THE ENERGY INDUSTRY TIMES

July 2019 • Volume 12 • No 5 • Published monthly • ISSN 1757-7365 www.teitimes.com

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EU bloc not yet swayed by UK net zero emissions ambition

Hungarian Prime Minister, Viktor Orbán also opposed the EU text

The EU has stopped short of agreeing on more ambitious targets for carbon emissions despite the UK taking the lead on signing a national net zero 2050 target into law. **Junior Isles**

Hopes that the EU would agree to a net-zero carbon emissions target for 2050 were dashed at a recent climate debate.

During talks in late June, Poland and the Czech Republic refused to sign up to a text that referred to a climate-neutral EU by 2050. Hungarian Prime Minister, Viktor Orbán, also opposed the EU text, despite earlier indicating that the country was ready to compromise.

Hopes that the EU would be seen to be moving towards more ambitious carbon mission targets, ahead of a major UN climate summit in September, were buoyed by the UK's announcement that it has legally adopted a net zero 2050 target.

Two weeks before the EU debate, the UK became the first major economy to pledge to cut CO_2 emissions to close to zero. The target will require the UK to bring all greenhouse gas emissions – excluding aviation and international shipping – to virtually zero by 2050, compared with the existing target of an 80 per cent reduction.

UK Prime Minister Theresa May's parliament took the decision following a report from the Committee on Climate Change (CCC) published in May. The report calls for extensive electrification of the economy and a quadrupling of low-carbon power generation by 2050.

The move was broadly welcomed by industry. Dr Nina Skorupska CBE FEI, Chief Executive of the Renewable Energy Association (REA) commented: "Being the first G7 nation to adopt a net zero greenhouse gases emissions target by 2050 is a historic step not only for our industry but for the UK as a whole.

"This decision demonstrates that government is listening to both the scientific evidence regarding climate change and to the tens of thousands of school children and members of the public who have taken to the streets in recent months.

"In their net-zero recommendations, the Committee on Climate Change rightly identified that the variety and sophistication of renewable technologies needed to reach net-zero already exist. What is needed now is clear and consistent policy that will allow for a route to market for renewable and clean technologies that will attract investors," she added.

James Robottom, IET Energy and Climate Change Lead, said: "Progress has been made in transport and electricity but this needs to continue at a great pace and significant challenges remain in decarbonising heat and industry. Eight per cent of the homes we

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Political inaction to blame for lack of progress on climate

Erratic policymaking is holding the renewable energy sector back from its potential contribution to cutting carbon pollution and meeting climate and development targets, according to REN21's Renewables 2019 Global Status Report (GSR).

Renewables now supply more than a quarter (26 per cent) of global electricity production but current trends in the sector show that bolder policy decisions are needed across all end-use sectors to make energy systems sustainable, said the report.

"A key breakthrough could occur if countries cut their fossil fuel subsidies which are propping up dirty energy," said Rana Adib, Executive Secretary, REN21. "Ambitious policy and regulatory frameworks are critical to creating favourable and competitive conditions, allowing renewable energy to grow and displace more expensive and carbon-emitting fuels.

Forty countries have undertaken some level of fossil fuel subsidy reform since 2015, but these subsidies continued to exist in 112 countries in 2017, with at least 73 countries providing subsidies of over $100 million each. Estimated total global subsidies for fossil fuel consumption were $300 billion in 2017, an 11 per cent increase from 2016, REN21 said.

BP's recent Statistical Review of World Energy 2019 noted that although renewables grew by 14.5 per cent, nearing their record-breaking increase in 2017, they still accounted for only around a third of the increase in total power generation.

A key finding from the Review is that global energy demand grew by 2.9 per cent while carbon emissions grew by 2.0 per cent in 2018, faster than at any time since 2010/11.

Introducing the findings, Spencer Dale, BP Chief Economist, said: "There is a growing mismatch between societal demands for action on climate change and the actual pace of progress, with energy demand and carbon emissions growing at their fastest rate for years. The world is on an unsustainable path."

Bob Dudley, BP Group Chief Executive, added: "The longer carbon emissions continue to rise, the harder and more costly will be the necessary eventual adjustment to net zero carbon emissions."

CDP, formerly known as the Carbon Disclosure Project, recently noted that many of the world's biggest companies, from Silicon Valley tech firms to large European banks, are bracing for the prospect that climate change could substantially affect their bottom lines within the next five years.

Under pressure from shareholders and regulators, companies are increasingly disclosing the specific financial impacts they could face as the planet warms, such as extreme weather that could disrupt their supply chains or stricter climate regulations that could hurt the value of coal, oil and gas investments.

In 2018, more than 7000 companies submitted such reports to CDP and, for the first time, CDP explicitly asked firms to try to calculate how global warming might affect them financially.

After analysing submissions from 215 of the world's 500 biggest corporations, CDP found that these companies potentially faced approximtely $1 trillion in costs related to climate change in the decades ahead unless they took proactive steps to prepare.

THE ENERGY INDUSTRY TIMES is published by Man in Black Media • www.mibmedia.com • Editor-in-Chief: Junior Isles • For all enquiries email: enquiries@teitimes.com

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will be living in, in 2050, have already been built, meaning foremost a national retrofit programme has to be seriously considered and implemented to bring these into net-zero targets."

