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Special Technology supplement

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Shell has accelerated its move into the utility sector with the acquisition of Limejump, a UK-based demand side aggregator.

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World Bank Group pushes offshore wind in emerging markets



In a drive to accelerate clean deployment efforts in developing countries, the World Bank Group and Global Wind Energy Council are working together to fast-track a growing pipeline of offshore wind projects. **Junior Isles**

The World Bank Group (WBG) is looking to accelerate the adoption of offshore wind energy in developing countries.

Under the new programme, the World Bank and sister organisation International Finance Corporation (IFC) will help emerging markets assess their offshore wind potential and provide technical assistance to develop a growing pipeline of projects that are ready for investment by renewable energy developers.

This work will be carried out in cooperation with the Global Wind Energy Council (GWEC) and its recently formed Offshore Wind Task Force, which brings together leading offshore wind developers, equipment manufacturers and service providers.

Led by the World Bank's Energy

Sector Management Assistance Programme (ESMAP), the \$5 million programme is being initiated thanks to a £20 million (\$26.4 million) grant to ESMAP from the United Kingdom government to help low- and middle-income countries implement environmentally sustainable energy solutions.

The initiative presents an important opportunity for countries with strong offshore wind resources, including Brazil, Indonesia, India, the Philippines, South Africa, Sri Lanka and Vietnam. Vietnam's technical potential for fixed and floating offshore wind is 309 GW, while South Africa and Brazil have 356 GW and 526 GW in total technical offshore wind potential, respectively.

The programme will bring together developing country governments,

commercial developers, development partners and wind energy experts to raise awareness around offshore wind opportunities in emerging markets and lay the groundwork for a pipeline of new projects that could be supported by World Bank or IFC financing. The World Bank and IFC will work with public and private sector partners to undertake technical studies and develop national strategies to facilitate the adoption of this increasingly cost-competitive technology.

According to the World Bank, offshore wind has grown nearly five-fold since 2011, with 23 GW installed at the end of 2018 and a large volume of planned projects in Europe, China and the United States. Offshore wind now represents about \$26 billion in annual investments or 8 per cent of

new global investments in clean energy and this proportion is set to increase dramatically, with about \$500 billion expected to be invested in offshore wind projects by 2030.

"Offshore wind has already made significant strides in markets such as Europe and China, but its true potential reaches far beyond these established areas," Ben Backwell, CEO at GWEC, said.

Riccardo Puliti, Senior Director and Head of Energy and Extractives at the World Bank added: "Offshore wind is a clean, reliable and secure source of energy with massive potential to transform the energy mix in countries that have great wind resources. We have seen it work in Europe – we can

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Carbon emissions reaches all-time high despite renewables growth

Rapid growth in wind and solar was not sufficient to prevent carbon dioxide emissions reaching a historic high in 2018, according to an International Energy Agency (IEA) report.

In its latest assessment of global energy consumption and energy-related CO₂ emissions for 2018, the IEA found that energy demand worldwide grew by 2.3 per cent last year, the fastest pace this decade, with fossil fuels meeting nearly 70 per cent of the growth for the second year running.

According to the 'Global Energy & CO₂ Status Report', the rapid growth in energy demand was driven by a robust global economy and stronger heating and cooling needs in some regions. Natural gas emerged as the fuel of choice, posting the biggest

gains and accounting for 45 per cent of the rise in energy consumption. Gas demand growth was especially strong in the United States and China.

Solar and wind generation grew at double-digit pace, with solar alone increasing by 31 per cent. This, however, was not fast enough to meet higher electricity demand around the world, which also drove up coal use.

As a result, global energy-related CO₂ emissions rose by 1.7 per cent to 33 Gt in 2018. Coal use in power generation alone surpassed 10 Gt, accounting for a third of the total increase. Most of that came from a young fleet of coal power plants in developing Asia. The majority of coal fired generation capacity today is found in Asia, with 12-year-old plants

on average, decades short of average lifetimes of around 50 years.

The report says electricity continues to position itself as the "fuel" of the future, with global electricity demand growing by 4 per cent in 2018 to more than 23 000 TWh. This rapid growth is pushing electricity towards a 20 per cent share in total final consumption of energy. Increasing power generation was responsible for half of the growth in primary energy demand.

Renewables were a major contributor to this power generation expansion, accounting for nearly half of electricity demand growth. China remains the leader in renewables, both for wind and solar, followed by Europe and the US.

Energy intensity improved by 1.3 per cent last year, just half the rate of the period between 2014-2016. This third consecutive year of slowdown was the result of weaker energy efficiency policy implementation and strong demand growth in more energy intensive economies.

Commenting on the findings, Dr Fatih Birol, the IEA's Executive Director, said: "Despite major growth in renewables, global emissions are still rising, demonstrating once again that more urgent action is needed on all fronts – developing all clean energy solutions, curbing emissions, improving efficiency, and spurring investments and innovation, including in carbon capture, utilisation and storage."

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now make use of global experience to scale up offshore wind projects in emerging markets.”

According to Navigant Research the world is expected to deploy more than 69 GW of new offshore wind power capacity in the period between 2018 and 2027.

It said the cumulative operational offshore wind capacity on a global level is anticipated to surpass 100 GW by 2030 as the industry is expanding “at a steady pace”, and takes hold of new markets thanks to continued technology cost reductions.

The global offshore wind market has grown by 0.5 per cent, with 4.49 GW of new capacity installed in 2018, the GWEC reported. According to its latest Global Wind Report, there is now 23 GW of offshore wind capacity installed, which represents a 20 per cent increase compared to the end of 2017.



Puliti: we can make use of global experience to scale up offshore wind projects in emerging markets

The main contributor was China with the installation of 1.8 GW of capacity, followed by the UK’s 1.3 GW and Germany’s 900 MW.

The total wind energy industry, combining both offshore and onshore, installed 51.3 GW of new capacity last year, a 3.6 per cent decrease compared to the 53.2 GW the year before. Total installed capacity reached 591 GW at the end of 2018, a 9.6 per cent growth compared to the end of 2017.

Backwell said: “2018 was a positive year for wind in all major markets, with China leading both onshore and offshore growth. We expect huge growth in Asia through the coming decade and beyond as part of the continuing shift from Europe to Asia as the driving region for wind development. However, government support and policy are key to enabling faster market growth in key regions such as South East Asia.”

GWEC believes that new installations will reach 55 GW or more each year until 2023 and the stable volume will come from mature regions in Europe and the US, while significant growth will be driven by developing markets in South East Asia and the global offshore market.

In a separate report, Wood Mackenzie Power & Renewables said it expects 723 GW of new global wind power capacity (offshore and onshore) from 2019 until 2028. It noted that 50.2 GW of new wind power was added globally in 2018 – a 4 per cent increase year-on-year and the third highest annual total on record.

The report also noted that aggressive renewables targets in India and explosive growth in the offshore sector are expected to drive a 10-year CAGR of 12.2 per cent in Asia Pacific, excluding China.

Green hydrogen becoming affordable alternative

The outlook for hydrogen as an energy carrier is looking increasingly promising, according to recent research. **Junior Isles**

Junior Isles

In a study undertaken by DNV GL, the economic feasibility of hydrogen as an energy carrier in the electricity sector will materialise between 2030 and 2050.

The research paper, ‘Hydrogen in the electricity value chain’, finds that the economically viable use of green hydrogen becomes feasible due to the increasing penetration of wind and solar power in the coming years.

Last year, in its ‘Energy Transition Outlook’, DNV GL forecast that solar PV, wind energy and hydropower will account for 80 per cent of global electricity production in 2050. As this capacity increases, opportunities to utilise its low-cost electricity are becoming feasible to avoid curtailment: initially conversion into heat then (daily) battery storage and eventually

conversion into green hydrogen.

The results provide an encouraging outlook for the acceleration of the energy transition, as hydrogen is a unique energy carrier with no carbon emissions that can complement electricity and accelerate the decarbonisation of industrial feedstock and heat, as well as providing long-term storage solutions.

“The prospect of delivering affordable hydrogen applications in the mid-term future provides a very encouraging signal to accelerate the global energy transition,” said Lucy Craig, Vice President of Technology and Innovation at DNV GL – Energy. “Our research demonstrates that green hydrogen provides an optimal use for surplus electricity, which we expect to see in the years to come due to the rapid rise of renewable energy. In combination with electrolysis, hydrogen proves to be an economically feasible

solution for the decarbonisation of the heat and storage sector.”

The report follows a separate study by economists at the Technical University of Munich (TUM), the University of Mannheim and Stanford University, who claim that hydrogen production based on wind power can be commercially viable today.

Gunther Glenk of the Chair of Management Accounting at TUM and Prof. Stefan Reichelstein, a researcher at the University of Mannheim and Stanford University, recently completed an analysis based on market conditions in Germany and Texas, USA, which demonstrates the feasibility of zero-emission and profitable hydrogen production.

The study, published in the journal *Nature Energy*, shows that one factor is essential in the current market environments in Germany and Texas: the concept requires facilities that can be

used both to feed power into the grid and to produce hydrogen. Such facilities, which are not yet widespread, must respond optimally to the wide fluctuations in wind power output and prices in power markets – with the operator deciding whether to sell the energy or convert it.

Depending on output levels, such facilities can already produce hydrogen at costs that are competitive with facilities that use fossil fuels, say the researchers.

“For medium and small-scale production, these facilities would already be profitable now,” said Reichelstein.

The economists predict that the process will also be competitive in large-scale production – for example in refineries and for ammonia production – by 2030, assuming that wind power and electrolyser costs maintain the downward trajectory seen in recent years.

Off-grid investment gathers pace

■ Nearly \$1.7 billion invested in energy access by end of 2018

■ Still short of financing needed for universal electricity access

Total annual investment in the off-grid energy access sector surpassed \$500 million in 2018, according to a new report from Wood Mackenzie Power & Renewables and Energy 4 Impact.

“Strategic investments in off-grid energy access: Scaling the utility of the future for the last mile” highlights the rapid acceleration in investment across the energy access sector. Nearly \$1.7 billion in cumulative disclosed investment was deployed into energy access markets by the end of 2018, with over \$1.2 billion deployed since the beginning of 2016.

In 2017, year-on-year transaction volume grew 37 per cent and total capital composition by volume shifted to over 50 per cent debt, signalling scale-up and further maturation of the sector. In 2018, total transaction volumes grew another 22 per cent year-on-year, and the average equity investments doubled and debt increased nearly 5.5 times.

Commenting on the new report,

Benjamin Attia, Wood Mackenzie Power & Renewables Analyst and lead author, said: “This emerging sector has seen a steep uptick in investments and partnerships from strategic groups within many of the oil and gas majors, European utilities and IPPs, clean energy OEMs, and the technology sector looking to capitalise on new opportunities in fast-growing emerging economies.”

Peter Weston, Energy 4 Impact Director of Programmes, said: “Strategic investors are playing an increasingly important role in the off-grid sector, attracted by the size and potential growth opportunities in the market. Most of the interest so far has been in pay-as-you-go solar home system companies, although there has also been some notable investments in mini-grids as well.”

The report noted, however that investment volumes “still fall well short” of the total estimated financing needed to reach universal electricity

access globally by 2030.

Attia also warned that an “investment cliff” could be looming in the short-term future of the sector, particularly for pay-as-you-go solar home systems.

“Capital concentration by company, technology, geography and business model, paired with aggressive growth expectations from VCs and few successful exits to date, leads to some outsized macro-level risks that may cause a dip in annual investment in 2019,” he said.

In February, a report by Bloomberg-NEF (BNEF) and commissioned by the Clean Technology Fund (CTF), a programme of the \$8.3 billion Climate Investment Funds (CIF), noted that cut-rate financing has the potential to substantially speed the transition from fossil fuelled power generation to renewable energy in developing countries.

The BNEF and CTF report, ‘Clean Technology Fund and Concessional

Finance: Lessons Learned and Strategies Moving Forward’, quantifies for the first time how much reduced-price cash can lower the levelised cost of energy for different clean energy technologies in specific countries.

Last month the President of the African Development Bank (AfDB) said renewable energy, particularly solar power, is the key to driving economic development in Africa and combating climate change.

Whilst committing to \$25 billion in new climate financing between 2020 and 2025, Akinwumi Adesina said: “Africa has 11 terawatts of solar power potential: that’s the largest we find anywhere in the world.”

The AfDB also launched a new facility to provide concessional finance to projects that can help countries to deliver base load power with renewable energy sources. Many countries still rely on fossil fuels to provide the base load power required to run the grid.

EU boosts clean technology innovation with €10 billion funding

The European Commission says it will invest more than €10 billion to boost global competitiveness of low carbon technologies across several sectors.

The Innovation Fund is aimed at creating the right financial incentives for companies and public authorities to invest now in the next generation of low-carbon technologies and to give EU companies a first-mover advantage to become global technology leaders.

The Innovation Fund builds on the

experience from the EU’s NER300 programme, the current programme to support the demonstration of carbon capture and storage and renewable energy technologies.

The fund will offer grants to cover up to 60 per cent of the additional capital and operational costs linked to innovation for the selected projects, disbursing the money in a flexible way based on the needs of each individual project.

The fund will pool together resources amounting to around €10 billion,

depending on the carbon price. The Commission aims to launch the first call for proposals under the Innovation Fund in 2020, followed by regular calls until 2030.

Commissioner for Climate Action and Energy Miguel Arias Cañete said: “Less than three months after adopting our strategic vision for a climate neutral Europe by 2050, we are putting the money where the mouth is.

“Our objective is to keep building a modern, competitive and socially fair Paris-aligned economy for all Euro-

peans. For this to happen, we will need deployment of clean innovative technologies on an industrial scale.

“This is why we are investing in bringing to the market highly innovative technologies in energy intensive industries, in carbon capture, storage and use, in the renewable energy sector and in energy storage.

“We are today unleashing technological solutions in all Member States and pressing the fast-forward button in our transition to a modern and climate-neutral society in Europe.”



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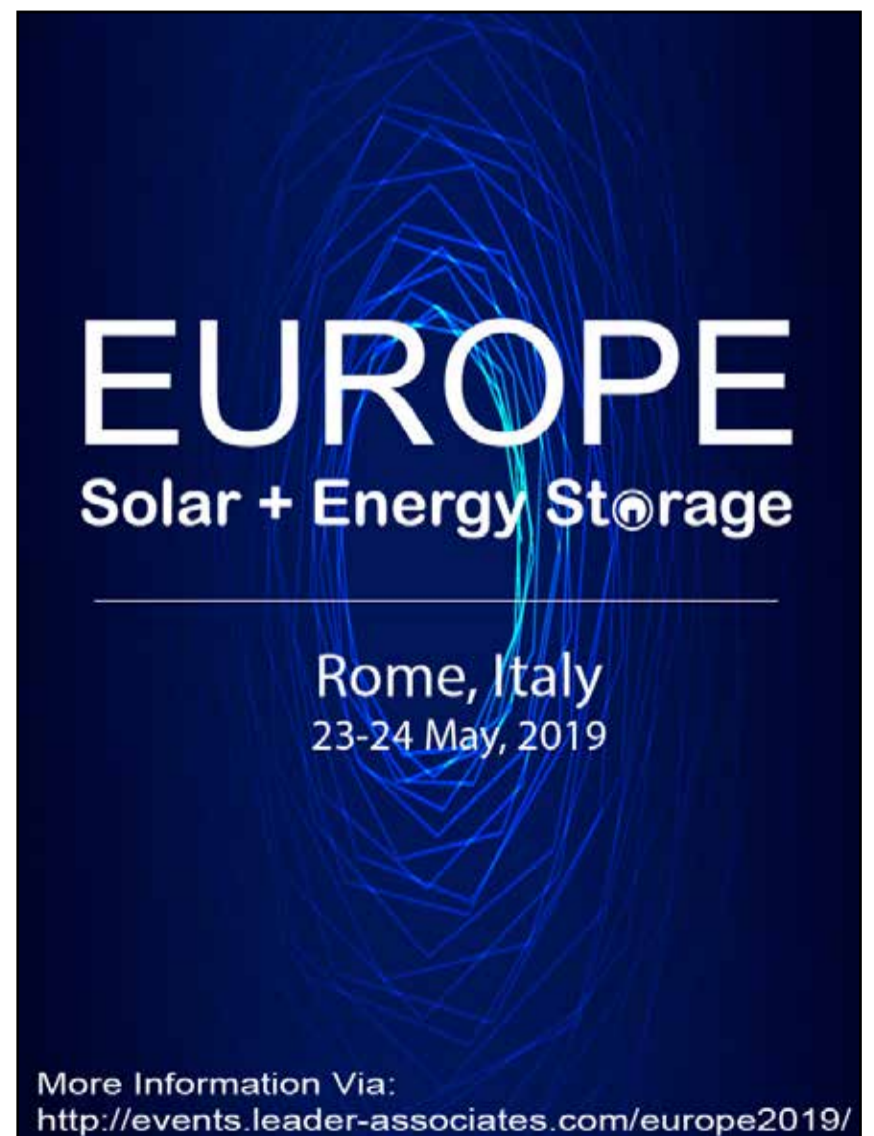
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NB Power outlines green grid ambition

■ World's first hydrogen grid ■ 30 hydrogen stations proposed

Siân Crampsie

Canada could play host to the world's first hydrogen-based green electricity grid thanks to plans outlined by energy company New Brunswick Power.

