# THE ENERGY INDUSTRY TIMES

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**Special Supplement**

*TEI Times* hears why industrial gas turbines will be crucial in complementing renewables-plus-storage in an optimised system.

**Decarbonisation of two cities**

With just two months to COP26, Asia energy expert and author, Joseph Jacobelli, compares the decarbonisation efforts of Hong Kong and Singapore. *Page 14*

**Final Word**

Budding rock stars need to wear the right colour, says Junior Isles. *Page 16*

## News In Brief

**IPCC report is stark warning in run-up to climate talks**
The Intergovernmental Panel on Climate Change's (IPCC) recent assessment report has been hailed as a stark reminder of the need for a successful outcome at the upcoming COP26 climate summit. *Page 2*

**China and India unveil big plans for hydrogen**
China and India have both set out bold strategies for the development of hydrogen production. *Page 5*

**Germany under pressure to grow renewables faster**
Germany has added 240 new onshore wind turbines with a potential output of 971 MW during the first six months but that deployment is not fast enough to meet its renewable targets. *Page 7*

**Industry Perspective: A model for nuclear new build in Europe?**
Hanhikivi 1 in Finland could offer some clues on how nuclear plants, including small modular reactors, could be successfully developed in the future. *Page 13*

**Technology Focus: An imaginative approach to long duration storage**
US-based 247Solar has developed an innovative thermal battery that looks set to facilitate around-the-clock wind and solar energy. *Page 15*



# UK Hydrogen Strategy questioned ahead of COP26

Conscious of its role to show leadership on climate action, the UK government has set out its Hydrogen Strategy. But the announcement has met a mixed reaction. **Junior Isles**

The UK government's recently published hydrogen strategy has come under scrutiny as the country prepares to host the crucial COP26 climate summit later this year.

As part of its 'Ten Point Plan' for a green revolution announced earlier this year, the government has outlined how it will cooperate with industry to achieve 5 GW of low carbon hydrogen production capacity by 2030. Government analysis estimates that up to 30 per cent of the UK's energy consumption could be hydrogen-based by 2050, making it a key technology in achieving net zero emissions by 2050 and meeting the country's target of cutting emissions by 78 per cent by 2035.

It could also play an important role in rebuilding an economy driven by clean energy technology.

According to the government, the UK's first-ever Hydrogen Strategy will unlock over £4 billion ($5.5 billion) in investment and create thousands of jobs in the move to establish a low carbon hydrogen sector by 2030. It said a thriving, UK-wide hydrogen economy could be worth over £900 million and create over 9000 high-quality jobs, which may rise to 100 000 jobs and be worth up to £13 billion by 2050.

"With the potential to provide a third of the UK's energy in the future, our strategy positions the UK as first in the global race to ramp up hydrogen technology and seize the thousands of jobs and private investment that come with it," said Business and Energy Secretary Kwasi Kwarteng.

The government wants to mimic its success with offshore wind, where early government action and Contracts for Difference (CfD) support have helped secure the country a leading position. It said it is publishing a consultation on a preferred hydrogen business model, shaped on a similar premise to the offshore wind CfDs.

A consultation is also being initiated on the design of the £240 million Net Zero Hydrogen Fund, intended to back new plants for low-carbon hydrogen production in the UK.

The government says it will take a "twin track" approach, developing both blue and green hydrogen simultaneously. Green hydrogen is produced via electrolysis, using electricity from renewable electricity and is therefore zero emissions. Blue hydrogen is generated from steam methane reformation combined with carbon capture and storage (CCS). It has lower emissions than current production, but is not zero emissions.

The decision to pursue blue hydrogen alongside green has drawn criticism from some quarters.

Dr Doug Parr, Chief Scientist for Greenpeace UK, said: "Hydrogen produced from renewable energy is genuinely low carbon, and genuinely useful in some areas of the economy where electrification is difficult. But producing large quantities of hydrogen from fossil gas locks us into costly infrastructure that is expensive and may be higher carbon than just burning the gas. So the emphasis put on that part of the government's plan looks like a bad idea both environmentally and economically."

A recent study conducted by Cornell University and Stanford University found that blue hydrogen could be 20 per cent worse for the climate than burning natural gas. The study, pub-

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found that blue hydrogen could be 20 per cent worse for the climate than burning natural gas. The study, published in *Energy Science & Engineering*, is claimed to be the first in a peer-reviewed journal to layout the lifecycle emissions intensity of blue hydrogen

Concluding that there is "no role for blue hydrogen" in a carbon-free future, the authors suggested that "blue hydrogen is best viewed as a distraction, something that may delay needed action to truly decarbonize the global energy economy".

**Howarth says countries are "placing expensive bets" on blue hydrogen**

Robert Howarth, co-author of the study and Professor of Ecology and Environmental Biology at Cornell University noted: "Politicians around the world, from the UK and Canada to Australia and Japan, are placing expensive bets on blue hydrogen as a leading solution in the energy transition."

Others, however, see the strategy as a welcome development for both the energy industry and communities alike, as it creates a road map for future power generation from both blue and green hydrogen.

Stuart Carter at Keystone Law, commented: "This also plays into the government's model for carbon capture and storage, which is focused on the UK's industrial hubs such as Teesside and Humberside… if the government aims to achieve its net-zero targets, the blue hydrogen model and the CCUS [carbon capture usage and storage] model will need to be fully integrated. This may mean that blue hydrogen solely becomes the fuel for power generation at industrial hubs where CCUS will be highly developed, and leaving carbon-free green hydrogen, to be produced, possibly at a more regional level, to be used by domestic consumers for transport, heating and cooking."

David Parkin, Project Director from Progressive Energy and Project Director of HyNet North West, a project to capture and store carbon from industry in the North West of England and North Wales, said: "Industry across the UK's North West industrial heartland is crying out for low carbon hydrogen so we welcome the promise of more support.

"With initial engineering nearly completed on HyNet's first hydrogen production plant at Essar's Stanlow Manufacturing Complex, hydrogen production will begin as soon as 2025 and deliver up to 4 GW of low carbon hydrogen by 2030. The key now is for the government to build momentum by prioritising projects that are ready for development today."

# IPCC report is stark warning in run-up to climate talks

- Human influence has warmed climate at unprecedented rate
- Only just over half of countries submit climate targets

Junior Isles

The Intergovernmental Panel on Climate Change's (IPCC) recent assessment report has been cited as a stark reminder of the need for a successful outcome at the upcoming COP26 climate summit scheduled for November in Glasgow, UK.

Britain's Prime Minister Boris Johnson called the IPCC Report "sobering reading" and a "wake-up call", while COP26 President Alok Sharma said it "shows all too clearly… the deficiency of our response [to the climate crisis] to date".

The Working Group I report is the first instalment of the IPCC's Sixth Assessment Report (AR6), which will be completed in 2022. Prepared by 234 scientists from 66 countries, it highlights that human influence has warmed the climate at a rate that is unprecedented in at least the last 2000 years. It also states that many changes due to past and future greenhouse gas emissions are irreversible over hundreds to thousands of years, especially changes in the ocean, ice sheets and global sea level.

The report shows that emissions of greenhouse gases from human activities are responsible for approximately 1.1°C of warming since 1850-1900, and finds that averaged over the next 20 years, global temperature is expected to reach or exceed 1.5°C of warming. This assessment is based on improved observational datasets to assess historical warming, as well as progress in scientific understanding of the response of the climate system to human-caused greenhouse gas emissions.

The IPCC projects that in the coming decades, climate changes will increase in all regions. For 1.5°C of global warming, there will be increasing heat waves, longer warm seasons and shorter cold seasons. At 2°C of global warming, heat extremes would more often reach critical tolerance thresholds for agriculture and health, the report shows.

The report has huge implications for policymakers in terms of tackling greenhouse gas emissions and adapting to the levels of climate change the world is already locked into. To keep the 1.5°C target alive and adapt to a changing climate, governments around the world must provide unequivocally clear policy signals to significantly accelerate the investment needed for a zero carbon future.

Nick Molho, Executive Director at the Aldersgate Group, said: "The UK government has a critical role to play in the coming months. On the global stage, it needs to gather maximum momentum to bring emission reduction pledges from all key emitting nations in line with the 1.5°C target and look to underpin this with tangible global collaboration and initiatives in areas where cutting emissions is particularly complex."

Christiana Figueres Founding Partner, Global Optimism & former Executive Secretary, UN Climate Change Convention, said the report is yet another reminder of the need to accelerate global efforts to "ditch fossil fuels" and shift to a cleaner, greener growth model.

"We have a plan – it's called the Paris Agreement," she said. "Everything we need to avoid the exponential impacts of climate change is doable. But it depends on solutions moving exponentially faster than impacts, and getting on track to halving global emissions by 2030. COP26 will be the moment of truth."

COP26 presents a clear opportunity to implement credible policies in areas that will cut emissions quickly but countries are failing to deliver on the ambitions agreed at the COP meeting in Paris in 2015.

At the start of August, it was revealed that only just over half of countries signed up to the Paris Agreement had submitted their nationally determined contributions (NDCs) before the deadline.

By the cut-off date, the UNFCCC revealed that it received new or updated NDCs from 110 Parties. This means that only 58 per cent of the Parties have met the cut-off date.

A landmark report, aimed at informing policy and business on the task of reaching net zero, has revealed the huge task of achieving net zero by 2050. Providing a globally applicable framework, with the US utilised as the core case study, the report says that without an unprecedented restructure to energy project delivery, the world may not make it even halfway to net zero by mid-century.

Produced by Worley, a global provider of engineering, procurement, and construction services to the energy, chemicals and resources industries, in collaboration with Princeton University's Andlinger Center for Energy and the Environment, the study uses pathways developed in the Net-Zero America study by Princeton in 2020.

This further examination says the US will have to drastically exceed its current low-emissions project build rate. Under one pathway, to reach net zero, individual solar projects with an area equivalent to 260 Tokyo Olympic stadiums need to be built every week from now until 2050. In another, more than 250 large nuclear power stations will be needed – under current processes, one such nuclear plant can take upto 20 years to get operational.

The report explores five key shifts in the approach to energy infrastructure that can deliver a transition to net zero.

Dr. Paul Ebert, Group Director Energy Transition at Worley said: "We hope our work with Princeton University will help to equip key players in the industry with strategic guidance for the path ahead, using breakthrough thinking, and shifting the focus from what technologies we need, to how to get them built, working to deliver a more sustainable world for us all."

# UK nuclear programme could be under threat

The UK's plans for a new fleet of large nuclear power plants could be under threat, as the government is reportedly reconsidering China's involvement in the development of projects amid cooling diplomatic relations and concerns over potential security threats.

According to the *Financial Times*, the British government is exploring ways to remove China General Nuclear (CGN) from the consortium planning to build the Sizewell C nuclear power station in Suffolk. It said ministers are also going cold on plans by CGN to build a plant at Bradwell-on-Sea in Essex using its own reactor technology. CGN is already a minority investor in the 3.2 GW Hinkley Point C nuclear power station, which France's EDF is currently building.

One nuclear industry executive told the *FT* that CGN might now reassess its involvement with Hinkley Point. They pointed out there were four interlinked agreements between CGN, EDF and the government dating to 2015: Hinkley Point, Sizewell, Bradwell and the pursuit of regulatory approval for China's own reactor design.

CGN is eager to get UK regulatory approval at Bradwell for its own Hualong One HPR1000 reactor in order to help market it in other countries. The reactor design is going through the UK's rigorous approval process, with a decision expected in the second quarter of next year.

According to the *Daily Telegraph*, a "cross-party" group of "China hawks" in the House of Commons is putting pressure on the government to impose an "outright" ban on a Chinese state-owned firm's involvement in all UK nuclear power plants.

The group – led by Tory MPs Iain Duncan Smith and Chairman of the Foreign Affairs Committee, Tom Tugendhat – reportedly has the full backing of the Inter-Parliamentary Alliance on China (IPAC), which claims to be an international body working to "reform how democratic countries" engage with the Asian giant.

The *Daily Telegraph* quoted IPAC as warning that the UK is "dangerously exposed" by its "overreliance" on Chinese investment and technology in the "critical national infrastructure" sector.

UK Foreign Secretary Dominic Raab observed last year that Britain could no longer conduct "business as usual with China". The UK's highest-profile action so far has been to force the Chinese telecoms supplier, Huawei, out of Britain's 5G network.

British ministers are now said to be "looking for ways" to enable EDF energy to develop the £20 billion Sizewell C project without any input from CGN, which has a 20 per cent stake in the project.

The *Times* said the government is mulling options for funding the plant, including buying a multi-billion pound stake in the project or finding new investors to replace CGN.

Tim Yeo, a former Tory energy minister who chairs the New Nuclear Watch Institute, an industry-supported think-tank, said concerns about Chinese involvement in the UK nuclear power sector had been overstated. Any disruption or interference in its operations would close down all export opportunities elsewhere for CGN, he argued.

"The notion that China would arbitrarily close down a plant which they had built in UK for some geopolitical reason is absurd," he said. "They have nothing to gain and everything to lose by disrupting the supply of electricity from a nuclear plant which they had built here."

A spokesperson for the UK government did not comment directly on the claims that ministers would seek to forge a nuclear programme without CGN, instead only saying that "all nuclear projects" must comply with "robust and independent regulation" in order to meet the UK's "rigorous legal, regulatory and national security requirements, ensuring our interests are protected".

# Brazil's hydropower drought boosts expansion of wind and solar

- Coastline a key future energy source
- Transmission investment given green light

Janet Wood

A drought that has disrupted electricty generation from Brazil's hydroelectric power stations – the country's largest source of power – has highlighted new plans to invest in wind and other generation. Brazil's dams have reported the lowest water inflows in more than 90 years pushing up prices and boosting broader inflation rates. Meanwhile, a recent Energy Research Office (EPE) report indicated that the Brazilian coastline could support 700 GW of offshore wind capacity.

In this context Enterprize Energy has signed an agreement to identify and develop offshore wind, green hydrogen and green ammonia projects off Brazil's northern coast. The MoU with Rio Grande do Norte incorporates site and impact assessments, supply chain appraisal and infrastructure requirements. The relationship could see the company developing multi-gigawatt offshore projects.

Ian Hatton, Chairman, Enterprize Energy, said: "The northeastern coastline of Brazil holds great potential… In addition to offshore wind's capacity to decarbonise energy supply, advances in wind-driven electrolysis should enable Rio Grande do Norte to become a centre for green, zero-carbon hydrogen and ammonia production in South America. These 'renewable gases' will be instrumental for use in not only the domestic agrichemical, industrial and maritime sectors, but also for international export."

The state of Rio Grande do Norte currently claims to lead Brazilian states in renewable energy development. But recently FEPAM, the environmental protection agency of the neighbouring state, Rio Grande do Sul, gave transmission company Neoenergia permission to start construction of a 525 kV transmission line running 235.5 km between Rio Grande and Eldorado do Sul. The Povo Novo-Guaiba 3 project will be used to transport wind power generated in the state.

Meanwhile, construction continues apace elsewhere in Brazil. Development bank BNDES has arranged a $317.6 million debt package to finance ten wind farms totaling 409.2 MW in Piaui and Pernambuco states. The funding will be provided to ten special purpose vehicles owned by VTRM Energia Participações for the Piaui II and Piaui III wind complexes, due online in 2022.

"The Ventos do Piaui II and III complexes represent a 72 per cent increase in our installed capacity in the region," said Carlos Guerra, Votorantim Financial Director. "Along with the Ventos do Piaui I and the Ventos do Araripe III projects, already operating, these assets form the largest wind cluster in Brazil."

Just three months ago BNDES approved loans for another project owned the group – a 68 MW solar farm to be attached to the 205 MW Ventos do Piaui I wind farm in Piaui.

# US makes big investments in battery storage

Texas-based independent power producer Broad Reach Power has announced plans to acquire 1 GW of batteries from China's Sungrow Power Supply. It has ordered the equipment for six standalone battery storage projects in Texas to help balance the grid.

"This is one of the largest orders ever placed in the energy storage industry for this equipment and represents a historical inflection point for this globally important and purpose driven ESG-focused industry," said Mizhi Zhang, Managing Director of the ESS business, Americas Region at Sungrow.

As well as Texas, Broad Reach operates utility-scale solar and energy storage power projects in Montana, California, Wyoming and Utah, totalling 13 GW.

Another California operator, Pacific Gas & Electric, has also recently invested in large scale storage. It has chosen renewables developer Recurrent Energy LLC, owned by Canadian Solar Inc, to provide it with 150 MW/600 MWh of energy storage. This includes phase two of the Crimson battery energy storage project in California, totalling 350 MW/1400 MWh, which is due to start operations next summer. PG&E has chosen to fund the battery under a 15-year resource adequacy agreement. A second long-term contract will see Recurrent Energy deliver Phase 1 of 200 MW/800 MWh under a long-term contract with Southern California Edison.

Both are part of reliability procurements directed by the California Public Utilities Commission (CPUC). "It is becoming increasingly important to be able to send energy to the grid during heatwaves and other peak demand events," said Shawn Qu, Chairman and CEO of Canadian Solar.