Commenting on the impact of carbon targets on UK competitiveness, Nick Molho, Executive Director at the Aldersgate Group, noted: "The best way to address competitiveness concerns will be for the government to introduce measures such as product standards to protect British industry from high carbon competition and use its extensive diplomatic network to encourage other emitters to adopt similar targets and grow low carbon trade."

Concerns, however, remain on the cost and difficulty of achieving net zero. "If you really want to do this – and it is a huge ask – you have to come out of the block running," said Dieter Helm, Professor of Economics at Oxford University. "It is a huge industrial undertaking."

Chancellor Philip Hammond warned Theresa May that her plan will cost the UK over £1 trillion.

In a letter to the Prime Minister seen by the *Financial Times*, the Chancellor said the cost meant that less money would be available for schools, police, hospitals and other areas of public spending. He also warned that the target would render some industries "economically uncompetitive" without huge government subsidies.

The UK is among a majority of EU countries that are pushing for the bloc to formally adopt a net zero 2050 target. At last month's meeting, German Chancellor, Angela Merkel, told fellow leaders that the EU needed to signal ambition ahead of the UN meeting. French President, Emmanuel Macron, called for the EU to agree an unambiguous target for net zero carbon emissions by 2050.

Bulgaria, Poland and the Czech Republic, however, were against any mention of 2050 in the main EU summit communiqué. The Czech Prime Minister, Andrej Babiš, had remarked on his arrival at the summit: "Why should we decide 31 years ahead of time what will happen in 2050?"

At the meeting, Babiš questioned why Europe should act when emissions in China were rising. Merkel countered that the Chinese were taking action that would mean a reduction in Chinese emissions after 2030.

Hope that the bloc would unanimously support the target had risen just ahead of the talks after Slovakia, Bulgaria and some Baltic states announced their support, seeing economic gains from the transition to a green economy. "We have come to the conclusion that this is a hell of an opportunity," the Latvian Prime minister, Krišjānis Kariņš, told fellow leaders.

UN secretary general, António Guterres voiced the importance of the EU in achieving global climate targets. He wants the climate summit in September to put the world on a path to limiting global warming to 1.5°C – a non-binding aspiration of the 2015 Paris accord.

Guterres wrote to European council President, Donald Tusk, in May calling on him to demonstrate the leadership of the EU. "I write to you today both as a G20 member and as a leader who I believe can bring the ingenuity needed to transform our economic systems and avert the negative impacts of a world with high levels of carbon emissions – from rising levels of pollution to costly natural disasters," he stated.

Clean technology progress failing to meet long-term goals

Although the costs of solar, wind and battery storage are falling, the gains made in these technologies are not sufficient to achieve long term climate and sustainable development goals. **Junior Isles**

The vast majority of technologies and sectors are failing to keep pace with long-term goals, says the International Energy Agency's latest assessment of clean energy transitions.

Of the 45 energy technologies and sectors assessed in the IEA's latest Tracking Clean Energy Progress (TCEP), only seven are on track with the IEA's Sustainable Development Scenario (SDS). The SDS represents a pathway to reach the goals of the Paris Agreement on climate change, deliver universal energy access and significantly reduce air pollution.

Some clean energy technologies showed major progress last year, according to the new TCEP analysis. Energy storage is now "on track" as new installations doubled, led by Korea, China, the United States and Germany. Electric vehicles had another record year, with global sales hitting 2 million in 2018. China accounted for more than half of total sales.

Solar PV remains on track with a 31 per cent increase in generation – representing the largest absolute growth in generation among renewable sources. But annual capacity additions of solar PV and renewable power as a whole levelled off in 2018, raising concerns about meeting long-term climate goals.

In its own projections, Bloomberg-NEF (BNEF) said that deep declines in wind, solar and battery technology costs will result in a grid nearly half-powered by the two fast-growing renewable energy sources by 2050.

In its New Energy Outlook 2019 (NEO), BNEF sees these technologies ensuring that – at least until 2030 – the power sector contributes its share toward keeping global temperatures from rising more than 2°C.

Each year, NEO compares the costs of competing energy technologies through a levelised cost of energy analysis. This year the report finds that in approximately two-thirds of the world, wind or solar now represent the least expensive option for adding new power generating capacity. Electricity demand is set to increase 62 per cent, resulting in global generating capacity almost tripling between 2018 and 2050. This will attract $13.3 trillion in new investment.

Matthias Kimmel, NEO 2019 lead analyst, said: "Our power system analysis reinforces a key message from previous New Energy Outlooks – that solar photovoltaic modules, wind turbines and lithium-ion batteries are set to continue on aggressive cost reduction curves, of 28 per cent, 14 per cent and 18 per cent respectively for every doubling in global installed capacity. By 2030, the energy generated or stored and dispatched by these three technologies will undercut electricity generated by existing coal and gas plants almost everywhere."

The deep decline in costs were confirmed in a separate report released by the International Renewable Energy Agency (IRENA), which noted that costs for renewable energy technologies fell to a record low last year. The global weighted-average cost of electricity from concentrating solar power (CSP) declined by 26 per cent, bioenergy by 14 per cent, solar photovoltaics (PV) and onshore wind by 13 per cent, hydropower by 12 per cent and geothermal and offshore wind by 1 per cent, respectively.