NB Power has teamed up with Joi Scientific to develop an electricity system that uses hydrogen as its baseload by drawing on seawater resources and energy from wind, hydropower

and nuclear power plants.

The two companies say they will deploy Joi Scientific's proprietary Hydrogen 2.0 production system at multiple distributed stations alongside wind turbines, hydro, and nuclear power to generate hydrogen from untreated seawater.

New Brunswick could see up to 30 production stations deployed for zero-carbon baseload generation, NB

Power added.

"Hydrogen 2.0 has the potential to provide a localised, on-demand hydrogen production capability which, when mixed with other renewable sources such as wind and hydro, gets us closer to our customers by delivering zero-carbon loads at lower cost and greater efficiency," said Gaëtan Thomas, President and CEO, NB Power.

The proposed project follows the

successful third-party verifications of Hydrogen 2.0 technology efficiency and throughput by scientific institutions and experts. Both companies are planning to work closely together to co-develop and test a commercial prototype unit at Joi Scientific's labs at the Kennedy Space Center.

"This historic agreement with NB Power signals the transition of our Hydrogen 2.0 technology from the

laboratory into full-scale development and commercialisation," said Traver Kennedy, CEO, Joi Scientific. "New Brunswick is a prime example of what can be achieved by a far-sighted, ecologically-minded institution. Their innovative approach for realising a new zero-carbon distributed grid architecture could provide the blueprint for the way the world generates and consumes electricity going forward."

Costa Rica plans total decarbonisation



President Carlos Alvarado Quesada says Costa Rica must be among the first countries to achieve decarbonisation

Costa Rica has received international praise for its plans to decarbonise its economy by 2050.

UNFCCC Executive Secretary Patricia Espinosa congratulated the country for its "ambitious decarbonisation plan" and said that Costa Rica's leadership was "fundamental" to the fight against climate change.

The decarbonisation plan could make the Central American country one of the first in the world to become zero-emission. The plan includes short term goals to 2022 as well as longer-term targets to 2050.

"Decarbonisation is the great challenge of our generation and Costa Rica must be among the first countries to achieve it, if not the first," said Costa

Rican President, Carlos Alvarado Quesada on February 24 during the presentation of the 2018-2050 National Decarbonisation Plan in the capital, San José.

The plan is based around ensuring the national electricity grid is capable of operating with 100 per cent renewable energy by 2030, and making 70 per cent of buses and taxis zero-emissions by 2030 and 100 per cent by 2050. It has identified roadmaps for each sector of the economy and outlined policy packages to be deployed to 2050.

To combat the problem of deforestation, the plan also includes a goal to ensure that the rainforest makes up 60 per cent of Costa Rica's land cover.

Costa Rica will incorporate these measures in its new national climate action plan to be presented to the UNFCCC by 2020.

"I congratulate Costa Rica for its leadership and permanent commitment to the environment," said Michelle Bachelet, United Nations High Commissioner for Human Rights. "It is a new sign of the will of Costa Rica to fulfill its commitments under the Paris Agreement and the Sustainable Agenda 2030."

"The launch of this National Plan makes Costa Rica one of the first countries in the world in promoting an initiative of this magnitude, we know that it will be an example to follow for all countries."

NY reveals storage incentives

New York state is keeping its energy storage targets on track with the unveiling of a proposed package of incentives to boost deployment of the technology.

The New York State Energy and Research Development Authority (NYSERDA) has released an energy storage implementation plan aimed at helping the US state to reach 3000 MW of energy storage by 2030.

The implementation plan targets retail and bulk energy storage deployment. It proposes a \$130 million budget for behind-the-meter or small-scale storage projects up to 5 MW in size, and a \$150 million budget for projects exceeding 5 MW in size that are connected directly into the transmission, sub-transmission or distribution systems.

A further \$70 million will be allocated toward "opportunities that have the greatest potential to build a self-sustaining storage market", and \$53 million in Regional Greenhouse Gas Initiative (RGGI) funds will be used for retail and bulk storage deployment incentives on Long Island.

NYSERDA expects to kick off its retail and bulk incentive programmes in the second quarter of 2019. It has also published a storage system guide-

book designed to help local governments and developers navigate the siting and review processes for the development of battery energy storage projects.

NYSERDA said that the guidebook would be a "critical tool" for ensuring the safe deployment of battery storage technology and includes information on legislation, permitting plans and inspections.

The proposed incentives programme will be based around payments per installed kWh, with incentive levels projected to decline as deployment increases and costs fall. In 2019, projects over 20 MW in size will be offered \$85 per installed kWh, while projects rated at 5-20 MW will receive \$110/kWh.

CellCube has signed an agreement with an unnamed, US-based energy asset development company to develop up to 100 MW of energy storage systems for deployment throughout the USA. The energy storage systems will be placed as stand alone plants or co-located with solar to offer power market traded energy supply and ancillary services products. Deployment will take place over the next 24-36 months.



US solar sector expects strong growth

The solar energy industry in the USA remains optimistic about growth prospects in spite of a slight drop-off in business in 2018.

The USA installed 10.6 GW of solar photovoltaic (PV) capacity in 2018, a 2 per cent decline on installations in 2017, according to a new report from Wood Mackenzie Power & Renewables and the Solar Energy Industries Association (SEIA).

The slight decline was due to tariffs imposed on solar cell imports, according to SEIA. However, the organisation is expecting solar capacity additions to remain on track.

"The solar industry experienced growing pains in 2018, in large part due to the unnecessary tariffs that were imposed on solar cells and modules, but this report still finds significant reason for optimism," said SEIA's president and CEO, Abigail

Ross Hopper. "The total amount of solar installed in America is on track to more than double in the next five years, proving solar's resiliency and its economic strength. It's clear, this next decade is going to be one of significant growth."

Overall, in 2018, solar PV accounted for 29 per cent of new electricity generating capacity additions, a lower share compared to 2017 due to a surge in new natural gas fired powerplants in early 2018. SEIA is expecting the total installed PV capacity in the US to rise by 14 per cent in 2019, and annual installations to reach 15.8 GW in 2021.

In 2018, non-residential PV saw an annual decline of eight per cent due to policy transitions in major markets, according to Wood Mackenzie. Utility-scale solar underwent a seven per cent contraction in 2018, largely

related to Section 201 tariffs.

However, in 2018, 13.2 GW of utility-scale solar power purchase agreements were signed, pushing the contracted project pipeline to its highest point in the history of US solar.

Wood Mackenzie also increased its five-year forecast for utility PV by 2.3 GW since Q4 2018. This was the result of a large volume of project announcements, the inclusion of more solar in long-term utility resource planning and an increase in project development driven by renewable portfolio standards and growing corporate interest.

While annual growth fell in both the non-residential and utility-scale solar sectors, residential solar growth stabilised in 2018 after the previous year's contraction. The US residential solar market has now seen five consecutive quarters of modest growth.

Key role for hydro in India's clean energy expansion

■ Hydro projects above 25 MW now part of non-solar RPO ■ US deal signed for six nuclear plants

Syed Ali

Large hydropower plants (HPPs) will become part of the non-solar Renewable Purchase Obligation (RPO) in India, as the government moves to support the expansion of hydropower generation and clean energy in the country.

In March the Union Cabinet gave the thumbs-up to a number of measures that would allow India to take advantage of its significant hydropower potential, estimated at 145.3 GW. Only 45.4 GW of this has been tapped so far. One of the measures includes the classification of large hydro as renewable energy – until now this was reserved only for projects of up to 25 MW.

It is not yet clear how the RPO scheme would change in order to include large hydropower. Indian consultancy RE-Connect Energy, said: "This change will prove complex to implement and

may meet with resistance from many states. One option available would be to just incorporate large hydro in the existing Non-solar RPO. However, this will put a strong negative pressure on REC [renewable energy certificate] prices and future non-solar (primarily wind) capacity addition."

Following the decision, state-owned hydropower producer NHPC (National Hydroelectric Power Corporation) announced plans to raise its installed power generation capacity by approximately 30 per cent by 2022 to reach a total of 10 GW. The company plans to spend Rs38 billion (\$544 million) for the fiscal year to March 2020 as a first step to reach this objective.

News to include large hydro as part of the non-solar RPO comes as the country saw a slowdown in growth of wind capacity additions. At the start of March, Crisil Research said a shift to a competitive bidding mechanism has slowed industry growth due to a

significant fall in tariffs, triggering a decline in both bid response and profitability for original equipment manufacturers (OEMs).

The company added that the wind energy sector is likely to see a slow growth with regard to capacity additions over the next five years.

It said in a statement that capacity additions are expected to rise by 14-16 GW over fiscal 2019 to 2023, entailing investments of Rs1100 billion (\$16 billion). New capacity will mainly be driven by central government allocations with relatively stronger counter parties like Solar Energy Corporation of India (SECI) and PTC India (formerly known as Power Trading Corporation of India), reducing risk as compared to direct exposure to state distribution companies.

State auctioning, on the other hand, has slowed as several states have signed power supply agreements (PSAs) with PTC and SECI to procure

wind power under the schemes auctioned by them, to help fulfil their non-solar renewable purchase obligations targets.

Crisil also said that moving to a competitive bidding mechanism sector has caused a slowdown in additions, as participants are yet to adjust, with tariffs having fallen to Rs2.4-2.6 per unit, from Rs4-4.5 per unit under the feed-in-tariff regime.

India has been taking significant action to boost its clean energy and recently signed a major deal with the US to build six nuclear power plants.

The agreement came after the ninth round of India-US Strategic Security Dialogue in March. A statement issued by the Ministry of External Affairs (MEA) said: "They committed to strengthening bilateral security and civil nuclear cooperation, including the establishment of six US nuclear power plants in India."

The statement seeks to breathe new

life into the civil nuclear cooperation agreement between the two countries, which has failed to live up to expectations since it was signed in 2008.

A law limiting civil liability for nuclear damages from the plants passed in 2010 was meant to overcome a stumbling block for US companies looking to set up nuclear power plants in India.

However, financial problems at US company Westinghouse, which had agreed in 2016 to build six plants in Andhra Pradesh, put the plans on hold when it went into bankruptcy in 2017.

Now owned by Brookfield Asset Management, Westinghouse has received the backing of the Trump administration for the project and US Energy Secretary Rick Perry promoted it during a visit to India last year.

India has ambitious plans to increase its nuclear electric generation capacity to meet its growing needs with clean energy.

Bangladesh moves to attract energy investment



Bangladesh is planning to raise \$2 billion through issuing bonds to bankroll investment in the power and energy sector, according to State Minister for Power, Energy and Mineral resources, Nasrul Hamid.

"I am trying to float an energy power bond at least for \$2 billion," he said. "Two things we will get from there: finance; and branding Bangladesh as an investment destination. If I become successful in raising \$2 billion, albeit a small amount given what we need in the power and energy sector, the whole world will be eager to invest in the country."

The country is already beginning to prove an attractive destination for overseas investors. In late February, Arab Investment Development Authority (AIDA) committed \$5 billion of investment to develop 5 GW of solar power plants in cooperation with Almaden Emirates Fortune Power (AEFP) and Bangladesh-based Intraco Solar Power (ISP).

The solar power project along with the manufacturing facility, which is to be completed within the next 6-8 years,

will be powered by a total of 14 million solar panels, making it the largest solar power plant investment in Bangladesh.

Commenting on the project, Adil Al Otaiba, Chairman of AIDA, said: "The project is likely to reduce power costs by billions as well as create jobs for both the power plants and the proposed solar manufacturing facility based on an annual 500 MW capacity. The development will reach its maximum capacity by 2030, in line with the expectations of the government of Bangladesh."

Safa Capital Limited (SCL) a company regulated by Dubai Financial Services Authority, is the lead financial advisor and arranger for the project.

■ In mid-March the government signed five separate contracts with Summit Corporation Limited and GE Consortium for constructing a combined cycle power plant at Meghnaghat, Narayanganj with a power generating capacity of 583 MW. According to sources at Power and Energy Ministry, Summit and GE are scheduled to complete the power plant by March 2022.



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Vietnam must manage “discontinuous power resources”

Generation from renewable sources is on the rise. This will present challenges in the coming years according to the US Agency for International Development. **Syed Ali**

Vietnam's challenge in the next 5-10 years is managing “discontinuous power resources” and transmission systems to bring power to areas in demand, according to Christopher Abrams, Director of the US Agency for International Development (USAID)'s Environment and Social Development Office.

In a recent interview with *Vietnam News Agency*, Abrams said Vietnam and other countries have recognised that clean and renewable energy is the future of the energy sector. With annual economic growth of 6-7 per cent, Vietnam's energy demand will increase by 10-11 per cent between now and 2030.

The capacity of the domestic power sector is about 40 GW annually. As of this June, the country will have nearly 2000 MW of solar power, a figure that has surged some 2000 per cent over the past three years.

This will, however create challenges. He said the interactions between rooftop solar power and the national grid, power purchase prices and taxes need to be clarified, adding that the USAID is assisting the Ministry of Industry and Trade (MOIT) and the Vietnam Electricity on the issue.

Vietnam is adding increasing amounts of renewable generation to the grid. Notably the country's biggest renewable energy project – including solar and wind power plants with total capacity of 350 MW – will be put into operation in the coastal province of Ninh Thuận on April 30.

Meanwhile, construction of the LIG-Quang Tri Solar Power Plant (LIG-QTSPP) in the central province of Quang Tri is near completion, with the plant expected to be put into operation in June.

In March the People's Committee of the southern coastal province of Ba

Ria-Vung Tau gave the green light to two companies to build two solar power plants with a total investment of more than 1.5 trillion VND (\$64.66 million) in the province.

USAID is assisting with the development of the country's power Master Plan, which will be announced in the near future. The Plan will devise measures to enhance the use of both renewable and thermal power, the development of wholesale and auction markets, and promote public-private partnerships for building transmission systems.

Although the government is increasing its renewable energy capacity, Vietnam's power industry is forecast to see a rise in coal powered generation as the cheap and reliable source remains the most feasible option to meet the country's rapidly rising power demands.

Yoel Sano, Head of Global Political and Security Risk of Fitch Group's

Fitch Solutions Macro Research, recently said Vietnam's coal fired generation growth is expected to increase rapidly over the next decade and dominate the country's power sector expansion.

“While the government also intends to increase LNG imports and non-hydro renewable energy generation capacity, coal would remain the more attractive option over the next decade as it is cheaper and more reliable at present. As such, we forecast that coal generation will reach 50.5 per cent of the total consumption power mix by 2028, with gas at 22.5 per cent, hydropower at 22.8 per cent and non-hydro renewables at 3.8 per cent,” Sano said.

In addition to pooling domestic resources to develop renewable energy, USAID also suggested Vietnam should import natural gas to increase its supply in the future.

This will help power the various projects that have been undertaken in recent years, as well as those currently on the drawing board.

Just last month Le Van Luc, Deputy Head of the Ministry of Industry and Trade's department of electricity and renewable energy, announced that a \$3.3 billion gas fired power plant will be built in the central Quang Ngai Province and will go on stream in 2023.

The project will have three 750 MW gas turbine blocks and space for a fourth if needed. Luc said the plant would use gas from the Blue Whale field in the South China Sea, known as the East Sea in Vietnam.

The World Bank has estimated Vietnam's electricity demand to grow by around 8 per cent a year for the next decade and said it would need to invest \$150 billion by 2030 to develop its energy sector.

Indonesia attempts to accelerate electrification

State-owned electricity company PLN plans to issue global bonds worth \$1.5 billion in an effort to accelerate electrification and the development of more power plants.

“We plan to realise the plan in middle of this year,” said PLN finance director Sarwono Sudarto speaking in Jakarta last month.

He said the proceeds from the global bond issuance would be used to finance the 35 000 MW electricity

programme launched in 2015, as well as to expand the power transmission infrastructure.

Energy and Mineral Resources Ministry Electricity Director General Andy N Sommeng said that as of December 2018, from the 35 000 MW programme, 2899 MW was now in commercial operation. This had reached 3009 MW as of January 15th. Projects that can produce a further 18 207 MW are still under construction.

Despite the slow pace of development, the government remains optimistic with regards to the 35 GW programme.

Director of supervision for electricity programmes Jisman Hutajulu at the Energy and Mineral Resources Ministry said that most projects had finalised power purchase agreements (PPAs) with state-owned electricity company PLN and third parties.

“The amount seems meagre, but if we look closely at the projects, 93.37 per cent have finalised PPAs. Only 6.63 per cent [of the projects] have not finalised an agreement,” Jisman said during a public briefing on the 2019-2028 Electricity Procurement Business Plan (RUPTL).

