East Coast 'marshalling ports', and up to ten turbine installation and heavy lift vessels.

"This conceptual supply chain would generate significant workforce and economic benefits throughout the United States, not just in coastal locations with active offshore wind energy programmes," the authors wrote.

They want the US Bureau of Ocean Energy Management to ensure it manages a steady stream of offshore leases to provide a predictable revenue stream that will allow the supply chain to grow.

Critics have complained that the grid operators have been slow to come to grips with the surge in renewable projects entering their interconnection queues and planning regimes are too slow.

A study from the Brattle Group calls for expanded staffing and budgets at state regulatory agencies, and new multi-state decision-making bodies, that can take decisions on shared infrastructure to reduce the overall cost and time required to install networks.

Hydro PPA sets the scene for green fertiliser industry

Green fuels developer NeoGreen Hydrogen Corp. has signed a long term 75 MW baseload power purchase agreement (PPA) with ANDE, the national electricity company of Paraguay, to buy power produced by the Itaipú hydroelectric facility.

It will be used to power a green hydrogen project in Tres Fronteras, where Brazil, Paraguay and Argentina converge. The green hydrogen will be turned into green fertiliser for supply to the domestic market and regional customers by river export.

The project will initially produce 10 000 million tonnes per year of green hydrogen that will be converted into ammonium nitrate for use as part of NPK fertiliser blends.

NeoGreen is now planning to move the so-called Tres Fronteras project towards front end engineering and design stage. Final investment decision is expected by Q4 2023 and green hydrogen and ammonia production is targeted for mid-2026.

Felix Sosa, President of ANDE, said: "This agreement forms another important step in Paraguay's green hydrogen roadmap and we look forward to working with NeoGreen and their partners to maximise the efficient use of our renewable energy resources within this emerging industry."

The Tres Fronteras project is one of several that the company has announced. Recently NeoGreen announced details of a project in the Port of Sines in Portugal.

Renewables lose competitive edge in Asia Pacific

With the exception of China, the competitiveness of renewables-based power generation worsened in 2022 as inflation, supply chain constraints and higher interest rates took hold.

Syed Ali

The levelised costs of electricity (LCOE) for utility solar and onshore wind in Asia Pacific rose 16 per cent and 12 per cent, respectively, since 2020, as equipment, construction costs and interest rates rose in the region. The trend is expected to reverse in 2023, but volatility risks including geopolitical tensions, trade policy and financing remain according to latest analysis from Wood Mackenzie.

The average cost of utility solar power has gone up from $78/MWh in 2020 to $91/MWh in 2022. Onshore wind follows a similar trend, rising from $93/MWh in 2020 to $104/MWh last year. South Korea saw the highest cost inflation between 2020 and 2022, while China avoided cost increases.

Alex Whitworth, Research Director at Wood Mackenzie, said: "China has been insulated from cost inflation trends, gaining competitiveness against other markets due to massive scale, depth of local supply chain, and increasing technology dominance."

Solar and onshore wind costs remain low in China, but offshore wind is the big mover with costs falling 22 per cent to $72/MWh in 2022, less than half of the Asia Pacific average of $171/MWh.

Whitworth added: "Offshore wind in China is now competitive with gas and coal power in coastal regions, and a further drop in costs of nearly a quarter by 2025 will allow the technology to undercut coal power nationally."

China took the top spot from India this year for the lowest-cost renewable power in the region. China's average utility-scale solar LCOE declined 4 per cent to $44/MWh in 2022, while India's increased over one third to $56/MWh. These two markets along with Australia are the only ones in Asia Pacific where renewables costs are competitive with new coal power projects.

The increase in LCOE in 2022 was driven by higher CAPEX and interest rates, with CAPEX for solar and onshore wind rising to 12 per cent and 6 per cent since 2020, while fossil fuel CAPEX rose by 5 per cent to 8 per cent.

In addition, interest rates for power projects in Asia Pacific jumped 30 per cent from a low of 5.8 per cent in 2021 to 7.5 per cent in 2022 on average across solar, onshore wind, coal, and gas.

Higher renewables costs mean that Asia Pacific's average solar LCOE is at a 7 per cent premium to coal power in 2022. This is despite higher fuel costs driving up the LCOE for new coal projects by 16 per cent and gas by 11 per cent in the last two years.

Coal will remain the cheapest new-build power generation option in Asia Pacific until 2024, even with the high fuel price environment, according to Wood Mackenzie findings.

New low-carbon technology options are developing but still expensive, with hybrid renewables and battery storage power costs 41 per cent to 72 per cent more expensive than gas LCOEs in 2022. Solar or wind plus storage projects will become competitive with gas by 2032 as costs fall to around $107 to $111 per MWh.

Overall, the cost of a "firmed" mix of renewables, gas turbine backup, and storage is expected to fall from $130 per MWh in 2022 to $90 per MWh in 2030, becoming competitive against gas and nuclear.

Robust growth predicted for China renewables

China will continue increasing the deployment of renewable power in 2023 on strong demand, lower raw-material costs and a low-base effect for wind power, according to Fitch Ratings.

China's large state-owned power generation companies remain committed to the country's energy transition strategy and are the largest investors in renewable power, said Fitch Ratings, adding that the companies' active bidding bodes well for new installations in 2023.

In 2022, a total of 446 wind power projects with a capacity of 87 GW completed equipment bidding in 2022, compared with around 60 GW in 2021, said Fitch Ratings, citing data from wind power information provider Windmango.

The installed capacity of wind and solar power in China rose 22 per cent year-on- year last year, according to Fitch Ratings.

The country is also increasing its energy storage capacity as its wind and solar capacity grows. At the end of January GE announced that all units of the 1.2 GW Jinzhai pumped storage power plant have now been successfully connected to the grid and completed 15 days of trial operation. The first two of units were connected to the grid in October 2022.

Pascal Radue, President & CEO, GE Hydro Solutions, said: "Pumped storage is the largest source of energy storage that exists today, which can help stabilise the grid with the integration of wind and solar power."

China aims to build more than 200 pumped storage stations with a combined capacity of 270 GW by 2025 according to Bloomberg data.

ASEAN grid takes shape

The realisation of an interconnected Asean Power Grid has come a step closer with the recent announcement that power will be transferred from Malaysia to Singapore on a commercial basis.

At the end of January, YTL Power International Bhd's wholly-owned subsidiary, YTL PowerSeraya Pte Limited, and TNB Power Generation Sdn Bhd (TNB Genco), a wholly-owned subsidiary of Tenaga Nasional Bhd (TNB), said they have teamed up to export and import 100 MW of electricity to Singapore via the newly upgraded interconnector.

In a statement, YTL said it is the first time electricity from Malaysia would be supplied to Singapore on a commercial basis, adhering to the Malaysian Energy Commission's guide for cross-border electricity sales (CBES Guide).

YTL PowerSeraya was awarded the electricity importer licence for Malaysia for a two-year trial by the Energy Market Authority of Singapore (EMA) after a competitive request for proposal process in October 2021, and will purchase the electricity from TNB Pasir Gudang Energy Sdn Bhd, a wholly owned special vehicle company by TNB Genco.

Both parties will work closely with the EMA and the Energy Commission to refine all technical settings and regulatory arrangements under the Electricity Import Framework and the agreement will be effective upon fulfilment of the conditions precedent.

"We believe that this is the first step in our vision of a strong Asean power grid, where electricity imports may eventually form a key part of Singapore's energy mix," YTL PowerSeraya Chief Executive Officer John Ng said.

TNB Genco Managing Director Datuk Nor Azman Mufti said: "This is a positive step for the strengthening of cross-border energy supply towards the realisation of a fully interconnected Asean Power Grid. This will mark TNB Genco's maiden foray into the Singapore market via CBES and we hope this will become the catalyst to capture future projects in this market."

In a separate development, Singapore will improve grid resilience with the official launch of what is claimed to be the largest battery energy storage system in Asia.

Singapore energy company, Sembcorp said that the energy storage system has a maximum storage capacity of 285 MWh, and, in a single discharge, can meet the electricity needs of around 24 000 four-room households for one day.

Second Minister for Trade and Industry Tan See Leng noted that when there is heavy cloud cover or rain, solar power efficiency drops significantly. "So, with the energy storage systems, we can store excess power that is generated during the peak production periods for use at other times," he said.

Australian wholesale energy prices remain elevated at year-end

In the October-December 2022 quarter, wholesale gas and electricity prices in Australia fell from the record levels seen earlier in the year but remained higher than prices seen during the same period in 2021, according to the Australian Energy Regulator's (AER) latest 'Wholesale Markets Quarterly Report'.

Record low electricity demand in the National Electricity Market (NEM) as a result of a mild start to summer and strong rooftop solar output, together with high output from large-scale solar and wind generators, contributed to the easing of wholesale electricity prices.

In gas markets, the lower demand for electricity led to lower gas fired generation in the NEM, which in combination with the lowest liquefied natural gas exports in Q4 since 2018, eased pressure on domestic gas spot prices. The Iona gas storage facility in Victoria was refilled to its highest end-of-year levels since reporting commenced, with the facility looking better placed to assist with 2023 peak winter levels.

Despite wholesale gas and electricity prices easing from their peak seen in mid-2022, high fuel costs kept prices elevated compared to historical levels.

AER Chair Clare Savage said while wholesale prices remained high, early indications suggest that the outlook for 2023, while still carrying risk, may have improved.

She said: "A reduction in forward contract prices were observed since discussion of market intervention began with the October Budget and continued following the announcement of coal and gas price caps by National Cabinet in December 2022.

"While lower spot prices were also observed, there are likely other contributing factors and it remains too early to tell what impact the interventions have had on spot outcomes but, we will continue to monitor and report on the effect of the price caps on both forward contract and spot prices."

Europe concerns over maintaining offshore wind momentum

- Denmark puts plans on hold to clear state aid hurdle
- Energy islands and large projects need shared connection framework

Janet Wood

The Danish government has shocked the wind industry by announcing a hold on its so-called 'open door' development procedure. Wind organisations said the change creates uncertainty for 20 GW of offshore wind currently under planning and development.

Denmark said it wanted to be sure its framework did not breach the EU's state aid rules, which were changed slightly under the EU's recent Green Deal Industrial Pact.

"Many projects essential to delivering Denmark's 2030 offshore wind target are already under planning or development. Pausing their established and effective 'open door' approach to offshore wind development now will seriously undermine these targets," said WindEurope Chief Executive Giles Dickson. Rasmus Errboe, Chief Executive of Orsted Europe, said the decision was, "surprising and regrettable".

The Danish situation was made more unclear when the government later said 9 GW of wind being developed alongside the 'open door' projects would be put out to tender this year.

Denmark also said the hold would not apply to plans to develop 'energy islands' in the North Sea and Baltic Sea.

They and another 'energy island', Belgium's Princess Elisabeth Island in the North Sea, along with other shared offshore grid infrastructure, are key to ensuring offshore wind farms are developed and used most efficiently. The EU recently kicked off InterOPERA, a pan-European project whose main objective is to make future HVDC systems mutually compatible and interoperable by design and to improve grid forming capabilities of offshore and onshore converters. The project brings together eight transmission network operators, three offshore wind developers, four HVDC equipment manufacturers, two wind turbine manufacturers, two sector associations and two universities. Funding is being provided by the EU (€50 million) and the project partners (€19 million).

The need for shared infrastructure is made more urgent as wind farm sizes are stepped up. Recently Equinor and SSE Renewables decided to explore options to expand the Dogger Bank wind farm in the southern North Sea – already Europe's largest offshore wind farm.

Equinor and SSE Renewables have equal shares in the proposed expansion, which will add 1.32 GW to the 3.6 GW of capacity already being installed at the project. SSE Renewables' Offshore Wind Director Paul Cooley said: "We're already building the world's largest offshore wind farm at Dogger Bank, and now with our established partners Equinor, we're delighted to unveil plans to develop a potential fourth phase of the project, Dogger Bank D.

The EU and its member states have committed to 2030 offshore wind targets of 76 GW and 20 GW in the North Sea and Baltic Sea, respectively.

Nuclear gets go-ahead in Finland

Finland has reinforced its commitment to nuclear power with recent confirmation that it can extend the life of the existing Loviisa nuclear plant and a step forward in plans for small modular reactors (SMRs).

New operating licences for the two units at Fortum's Loviisa plant will allow them to operate until the end of 2050.