Falling renewable and battery costs, however, is not sufficient to avoid climate change. BNEF's outlook for global emissions and keeping temperature increases to 2°C or less is mixed. On one hand, the build-out of solar, wind and batteries will put the world on a path that is compatible with these objectives at least until 2030. On the other hand, a lot more will need to be done beyond that date to keep the world on that 2°C path, says the NEO.

One reason is that wind and solar will be capable of reaching 80 per cent of the electricity generation mix in a number of countries by mid-century, with the help of batteries, but going beyond that will be difficult and will require other technologies to play a part – with nuclear, biogas-to-power, green hydrogen-to-power and carbon capture and storage among the contenders.

International action can scale up hydrogen

International action can scale up hydrogen to make it a key part of a clean and secure energy future, according to a new report released by the International Energy Agency (IEA).

The in-depth study, which analyses hydrogen's current state of play and offers guidance on its future development, was launched by Dr Fatih Birol, the IEA's Executive Director, alongside Hiroshige Seko, Japan's Minister of Economy, Trade and Industry, during the meeting of G20 energy and environment ministers in Karuizawa, Japan.

The report – 'The Future of Hydrogen: Seizing Today's Opportunities' – finds that clean hydrogen is currently receiving strong support from governments and businesses around the world, with the number of policies and projects expanding rapidly. It recommends actionable steps to bring down costs, build infrastructure and spur trade across a wide range of sectors.

A wide variety of fuels are able to produce hydrogen, including renewables, nuclear, natural gas, coal and oil. Hydrogen can be transported as a gas by pipelines or in liquid form by ships, much like liquefied natural gas (LNG). It can also be transformed into electricity and methane to power homes and feed industry, and into fuels for cars, trucks, ships and planes.

"Hydrogen is today enjoying unprecedented momentum, driven by governments that both import and export energy, as well as the renewables industry, electricity and gas utilities, automakers, oil and gas companies, major technology firms and big cities," said Dr Birol. "The world should not miss this unique chance to make hydrogen an important part of our clean and secure energy future."

To build on this momentum, the IEA report offers seven key recommendations to help governments, companies and other stakeholders to scale up hydrogen projects around the world. These include four areas where actions today can help to lay the foundations for the growth of a global clean hydrogen industry: making industrial ports the nerve centres for scaling up the use of clean hydrogen; building on existing infrastructure, such as natural gas pipelines; expanding the use of hydrogen in transport by using it to power cars, trucks and buses that run on key routes; and launching the hydrogen trade's first international shipping routes.

Speaking at the meeting as a co-chairman of the Hydrogen Council, Hyundai Motor Group Executive Vice Chairman Chung Eui-sun urged CEOs and energy ministers of G20 countries to start a global initiative to use hydrogen as a key energy source. "We hope the close collaboration between the IEA and the Hydrogen Council will ultimately lead to clear recognition of the benefits from hydrogen technologies."

The Hydrogen Council expects the gas will account for about 20 per cent of world energy demand by 2050. This will cut global carbon emissions by 6 Gt, accounting for a big portion of worldwide efforts to limit global warming.

Unplanned repairs to cost wind turbine industry over $8 billion

Global onshore wind operation and maintenance (O&M) costs will reach nearly $15 billion in 2019. Of that number, $8.5 billion (57 per cent) will be spent on unplanned repairs and corrective measures resulting from component failures, according to new research by Wood Mackenzie Power & Renewables.

Commenting on the research, Daniel Liu, Wood Mackenzie Power & Renewables Principal Analyst, said: "Tender prices for new wind turbine developments are declining globally. This has sharpened the focus on operational expenditures for wind power plants and asset owners are searching for new solutions in an effort to reduce O&M costs.

Unplanned failures can cost the asset owner as much as $30 000 per turbine per year in terms of repairs and spare parts and up to seven days worth of lost production per year, said the study. It noted this figure does not include production losses caused by pre-emptive shutdowns or long delivery times for materials, equipment and technicians to the affected turbine.

According to Wood Mackenzie, spare parts and associated logistics comprise approximately 50 per cent of the direct costs associated with unplanned repairs. Capital components alone – gearboxes, generators and blade – can cost up to $10 000 per turbine per year in replacements, said the report.

While digitalisation is often touted as the solution to improving O&M, the report indicates that it is not always the answer.

Liu said: "For all the touted benefits offered by digital technology, adoption rates by asset owners are mixed. Many of the leading asset owners only deploy a basic form of digital technology and cases of full digital ecosystem deployment are rare.

He added: "In quite a few cases, the basic economics do not always stack up for digital solutions. Deployment costs for retrofitting a complete ecosystem to existing fleets and operations ranges into the hundreds of thousands of dollars per site."

USA rolls back Obama-era climate rules

■ Bloomberg pledges pro-climate funding ■ Environmental groups plan legal challenges

Siân Crampsie

US President Donald Trump is making good on campaign pledges to support the country's coal sector with plans to replace legislation brought in by the previous administration curtailing emissions from power plants.

The Environmental Protection Agency (EPA) has finalised new rules governing carbon dioxide emissions from power plants that will replace the Obama administration's Clean Power Plan, which was designed to push the US electricity industry away from coal and towards renewable energy and gas.