In late February, however, the Energy and Mineral Resources Ministry announced a downward revision of its electricity procurement target due to an unexpected slowdown in the growth of electricity demand.

In the 2019-2028 RUPTL, the projected growth of electricity demand is set at 6.42 per cent annually, down from 6.86 per cent in the 2016-2025 RUPTL. The ministry therefore also revised down its targets for the construction of electricity transmission networks, substations, distribution networks and



distribution stations.

Under the new RUPTL, the targeted contribution of renewable energy to overall electricity production increased to 16.7 GW from 14.9 GW in the previous RUPTL, he said, adding that the targeted installed capacity of

all power plants was 56 395 MW.

Another significant change was that the new RUPTL allowed for the construction of renewable energy and gas-powered plants to proceed without the projects being included in the annually revised RUPTL.

Japan releases results of V2G experiment

Mitsubishi Motors has released results of a ‘Vehicle-to-Grid’ (V2G) experiment undertaken by seven Japanese companies.

The results released to the Ministry of Economy, Trade and Industry, offer insights to a demonstration that has been ongoing since June 2018.

The demonstration – jointly carried out by Tokyo Electric Power Company Holdings, Inc., Tepco Energy Partner, Inc., Tepco Power Grid, Inc., Hitachi Systems Power Services, Ltd., Mitsubishi Motors Corporation, Shizuoka Gas Co., Ltd. and Hitachi Solutions, Ltd. – is believed to be the largest experiment that enables a two-way

power exchange between electric vehicles (EV/PHEV) and a power grid.

The experiment confirmed that congestion can be managed (current control) by the output control of EV/PHEV power stations (EVPS) according to control commands.

In a press statement Mitsubishi Motor said: “In fact, since EVPS can be controlled and tracked on a second-by-second basis, we believe that output control can be realised in a matter of seconds in the near future even in remote areas through combination with high-speed communications networks.”

“It was also confirmed that voltage

control (reactive power control) can give output responses as signalled by control commands in the same manner as grid congestion management (current control).

“By leveraging EV/PHEV to improve power grid stability technology we can further promote the spread of naturally fluctuating power sources, such as solar energy, etc., and contribute to the flexible operation of power grids.”

All seven companies will continue their research on V2G-related technology and strive to create a business model aimed at the practical application of V2G aggregators.



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Europe News

Netherlands assessing zero subsidy offshore bids

The Netherlands is reviewing several bids submitted by companies willing to develop the Hollandse Kust Zuid 3 & 4 offshore wind farms without a government subsidy.

The Dutch Enterprise Agency (RVO) says it is reviewing the technical and financial feasibility of several bids submitted for the construction of the Hollandse Kust Zuid 3 & 4 offshore wind farms.

RVO last month held an auction for the two zones in the Dutch North Sea, inviting bids from companies willing to develop wind farms without a government subsidy. Danish giant Ørsted and a consortium led by Shell both confirmed that they had tendered bids in the auction.

The Hollandse Kust Zuid wind farm

could have a capacity of up to 760 MW. As part of its proposal, Ørsted said it had already taken the final investment decision on the project, and is working to establish green hydrogen projects associated with the wind farm.

Henrik Poulsen, CEO and President of Ørsted, said: "We're strongly committed to the Netherlands, and we believe that our bid for Holland Coast South 3&4 offers significant benefits for the Dutch society in terms of clean and cost-competitive energy as well as industrial development."

Ørsted says it will use energy from

its offshore wind farms to produce hydrogen for use in other sectors of the economy. The move would help the Netherlands to accelerate its decarbonisation as well as stabilise revenues from offshore wind farms, it said.

"As a strong sign of our commitment, the Board of Directors of Ørsted has already approved the final investment decision for Hollandse Kust Zuid 3 & 4," said Martin Neubert, VP and CEO of Ørsted Offshore. "The funding is secured and guaranteed on our balance sheet, so if the Dutch gov-

ernment selects Ørsted, they can be certain that the wind farm will be built."

RVO has received bids from the Witwind consortium, comprising Shell, Eneco and Van Oord, as well as Vattenfall.

Vattenfall won the bidding in 2018 to develop the 700 MW Hollandse Kust Zuid 1&2 zones.

Ørsted is already engaged in the Dutch offshore wind market, having won the 752 MW Borssele 1&2 project tender in 2016. It will be Holland's largest offshore wind farm when it is

completed in late 2020-2021.

The Hollandse Kust Zuid 3 & 4 auction is the fifth call for tenders for offshore wind energy in the Netherlands. The winning bidder will receive a 30-year permit to build and operate the wind farm.

Construction of the offshore wind farms in the Borssele wind farm zone will start at the end of 2019. TenneT is currently installing the offshore electricity grid.

The Netherlands is aiming to install 11.5 GW of offshore wind capacity in the North Sea by 2030.

Finland moves to phase out coal

- Parliament approves government plans for 2029 closure
- Nuon plant to shut this year



Finland will cease to use coal for energy production in 2029 after the country's parliament gave the nod to government proposals drawn up in 2018.

The move makes Finland the latest country to phase out the use of coal in the energy sector to combat greenhouse gas emissions.

Under the government's plans, coal will be banned for use as an energy source – except in emergencies – from 1 May 2029. The country's approximately 1 GW of coal fired generating capacity will have to cease operations by that date.

Coal accounts for around 14 per cent of power generation in Finland and eight per cent of energy consumption. Greenhouse gases in the country are on the rise, however, growing six per cent in 2017.

Costs associated with coal plant shutdowns will be supported through a large-scale subsidy scheme. Finland has unveiled legislation for a carbon tax and the government is pushing for a startup of that scheme in 2019, according to reports.

Several European countries are aiming to phase out coal use over the coming few years to help reduce carbon emissions.

Last month the government of the Netherlands announced plans to retire Nuon's 650 MW Hemweg-8 hard coal fired unit by the end of 2019, five years earlier than originally planned.

The decision comes in the wake of the 2018 court order instructing the government to make sure greenhouse gas (GHG) emissions are reduced by at least 25 per cent by the end of 2020 from 1990 levels.

In May 2018, the Dutch government confirmed plans to shut down the country's remaining five coal fired power plants by 2030 at the latest.

Under the plans, Nuon's Hemweg-8 unit and RWE's 600 MW Amercentrale coal fired power plant, which have been in operation since 1994, will be the first to be shut down, by 2020 and 2024, respectively.

Three more units – RWE's two-unit 1560 MW Eemshaven power plant and Uniper's 1100 MW Maasvlakte-3 unit, which were commissioned in 2015 and 2016 – will have to stop operations by the end of 2029.

RWE is challenging the coal phase-out policy, claiming that it invested €3.2 billion in its newest plants at the request of the government, which will not offer any compensation for the closure.

Romania outlines energy sector investment needs

Romania needs to invest €15-30 billion by 2030 to revive its ageing and outdated energy sector, the country's government has warned.

The country has published a draft energy strategy, highlighting the state and investment needs of its power generation, oil and gas and mining sectors.

The draft energy strategy expects power generation to increase from 63 TWh in 2017 to 77 TWh in 2030 and 86 TWh in 2050, and notes that even more investment will be required

beyond 2030 to meet the demands of growing energy consumption.

Romania's 25 GW of installed generating capacity is at least 30-40 years old and requires upgrading or replacing. Proposed projects include the construction of two nuclear units at Cernavoda and a €1 billion hydro-power plant.

There are also plans to invest in smart grid and metering infrastructure and in expanding gas and power interconnections.

EMEC leads new floating wind farm demo

Plans for Ireland's first floating offshore wind farm demonstration project have been revealed by a European consortium.

The European Marine Energy Centre (EMEC) says that it has secured €31 million of funding for the project, which will see a single floating turbine installed at a test site off the west coast of Ireland by 2022.

EMEC says that it will work in partnership with the Sustainable Energy Authority of Ireland (SEAI), Italian engineering firm SAPIEM and other organisations from France, Germany, Ireland, the Netherlands and the UK on the project.

The project will use a full-size wind turbine installed on a SAIPEM-made floating foundation off the coast of Belmullet, County Mayo. The project will demonstrate the survivability and cost-competitiveness of a floating offshore wind technology, as well as support the development of an active supply chain in the region.

The west coast of Ireland has some of the world's best wind and ocean energy resources, EMEC said. The project – dubbed AFLOWT (Accelerating market uptake of Floating Offshore Wind Technology) – has secured funding from Interreg North West Europe.

"Almost one third of Ireland's electricity currently comes from renewables, with wind being the highest

contributor," said Ireland's Minister for Communications, Climate Action and Environment, Richard Bruton T.D.

"However, we need to step up our ambition in this area and stretch ourselves further. I welcome this project as an excellent opportunity to further explore the potential of offshore wind."

EMEC said that the demonstration would enable it to continue its work with SEAI on development of offshore test sites in Ireland over the past four years. "If floating offshore wind technology can operate reliably and efficiently on the west coast of Ireland, it will work anywhere. Through this project we hope that the successful technology demonstrations will fundamentally expand the global offshore wind market," said Oliver Wragg, Commercial Director at EMEC.

Several floating offshore wind farm demonstrations are due to start operating in Europe over the next three years, including Kincardine in Scotland, WindFloat Atlantic in Portugal, and four projects off the coast of France.

In February the European Commission gave the green light to state support for the four 24 MW projects in France, which will use different combinations of floating foundation, turbine and cable technologies. One project is located in the Atlantic Ocean while the remaining three will be in the Mediterranean Sea.

South Africa faces power shortages once more

Eskom has embarked on a new turnaround plan in a bid to overcome severe operational challenges.

Siân Crampsie

South Africa's economy is suffering in the country's latest round of load shedding events.

The country's state-owned utility, Eskom, has been implementing its load shedding programme for much of the last two months to overcome energy supply challenges and prevent uncontrolled blackouts.

The situation is having a major impact on the country's economy as well as a wider impact on neighbouring countries.

Botswana Power Company said last month that it had received power alerts from Eskom and that some towns situated along the border with South

Africa that are directly supplied by Eskom were affected.

Meanwhile in Uganda legislators have called for contracts with Eskom to be terminated.

Eskom holds 20-year concessions to manage the 200 MW Kiira and 180 MW Nalubaale power stations in Botswana. Under the contracts it is due to invest \$100 million into the assets but has so far only invested one-quarter of that.

Eskom's current troubles have been caused by repeated faults at its fleet of conventional power plants, including newly commissioned units at Kusile, a 4.8 GW power plant under construction in Mpumalanga Province.

Over the course of February and

March Eskom has implemented load shedding up to stage four of its programme, where it is able to meet only 80 per cent of the country's demand. The utility has warned that the risk of continuing supply shortages remains high.

Last month Eskom's Deputy President David Mabuza told Members of Parliament that the company has developed a detailed turnaround plan to address its challenges.

The plan centres around improving efficiencies and reducing costs, and includes measures such as optimising primary energy costs, refining capital efficiency, driving cost efficiency in procurement, and growing revenue with pricing incentives.

Eskom says that its operational problems have been caused by the growth of the population and the extension of supply to all South Africans, as well as governance, financial and operational challenges within the company.

Funding constraints have been a particular challenge, according to Mabuza, affecting the company's ability to fund critical power plant maintenance. More than half of Eskom's fleet is over 37 years old, the firm said.

The South African government has allocated R23 billion (\$1.37 billion) per year for the next three years to help Eskom execute its turnaround plan. "This turnaround plan will address the immediate plant performance and coal quality challenges

restoring the security of supply, and this will lay the foundation for addressing both the financial and operational sustainability," Mabuza told parliament. He added that an independent technical review team has also been appointed to review the plan and evaluate the state of power stations.

Eskom has asked South Africa's regulator to approve double-digit tariff hikes to help improve its financial position but the regulator told Eskom in March that a maximum 7.5 per cent per year would be allowed.

Eskom is saddled with around R420 billion of debt and its current position is likely to be a major point of debate for politicians in South Africa's upcoming elections in May.

Ukraine boosts wind sector

- 900 MW wind pipeline taking shape
- DTEK finances Prymorska phase 2



Siân Crampsie

Ukraine will add around 300 MW of new wind energy capacity in 2019, double the amount added in 2018, according to the country's wind energy association.

UWEA reported last month that two 50 MW wind farms are currently being built by Wind Parks of Ukraine LLC in Mykolaiv and Donetsk regions. The

DTEK Group is building the first phase of the Prymorska Wind Farm in Zaporizhia region, expected to be completed in the first half of the year, as well as the Orlovka wind farm.

In addition, Windkraft Ukraine is completing the construction of the 70 MW Overianivka wind farm, and the company is starting construction of a 163 MW Myrne wind farm.

UWEA has also reported that the

project pipeline in Ukraine stands at almost 900 MW, including the 250 MW Syvash wind farm. Most of this capacity will be brought on line by 2021.

In February DTEK Renewables said that it had sealed a \$102.6 million finance deal from commercial banks in Germany for the construction of the second stage of the Prymorsk wind farm.

Acwa targets Egypt for investments



Saudi Arabian firm Acwa Power says that the investment climate in Egypt has improved thanks to the New Investment Law and moves by the government to introduce energy subsidy cuts.

The company has reportedly signed an agreement with the Egyptian government to build a 2250 MW power plant in Luxor at a cost of \$2.5 billion, and is also waiting for final approvals for the construction of 500 MW of wind energy capacity in the Ras Ghareb area in eastern Egypt.

Acwa Power said it is also due to finalise three projects, valued at \$200 million and with a total capacity of 160 MW, at Benban Solar Park in Aswan.

In February, Acciona Energia and Enara Bahrain said they had com-

pleted the construction of three solar photovoltaic (PV) plants totalling 150 MW (186 MWp) in Egypt.

The three plants, which required an investment of approximately \$180 million, will be owned 50/50 by Acciona and Swicorp, the Spanish company said. Financing for the projects has been secured from the International Finance Corporation (IFC) and the Asian Infrastructure Investment Bank (AIIB).

The three parks will benefit from the country's feed-in tariff (FiT), secured in the Round 2 tender in October 2016. They will sell electricity under a 25-year power purchase agreement (PPA) with utility Egyptian Electricity Transmission Company (EETC).

The plants are located in the Benban solar complex in the Aswan region.

Oman sets out renewables goals

Oman is expecting renewables and waste to energy (WTE) projects to account for 30 per cent of its energy mix by 2030.

Oman Power and Water Procurement Co (OPWP) has launched a number of new and renewable energy projects in the sultanate and has been successful in attracting global investors to its energy sector.

Last month OPWP announced plans to develop a 300 MW wind farm in Duqm by 2023, and said that a Request for Qualifications (RfQ) for the

procurement of Oman's first WTE project is expected to be floated in June.

The 300 MW wind farm – known as Wind 2023 – will be developed as a \$1 billion independent power project (IPP). A wind resource assessment (WRA) for the project will be initiated during the third quarter this year, with the qualification process expected to commence in Q3 2020.

The proposed WTE plant will have a capacity of 125-160 MW and will be set up at Barka in South Al Batinah Governorate, also as an IPP.

Also in March OPWP announced plans for a 500-1000 MW solar farm in Manah in the Governorate of A'Dakhiliyah, to be operational by 2022. The RfQ for the project is expected to be released around the middle of this year and request for proposals before the year end.

OPWP recently announced that the planned 500 MW Ibra II solar power plant will be developed by a consortium led by Saudi Arabian firm Acwa Power. Meanwhile a consortium led by Japanese firm Marubeni Corporation

has signed a 23-year power purchase agreement with Petroleum Development Oman (PDO) for the 105 MW Amin solar PV IPP Project.

According to OPWP, solar energy will likely produce 21 per cent of total power needed in Oman by 2030, while wind power and waste energy are projected to account for 6.5 per cent and 2.5 per cent of total energy mix, respectively. Gas-fired power plants, however, will continue to dominate the generation capacity, with an expected share of at least 70 per cent in Oman's energy mix in 2030.

OPWP has also set a target that by 2025 renewable energy sources will produce around 16 per cent of total power needed in the sultanate. Solar energy is expected to contribute for 12 per cent of total power generation by 2025, while wind power and waste energy will account for two per cent each in Oman's energy mix.

To meet an expected five per cent annual growth in power demand, OPWP expects total contracted power capacity to grow to 10 804 MW by 2021 from 8714 MW in 2018.

Energising Bolivia

A megaproject is under way in Bolivia that is part of a strategic programme aimed at turning the country into a regional energy hub. The project, which sees the conversion of three separate simple cycle plants into combined cycle, is a showcase in project logistics under challenging conditions.

Junior Isles

As a commodity, energy, especially gas, is key to Bolivia's economic development. With sizeable gas reserves, the country is an important energy provider to its neighbours, exporting gas to Brazil and Argentina. Further, in 2015 Bolivia had an installed electricity generating capacity of nearly 2000 MW with gas accounting for 57 per cent of the annual 9 TWh generation.