"This decision is an important and welcome one not only for Fortum, but for a clean and prosperous future for Finland. Continuing production at Loviisa is above all an investment in providing the power the Finnish society needs to meet its ambitious climate targets," said Fortum President and Chief Executive Markus Rauramo.

Meanwhile the EcoSMR (Finnish Ecosystem for Small Modular Reactors) project, funded by Business Finland, has moved into a new phase. The EcoSMR project was completed at the end of 2022, but EcoSMR Hub, which develops business networks for SMRs will shortly be launched as a successor. EcoSMR Hub welcomes all Finnish parties interested in SMRs as part of the network.

The EcoSMR Hub launch coincides with plans for Finland's largest and newest reactor, Olkiluoto 3, to move from a test generation phase into commercial electricity production, due in March 2023.

Coal competes with demand response to cover UK winter peaks

Recent months have seen old and new tools for managing peak electricity demand in operation in Great Britain.

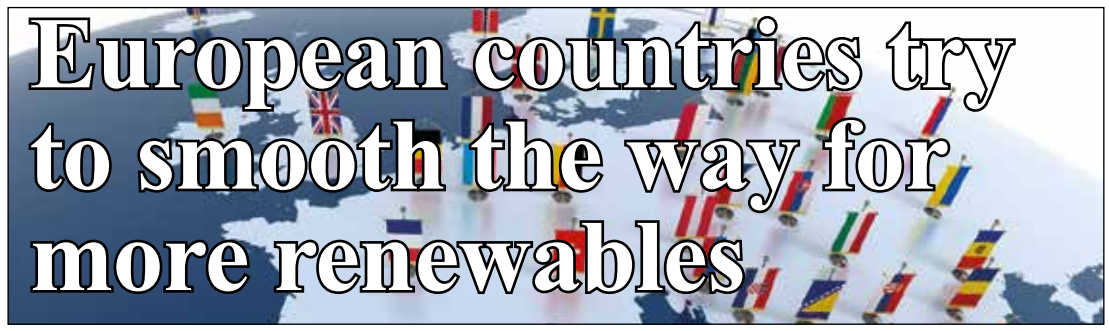
System Operator NGESO was given the option at the start of the winter to use coal stations that had been due to close, as the government was concerned about whether there were sufficient other supplies to meet peak electricity demand.

Among the government's concerns were whether gas supplies would be available for generation – although stocks have been higher than expected across Europe throughout the winter – and whether GB would be able to obtain its typical imports from France, given that several French nuclear units remained offline.

In the event, the system operator several times asked coal plant operators to 'warm' their units – a process that takes between 12 and 24 hours – so they would be available if required. However, in each case the system operator later 'stood down' the units as the market responded.

NGESO also activated a demand response options with payment for domestic customers who reduce demand during peaks, after trials at small scale last winter.

The measure was deemed a success: one domestic supplier, Octopus Energy, said its domestic customers had reduced peak demand by over 100 MW in each of the first two 'saving sessions'.



European countries try to smooth the way for more renewables

- UK acts on delays in connection and planning
- Germany puts new plan in place

Janet Wood

The UK government has produced an 'Action Plan' to speed up development consent for so-called 'Nationally Significant Infrastructure Projects' such as large energy assets. Ministers in several government departments concerned with infrastructure said: "By working together, we can support the delivery of nationally significant infrastructure, incentivise more investment into the UK and ensure we are able to meet our infrastructure, energy and environmental challenges."

Meanwhile the GB system operator NGESO also recently launched a "major initiative" setting out its own action plan to speed up connections to the electricity network, saying it "recognises that the existing process needs to change and be widely reformed to give investors and developers better certainty".

The UK had seen more delays and legal challenges consenting for energy projects – recently a decision on the Hornsea 4 offshore wind farm was delayed by four months. Developers are waiting up to as much as 10 years for grid connections.

The UK's action is the most recent attempt by a European country to smooth regulations to speed up the deployment of renewable energy across the continent.

The need to streamline permitting and remove regulatory barriers has been a major concern for the European energy sector for several years but resolving the issues became still more urgent after Russia's invasion of Ukraine.

A regular report from LevelTen Energy identified a lack of availability of power purchase agreements (PPAs). Frederico Carita, senior manager of developer services, Europe at LevelTen Energy, said: "A lack of available land and years-long lead times for turbine deliveries are straining wind project economics – particularly in mature markets with high competition. The market desperately needs permitting reforms to kick in faster."

Germany has responded to industry pleas. The Federal Maritime and Hydrographic Agency (BSH) recently published a new area development plan for the expansion of offshore wind energy. Federal Minister Robert Habeck said: "The expansion of offshore wind energy is a mammoth task in itself… the BSH area development plan is another part of our master plan to achieve the high goals for the expansion of renewable energies. With the publication, we show that we are serious about planning acceleration and are consistently advancing the expansion of renewable energies."

Germany has specified the areas for new offshore wind farms in the North and Baltic Seas, the tendering timeline, commissioning and grid connection. The plan also implements acceleration measures adopted in the amended German Offshore Wind Act, approved by the European Commission in December 2022.

Germany claims first use of electric vehicles for frequency control

For the first time, digitally networked electric vehicles (EVs) have been used to stabilise the German network as part of a virtual power plant. Transmission system operator TenneT was able to use storage within EVs belonging to Sonnen customers to manage short-term frequency fluctuations in the power grid.

Sonnen provides storage and networking technologies and to offer the balancing option, it expanded its virtual power plant (sonnenVPP) – previously based on standalone batteries – to include EVs. Together their storage capacity is adjusted within 30 seconds to compensate for load changes and thus frequency fluctuations in the power grid. This is achieved solely via an intelligent charging process, so there is no additional wear and tear on the vehicle batteries due to discharging.

In the next step, Sonnen wants to add 5000 households with an EV charger and household battery, bringing its VPP to 80MW. TenneT has a primary control power requirement of 170 MW.

"We are on the verge of developing a renewable energy ecosystem that can be compared to the dawn of the internet age. Assets that have been operating in isolation until now are networked with each other and thus develop their full potential," said Oliver Koch, Chief Executive of Sonnen. "By including electric vehicles in our virtual power plant, we are doing one big step by using the charging of electric cars to simultaneously balance supply and demand in the power grid and thus stabilise it."

Offshore wind developer backs lifecycle carbon footprint calculation

- Low-carbon focus essential as sector scales up
- Lifecycle emissions methodology due for release in 2025

Nadia Weekes

Leading offshore wind developer Ørsted will collaborate with climate consultancy the Carbon Trust to develop the first industry-backed methodology to measure the carbon emissions associated with offshore wind farms throughout their life cycle.

The project aims to help the global offshore wind industry scale as sustainably as possible as it supports the drive towards net zero by 2050. A common standard will ensure that offshore wind installations are delivered in a low-carbon way while encouraging comparability across developers and assets.

"Global climate targets can't be met without stepping up renewable energy generation, and offshore wind is particularly crucial to the world's transition away from fossil fuels," said Jan Matthiesen, Director of Offshore Wind at the Carbon Trust.

Experience showed that collaboration was crucial to success in the offshore wind sector, Matthiesen said, adding that it was "time to turn our attention to supporting innovation and scaling up sustainably to create a more resilient and competitive industry".

With energy still accounting for 73 per cent of global emissions, a fast transition from fossil fuels to renewables is the single most important climate action, explained Ørsted's Senior Vice President and Head of Global Stakeholder Relations, Ingrid Reumert.

"As our industry prepares for a massive and necessary build-out of offshore wind farms, we must also pay attention to driving down emissions from supply chains and operations," she said. "This common methodology will help us do that as well as increasing transparency for governments, investors, and suppliers – and enabling comparability across developers and assets."

Global installations of offshore wind stood at 55 GW at the end of 2021, but an additional 70-80 GW will need to be installed every year from 2030 in order to achieve net zero by 2050.

While offshore wind energy generation has a significantly lower carbon impact than fossil fuels, the sector must work collaboratively to decouple its own value chain from carbon and resource-intensive models of production, deployment and operation, addressing key hotspots such as steel, cement and fuels.

The measurement project will:

- Develop a standardised methodology to enable developers to calculate the lifecycle emissions of their offshore wind assets, including upstream supply chain emissions, construction and operation;
- Engage with the industry to improve data quality and availability and promote greater transparency;
- Identify key carbon emission drivers and hotspots.

Release of the methodology for use across the industry is expected in 2025.

Iran plans to add 10 GW of renewables by 2025

Iran's Energy Ministry has laid out a goal to add 10 GW of renewable energy capacity by the end of the current government's administration, in August 2025. This would represent a 13-fold rise from the 800 MW of renewable energy generation capacity that was in operation when the government took office in August 2021.

The announcement comes as the National Transmission and Despatch Company Limited (NTDC) completed construction work on the 29 km long, double-circuit transmission line from Polan, Sistan and Baluchestan province, in southeastern Iran, to neighbouring Gwadar on the southwestern coast of Balochistan, Pakistan.

This will allow Pakistan's transmission system to import an additional 100 MW from Iran, boosting the confidence of business people and investors looking to operate in the Gwadar region.

IEA: Eurasia's electricity demand on growth path despite Russia-Ukraine war

Eurasia's electricity demand will grow at an average 2 per cent a year from 2023 to 2025, up from an estimated 1.5 per cent in 2022, according to the latest electricity market forecast from the International Energy Agency (IEA).

Population and GDP growth in the region will underpin rising demand, although Eurasia's macroeconomic outlook has been downgraded since the Russia-Ukraine war started.

Energy production from fossil fuels will continue to dominate the region's energy mix with a share of about 65 per cent in the projected period, but the commissioning of new nuclear plants, including in Belarus and Russia, is set to reduce the CO_2 intensity of power generation.

While the development of renewables remains slow, the European Bank for Reconstruction and Development (EBRD) is supporting a number of low-carbon power projects in the region, including a wind power plant in the Absheron peninsula under a Memorandum of Understanding (MoU) with Azerbaijan that also covers grid expansion, upgrade and digitalisation.

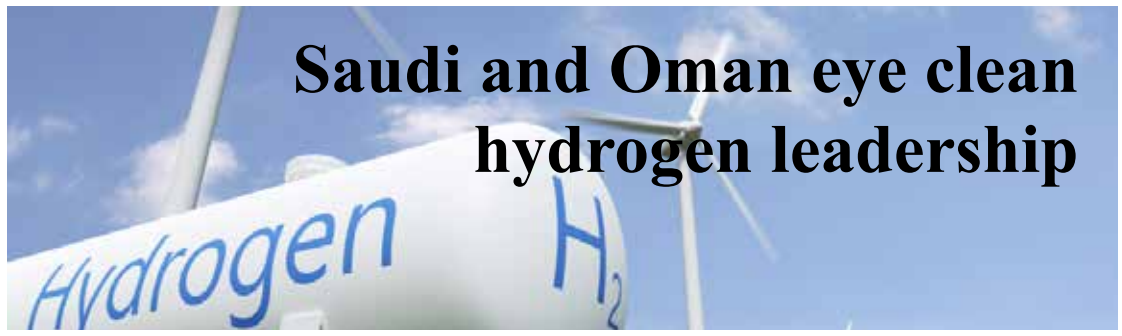
In a separate development, Azerbaijan's Energy Minister, Parviz Shahbazov, signed a cooperation agreement with Saudi Arabia's ACWA Power Chairman Mohammed Abdullah Rashid Abunayan on the implementation of a 1.5 GW offshore wind power project.

The partnership with ACWA Power extends to other wind power plants for a total capacity of 2.5 GW, and envisages the creation of battery energy storage systems for the first time in the country.

"These projects are further contributions to the implementation of the state policy on the development of Azerbaijan as a country of 'green growth' and supplier of green energy," the minister said.

Timely implementation of energy projects is of great importance for Azerbaijan's energy partnership with the EU, Parviz Shahbazov added. He is also discussing cooperation with Masdar on wind, solar and green hydrogen projects for a total capacity of 10 GW.

"As part of a strategic energy partnership with the EU, we are interested in exporting electricity and hydrogen produced from renewable energy sources. In this aspect, the timely implementation of projects with Masdar is very important," the minister said.



Saudi and Oman eye clean hydrogen leadership

- CCS key plank of Saudi pathway to net zero by 2060
- Oman positions itself as green hydrogen exporter

Saudi Arabia plans to invest more than SAR 1 trillion ($266 billion) to produce cleaner electricity and expand its power grid. Speaking at a forum organised by oil giant Aramco, the kingdom's Energy Minister, Prince Abdulaziz bin Salman, said his country was looking to become a global leader in hydrogen production.