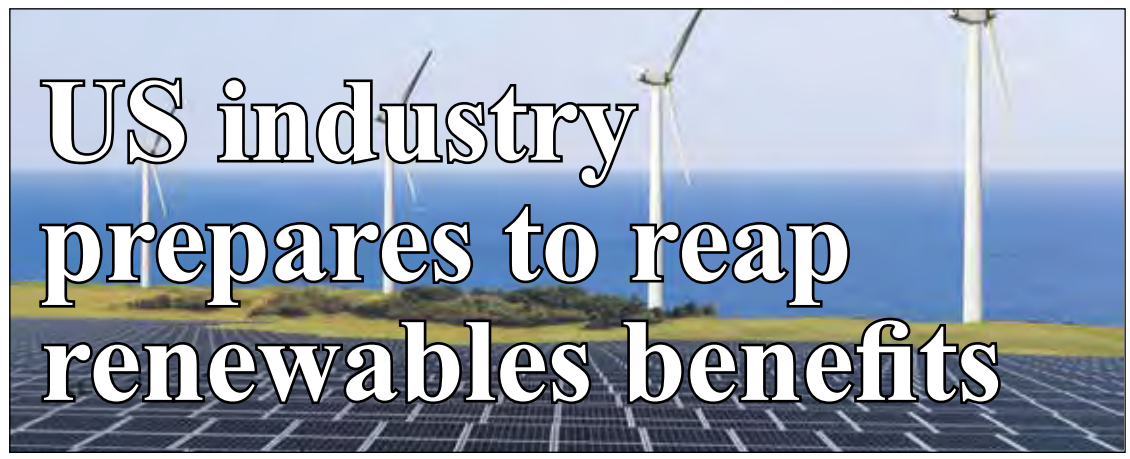
# St Lucia taps global funds for geothermal power

Saint Lucia has won grant funding from the World Bank, which approved US$21.9 million for the island's Renewable Energy Sector Development Project. The money will be used to assess the viability of the Caribbean country's geothermal resources for power generation and strengthen the business environment for the private sector to pursue clean energy projects.

Over 55 per cent of firms identify high electricity prices as a major constraint to doing business in Saint Lucia. The country depends on costly imported fuels for diesel-based generation. Securing clean and resilient energy will also help the country to achieve a green economic recovery, in line with Saint Lucia's Economic Recovery Resilience Plan.

"This project will help the country evaluate how geothermal energy can contribute to the country's national energy mix. Clean energy from geothermal sources can improve electricity system reliability and reduce the cost of oil imports. Transitioning to renewable energy would also decrease the country's vulnerability to the volatility of fuel markets," said Lilia Burunciuc, World Bank Country Director for the Caribbean.

The project will support exploratory drilling, capacity building, technical assistance, and market engagement.



# US industry prepares to reap renewables benefits

- Production tax credit aims to boost manufacturing
- Coal communities win transition funding

As work starts on Vineyard Wind, the first major offshore wind farm in federal waters in the USA, which won federal approval recently, four US Senators have introduced a bill that would enable companies to claim offshore wind manufacturing tax credits. With over 150 potential offshore wind projects in the US pipeline, and leases being auctioned on both the east and west coasts for the first time, the Offshore Wind American Manufacturing Act aims to boost domestic manufacturing. It proposes an investment tax credit and a production tax credit for qualified offshore wind components and dedicated offshore wind vessels.

Production tax credits have previously been instrumental in boosting onshore wind projects in the country. The new legislation would create a 30 per cent investment tax credit for qualified facilities to the end of 2028. Alongside, it would grant new production tax credit of up to 5 cents per watt to December 2030 for components including blades, towers, nacelles, generators, gearboxes, foundations, and related vessels.

Lead bill sponsor Senator Edward J. Markey (Democrat-Mass) said: "Offshore wind is a booming market, but without effective manufacturing policy, American workers will be left behind… Our clean energy future is blowing in the offshore wind – it's time to put those winds to work for American industry."

The new bill will add to recent investment in the US offshore wind industry. US Wind included a promise to invest $150 million in a monopile manufacturing facility in Maryland in plans for the 1.2 GW Momentum offshore wind project.

Meanwhile, the Biden administration has announced plans invest in coal and fossil power power plant communities. The new funding is part $3 billion from the American Rescue Plan.

Established by President Biden's Executive Order on Tackling the Climate Crisis at Home and Abroad, the White House Interagency Working Group (IWG) on Coal and Power Plant Communities and Economic Revitalization is working to catalyse economic revitalisation, create good-paying union jobs, and support work in energy communities, especially hard-hit coal, oil and gas, and power plant communities, across the country.

The group's initial report assessed priority geographies and existing authorities available to the government to support energy communities. The IWG is now charged with partnering with energy communities and ensure the creation of well-paid jobs in areas such as remediating mining land, drilling lands and plant sites.

# New York State prepares to meet climate risks

The New York Power Authority (NYPA) has opened a new study into the long-term effects of climate change on its power generation and transmission assets and on system operations. It has joined with Argonne National Laboratory, the Electric Power Research Institute (EPRI) and Columbia University's Center on Global Energy Policy (CGEP). NYPA produces 25 per cent of the state's power and more than 80 per cent of its supply from hydropower.

The study outcomes will help NYPA in its risk and expenditure planning and strengthen its resilience against hazards such as major weather events. The new study was announced as the state prepared to manage landfall of Hurricane Henry (later reclassified as a tropical storm), which brought record-breaking rainfall levels.

The study will be led by Argonne National Laboratory, which is known for creating local climate model simulation datasets and for its expertise in detailed climate projections.

"It's imperative that NYPA assess the vulnerability and sensitivity of its generation and transmission systems to climate-driven risks such as increased flooding and extreme temperatures so we can prepare to stand up to these hazards and make smart investments in resiliency strategies," said Gil Quiniones, NYPA President and Chief Executive.

# China and India unveil big plans for hydrogen

- China to setup 10-15 leading industrial chain enterprises by 2025
- India formally establishes National Hydrogen Mission

Syed Ali

China and India have both set out bold strategies for the development of hydrogen production.

In mid-August, Beijing authorities released a blueprint for the development of its hydrogen energy industry from 2021 to 2025. According to the plan released by the Municipal Bureau of Economy and Information Technology, by 2025 the Beijing-Tianjin-Hebei region will achieve a hydrogen energy industry chain valued at more than Yuan100 billion ($15.4 billion) and reduce carbon emissions by 2 million tonnes.

Before 2023, five to eight leading enterprises with international influence in the hydrogen energy industry chain will be setup, and the scale of the industrial chain in Beijing-Tianjin-Hebei region will exceed Yuan50 billion to reduce carbon emissions by 1 million tonnes.

Ahead of 2025, 10-15 leading industrial chain enterprises with international influence will be established, and three to four world-class industrial R&D and innovation platforms will be built.

At the same time China's Inner Mongolia region was given the green light for a massive hydrogen production plan that will utilise roughly 2.2 GW of wind and solar power capacity. The project envisages the installation of 1850 MW of solar photovoltaic (PV) and 370 MW of wind farms to power the production of 66 900 tonnes of renewable hydrogen annually, according to Bloomberg, citing a report by the Hydrogen Energy Industry Promotion Association.

These clean energy plans, however, came as it was revealed that state-owned firms proposed 43 new coal-fired generators and 18 new blast furnaces in the first half of 2021. If all are approved and built, they would emit about 150 million tonnes of carbon dioxide per year. According to the Centre for Research on Energy and Clean Air (CREA) China limited emissions growth in the second quarter to a 5 per cent increase from 2019 levels, after a 9 per cent rise in the first quarter.

India, Asia's other major global emitter, also unveiled its plans for hydrogen last month, as Prime Minister Narendra Modi formally announced the formal establishment of its National Hydrogen Mission.

He said the aim is to make India the new global hub of green hydrogen, and also its largest exporter. Last year in October, Modi outlined a new energy map for India with seven key drivers – one of them being the development of emerging fuels, particularly hydrogen.

Announcing the Mission in his Independence Day speech, Modi said: "Of every effort being made by India today the thing that is going to help India with a quantum leap in terms of climate is the field of green hydrogen… We have to make India a global hub for Green Hydrogen production and export… India has to make a resolution to make India energy independent before the completion of 100 years of independence and our roadmap is very clear for the same. It should be a gas-based economy.

"There should be a network of CNG [compressed natural gas] and PNG [pipeline natural gas] across the country. There should be a target of 20 per cent ethanol blending. India is moving ahead with a set goal. India has also made a move towards Electric Mobility."

The announcement comes ahead of COP26 in Glasgow, UK, where nations will be under pressure to pledge more ambitious climate action and substantial financing, especially regarding energy requirements.

In a meeting with Union Minister of Power and Renewable Energy, Shri RK Singh, Alok Sharma, COP 26 President, expressed the UK's willingness to collaborate with India on green hydrogen. Both sides discussed the possibility of establishing a World Bank for Green Energy, which could realise the proposal for $100 billion in climate finance pledged by developed countries under the Paris Agreement.

# Japan steps up offshore wind activity

- Preferred bidder selected for stake in floating offshore wind project
- Largest offshore wind powered hydrogen project takes shape

Syed Ali

Japan is inching forward with plans to boost its offshore wind capacity, which will help accelerate the country's production of green hydrogen.

Last month Aker Offshore Wind and global wind and solar company, Mainstream Renewable Power ("Mainstream") were together selected as the preferred bidder to acquire an initial 50 per cent stake in Progression Energy's 800 MW floating offshore wind project in Japan. The project is a well-formed early-stage development asset.

The two companies will now enter into exclusive negotiations with Progression Energy with a view to establishing a special purpose vehicle ("SPV") to continue collectively developing the project.

"In 2015, Progression recognized that floating offshore wind would become a major segment of the offshore wind industry. Since that time, Progression has originated floating projects in four markets globally," said Chris Swartley, CEO of Progression Energy. "Japan has set a goal of zero emissions by 2050 with a strong focus on offshore wind.

Japan aims to expand offshore wind energy capacity to 10 GW by 2030 and 30-45 GW by 2040, according to the Ministry of Economy, Trade and Industry (METI). Project areas for offshore floating wind will be put to auction for interested companies to submit their proposals.

Projects like Progression Energy's will be integral to Japan's plans to increase the production of green hydrogen.

In late July *Nikkei Asia* reported that four Japanese companies intend to build Japan's largest hydrogen plant powered by offshore wind energy on the northern island of Hokkaido as part of a national effort to slash carbon dioxide emissions.

Participating in the project are Hokkaido Electric Power, renewable energy developer Green Power Investment, Nippon Steel Engineering and industrial gas supplier Air Water.

Scheduled to begin operation as early as the year ending March 2024, the plant will produce up to roughly 550 tons of hydrogen a year – enough to fuel more than 10 000 hydrogen vehicles, according to plans.

The Japanese government aims to attain net-zero greenhouse gas emissions by the middle of the century. Hydrogen is to play a big part of that goal. The government's Green Growth Strategy announced last year calls for up to 3 million tons of hydrogen production capacity to be introduced in 2030, rising to about 20 million tons in 2050. This plan requires Japan to develop its own hydrogen industry without relying on imports.

- Chiyoda Corporation (Chiyoda) and GridBeyond have signed a Memorandum of Understanding (MoU) to collaborate in providing flexibility solutions for the Japanese electricity markets. Such solutions help grid operators to balance demand and supply on the electricity network and enables greater integration of intermittent renewable generation sources into the energy mix.

# Indonesia to increase renewable investment, as coal financing dries up

State-owned electricity company PT PLN Persero has said it will increase investment directed at renewable-energy power plant construction in anticipation of a five-fold jump in Indonesia's electricity demand by 2060.

PT PLN said it will ensure several old plants that are still operational are included in the biomass co-firing programme, and will also convert fossil fuel power stations into green energy power plants to reduce the use of polluting oil and coal.

According to PT PLN's General Vice Director Darmawan Prasodjo, the company will start to phase out the first generation of conventional steam plant by 2030. He said all of these oil and coal fired stations will be replaced by renewable energy power plants by 2060.

The announcement is timely. It coincides with the news in early August that some of the world's biggest financial institutions are working on a plan to speed up the closure of coal fired power plants in Asia.

According to a recent *BBC* report, the initiative created by UK insurer Prudential, which includes major banks HSBC and Citi, is being driven by the Asian Development Bank (ADB). The ADB hopes the plan will be ready for the COP26 climate conference in Glasgow, UK.

Under the proposal, public-private partnerships will buy coal fired plants and shut them far sooner than their usual operating lifespan. The ADB hopes to launch a pilot programme in a developing South East Asian nation – potentially Indonesia, the Philippines or Vietnam – in time for the COP26 event in November.

The International Energy Agency has forecast that global demand for coal will grow by 4.5 per cent this year, with Asia making up 80 per cent of that rise.



# Vietnam wind developers scramble for tariff incentive

Wind power farms in Vietnam's central province of Quang Tri are scrambling to complete construction of projects to benefit from the 20-year incentive feed-in tariff available until 31 October 2021.

Quang Tri has 29 wind farms under construction with a total capacity of 1117 MW and costing over VND30 trillion ($1.32 billion).

At two projects – Phong Huy and Phong Nguyen – the foundations are complete but only four out of 24 towers have been built. Nguyen Ngoc Tien, CEO of the projects, said he has increased the number of workers and even transports materials at night to finish the projects before the deadline.

Developers are also calling for a change in quarantine restrictions to allow foreign experts to quarantine on-site upon arrival and start working immediately.

Wind power is becoming an increasingly important part of Vietnam's energy mix. Vietnam is striving to produce about 3000-5000 MW of offshore wind power by 2030 and 21 000 MW by 2045.

Addressing a webinar last month, Chairman of the Vietnam Union of Science and Technology Associations (VUSTA) Phan Xuan Dung said the country will benefit from the development of offshore wind power, whose cost will gradually decrease in the future.

Experts say, however, that the country still lacks legal regulations and technical standards for the production, installation, operation, and maintenance of offshore wind power. A mechanism for offshore wind power purchase is also necessary to stimulate this market, they said.

# Germany under pressure to grow renewables faster


- Wind and solar deployment 'not fast enough'
- Storage installed to work with renewables

The German electricity grid added 240 new onshore wind turbines with a potential output of 971 MW during the first six months of this year, the Wind Energy Association (BWE) reported recently. But it said that deployment was not fast enough to meet the targets for renewable energy set by the government.

As well as the new installations, 135 small wind turbines totalling 140 MW were shut down. Also recently calling for faster renewables deployment was the Fraunhofer Institute for Solar Energy Systems, which said in a new report for Greenpeace that a fully renewables-based system would require 303-446 GW of solar PV. At the end of 2020 the German total was just 54 GW. The higher target would require solar to grow at up to 20 GW annually by 2040 – far more than the goal recently agreed by the German government, which said in April it would significantly raise the cap on an auction next year from 1.9 GW to 6 GW.

The report also called for an increase in solar thermal from 15 GW to 49 GW. It assumed that power demand would at least double by 2040.

In 2020, about 45 per cent of the gross electricity consumption in Germany came from renewables.

Germany also needs to increase flexibility on the grid to manage more renewables and RWE recently announced it would add battery storage to its hydropower plants in 'virtual coupling'. It recently began construction of a 117 MW battery complex, which comprises Lingen at Emsland, Lower Saxony (45 MW) and Gersteinwerk HPP in Werne, North Rhine-Westphalia (72 MW). The €50 million system is due to go into operation at the end of 2022, RWE said. It expects that the 'virtual coupling' will raise the total capacity of the batteries by 15 per cent. "Our project is setting new standards and shows how we can offer the market even more flexibility by intelligently linking up battery capacity with run-of-river power stations," said Roger Miesen, Chief Executive of RWE Generation.

Air Liquide, meanwhile, is planning to use excess renewables to produce 'green' hydrogen by electrolysis at Oberhausen. The first phase of the project – 20 MW – is expected to be operational by early 2023 and it will eventually total 30 MW.

The electrolyser will be integrated into the existing local pipeline infrastructure of Air Liquide to supply local industry with renewable hydrogen. The proton-exchange membrane (PEM) electrolyser will be the first to be built under a partnership between Air Liquide and Siemens Energy.

# Nuclear on the agenda in Czech, Romania, UK

The Czech nuclear power plant at Temelin could house two new units, each adding 1600 MW of capacity, Czech Prime Minister Andrej Babis and Industry Minister Karel Havlicek said recently. They suggested the project could follow a new unit planned at the Dukovany site.