Several years ago, in a move to capitalise on its gas reserves while at the same time increasing the electrification rate in the country, the government took the decision to expand three of its strategic gas fired power plants. The expansion project would not only enable the country to efficiently use more of its gas for domestic power production but would also allow it to export some of that electricity to its bordering countries and become an energy hub for the region.

Implementation of that decision began in 2015 when Bolivia's Energy Ministry and Siemens agreed on an energy collaboration with the goal of adding roughly 1100 MW to the national power grid.

Siemens and its consortium partner, Spanish company TSK, signed a

contract with state-owned electricity generator Ende Andina S.A.M in 2016 to expand three existing simple cycle power plants – Termoeléctrica del Sur, Termoeléctrica de Warnes, and Termoeléctrica Entre Ríos.

The project is part of a wider vision for development of the country's power sector to reach 100 per cent electrification by the middle of the next decade. Known as Vision 2025, Bolivia is developing projects that will see generating capacity go from 1924 MW in 2015 to 6000 MW in 2025, of which 3000 MW will be for export. The plan will see a major boost for renewables including wind, solar, biomass, geothermal and hydroelectric power generation. But with gas providing the bulk of generation, and expected to maintain a significant share in the generating mix, gas fired combined cycle technology is a key part of realising the vision.

Certainly, Bolivia is now undergoing change. It is experiencing a transformation process in its hydrocarbon sector, in its industry, road transport development, and in its electricity sector. Ende Andina was initially entrusted with the task of guaranteeing electricity supply in the

national grid by building its first gas fired power plant at Entre Ríos.

It was then assigned the task of increasing system reliability by installing additional power through the del Sur and Warnes projects in the first open cycle stage. Today Ende Andina has the task of changing the generation technology by moving current open cycle plants to combined cycle systems.

Ramiro Becerra Flores, Project lead, Ende Andina, said: "Incorporating new technology is fundamental because the gas/energy conversion process is more efficient and gives the country the opportunity to find other uses for the surplus or residual amounts of gas that are going to be produced as a result of mainstreaming this more efficient new technology. The scale of the projects, not only with regard to the electricity industry but for projects in general in Bolivia, presents challenges, above all for example in the field of logistics."

Under the contract, Siemens' scope of supply includes the delivery of a total of 14 industrial gas turbines, 11 steam turbines, 22 heat recovery steam generators (HRSGs), and other power plant equipment to Bolivia, in

what has been a logistically very challenging project.

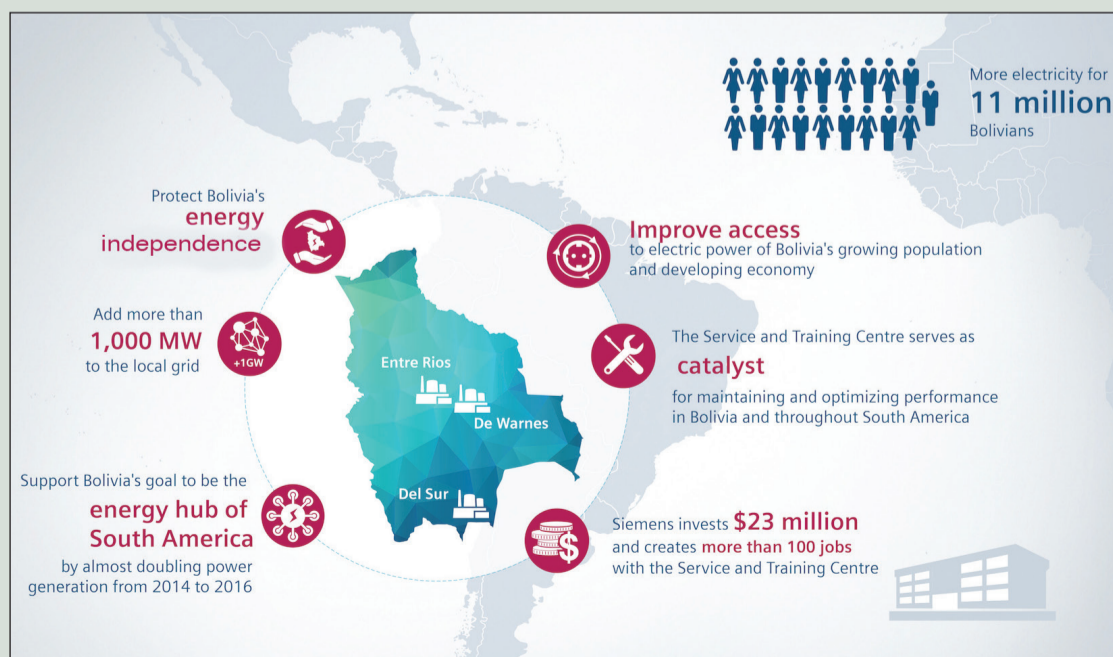
In a mega project that will see the plants converted from open cycle to combined cycle, Siemens will supply and commission: four SGT-800 gas turbines, four SST-400 steam turbines and eight HRSGs at Termoeléctrica del Sur; four SGT-800 gas turbines, four SST-400 steam turbines and eight HRSGs at Termoeléctrica de Warnes; and six SGT-800 gas turbines, three SST-400 steam turbines, and six HRSGs at Termoeléctrica Entre Ríos.

The main aim of the new contract is to boost the output of the three plants and improve efficiency. The extension will see the power output from Termoeléctrica del Sur increase from 120 MW to about 480 MW; output from Termoeléctrica de Warnes will be increased from 200 MW to about 520 MW; and Termoeléctrica Entre Ríos will see its capacity boosted from 100 MW to about 480 MW.

Siemens is familiar with the power plants, having installed the existing 13 gas turbines, which have been operating at the sites for a number of years. There are already four existing SGT-800 turbines at del Sur and five at de Warnes; Entre Ríos has four SGT-700s. The conversion of these plants to combined cycle, through the addition of HRSGs and steam turbines, will increase plant efficiency from round 40 per cent to 50-52 per cent, depending on ambient conditions.

Commenting on the decision to opt for Siemens equipment for the projects, Josef Entfellner, Overall Project Director, said: "The easiest thing for the client is to use the same gas turbines they already had for the extension. It's easier for them to handle, it's easier for spare parts and for maintenance. There is an existing maintenance contract for the gas turbines in the country, and this has been extended for the new units."

The Termoeléctrica del Sur and de Warnes projects are very similar. In addition to steam tailing of the existing units, both will also feature two completely new combined cycle blocks, also in a '2-on-1' configuration. Each block comprises two gas turbines, each with an associated HRSG that will feed steam to a single



The expansion project will, among other things, allow Bolivia to export electricity to its bordering countries and become an energy hub for the region

Special Project Supplement

steam turbine. The fifth of the existing gas turbines at de Warnes will remain in open cycle.

These two plants will also be cooled differently. Due to its location in the south of the country, where the conditions are dry, Termoeléctrica del Sur will use air-cooled condensers. As Termoeléctrica de Warnes is in an area where there are small rivers and wells and rainfall is high, cooling towers will be employed.

At Entre Ríos, the existing gas turbines will all remain in open cycle. The new equipment will be used to build three new 2-on-1 combined cycle blocks. With the availability of sufficient cooling water, this plant will also use cooling towers, which allows slightly higher efficiency than air-cooled condensers.

The decision to keep some of the gas turbines at the plant in open cycle allowed each of the combined cycle blocks to be designed identically. This not only reduces costs but also means that the open cycle units can be kept for use at times of peak demand.

The three plants are geographically spread in different parts of the country, and were selected for expansion, as opposed to building a single new large facility, for several reasons. The high voltage grid connections were already available, as was cooling water, and smaller plants provide more flexibility in terms of power output and speed of start-up. Further, the transport of the heavy equipment that would have been required for a larger plant would have been almost impossible.

Each site is also at a fairly low altitude. Bolivia is perhaps five times bigger than Germany but only has a population of around 11 million, mostly living in two or three major cities. While it might be expected that

the equipment from different parts of the world to three dispersed sites in Bolivia.

Following finalisation of the Memorandum of Understanding (MoU) in 2015, Siemens signed the final contract and was given Notice-to-Proceed on May 31, 2016. Siemens' consortium partner TSK was largely responsible for electrical systems, civil works, erection and installation.

Manufacture of the gas turbines began immediately in Finspång, Sweden, and the first unit was ready for shipping in April 2017.

Manufacturing of the steam turbines, HRSGs as well as the 25 generators, eight bypass stacks, 25 transformers and the power plant control systems began on completion of engineering design.

As custom-engineered components, manufacturing of the boiler and steam turbines started slightly later than the gas turbines. Manufacture of the boilers was carried out in China and the first was shipped in May 2017. Steam turbine manufacture was undertaken in Brazil and the first machine was shipped in June 2017.

Shipping and delivery of the major equipment was quite a challenge, one that required a great deal of coordination.

Entfellner said: "We had a team in Vienna coordinating the engineering, as well as people in Spain to coordinate the civil works and balance-of-plant. And of course we had people working on the gas turbine development, boiler design and steam turbine design, etc. This means we had an international team to coordinate getting all the equipment ready for exports and getting it to site on time."

Marcus Koerber, Transport and Logistics Manager says the project was "interesting" as well as "challenging



turbines, whenever possible.

The first gas turbine was loaded onto a ship in Norköping, Sweden. The ship then travelled to the port of Hamburg, Germany, where the gas and steam turbine generators and other auxiliaries for the gas turbine were brought on board. The ship then travelled to Arica, Chile, through the Panama Canal. In Arica, the parts were unloaded and trucked to each project site.

With equipment arriving from several countries, different ports of entry had to be used, as a single port was not large enough to handle all the cargo. For the 22 boilers, each consisting of two modules, a total of 44 boiler modules were shipped from China to the ports of Angamos and Arica, Chile, and then transported on to the

routes. Crossing bridges and rivers, as well as coping with the rainy season, were some of the key challenges faced in implementing the project. The constantly changing and often extreme weather conditions along the route (heat, snow, heavy rain, mudslides, flooding), presented a special challenge.

"We had to cross different climatic zones and the transport on the truck itself was a huge effort," said Koerber. "Normally we try to keep truck transport for heavy-lift equipment as short as possible. But for this project, in some instances we had to travel over 1800 km to reach a site with 100 heavy-lift cargoes."

Transporting the boilers was particularly challenging. "They are very large pieces of equipment, weighing around 170 t. It required several trucks to pull or push the weight over the Andes," said Koerber.

Some journeys involved crossing 50 bridges, with many requiring the construction of temporary metal supports. In some cases, new roads had to be built. "We did a study even before the project began to make sure it was all feasible," said Koerber.

He added: "In South America, you always need to have communication with the local authorities. The first road may be fine but on the second there may be a problem; and in Bolivia not all the roads are paved. We needed to be flexible to find a new road if necessary or change plan to find the best solution to get the equipment to site in time."

Entre Ríos provided a good example of the adaptability of the logistics team. Along the route to the plant, there were two bridges that were too high to be supported. The team therefore took the decision to transport the six HRSGs from Chile to Bolivia by aeroplane.

"We had to use the world's biggest cargo plane, the Antonov An-225, to get the heavy equipment past these bridges and to deliver what we promised to the customer," said Koerber. "We had 12 deliveries; it was a huge effort."

The first gas turbines arrived at del Sur in August 2017, four months after leaving Sweden. The first steam turbine from Brazil also arrived in August. There was approximately a two-month stagger between the three plants, with Warnes following two months after del Sur and Entre Ríos, two months after Warnes.

Erection began as soon as main equipment began arriving at the sites. At the peak of construction, there were more than 1700 people deployed across the three sites.

A major milestone was reached on September 18, 2018 with first fire of the first two new gas turbines at Termoeléctrica del Sur. Firing of the next

Bolivia's three combined cycle power plants. From left to right: Termoeléctrica del Sur (480 MW); Termoeléctrica Entre Ríos (480 MW) and Termoeléctrica de Warnes (520 MW)



Most of the equipment arrived by boat and was then transported by road to the three sites

a power plant could be located close to areas of high load, a couple of those cities are at a high elevation.

Entfellner noted: "The power plants are between 200-400 m above sea level. La Paz, which has about 3 million people, is between 3600 m and 4100 m above sea and Cochabamba, which has about 1 million people is also at an altitude of 2600 m. Building the plant at a lower altitude means a higher output from the gas turbines."

Termoeléctrica del Sur is located in southern Bolivia near the border with Argentina about 120 km east of the city Tarija, and due to its location will be able to export power to neighbouring South American nations. Termoeléctrica de Warnes, is in the Warnes province next to the city Santa Cruz; and Termoeléctrica Entre Ríos is in Cochabamba province, 175 km southeast of Cochabamba.

The overall project has moved at a relatively fast pace, especially when considering the logistics of delivering

from time-to-time". Overall there were about 1000 shipments – all scheduled to be delivered within a time frame of roughly one year.

Koerber noted: "We had a lot of heavy equipment such as the gas turbines and boiler parts. Some of the boiler parts weighed up to 170 t each. And in Bolivia there was a shortage of the [transport] equipment needed to deliver everything at the same time. The main task was to coordinate the shipments in a way so that equipment was available at the same time and to arrive at the sites according to the schedules for erection and execution."

The overall project called for approximately 400 heavy haulage shipments to the three power plants – nearly 100 heavy-lift shipments and 300 oversize cargo shipments.

In order to streamline deliveries and have equipment arriving at the same time to site, Siemens shipped generators on the same vessel as the gas

project sites.

It took approximately five to eight weeks to ship the gas turbines by sea from Sweden or Germany to the port of Arica and then roughly four weeks to transport them onward to the construction sites.

With limitations on trucks capable of transporting equipment, it was impossible to transport equipment to all three sites in parallel. Deliveries were therefore staggered to ship a maximum of four boilers at one time and two gas turbines on one vessel.

The main challenge began when equipment arrived in the country. Landlocked Bolivia is the highest and most isolated country in South America. It has a varied terrain spanning the Andes Mountains, the Atacama Desert and Amazon Basin rainforest. Much of the equipment had to be navigated across the Andes at a height of 4680 m.

Many challenges were encountered at a number of points on the land

Special Project Supplement



Becerra from Ende Andina says the availability of electricity will facilitate the general socio-economic development of the country

two followed in mid-December and the plant received its Provisional Acceptance Certificate in February. The first two SGT-800s at Warnes were ignited in January this year, with the second two following in late February. Now just six months after first firing at del Sur, commissioning of these two plants is currently ongoing under the watchful eye of the commissioning teams.

At Entre Ríos, commissioning began recently with back-energising taking place in March to provide power from the grid to operate auxiliary equipment. The next key milestone will be firing of the gas turbines, which is expected in early to mid-April.

Entfellner commented: "The first unit is always the most complicated because there are always some new competences involved but with lessons learned, you can see synchronis-

ing of subsequent gas turbine or putting water treatment plants, etc., into operation is always much quicker."

Due to the logistical challenges with transport, buffers of between three and six months were built into the agreed schedules to allow for *force majeure*.

Entfellner explained: "For example, in del Sur there is a buffer of three and a half or four months, and similar for Warnes; and at Entre Ríos, we have a buffer of eight months. So for Entre Ríos, our intention is to handover the project in October/November but we are allowed until June next year."

The additional capacity from all three sites is scheduled to be fully available by the end of this year or the beginning of next year.

In addition to the jobs resulting from the use of several local companies during erection, operation and maintenance of the plants will also provide jobs for the local communities. "We have already carried out a lot of training for operators, who have been issued with certificates," said Entfellner. "We are now doing on-the-job training for people who will finally operate the plants."

He also noted that a Long Term Service Agreement (LTSA) is already in place for the existing units and this will be extended to cover the new units as well.

Notably, servicing will be carried out by a new service and training centre that is being built by Siemens on a 9200 m² site at the Parque Industrial Latinoamericano (PILAT) in the city of Warnes. The centre will also function as a hub for servicing power equipment installed in the South America region. The service centre will be complete by November this year, with the training centre operating in the first quarter of next year.

Tim Frace, Head of Siemens Power Generation Services Latin America, said: "The Service Centre is key to being able to service the large SGT-800 fleet in Bolivia. It will also eventually become a regional Service Centre for the SGT-800 fleet. We will be able to provide remote monitoring for our SGT-800 technology and other units in Bolivia. Moreover, the service centre will also work as a training centre for our customers and personnel."

Siemens is investing over \$23 million in the facility, which it says will improve delivery time on parts, tooling and other resources.

One of the important aspects of the centre will be an innovation room. This room will be used to monitor the performance the entire SGT-800 fleet in Bolivia by using Siemens' latest digital technologies and solutions to diagnose and analyse the data produced by the fleet.

The centre is expected to employ about 130 people and is predicted to grow. "The Service Centre will continue to grow and in order to cover the needs for this centre, many high skilled jobs will be generated for the local communities" said Frace. "This will help develop more specialised professionals with international certification."

Certainly, the centre and new plants will improve living standards quickly. Some areas of Bolivia have suffered several power cuts in recent times, due to demand outstripping supply.