He said the kingdom would also double-down on carbon capture solutions. Saudi Power Purchasing Company (SPPC) has issued requests for proposals (RFPs) for four combined cycle power generation projects ready for Carbon Capture and Sequestration (CCS).

Totalling 7200 MW, two plants will be located in Taiba city, with the other two in Qassim city, with each project sized at 1800 MW. The developers aim to implement CCS or other solutions to address carbon emissions. The projects align with the Saudi Green Initiative's target to achieve net zero by 2060.

The Sultanate of Oman is also positioning itself as a leading exporter of clean energy, and green hydrogen in particular. According to a new report released at the Abu Dhabi World Future Energy Summit (WFES) in January, "the UAE, Saudi Arabia and Oman are working on national strategies aimed at developing the hydrogen market in the region and positioning themselves as future hydrogen exporters".

Vast solar and wind resources, coupled with financial capabilities and export potential, make this region well suited to produce and transport green hydrogen. If these countries are able to leverage their first-mover advantage, they could beat rising competition from regions in North Africa, Europe and Australia, the report finds.

Oman has allocated 250km^2 in the Special Economic Zone of Duqm (SEZAD) for solar and wind farms to support the production of green hydrogen and green ammonia for local use and export. According to Dr. Ali Masoud al Sunaidy, Chairman of the Public Authority for Special Economic Zones and Free Zones (OPAZ), two licences have already been granted – one for a 300 MW plant at the implementation stage, and one for a much larger plant at the stage of detailed studies.

Blackouts lead South Africa to declare 'national disaster'

South Africa declared a national state of disaster last month after the country experienced another spate of rolling blackouts. President Cyril Ramaphosa said the recurrent power cuts were "an existential threat" to the economy and the country's "social fabric".

Faced with the accelerating collapse of ageing coal power plants, energy incumbent Eskom has had to cut off customers for up to 10 hours a day several times this year, leading to factories grinding to a halt, crops withering without irrigation and food rotting in refrigerators.

Ramaphosa's government has made policy changes to unleash private power production outside Eskom, but experts and investors have warned that these will take years to bear fruit. The declaration of a disaster will enable the country "to accelerate energy projects and limit regulatory requirements", Ramaphosa said.

The President said he would appoint a dedicated minister for electricity directly reporting to him "to assume full responsibility for overseeing all aspects of the electricity crisis response". But Eskom will remain under the control of the cabinet minister overseeing state-owned companies, while the energy minister will continue to control power procurement by the state. Critics have noted this is likely to create confusion at the top of government.

Days of energy companies' windfall profits could be numbered

Centrica, bp and Equinor are the latest companies to follow Shell in reporting extraordinary profits. Some argue, however, that the good times are unlikely to last. **Junior Isles**

UK-based Centrica and international energy major bp have become the latest energy companies to post huge profits as a result of the energy crisis. But with oil consumption on a downward trajectory and the growing use of renewables, some are already questioning how long the good times will last.

Last month Centrica posted a more than threefold rise in operating profits to a record £3.3 billion ($3.9 billion) for 2022, while bp recorded a full year profit of $27.7 billion compared with $12.8 billion the previous year. France's TotalEnergies and Norway's Equinor also reported record earnings from the surge in gas prices caused by the war in Ukraine. TotalEnergies posted a record net profit of $36.2 billion in 2022, double the previous year, while Equinor reported a net profit for the year of $28.7 billion, up from $8.6 billion a year earlier.

Commenting on bp's results, Neil Shah, Executive Director of Content and Strategy at Edison Group said: "This set of full year results comes as no surprise to investors who have been watching a succession of oil companies cash in on soaring oil and natural gas prices."

The results come after rival Shell posted its best-ever annual profit of $39.9 billion at the start of February. Altogether, according to Greenpeace, Shell, bp, Chevron, Exxon, and Total are set to report profits of $199 billion for 2022. But how long the energy majors' good fortune will continue is uncertain.

Although energy prices are expected to remain volatile this year, it is unlikely that the extraordinary profits of 2022 will be repeated.

The US Energy Information Administration forecasts that oil usage will continue to decline in 2023 and 2024 after falling 6 per cent last year compared with pre-pandemic levels.

"The consensus is we are not going to get back to pre-Covid levels of consumption," one industry expert told the *Financial Times*. "That matters because US gasoline is the world's largest single market for an oil product. It dwarfs any other national gasoline market in the world."

Also, in its latest report on the electricity sector, the International Energy Agency noted that renewables are set to meet almost all the new global electricity demand in the next three years. The Paris-based agency also forecasts natural gas fired power generation in the EU will fall in the coming years, based on current trends, although significant growth in the Middle East is set to partly offset this decrease.

Edison Group commented, however, that the recovery of the Chinese energy market will have a major influence on the industry's outlook as the country begins to reopen after abandoning its zero-Covid policy late last year. "Indeed, oil prices have been rising in recent days due to continued optimism over the recovery in demand from China, one of the largest crude importers in the world," said Shah.

The oil and gas majors have faced intense criticism for making huge profits at a time when consumers are struggling and greater investment in clean energy is needed.

Commenting on Shell's fourth quarter 2022 trading update, Julie Palmer, Partner at Begbies Traynor, said: "If Big Oil companies like Shell are to avoid further [windfall] tax hits, they need to show that profits like this are being used to fund a transition to green renewable power. Like oil, record profits like this won't last forever, and Shell needs to make sure it keeps ahead of the curve in a world target to net zero."

Adani's woes deepen

Adani group's significant recent falls on the stock market are having an impact on the Indian conglomerate's strategic plans.

Last month French energy major TotalEnergies put its multi-billion dollar plan to go into business with the Adani group on hold, saying it was awaiting clarity on the situation amid turmoil sparked by allegations of fraud against the Indian conglomerate. A January 24th audit report by the US-based Hindenburg Research, which cited financial irregularities, has so far eroded over $120 billion in Adani's market capitalisation.

"It (the partnership deal) was announced, nothing was signed. It doesn't exist," TotalEnergies Chief Executive Patrick Pouyanne said, referring to his firm's plan with Adani's new hydrogen venture. "Mr Adani has other things to deal with now; it's just good sense to pause things while the audit goes forward."

TotalEnergies was supposed to invest initially $5 billion in Adani's gas distribution and solar projects.

In mid-February Adani also abandoned plans to buy a coal plant in India for $850 million. It has decided not to pursue the deal with Chhattisgarh-based DB Power after a deadline to finalise it expired on February 15th, Bloomberg reported.

The Adani group was expected to step back on spending following the fall in its stocks.

Ørsted anticipates higher offshore earnings in 2023 but turbine manufacturers continue to struggle

Danish wind project developer Ørsted reported earnings of €2.84 billion ($2.98 billion) for 2022, even as wind turbine manufacturing giants Vestas and Siemens Gamesa returned poor end of year results.

For its offshore business, the developer anticipates 2023 earnings to be "significantly higher". Offshore wind is also one of the main drivers behind the company's expected gross investments planned for this year, which are estimated to be around €7 billion.

The company said its offshore wind farms are largely subject to regulated prices, implying a high degree of revenue certainty.

"This means that we know the price per generated MWh for most wind farms in Denmark and Germany, our first Dutch wind farm, and the CfD wind farms in the UK. For our British renewable obligation certificate wind farms, we also know the subsidy per generated MWh which we will receive in addition to the market price," the company stated in its 2023 financial outlook.

"The part of our generation from offshore and onshore assets which is exposed to market prices has, to a large extent, been hedged for 2023."

European wind turbine manufacturers, however, continue to struggle.

Vestas, the world's largest wind turbine manufacturer, posted a net loss of $1.69 billion for 2022, compared with a net profit of $153 million in 2021.

In a statement, Vestas' Chief Executive Officer, Henrik Andersen, described 2022 as "a business environment characterised by unforeseen geo-political uncertainty, high inflation, and supply chain constraints".

Vestas said it made strategic and commercial progress in terms of strengthening operations and substantially raising prices, which indicate it will deliver improved financial results in 2023. It noted, however, that although increasing prices on the company's order intake is an offsetting factor, it still leaves the company challenged on profitability in 2023. Vestas' guidance for 2023 triggered a credit rating downgrade from Moody's to Baa2.

Meanwhile Siemens Gamesa ended the quarter October and December 2022 (the first quarter of fiscal year 2023) with a net loss of €884 million. As of December 31, 2022, net financial debt totalled €1.9 billion.

It said, however that its Mistral strategy programme continued to show progress in addressing current challenges and building the path to regaining profitability.

The company also announced two significant international expansions. Early last month it signed a binding framework agreement for a strategic partnership with Doosan Enerbility, formerly Doosan Heavy Industries, for the South Korean offshore wind market. Meanwhile, for the US market it announced its intention to build a major offshore nacelle manufacturing facility in New York state. This is subject to the company's wind turbines being selected by the New York authorities in their third offshore wind solicitation.

France may tap 'savings' to fund new nuclear build after EDF reports heavy losses

State-owned nuclear operator EDF and the French government are reportedly considering tapping into considering tapping into funds from a centuries-old savings account to finance part of a €50 billion plan to build six nuclear reactors in the country.

According to the *Financial Times* France is considering using some of the €370 billion in deposits in the "Livret A" savings account, which is deployed by the Caisse des Dépôts et Consignations (CDC), a state-linked bank that carries out projects in the public interest, such as building social housing.

Between €10-20 billion of Livret A funds could be freed up for the nuclear build, one source told the *FT*.

In 2021 French President Emmanuel Macron outlined plans for EDF to build several new plants, as concerns over energy security mounted just before Russia's invasion of Ukraine.

EDF, however, has continued to post losses and is now being fully renationalised. In February it revealed a near €18 billion loss for 2022.

Outages at its nuclear plants forced the French group to buy electricity on expensive wholesale markets during the energy crisis in Europe. It also had to pay for the cost of government-mandated price caps on consumer bills.

Americas

Hellenic Cables contract for US wind farms

Hellenic Cables has signed contracts with Ørsted and Eversource for the supply of inter-array cables for their South Fork Wind and Revolution Wind offshore wind projects in the USA.

Under the contracts, Hellenic Cables will design, manufacture, test and supply 260 km of 66 kV XLPE-insulated subsea inter-array cables and associated accessories for the two offshore wind farms, with production to be phased through 2024.

Alex Alexiou, CEO of Hellenic Cables, said: "This long-term partnership with Ørsted and Eversource is proof of Hellenic Cables' commitment to the US offshore wind industry as a core part of our business and our strategy for the future."

Texas utility selects Wärtsilä technology

Lower Colorado River Authority (LCRA) has awarded a contract to Wärtsilä to supply the generating equipment for a 190 MW power plant to be built in Texas, USA.

The project will be a peaking power plant capable of starting and stopping rapidly to provide dispatchable power to increase reliability and provide power to balance the grid.

The plant will be located in Central Texas and will operate with ten Wärtsilä 50SG engines running on natural gas. It is expected to become fully operational in 2025. Each Wärtsilä engine consumes little to no water every week, which in Texas, an area often affected by drought, is an important feature.

Randa Stephenson, Chief Commercial Officer of LCRA, said: "This new dispatchable peaker power plant with Wärtsilä technology will support the Texas power grid within minutes. We sometimes need more power that can be available quickly, depending on market conditions and demand."

Wärtsilä to supply engines for Latin America

Wärtsilä will supply the engines for a large power plant to be installed in Latin America. Initially, the plant will provide baseload power to the grid, but the rapid start-up flexibility of the engines will enable it to take on a grid balancing role as the system's share of renewable energy increases.

The order, valued at over €100 million, was placed by an undisclosed purchaser, described as a major EPC contractor, for a project in an unspecified location in Latin America.

The plant will operate with 18 Wärtsilä 50SG gas engines, which in simple cycle deliver an output of 339 MW. In combined cycle mode, the heat from the stacks will be recovered to provide more than 350 MW. The equipment is scheduled to be on site early in 2023. The plant is expected to commence commercial operations in August 2024.

Asia-Pacific

Mitsubishi GT for Chang Chun Petrochemical plant

Mitsubishi Power, a subsidiary of Mitsubishi Heavy Industries (MHI), has received an order for an H-25 gas turbine for the Taiwanese firm Chang Chun Petrochemical.