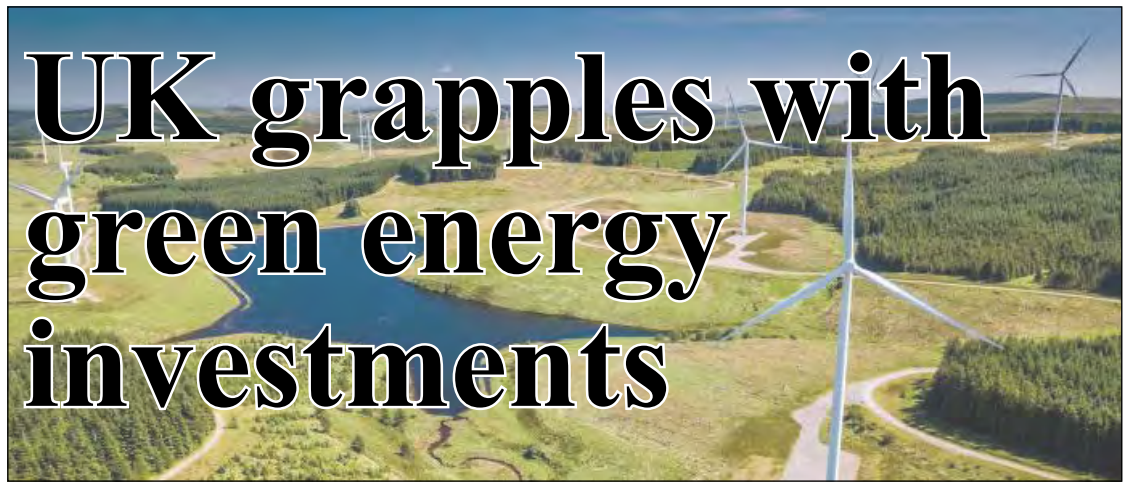
Current discussion on the Dukovany expansion overshadows a debate on the wider challenges within the Czech energy sector, but Havlicek said a Temelin proposal would have to be on the agenda for the government after the upcoming elections. Czech Chamber of Commerce President Vladimir Dlouhy agreed that the government should update a longstanding state energy strategy and related legislation.

A more positive step on nuclear expansion occurred recently in Romania, where a memorandum of understanding on cooperation in civil nuclear was signed by Natural Resources Canada and Romania's energy ministry. It includes collaboration on nuclear refurbishment and new-build projects in Romania, where the Cernavoda site has two operating 650 MWe Canadian-supplied 'Candu-6' reactors and two partially built, but in suspension.

Annick Goulet, Canada's ambassador to Romania, said "nuclear cooperation has been a pillar of the 55-year-long Canada-Romania relationship".

Meanwhile, the UK's Nuclear Industry Association has continued to press for faster government action to support new-build. Chief Executive Tom Greatrex welcomed new plans for an Advanced Modular Reactor (AMR) demonstrator, and said: "We hope the government will move swiftly forward to agree a funding settlement and delivery timeline for a demonstrator this year." The devolved Welsh Assembly Government has recently given public support to deploying small modular reactors, potentially at past nuclear sites Trawsfynedd or Wylfa.

# UK grapples with green energy investments



- Network returns set lower for the next five years
- Government told to increase ambition on CfD auction

The UK's coal phase-out was dramatically illustrated in August when stacks and the boiler house at SSE's Ferrybridge power plant, now closed, were demolished. Alok Sharma MP, previously Secretary of State at the Department for Business, Energy and Industrial Strategy and now Chair of the upcoming COP meeting in Glasgow, pushed the button that detonated the explosion.

In December last year the UK brought forward a commitment to phase out unabated coal plant to October 2024 and recent announcements have also confirmed closures by then. Uniper said it will end its coal fired generation in the UK in September 2024, with closure of the last unit at its Ratcliffe-on-Soar power station, with one unit closing in September 2022. The company said that would allow it to fulfill its commitments under the capacity market.

Mike Lockett, UK Country Chairman and Chief Commercial Office Power, said: "Over the past 54 years Ratcliffe power station and our colleagues, have made a critical contribution to power generation in the UK." He said the new vision for the site was to move towards becoming a zero-carbon technology and energy hub "based around modern industrial and manufacturing uses, with sustainable onsite energy generation".

## Natural gas hikes drive up European power prices

Natural gas prices remain at record high levels in Europe, where they recently hit €40/MWh for the first time, and energy traders expect to see them remain elevated. The high gas price continues to put upward pressure on power prices.

In previous periods of high prices, fuel switching by electricity generators to coal fired generation has lowered demand, but this is becoming less viable as rising carbon prices make thermal coal more expensive.

European buyers are competing with global counterparties to try to attract gas imports and that includes strong demand in Asia, where higher prices are being offered to try to attract cargoes of liquefied natural gas (LNG).

It also includes record-breaking LNG imports into Brazil for gas generation to substitute for hydropower, which has been affected by Brazilian droughts.

Natural gas supplies have tightened recently as major economies have rebounded from the coronavirus pandemic, a series of outages and planned maintenance and low exports from the US.

"If anything, it's surprising there hasn't been more concern," Tom Marzec-Manser at ICIS. "In terms of additional supply, there aren't many options on the table globally. Russia is really the only discretionary source of supplies out there but we don't know when additional deliveries might start. So traders around the world, from Japan to Brazil, are starting to watch European prices too."

# Saudi Arabia targets renewables and energy efficiency drive

■ Half of electricity to come from renewables by 2030 ■ Energy efficiency to save $6.6 billion

Nadia Weekes

Saudi Arabia's National Energy Services Company (Tarshid) said it plans to reduce energy consumption in the Kingdom by SR25 billion ($6.6 billion) by 2030, and to produce 50 per cent of its electricity from renewable energy sources by the same date.

"We are targeting integrated savings through the Saudi Energy Efficiency Program (SEEP), and in the public sector alone we will be saving 8 terawatts and SR2.5 billion annually," Tarshid CEO Waled Alghreri told *CNBC Arabia* in an interview.

The SEEP is a rare example of a country creating a dedicated, integrated initiative to target energy efficiency, said Alghreri, adding that such programmes were mostly decentralised and did not produce encouraging results.

Tarshid was established by the Public Investment Fund (PIF) to pioneer energy efficiency in Saudi Arabia in collaboration with the Ministry of Energy.

Its services include retrofitting buildings and street lighting. It also promotes the use of renewable energy, including rooftop solar PV.

Meanwhile, a consortium led by developer ACWA Power has reached financial closure for the 1.5 GW Sudair solar plant, a key project in Saudi Arabia's renewable energy push.

Approximately SR3.4 billion will be invested to build the facility, to be located in Sudair Industrial City, in Saudi Arabia's north. Once operational, it is expected to power 185 000 homes and offset nearly 2.9 million tons of emissions per year.

"Sudair solar is testament to the Kingdom's continuous efforts to reduce energy sector emissions," ACWA Power said in a statement.

The developer also announced that Aramco-owned SAPCO has joined the consortium, marking the oil giant's first participation in the Saudi PIF's renewable energy programme.

The fund has a 30 per cent stake in ACWA Power and owns utility company Badeel, another member of the consortium.

Under the country's National Renewable Energy Program, the Saudi Ministry of Energy is also building two solar energy plants for a total capacity of 600 MW in Jeddah and Rabigh.

The Ministry of Energy is seeking to diversify the sources of electricity generation by increasing the share of natural gas and renewable energy.

Trial operation has started at the Dumat Al-Jandal wind farm project in the northern Al-Jouf region, some 900 km north of Riyadh, the ministry announced.

The 400 MW onshore wind farm will become Saudi Arabia's first utility-scale wind power source, and the largest in the Middle East. It is being developed by a consortium of EDF Renewables and Masdar and is expected to be completed in 2022. It will generate about 1.4 TWh of electricity a year, enough to power 70 000 homes.

Saudi Arabia is also in the process of selecting advisory firms for its first planned nuclear power project.

The kingdom is planning to develop nuclear capacity through conventional nuclear power plants, smaller system-integrated modular advanced reactor technology (Smart) projects, and mining uranium reserves to fuel the plants.

While Saudi Arabia has not set a formal target for nuclear energy capacity, the government had previously indicated it would seek to develop up to 19 GW of nuclear power capacity.

# Uzbekistan reveals renewable energy ambition

Uzbekistan is planning to increase its renewable energy targets by installing up to 7 GW of solar PV and 5 GW of wind generation capacity by 2030, the Ministry of Energy has revealed.

The success of the utility-scale renewable energy tenders held so far, coupled with the rapid growth in electricity demand, is behind the plans to increase clean energy capacity targets by 2030, according to the energy ministry.

A 2020 government report laid out plans to upgrade existing power plants and attract private investors to develop new generation capacity.

In its wake, the Ministry of Energy, in cooperation with the Ministry of Investments and Foreign Trade, has signed 16 power purchase agreements (PPAs) with international power producers to develop power generation capacity in the country, including a number of renewable energy projects.

In July, UAE-based Masdar signed contracts to develop two solar PV projects in Uzbekistan with a total capacity of 440 MW. Masdar has also been awarded a contract to develop a 457 MW PV independent power producer (IPP) project in the Sherabad district, reached financial close for the 100 MW Navoi solar project, and is developing the 1.5 GW Zarafshan wind project.

Saudi Arabia's Acwa Power has also signed agreements to develop sizable renewables capacity in Uzbekistan, including a 1.5 GW wind farm in the Karakalpakstan area. Another two wind projects, Bukhara and Navoi, will have a combined capacity of 1 GW.

Electricity demand is expected to surpass 100 TWh by 2030, a significant increase from 61 TWh in 2018. "We have to satisfy this demand to fulfil our country's economic potential, whilst also decarbonising our electricity sector," said Uzbekistan's Energy Minister, Alisher Sultanov.

"Recent tenders showed some previously hidden potential in the renewables sector, and we are confident that exploiting this potential will be successful," he added.

As well as boosting solar and wind energy capacity, the Uzbek government is also promoting GTL projects, metering systems and improved monitoring and online control.

An updated concept document is expected to be published early next year.

# Russia outlines large-scale hydrogen plan

Russia's government has set out its vision to create hydrogen production clusters and lay the ground for huge export opportunities. **Nadia Weekes** reports.

The Russian government has approved a concept for the development of hydrogen energy for the period through 2050, according to a resolution signed by Prime Minister Mikhail Mishustin on August 5.

Government officials estimate that additional global demand for hydrogen could be 40-170 million tonnes per year by 2050, and that Russia could potentially export as much as 200 000 tonnes in 2024, up to 12 million tonnes in 2035 and up to 50 million tonnes in 2050.

"The development of hydrogen energy will make it possible to reduce the risks of losing energy resource markets and to maintain economic growth by establishing new production facilities, as well as create high-tech jobs and exports of products and technologies," Mishustin said.

The concept document outlines a number of recommended measures, including the launch of pilot projects to produce low-carbon hydrogen, the creation of consortia for the production of equipment and components, and the formation of infrastructure for hydrogen storage and transportation.

Under the concept, at least three territorial production clusters will be created. The North-West cluster will specialise in hydrogen exports to Europe and measures aimed at reducing the carbon footprint of export-oriented companies. The Eastern cluster will supply hydrogen to Asian countries, and develop hydrogen infrastructure in the transport and energy sectors. The Arctic cluster will seek to provide low-carbon power to the Russian Polar region.

An additional Southern cluster could be created, relying on natural gas and the potential for renewable energy in southern Russia, as well as the proximity to major export ports.

The document lists priority technologies necessary for development of the industry, including obtaining hydrogen by means of steam conversion of methane and coal gasification, carbon dioxide capture, special fuelling stations, hydrogen storage and transport in liquefied form.

The government expects state support measures to help introduce these technologies through special investment contracts, subsidies for manufacturing of pilot batches of products, and compensation for expenses related to scientific research.

Over the next three years, the concept assumes the creation of profile clusters and implementation of pilot projects on hydrogen production and export, according to Mishustin. From 2025, it envisages large export-oriented production centres and the serial application of hydrogen technologies in different economic sectors.

# Nigeria's grid collapse causes major blackouts

A collapse of Nigeria's national grid in late July caused major blackouts in most parts of the country, confirming existing concerns about the country's ability to maintain a reliable supply of electricity.

Abuja Electricity Distribution Company (AEDC) said the latest incident occurred at about 12:26 pm on 28 July – the fourth such episode this year.

Several Nigerian cities including the capital, Abuja, and Lagos were plunged into darkness.

"We have been unable to serve our customers in Niger, Kogi and Nasarawa states as well as a significant portion of the entire Federal Capital Territory. At the moment, only 20 MW has been allocated to AEDC as against the over 400 MW that we have been receiving in recent times," the distribution operator said in a statement.

Zimbabwe also suffered power cuts in several regions a week later, on August 4, after its biggest coal fired generating station suffered a technical fault.

Hwange power station, which has a design capacity of 920 MW, was generating around 360 MW, leaving only the Kariba hydropower station in operation, producing 1 GW – some 500 MW short of demand.

The southern African nation has in the past experienced significant power cuts lasting up to 18 hours due to drought and ageing equipment at its power plants.

China's Sinohydro has been contracted to add two units of 300 MW each at Hwange. They are expected online next year.

# Industrial gas turbines: the perfect complement for renewables-plus-storage

With the growth in variable renewables, energy storage is expected to be the key technology for providing grid support and shifting renewable power to when it's needed. Siemens Energy's Anders Stuxberg explains to ***TEI Times*** why industrial gas turbines will be crucial in complementing renewables-plus-storage in an optimised system. **Junior Isles**

With the urgent need to combat climate change, wind and solar power are growing at a phenomenal rate. According to the International Energy Agency, renewables will meet 80 per cent of global electricity demand growth during the next decade. Solar PV, for example, dubbed by the IEA as "the new king" of electricity supply, grows by an average of 13 per cent per year between 2020 and 2030, meeting almost one-third of electricity demand growth over the period.

The variable nature of wind and solar, however, presents challenges in terms of grid stability and how best to provide backup power for when the wind is not blowing or the sun is not shining.

With targets set for reaching zero carbon emissions in the electricity sector, clearly the goal must be to support renewables as far as possible with energy storage – a zero carbon source of grid flexibility. The question, however, is what generating assets to deploy alongside storage, and how to achieve the best mix of storage and those assets in terms of cost and operability.

Anders Stuxberg, Specialist in Power Plant Process Integration at Siemens Energy AB said: "Gas turbines (GTs) will be the technology of choice to be dispatched when storage power capacities are insufficient for the demand and also when the storage becomes emptied. If you look at balancing supply and demand through the grid in general, you have to look at it over a number of different timeframes. The system has to be managed, second-by-second, minute-by-minute, hour-by-hour, using different technologies. You also have to look at balancing over longer timeframes… The question is how to optimise these storage and generating resources. Storage will handle the bulk of energy for balancing, but there will not be a business case to try to cover everything with storage alone, you will need to complement it with GTs.

"By implementing storage, the operating profile for GT-based plants will be significantly changed. GTs will be a cornerstone of the grid infrastructure but with a new role in future compared to what we have been used to seeing. You will see a shift to backup power instead of peaking units and flexible mid-merit combined cycle plants instead of baseload plants; this will favour industrial GTs for new installations. Industrial gas turbines are also suited to use hydrogen as fuel and fuels produced through power-to-X schemes," said Stuxberg.

With storage expected to take centre-stage in maximising the integration of renewables and distributed generating sources, the market for the technology is forecasted to grow exponentially over the next decade *(see box)*.

Regardless of which of the various storage solutions is selected, however, they are all generally limited by two parameters: power capacity and energy capacity, i.e. duration of storage at full power. Stuxberg noted that when optimising storage solutions, power plant owners will size for the most frequent instances that give the most energy trade volume and then leave the residual load to some other technology.

He said: "There will be many days the energy in the storage is insufficient for the demand and many days when storage systems have less power capacity than needed, at least during part of the dispatch duration. So other technologies will be called for both at surge of power and of energy, there will be a play between different types of storage solutions and capacity backup."

He also noted: "Storage technologies that can shift operating mode after the storage is emptied – continuing power production by firing a supplementary fuel – will also play a role in backup supply, i.e. double benefits to the system. Examples are: power-to-hydrogen-to-power where the hydrogen-to power unit (gas turbine) operates on e-methanol when the gas storage is emptied, or a thermal storage plant that also can run by firing of e-ammonia when the thermal storage is emptied."

Stuxberg says there will also be competition between storage and demand response (DR). If altering the time of energy use (e.g. smart charging electric cars) does not damage business, then DR will be more efficient and cost competitive than storage.

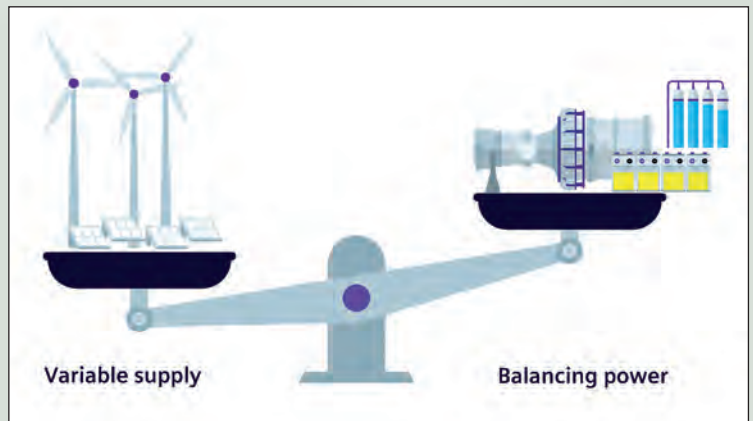
Many types of DR will, however, be limited in much the same way as storage. For example, duration – mainly limited by the nature of the demand that has been put on hold – will normally be limited to a number of hours. The amount of DR that will be available naturally depends on the price incentive, the volatility of energy prices for final consumers, and the use of smart meters.