Regarding the importance of this project Becerra said: "Ende Andina is part of a development project devised by the administration of President Evo Morales in the electricity field. It's going to make the national interconnected system highly reliable, and the availability of electricity means

we will have the tools to facilitate the general socio-economic development of the country, thanks to the availability of a service and a resource such as electricity.

"It will also trigger the growth of the electricity network, the national interconnected system. Although this extends to eight of the nine provinces in Bolivia, there is still huge scope for integrating users.

"What's more, another main impact is the rational and efficient use of gas as a resource, which is a pillar that keeps the Bolivian economy going. It will free-up volumes of gas that will be used for the industrialisation that is currently under way on a grand scale, the industrialisation of gas, as well as other types of industrialisation, such as agricultural production, finished products, etc."

John Prado, Siemens Country CEO of Bolivia believes that bringing reliable electricity to urban and rural areas, while improving supply to industrial sectors, will help the economy to grow. This will in turn present further opportunities – in Bolivia and the rest of the region.

"This project also helped Argentina. Argentinean customers witnessed what was being implemented in Bolivia and wanted the same technology to benefit from the flexibility and efficiency it offers. Other countries like Colombia have also visited the Bolivia power plants to adopt similar models."

He concluded: "This type of collaboration with the government and other entities is a great model to follow in other regions of the world to develop and implement electricity for generations. With our innovative technologies and our huge project expertise we improve the quality of life for people all over the world."

Almost all of the equipment had to be navigated across the Andes mountains at a height of 4680 m





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RWE-E.On deal gets EU approval

■ Firms on track to complete deal in 2019 ■ RWE plans renewables boost

Siân Crampsie

The European Commission says that plans for RWE to gain control of E.On's renewable energy and nuclear businesses as part of a proposed asset swap between the two firms does not raise any concerns over competition.

The Commission said in a statement that the transaction is not likely to hinder effective competition in the generation and wholesale supply of electricity or affect RWE's ability and incentives to influence market prices.

Germany's own competition watchdog also gave its approval to the deal.

The Commission is continuing to assess proposals for E.On to acquire RWE's distribution and retail business under the proposed transaction, which the two utility giants announced last year.

RWE said in March that completion of the asset swap deal with E.On will help it to complete its transformation and move forward with plans to boost its renewable energy portfolio.

The company says it is planning to

add 2-3 GW of capacity annually to its renewable energy portfolio in three core markets: Europe, North America, and Asia-Pacific. Its focus will be on offshore and onshore wind energy, as well as photovoltaics and energy storage, according to Rolf Martin Schmitz, RWE's CEO.

One year after closing the asset swap deal with E.On, renewable energy will account for more than half of the company's adjusted EBITDA, while RWE Renewables will become the second largest offshore wind owner

and operator behind Ørsted. The company will also receive a pipeline of projects with a combined capacity of around 17 GW.

RWE and E.On are swapping assets as part of a complex deal agreed in March 2018 that also involves Innogy SE, which is currently majority owned by RWE. As part of that deal RWE will sell its majority interest in Innogy to E.On, while keeping Innogy's renewables business and merging it with the green assets of E.On.

The move will give RWE ownership

of an 8.6 GW renewable energy portfolio that will be housed in a new company with three operating divisions.

At the same time, RWE will get a 16.67 per cent interest in E.On, while the latter will take possession of RWE's distribution and retail business.

The European Commission said that after all asset transfers RWE will be primarily active in the upstream power generation and wholesale markets, while E.On will concentrate on the distribution and retail of electricity and gas.

Engie moves to create new energy services

Engie is aiming to create new energy services for residential customers through the acquisition of a majority stake in Tiko Energy Solutions, a Swiss energy management systems provider.

The French utility has invested an undisclosed sum in Tiko through a capital increase. Other stakeholders in Tiko include Swisscom and Repower. "The unique technology developed by Tiko will enable us to create new services for our residential customers and move towards the building of decentralised energy communities," said Yves Le Gelard, Chief Digital Officer of Engie.

Tiko provides intelligent energy management solutions for the residential sector through an Internet of Things (IoT) platform that connects different electrical equipment, including photovoltaic (PV) plants and batteries, into a virtual power plant. The company's

clients can also take part in projects aggregating connected homes and thus form a wider network that allows flexible energy consumption.

The purchase of a stake in Tiko is part of Engie's efforts to reduce its carbon footprint. Earlier in March the company announced it had completed the sale of its 69.1 per cent stake in Glow, a Thai independent power producer.

Engie sold its Glow stake to Global Power Synergy Public Company for €2.6 billion. Glow owns and operates power production facilities in Thailand and Laos with a generating capacity of 3.2 GW, including 1 GW of coal and 2 GW of gas.

After the sale of Glow, Engie will no longer have any coal assets in the Asia-Pacific region. In addition, coal will account for six per cent of its total electricity production capacity, compared with 13 per cent at the end of 2015.

BNP Paribas ditches fossil fuel investment

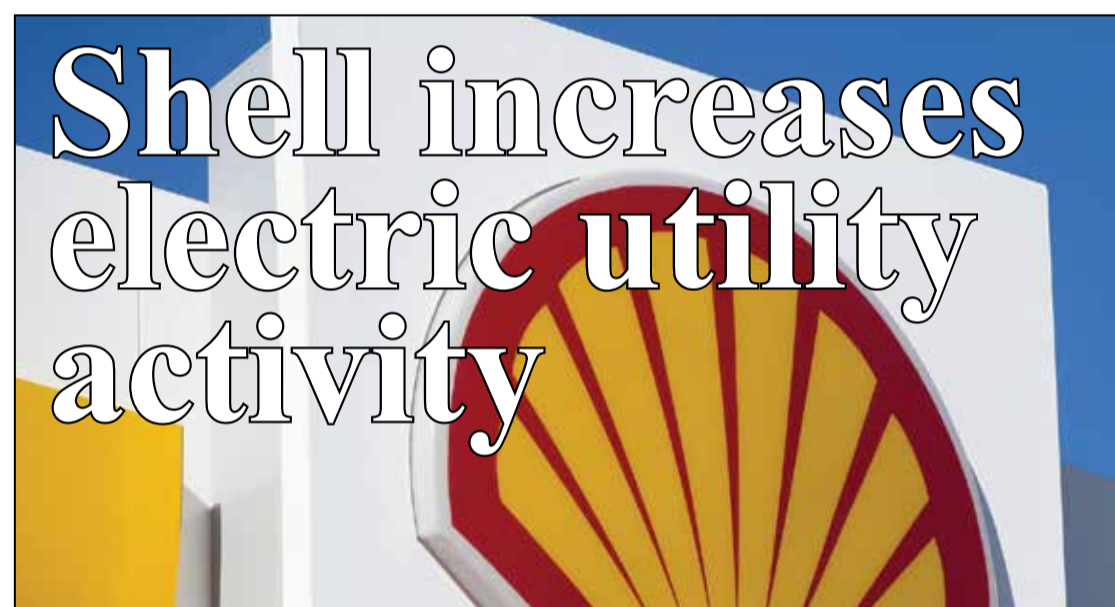
BNP Paribas has become the latest financial firm to ditch investments in fossil fuels.

The French firm has launched a new strategy "to enhance and accelerate commitment to sustainable investment" that will include firm-wide targets for measuring and aligning investments with a sustainable future.

BNP's Global Sustainability Strategy includes plans to reduce the carbon

intensity of its investments and the water footprint of its portfolios. Its asset management arm will tighten exclusions on companies engaged in coal mining and power generation, it said.

The move makes BNP one of the latest large investors to shun industries judged to be detrimental to the goal of the 2015 Paris climate agreement. It said that reducing exposure to fossil fuels will reduce economic risk.



Shell has accelerated its move into the utility sector with the acquisition of Limejump, a UK-based demand side aggregator.

The oil giant has reached an agreement to buy Limejump for an undisclosed sum and says that the UK company will become a wholly-owned subsidiary.

The move follows Shell's purchase of First Utility in 2018 and its more recent acquisition of home battery storage company Sonnen.

"We are impressed by the Limejump team and their track record of building a digital energy platform that connects and optimises a diverse range of assets," Brian Davis, VP Energy Solutions at Shell New Energies, commented. "Together, we can offer more choices to our customers in the UK as we accelerate the building of a customer-focused energy system in support of Shell's strategy

to offer more and cleaner energy solutions to customers."

According to Shell, Limejump will continue to focus on three main objectives: paving the way to a more sustainable energy future; maximising revenue streams for all decentralised asset owners; and utilising data science and technology to enhance the interplay between renewable supply, demand flexibility and energy storage.

"With the backing of one of the largest energy companies in the world, Limejump now has full financial security across our entire product suite, and this will allow us to strengthen Limejump's offering including new innovative features and products, as well as increased platform robustness," Erik Nygard, CEO of Limejump, said.

Nygaard continued: "We are in the middle of an energy revolution and joining forces with Shell allows Limejump to make a much greater impact

on the market while enhancing the experience of our valued Limejump customers.

"It allows us to further increase the quality and scale of our products in ways that truly excite us. With Shell's support, we can accelerate the advent of a future where our customers play a more significant part in the energy system whilst maximising the value for this participation. This development is about maintaining our momentum in an unprecedented industry revolution."

Shell has committed to spend \$1 billion-\$2 billion annually on clean energy projects and research by 2020, and recently announced that it was exploring the feasibility of doubling annual green energy investments.

The company has already invested in hydrogen refuelling infrastructure, electric vehicles, battery storage and solar energy.

Aquila purchase targets Iberian profits

Germany-based alternative investment specialist Aquila Capital is planning to start construction this year on a large scale renewable energy portfolio in Spain after sealing a deal to buy the assets.

The company says it has purchased a 700 project portfolio that includes project rights for 400 MW of onshore

wind capacity and 300 MWp of solar capacity in Spain. Grid connection of the portfolio is expected in 2021, it added.

"Based on the very favourable local conditions and the strong decrease of technology costs over recent years, renewable energies in Spain can be operated profitably independent of

state subsidies," Aquila said in a statement. "In order to secure project revenues, Aquila Capital intends to contract long-term power purchase agreements (PPAs)."

The transaction expands Aquila Capital's project portfolio on the Iberian Peninsula to a capacity of more than 1 GW. The alternative investment

manager entered the Iberian market in 2017 with the acquisition of a Portuguese photovoltaic project portfolio with a generating capacity of more than 180 MWp.

Roman Rosslenbroich, co-founder and CEO of Aquila Capital, said: "This successful transaction underlines the importance of the Iberian

Peninsula for investments in European renewable energy infrastructure." He added: "In this region alone, investors are able to diversify across solar, wind and hydro. To us, Spain and Portugal are key locations for our institutional investors and we intend to further expand our operations in the area."

10 | Tenders, Bids & Contracts

Americas

Posco wins Mexico CHP

South Korea's Posco Engineering & Construction Co. has won a \$100 million project to build a 100 MW combined heat and power plant for Mexico-based Ener AB.

The plant, to be built in Coahuila, Mexico, will supply stable power to the Magnelec chemical plant nearby. Posco E&C aims to complete the construction in 24 months, it said.

Ener AB is a joint-venture between US-based power company AES and Mexico's Grupo Bal.

Bahamas set for new plant

Bahamas Power and Light (BPL) has placed an order with Wärtsilä for a 132 MW power plant on a full engineering, procurement, and construction (EPC) basis.

The plant will operate on seven high efficiency Wärtsilä 50 engines using heavy fuel oil initially and able to convert to liquefied natural gas (LNG) fuel when it becomes available. It will be delivered as a fast-track project and is due to go into commercial operations at the end of summer 2019.

The installation will be in BPL's existing Station A on the island of New Providence, which is being stripped of all of its current slow speed reciprocating engines to make room for the new generating sets. The facility will enhance flexibility in the Bahamas' power system, helping it to integrate increased levels of renewable energy.

"This will be our first major EPC project in the Bahamas, and we look forward to meeting BPL's tight delivery schedule and their expectation for reliable and efficient additional power generation," said Edmund Phillips, Business Development Manager, Caribbean, Wärtsilä Energy Business. "We are also mindful of BPL's future strategic interests in utilising clean burning LNG and in adding renewable capacity."

Bolivia awards geothermal contract

Bolivian power company Ende has awarded an \$18 million for the country's first geothermal power project to Asociación Accidental Sacyr Ormat (AASO).

AASO will build a 5 MW pilot plant, the first stage of the proposed 100 MW Laguna Colorada plant. The pilot phase will collect information regarding the geothermal reservoir and will supply electricity to build the 100 MW complex, as well as provide power to neighbouring communities.

The contract covers detailed engineering, equipment and materials supply, civil construction, electro-mechanical installation, tests and startup.

Asia-Pacific

GE T&D to modernise Rajasthan grid

Rajasthan Rajya Vidyut Prasaran Nigam (RRVPL) has awarded GE T&D a contract to modernise its grid.

GE T&D will use its Advanced Energy Management System (AEMS) as a foundation for RRVPL's roadmap and enable the utility to alter production levels based on demand. Part of GE's Digital Energy portfolio, the software will provide real-time data acquisition and a decision support system that will help in visualisation and situational awareness of the transmission grid.

Smart Transmission Network and Asset Management System

(STNAMS), RRVPL's state-of-the-art power transmission roadmap, was designed to integrate large-scale renewable energy and support managing existing and future power structure.

Wärtsilä signs lifecycle agreement

Wärtsilä has signed five-year Lifecycle solution agreements for two power plants in Bangladesh, it has announced.

The technology firm has sealed a maintenance management and operational advisory services agreement with PowerPac Mutiara Jamalpur Power Plant Ltd, an independent power producer (IPP), for the PowerPac Jamalpur plant in Jamalpur. It has also signed an operation and maintenance and spare parts supply agreement with LafargeHolcim Bangladesh Ltd, a major cement producer that operates a 30 MW power plant.

The two agreements will ensure optimal operational efficiency at the two plants as well as effective maintenance planning, Wärtsilä said.

Voith to deliver Pakal Dul turbines

Voith Hydro has signed a contract with Chenab Valley Power Projects Private Limited (CVPPPL) to supply four 250 MW Francis turbines and generators for the Pakal Dul hydropower plant in the Indian state of Jammu and Kashmir.

Pakal Dul is being constructed by CVPPPL, a joint venture company of NHPC, JKSPDC and PTC, on the Marusadar river, the main tributary of the Chenab river, 45 km from Kishtwar. The hydropower project will help add to the power generation in this northern region and will also improve the economic prospects of Jammu and Kashmir.

Doosan wins transmission line contract

Myanmar's Ministry of Electricity and Energy (MoEE) has awarded Doosan Engineering and Construction (E&C) a Won100 billion (\$88 million) contract to build the Taungwoo-Kamanat transmission line.

Under the contract, E&C will build 368 steel towers in a 174 km, 500 kV section from Taungungoo to Kamanat in Myanmar with a loan from the Economic Development and Cooperation Fund (EDCF). It has 27 months from contract signing to build the link.

SGRE wins first SPIC deal

Siemens Gamesa Renewable Energy (SGRE) has signed a contract to supply six SG 3.4-132 wind turbines with a flexible power rating of 3.65 MW to a wind farm project in Inner Mongolia, China.

The project is developed by the State Power Investment Corporate (SPIC) of China, and it is the first order SGRE has received from SPIC. It is also the first order for the SGRE 3.X platform model in China.

Commissioning of the wind farm is expected in August 2019. SGRE will also be responsible for the operation and maintenance of the turbines for five years, with warranties of 6-20 years for major components.

BSR EPC secures solar and storage contract

BSR EPC has been selected to deliver the engineering, procurement and construction (EPC) for a 33 MW solar and storage facility in Katherine, in Australia's Northern Territory.

The Katherine project was developed by a joint venture between Epuron and Island Green Power, and was recently acquired by Eni, the Italian Fortune Global 500 energy company. It will include a 6 MW battery storage facility that will provide stability to the grid, BSR said.

"2019 is forecast to become the first year that global solar installations top 100GW and we are excited to contribute to this impressive milestone with our first project in Australia," said Graham Harding, Managing Director of BSR Group.

Construction will start on the Katherine solar and storage facility from March 2019 and it will be operational from Q4 2019.

Europe

PGL floater picks Prysmian

Prysmian Group has won a contract to develop a turnkey cable system for the Provence Grand Large (PGL) floating offshore wind project in France.

Under the €30 million deal, Prysmian will supply 3 km of inter-array cables, 19 km of export cables and onshore cables for a 9 km route.

Prysmian will also provide a full combined PRY-CAM permanent monitoring system, which will enable all the inter-array connections to be permanently monitored and the measurement of all key operating parameters of the entire cable system.

"It is the first turnkey project for a floating wind farm ever developed by the Group, where we employ our innovative dynamic 66 kV submarine cables with EPR insulation. This project is also the first pre-commercial floating offshore wind farm ever developed in France," said Alessandro Panico, Sales Team Manager - Offshore Wind, Prysmian Group.