The 30 MW turbine will be the core of a new natural gas fired combined heat and power (CHP) facility at the company's Miaoli Factory in Miaoli City in the north central region of Taiwan. Operation is scheduled to begin around Spring 2025, with the unit supplying power for the company's factories, and steam for manufacturing processes.

The gas turbine will replace the existing oil and coal fired boiler facility, as part of a project conducted in response to a request from administrative authorities to reduce coal consumption based on the global trend toward reducing CO_2 emissions.

Mitsubishi Power will supply the H-25 gas turbine and auxiliary machinery, and dispatch engineers to provide support for installation and trial operations.

Nepal orders substation upgrades from GE

Nepal Electricity Authority (NEA) has awarded a contract to GE Renewable Energy's Grid Solutions business to automate 39 substations of various ratings across Nepal. This will include construction of six Master Control Centres (MCCs), which will be monitored by GE Digital Solutions.

The project also includes retrofitting of relay panels and other electrical components in the substations. When the substations are automated, GE will connect them to Nepal's National Load Dispatch Centre (NLDC) to enable real-time monitoring of power transmitting through these substations.

The project is funded by the Asian Development Bank (ADB).

Enapter wins electrolyser order from South Korea

Enapter, together with its partner YEST, has received an order from South Korea for delivery of two AEM electrolysers with a total capacity of 2 MW.

The systems will be used in a 12.5 MW hydrogen pilot project on Jeju Island. The demonstration project is supported by the South Korean Ministry of Industry and Trade (Motie) with $43.3 million and aims to investigate and compare hydrogen production with different electrolysis technologies. The systems supplied are expected to produce more than 1000 tonnes of green hydrogen per year.

Europe

Vestas wins 68 MW Estonia wind project

Vestas has received a 68 MW order from Dirkshof Estonia OU to power the Aidu project in Estonia. The order includes supply, installation, and commissioning of 15 V150-4.5 MW turbines, as well as a 20-year Active Output Management 5000 (AOM 5000) service agreement.

The site is located in Luganuse, Ida-Viru County, in the northeast of Estonia.

Delivery and installation of the wind turbines are scheduled for Q3 2023, with commissioning scheduled for Q1 2024.

Modernisation of I&C at Dukovany

ČEZ has awarded Framatome a contract to modernise the existing I&C Spinline testers for safety systems installed on four VVER type reactors at Dukovany Nuclear Power Station, located in Czechia.

Framatome will redesign, manufacture, validate and install the new Spinline testers. The first installation is planned for mid-2024 during the Dukovany-2 planned outage. This project is the first step in the comprehensive modernisation of the existing Spinline safety I&C platform that will allow ČEZ to operate Framatome systems until 2045.

GE turbines for Irish 49 MW wind project

Irish renewables developer and operator Energia Renewables has placed an order with GE Renewable Energy for the supply of turbines to equip its 49 MW Drumlins Park wind project in Ireland. The turbine supply deal comes with a 25-year full-service contract for the hardware.

Eight units of GE's 6.1 MW turbines will power the Drumlins Park wind farm near Newbliss in the County Monaghan, Ulster province. According to the project developer, Drumlinks Park will be the first one in Ireland to be powered by GE 6 MW class machines.

Energia Renewables is developing the project under a corporate PPA with Microsoft. Energia Renewables expects to finalise construction works and have the wind farm ready for commissioning during the autumn.

GE Hitachi's BWRX-300 for Estonia SMR

Fermi Energia of Estonia has selected GE Hitachi as a technology provider for BWRX-300 SMR for a planned nuclear power plant due for completion by the early 2030s.

In order to build a nuclear power plant in Estonia, a decision of the Riigikogu to enable nuclear energy in Estonia and initiation of a special national plan to find a suitable location for the plant, as well as the development of nuclear energy legislation are required to build a new nuclear power plant in Estonia.

Kalev Kallemets, CEO of Fermi Energia, said: "We have analysed all the work ahead and consider it realistic to produce reliable, clean and affordable nuclear energy in Estonia by Christmas 2031."

Iberdrola wins French floating solar project

Iberdrola has won a contract for a 25 MW floating solar plant for the municipality of Kurtzenhouse in France's Alsace region. The Spanish utility will develop, install and operate the floating plant on the basin of the Bischwiller gravel pit.

The pit is partly owned by the municipality, and is currently operated by building materials specialist Eqiom Granulats, which extracts and markets sand and gravel.

Iberdrola plans to install the solar panels on an area spanning some 13.5 hectares of the 28 hectares available at the site.

Iberdrola expects to apply for a building permit in the spring of 2024 and commission the solar arrays in late summer 2026. The floating panels will be in operation for 30 years, producing around 27 GWh of electricity per year.

Upgrading the UK electricity grid

Prysmian will help upgrade the UK's electricity grid, with Prysmian signing a medium voltage cable framework agreement with National Grid for a minimum of three years.

Medium voltage cables will be supplied primarily from the Prysmian's manufacturing plant in Wrexham, North Wales, and will assist National Grid to expand and modernise the network supporting the increase in demand.

Juan Mogollon, Energy division Executive Vice President at Prysmian, said: "The development of more reliable and smarter grid infrastructures for power transmission and distribution is key for the integration of renewables. The ambition of Prysmian is to act as an enabler for accelerating the energy transition by supporting the development of greener and smarter power grids with innovative cable technologies, ensuring higher performances, reliability and sustainability."

Solar plant for Toledo, Spain

Dunas Capital has awarded a contract to GES to construct a 19.79 MW solar plant in Toledo, Spain. Construction has already started and the plant will be commissioned in Q3 2023.

The plant will consist of 34 720 panel of 570 W/unit and will cover 58.8 ha (588 000 m^2) in Torrijos, Toledo. GES is responsible for the design and engineering, construction of the civil and electrical works, supply of equipment and materials, commissioning, testing the operation of the PV units and the voltage step-up substation, and maintenance of the plant.

GE wins three onshore wind projects in Germany

GE Renewable Energy has been awarded a contract by wpd to supply 16 onshore wind turbines to three wind farms to be built in Landkreis Uelzen, Niedersachsen, 100 km southeast of Hamburg, Germany. The three projects will have a total installed capacity of 88 MW, and will use GE's 5.5 MW turbines with a rotor diameter of 158 m. The agreement also includes a 15-year full-service contract with an extension option of another 5 years.

Two projects, Bankewitz and Müssingen, are due to be commissioned and operational by the end of 2023 while the third one, Flinten, is scheduled to be operational in Q1 2024.

International

Elsewedy to build solar project in Saudi Arabia

Elsewedy Electric for Transmission and Distribution (EETD) has signed an EPC contract with Al-Ghazala Energy Company, the KSA-based subsidiary of Jinko Power for the 300 MW Saad PV Solar IPP Project in Saudi Arabia.

EETD will manage the design, supply, and construction works and perform the operation and maintenance for the initial years.

The Saad Project is located 85 km east of Riyadh City. It is part of Category B projects under the third round of competitive tenders of Saudi Arabia's National Renewable Energy Programme (NREP).

GE to strengthen Iraq power infrastructure

An agreement between GE and Iraq's Ministry of Electricity has been signed to increase output through establishing new power plants and expanding capacity at existing facilities.

The agreement also provides for maintaining and rehabilitating installed power generation and transmission infrastructure for more secure electricity supply; establishing new substations to relieve grid congestion; enhancing the interconnectivity between the Jordanian and Iraqi grid; and driving decarbonisation of Iraq's energy sector.

Hydrogen

ExxonMobil plans world's largest hydrogen plant for 2027-28 start-up

Companies that just a decade ago were denying that burning fossil fuels had anything to do with global warming – like ExxonMobil – are now turning their attention to producing blue hydrogen and blue ammonia and capturing carbon with the intention of launching a new more eco-friendly industry that still makes use of the energy giants' huge fossil fuel reserves.

Gary Lakes

Energy giant ExxonMobil is taking steps to proceed with building the world's largest low-carbon hydrogen plant in Baytown, Texas, USA. The company announced in late January that it had awarded a front-end engineering and design (FEED) contract to French-headquartered Technip Energies for a facility that will have a capacity target of 1 billion cubic feet (bcf) per day (28.3 million m^3/day) of blue hydrogen. A final investment decision (FID) is expected to be made by ExxonMobil in 2024, and start-up for the plant is scheduled for 2027 or 2028.

Blue hydrogen is produced by using fossil fuels, either through natural gas reforming or coal gasification. The CO_2 produced during the process is captured and stored, or used in products through carbon capture, utilisation and storage (CCUS) technologies. Low carbon hydrogen is produced when most of the CO_2 emissions are removed. Green hydrogen is green because it is made through the process of electrolysis using renewable energy, which are free of carbon emissions.

ExxonMobil has also awarded contracts to several technology companies to contribute to the facility. Carbon capture will be the key to its success as an industry that is environmentally friendly. While carbon capture is currently the darling of the big fossil fuel companies, claims of its effectiveness have yet to be proven.

In a statement announcing the FEED contract award, ExxonMobil said that more than 98 per cent of the associated CO_2 produced by the facility, or around 7 million tons metric tons annually, is expected to be captured and permanently stored.

"The carbon capture and storage network being developed for the project will be made available for use by third-party CO_2 emitters in the area in support of their decarbonisation efforts," the company statement said.

Reuters reported last month that ExxonMobil expects to see a 10 per cent return on the business of reducing greenhouse gas emissions from other companies looking to decarbonise their own operations. More than a dozen fossil fuel-oriented companies in the Houston, Texas, area are reported to be involved in ExxonMobil's plan which will capture CO_2 produced by these businesses and store it in depleted oil reservoirs and other underground formations in the Gulf of Mexico area.

According to a report prepared by IDTechEx, the future viability of the blue hydrogen market will be highly lucrative, forecasting that it will grow to reach $34 billion by 2033.

"Low carbon hydrogen production is one of the key paths to decarbonising hard-to-abate industries like oil refining, ammonia, steel, and long-haul transportation," IDTechEx said in a statement introducing the report.

"CCUS infrastructure has significant government backing and is being developed by companies worldwide to capture and store emissions from various industries by locating infrastructure near industrial clusters. These forces are accelerating blue hydrogen production, which is expected to grow as global decarbonisation efforts intensify."

ExxonMobil is looking to invest $7 billion in hydrogen, carbon capture and biofuel projects over the next five years. The company in 2021 announced its Scope 1 and Scope 2 greenhouse gas emission reduction scheme for 2030 covering operated assets compared to 2016 levels. Those plans call for a 20-30 per cent reduction in corporate-wide greenhouse gas intensity; a 40-50 per cent reduction in greenhouse gas intensity in upstream operations; a 70-80 per cent reduction in corporate-wide methane intensity; and a 60-70 per cent reduction in corporate-wide flaring intensity. The company said with advances in technology and with the support of clear and consistent government policies, it aims to achieve net zero Scope 1 and 2 greenhouse gas emissions from its operated assets by 2050.

"This project allows us to offer significant volumes of low carbon hydrogen and ammonia to third party customers in support of their decarbonisation efforts," Dan Ammann, President of ExxonMobil Low Carbon Solutions was quoted as saying in the company statement. "The project is expected to enable up to a 30 per cent reduction in Scope 1 and 2 emissions from our Baytown integrated complex, by switching from natural gas as a fuel source to low carbon hydrogen."

From its various CCS projects around the world, ExxonMobil said it expects to have the capacity to capture about 50 million tons of CO_2 by 2030 and increase that to 100 million tons by 2040.

Among the companies contracted to participate in ExxonMobil's Baytown plant is Honeywell in partnership with Denmark's Topsoe, which will supply carbon capture technology for the facility. Honeywell said that currently its technologies are employed in the capture or utilisation of some 15 million tons of CO_2. It said its customers have the capability to capturing 40 million tons of CO_2 annually across the globe. Topsoe's technology concentrates on large-scale hydrogen production and carbon capture.

Gas

US seen becoming world leader of LNG exports in 2023

It was once forecast that the US would become one of the world's biggest LNG importers. But then came fracking, gas surpluses, the pandemic, the war in Ukraine, exorbitant prices, and a scramble for scarce LNG supplies. Now as the global LNG market regains some composure, and US companies line up for FERC approval, the US is set to become the biggest LNG exporter in the world this year.

Gary Lakes

The anticipated return of Freeport LNG to partial operations after being closed for eight months following an explosion in June 2022 will push the US into the position of being the world's largest exporter of LNG during 2023, according to Edinburgh-based consultancy Wood Mackenzie.