"When you look at the demand for balancing power, storage solutions are efficient systems, with up to 80 per cent of the energy coming back [from the storage]. But it is not economical to design an energy storage system for all possible situations. And when you empty the storage, you have to fill-in with something else," said Stuxberg.

That "something else", he says, will typically be (fuel fired) thermal plants, i.e. the backup power capacity that must exist in the grid anyway to ensure reliable supply when there is no wind or solar for a long period.

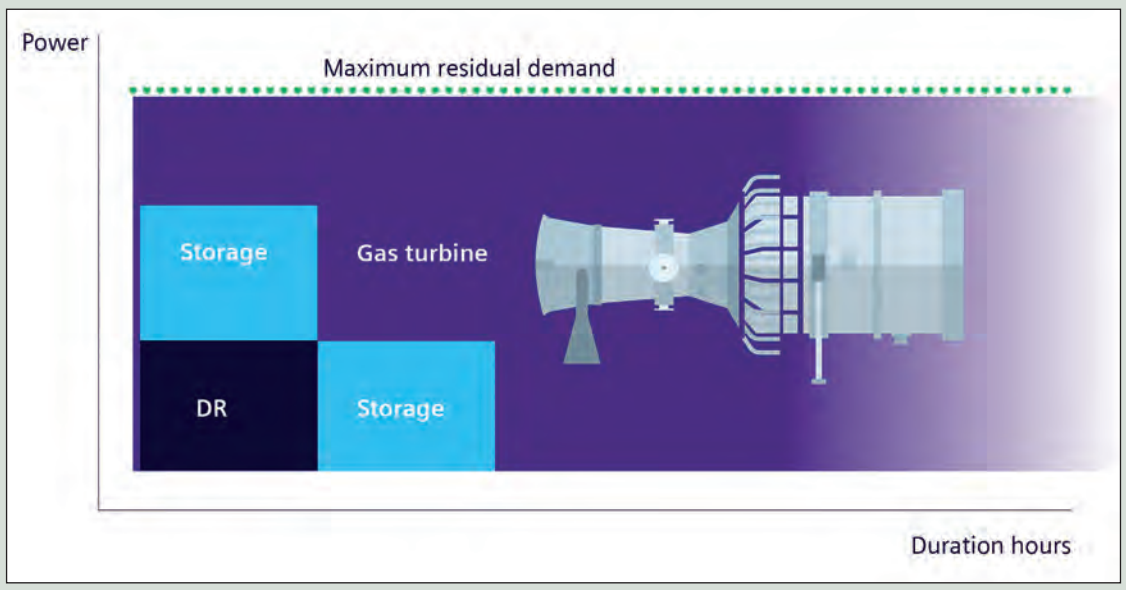
There are several options as to which technology, or group of technologies, can support renewables-plus-storage depending on the scenario. For example, arguments are sometimes made for fuel cells while other experts present compelling cases for fast-start generating assets such as gas turbines and reciprocating engines.

Stuxberg believes industrial gas turbines are currently the best all-round option. He commented: "In a deeply decarbonised energy system, gas turbines will play a key role both for mid-merit power supply and as backup power. Although some argue that fuel cells will take that role, that can only happen if fuel cells for a fully functional and installed power generation plant become cheaper than gas turbines. We are not there today and I believe that if it happens, it will take many decades. Fuel cells, though, are already a good option for microgrids and mobility applications. The requirement that backup power also should be fuel flexible, e.g. use both hydrogen and liquid renewable




*Don't let balancing power capacity get out of balance*

**Storage will handle the bulk of energy for balancing but it will need to be complemented with GTs**




**Power plant owners will optimise storage solutions size for the most frequent instances that give the most energy trade volume and leave the residual load to another technology**

fuel is also a cost issue, if not a problem, for fuel cell plants.

"Reciprocating engines compared with gas turbines have pros and cons. In short, they are less efficient than combined cycles and are more expensive per capacity than simple cycle GTs, with the exception of emergency diesels gensets, which have a shorter lifespan. For mid-merit operation, maintenance cost is an important factor to consider – industrial GTs have lower maintenance cost than, e.g. recip engines or fuel cells."

He also notes that conventional boilers with steam plants are too inflexible to handle the frequent starts and stops to balance residual power demand. Further, their efficiency is low, especially if designed for renewable fuels such as biomass.

Based on the shortcomings of these technologies, Stuxberg believes the focus for grid balancing should therefore be on a blend of industrial gas turbines (IGTs) and storage solutions and a probable future dispatch profile for those assets.

IGTs in the range up to 70 MW are typically used in a number of applications. CHP applications are common across the whole range due to their ability to meet heat demand. The smaller machines may be deployed in settings like hospitals, universities, small industries and O&G, to provide power in areas where the grid is not completely stable or onsite generation is required. Medium-sized machines in the upper range of 30-70 MW may be used by, independent power producers (IPPs), industrial CHP asset owners, the O&G industry, municipalities producing electrical power for the grid and heat for district heating networks, as well as utilities.

Stuxberg believes the operating profile of IGTs in the future will not be same as the peaking units of today. Units in the future he says might start-up and shut down once a day during parts of the year, be in standby other periods and also occasionally run for a longer period, as opposed to cycling several times per day.

With storage expected to be the first option for supplying multiple daily power peaks, operators must then decide how gas turbines will operate to complement this storage.

Stuxberg foresees gas turbines being dispatched when the energy required exceeds what is available in the storage. This will likely be after the large afternoon/early night peak or possibly in the morning. Gas turbines will also be called for when all storage solutions are already providing near full power capacity, i.e. typically during the evening peak.

He explained: "If GTs are being called on every day for one of the two reasons, power surge or energy surge, then that's a signal to storage investors that here you have an attractive business opportunity – just buy some more capacity. It's low-hanging fruit. So my conclusion is that GTs will typically start once every 2-4 days on average; some days they might be called on twice and many other days not at all.

"Traditional peaking plants and base load plants will no longer be suitable for this kind of market. So if we have a GT on the system to ensure backup anyway, the question is: should you operate it for more hours, which means more fuel consumption, or should you make the storage slightly bigger?"

According to Stuxberg, that optimisation determines how the gas turbine is operated, the type of turbine selected and whether the plant should be simple cycle or combined cycle.

He explained: "Generally, each addition of duration for a storage technology comes at an added investment, which needs to be paid for by less and less events since long duration events are less frequent than shorter events. The marginal cost of longer operation for a GT plant firing renewable fuel on the other hand is constant as it just adds fuel consumption (fuel storage is relatively cheap). The duration at the cross-over point between technologies depends on event probability, a number of economic factors and choice of technology. The decreasing probability of long events explains why even pumped hydro plants, at present, often are sized to fit just one day cycles."

He added: "Grid balancing of up to a couple hundred megawatts would be fairly common. This could be divided across a number of machines so you can follow demand better without running machines at part-load."

Such an installation would have to be capable of meeting several requirements. Firstly, it should be capable of starting "reasonably" fast.

"If there is some kind of communication protocol (using new IT solutions and advanced forecasting tools) in the market telling GT operators to start in fair time before stored energy runs out, then very fast GT start is not required, 20 minutes should suffice," said Stuxberg. "Also when power capacity becomes the issue, it should on most occasions be possible to predict when to dispatch GTs. However, power peaks come faster than drainage of energy, so here dispatch centres can reserve some power in the storage by starting the GTs a bit in advance when a demand ramp-up is expected. Here a fast GT start pays off a little as there is less need to reserve power from storage dispatch and thus there is a bit less operation of the GTs, which could be assumed to produce slightly more expensive power than the storage system. If the dispatch is just based on a commercial energy trade, then hybrid plants comprising a combination of e.g. renewable power, storage and GT may be a good business as smarter dispatch can be achieved."

Typically, many gas turbines will be installed in an electric grid to provide the necessary backup power. The dispatch order for these will be based on cost or environmental footprint. Since the requirement will be for a fairly low dispatch rate, Stuxberg says a large portion of dispatch may be based on capacity auctions where a fixed compensation for just existing as available backup is paid out.

If efficiency is also credited, e.g. by dispatch order, then a fair portion of these cycling GTs will be configured as combined cycle. However, the bottoming steam cycle must then be suited to frequent starts, i.e. fast and with low start-up cost. Stuxberg notes that in a future where these mid-merit plants need to operate on renewable fuel, which will be expensive, a bottoming cycle will be required for many of these plants for the sake of opex. The remaining plants, which will have a low dispatch rate of, say, less than 500 hours per year, will not be so sensitive to efficiency but will need to have low capex and fixed standstill cost.

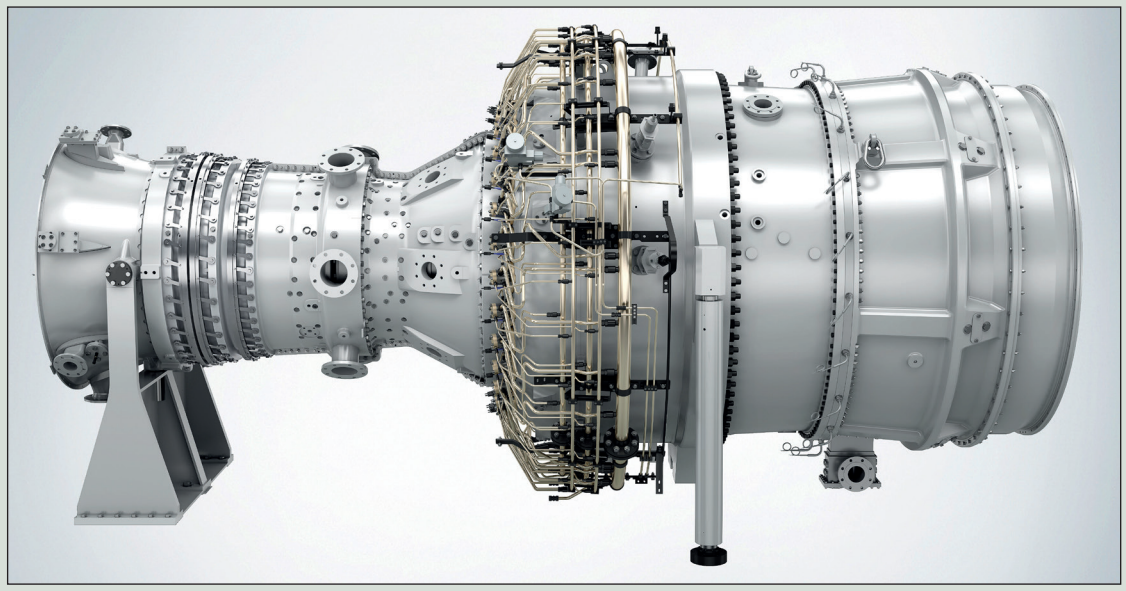
"So, for the power generation business, we will see two typical types of GT plants for the future: combined cycle plants for cycling operation, dispatching in a mid-merit pattern of somewhere between 1000 and 3000 hours per year; and simple cycle plants, with dispatch often less than 500 hours per year. The traditional base load plant is thus replaced by a very flexible mid-merit plant, while the traditional peaking plant is replaced by demand response and storage solutions plus a large quantity of backup power."

**Stuxberg: in a deeply decarbonised energy system, gas turbines will play a key role both for mid-merit power supply and as backup power**

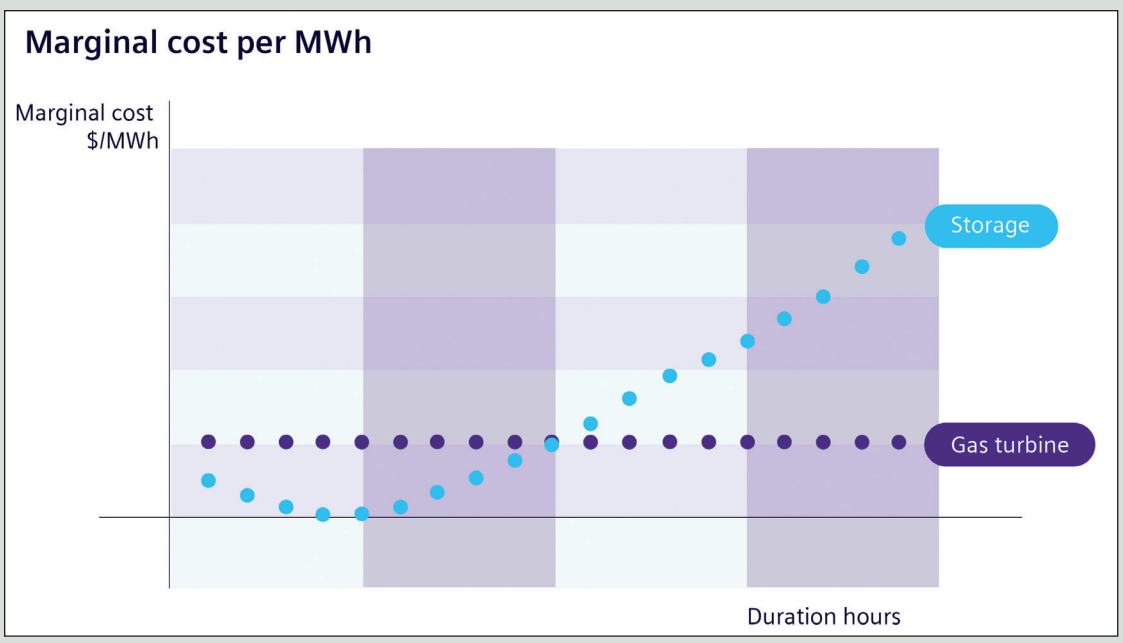
His absolute conviction is that industrial gas turbines present the best suitability to this type of future duty for both these plant types. "They have very high reliability due to simplicity in design concept, high combined cycle efficiency, low price, low maintenance cost, good fuel flexibility and much better grid stabilisation characteristics (by high inertia and strong control response) than aeroderivative GTs or recip engines," he said.

For both these plant types, his expectation is that there will be an average of one start every one to four days, most frequent for the mid-merit type. Stuxberg predicts a wide operating regime for such gas turbine plants. For demand response (DR) and for energy storage systems, he noted that they will dominate dispatch of balancing power for short duration and during periods of low demand for residual power.

He noted, however: "When looking at capacity it is hard to rule out rare events with low probability, thus installed GT power capacity in the grid will need to be large. The scale of backup capacity needed depends predominantly on the capacity factor



**IGTs such as the SGT-800 are typically used in a number of applications**




**The dispatch order for GTs in the grid for backup will be based on cost or environmental footprint**

# The energy storage market is forecasted to grow exponentially

All storage technologies can store surplus renewable energy and return it to the grid later, thus avoiding curtailment and increasing the use of renewable power.

According to analysis from IHS Markit, annual installations of energy storage capacity globally will exceed 10 GW in 2021, more than doubling the 4.5 GW increase in 2020. The existing capacity in stationary energy storage is dominated by pumped-storage hydropower (PSH), but because of decreasing prices, new projects are generally lithium-ion (Li-ion) batteries.

PSH capacity additions are predicted to remain constant at 5-10 GW per year, while battery capacity is expected to grow from 2.3 GW/year in 2018 to above 30 GW/year in 2050. Total installed storage capacity was around 170 GW in 2019, a figure that is expected to reach 950 GW by 2050, according to IHS Markit.

Another report – 'The Energy Storage Grand Challenge Energy Storage Market Report 2020' – published by the US Department of Energy forecasts a 27 per cent compound annual growth rate (CAGR) for grid-related storage through to 2030. It projects annual grid-related global employment to increase about 15 times from around 10 GWh in 2019 to almost 160 GWh in 2030.

The type of storage deployed will depend on grid design and the distribution of generating plants and loads unique to each grid. The technology selected depends on which offers the best economic and operational capability according to the services, range of capacity and energy discharge duration needed.

Super-capacitors and rotating grid stabilisers (flywheels and synchronous condensers) provide instantaneous system responses and grid control. Both technologies are aimed at applications in the range of approximately 1-100 MW.

Pumped storage hydro is the most dominant energy storage solution in terms of globally installed megawatt capacity, representing some 93 per cent of the operating system. It is a gigawatt-scale technology mostly used for energy shifting and high-capacity firming with storage durations of around days or weeks with minimal energy losses.

Further, capacity and operating reserve is provided when the asset is connected to the grid. But although a mature and widespread technology, its main drawback is the required topology of the site (large height differences are needed) and its physical impact on the environment.

Thermal energy storage (TES) can improve utilisation of waste heat, assist in the electrification of process heat supply, or store renewable energy for re-electrification using a steam turbine. TES can also be integrated with thermal generation plants, e.g. a combined cycle plant. A wide variety of heat storage media are available, including liquids such as molten salt and pressurised water, or solids such as stone, steel, concrete, or sand.

Liquid air energy storage (LAES) and compressed air energy storage (CAES) are further technologies aimed at gigawatt-scale applications. LAES is based on the cryogenic liquefaction of air when it is compressed with the use of (preferably) renewable electricity. The liquid and the produced heat can be easily stored and discharged when needed for re-electrification. CAES works similar but stores compressed air. By adding a thermal storage to this technology, the overall efficiency is improved.