The new Affordable Clean Energy (ACE) rule will empower states to reduce emissions while "providing affordable and reliable energy", EPA said in a statement. It added that it would "restore the rule of law" following Omaba's "overreaching" Clean Power Plan.

The ACE rule establishes emission guidelines for states developing plans to limit carbon dioxide at coal fired power plants. It identifies heat rate improvements as the best means of reducing emissions and gives states three years to submit plans.

Environmental groups have widely criticised the measures, announced by EPA chief Andrew Wheeler, a former coal industry lobbyist, and have pledged to challenge the new rule in court.

The Sierra Club said that the initiative was a "deadly rollback and an illegal giveaway to the coal industry" that ignored peer-reviewed science. Glen Hooks, Director of the Arkansas Sierra Club, said: "Trump and Wheeler are pushing a plan that will lead to thousands of deaths while ignoring the public's demands for aggressive climate action, just so a handful of wealthy coal executives can make a little more money.

"This is an immoral and an illegal attack on clean air, clean energy, and the health of the public, and it shows just how heartless the Trump administration is when it comes to appeasing its polluters allies."

The Clean Air Task Force said that the rule was a "cynical attempt to preclude coal fired power plants from reducing their climate pollution" and added that it would challenge the rule in the courts this summer. Conrad Schneider, Advocacy Director for the Clean Air Task Force said: "The so-called ACE rule is nothing more than an unlawful life-extension programme for coal plants masquerading as a climate rule.

"Instead of reductions in the carbon pollution required by law, the ACE rule simply checks the box of a Trump campaign promise in a futile attempt to save the coal industry by calling for investments in old, dirty coal plants that will run harder and longer, resulting in increased pollution."

According to the EPA, the ACE rule will reduce emissions of carbon dioxide by 11 million tons by 2030, as well as reduce emissions of sulphur dioxide, nitrous oxides, mercury and particulates. The rule will go into effect shortly after publication in the Federal Register.

Earlier in June, former New York City Mayor Michael Bloomberg announced plans to donate $500 million to fund a new initiative to shut down every remaining coal fired power plant in America by 2030.

The plans – an overt attempt to counter the US coal lobby – would fund lobbying efforts within local governments in an effort to help states transition to renewable energy. Some of the money will also go towards election campaigns for candidates who focus on clean energy. The funding will also be spent to help wean America off natural gas.

"We're in a race against time with climate change, and yet there is virtually no hope of bold federal action on this issue for at least another two years," Bloomberg told *The New York Times* in a statement. "Mother Nature is not waiting on our political calendar, and neither can we."

The new campaign will be called Beyond Carbon and stem from Bloomberg's previous support of the Sierra Club's Beyond Coal initiative.

It is thought to be the largest ever philanthropic donation to combat climate change.

Argentine fault triggers blackout

A fault in the Argentinian electricity network triggered a massive blackout across Argentina and Uruguay last month.

Argentine President Mauricio Macri promised a full investigation into the cause of the event, which started at 7am on Sunday 16 June and left tens of millions of people in the dark.

Parts of Chile and Paraguay were also affected, according to media reports. In Argentina, it took 10 hours to restore services to 95 per cent of consumers.

A statement from distribution firm Edesur said: "The failure in the network that caused the blackout at the national level originated in a connection to transport electricity between the Yacyretá and Salto Grande power stations in the Argentine Coast." It added that the protection systems of power plants on the network were activated, taking them offline and causing the widespread blackout.

Uruguayan power company UTE said the failure left Uruguay's "entire national territory without service". It said it had restored interrupted services by 6.30 pm that evening.

Local media reported that Gustavo Lopetegui, the Argentine Energy Secretary, said that the blackout originated at an electricity transmission point between the power stations at Argentina's Yacyretá dam and Salto Grande in the country's northeast.

Chile closes coal fired plants

Chile will close eight coal fired power plants over the next five years as part of bold plans to decarbonise the economy.

The country's government has reached agreements with several generators, including AES Gener, Colbún, Enel and Engie, to retire around 1000 MW of capacity at the country's eight oldest coal fired power plants by 2024.

The so-called Decarbonisation Plan also envisages the total closure of all coal fired power plants in Chile by 2040. Chilean President Sebastián Piñera, together with the Minister of Energy, Susana Jiménez, announced the plan in early June, pledging to minimise the impact of the closures on local economies and jobs.

There are 28 existing coal fired power plants in Chile with a combined capacity of around 5500 MW. Chile's ambition is to have a carbon neutral economy by 2050.

Piñera said that "the eight plants that cease production will remain for a period of five years in the strategic reserve stage to be called to operate if necessary to ensure the forecast of energy in the country".

Enel said that its 158 MW Central Tarapacá would close in 2020, and its 128 MW Bocamina 1 plant would be shut in 2023.

"As a group we have been leading the energy transition towards a clean and sustainable matrix, and today we confirm our commitment by signing an agreement that provides for the progressive closure of our coal fired plants, reducing them by half by 2023," said Paolo Pallotti, general manager of Enel Chile.

ACORE reports positive growth outlook for US clean energy

Investment attitudes in the US renewable energy sector are positive but the industry has warned that policy gaps could affect financing flows in the longer term.