With the return of Freeport, seven LNG facilities will be operating in the US and at least three more companies are looking to clear contracting and financing hurdles this year, moving them closer to final investment decisions (FIDs) and thus giving the US an even larger production and export capacity. The new facilities are under construction and several other companies are planning regasification terminals that in the years ahead could see the US become a massive LNG exporter.

With the contractual advances the US industry has made this year when European and Asian countries were scrambling for supplies, the US is predicted to jump ahead to become the world's largest exporter in 2023, passing Australia and Qatar, where annual capacities are 88 million tons and 77 million tons, respectively.

After months of investigation over the cause of the explosion at Freeport – attributed to inadequate operating and testing procedures and operator fatigue – the US Federal Energy Regulatory Commission (FERC) approved the partial restart of two of Freeport's three LNG trains, two storage tanks, and a single tanker berth. Full operations, including another train, a third storage tank and a second tanker berth should begin by the middle of this year. The plant has a capacity to process 2 billion cubic feet per day (bcfd), according to US reports.

With Freeport operating again, US LNG exports are expected to increase by 16 per cent during 2023. *Reuters* said in mid-February that data provider Refinitiv reported that US LNG exports during 2022 increased by 8 per cent to 10.6 bcfd, close to Australia's 10.7 bcfd, and that Qatar had exported 10.5 bcfd during the year.

The US Energy Information Administration (EIA) estimates that the US will export 11.8 bcfd during 2023 and 12.6 bcfd in 2024. Current total US export capacity is put at 13.8 bcfd, including Freeport.

Freeport's offloaders, including bp, TotalEnergies, Japan's JERA and Osaka Gas, and South Korea's SK E&S, were cut short when the mid-summer explosion forced exports to halt. Western sanctions against Russia for the invasion of Ukraine and Moscow's subsequent decision to halt pipeline exports to Europe sent demand for LNG soaring resulting in the signing of many long-term contracts with US suppliers.

Russia had supplied Europe with 40 per cent of its gas supplies before the war, and with Russian gas no longer available, Europe concentrated on filling its gas storage facilities, a task that has since been largely accomplished. US LNG is now expected to assume the role of a steady source. Furthermore, global demand for US LNG is expected to grow to the point where processing capacity could put pressure on US natural gas producers to meet export demand and that of the US gas market. But for now, US LNG developers are keen to press ahead with their projects.

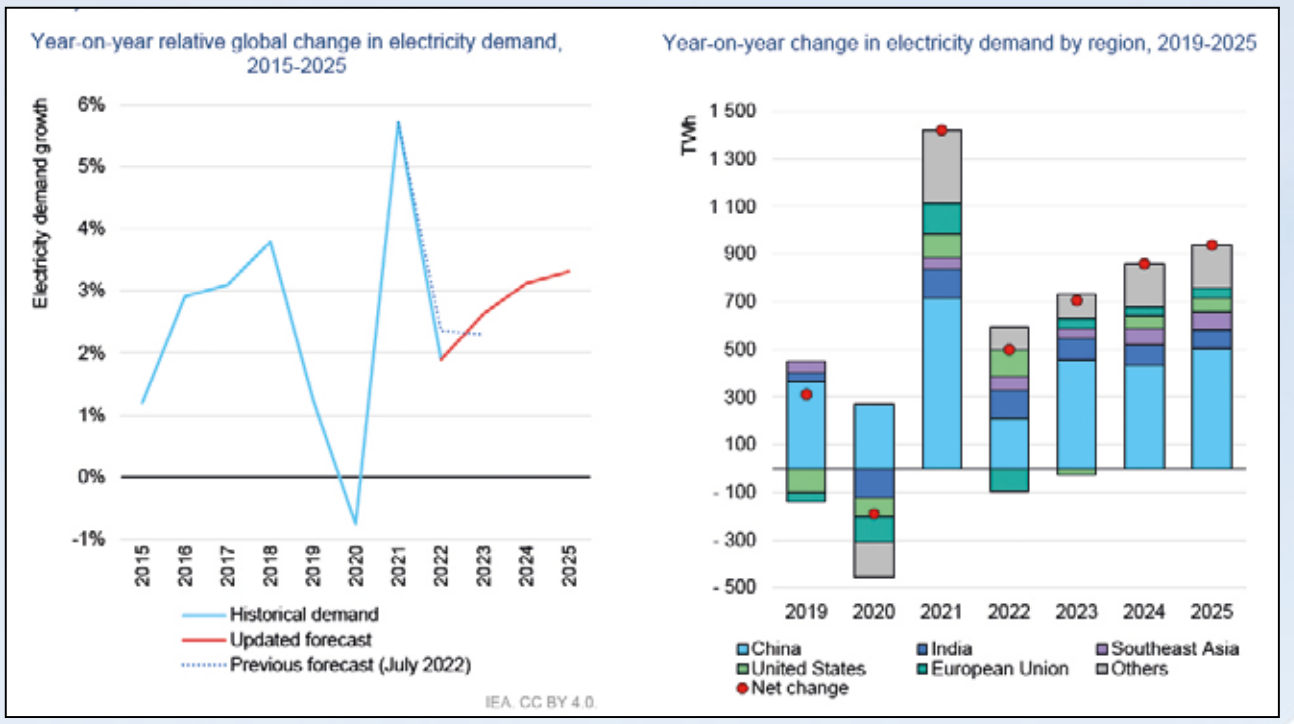
The largest US exporter, Cheniere Energy, reported an increase in profits as a result of the Ukraine war. It reported a total revenue of $33.43 billion for 2022, up from $15.86 billion in 2021. The company reported a net attributable profit to stockholders of $1.43 billion for 2022, compared to a loss of $2.34 billion in 2021.

According to Statista, Cheniere has a production capacity of 55.4 million tons per year.

Three LNG projects have almost completed their financial requirements by securing bank loans that will enable them to move ahead with FIDs and then construction within the next year. Sempra Energy's facility in Port Arthur, Texas, the Lake Charles plant in Louisiana owned by Energy Transfer LP, and the Rio Grande plant in Texas, planned by NextDecade Corporation are expected to be operational by 2027 or 2028, *Reuters* said.

Last autumn the EIA reported that construction had begun on three more developments: Golden Pass LNG with a total capacity of 2.4 bcfd; Plaquemines LNG with a peak capacity of 1.8 bcfd; and Corpus Christi Stage III with a total capacity of 1.6 bcfd. Completion of these projects will put total US LNG capacity at nearly 20 bcfd by the end of 2025.

Out to 2025, more than 70% of the growth in global electricity demand is set to come from China, India and Southeast Asia combined



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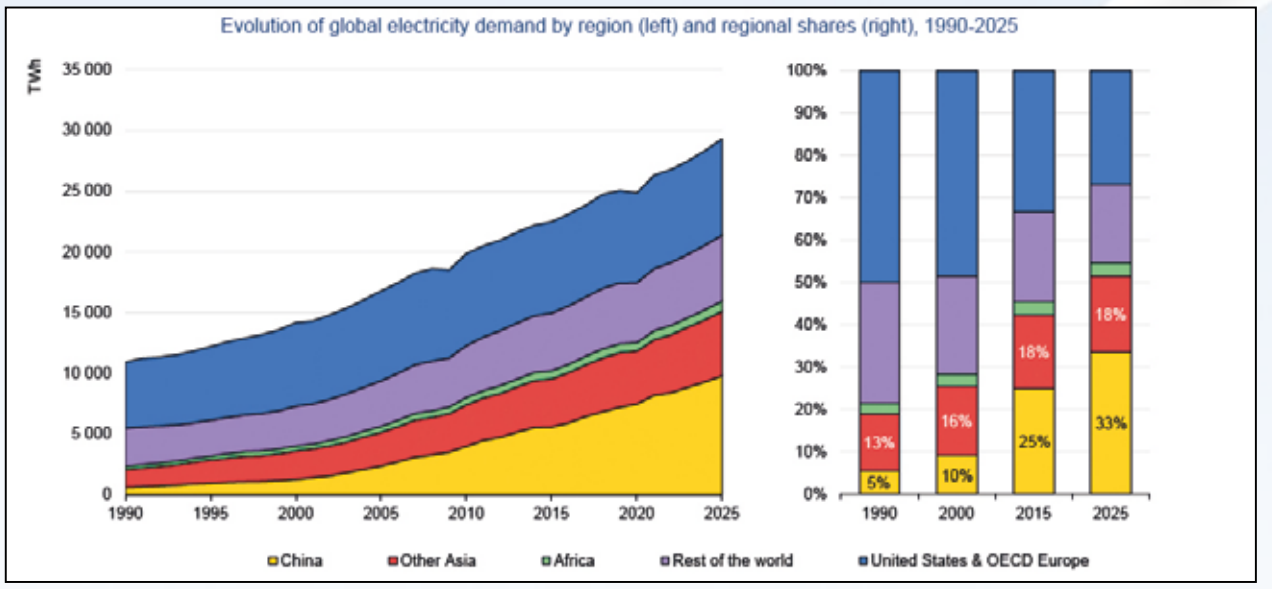
By 2025, Asia will account for half of the world's electricity consumption and one-third of global electricity will be consumed in China



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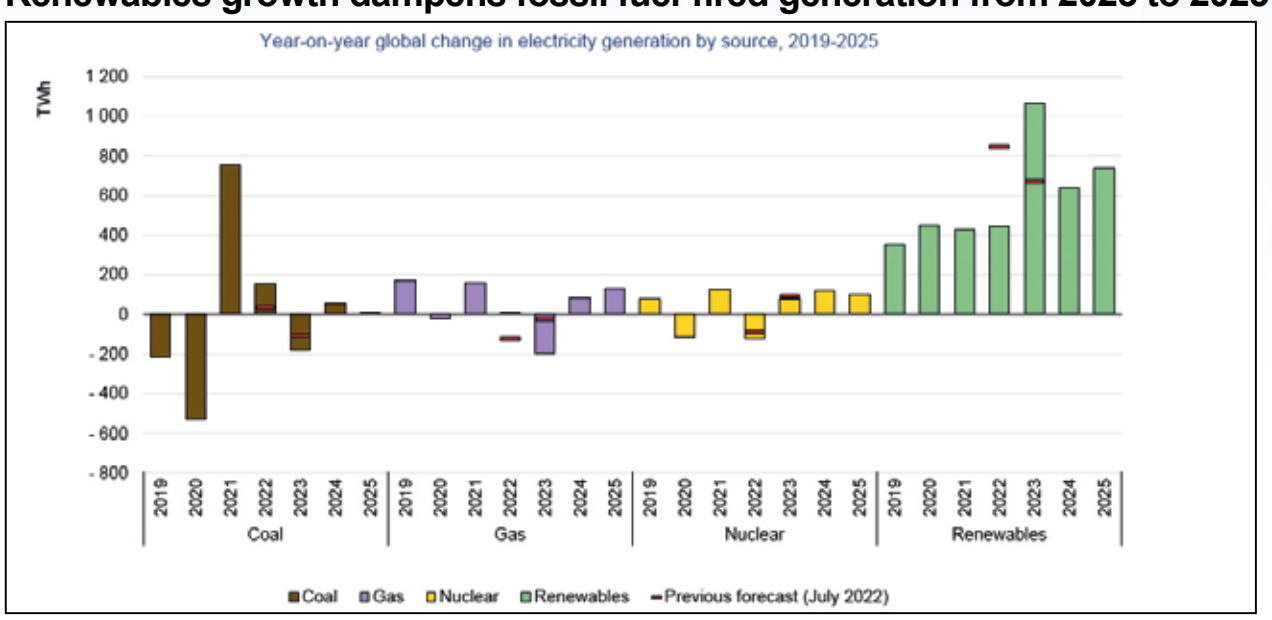
Renewables growth dampens fossil fuel-fired generation from 2023 to 2025