Li-Ion batteries are currently the technology of choice driven by their cost-effectiveness and speed characteristics. They offer several applications, such as frequency response, flexibility enhancements of conventional power generation assets, black start capabilities or energy arbitrage. Their sweet spot is up to around 250 MW and 5 hours of duration.

of wind and solar and level of long distance power transmission. Up to about 50 per cent of grid capacity may be expected; in isolated grids or grids with weak connection to other grids one may even argue for 100 per cent. When you also look at resilience and tolerance for grid failures most of the GT installations should be distributed in the grid, this favours mid-sized gas turbines as well as flexible CHP. In large, high capacity grids, large GTs will also be attractive for backup power capacity due to low specific investment.

"When looking at energy supply rather than the installed capacity, demand response and storage will dispatch maybe 80 per cent of all energy needed for grid balancing and GTs only the remaining 20 per cent. Those GTs should preferably operate on renewable fuel." he added.

The figure below shows demand as well as solar and wind supply in a simplified fictitious medium size grid. On the left, wind supply during an average day, where energy fed into storage covers about 85 per cent of the balancing need. On the right, where wind supply is low, thermal power generation is needed to replace lower wind supply during the evening through to morning and for the balancing duty that storage solutions would otherwise provide, as there is no surplus renewable power during the day for charging the storage. Here, high efficiency storage is charged from high efficiency mid-merit GT plants during the day, as this limits the need of thermal plant capacity during the peaks. The result is that the required thermal plant capacity is about twice the capacity of installed storage.

If DR is added, it would reduce the required amount of storage as well as the power capacity for storage charging/discharging during an average wind day. In the low wind scenario, it would also reduce the need for installed thermal capacity, as it flattens the thermal power supply.

"Naturally reality is more complex than these simple scenarios, with seasonal variations on both demand and supply, effects of clouding, fast fluctuations, grid disturbances etc.," noted Stuxberg.

Fuel flexibility also has to be a key consideration. If a machine is operated for less than 1000 hours/year, the impact of fuel consumption on environment and economics is relatively small. However, the goal is to run turbines on renewable fuels, and uncertain policy in the long-term outlook in this area is a challenge.

Stuxberg said: "There are a number of optional renewable fuels for use in GTs, hydrogen being one of the top candidates, but today we don't know which of these will be economical or available in the future and obviously it will always depend on the site location and operating profile. But the point is, industrial gas turbines are flexible"

The market for IGT-based grid balancing assets is huge – anywhere in the world where there is renewables growth calling for day-to-day renewables support, while offering emergency backup for the grid. There is also room for large frame gas turbines, where countries have large robust grids.

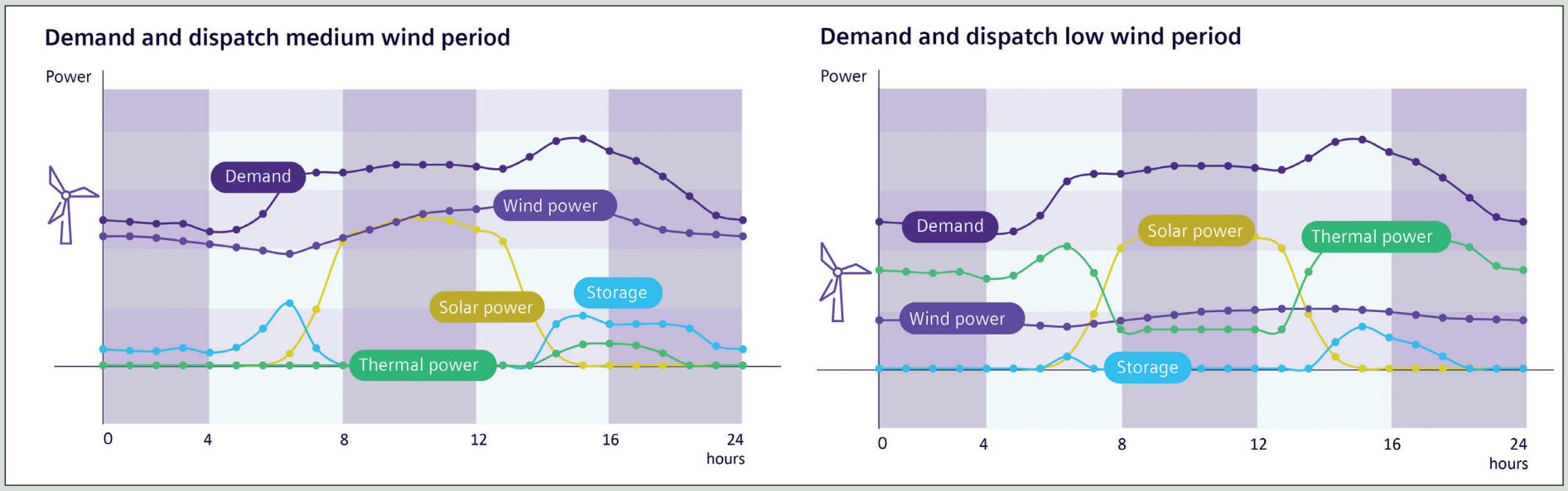
"In Sweden, we have a lot of hydropower but when we close down nuclear capacity and replace with wind farms, there isn't enough capacity to handle the residual power peaks. There we will see a large demand for [GT] backup power. Those machines would probably operate for less than 10 per cent of the time. In many markets today, there is no compensation for having capacity in place and that is an issue.

"Grid integrity and resilience via sufficient backup should mainly be seen as part of the grid infrastructure rather than energy trade. Solving backup power supply with existing coal fired plants is a route that has already proven a failure as it counteracts the greenhouse gas savings from renewable power, i.e. incentives for investment in more suitable backup technology is needed" said Stuxberg.

He concluded: "Renewables and storage systems will play the major future role for energy supply but that requires a lot of flexible backup and for that gas turbines are the most cost effective today – if you need to build capacity today; it's gas turbines.

"We can only speculate on what will happen in the future through development of other technologies. But we need to change the energy system now. With the environmental challenge, we cannot wait 30 years; so we have to base it on the technology we have today and industrial gas turbines is an available technology well fit for the purpose. Backup power also needs to be installed ahead of renewable implementation to ensure grid resilience, so the need is urgent."

**Demand, solar and wind supply in a simplified fictitious medium size grid**



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# Changing winds for OEMs

- Vestas and Siemens Gamesa lower full-year guidance
- Turbine prices to continue upward trend

Junior Isles

Already affected by the Covid-19 pandemic, wind turbine manufacturers are now bracing for the impact of higher wind turbine prices.

Danish wind turbine manufacturer Vestas has lowered its full-year guidance citing supply chain constraints, cost inflation, and restrictions in key markets caused by Covid-19.

The company now expects full-year revenue in 2021 of between €15.5 billion and €16.5 billion, including Service. The previous expectation was €6-17 billion.

It was a similar story for Siemens Gamesa. The company adjusted its guidance for financial year 2021 with an EBIT margin pre-PPA and before Integration and Restructuring (I&R) costs in the range of between -1 per cent and 0 per cent. It said group revenue is expected to be at the low end of the range announced during the presentation of results for the second quarter (April 30, 2021), i.e. €10.2-10.5 billion.

"We are operating in what is currently a very difficult environment and have taken additional steps to balance our risk profile as we focus on delivering long-term sustainable profitability," said Andreas Nauen, Siemens Gamesa's Chief Executive Officer. 'Despite current challenges, the company is soundly placed to take advantage of the huge potential of wind energy, which is reflected in our strong order backlog.

Meanwhile, the Nordex Group is maintaining its guidance for the current financial year of achieving consolidated sales of €4.7-5.2 billion and an EBITDA margin of 4.0-5.5 per cent. The group said the impact of the pandemic on the operating business only had a limited influence on its positive performance in the second quarter but noted its indirect effects were still clearly evident in the upheaval in the raw materials and logistics markets.

According to Wood Mackenzie, wind turbine prices are set to continue their upward trend, rising by up to 10 per cent over the next 12 to 18 months on higher commodity prices and logistics cost, as well as challenges linked to the coronavirus.

Turbine prices have increased over the last six months, pushed up by rises in steel, copper, aluminium and fibre prices and a four-fold surge in logistics costs. According to the research and consultancy group, they will likely return to normal levels by end-2022.

"Turbine OEMs and component suppliers face a double whammy of cost increases and demand softening over the coming two years due to the US PTC (Production Tax Credit) and China feed-in-tariff (FiT) phase-outs," said Wood Mackenzie principal analyst Shashi Barla.

Further cost pressures in relation to the US-China trade tussle have caused the likes of Vestas, Siemens Gamesa Renewable Energy and Nordex to explore alternative supply hubs such as India, the firm said.

Wood Mackenzie also warned of supply chain bottlenecks for key materials over the next four to five years and advised OEMs and turbine suppliers to adopt next-generation technologies and materials.

Last month Siemens Gamesa said it will expand its offshore blade factory in Hull, England by 41 600 m², more than doubling the size of the manufacturing facilities. The expansion represents an investment of £186 million and is planned for completion in 2023.

Earlier, the company said it aims to manufacture fully recyclable blades by 2030, and redesign the rest of the wind turbine components to put a 100 per cent recyclable generator on the market by 2040.

# Companies charge up battery manufacturing

A growing number of companies are ramping up plans to build battery manufacturing plants around the world, as the world accelerates its transition to low carbon economy.

In mid-August Reliance led a $144 million fundraising by US energy storage start-up Ambri, as part of the Indian group's plans to manufacture batteries in its home market.

Reliance New Energy Solar said it would invest $50 million in Ambri and that the two were in talks "to set up a large-scale battery manufacturing facility in India, which could add scale and further bring down costs for Reliance's green energy initiative".

The deal, which follows an announcement in July that ArcelorMittal had invested in Massachusetts-based start-up Form Energy, is the latest in a series of tie-ups between large industrial groups and start-ups seeking to develop energy storage technology.

In Europe, Norway-based Freyr Battery recently said it remains committed to plans to build five gigafactories in northern Norway, despite potential complications caused by Brexit. There are fears that a clause in the Brexit agreement between the UK and EU could mean that any cars built in the EU containing Norwegian batteries would face tariffs of 10 per cent to enter the UK from 2027 and vice versa.

Tom Jensen, the Chief Executive of Freyr Battery, said: "It has not caused us to change our plans whatsoever. But it doesn't mean we're not paying attention to it." The first gigafactory is due to produce batteries from next year. Jensen said the first two gigafactories would be used for energy storage rather than electric vehicles.

Iselin Nybo, Norway's Minister of Trade and Industry, said the country has "initiated dialogue" with the European Commission and the UK "in an attempt to find solutions to the issue".

Norway has high hopes for its battery industry as it looks to use its extensive renewable energy from hydroelectric power to attract green businesses.

Freyr, whose shareholders include Koch Industries and commodity giant Glencore as well as institutional investors Fidelity and Franklin Templeton, is aiming to have 43 GWh of battery production capacity by 2025 and 100-150 GWh by 2030.

Meanwhile, Glencore last month acquired a stake in Britishvolt, the battery start-up behind ambitious plans for Britain's electric battery gigafactory. The £2.6 billion ($3.56 billion) project, designed to equip the UK's car industry for an electric future, will be important in helping the government meet its carbon reduction targets.

As part of the agreement, Glencore will also supply the gigafactory, which is under construction in Northumberland, with cobalt, a raw material used in electric batteries.

# MAN Energy and Andritz agree on hydrogen, as Johnson Matthey accelerates scale-up

Two significant deals in late July look set to accelerate the growing hydrogen market.

MAN Energy Solutions and Andritz Hydro announced they have completed a strategic framework agreement to jointly develop international projects for the production of green hydrogen from hydropower.

A pilot project in Europe will mark the start of the collaboration. Subsequently, the companies want to jointly identify further projects and implement them in the context of the German federal government's H2 Global initiative. H2 Global is a market-based funding platform, which aims to efficiently promote the market launch of green hydrogen and hydrogen-based power-to-X products. For this purpose, hydrogen energy partnerships are to be established with countries with a correspondingly high potential to provide a long-term, cost-effective and reliable green hydrogen supply to Germany and the EU.

Frank Mette, CEO of Andritz Hydro in Germany, commented: "Hydropower is one of the few completely climate-neutral forms of energy, which is capable of providing base load power. We therefore see excellent potential for worldwide expansion – in new construction projects just as much as in repowering. By adding the possibility of producing hydrogen to hydropower plants, we are taking the next step and also making the energy generated there ready for export and storage without restriction. Together with MAN Energy Solutions, we can open up new markets and opportunities for the operators."

The companies are aiming to launch an initial joint pilot project before the end of this year to provide about 650 tons of green hydrogen by using an electrolysis output of up to 4 MW, initially for local use. In follow-up projects, designed for the export of hydrogen, the installed electrolysis output is expected to increase to up to 100 MW in the coming years.

In another move, Johnson Matthey (JM), a global leader in sustainable technologies, announced its acquisition of the assets and intellectual property of UK-based Oxis Energy Limited. Oxis Energy was a lithium-sulphur battery developer with assets, which can be adapted for the manufacture of components for green hydrogen production. The company entered administration on 19 May 2021.

With moderate additional investment in upgrades, this transaction will significantly accelerate the scale-up of JM's growing green hydrogen business. The facility will further expand JM's ability to develop, test, and manufacture catalyst coated membranes and advanced materials for electrolysers.

The site will enable the production of tens of thousands of catalyst coated membrane parts per year – enough to equip hundreds of megawatts of electrolyser capacity.

# CYE partners with Otorio to combat ransomware attacks

CYE, a specialist in cyber security optimisation platforms is partnering with Otorio, a provider of next-generation OT cyber and digital risk management solutions, to provide an integrated solution to companies with converged IT/OT/IOT environments looking for proactive ransomware protection.

The partnership aims to help customers convert the new rigorous US government regulations for critical pipeline owners and operators into practical cyber security plans, and to develop actionable steps to improve their cyber hygiene and overall security.

In recent months, there has been a significant increase in ransomware attacks on industrial companies and critical infrastructure, including the Colonial Pipeline attack, which caused fuel shortages across the East Coast of the US for over a month and led to the payment of a $4.4 million ransom.

CYE and Otorio provide cyber visibility across all IT, OT and IOT environments, quantifying risks, identifying exposures, and building long-term cyber security best practices. The companies claim the solution is fully automated and simplifies compliance processes and ongoing risk monitoring. Furthermore, by proactively identifying exposure and potential attack vectors, and addressing them before they become breaches, it enables companies to significantly reduce risks, while minimising cost.

## Americas

### Inter-array cables ordered for Vineyard Wind 1

Jan De Nul Group, with JDR Cable Systems as a subcontractor, will supply and install the inter-array cables for the Vineyard Wind 1 offshore wind farm in Massachusetts, USA.

Jan De Nul and JDR will deliver 210 km of 66 kV cables to connect the project's 62 GE Haliade-X turbines and transfer electricity to an offshore substation for transmission to the grid. From here, the electricity will be sent ashore to the grid via a cable to be supplied by Prysmian.

Vineyard Wind, a joint venture between Avangrid Renewables and Copenhagen Infrastructure Partners (CIP), is developing the 800 MW wind farm some 56 km off the coast of Massachusetts.

The project was given approval to start construction in May 2021. It is the first large-scale offshore wind farm to be built in the USA.

### OSS wins 130 MW solar project in USA

Orbital Solar Services (OSS), a subsidiary of Orbital Energy Group, was awarded an EPC contract in August to construct a 132.2 MWdc/100 MWac solar power farm in southeastern USA. OSS will design, engineer, and produce a utility-scale solar array to be delivered in early 2022. The project will consist of 350 000 solar panels installed across 800 acres.

Jim O'Neill, Vice Chairman and CEO of Orbital Energy Group, said: "This project and others like it serve to expand OSS's industry relationships based on a solid record of achievement and the expertise to provide end-to-end solutions."

## Asia-Pacific

### NTDC awards load dispatch system contract

Pakistan's largest transmission company, National Transmission & Despatch Company (NTDC) has awarded a contract for delivery of a load despatch system (LDS) from a consortium that includes China Machinery Engineering Corporation (CMEC) and Hitachi ABB Power Grids. The LDS system will help to improve grid visibility and automation, enabling the seamless integration of renewables.

The consortium will deploy a SCADA Energy Management System at NTDC's national control centre in Islamabad and at the back-up control centre in Jamshoro. The system will connect the control centres with all power plants and grid stations not currently monitored in real-time. The project includes installation of a new mission-critical communication network with a fibre-optic foundation, with a microwave network as back-up.

The LDS will enable optimal power flow, load forecasting, and automatic generation, automating the process of deciding the most efficient use of power plants to meet the energy needs of the country.

Pakistan aims to increase the contribution of renewables from its current level of 4 per cent to 30 per cent by 2030.

### Vestas wins 58 MW Australian order

Vestas, in partnership with Global Power Generation, has won an order to supply and install 16 V126-3.45 MW wind turbines for the 58 MW Crookwell 3 wind farm in New South Wales, Australia. The turbines will be in 3.6 MW operating mode.