The PGL project will comprise three Siemens Gamesa 8.4 MW turbines mounted on a float system developed by SBM Offshore and IFP Energies Nouvelles.

The 25 MW floating offshore wind farm, owned by EDF Energies, is scheduled for commissioning in 2021.

Nexans helps Amprion underground

Nexans is helping Amprion take a key section of its 400 kV transmission network in Germany underground.

Nexans will supply 31.8 km of 400 kV cable for a major project at Legden on the route between Wesel and Meppen. The project is part of wider efforts by Amprion to upgrade its transmission network in preparation for Germany's *Energiewende*.

Nexans is supplying the cable for one double circuit with a 2500 mm² copper cross-section on the Legden section. The section of cable installed in the tunnel will feature a halogen-free flame-retardant (HFRR) sheath and Nexans is also providing the steel support structures.

Delivery of the cables is scheduled for July 2022, with installation completed in 2023.

JDR wins Kriegers Flak contract

UK subsea cables provider JDR Cable Systems has won a contract from Vattenfall AB to supply inter-array cables for the 605 MW Kriegers Flak offshore wind farm.

JDR will manufacture more than 170 km of aluminium core inter-array cables and a range of termination accessories for the Danish project, which is due to be on-line in 2021.

Mitsubishi venture preferred for Walney

A consortium made up of Mitsubishi Corporation, Chubu Electric Power Co., Inc. (Chubu) and HICL Infrastructure Company Limited has been selected as the preferred bidder for a new offshore electricity transmission link in the UK.

The £500 million (\$658 million) link will connect the 660 MW Walney offshore wind farm off the UK's west coast to the national grid. The winning bidders will operate the asset - comprising subsea cables, land cables, offshore substations and an onshore substation - for 20 years under an Offshore Transmission Owner (OFTO) license.

Nordex wins Terna deal

Terna Energy has placed orders with Nordex for the supply of 36 wind turbines for a number of wind farm projects in Greece.

The 36 machines include a number of different models and will have a combined capacity of 108 MW, Nordex said. The orders also include a Premium Service contract covering five years with an option to extend for a further five.

DS Smith plans new CHP

Packaging firm DS Smith has contracted E.On to construct a state-of-the-art combined heat and power (CHP) facility at Kemsley Paper Mill in Kent, southeast England.

The 75 MWe facility will replace an existing CHP plant and extend E.On's partnership at the site with DS Smith for the next 20 years. The plant will generate energy and steam for DS Smith's production processes at the mill, helping the company to achieve its corporate goal of reducing carbon emissions by 30 per cent by 2030.

E.On will finance, build and operate the CHP. The two-year construction phase of the CHP plant is due to start this year. The facility is planned for commissioning in 2021.

International

Dubai issues solar RFQ

Dubai Electricity and Water Authority (DEWA) has issued a Request for Qualification (RFQ) for developers to build and operate the fifth phase of the Mohammed bin Rashid Al Maktoum solar park.

The 900 MW solar PV plant will be developed as an Independent Power Producer (IPP) project. It will be commissioned in stages starting from Q2 of 2021. The move supports the Dubai Clean Energy Strategy 2050 to provide 75 per cent of Dubai's total power output from clean energy.

The Mohammed bin Rashid Al Maktoum solar park is the largest single-site strategic solar park of its kind in the world. It will generate 5000 MW by 2030 with investments worth AED 50 billion (\$13.61 billion).

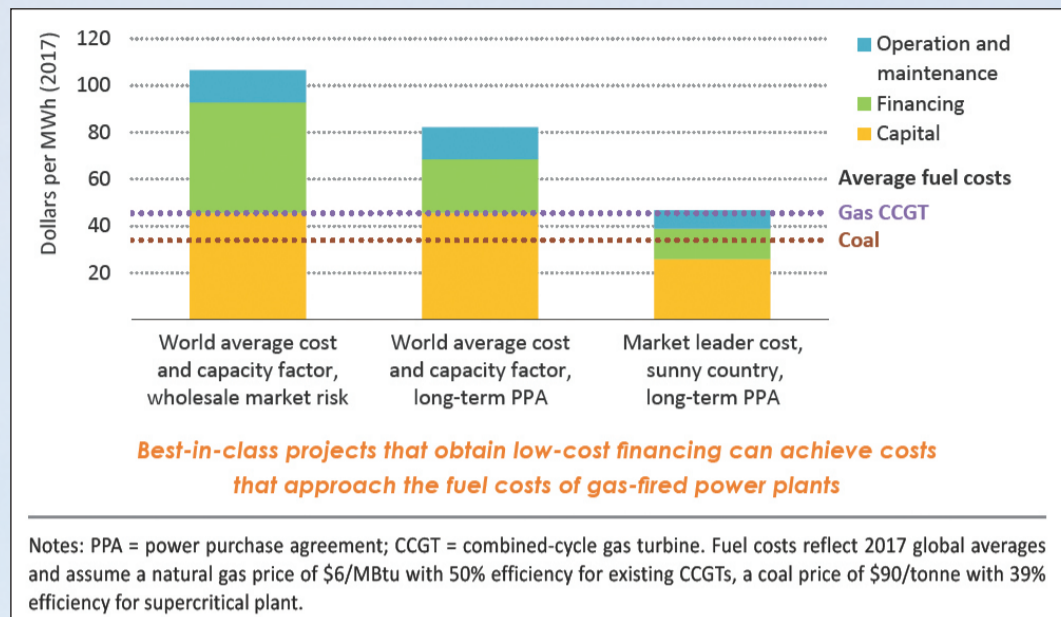
ACWA to build Bahrain solar plant

A consortium of Saudi Arabia-based ACWA Power, Japanese contractor Mitsui & Company and Bahrain industrial conglomerate Al Moayed will build own and operate a 100 MW independent solar power plant in Bahrain.

The ACWA consortium placed a bid of BD14.668/MWh (\$38.91/MWh) for the project. Contracts including the power purchase agreement are due to be signed this month.



Solar PV levelised cost of electricity, 2017



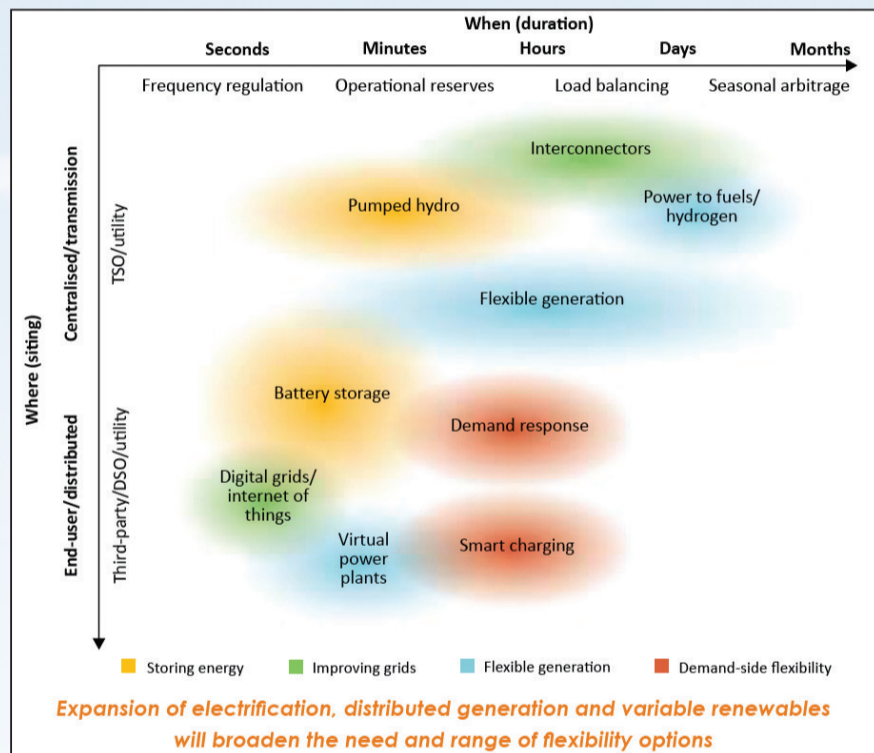
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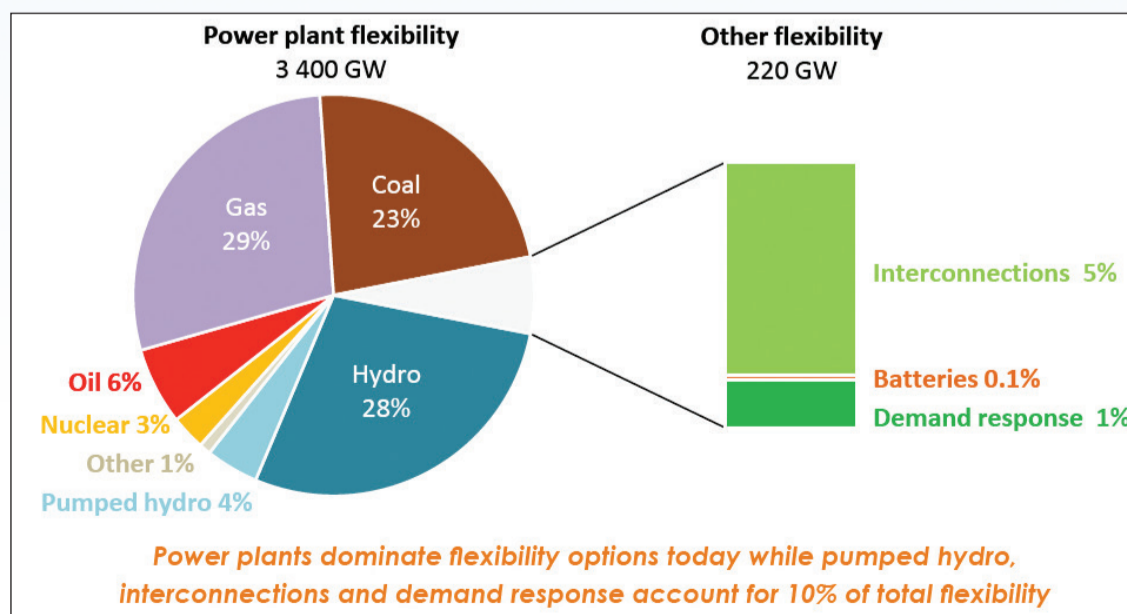
World Energy Outlook 2018, © IEA/OECD, Figure 7.15, page 297

Growing needs and range of options for flexibility



World Energy Outlook 2018, © IEA/OECD, Figure 7.19, page 302

Flexibility in the global power system, 2017



World Energy Outlook 2018, © IEA/OECD, Figure 7.20, page 302

Oil

Oil prices make gains but market will remain volatile

- Riyadh moves to take more oil off market
- Demand growth fell sharply during last quarter of 2018

Mark Goetz

Opec and its allies, together known as Opec+, agreed last month to forego a ministerial meeting and wait until this summer to make an assessment of the oil market and the impact that production cuts that began in January are having on oil prices.

Since January, crude oil prices have increased to around \$67/b for Brent and \$59/b for West Texas Intermediate (WTI). But even with Brent, which is used by many oil producers as the benchmark price against which their own crude is valued, now near \$70/b, rumours are rife that Saudi Arabia, which is swamped by major domestic and foreign investment projects and seemingly dedicated to restructure its economy beyond a narrow focus on oil, is keen to see the price back up at around \$80/b or better.

Riyadh argues that the production

cuts are meant to remove oil surplus and return the market to balance and that prices will be determined by supply and demand. It also says, however, that a consequence of removing oil from the market is that prices will go up.

The price increase is being helped by US sanctions against Iran and Venezuela but Riyadh will cut exports to its main customers during March and April in order to take more oil off the market.

It plans to cut domestic production below 10 million b/d, below the 10.3 million b/d commitment it has made to the current round of output cuts. But it remains to be seen if this strategy will work. What Opec+ really needs is a spike in demand but that is not anticipated.

While they don't voice their concerns openly, the Saudis are likely worried about the ever-rolling output of US shale oil, which could eat into

Saudi market share. Higher prices will only encourage US shale producers and it could be this concern that has brought reports that Saudi Arabia is promoting a possible extension of production cuts beyond June that would last until the end of 2019.

Since Saudi Arabia opened its taps earlier this decade in an attempt to force US shale out of the market, Riyadh has been forced to dig into its financial reserves, spending billions of dollars to cover its enormous costs. According to the International Monetary Fund (IMF), \$70/b oil will not enable Saudi Arabia to balance its books this year. It needs \$85/b.

Whether non-Opec Russia, which is moving slowly to implement the production cuts that it has agreed to, would want to see production cuts extended throughout the second half of 2019, is a question.

Growing US crude production and exports would likely cut into Russia's

market share as well, a factor that Moscow would not favour.

Moscow can meet its budget at a price of \$55/b, so the thought of sacrificing market share for a higher price in the face of growing US exports would not auger well in Russia.

Demand is unlikely to play a big role in the months ahead and offer the market little respite, according to data released earlier this month by the International Energy Agency (IEA).

In its latest monthly 'Oil Market Report', the IEA noted that demand growth fell sharply to 0.95 million b/d during the last quarter of 2018 from 1.5 million b/d in the third quarter of last year. It attributed this to feeble growth in the OECD market.

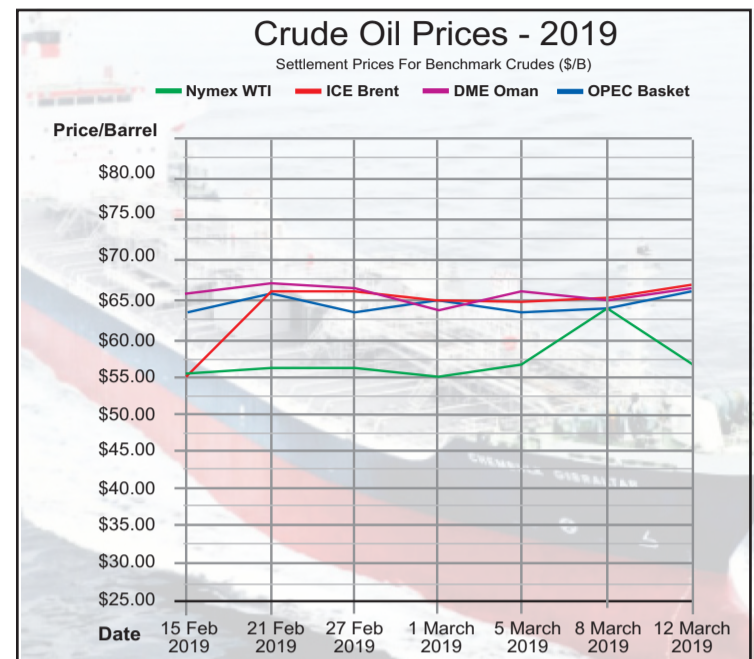
Year-on-year, total OECD demand fell by 0.3 million b/d during 2018, according to fourth quarter data. It said its forecasts for oil demand growth in 2018 and 2019 were unchanged at 1.3 million b/d and 1.4

million b/d, respectively.

Meanwhile, the US Energy Information Administration (EIA) said in its monthly report US crude production averaged 11.9 million b/d during February, down slightly from January. During 2019, the EIA forecasts that US oil output will average 12.3 million b/d and increase to 13.0 million b/d in 2020.

Net imports to the US have declined by an average of 3.8 million b/d in 2017 to 2.3 million b/d in 2018, the EIA said. Net imports will continue to fall in 2019 to 1.0 million. By 2020, the US will be a net exporter of crude oil and petroleum products by about 0.9 million b/d.

According to the Paris-based IEA, US oil production will rise by 4 million b/d over the next four years. The agency said the development would bring greater choice to consumers and contribute to security of supply at a time of geopolitical concerns.



Gas

Gas condensate discovery offshore South Africa

A major gas condensate discovery off the coast of South Africa is expected to lead to more exploration activity off the continent's southern coast and attract other major international energy companies to the region.

David Gregory

A "significant" major discovery bodes well for South Africa's energy future, but development, exploitation, monetisation and an overall improvement for the country's domestic energy industry may be years away.

French oil and gas major Total announced in February that its Brulpadda-1 well encountered 57 m of net gas condensate pay on Block 11B/12B in the Outeniqua Basin some 175 km off the southern coast. Brulpadda, or Bullfrog in Afrikaans, was drilled to a depth of 3633 m in 1432 m of water. As with other major discoveries, it has been designated a 'game changer' for South Africa, which relies on coal and hydrocarbon liquids for most of its power generation. Total did not speculate on the size of the discovery, but industry analysts have commented that the resource could be as much as 1 billion barrels of oil equivalent.

A considerable amount of work lies

ahead for Total and its partners before the resource is commercialised. The most immediate prospect for the discovery is linking it to an existing offshore development what supplies gas to the gas-to-liquids (GTL) project at Mossel Bay.

Commercial development is expected to save South Africa millions in dollars that it spends annually for imported liquid fuels, supplied primarily from the Middle East and other African countries. It would also put the country's gas-to-power project on track and enable a shift away from dependence on cheap coal.