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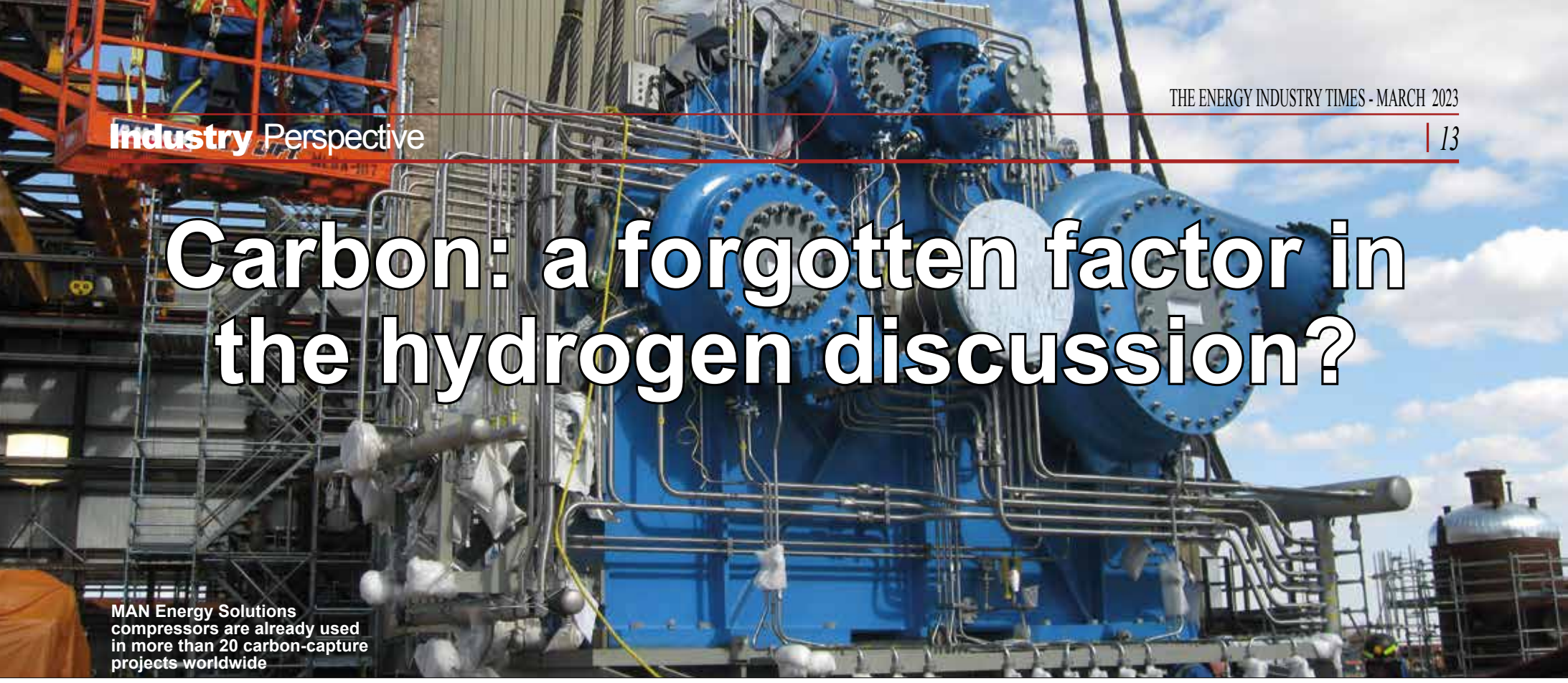
Industry Perspective

Carbon: a forgotten factor in the hydrogen discussion?



MAN Energy Solutions compressors are already used in more than 20 carbon-capture projects worldwide

While hydrogen-based fuels are urgently needed for decarbonisation, it is often forgotten that their production requires carbon. MAN Energy Solutions' **Sebastian Schnurrer** explains why it must also be viewed as a raw material.

With the discussion about green hydrogen (H_2) gaining momentum over the past couple of years, the question also arises as to how we can cover the huge amounts of hydrogen needed to decarbonise various industrial sectors in the future. This question is posed too in the context of the IEA's prediction that, already by 2030, worldwide hydrogen demand will reach around 180 million tons.

To cover this huge hunger for green hydrogen, an increasing number of proposals suggest producing hydrogen in sunny regions such as the Saharan countries or Australia. Similarly, regions blessed with consistent wind conditions, such as the Patagonian region in the South of Chile and Argentina, come into play. In these areas, the conditions for renewable energy production – the inevitable prerequisite for green hydrogen – are eminently favourable in that they deliver affordable green energy and, consequently, significantly reduce the cost of green hydrogen.

But how to bring this economically-produced green hydrogen to those world regions where the energy need is greatest? The remoteness of these potential, new hydrogen hubs make pipelines impracticable, while transporting hydrogen by ship is technically complicated owing to both its low volumetric energy-density and high fugacity. A much easier solution would be to further convert the hydrogen, with the help of power-to-X technology, into synthetic fuels such as synthetic natural gas (SNG) or methanol with both fuels then easily transportable using current infrastructure. As an example, SNG is more or less pure methane and, thus, existing LNG infrastructure can be used for its transportation. The same situation applies to methanol, which is already traded worldwide as a standard chemical. Of course, other transport media like ammonia and LOHC (Liquid Organic Hydrogen Carrier) are available as well, and we expect to see a broad mix of media being established over the next decade.

Upon transportation to Europe, such fuels could then either be converted back to green hydrogen or used directly as climate-neutral fuels. For example, SNG can already power today's gas-engine power plants and 'green' them without significant technical adjustment. Similarly, methanol-running engines for power plants are also a viable prospect. Additionally, such synthetic fuels are also urgently required to decarbonise sectors such as shipping, aviation and the chemical industry where new markets with new off-takers are imminent.

But what is often left out of the hydrogen discussion, is that the production of these fuels requires another raw material, namely carbon. An example: to produce 4 kg of SNG requires 1 kg of green hydrogen and nearly 11 kg of carbon dioxide (CO_2).

This makes the discussion ambiguous: on the one hand, we need to reduce carbon emissions as much as possible to prevent global warming, but on the other hand carbon is needed as a raw material to produce the synthetic fuels urgently required to reduce emissions from sectors that cannot be directly electrified, including the aforementioned shipping, aviation and chemical industry sectors.

Therefore, the discussion must be broadened. Besides green-hydrogen strategies – which are currently adopted by many governments worldwide – there has to be discussion around carbon management and both views must be reconciled. The main question then becomes how to supply enough carbon for synthetic-fuel production in the future without causing harmful emissions to the atmosphere.

The answer mainly lies in carbon-capture technology. This facilitates the capture of inevitable carbon emissions, for example those from industrial processes, preventing them from entering the atmosphere. A look at the cement industry, responsible for 8 per cent of worldwide CO_2 emissions, shows that two-thirds of these emissions are caused by the process and thus cannot be reduced by using a climate-neutral energy source. Accordingly, such 'hard-to-abate' industries urgently need carbon-capture technology to reduce their harmful atmospheric emissions.

What happens to the captured carbon afterwards? Certain countries, such as Norway, the Netherlands and Canada, send it underground – mostly to exploited gas fields – for storage, a process called Carbon Capture and Storage (CCS). But you can also take the idea further and bring this captured carbon back into the cycle for use in synthetic-fuel production, called Carbon Capture and Utilisation (CCU). The vision is to create a circular system where carbon is captured, transported, stored and re-used – for example in synthetic-fuel production.

For some, this may seem like a bold vision but the carbon-capture technology is already proven and in use in various projects globally. As an example, MAN Energy Solutions compressors are already used in more than 20 carbon capture projects worldwide. Currently, the world's first large-scale carbon capture plant for the cement industry is under construction for Heidelberg Materials in Brevik, Norway, which will help reduce emissions from the cement plant by around 50 per cent or 400 000 t CO_2 annually.

While the current projects in Norway, the Netherlands and Canada – and, following the US Inflation Reduction Act, carbon capture technologies are also building momentum there – show that the technology is already available and mature, unfortunately carbon capture is often viewed as just standalone technology and not connected to a broader picture. However, there is no doubt that carbon capture has not only the potential to reduce inevitable emissions from hard-to-abate industries, but also has the ability to supply enough carbon as a raw material to produce the huge amounts of synthetic fuels that will be needed in the future. Furthermore, carbon can easily be compressed, stored and shipped to remote hydrogen hubs the world over.

Accordingly, hydrogen, power-to-X and carbon capture are not competing technologies, rather they are all part of a bigger picture and we need them all to prevent climate change. But what's needed to make sure that carbon-capture technologies support a hydrogen economy?

Ideally, some kind of worldwide deposit system for carbon needs to be created which enables its capture, storage, transport and re-use to create a circular economy. The basic idea begins with hydrogen production at a remote location, its subsequent shipping as synthetic fuel – for example to Europe – and its use or conversion back to hydrogen. During this process, any emitted carbon is captured and shipped back to the remote hydrogen hub, and the circle begins again.

Of course, this requires the building up of a dedicated, worldwide infrastructure to transport, handle, store and trade carbon that complements the hydrogen and synthetic fuels infrastructure. In the mid-term, a CO_2 pipeline network is needed to transport the captured carbon from industrial emitters to either a nearby power-to-X or storage facility, or a port from where it can be shipped overseas. Such ports will also require the infrastructure to store and handle compressed CO_2 as well as a worldwide fleet with CO_2-transport-tankers.

The capture and re-use of carbon also needs to be incentivised to make it economically viable to invest in such technologies. One approach to this could be to introduce certificates of origin to create transparency around the origin of the used carbon: is it carbon that has already circled round? Thus, synthetic fuels produced with 'recycled' carbon would be labelled as such and its use incentivised. Ideally, users would be further rewarded for re-capturing the carbon and bringing it back to the cycle.

Finally, it needs to be emphasised in this discussion that carbon-capture technology does not interfere with the much needed ramping-up of renewable energies, rather it is a complementary technology that is necessary to supply carbon as the raw material needed in the power-to-x process to produce synthetic fuels. Carbon-capture technology should not be used to 'greenwash' oil or coal fired power plants, and prolong their life-span when they could just as easily be replaced by renewable or lower-emission energy sources. Also, even if such carbon cycles can take up large volumes of CO_2, they cannot replace the strong need to decarbonise processes emitting CO_2 wherever possible.

Accordingly, in the future, CO_2 must not only be viewed as the source of harmful emissions but also as a raw material that can play a pivotal role in the hydrogen and synthetic-fuel production chain. Ultimately, we will need both a worldwide hydrogen and carbon economy that are closely connected.

Sebastian Schnurrer is Business Development Manager Power at MAN Energy Solutions.

Schnurrer: We need to reduce carbon emissions as much as possible to prevent global warming, but on the other hand carbon is needed as a raw material to produce the synthetic fuels

V2G is coming of age

Vehicle-to-grid (V2G) technology is not only capable of providing grid balancing, but could also be a key tool in decarbonising power grids. **Junior Isles** discusses the technology and the current state of commercialisation with Octopus Energy's Claire Miller.

According to the International Energy Agency's (IEA) tracking report, published in September last year, the global electric vehicle (EV) fleet will reach 300 million in sales in 2050 in its Net Zero 2050 Scenario. This accounts for 60 per cent of all new car sales. With that share expected to hit 13 per cent in 2022, it appears there is every likelihood the IEA's long-term prediction will be realised.

The role of EVs in decarbonising transport is well understood but using them – through vehicle-to-grid (V2G) technology – as a tool to decarbonising power grids by supporting grid balancing and flexibility, is an area that is also seen as important in tackling climate change.

"From a decarbonisation perspective, V2G is one of the key technologies, which will allow the grid to move to wholly renewables in the future," said Claire Miller, Head of Technology and Innovation at UK-based energy supplier Octopus Energy. "Storage is crucial for this renewables grid of the future and V2G is one of those really important storage technologies – one that customers can engage with. In terms of that storage element, we're already using over 20 000 EV batteries every night on our Intelligent Octopus [platform] to store energy at times that help the grid. And with V2G, when we have V2G-enabled cars at scale, customers will be able to export energy in the evening when there is a peak demand. This will increasingly eliminate the need to use gas fired peaking plants, which is a really important part of grid decarbonisation."

In August last year, Octopus Energy Group and National Grid Electricity System Operator successfully demonstrated the viability of V2G technology for the first time in Great Britain. The project is one of the most significant of the various demonstrations conducted around the world in recent years in terms of showing how consumers could play a direct role in balancing the national transmission system through their electric vehicles.

With several demonstrations conducted in countries such as Japan and the US, for example, the question of when the technology will start to play a part in decarbonisation still remains.

Miller commented: "It seems like the technology has been a year or two away for the last ten years almost. But now we're actually seeing vehicles about to come to market – mass production EVs that are V2G-ready. This year will be a very important year for the technology."

One challenge is the lack of a standard charging system. Currently the Nissan Leaf is capable of V2G with the CHAdeMO charging system developed in Japan. But although it is relatively mature technology, it has not seen universal adoption.