The American Council on Renewable Energy (ACORE) has reported high near-term confidence for renewable energy growth over the next three years and a strong appetite for increased investment after surveying a group of leading financial institutions.

However, it believes that a lack of coherent federal-level policy for renewables, coupled with other hurdles, threatens continued growth in the US renewables sector.

In 2018, the private sector invested more than $56.7 billion in the US renewable energy sector, including $8.2 billion in enabling grid technologies such as energy storage, ACORE said.

According to the ACORE report, solar PV and energy storage technologies are the two most attractive investment options for the 2019-2022 period. It also notes that investors' confidence in renewable energy sector growth over the next three years remains high, and that renewable energy maintains its attractiveness compared with other asset classes in the portfolios of survey respondents.

Investors cited the low cost of renewable energy, expanded state renewable portfolio standards, increased demand from corporate end-users, the potential for new carbon legislation and a rush to benefit from the tax credits before they sunset, among their main reasons for optimism over the next three years, ACORE said.

It added that in recent weeks, a number of federal legislative proposals have also been introduced that could have important impacts for the renewable sector. These bills include a new tax credit for energy storage, new national renewable energy and clean energy standards, a federal price on carbon emissions, and a technology-neutral tax credit for carbon-free electricity generation.

"Renewable energy remains one of the most attractive investment options in America today," said Gregory Wetstone, ACORE's President and CEO. "Over the long-term, however, the renewable sector is going to need predictable policy drivers, competitive power markets and a modernised grid to meet its potential and answer Americans' growing calls for a clean energy economy."

ACORE has been campaigning to raise renewables investment to $1 trillion by 2030. Barriers to continued growth in investment include trade disputes and insufficient investment in the grid.

■ A consortium led by Mitsubishi Hitachi Power Systems has launched a pioneering $1 billion energy storage project in Utah. The Advanced Clean Energy Storage project would use compressed air energy storage (CAES) technology to store up to 1000 MW generated by excess renewables in large salt caverns in Utah. The project could be operational with an initial 250 MW phase in 2025.

Japan continues energy sector transformation

■ FITs for renewables to be replaced by bidding system ■ EVs and VPPs facilitating renewables integration

Syed Ali

Japan has taken several important steps in advancing its transition to a low carbon emissions energy sector. Last month, the Ministry of Economy, Trade and Industry (METI) said it will replace its renewables feed-in-tariff (FIT) with a competitive bidding system along the lines of those used in Germany and other European countries.

The FIT system, introduced in 2012 to promote greater development of renewable energy, is being scrapped as part of the government's effort to make renewable energy become a major component of Japan's power mix.

Under the FIT system, the government sets favourable prices for energy from wind and solar operators, where the higher rates are passed on to consumers via electricity bills. Those purchasing fees, however, have grown as solar and other forms of renewable power have gained. In fiscal 2019, they are expected to amount to about Yen3.6 trillion ($33.2 billion), with about Yen2.4 trillion being passed on to households and businesses. Policy-makers decided reforms are needed, as project developers have been slow to realise cost reductions.

In the proposed competitive bidding, expected to be introduced as early as 2020, mid-size operators that produce more than 50 to 100 kW will be obligated to find their own customers and to sell on the wholesale market. Prices will not be fixed but rather negotiated based on market conditions. Companies will only be compensated for losses if prices fall below a set level based on the lowest prices that come from competitive bidding.

Japan is calling for further efforts to cut its carbon emissions by promoting renewable energy while also pushing nuclear power, despite its 2011 Fukushima nuclear plant disaster.

An energy policy paper, adopted by the Cabinet in June, said Japan faces the urgent task of reducing carbon emissions by utilities that rely heavily on fossil fuel plants to make up for shortages of cleaner nuclear energy. The call comes as nuclear reactors around Japan are slowly being restarted after being shut down to meet tougher safety standards.

Japan wants renewable energy's share in 2030 to grow to 22-24 per cent of power supply from 16 per cent, while increasing nuclear energy to 20-22 per cent from just 3 per cent in 2017. The report said the cost of renewables also needs to be reduced.

In an effort to help integrate the growing amount of renewables coming onto the grid, the country is seeing how it can utilise distributed energy sources such as electric vehicles (EVs) and virtual power plants (VPPs).

At the start of June, Kyocera Corporation and BYD Japan Co., Ltd., the Japanese arm of Chinese EV producer BYD Co. Ltd., announced a joint project to develop an integrated renewable supply-demand energy system for EVs. By combining renewable energy from Kyocera's solar power generating systems and BYD's electric buses, the collaboration will maximise the effectiveness of renewable energy, greatly reduce power losses, and maintain a stable supply-demand energy balance.

For this project, Kyocera will develop the energy charge management system to optimally control the supply-demand balance between energy production and consumption by using aggregation technology developed during VPP test projects over the past several years.

In a separate development, Tokyo Electric Power Company Holdings, Inc., TEPCO Energy Partner, Inc., TEPCO Power Grid, Inc., Mitsubishi Motors Corporation, Hitachi Systems Power Services, Ltd. and Shizuoka Gas Co., Ltd. announced that they have applied as a consortium for a grant to cover the costs of its 'FY2019 Virtual Power Plant Construction Demonstration Project That Utilizes Demand-side Energy Resources (V2G Aggregator Project)'. Experiments will be conducted at five locations within from June 3, through February 17, 2020.