Upon completion, Vestas will also deliver a 15-year Active Output Management 5000 (AOM 5000) service agreement to optimise energy production.

Delivery of the wind turbines is expected to occur in the second quarter of 2022, with commissioning to commence in the fourth quarter of 2022.

Purvin Patel, President of Vestas Asia Pacific, said: "As the largest installer and maintainer of wind turbines, both globally and nationally, we are pleased that customers like Global Power Generation continue to choose our leading technology, market experience and broad service solutions."

### Wärtsilä to supply 40 MW to Bangladesh

Wärtsilä announced in August that it will supply a 40 MW power plant to Sigma Powertech in the Adamjee Export Processing Zone (EPZ) near Dhaka in Bangladesh. The contract comprises orders placed in Q1 and Q2, 2021. The plant is expected to encourage industrial investments in the zone.

The plant will operate with four Wärtsilä 34SG engines operating on natural gas. Delivery of the engines with all equipment is scheduled before the end of 2021. Commissioning and commencement of operations is expected before the end of June 2022.

Mohammad Moyeen, Chairman of Sigma Powertech, said: "This is an important project for the region and for the continued economic growth of Bangladesh through export enhancement as per government's initiative. Growth throughout the industrial sector is very much dependent on having a reliable power supply, and the new power plant will provide this."

### Taiwan selects Wärtsilä energy storage system

Shangfa Construction placed an order in August for group Wärtsilä to supply a 5.2 MW / 5.2 MWh energy storage system. The system will provide frequency regulation in the ancillary service market for the Taiwanese grid as the country seeks to achieve 20 per cent of its energy from renewable sources by 2025. Shangfa Construction will build the energy storage facility on behalf of North Star International.

The Beimen Energy Storage project will be in the city of Kaohsiung in Taiwan. It will include Wärtsilä's Gridsolv Quantum, a fully integrated, modular, and compact energy storage system, a Power Conversion System, as well as Wärtsilä's GEMS Digital Energy Platform. GEMS will provide complete energy asset control and optimisation.

The system will be operational in late Q1, 2022. Taiwan aims to have 20 per cent of its energy from solar and wind power by 2025, which will be augmented with an additional 15 GW of offshore wind power by 2035.

### Andritz to rehabilitate Kopili hydropower plant

Andritz has received an order from the Indian utility North-Eastern Electric Power Corporation (NEEPCO) for the rehabilitation of the electro-mechanical equipment of the 200 MW Kopili hydropower plant on the Kopili River in Assam, India. The project is expected to be finished by Q3, 2023.

Andritz's scope of supply includes detailed design and engineering, manufacture, transportation to the project site, supervision of assembly, erection, testing and commissioning of all the electro-mechanical equipment to be installed in the powerhouse of the Kopili plant.

The rehabilitation works will be carried out by the Indian hydro subsidiary of Andritz with manufacturing facilities in Mandideep, near Bhopal, amd Prithla, near Faridabad.

## Europe

### France to return nuclear waste to Germany

The French nuclear group Orano has signed a €1 billion contract to return high-level nuclear waste processed in France back to Germany by the end of 2024. Orano announced in mid-August that a package of deals between PreussenElektra, RWE, ENBW, and Vattenfall formalised an in-principle agreement made in June by the French and German governments.

German electricity companies have been sending spent nuclear fuel to the reprocessing plant in Normandy for recycling for 44 years.

Under the terms of the agreement, high-level French waste from EDF plants will be returned to Germany rather than medium-level German waste. Orano said that this would require less volume and less time to send the same level of radioactive waste back to Germany.

A single train of 100 containers carrying the spent nuclear fuel will be transported from Orano's plant in La Hague, Normandy to Germany within the next three years.

### Siemens Energy to supply switchgear

Primeo Energie has placed an order with Siemens Energy for high-voltage switchgear with "Clean Air" insulation for the Therwil substation in Switzerland. This solution has zero greenhouse gas implications over its entire service life. It is the first system of its kind to be installed by Siemens Energy in Switzerland.

The new switchgear will be manufactured in Berlin and delivered to Therwil in Autumn 2022. The new substation is scheduled to go into operation in 2023.

The new plant in Therwil will use processed air consisting of 80 per cent nitrogen and 20 per cent oxygen for insulation and is thus climate neutral. This is made possible by an innovative circuit breaker with vacuum technology inside the switchgear.

Dr Lukas Küng, Managing Director of Primeo Netz and member of the Primeo Energie Group Executive Board, said: "In addition to economic and technical aspects, it was above all the sustainability aspect that convinced us that the F-gas-free switchgear from Siemens Energy was the right choice for the substation in Therwil."

### Van Oord foundations for Baltic Eagle

Van Oord has signed a contract with Iberdrola for installing foundations and transmission cables on the 476 MW Baltic Eagle offshore wind farm in Germany. Under the terms of the contract, Van Oord will install 50 monopile foundations and install transmission cables for the facility.

The project will feature 50 units of Vestas Wind Systems' V174-9.5MW turbines. The offshore works are slated to start in 2023, with operations planned to start by the end of 2024.

### Decommissioning extension for Costain

Costain has been awarded a two-year contract extension by EDF Energy to support the safe operation and decommissioning of the UK's existing nuclear power stations. EDF Energy has extended the Project Controls Resources (PCR) framework contract to run from April 2022 to March 2024, adding to the four-year contract already in place.

Costain provides a project controls managed service to portfolios and programmes of work across EDF Energy's eight UK nuclear power stations and is supporting EDF on its transition from generation to defueling of the Advanced Gas Reactors along with the Long-Term Operation for Sizewell B.

### Siemens Gamesa to supply Swedish Twin Peaks

Siemens Gamesa will supply 39 of its SG 5.8-170 wind turbines to two sites totaling 242 MW in Sweden dubbed the 'Twin Peaks'. Siemens Gamesa will supply 25 turbines to the Ranasjö site and 14 to the Salsjö location, both in central Sweden. These are due to be commissioned by Q1 in 2024 and will be covered by a service agreement of 30 years.

The turbines will have a nominal capacity of 6.2 MW with a rotor diameter of 170 m.

## International

### L&T wins $70 million Saudi substation contract

Saudi Electricity Company has awarded a $70 million contract to Larsen & Toubro (L&T) to construct the 380/132/13.8 kV Al Buhairah gas-insulated substation in Saudi Arabia, to be built in Tabouk City.

L&T will deliver the project on a turnkey basis, and is responsible for the design, engineering, materials procurement, installation, construction, testing, and commissioning.

### SEC transmission infrastructure upgrade

Saudi Electricity Company (SEC) has awarded a $130 million contract to Trading Development Partnership (TDP) for installation of 380 kV underground cable linked with substation 9097 in Riyadh, Saudi Arabia. TDP will be responsible for the complete design, supply, and installation of two 380 kV cable circuits 39 km long, as well as associated civil works. Work is scheduled for completion within 29 months.

In addition, SEC has launched a tender for design and construction of two overhead power transmission lines in Tabouk. The tender involves 390 km of 380 kV overhead power line starting from Tabarjal bulk supply point (BSP) to Buhirah BSP. The winning contractor will deliver the project on a turnkey basis, being responsible for the design, engineering, materials procurement, installation, construction, testing and commissioning of the project.

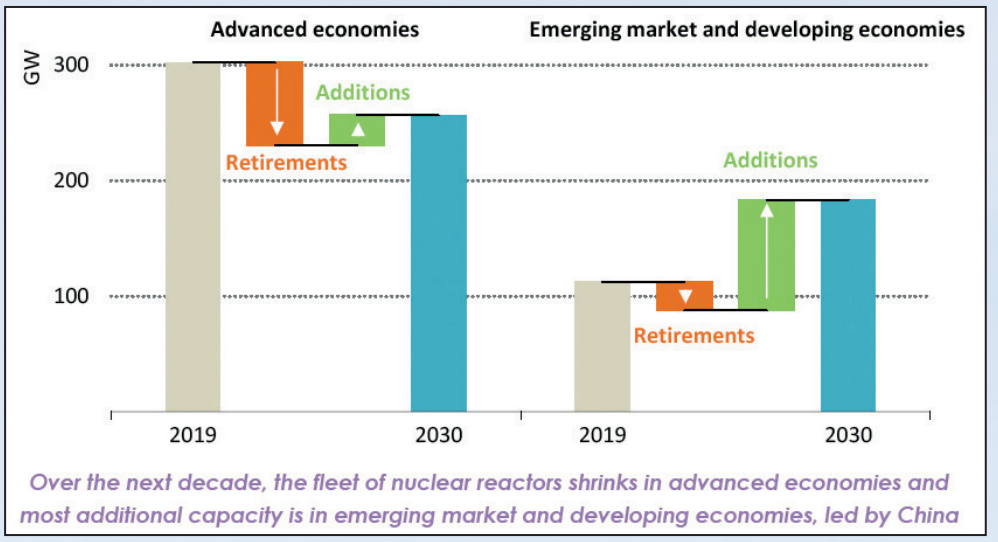
### Koeberg nuclear power plant modernisation

Jacobs has secured a construction management contract as part of the $1.2 billion modernisation programme at Koeberg nuclear power plant in Cape Town, South Africa. The scheme includes installation of six new steam generators.

Under the terms of the contract, Jacobs will be responsible for managing works related to modifications to the secondary turbine system, including prefabrication of piping, pipe supports and modification, and piping replacement.

Work on replacing the steam generators for the first of the two Koeberg units is scheduled to start in January 2022. The entire project is due to be completed in two years.

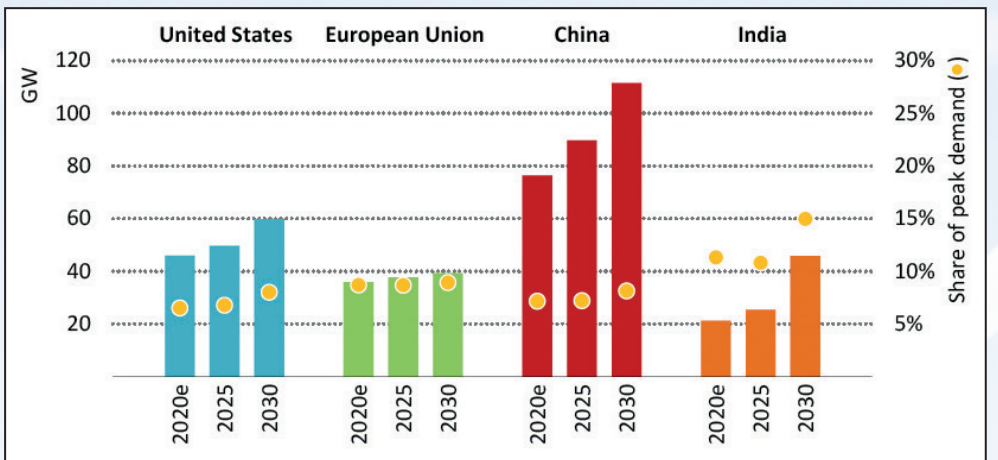
## Nuclear power installed capacity, capacity additions and retirements in the Stated Policies Scenario, 2019-2030




*Over the next decade, the fleet of nuclear reactors shrinks in advanced economies and most additional capacity is in emerging market and developing economies, led by China*

*World Energy Outlook 2020, © IEA/OECD, Figure 6.14 , page 233*

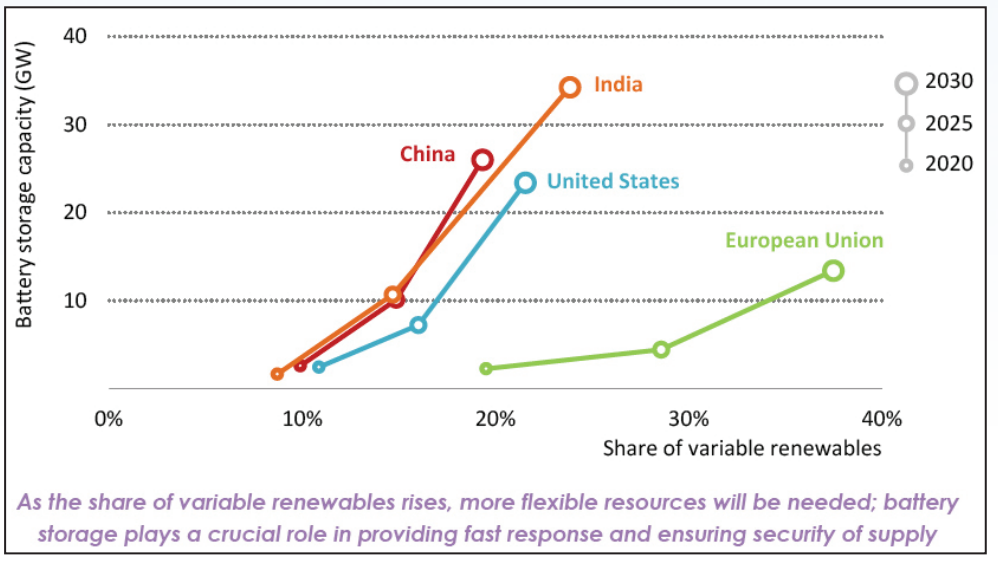
## Power system flexibility needs in selected regions in the Stated Policies Scenario




*Changes in the shape and variability of electricity demand and strong growth of variable solar PV and wind power increase flexibility needs in power systems*

*World Energy Outlook 2020, © IEA/OECD, Figure 6.17, page 241*

## Battery storage capacity and share of variable renewables in selected regions in the Stated Policies Scenario




*As the share of variable renewables rises, more flexible resources will be needed; battery storage plays a crucial role in providing fast response and ensuring security of supply*

*World Energy Outlook 2020, © IEA/OECD, Figure 6.21, page 248*

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**Hydrogen**

# UK government future plans for blue hydrogen prompts lobbyist's resignation

- Twin track approach will lock-in use of fossil fuels
- Blue hydrogen is at best an expensive distraction

Gary Lakes

Anger over the UK government's plans to include blue hydrogen in its decarbonisation plans has prompted the resignation of the Chairman of the UK Hydrogen and Fuel Cell Association. Chris Jackson, who headed the group for little more than a year, resigned after learning that the government would include the prolonged use of blue hydrogen in its plans to transition to an emissions-free economy in the future. Blue hydrogen is produced by the burning of fossil fuels.

Jackson said the plan could very likely lock-in the use of blue hydrogen indefinitely and enable the fossil fuel industry to retain a grip on energy production and usage. Jackson accused energy companies of making false claims about blue hydrogen in order to access billion of pounds in subsidies from taxpayers.

The government of Boris Johnson in late August adopted a 'twin track' strategy in the case of hydrogen production, but it did not determine a balance between the production of blue or green hydrogen. Green hydrogen is produced by using renewable energy for the electrolysis process that results in its production.

Jackson has not been the only environmental campaigner to criticise the government for including blue hydrogen in its long-term energy scheme. Activists say that long-term use of blue hydrogen could make the UK dependent for decades on North Sea oil production, fossil fuel imports and millions of tons of carbon emissions.

According to an analysis undertaken on behalf of *the Guardian* newspaper by Friends of the Earth Scotland, and which was based on the data released by the UK government, the use of blue hydrogen would create the same carbon emissions than more than a million petroleum using cars would produce, the equivalent of eight million tons, every year by 2050. This would not be the case using green hydrogen, which is zero-carbon.

The government intends to use both types of hydrogen to replace fossil fuels in factories, refineries and for heating, but the analysis shows that over-reliance on blue hydrogen would lead to millions of tons of carbon dioxide being emitted into the atmosphere every year.

The energy industry is arguing that carbon capture technology, which must still be developed, would eliminate much of the carbon from the blue hydrogen process, but it still allows between 5 per cent and 15 per cent of carbon dioxide to escape. Furthermore, carbon dioxide is released from oil and gas fields during the drilling process for fossil fuels and escapes from fossil fuel facilities. Methane is also produced during drilling and processing, which is even more harmful to the atmosphere.

The UK Treasury is now considering subsidies for the production of both blue and green hydrogen in order to get the industry rolling. Both are still too expensive to produce at market prices.

However, Jackson said he resigned because he could no longer lead an industry association that included oil companies that are promoting blue hydrogen projects because those plans are not sustainable and "make no sense at all." He said he could no longer be in a role where he would be expected to take a neutral stance.

"The Treasury has been told that blue hydrogen is cheap and will take millions of carbon emissions out of the economy, which is all they [the government] need to hear. It checks all the boxes [the government] is worrying about," he said.

"If the false claims made by oil companies about the cost of blue hydrogen were true, their projects would make a profit by 2030, after starting up in 2027 or 2028, because carbon prices are forecast to rise to £80/ton," Jackson said in an online statement. "Instead, they [oil companies] are asking taxpayers for billions in subsidies for the next 25 years. They should tell the government they don't need it. The fact that they don't tells you everything you need to know."

With their big, bold, multi-billion pound blue hydrogen projects, the oil companies have managed to attract ministers who are looking to show that they are doing something about supporting the efforts to combat climate change, Jackson asserted.

"I believe passionately that I would be betraying future generations by remaining silent on the fact that blue hydrogen is at best an expensive distraction, and at worst a lock-in for continued fossil fuel use that guarantees we will fail to meet our decarbonisation goals," he said.