Furthermore, the Brulpadda discovery may show to be more than double the 350 million barrels of oil equivalent discovery offshore Mozambique earlier this decade that is now being developed for large-scale LNG export for start-up some time in the next decade. Should that scenario develop, South Africa could reap significant benefits depending on market conditions at the

time – perhaps some time in the late 2020s at the earliest.

Total, which operates the 19 000 km² Block 11B/12B with a 45 per cent working interest, described Brulpadda as "a new world-class gas and oil play and is well positioned to test several follow-on prospects on the same block". The company intends to proceed to acquire three-dimensional seismic data over large areas of the block and eventually drill four more exploration wells in order to establish the full extent of the discovery.

Total was forced to abandon its first attempt to drill the Brulpadda in 2014 due to the region's well-known challenging environment and the limits of its drilling rig. This success can be largely accredited to a state-of-the-art drill ship, the Deepsea Stavanger, owned by Odfyell Drilling, which is capable of drilling in water depths of 3000 m.

The big discovery emphasises South Africa's need to speed ahead with

legislation regulating its gas industry. Failure to put legislation in place to govern the conduct of this new side to the country's energy sector could result in it losing out on future opportunities to make the best use of its gas resources and to attract investment from foreign firms that want a solid framework in which to conduct their business.

Development of Brulpadda at this point is estimated to cost around \$3 billion, much of which according to one South African media report, will be carried by the state.

Brulpadda and the prospect of more discoveries equivalent in size also raises questions about South Africa's coal industry, which is vital to the country's economy.

South Africa holds about 11 per cent of world coal reserves and coal is the country's largest foreign exchange earner as well as a major source of employment.

Despite this, the country must tolerate

frequent power outages. How South Africa will navigate its way around its coal industry in the face this huge wet gas discovery as well as global warming and international plans to convert to a carbon-free energy system is a dilemma shared not only by South Africa but by everyone involved in the energy industry.

The announcement of the Brulpadda discovery prompted South Africa's environmentalist media to question the point of pressing ahead with development. It estimated that first gas production would come in 2027, by which time the country should be transitioning away from a hydrocarbon energy sector, not transitioning from coal to gas.

The argument was also put forward that it would take at least a decade before the new resource would have any impact on South Africa's power generation system and questioned the government's commitment to cutting carbon emissions.



Will AI save the utility business?

In an age where large cloud servers running complex algorithms using artificial intelligence (AI) and machine learning solve problems, it is possible to unlock the big data produced by smart meters – data that contains information about the load in each home. Some believe that unlocking this data is key to the survival of energy companies.

Abhay Gupta

Most industries have gone through revolutionary changes over the last two decades. Blockbuster and Hollywood Video rental stores were disrupted by Netflix. Retail shopping was interrupted by e-commerce, led by Amazon, followed soon by almost every brick-and-mortar store. The transportation market is in the process of being disrupted by Uber and Lyft; the hotel industry by Airbnb; and the list of examples goes on.

During these revolutions, some industries end up with extinction of traditional players while others see the dust settle with old players holding a much smaller market position. Part of the extinction depends on how fast the incumbents adopt new technologies and innovate on their own. Intel for years has followed the philosophy of disrupting its own product before anyone else does and introduces newer versions of its microprocessor chips every year or two, for example.

The energy industry is currently going through its own disruption cycle. The traditional business model for regulated utilities has been to build infrastructure for the generation, transmission and distribution of electricity and to earn a rate of return on capital investments. The public commissions regulate utility profits by defining the energy rate that gives them a specific rate of return on their investment.

Importantly, what is changing in the energy industry is the availability of new technology.

First, the presence of renewable energy resources like solar gave consumers the option to produce their own energy, which takes revenue away from the traditional utility model. Then came the commercialisation of battery storage technology at scale funded by electric vehicles, allowing consumers to store the energy they produce from renewables. The net effect is a big dent in the traditional business model of utilities since their infrastructure costs are not reduced in the same proportion as their revenues. As they are a regulatory-protected industry, they are more immune to external pressures and the threat of extinction as compared to the other independent, unprotected industries, but they are not 100 per cent safe.

Also, a new class of technology companies is looking to address another new phenomenon in energy: opposite swings on the grid. As more and more homes produce their own energy with solar and more electric vehicles get on the road, the grid has two opposite load swings. In the US, California's landmark mandate that all new homes built starting in 2020 are required to have solar and an International Energy Agency estimated 125-220 million EVs worldwide coming by 2030 are clear signs of the direction the industry is headed –

putting immense pressure on a grid that was never built for this model.

Technologies looking to control devices in the home (or so-called Smart Home) like smart thermostats that pre-cool the home during off peak hours, or consumer technologies designed to motivate people to run their major appliances, such as the dryer or pool pumps, when there is a surplus on the grid, are significantly changing the energy supply to the home. What was once a simple supply of electrons is becoming a very complex industry where many other players outside of utilities have a say in solving the problems – and adoption of these means utilities only own a fraction of total energy supply, essentially reducing their market share.

Luckily, not all odds are against utilities. Technology can also be part of the solution that presents utilities with new, innovative ways to meet external pressures and tackle head-on the shifting industry dynamics. One major technological change in the last decade is the arrival of smart grid. Smart meters, smart routers and other equipment have been modernising the grid for reliable power and automation. There is a treasure trove of data produced by smart meters that contains information about the load in each home. But, it is locked. Will technology come to rescue utilities and unlock this data, which is the key to understanding each customer and personalising utility service?

In the age of big data, where large cloud servers running extremely complex algorithms using artificial intelligence (AI) and machine learning solve big problems, it is absolutely possible to unlock this data. Technologies like energy disaggregation and lifestyle segmentation allow the time series, whole-home consumption data from smart meters to be analysed and identify appliance-level energy use without the need for any sensors in the home.

Large appliances like air conditioners, heaters, refrigerators, dryers, electric vehicles, etc., leave their electronic “fingerprint” when turned on and off. But, they are not easily visible because they are often in use overlapping with each other and hard to separate from whole-home consumption waveforms. AI technology comes to the rescue and applies algorithms that have been pre-trained to separate the signatures.

This is similar to how Facebook or Google pattern recognition technology identifies faces in an image, and once tagged, can even identify whose face it is automatically in the

future. In other words, AI has learned to recognise this person. For utilities, faces are replaced with appliance recognition. Now that utilities can understand the consumption behaviours of appliances by type, time and frequency of use, combined with all the publicly available demographic information on homes and weather, they are in a position to personalise customer engagement à la the consumer tech giants.

In what ways are utilities using this newly found information? For starters, energy bills are becoming itemised – just like mobile phone and credit card statements are – breaking down for customers where their spend is going each month. Next, the \$7.5 billion utilities spend on energy efficiency programmes to fund a variety of rebates (like that on smart thermostats and LEDs), home upgrades, appliance replacements (refrigerators, pool pumps, etc.), can now be spent more efficiently by targeting customers who would benefit the most. No more sending pool pump rebates to homes without pools.

Lastly, new business models are enabled through this customer usage information. Most utilities are starting to upsell other products and services like electric vehicle chargers; system installations and repairs; and energy efficiency products such as smart thermostats. In the competitive selling world where consumers make decisions by looking at user ratings on Amazon and Yelp, utilities were at a disadvantage. With the personalised information, however, their ability to not only target the right customers for right offers but also show them the return on investment (ROI) when buying a product or service from their utility gives them a selling advantage.

While AI has revolutionised many industries over the last decade, it is still relatively a new frontier in the energy space. The myriad ways in which AI will redefine the landscape for utilities is unfolding everyday. In the near future, do not be surprised if electric utilities reach out to customers to sell them an electric car or a solar and energy storage system; a smart thermostat or new energy efficient refrigerator; a security system or even a vacation package. Utilities may not know your internet browsing habits like Amazon and Google, but they surely have found an alternate way of catching up in the game of survival.

Abhay Gupta is Founder & CEO of Bidgely a technology company offering disaggregation-powered utility solutions.



Gupta: The myriad ways in which AI will redefine the landscape for utilities is unfolding everyday

A battery-powered renewable future

The case for battery storage is clear: it will reduce costs, improve energy security and above all increase the percentage of renewable energy sources in the global power mix. The question is how to increase global deployment. **Marianne Boust**

Renewable energy sources are estimated to account for over 30 per cent of the global power supply by 2040, with this figure rising to as high as 50 per cent in advanced markets such as Europe.

Yet if the potential of renewables in playing a larger role in the global energy mix is to be achieved and contribute to a global reduction in carbon emissions, several technological barriers must be overcome. Chief among these is the challenge of matching renewable energy supply with consumer demand and fixing the intermittency of solar and wind energy sources. How can power supply be rendered reliable, even when the sun isn't shining and the wind is not blowing?

Recent improvements in battery technology offer hope of a comprehensive answer to this problem. If energy generated from intermittent sources can be stored cost-effectively and at scale, one of the primary factors holding back renewable energy

development will have been resolved.

As such, while the renewable energy debate has long been focused on competing means of supply, the cost and capacity of storage is now fast rising up the agenda. Over \$600 billion of investment into energy storage is expected between 2018 and 2040, according to findings from Bloomberg NEF. This is already taking effect. In the United States, utilities are investing in grid-scale storage rather than building new power plants. Over 2018, battery storage grew by 27 per cent, with 431 MWh installed. US storage capacity is expected to triple in 2019 to 1233 MWh.

Acquisitions, including Shell's recent purchases of Sonnen and Limejump, also indicate a market that is turning its attention to batteries and energy management solutions.

As batteries start to play an active role in national energy infrastructure, the role of batteries in powering the renewable revolution is shifting from concept to reality. That in turn raises questions over what happens next, and how developments to date can be catalysed into meaningful, long-term progress.

Batteries are attracting increasing investment and interest for a number of reasons, the first of which is their versatility regarding the number of possible applications across the energy supply chain. Batteries have a role to play both at grid-scale, plugging gaps and creating flexibility in critical energy infrastructure, and behind the meter, giving individual enterprises and households more control over their renewable energy supply.

Secondly, the cost of battery storage has been reducing rapidly, down five-fold over a decade, and is expected to continue falling. From \$200/kWh in 2017, the cost of a battery cell is expected to decrease another 66 per cent by 2030, according to Capgemini's 'World Energy Market Observatory' report.

Thirdly, we are approaching a technological breakthrough that would transform the potential of battery storage. Currently, most battery storage relies on the lithium ion model that was developed in the 1980s. Over the last decade, strides have been taken towards the development of solid state batteries, which replace the liquid electrolyte that facilitates conduction within lithium ion models with a comparable solid.

This allows for improved energy density, increasing the storage potential of each battery at the same time as reducing its weight, and ultimately

bringing down its cost further. Solid state batteries will also be able to charge more quickly, and require charging less frequently. And, by replacing a flammable liquid for a solid, there is potential for safety to be improved too. The solid state battery's increased tolerance for heat will obviate the need for cooling systems that add both bulk and cost.

Manufacturers vary on how soon the solid state battery will be ready for use, with Panasonic and Toyota among those warning that it cannot be expected to enter the mainstream for another decade. But the prospect of such a significant breakthrough, on top of the already notable progress made on cost and capacity with existing technology, points towards a market that will before long have storage of renewable energy as its fulcrum. So what's next for an industry that can see its future, but can't yet access the technology that would realise the vision?

In recent years, developments in battery technology have largely been led by Asian battery manufacturers seeking to unlock the electric vehicle (EV) market. Players such as Panasonic and BYD have been competing to develop the battery that will keep an EV on the road for the longest time between charges at the lowest cost.

That has led to a beneficial spill over effect on the energy market and a slow take-off of the EV market, with Tesla leading a project to create the world's largest lithium ion battery in South Australia, an area which has been consistently affected by extreme weather and blackouts. The installation has a storage capacity of 129 MWh. In its first year it delivered cost savings estimated at \$40 million, and contributed to improved grid security in the aftermath of a major lightning strike. Similar projects are now under way, as a keystone of the South Australian government's target to source 100 per cent of power from renewable sources by 2025.

Now the wider industry is starting to follow, and both carmakers and utilities are jumping in. Utilities are upping their investments in energy storage, with the UK's ScottishPower recently announcing a £2 billion investment programme. In Germany, Volkswagen recently partnered with the battery production startup Northvolt, to create a new consortium to advance batteries for EVs in Europe.

For that potential to be realised, some challenges must be addressed. Primarily, there is a mismatch between the design of current energy

systems and regulation. It will also be a challenge for energy storage to reduce costs and improve regular access to clean energy. A new regulatory framework is needed that can monetise flexibility and include battery storage in different market mechanisms, such as ancillary services.

Recycling materials in batteries will also be key to ensuring the sustainability of the industry. Recycling processes for industrial Li-ion batteries remain immature and expensive, and are not expected to take-off for a while. While the cost of fully recycling a battery is falling towards €1 per kg (approx. €10/kWh), this is still approximately three times higher than what can be expected from selling the reclaimed materials on the market.

Additionally, batteries are still too expensive for households to adopt, without even counting for battery pack and balance of plant costs. Germany has achieved success in democratising access to battery storage through public funding. Germany marked its 100 000th home to install a battery storage system. In the UK, the total is just a tenth of that number as subsidies are lower and the case to increase PV self-generation is less attractive.

Battery storage represents an exciting opportunity for the energy market and one that has the potential to radically reshape power networks and rapidly accelerate global progress towards a renewable future. However, swift progress should not be taken for granted. Its future is dependent on a complex set of considerations, from ongoing research and development, to regulatory frameworks, a new mindset from commercial providers and further cost reduction.

The overall case for battery storage is clear: it will reduce costs, improve energy security and above all increase the percentage of renewable energy sources in the global power mix. The question now is how to increase the existing few GWh deployed globally currently by helping battery storage enter the mainstream market. A battery powered energy future will not create itself: it will take conscious, co-ordinated efforts across the public and private sectors to become reality.

Marianne Boust is Expert in Renewable Energy Technologies, Energy Storage and Utilities Transformation, Capgemini Invent. For further research on the role of battery storage, read Capgemini's Solar and storage: a roadmap for successful utilities.



Boust: there is a mismatch between the design of current energy systems and regulation

Hydrogen and electricity from plastic

A new process for converting waste – typically unrecyclable plastic and used tyres – into hydrogen and electricity has been independently assessed and is now in the commercialisation phase.

Junior Isles reports.

The environmental problem created by waste plastic has attracted a huge amount of mainstream publicity in recent times. At the same time there has been a growing interest in the potential of hydrogen as a fuel that could play a huge role in decarbonising the global economy.

During the last several months, UK company PowerHouse Energy Group has moved forward a proprietary technology, known as DMG®. It says the process is capable of eliminating waste, including plastic waste and used tyres with high levels of energy recovery, while producing hydrogen and electric power.

The ability to produce hydrogen to support the idea of a hydrogen economy is an attractive one, especially for the energy and transport sectors. While there has been much work on burning hydrogen in place of natural gas in gas engines or even gas turbines for power generation, it is its application in transport that could be a major driver. It is believed that using hydrogen to fuel transport could help reduce worldwide CO₂ emissions by more than 25 per cent. This would be a significant contribution in efforts to combat climate change.

Certainly, David Ryan, PowerHouse Energy's CEO believes in the feasibility of a hydrogen economy. "It can become a reality but in the UK, you would need national infrastructure investment on a scale not seen since the 1960s, when we moved away from town gas, which was similar to hydrogen.

"In Japan, however, it is being driven by fuel cell vehicles where there are already existing vehicles. Whereby in the UK you would struggle to find a buyer for 1 t/day of

hydrogen, in Japan there would be many buyers. There is a market there... and Korea is almost as well established."

But the ability to produce hydrogen is only one part of the story. The more immediate impact, at least in the UK, may be the waste handling aspect of the process. Eliminating unrecyclable plastic and end of life tyres are two of the biggest challenges facing the waste management sector.

PowerHouse Energy's DMG (distributed Modular Gasification) technology is essentially a pyrolysis process. Gasification is carried out at around 1000°C with the help of an oxidising agent but without introducing any oxygen or air into the process. The operation takes place in a slight vacuum but although there is a little air in the chamber, the product is not being burned.

Ryan explained: "It's not like a fluidised bed where you are beginning the burn but you are starving it of oxygen. We are just gasifying it. So we are melting the product and boiling it so it becomes vapour. We then control several of the reactions in that vapour to produce hydrogen."

The temperature, oxidising agent and the residence time of the gases in the chamber are controlled to produce either a hydrogen-rich gas or a methane-rich gas. When looking to produce electricity, the methane content would be increased so it can be burned in a reciprocating gas engine.

Ryan commented: "Knowing the model of what's going on in the process and where the target operation points are is our IP [intellectual property], but what we are controlling are temperature, oxidising agent and residence time. The work we are

doing on our demonstrator and lab equipment means we're building different operating curves for different plastics, different waste and our target syngas. We can fix the control point to give us a sweet-spot for either methane-rich gas or hydrogen."