The demonstration aims to balance the introduction of renewable energy with power grid stability by using EVs and plug-in hybrid EVs (PHEV) as VPP resources. V2G (Vehicle-to-Grid) enables electricity supply/demand to be adjusted through a two-way power exchange between the accumulators in EV/PHEV and power grids. With commercialisation of V2G planned for FY2021, the consortium is currently examining viable business models.

This is the second time that the six companies have participated in this project, which was founded in FY2018 by the Ministry of Economy, Trade and Industry (METI) through its Sustainable open Innovation Initiative (SII). The first time the companies worked together in FY2018, they constructed an experiment environment that enables a two-way power exchange between EV/PHEV and a power grid, and demonstrated that this technology will be effective in contributing to power grid stability.

Chinese investment in thermal generation hits record low


Investments in coal fired generation fell by 8.8 per cent

Investment in thermal power generation contracted by 8.3 per cent to CNY78.6 billion ($11.35 billion), its lowest level since 2004.

According to the China Electricity Council (CEC), total investments in power generation across the board in China declined by 3.9 per cent in 2018 to CNY278.7 billion ($40 billion), as investments in coal fired power generation dipped by 8.8 per cent to CNY64.4 billion ($9.3 billion). Hydropower benefitted most from the fall, as investment increased 13 per cent to CNY70 billion.

Investments also declined in nuclear power generation (-1.6 per cent to CNY44.7 billion, as well as in wind and solar. Investments in wind power decreased by 5.2 per cent to CNY64.6 billion, while those in solar power generation fell by 27 per cent to CNY20.7 billion. The fall is related to Chinese policies aimed at tackling a subsidy payment shortfall and at curbing overcapacities.

The country saw the addition of 5.2 GW of solar photovoltaic (PV) capacity in the first quarter of 2019, down from 9.65 GW a year ago. Data from the National Energy Administration (NEA), however, shows cumulative installed solar power capacity at the end of March was 28 per cent higher than in the year-ago period, standing at 179.7 GW.

In late May, China's National Development and Reform Commission (NDRC) gave the go-ahead for 20.76 GW of renewable energy projects that will be developed without government subsidies. The list, being the first batch of such projects planned for 2019, includes 56 wind farm projects totalling 4.51 GW, and 168 of solar PV schemes of 14.78 GW in total. Distributed generation trading pilot projects of 1.47 GW are also in that list.

China Knowledge reported that China will be ending subsidies for new onshore wind power projects starting from 2021 with renewable projects expected to be able to compete with traditional coal and gas fired electricity by then.

■ Energy giant EDF announced that its Taishan 2 reactor has carried out its first chain reaction. The fission reaction at Taishan 2 reactor follows the Taishan 1 reactor becoming last year the first of its next generation EPRs to advance to the operational stage.

Energy transition boosted by $7 billion investment

The Asian Development Bank (ADB) and the United States Agency for International Development (USAID) have launched a partnership to accelerate the transition to a more sustainable, secure, and market-driven energy sector in Asia and the Pacific.

Under the framework of this agreement, USAID and ADB will work to mobilise $7 billion of investment for energy projects in Asia and the Pacific, boost the capacity of clean energy systems by 6 GW, and increase regional energy trade by 10 per cent over the next five years. This agreement will promote energy efficiency, energy sector reform, and good governance of Asia and the Pacific's energy sector.

USAID Asia Bureau Acting Assistant Administrator Gloria Steele and ADB Strategy, Policy, and Review Department Director-General Tomoyuki Kimura signed the partnership at the Asia Clean Energy Forum, held in Manila, Philippines, in June.

The pact follows decades of development collaboration between the US government and ADB, and the new partnership is part of Asia Enhancing Development and Growth through Energy (Asia EDGE), a key initiative contributing to the US government's Indo-Pacific Strategy.

Specifically, the Asia EDGE seeks to strengthen energy security, increase energy diversification and trade, and expand energy access across the region by drawing on the expertise and resources of the US government, private sector, and international financial institutions and partnering with like-minded stakeholders.

South Korea approves energy roadmap

South Korea has reaffirmed its strong commitment toward reduced dependency on conventional energy sources, with the approval of the new energy policy roadmap, proposed in April.

South Korea's energy guidelines are renewed every five years with a 20-year goal. The Ministry of Trade, Industry, and Energy said in a statement: "The government plans to gradually decrease the number of nuclear and coal plants to have a clean and safe portfolio of energy."

Under the plan, renewable energy sources, such as solar and wind, will account for up to 35 per cent of the country's electricity output in 2040, sharply up from around 6 per cent in 2017.

The government says it will refrain from building new energy plants running on conventional sources. Some existing coal plants, however, will be repowered to run on cleaner resources, such as LNG.

Challenging times for Germany offshore wind

■ Offshore wind goal lacks ambition ■ Siemens and Amprion cooperate on grid stabilisation

Junior Isles

Although Germany's offshore wind sector offers significant opportunities, realising its full potential is not without challenges, according to industry experts.