"The UK has all the ingredients to be a world leader in green hydrogen, which is an essential net zero technology – we just need the will and support from government to make that happen," Jackson added.

Jackson is the CEO of Protium Green Solutions, which intends to develop green hydrogen projects.

**Gas**

# Scarborough LNG gets boost as Woodside takes on BHP O&G assets

BHP's oil and gas assets are to merge with Woodside Petroleum in a deal that will strengthen Woodside's position in its key North West Shelf LNG and Scarborough assets.

Gary Lakes

Australian giants Woodside Petroleum and BHP Group have agreed to merge their oil and gas businesses resulting in the likely creation of an international 'super independent' energy company. The deal was announced in mid-August and is expected to be finalised in 2022. BHP assets are expected to give Woodside the boost it needs to push ahead with its Scarborough LNG project, which is due for a final investment (FID) decision later this year.

BHP has been reported as giving consideration to shedding its oil and gas assets and return to its core business of mining. Shareholders in the Group had advocated for the change as the world prepares for an energy transition away from fossil fuels.

The agreement, valued at around $13 billion, will be carried out through an all-stock merger. BHP's oil and gas assets are to merge with Woodside, which will issue new shares that will be distributed to BHP shareholders. This will result with current Woodside shareholders owning 52 per cent of the company and existing BHP shareholders owning 48 per cent. The deal suggests a value of AU$18 billion for BHP's oil and gas business.

Despite the fact that BHP appears to be stepping out of oil and gas, the arrangement keeps the Group within the world of fossil fuels as its shareholders will own nearly half of Woodside. Clearly, BHP is not ready to transition away from oil and gas entirely.

For its part, the merger will make Woodside one of the top 10 oil and gas producers worth some $28 billion. Woodside will be able to double its output as it takes over BHP assets in Australia's Bass Strait, the Gulf of Mexico, Trinidad and Tobago and North West Shelf LNG.

It will be able to expand its LNG business and de-risk the Scarborough project, an investment of some $12 billion that will have a capacity to produce 7.5 million tons per year of LNG and is due to come into operation in 2026.

"Merging Woodside with BHP's oil and gas business delivers a stronger balance sheet, increased cash flow and enduring financial strength to fund planned developments in the near term and new energy sources into the future," Woodside's new CEO Meg O'Neill said in a statement. "We will have more optionality in where we invest and can prioritise the highest return opportunities," she said, adding that the planned deal supports the Scarborough FID and "enables more flexible capital allocation".

The firms said that the completed transaction would generate annual savings of more than $400 million from 2023.

Not all of BHP's shareholders are reported to be pleased about the deal. The share value of both companies declined after the announcement of the merger, and BHP said it would drop its listing on the FTSE 100 index and move its main listing to the Sydney stock exchange. Some investment analysts were reported by the media as suggesting that Woodside was not in a strong enough position for the merger and would have a rough time with the deal and possibly experience a decline in its share value. Woodside has not been seen as a strong performer given the situation with the Covid-19 pandemic and a number of its gas fields are in decline.

Yet many of the assets that Woodside will acquire are considered high-performing and will provide the company with cash that will give it a financial boost.

Woodside will acquire BHP's 26.5 per cent stake in Scarborough LNG, giving Woodside full control and making the FDI very likely to be approved. The project is comprised of three gas fields – Scarborough, Thebe and Jupiter – located some 375 km offshore. Together, they are estimated to hold gas resources of 13 trillion cubic feet (tcf).

The merger would allow Woodside to "strengthen its position in its key North West Shelf LNG and Scarborough assets," Wood Mackenzie's Harwood said. "Woodside would be firmly in control of the Scarborough development but will continue to look for new partners to optimise future capital outlays," he said.

Initial development calls for the placement of seven to nine gas wells that will be tied back to a semi-submersible floating production unit moored in 950 m of water. From the production unit, Woodside plans to construct a 430 km subsea pipeline that will transport the gas to the existing Pluto LNG production facility where a new LNG processing train will be built, Pluto Train 2. The train will produce 7.5 million t/year and the first loading of LNG is planned for 2026.

# Hanhikivi 1: a model for nuclear new build in Europe?

New build large nuclear plants often come under fire as a result of delays and high capital costs, which usually go over budget. Fennovoima's Hanhikivi 1 power plant in Finland could offer some clues on how plants, including small modular reactors, could be successfully developed in the future. **Junior Isles**

The challenges facing the development of large nuclear power plants, especially in Europe, have been well documented over the last 15 years or so. Finland's Olkiluoto 3 is nearly 13 years behind schedule and about three times over the original €3.2 billion budget. It is a similar story at Flamanville 3 in France and Hinkley Point C in the UK. Even across the pond in the US, delays and costs at Vogtle 3 & 4 continue to head north.

Yet despite the poor track record of the industry, Philippe Bordarier, Chief Operating Officer at Fennovoima, believes the 1200 MW Hanhikivi 1 project, currently under development in Finland, can provide some valuable lessons for plants going forward.

Fennovoima is owned by a number of shareholders, which include dozens of major Finnish industry corporations such as Outokumpu and Fortum, and local energy utilities. These shares, representing a 66 per cent stake in Fennovoima, are held by Voimaosakeyhtiö SF, a Finnish holding company. As these shareholders require a large amount of energy for their operations, a reliable and stable priced power supply is crucial for their businesses.

RAOS Voima, a 100 per cent Finnish subsidiary of Rosatom, owns the remaining 34 per cent of the shares in Fennovoima. RAOS Voima plans to sell its share of the electricity from the plant on the NordPool market.

Fennovoima operates under the "mankala principle", i.e. it will sell all the electricity generated by the plant to the owners at cost price in proportion to their ownership. This price includes operating and financing costs, as well as the organisational costs of the company. The mankala principle has been widely used in Finland's energy sector for decades – about 40 per cent of the electricity in Finland is produced by the mankala companies.

Commenting on Fennovoima's approach, Bordarier said: "We could be paving the way; maybe what we are doing here could be replicated elsewhere. If you look at other opportunities in the nuclear sector, like developing small modular reactors [SMRs] for example, this could be a useful model for future companies. We are proving that it is possible to develop, build and commission a nuclear power station design and be a safe operator starting from the commercial decision."

Bordarier, who joined Fennovoima from EDF in April, sees the company as somewhat "unique" – doing three things at the same time.

"Firstly we are building a nuclear power plant, which is a massive infrastructure project. Secondly, we are building the operator of the station, which means we develop the skills – the people, the processes – to operate the station. This is quite unique in itself because the nuclear industry is very specific. And because Fennovoima is a brand new company, we are building that company. All of this makes the project very different and that's part of what attracted me."

Bordarier calls Fennovoima "the first 21st century nuclear energy company in the world".

He explained: "The vast majority of today's nuclear new build projects are controlled by either a large shareholder that is usually an existing utility company or state agency, or by an EPC company. Fennovoima is a commercial project that started almost from scratch – we don't have a massive utility or EPC company as our main shareholder. Rosatom is the EPC contractor but does not control the company; it's a kind of unique model."

What makes such a commercial project possible in Finland is partly due to the country's long nuclear experience – it has a major regulator, nuclear operators, experienced nuclear engineers and access to suppliers in both western and eastern Europe that can provide both equipment and services.

The Hanhikivi 1 plant is located in the Hanhikivi peninsula, a coastal site near the municipality of Pyhäjoki in Northern Ostrobothnia on the shore of the Baltic Sea in Northern Finland.

The power station is based on tried and tested Russian nuclear technology. It will employ a 3+ Generation VVER-1200 pressurised water reactor that has all the safety features proposed by the various authorities post-Fukushima. It is to be constructed by Rosatom under a fixed price turnkey engineering, procurement and construction (EPC) contract, which means the price that Fennovoima will have to pay for construction will not escalate in the event of an overrun on the project schedule.

It could prove to be a smart decision. With design and licencing work still ongoing, construction of the nuclear island is targeted for 2023. Pouring of first concrete will mark the beginning of a six-year construction period, with commercial operation planned for 2029.

Bordarier believes this target is still realistic despite the delays that have already been seen due to a protracted licencing period. The Construction Licence was originally expected to be issued in 2018 but 2022 is now the new target. The process, carried out by STUK (the Finnish nuclear regulatory agency) is notoriously complex, with several thousand requirements having to be met.

Bordarier noted: "We are absolutely preparing for construction to start in 2023. Some facilities, such as the training centre are already built; security gates and fences are there. We also have some warehousing, etc. for suppliers. At the moment, we are carrying out work such as dewatering the site and will start doing some earthworks. But we will need the licence to start construction of the nuclear building.

"Commercial operation in 2029 is still realistic. If you look at the VVER-1200, many have been built. Akkuyu [in Turkey] is currently making good progress and Titan 2, the company that will be in charge of constructing Hanhikivi 1, is becoming very experienced in building these stations. Yes it's an ambitious target but it's realistic and is still our reference schedule. We plan to stick to that but once we get an update on the licence, we will have a bit more clarity."

Still, Bordarier is seasoned enough to realise it will not be all plain sailing, and he will have to call on his extensive experience to keep things moving to schedule.

"In large projects like this, you have to learn quickly. We like to use the '5 P' model in the nuclear industry – Plant, People, Processes, Platforms and Partners. On the 'plant', which is the key challenge and priority, we need to get the licence. That means finalising the documentation with the EPC supplier to ensure we address all the usual safety questions in a coherent design.

"On 'people', we are developing the owner-operator's skills and competencies. For 'processes' and 'platforms', we are developing our management system. We are currently in the project phase and will move from licencing to construction to operation. On this journey, we also need to develop our tools. We are starting virtually from scratch, with no legacy, so we have to make the right decision to today on developing the right tools for the next 20-30 years. 'Partners' means developing our supply chain. This will be a blend of the Russian supply chain as well as the usual western European and of course Finnish companies that have been involved in other Finnish projects."

With the immediate challenge being to obtain the construction licence, Bordarier first wants a very clear understanding of what Fennovoima has to deliver in the coming months.

"We have a clear understanding with our supplier and the regulator on the documentation and basic design development needed to get the licence," he said. "We are still discussing a couple of very important items in terms of changes to Hanhikivi 1 compared to the reference plant. For example, the I&C (instrumentation and control) system will be more [advanced] compared to other VVER-1200 plants. We should have all the documentation ready for submission to the regulator within the next few months. This is being done in batches, so they already have most of the material… so I'm confident we will get the licence next year."

In the meantime, work has already started on some of the long lead-time items for the nuclear island. For example, the steam turbine generator is currently being manufactured in Belfort, France. The manufacturing documents for other long-lead items such as the forgings are still being approved with the suppliers, before being submitted to the regulator. In addition, other equipment needed for site preparation is currently being manufactured in Estonia for delivery next year.

In spite of the challenges facing large nuclear projects, Bordarier points out that the battle against climate change has to remain at the forefront of the minds of industry critics.

He concludes: "We have to decarbonise electricity; this is the foundation of Hanhikivi 1. It's part of the Finnish energy strategy to be carbon-free. It is true that we have seen many challenges for these large infrastructure projects in western Europe. But we have learned a lot of lessons and have a lot of people in Fennovoima that have been involved in new build projects in western Europe. We have a lot to do but our responsibility is to agglomerate and get the best of what we've learned from other projects."

**Bordarier: "We could be paving the way; maybe what we are doing here could be replicated elsewhere"**

# Hong Kong vs Singapore: a decarbonisation tale of two cities

Singapore is likely to maintain a better climate action track record than Hong Kong for the coming years but Hong Kong has a wild card: China. Asian energy expert **Joseph Jacobelli** compares these two important markets as COP26 draws nearer.

Singapore embraced the energy transition faster than Hong Kong. A clear vision and proactive government support allowed robust expansion of renewables and electrification in the 'Lion City'. Hong Kong has lagged despite benefiting from being a region of China, which is a global leader in clean energy and e-mobility. Singapore's superior track record will endure in the medium term.

The two cities are similar yet different. The population of the Hong Kong Special Administrative Region is 29 per cent larger than that of the Republic of Singapore. Its land area is about 49 per cent bigger but they both have a similar population density (7140 people/km$^2$ for Hong Kong vs 8358 for Singapore). The GDP structure is different and impacts the amount of energy used. About a third of Singapore's GDP comes from industry while over 94 per cent of Hong Kong's is services. The primary energy consumption and electricity generated was 3.42 EJ and 53.1 TWh, respectively, for Singapore and 0.93 EJ and 44.1 TWh for Hong Kong; actual consumption is actually higher as some nuclear power is imported from Guangdong province. In terms of greenhouse gas emissions, Hong Kong's was at 40.1 million tonnes of carbon dioxide equivalent ($MtCO_2e$) in 2019, mostly from power generation and transport, vs 47.4 $MtCO_2e$ for Singapore in 2018, with about half from industry.

Singapore and Hong Kong are keen to cut emissions. The path includes greener buildings, energy supply, and transport. A clearer vision and support by Singapore's government has translated into a stronger track record. It developed solid policy frameworks to boost investments in green projects. Also, it provided strong support to private sector efforts to transition energy supply and consumption to green and sustainable resources.

This has not been the same for Hong Kong. Many policies and efforts are either still on the drawing board or have been half-hearted. Its path has been infinitely slower than China's, which today is a global leader in clean energy investments and e-mobility. Climate action success by the two jurisdictions can be evaluated from a variety of lenses. One is clean energy. Another is the shift to transport electrification, especially that of private and commercial vehicles.

| | Unit | Year | Hong Kong | Singapore |
|---|---|---|---|---|
| Population | mn | 2021 | 7.6 | 5.9 |
| Land Area | km$^2$ | 2021 | 1,050 | 719 |
| GDP/capita | US$ | 2020 | 48,713 | 65,233 |
| GDP | US$bn | 2020 | 365.7 | 372.1 |
| Power Output | TWh | 2020 | 44.10 | 53.07 |

**Hong Kong and Singapore are similar yet different. The differing GDP structures impact the amount of energy they use**

*Source: Author, August 2020. Data sourced from Worldometers.info; World Bank; BP; and Statista*

Given land size and natural resources limitations for both, the most viable source of green sustainable energy is primarily solar power. There is also some potential for waste-to-energy and offshore wind, especially for Hong Kong. Both have a good amount of average annual solar irradiance. Singapore's is 1580 kWh/m$^2$ and Hong Kong's 1290 kWh/m$^2$, about 20 per cent less. Singapore targets at least 2 GW in solar capacity by 2030 from about 290 MW in 2020; it was 2.9 MW in 2010.

Hong Kong renewable energy data is hard to find, probably a reflection of the government's slow approach to renewables in general. In 2019, the government said that renewables accounted for about 0.1 per cent of electricity consumption without providing specific numbers. A calculation showed that government and the private sector had added approximately 4-5 MW in renewables up to 2018. The Special Administrative Region has no formal target for 2030 or 2050. It only says that by 2030 the potential for renewables is 3-4 per cent of consumption, with solar contributing 1-1.5 per cent. A study commissioned by the government concluded that the feasible maximum amount of rooftop solar PV output is 0.88 TWh while another study by a local university put the potential maximum amount at 4.67 TWh.

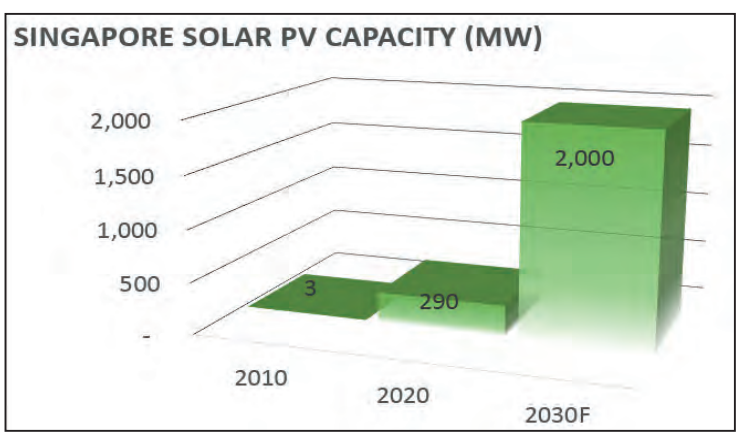
Both Hong Kong and Singapore are land restricted, though they can import clean energy. For Singapore, it could rely on clean power imports from Malaysia or Indonesia. Currently, there is even the possibility that it could possibly import renewable energy from Australia; albeit the proposed project is a long-term prospect that faces multiple hurdles. Hong Kong could easily import green and sustainable energy from neighbouring Guangdong province but It faces little hurdles to import clean electricity, given that it is an integral part of China. Singapore would face some geopolitical issues, but the city state does have a history of importing some forms of energy from its two closest neighbours.