"CHAdeMO charging technology – the connector, and the computer communications that go behind it – has been around for 8-10 years but unfortunately has not been adopted globally as a prevailing standard. There's a kind of VHS [vs] Betamax situation, where CCS, the Combined Charging Standard has won-out.

"The CCS is quite new, so it's taking a bit of time for vehicle manufacturers to fit it into their vehicles and for the charge-point manufacturers to develop chargers that are interoperable. There is an international standard called ISO 15118-20, which governs standardisation of communications but the new car development cycle can be pretty long. So actually we're at the very early days of this new V2G enabling technology. While our platform is sound and ready to go, we are waiting for this new technology to come to market. This year and next year are important years because this is when all of the interoperability testing, etc., is happening for bringing it to market."

Octopus Energy is among the frontrunners of players experimenting with V2G-enabled cars. The company's Powerloop V2G trial is born out of a UK government-funded initiative that began in 2017. It brought together several organisations, to form a consortium that would "think about the whole customer experience" – from leasing the vehicle, installing the bi-directional charger, getting permission to export power from the home and monitoring the customer day-to-day experience.

In a series of initial tests run in August 2022, Octopus charged and discharged the batteries of up to 20 electric cars from participating customers at times of grid imbalance. The trial saw customers use an app to set the time they want the vehicle to charge in the morning and how much charge they would like in the vehicle. In addition to covering the whole customer experience, the trial achieved its other key aim of integrating with the National Grid grid balancing mechanism.

"We were the first to dispatch V2G into the balancing mechanism," said Miller. "This meant working really closely with their and our tech teams to enable the control centre to accept a bid from our V2G cohort and for that signal then to be translated into activity in the real world to get those vehicles to export. It's a very important milestone because if you look at National Grid's future scenarios, each talks about V2G. We look forward to expanding that by proving it out with National Grid."

Although the technology worked as expected in the trial, being able to depend on consumers in the real world to deliver electricity when needed is a question that still needs to be answered. To this end, Octopus Energy is also working on an innovation it calls CrowdFlex.

CrowdFlex has three main objectives. The first is to think about domestic flexibility services and how commercial frameworks need to be developed around those offerings. The second is to address the technology that is needed and the required customer behaviour. The third objective is to learn about the statistical nature of flexibility – developing models around domestic demand flexibility across the range of domestic flexibility technologies.

"We need CrowdFlex to understand these things broadly at scale, to give us that confidence," said Miller. "We saw an incredibly high rate of plugging in compliance – partly because our customers were very engaged in it but also because it was very easy. They saw it as part of their day-to-day [routine]. I think this will be an interesting outcome of CrowdFlex… there is always that basic motivation of charging the vehicle, overnight when it's cheapest and easiest, in order to get around."

There is also the financial motivation, which is often the overarching driver for customer uptake.

As a customer coming from a fixed rate tariff to a V2G tariff, there are significant savings to be made. Here EV owners are rewarded for exporting to the grid while having access to import cheaper energy. Octopus' analysis shows customers could realise a potential saving of up to £840 per year, compared to unscheduled charging on a flat rate tariff. This is based on analysis from the original Powerloop V2G trial, scaled up for a driver travelling 10 000 miles a year. It would be a welcome saving during times of record high energy costs.

Despite such a lucrative saving there is the question as to whether it is sufficient to compensate for any potential impact of cycling on battery life. Miller stresses, however, that concerns over degradation are largely unfounded.

"On the face of it, it's natural to think along those lines but actually there are a couple of important things to point out," she said. "Firstly, we see leasing as a really important way of accessing vehicles… with the various incentives and schemes that provide low access cost to leasing EVs, customers are less and less likely to own vehicles going forward. With technology moving fast, whether it's around V2G or battery technology, leasing is a great option.

"Secondly, with regards to the battery itself, there's emerging evidence from around the world that V2G does not have a negative impact on the battery. Most manufacturers are offering 8-year or 100 000 miles warranties [on batteries]. Also, it's a much nicer life for a car battery to be gently charged and discharged while sitting on a driveway than actually being driven, which puts a varying load on the battery in terms of discharging. Also manufacturers are actually bringing EVs to market with batteries designed for V2G."

Developing technology and market evolution will no doubt see V2G become popular among consumers and an increasingly important tool for utilities in the tackling decarbonisation and grid flexibility.

"We're excited about the way the market is starting to move and develop. There will be more regional and locational pricing, and the evolution of more ancillary markets as well," said Miller.

With several vehicle manufacturers talking about V2G and making vehicles interoperable, 2023/24 will be an "exciting year".

Miller summed up: "This year you will hear more and more about it. We've learned a lot about how customers interact with V2G and we understand how it will work in a renewables-heavy grid. There's a lot of interest and a lot of demand for it. So we're really pleased that we are ready for when those vehicle manufacturers bring vehicles to market

Claire Miller, Head of Technology and Innovation at Octopus Energy, took part in the Powerloop V2G trial

Novel compact carbon capture technology can cut costs

A new process hailed as the next generation in carbon capture technology has been demonstrated. The novel process has the potential to cut costs and extend the breadth of applications for the technology. **Paul Willson** and Professor **Julieanna Powell-Turner**.

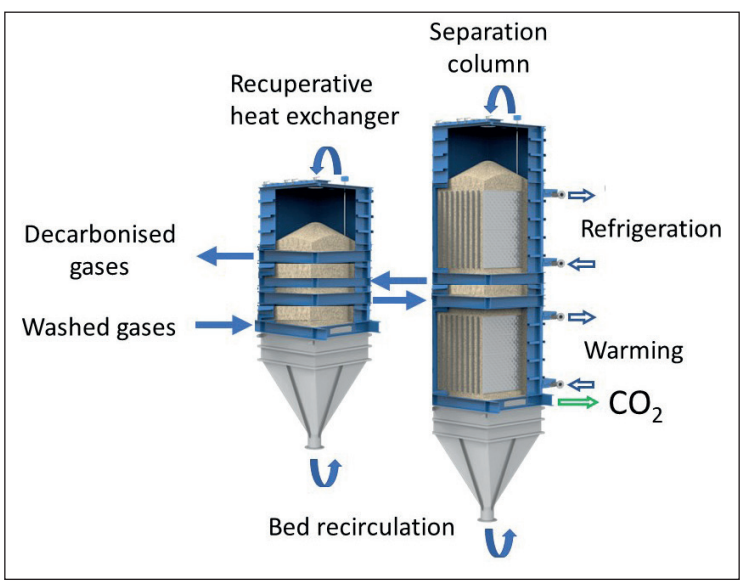
The Intergovernmental Panel on Climate Change has identified carbon capture as a key means of reducing the climate impacts of man-made carbon emissions. The scale and speed of emission reduction necessary to avoid irreversible climate change means that there is no option to simply "turn off" conventional energy sources. Instead, cleaning up their emissions is an essential component in the fight to limit global temperature rises while giving time for the transition to zero carbon energy sources. Indeed, many studies indicate that without carbon capture the cost of reducing carbon emissions will be much higher.

Many important industrial processes such as steel, cement and glassmaking emit carbon dioxide both from heating processes and from chemical reactions fundamental to production. While there are other options for heating, carbon capture is essential to reduce emissions from the fundamental reactions. However even this change may only be feasible for new processes and existing plant and energy systems, such as CHP (Combined Heat and Power), will need a viable transition path towards a zero carbon future.

In the transport sector shipping faces a different problem as alternative zero emission energy sources are not compatible with existing vessels. Rapid replacement of the global fleet of over 50 000 ships is impractical, uneconomic and would be environmentally damaging, given the large emissions generated by a premature replacement programme. Carbon capture offers a means of delivering a controlled transition to a zero-carbon future.

The legacy carbon capture technologies were developed for chemical processes rather than for cleaning exhaust gases and are not well suited to handling variable and often dirty gas streams. Conventional processes use a solution of a mixture of different amines to wash the carbon dioxide out of a gas stream. These amine solutions are toxic and environmentally damaging. The amine process needs to use an absorber column typically 10-20 m high to reduce the carbon dioxide content of the gas stream by 90-95 per cent. The washing solution is then heated to regenerate it and recover the carbon dioxide.

Outline of A3C separation process: The carbon dioxide separation process has two stages, each with a circulating packed bed of metallic or ceramic beads



The heat requirement is substantial, resulting in significant additional fuel burn and hence further carbon emissions that also need to be captured. The result is high CAPEX, high OPEX and large plant, which often is difficult to fit into a congested production site or on board a ship.

PMW Technology has worked with the Department of Physical, Mathematics and Engineering Sciences (PMES) at the University of Chester since 2017 to develop its radically different carbon capture process. Initial work was a successful doctoral project at laboratory scale by Dr David Cann, which was followed by the construction of a large pilot rig to demonstrate the novel process.

The initial studies were funded by Innovate UK and the Eco-Innovation project at the University, supported by the European Regional Development Fund. Subsequent work has been funded by the company, with support from the Department of Transport and the HEIF through the University. PMW Technology, has had excellent support from the University to reach this point and will continue its relationship as the technology progresses towards commercialisation.

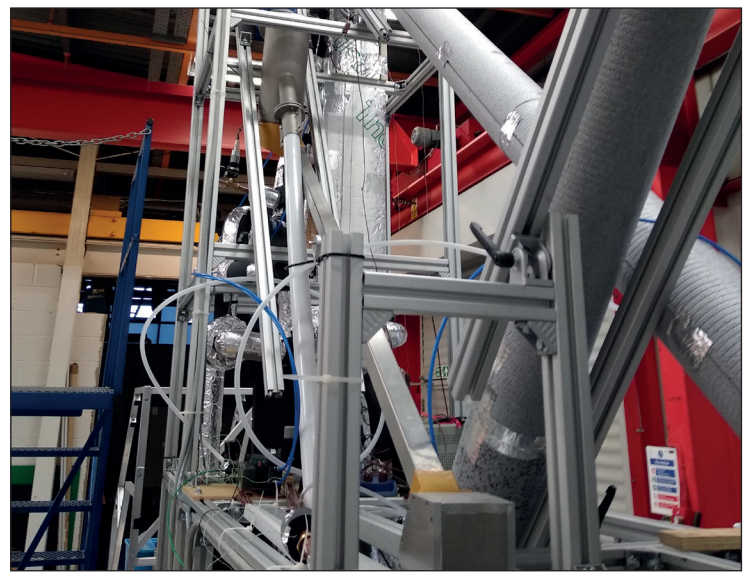
The A3C cryogenic carbon dioxide separation process has two stages, each with a circulating packed bed of metallic or ceramic beads. The first step cools and removes all traces of water from the gases, while the second cools the gases further to separate the carbon dioxide as a coating of frost on the slowly moving cold bed material.

Heat transfer within the moving beds of fine beads is intense, enabling a very compact separation to be achieved, with a comparable separation to a column 15 m high for the conventional amine process being delivered by a bed less than 100 mm deep.

The advanced recuperative refrigeration cycle exploits the low temperature heating required to recover the carbon dioxide from the frosted bed to offer a very low refrigeration energy consumption for a cryogenic system. A reverse Brayton cycle refrigeration cycle is used with air as the refrigerant gas, minimising the cost of refrigerant make-up and avoiding the hazards of combustible or toxic refrigerants that would otherwise be required.

The main challenge for the new process is achieving a uniform mass flow of bed material through the stages so that uniform conditions are maintained at each level in the bed. This is managed by careful design and refinement using physical models, thereafter giving reliable behaviour through life.

The pilot rig is designed to capture 50 kg of carbon dioxide per day. The rig stands 4.5 m high, close to the height expected for full-scale units, with a column a few cm square. The rig is designed to clean and decarbonise the exhaust gas from a test diesel engine, so it includes quench columns as well as the recuperative heat exchanger and separation column. Refrigeration is provided by a compressed air circulation cooled with liquid nitrogen, as small-scale refrigerators for the temperatures required are not commercially available.



View of the pilot rig. The rig stands 4.5 m high, close to the height expected for full-scale units

The objective of the pilot rig was to demonstrate the process and evaluate performance of its main elements. An important secondary objective was to learn how to design components working with a moving packed bed since this is an unusual process medium with less well-known characteristics.

Despite its unusual arrangement and low operating temperature the rig has performed very well. The refrigeration system has proved capable of delivering temperatures of -160°C and cooling the bed to -120°C. The heat exchangers have behaved well with initial estimates of heat transfer coefficient proving reasonably accurate. The initial trials have indicated an effectiveness of over 70 per cent removal of carbon dioxide from a test stream of 6 per cent concentration. Unfortunately further tests have been deferred due to the need to relocate the rig.