WindEurope CEO, Giles Dickson recently noted that although Germany could "comfortably deliver 20 GW and a higher volume by 2035", its National Energy & Climate Plan for 2030 currently envisages only 15 GW total installations by 2030.

"As things stand they are being less ambitious in relative terms on their offshore wind build-out than the UK, Netherlands, Belgium, Denmark and Poland," said WindEurope.

The organisation says that a lack of auctions – the last one being in April 2018 and no more scheduled until 2021 – and a disappointing outlook for future auction volumes to 2030, means order books are drying up. This, it says, is putting the supply chain under real pressure.

WindEurope also said there were concerns over whether Germany would have sufficient power generation capacity if it did not accelerate build-out of offshore wind at a time when nuclear and coal fired plants are closing.

While other experts note that wind is not the sole answer to Germany's looming generation problems, they point out that offshore wind poses challenges for the grid.

Commenting on whether wind will be able to compensate for the loss of nuclear and coal from the grid, Mirko Düsel, CEO of Siemens Distribution, said: "If you take a global view of generation today, in general there's always a mix. There is no one country that relies on a single generating source due to [grid] stability reasons as well as availability."

Ludger Meier, Vice President Engineering & Operations, EHV grid at Amprion GmbH, operator of the western part of the transmission grid in Germany, said: "The increase in wind generation and its volatility calls for extension of the grid to keep the system running."

Meier noted that a significant amount of generating capacity in the North Sea and Baltic Sea will lead to large transmission distances in order to feed power to the industrial middle and south of the country. "This can cause challenges with voltage fluctuations in the grid, so we have to invest in reactive power compensation in the grid."

The growth in offshore wind requires the creation of north to south HVDC corridors in Germany but being a point-to-point solution, there is also a requirement for static VAR compensation (STATCOM) technology. The increasing volatile load in the AC-grid also calls for STATCOM technology, Meier and Düsel explained.

Meier and Düsel were speaking just ahead of an event celebrating the delivery of Siemens' 100th STATCOM (static VAR compensator) from the SVC PLUS series. The turnkey installation for Amprion will be deployed in the important Kusenhorst node in North Rhine Westphalia, Germany.

"HVDC usually has a starting point and an end point, with overhead lines or cables in between. But as a densely populated country, with electricity demand in more than one location, we needed a multi-terminal solution for Amprion," noted Düsel.

AC electricity transmission requires reactive power, which has traditionally been provided primarily by large power plants. Due to the energy transition, many of these plants in Germany will be shut down – which is why grid operators like Amprion are responding by installing reactive power compensation systems.

EDF considers new model for Sizewell C

EDF Energy could put forward proposals for a new financing model for the Sizewell C nuclear power plant project in the UK.

The French energy giant has indicated that a new funding model, based on regulated asset base (RAB) funding, would mean that households would pay a £6 annual levy on energy bills to finance the project.

The RAB model – where consumers pay upfront to fund large infrastructure projects – is expected to be more palatable than the contracts for difference (CFD) system used for the under-construction Hinkley Point C nuclear power plant.

EDF Energy sealed a £92.50/MWh CFD strike price for Hinkley Point C – approximately double the current wholesale electricity price – leading to sharp criticism of the government over the costs of the project.

The RAB model has been successfully used for the Thames Tideway 'super sewer' through London. EDF believes that putting in place a guaranteed return via the RAB mechanism would make the project more attractive to investors.

It also believes it can cut the cost of the Sizewell C project by 20 per cent compared with the £19.5 billion Hinkley project due to the replication of the build.

■ EDF is now reviewing the start-up schedule and costs of its flagship Flamanville nuclear project in France after the regulator said it would have to fix faulty weldings that have already delayed the project. Nuclear watchdog ASN says that EDF needs to repair eight of the joins at Flamanville, where nuclear fuel loading was scheduled for the end of 2019.

EC approves Italian renewables support

■ €5.4 billion scheme will increase production from renewable sources
■ Approval comes as Commission publishes National Energy and Climate Plans

Siân Crampsie

Plans by Italy to introduce new renewable energy support measures have won the backing of the European Commission.

The Commission has approved the proposed scheme under state aid rules, noting that it will contribute to European Union environmental goals without distorting the energy market.

"More renewable energy in power generation is essential for the future of our planet and environment," said Commissioner Margrethe Vestager, in charge of competition policy.

"The €5.4 billion scheme will increase the level of Italy's electricity production from renewable sources. This is in line with the EU environmental objectives and our common state aid rules," he added.

Approval of the Italian scheme came as the Commission published an assessment of EU nations' National Energy and Climate Plans (NECPs), which aim to drive investments in clean energy technologies and ensure that the 28-nation bloc reaches its 2030 climate goals.

According to the Commission, the NECPs will not enable Europe to meet its 32 per cent renewable energy target because they lack ambition and because they do not contain sufficient detail on the mechanisms that will deliver renewable investment.

WindEurope CEO Giles Dickson said: "The message from the European Commission is clear: failing to plan is planning to fail. The draft Plans don't get Europe to 32 per cent renewables by 2030. And they're badly lacking when it comes to specific policy measures."