Hong Kong's slow e-mobility policy-making is highlighted in my book: 'Asia's energy revolution'. Singapore has been more aggressive on the electrification of transport vehicles policy-wise, although so far Hong Kong has managed to add more e-vehicles. The number of electric vehicles in Singapore is still small but has been ramping up. As of 2020, there were 1249 electric cars and taxis, or 0.2 per cent of the total. The percentage of electric commercial vehicles was just 0.1 per cent and that of buses 0.3 per cent. In 2020, the government announced that it will phase out all internal combustion engine (ICE) vehicles by 2040 with all vehicles running on clean energy by then. A year later it said it would grow electric vehicles (EV) charging points to 60 000, (40 000 public and 20 000 private). It committed to fuel the city's bus fleet with cleaner energy also by 2040. It also set up the National Electric Vehicle Centre to support EV adoption, including the acceleration of building a nationwide charging infrastructure, as well as regulations and standards.

Hong Kong has also set some EV targets, but they seem rearward by comparison to Singapore. Hong Kong had about 686 275 passenger cars and taxis as of June 2021. Tax incentives resulted in Hong Kong having about 18 500 e-vehicles as of January 2021, about 2.7 per cent of the total. The government said that it would ban ICE vehicles sales by 2035, provide a concrete timetable for the electrification of public transport and commercial vehicles by 2025, support the set up of 150 000 private charging points and build 5000 public ones by 2025. It also wants zero vehicular emissions by 2050 but has not provided a blueprint to arrive at this goal.

Singapore is likely to retain its strong climate action track record in the coming years. The city-state has consistently wanted to be a trailblazer, especially in the energy sector. It is likely to set aggressive clean energy targets post-2030. Also, its e-mobility targets could potentially be brought forward.

Hong Kong is likely to continue to lag, based on its past track record. It has a wild card, however: China. The nation is the undisputed global leader in clean energy additions and in EVs. It is possible that the central government may put pressure on Hong Kong to accelerate clean energy and e-mobility plans. It could also help in many other ways including selling clean energy to Hong Kong and assist on a more rapid deployment of the EV infrastructure. The key motivation could be China's '30–60 Goal': peak carbon emissions before 2030 and net zero before 2060. As an integral part of China, Hong Kong will have to play its part.




**Singapore solar PV (MW). Singapore has a good amount of average annual solar irradiance and is targeting at least 2 GW in solar capacity by 2030**

*Source: Author, August 2020. Data sourced from: Energy Market Company (EMC); SP PowerGrid Ltd (SPPG); Energy Market Authority (EMA)*

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# An imaginative approach to long duration storage

US-based 247Solar has developed an innovative thermal battery that looks set to facilitate 24/7 wind and solar energy. As a scalable long-duration storage solution that avoids the complexity and environmental drawbacks of electrochemical batteries, the market potential is enormous.

**Mark von Keszycki**

Long-duration storage has long been the missing link between intermittent solar and wind power and the promise of round-the-clock renewable energy. Although a variety of electrochemical battery solutions – vanadium flow, iron flow, iron-air – are emerging to address the issue, these are mostly expensive, unproven, or both. Now, US-based 247Solar has introduced an innovative thermal battery design that takes a different approach.

Because it is a thermal battery, 247Solar's solution, dubbed HeatStorE™, stores energy as heat instead of electricity. This enables energy to be stored in a variety of materials, like sand, rocks or ceramic pellets, that are both inexpensive and environmentally benign. When power is required, the stored heat is used to drive a unique turbine to produce electricity on demand.

The technology behind HeatStorE originated at the Massachusetts Institute of Technology (MIT), and was developed by co-inventor and now 247Solar CEO, Bruce Anderson. It was initially conceived as 247Solar's first commercial product, the 247Solar Plant™.

This modular, scalable concentrated solar power (CSP) plant captures solar energy using heliostats (solar mirrors) and a unique solar collector that heats air at atmospheric pressure to 970°C (1800°F). Some of this superheated air is directed toward a turbine to produce electricity. The remainder is directed toward a thermal storage module where it is stored for later use.

Always a feature that differentiated CSP from cheaper PV, long duration storage was to be expected as a part of this design. However, unlike conventional CSP, which stores heat in caustic, environmentally unfriendly molten salts, 247Solar's thermal battery uses inexpensive dry media – initially ceramic pellets and now ordinary sand. This not only makes it less complex and much less expensive, it also allows the system to operate at much higher temperatures, dramatically increasing efficiency.

Along the way, Anderson realised that the need for long-duration storage was even greater for PV and wind. While these were the dominant technologies in the marketplace, they produced electricity directly and could only store it in expensive, short-duration lithium-ion batteries. The challenge was, therefore, how to bring the benefits of long-duration thermal storage to these technologies. Simple electric resistance coils, not unlike an everyday electric stove, provided the answer. The coils could convert electricity to heat for storage, 247Solar's turbine could re-convert the stored heat back to electricity on demand, and the HeatStorE battery was born.

Each HeatStorE battery is a module of 200 kW/1800 kWh capacity. Multiple units can be combined in any quantity to create storage banks of any required size. Typical storage duration is 4-20 hours depending on temperature and depletion rate, and unlike electrochemical batteries, HeatStorE promises a service life of 20 years or more with little or no performance degradation. HeatStorE provides reactive power, and because it produces AC instead of DC, no inverter is required.

HeatStorE looks unlike any other battery, but the system is deceptively simple. Electricity from PV or wind heats air up to 1000°C (1850°F) using electric resistance coils. This hot air is blown through an insulated container containing ordinary silica sand, which absorbs the heat and retains it for up to 20 hours. As needed, more air is blown through the storage container, heated, and then used to drive a special turbine to reconvert the heat to electricity.

This unique turbine is the first commercial turbine able to be driven entirely by atmospheric pressure hot air, without burning fuel. 247Solar took an off-the-shelf Capstone C200 turbine and added a proprietary ultra-high-temperature heat exchanger. Superheated air from the battery's thermal storage (or any other source above 850°C) is passed through this heat exchanger and transferred to compressed air inside the turbine. The resulting temperature and pressure are sufficient to drive the turbine without combustion, producing emissions-free electricity.

247Solar sees a wide range of applications for this technology in the marketplace. The foremost of these is as a replacement for diesel gensets in mines, microgrids and other off-grid applications. Even when coupled with short-duration lithium-ion batteries, PV and wind are capable of producing electricity, on average, perhaps 40 per cent of the time. Off-grid, when power is required around the clock, the difference is usually made up by diesel gensets, which pollute and are costly to fuel. With up to 20 hours of storage, HeatStorE can increase renewables penetration (the amount of time during which power is produced from renewable sources) to 80 per cent or higher.

In the inevitable case where both solar and wind power are unavailable and thermal storage is depleted (the remaining 20 per cent), HeatStorE's turbine can also burn a variety of fuels. With an optional external combustor that can burn natural gas, diesel or virtually any other liquid or gaseous fuel, HeatStorE can completely eliminate the need for backup gensets. Further, by burning clean fuels such as biofuels or green hydrogen, HeatStorE provides a realistic pathway to 100 per cent renewable penetration whenever such fuels are available.

This is particularly important, as it means the system offers 100 per cent, 24/7 dispatchability, even when the storage is completely discharged. This is an unusual feature for batteries and is especially valuable for smaller (<10 MW) grid or microgrid applications that experience wide fluctuations in demand.

In another application that is unique to HeatStorE, the system can also be used behind the meter in industrial settings to convert otherwise-wasted hot process exhaust to electricity.

As an added benefit for applications that require both heat and power (CHP), HeatStorE provides two useable exhaust streams: 250°C from the heat exchanger and 640°C from the turbine itself. Both can be harnessed for useful purposes like creating steam or to drive other high-temperature industrial processes. System efficiency is approximately 30 per cent for electricity alone and can rise as high as 80 per cent when both exhaust streams are used.

As an alternative to gensets, HeatStorE offers significantly lower operating and maintenance (O&M) costs. In addition to substantial fuel savings, it has few moving parts and it is built with proven, extremely reliable, low-maintenance components.

The chart shows an indicative comparison of a 1 MW hybrid microgrid involving PV, diesel gensets, and lithium-ion batteries in one instance, and PV and HeatStorE in the other. The difference in OPEX over a 20-year lifespan is dramatic.

Like conventional batteries, all HeatStorE components are factory produced, and promise rapidly decreasing costs with increased production volume as the systems are deployed worldwide. Except for the turbine and the core storage module, most other components can be manufactured in local markets for job creation and to meet domestic-content requirements.

Negotiations are currently underway in several countries to deploy HeatStorE in a wide variety of settings. These include several mines in Australia in collaboration with global PV and wind suppliers, an Australian microgrid to power a small town, multi-site rural electrification projects in Africa, and many others. 247Solar is currently constructing its first commercial demonstration plant at a company-owned site in Arizona, USA.

As a scalable long-duration storage solution that avoids the complexity and environmental drawbacks of electrochemical batteries, the market potential for HeatStorE is enormous. When added to PV or wind, it can provide the operational flexibility and resilience to make high-penetration renewable energy solutions viable for mines, community microgrids, off-grid villages or islands. With up to 20 hours duration, it allows for substantial grid-support and load shifting, enabling users to harness all the available renewable energy they can while the sun is shining or the wind is blowing, and to store it for use whenever it is needed.

*Mark von Keszycki is Director of Marketing and Communications at 247Solar.*

## Cost comparison: 247Solar microgrid with HeatStorE battery vs conventional microgrid

| **247Solar microgrid with HeatStoreE battery** | **Capex ($)** | **Operating life (yr)** | **Capex/yr ($)** | **Fuel cost ($/l)** | **Annual fuel cost ($)** | **O&M ($/kWh)** | **O&M ($/yr)** | **Total annual cost ($)** |
|---|---|---|---|---|---|---|---|---|
| HeatStorE battery, 1 MW/14 MWh | 3 072 000 | 20 | 153 600 | | | | | 153 600 |
| PV, 4 MW | 3 200 000 | 20 | 160 000 | | | | | 160 000 |
| Li-ion battery, 0.5 MWh | 300 000 | 10 | 30 000 | | | | | 30 000 |
| O&M | | | | | | 0.010 | 17 520 | 17 520 |
| Fuel, 1752 hr/yr | | | | 1.00 | 470 00 | | | 470 000 |
| **Total annual cost of ownership** | | | | | | | | **831 120** |

| **Conventional microgrid: Diesel + PV + Li-ion** | **Capex ($)** | **Operating life (yr)** | **Capex/yr ($)** | **Fuel cost ($/l)** | **Annual fuel cost ($)** | **O&M ($/kWh)** | **O&M ($/yr)** | **Total annual cost ($)** |
|---|---|---|---|---|---|---|---|---|
| Gensets, 1MW | 350 000 | 10 | 35 000 | | | | | 35 000 |
| PV, 1 MW | 800 000 | 20 | 40 000 | | | | | 40 000 |
| Li-ion battery, 1MWh | 600 00 | 10 | 60 000 | | | | | 60 000 |
| O&M | | | | | | 0.025 | 219 000 | 219 000 |
| Fuel, 7000 hr/yr | | | | 1.00 | 1 880 000 | | | 1 880 000 |
| **Total annual cost of ownership** | | | | | | | | **2 234 000** |

*Notes: assumes 1 MW load, 24/7. $=USD*

Junior Isles

# Rock stars wear green

It seems the discussion around hydrogen has moved on from whether it is just hype or the next rising rap or rock star, to what colour outfit it should wear on stage. In some things, colour appears to be all-important.

With the UK preparing to host the COP26 climate summit in November, the country has naturally garnered the attention of the energy sector and those that have a major role to play in tackling climate change. Last month, Britain's Prime Minister Boris Johnson released the UK's Hydrogen Strategy, viewed as a key part of the government's commitment to achieving net zero carbon emissions by 2050.

The government set out what it calls a "twin track approach" supporting both electrolytic 'green' and carbon capture-enabled 'blue' hydrogen production, alongside other potential production routes, which will enable the rapid growth of the sector while bringing down costs. "We outline a comprehensive roadmap for the development of the wider hydrogen economy over the 2020s to deliver our 2030, 5 GW ambition," it said.

But the twin track has split the industry. There are those that argue the UK should only invest in green hydrogen, i.e. hydrogen produced by the electrolysis of water using electricity from zero carbon energy sources. Others, however, note that this is expensive – green hydrogen is about 2-3 times more expensive than blue – and will take too long to become cost competitive. They therefore see a role, at least in the interim, for the production of blue hydrogen, i.e. hydrogen produced from steam reforming of natural gas combined with carbon capture and storage (CCS) to capture the carbon emissions from the process.

Serious doubt, however, was recently cast on even this interim role. Ahead of the launch of the UK strategy, researchers at Cornell University and Stanford University published a study, which claims that blue hydrogen could be 20 per cent worse for the climate than burning natural gas. The report concluded "there really is no role for blue hydrogen in a carbon-free future".

Robert Howarth, co-author of the study and Professor of Ecology and Environmental Biology at Cornell University, said the report is "a warning signal" to governments that "the only 'clean' hydrogen they should invest public funds in is truly net-zero, green hydrogen made from wind and solar energy".

In his 'Ten Point Plan' for a green industrial revolution issued earlier this year, Johnson announced a £240 million fund for government co-investment in production capacity through the Net Zero Hydrogen Fund (NZHF) – a hydrogen business model to bring through private sector investment – and plans for a revenue mechanism to provide funding for the business model. It is also supporting fuel switching to hydrogen in industry through the £315 million Industrial Energy Transformation Fund and £20 million Industrial Fuel Switching Competition.

Experts are concerned that much of the money will go towards blue hydrogen, thereby locking the country in to continued fossil fuel use.

Referencing the Cornell study just ahead of the government's strategy, Juliet Phillips, Senior Policy Advisor Clean Economy, E3G said: "A climate-safe future demands a rapid and steep reduction in greenhouse gases, but today's new report warns that fossil fuel derived blue hydrogen is far from a truly zero emissions fuel. There is no time left to waste in second-rate solutions to the climate emergency.

"Worryingly, the UK government has so far allocated around 75 per cent of public investments in hydrogen towards this fossil-based fuel. We encourage the UK government to rethink its risky strategy of pursuing a 'twin track' approach of supporting both blue and green hydrogen, and instead focus on becoming a global leader in green hydrogen sourced from renewables."

No doubt the twin track approach will be welcomed by the oil and gas sector, as blue hydrogen is a natural fit for their operations and helps secure a demand that is likely to falter as pressure to decarbonise deepens. Earlier this year Al Cook, Executive Vice President for development and production at Norway-based Equinor, notably said: "Green is the destination, but we'll get there on a blue highway. At some point, green hydrogen might well be lower cost than blue, but that will likely not be for at least a decade."

Such thinking, on the face of it, is not without merit. It would help governments ramp-up hydrogen infrastructure and projects, and inject real momentum to this fledgling, but growing, industry.

As Victoria Judd, Counsel at Pillsbury, put it: "By pursuing a 'twin track' approach for its hydrogen strategy and promoting the production of both blue and green hydrogen, the UK government could well resolve the chicken-and-egg scenario that threatens to potentially hobble the UK's nascent hydrogen industry. Currently, the supply of hydrogen is unlikely to rise until there is sufficient demand for the gas, but equally demand will remain low until supply rises. Stuck between a rock and a hard place, promoting the more abundant blue hydrogen alongside green will ensure the sector has the much needed scale to attract vital investment. The twin track sets us on the right path.

"Some may criticise the strong support for blue hydrogen as part of the hydrogen strategy. But, if hydrogen supply rises, and brings up demand, markets will be far more attractive to developers considering the green approach. We can consider this a run-up before our green hydrogen ambitions take flight."

This was essentially echoed by global engineering, architecture and consultancy company, Ramboll, although with caution. UK Energy Market Director John Mullen, commented: "What this strategy will finally deliver, and what is really needed, is the business assurance that investment in hydrogen infrastructure and technology is a good bet. There are also still distinct challenges to overcome and the 'twin track' approach will need to be closely monitored as blue hydrogen and carbon capture are incredibly inefficient processes at present and the only justification for their use is to allow for the transition to a green hydrogen world. Blue hydrogen could be used to support business cases to implement new hydrogen infrastructure, however the government needs to put a cap on the greenhouse gases produced and place a deadline for the end of all blue hydrogen production in the next 10 to 15 years."

Yet BloombergNEF estimates that already by 2030 green hydrogen is likely to be cheaper than blue hydrogen in all geographies. CCS technology is also a problem for blue hydrogen. Although around for decades, it remains expensive and challenging to operate, resulting in just 26 projects operational globally as of December last year.

Whether to focus on green hydrogen only – an approach that will take time and greater expense but is ultimately where we need to be – or stick with the twin track approach, which will move hydrogen along more quickly at lower cost but locks-in fossil fuel dependence, is a tough call.

But with the recent IPCC report highlighting that human-induced climate change is already causing many weather and climate extremes in every region across the globe, the choice should be clear. It is time to spare no expense or effort into taking the zero carbon pathway, where that alternative exists. In the same way that costs of solar, wind and batteries have fallen, and continue to do so, there is ample reason to believe the same can happen with green hydrogen.

In response to a previous column I wrote on hydrogen, a colleague said hydrogen was neither rap star nor rock star but "more like the talented pub band that has always demanded high fees, now enlarging its paying audience in a world of music lovers". Well that pub band just got bigger and more expensive – especially when dressed in green – but in the end the show will be worth it.


Cartoon: jemsoar.com