PMW Technology plans to follow the pilot rig with a prototype unit. This will have a much larger capacity since the only scale-up of significance is the cross-sectional area of the bed rather than the path length of the process.

The prototype is sized to handle the exhaust gas flow of a 1MW diesel engine, capturing 12-30 tonnes of carbon dioxide per day. This prototype will be capable of treating industrial exhaust gas streams or being marinised for installation on board a ship. The prototype will be designed as a base module allowing rapid scale-up for application to engines up to 10 MW and up to 300 tonnes per day capture.

It is planned for the prototype to be operational in 2025/6 leading to commercial deployment in 2027.

The development of the A3C process has the potential to have a major impact on the application of carbon capture. A key differentiator for the process is its low energy consumption, which is typically less than a third of that for the conventional amine process. Its compact design and ease of application without large additional heat requirements and freedom from chemical hazards makes the process easy to deploy and operate. Another important benefit is the direct production of pure carbon dioxide.

One challenge for carbon capture is its perception as a "landfill" solution, with the only destination for carbon dioxide being mass geological sequestration. A better alternative would be to create closed environmental loops, which see the reuse of the captured carbon dioxide. A significant opportunity for such reuse exists in shipping which currently contributes around 3 per cent of global carbon emissions, comparable to the carbon emissions of Germany.

One of the key future fuels in shipping is green methanol. The current focus in the challenge to produce green methanol is the availability of hydrogen produced from zero carbon energy. Ironically a less discussed challenge is the availability of climate neutral carbon dioxide to combine with that hydrogen to create methanol. The efficiency of the A3C process and the purity of its product offers a clear pathway to a closed loop to produce green methanol using recycled carbon dioxide from methanol fuelled shipping. This methanol cycle is more efficient, safer and has smaller impacts on vessel capacity than alternative zero carbon fuels.

PMW Technology is currently recruiting partners for the development and manufacture of its commercial scale prototype.

This project has accelerated since 2022 within the Department of Physical, Mathematics and Engineering Sciences (PMES) at the University of Chester. The A3C pilot rig has real potential to capture carbon dioxide, and clean and decarbonise the exhaust gases at a lower energy consumption than similar processes. This application may be economically viable and provide the decarbonisation opportunity that is needed as we move towards science-based targets on emissions reduction.

It is anticipated that this research will contribute to the decarbonisation agenda, as the research moves towards prototyping.

Paul Willson is Managing Director at PMW Technology; and Professor Julieanna Powell-Turner is Associate Dean and Head of PMES at the University of Chester.

Junior Isles

Don't be green with envy

In a competitive world it doesn't pay to just shout from the sidelines, green with envy when the game is not going your way. It's far better to rise to the challenge. Get yourself into the game. In response to the US upping the ante on driving clean energy investment, at last we finally get a glimpse of how the EU plans to keep its position in the lucrative clean energy technology-manufacturing sector.

When US President Joe Biden launched the Inflation Reduction Act (IRA) last August, its European trading partners expressed alarm that the move would disadvantage European companies. EU countries were particularly concerned that the IRA, which gives tax credits for each eligible component produced in a US factory, would take away potential clean sector investment from the continent.

The IRA earmarked $369 billion for clean energy and climate-related projects, notably providing a tax credit of 30 per cent of the cost of new or upgraded factories that build renewable energy components in the US.

Unhappy with the move, Thierry Breton, the EU Commissioner for the internal market said in November that the US was starting a "subsidy race" through the investment incentives the IRA offers for companies.

"It is really unfortunate that our so-called like-minded partners resort to such means," Breton was quoted as saying by German newspaper *Handelsblatt*.

At the time, German Economy Minister Robert Habeck told a conference: "We are in talks with the Americans so we do not start a kind of trade war now, but we see what competition there is and we have to find European answers to that."

Breton's fear that the bill could push European companies to move significant parts of their supply chains to the US has not proved unfounded. In November Enel, Italy's largest utility company, said it plans to construct a factory in the US to manufacture PV cells and solar panels. When it reaches its full 6 GW capacity in 2025, it is expected to employ 1500 workers. Meanwhile, last month Spanish renewables developer-operator Uriel Renovables said it had started developing 675 MW of battery energy storage system projects in Texas and Massachusetts. Uriel Renovables said all of the Texas projects are eligible to benefit from the tax incentives provided by the IRA.

In an attempt to stave off a trade war, leaders from both France and Germany held talks with Washington.

But business leaders and US climate envoy John Kerry argue that instead of expecting major concessions from the US, the EU and other partners need to take urgent steps to make their own green investment conditions more attractive.

John Podesta, Senior Clean Energy Adviser in the Biden Administration went further. He told the *Financial Times*: "We make no apologies for the fact that American taxpayer dollars ought to go to American investments and American jobs," calling on Europe to take responsibility for developing its own clean energy sector.

Fortunately the EU is taking heed. While cooperation with partners is important, it makes little sense to wait for changes from the US. This would not only result in lost business, but would also likely slow EU efforts to address climate change within its own borders.

At the start of February, European Commission President Ursula von der Leyen presented plans to "make Europe the home of clean tech and industrial innovation on the road to net zero". To achieve that, the Commission proposed a new EU Green Deal Industrial Plan based on four pillars, with global competitiveness in mind. The plan is aimed at simplifying the regulatory environment, providing faster access to funding, upping skills and taking an open approach to trade to create resilient supply chains.

Explaining the plan, von der Leyen said: "To grow, our net zero industries need a legislative framework. This has to be faster, and predictable […] We want this industry to stay here and prosper here. We listened to the industries; we need to match with US solutions, through state aid and tax breaks."

Speaking during a recent webinar: 'Green Deal Industrial plan – future-proofing Europe's industry', Domien Vangenechten, Senior Policy Advisor at E3G, commented: "The impetus for the EU to respond to the IRA, which had some very clear climate dynamics to it, is an opportunity to get new and increased ambition on the table. There's an opportunity here to tell a story of economic growth across Europe, not just in some of the richer western parts, but throughout the continent. The EU needs to keep its eye on the prize. We're doing all this for green growth and decarbonisation. Let's focus on that, and not only on grabbing market share."

Bernice Lee, Chair, Sustainability Accelerator Advisory Council at Chatham House, added: "What we are already seeing is a reconfiguration of the landscape. Some call it the ice bucket moment, some call it the Sputnik moment, but it is indeed a moment where we are really looking at strategic competition, whether we need to harness competitive versus cooperative dynamics. The race is beginning properly, and we will probably have to see a combination of cooperation and competition. Believe it or not, not only in the domestic support system, but also in the trade arena."

Niclas Poitiers, Research fellow, Bruegel, however, questioned whether the EU has the tools to do industrial policy. "The question that we in the EU have to answer, is how do we want to do industry policy? Do we do subsidies in the right way for the right purposes? Do we have the right instruments? I'm happy that we have the discussion, because this is a trend that we've had for some time, and I think the tools are not really up to speed and not really made for purpose in the EU."

It is certainly more difficult for a bloc like the EU to agree and implement a cohesive policy than it is in the US. It will require revision of the state aid framework for net zero technologies and need broad support from 27 member states. Revising state aid rules could be controversial, as it will be easier for richer states to provide fiscal incentives for their companies than it would for poorer member states.

The Commission's draft proposal reportedly proposes the redirection of some of the $869.8 billion in Covid-19 recovery funding to green tax credits. It states: "The provisions on tax benefits would enable member states to align their national fiscal incentives on a common scheme, and thereby offer greater transparency and predictability to businesses across the EU."

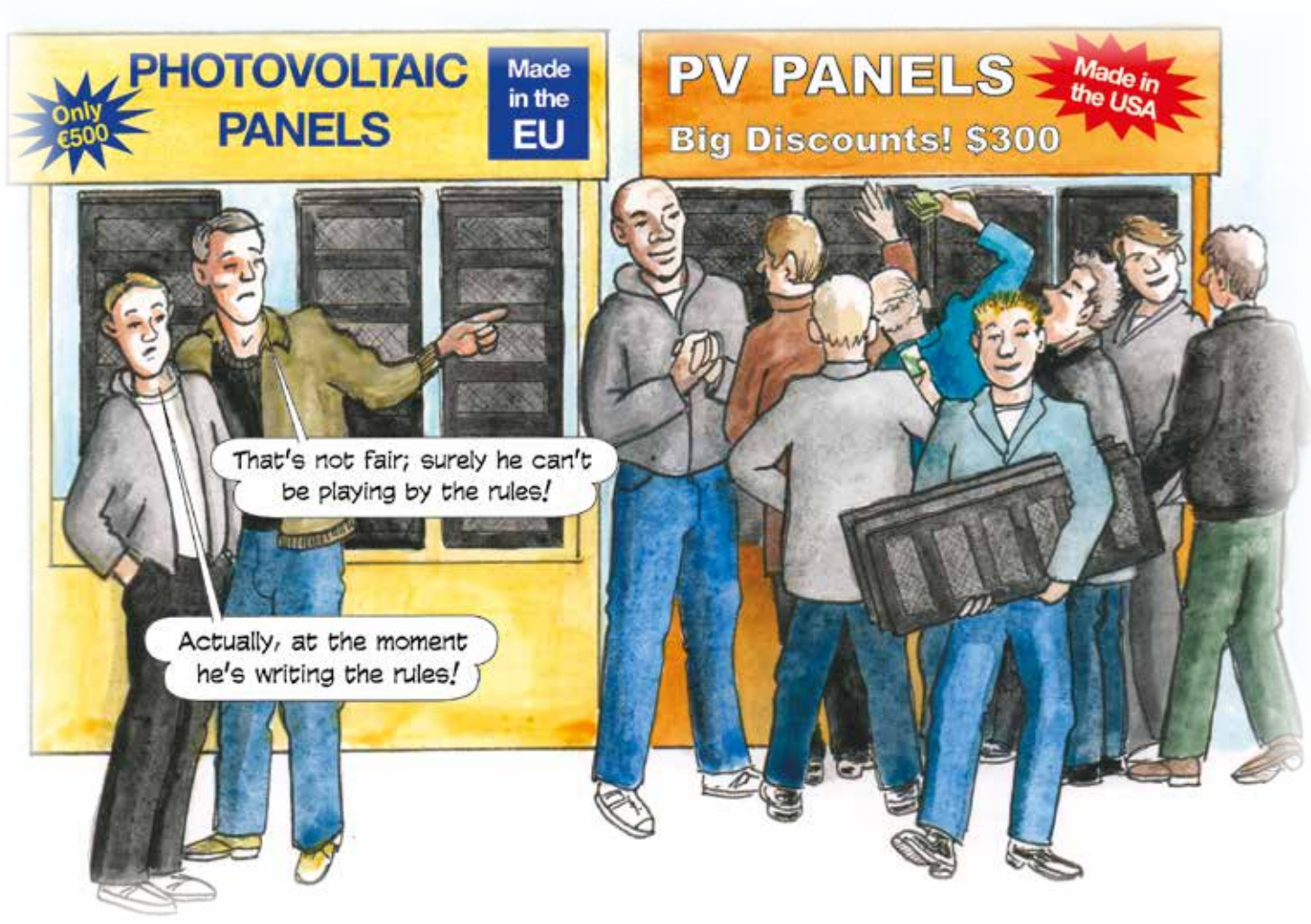
The Solar Heating & Cooling sector also called on the Commission and member states to ensure a level playing field among all renewables in line with the principle of fair competition.

"As the global race to subsidise clean technologies is pressuring the EU to intervene, policymakers cannot give up fair competition, the founding principle of the Single Market," said Costas Travasaros, President of Solar Heat Europe, in a press statement.

During the webinar, Nils Redeker, Deputy Director of the Jacques Delors Centre also voiced concern over the need for a policy that works for the Single Market. "It's quite clear the EU needs an industrial policy and needs to be targeted for certain industries. At the same time, the EU needs its Single Market. So it needs an industrial policy that works for the single market. What we really need is to use the US' IRA as a wake up call; to really get industrial policy at EU level to join financing and governance. If the EU can leverage this, this would be huge."

It would be huge indeed. As von der Leyen said, this is "a once in a generation opportunity to show the way with speed, ambition and a sense of purpose to secure the EU's industrial lead in the fast-growing net zero technology sector".

Let us hope the EU can agree on its proposed Green Industrial Plan quickly, as shouting foul from the sidelines will get it nowhere fast.



Cartoon: jemsoar.com