According to Ryan, the technique is a far cheaper way of producing hydrogen than steam methane reformation, which is currently the only industrial scale technique for hydrogen production. "We are smaller scale, cheaper and smaller footprint than an SMR."

He also noted that its DMG has a smaller footprint and is more efficient than electrolyzers.

"There is the argument that electrolyzers can be run from renewable electricity. Yes that can work but only up to a point, as there is only so much renewable energy. But we don't see ourselves competing with electrolyzers; we're more complementary. An electrolyser might be good for a petrol station application where there might be the occasional car coming through but an electrolyser for a fleet of buses would need a significant land-take and significant cost. Our land-take for that would be just over half an acre, maybe an acre."

The technology is also not aimed at power from waste applications that could be handled by other waste-to-energy technologies such as circulating fluidised bed boilers. "We are not going for large scale," said Ryan. "Typically many of the gasification processes are 40 000t/annum and upwards; they are centralised and are an incineration type technology. Circulating fluidised bed boilers also typically have a throughput of around 40 000-50 000 t/annum.

"We are not competing in that market; we are looking at industrial generators of waste such as plastics or tyres, etc., or those targeting the hydrogen itself. These could be major waste companies who do recycling but can find no route for their high calorific value plastic products, other than sending them to landfill."

PowerHouse Energy says the DMG could be commercial at a size as small as 15t/day, or 5000 t/annum, but would be more attractive at 25 t/day. The current vision is that once a number have been built and operated at 25 t/day, the size will be increased to 40 t/day (12 000 t/annum). According to Ryan, its DMG vessels could be "loaded on to the back of a lorry" and their small size would make them easier and faster to permit – taking in the order of months as opposed to years.

Installing a DMG could also offer waste companies a slightly different model. As Ryan explained, they could for example use it to dispose of their waste plastic and then use the hydrogen as fuel for their refuse collection lorries.

While the technology might be too early for the UK in terms of hydrogen, it is already attractive for markets like Japan.

"In terms of the hydrogen side of the technology, in the UK we could be a couple of years too early but if we were sat now in Tokyo, we are



Ryan: in Japan there is a healthy gate fee for waste and a good price for hydrogen

perfectly at the right time," said Ryan. "And in Japan there is a healthy gate fee for waste and a good price for hydrogen. Once we are into hydrogen generation from our product, the gate fee for the waste becomes less important."

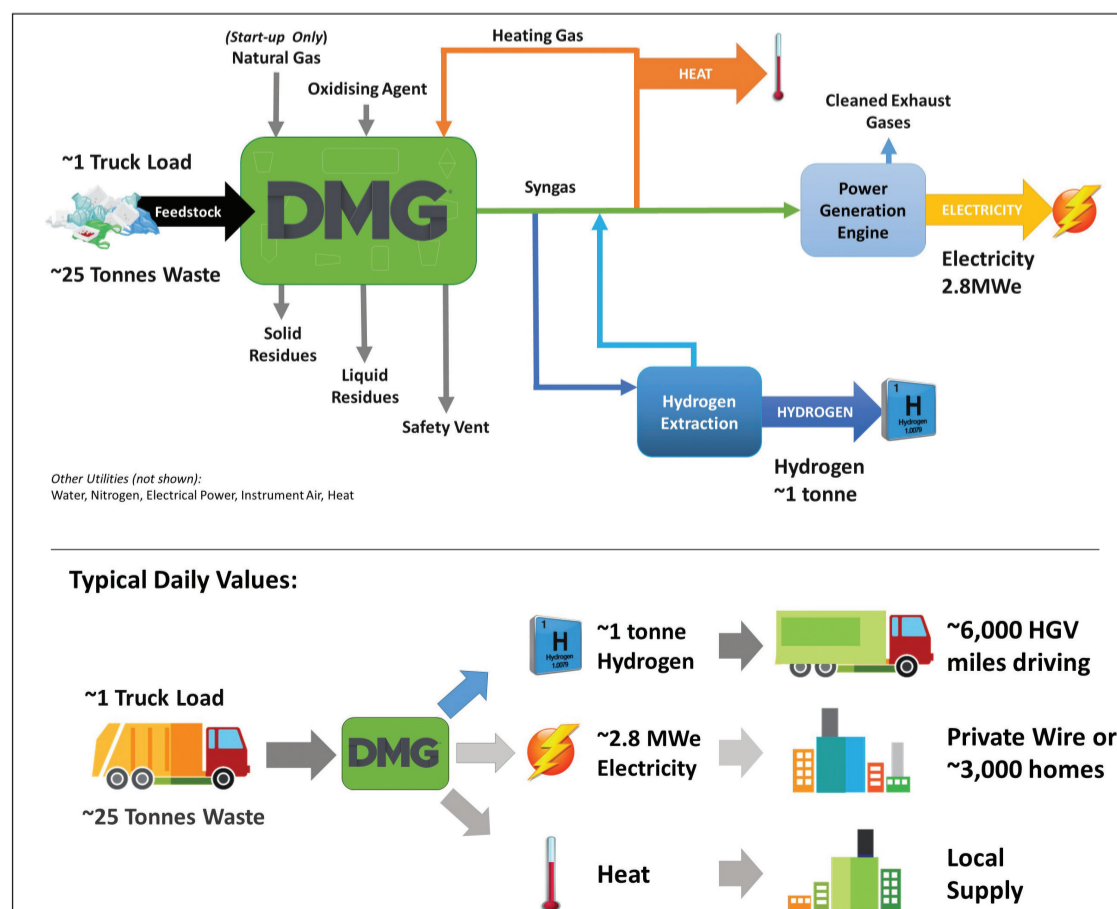
PowerHouse Energy has seen interest from Japan. Following successful in-house testing and gaining "Statement of Feasibility" from DNV GL, in November it received a formal invitation to engage in advanced commercial discussions with Toyota Tsusho Corporation ("Toyota Tsusho"), the industrial arm of Toyota. A deal could help Toyota Tsusho and Toyota fulfil a commitment to providing their fuel cell vehicles with at least two years of free hydrogen.

And as costs come down, DMG technology will become more attractive elsewhere. PowerHouse Energy is targeting equipment costs of less than £5 million (\$6.6 million) for a 25 t/day unit and says this will fall to around £4 million as more units are rolled out. If the total cost for delivery and installation is £6 million, Ryan says it could deliver a 15 per cent return on investment for the project developer and £1 million a year in savings to the host through reductions in electricity cost and waste handling.

Just over a year ago PowerHouse Energy announced a site at Ellesmere Port and is waiting to submit planning permits. Submission, however, depends on securing a power purchase agreement. In the meantime, six other sites have been identified at which PowerHouse Energy is now undertaking application specific engineering activities. An announcement is expected at one of these sites, also in the Ellesmere Port area, shortly.

With Japan looking promising and discussions under way with potential hosts, Ryan is confident of the future. He concluded: "We are doing about one firm proposal a week – mostly in the UK, with one in four for overseas. For sure, if someone comes with a firm commercial arrangement, we're able to go anywhere."

DMG simplified flow diagram of the process and what could be produced from 1 t/day of hydrogen from a truck full of waste





Junior Isles

A bolt from the blue?

Although some ideas appear to make perfect sense, when an actual plan is put forward, it can still come as a surprise. The recent news that the UK is looking to ban the use of fossil fuels, i.e. natural gas, for heating was one such bolt from the blue.

In his Spring Statement, UK Chancellor Philip Hammond said there will be a "Future Homes Standard" to mandate the end of fossil fuel heating systems in all new houses from 2025.

Certainly the plan is based on sound climate change-related advice. In November the Committee on Climate Change (CCC) warned that the UK's legally binding climate change targets will not be met without the near complete elimination of greenhouse gas emissions from UK buildings.

This is not only a UK problem. In its

2018 'World Energy Outlook', the International Energy Agency identifies the buildings sector as a key component of the energy transition in Europe. According to the International Energy Agency (IEA), buildings account for almost 30 per cent of direct CO₂ emissions in the European Union (i.e. not including indirect emissions from the use of electricity and district heating) compared with a worldwide figure of 17 per cent. As the buildings sector also accounts for almost 60 per cent of EU electricity consumption, it is also responsible for an important share of indirect CO₂ emissions.

While energy efficiency measures are seen as a first and important step in tackling cutting energy consumption, and therefore carbon emissions from buildings, the potential for replacing natural gas with hydrogen for

heating in buildings, as well as in other sectors, is starting to move from debate to action.

In its November report, 'Hydrogen in a low-carbon economy', the CCC cited hydrogen as a credible option to help decarbonise the UK energy system. The report found that hydrogen could make an important contribution to long-term decarbonisation if combined with greater energy efficiency, cheap low-carbon power generation, electrified transport and new 'hybrid' heat pump systems, which have been successfully trialled in the UK.

Lord Deben, Chairman of the CCC, said: "Hydrogen has the potential to contribute to near-zero carbon energy emissions if used strategically. The government must now decide whether it wishes to develop a UK hydrogen option, taking decisions now that will see the first deployment in the 2020s. This must be in parallel with efforts to improve energy efficiency, build further low-cost renewables and get carbon capture and storage under way. The time for the government to move from theory to practice has arrived."

Certainly, there are many potential uses of hydrogen in the energy system. It can be used simply as an electricity storage medium and converted back to electricity using a fuel cell, either close to where it was produced or after being transported. Hydrogen, or a hydrogen-based fuel such as methane, can also be combusted directly, for example to replace oil and gas in the transport, buildings, power or industry sectors.

Hydrogen produced from renewables-based systems via electrolysis can also be used as a feedstock for industrial processes, for example in refining and iron and steel, thereby "greening" industry. However, converting electricity to hydrogen is expensive. According to IEA calculations, if electricity is purchased from the grid, hydrogen would cost around \$6 per kilogramme of hydrogen – around three-times more than reforming natural gas using steam, currently the cheapest production option.

Many argue, however, that hydrogen from electrolysis becomes interesting when renewables are at zero marginal cost.

In a research paper released in March, DNV GL said that hydrogen from electrolysis will become competitive with production from natural gas by around 2035.

In the study, 'Hydrogen in the electricity value chain', DNV GL experts conclude that the main reasons for the economic feasibility of hydrogen between 2030 – 2050 are driven by three key developments: the cost of electrolyzers will fall in line with learning curve experiences and the expected decrease in cost of asset developments; time periods when low or zero cost prices for electricity are available will increase due to the rise of renewables, thus generating a surplus of energy available to the power grid; and thirdly, industries are expected to see a shift away from carbon-heavy activities, e.g. due to the introduction of a carbon tax and incentives for low carbon solutions.

The driver behind the study is the ability of hydrogen to provide a source of flexibility in the electricity system – it is converted quite easily to and from electricity and can be stored for a long time without significant losses. But it is its use outside the electricity value chain that will more likely drive

faster deployment.

In its 'Energy Transition Outlook 2018', DNV GL said that in 2050 hydrogen would only meet 0.5 per cent of the global energy demand due to infrastructure limitations. It notes, however, that this would vary greatly by region with uptake being much higher in Europe.

David Ryan, PowerHouse Energy's CEO believes the hydrogen economy can become reality but, at least in the UK, will require huge national infrastructure investment. "In the 1960s we changed all of our devices and bits of equipment to shift from town gas, which was rich in hydrogen, to natural gas. So now we will have to reverse that for hydrogen to be there as a fuel for heat and energy, or for fuel cell cars. As a fuel for heating it would require loosening of the specification on the national gas transmission grid, something that could happen at the national or regional level."

The areas where hydrogen will happen first, in terms of industry, are most likely to be where there can be CO₂ sequestration. For example, in November the 'H21 North of England' report outlines how hydrogen will be produced from natural gas at a self-powered 12.15 GW production facility with carbon capture technology, generating enough hydrogen to fuel homes and industries in the north of England. The by-product of the process, CO₂, would be stored in saline aquifers such as those in the southern North Sea off the northeast coast of England.

The hydrogen produced will be transported to the local city grids in a new high-pressure transmission system designed with extra capacity to enable future supply for industry, power and transport.

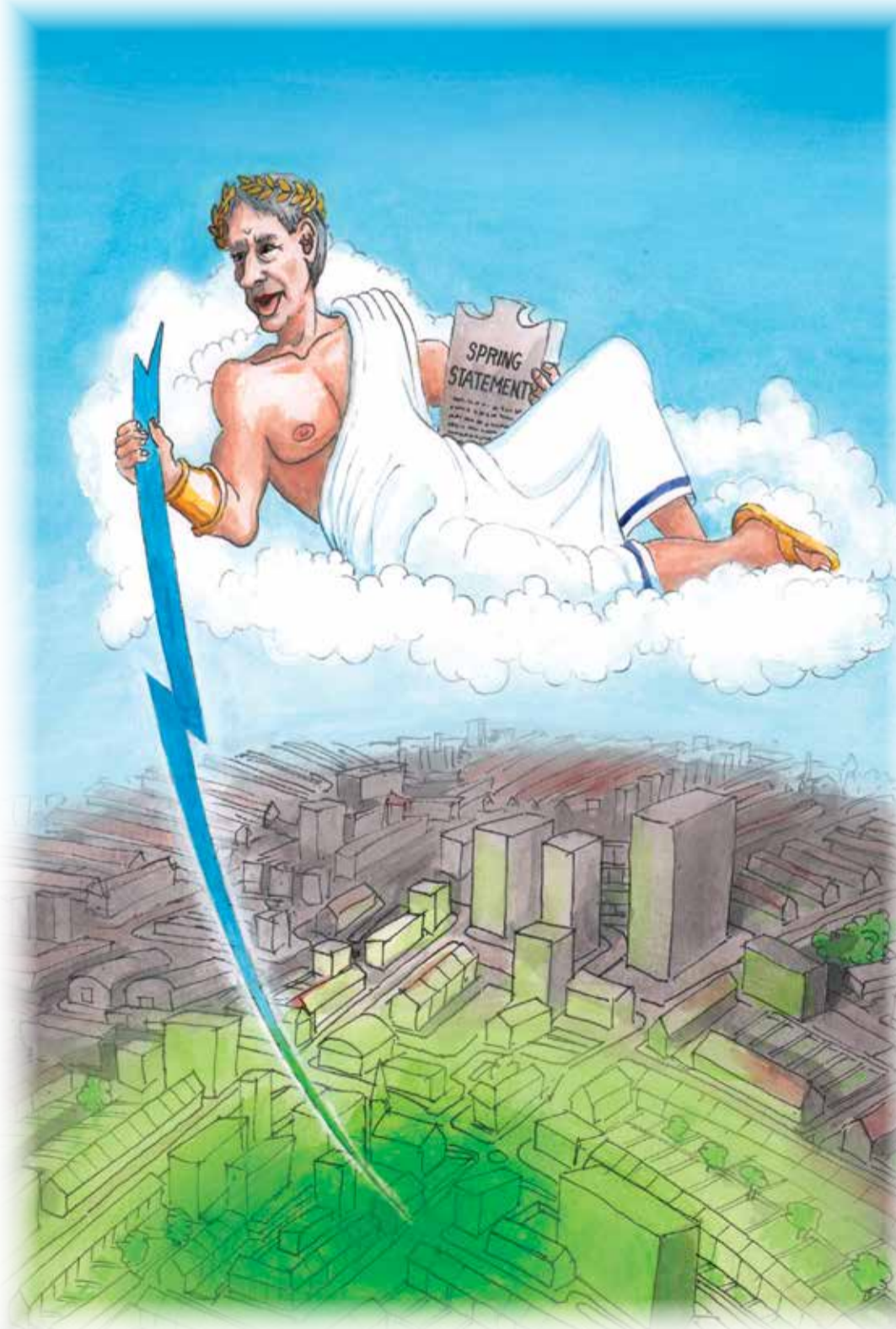
The report sets out detailed plans of how over 3.7 million homes and 40 000 businesses and industries in the north of England that are heated by natural gas could be converted to hydrogen by 2034. The project also proposes a six-phase UK rollout, which could see a further 12 million homes across the rest of the country converted to hydrogen by 2050.

The proposals will see homes across the north of England begin to be converted in 2028, with expansion across 3.7 million properties in Leeds, Bradford, Wakefield, York, Huddersfield, Hull, Liverpool, Manchester, Teesside and Newcastle over the following seven years. The cost of the project is estimated to be £22.7 billion.

It is an ambitious plan, which could easily fall foul of a downturn in the economy or a weakening in political will, but could be a showcase for the rest of Europe.

Globally, the speed at which hydrogen becomes an energy carrier of the future will ultimately depend on the cost of transforming gas transmission infrastructures; how far the cost of renewable electricity production and electrolyzers fall; the determination of governments to decarbonise heat, transport and industry; and not forgetting, the resistance that might come from the oil and gas majors.

An effective, working hydrogen economy may be a long way off and fraught with challenges but Hammond's plan – which should be carefully consulted on for a full assessment of the impacts – is a worthy one. Perhaps it should be seen as more of a bolt from the green than from the blue.



Cartoon: jemsoar.com