Dickson added: "The Commission's recommendations highlight the areas where countries need to step up their game, e.g. permitting, electrification, corporate PPAs, and the repowering of existing wind farms. Member States now know what they've to do – ramp up the ambition and fill in all the policy gaps."

The Italian scheme will run until 2021 and will support renewable energy generation schemes with a premium on top of the market price. Competitive auctions will determine which projects qualify for support.

The premium will not be higher than the difference between the average production cost for each renewable technology and the market price, and will also include a clawback mechanism in case the market price moves above the average electricity production cost for each renewable energy technology.

France boosts onshore wind

France will add over 500 MW of onshore wind energy to its grid following its latest tender round for the technology.

Some 516 MW of capacity spread across 21 wind farm sites won contracts in the onshore wind tender. The average bid price in the tender round stood at €63 ($71.2) per MWh, which represents a decrease from the €65.4/MWh and €68.7/MWh in the first and second rounds, respectively.

Winners will be awarded 20-year feed-in premium contracts. The tender is one of six rounds that aims to procure 3000 MW of onshore wind capacity over the next three years.

Proposals for the fourth round are due by August 1st.

■ The French Ministry of Ecology and Energy Transition has selected a consortium of EDF, Enbridge and Innogy to design, build, operate and maintain the nearly 600 MW Dunkerque offshore wind project in northern France. The consortium offered a price below 50/MWh. The project will consist of around 45 wind turbines and is expected to be commissioned in 2026.

Gates launches clean energy fund

Bill Gates' Breakthrough Energy Ventures has teamed up with the European Investment Bank to launch a new €100 million fund to support investments in clean energy.

EIB and Breakthrough Energy Ventures are both contributing €50 million to kick start the fund, known as Breakthrough Energy Ventures Europe.

The fund will invest in firms innovating to cut emissions in five energy sectors: electricity; transportation; agriculture; manufacturing; and buildings. Breakthrough Energy Investors have called these the 'Grand Challenges' – the largest contributors to greenhouse gas emissions and the areas in which ventures in innovation investment will have the most impact towards a future of zero emissions.

The initiative will boost public-private investments in clean energy innovation, the partners said. Maroš Šefčovič, Vice-President of the Commission for the Energy Union, said: "Business as usual is not an option. We need to boost our investments with more than €500 billion each year to achieve a carbon neutral economy by 2050. I am pleased that our pilot cooperation with Breakthrough Energy has taken off so fast.

"This is pioneering work: aligning private and public investment in cutting-edge innovation, to the benefit of the Energy Union and our climate."

CDC targets African grid investments

A financial boost from the UK will help the development of Africa's transmission and distribution infrastructure, thus easing a significant bottleneck to economic development.

Siân Crampsie

UK-based development finance organisation CDC has pledged $300 million to support investment in Africa's electricity transmission and distribution infrastructure.

CDC says that the lack of progress in the development of transmission and distribution infrastructure has become a significant bottleneck to economic development across the continent. It has launched a new company – Gridworks – dedicated to developing and investing in transmission, distribution and off-grid electricity infrastructure in the continent.

"For African countries to reach their economic potential they need reliable and affordable power," said CDC's Chief Executive, Nick O'Donohoe. "Getting that power to households and businesses requires well-financed, efficient electricity networks.

Gridworks' ambition is to invest over $300 million of long-term capital in viable projects, aimed at reducing the number of people without access to electricity from the current level of 600 million. Many countries in Africa are suffering from decades of under-investment in electricity infrastructure, CDC said.

A recent McKinsey report estimates that $345 billion of investment in transmission and distribution is required by 2040 to absorb current and planned power generation. Once generated, electricity still needs to reliably and safely reach its intended users, who in turn need to be able to pay for it in a practical and efficient way, CDC said.

It added: "Traditionally, the public sector and multilateral institutions have been responsible for financing the electricity network in Africa, but the scale of the challenge means there is a need for complementary investment from the private sector."

Gridworks will work with governments, multilateral organisations and other investors to bring capital and private sector expertise to the sector. It will develop and invest in commercially sustainable infrastructure with a focus on ensuring that power supplies are reliable and affordable.

Gridworks' remit will include on- and off-grid infrastructure through structured initiatives and partnerships including utility concessions, public private partnerships (PPPs), management contracts, rural electrification programmes, isolated grid systems, off-grid-to-on-grid investments, or utility services companies.

Simon Hodson, appointed as CEO of Gridworks, said: "The need for investment in electricity networks in Africa cannot be underestimated. Creating sustainable and investable opportunities in transmission and distribution means building the right environment and the right regulatory framework to attract private investment.

Globeleq closes SA acquisitions

- Financial close reached on Malindi PV
- Boshof PV acquisition agreed

Globeleq has strengthened its portfolio in South Africa with the purchase of four renewable energy plants and their asset management company from an affiliate of Brookfield Asset Management.

The UK-based project development company has bought 80 MW of solar and wind power capacity to add to its existing portfolio of 238 MW in South Africa.

It says that it is due to complete the acquisition of another asset – the 66 MW Boshof solar plant in the coming weeks. The transactions will unlock additional equity investments into the assets, said Globeleq, whose strategy is to establish itself as a leading sustainable energy producer in Africa.

Last month Globeleq disclosed it had reached financial close on a 40 MWac (52 MWp) solar photovoltaic (PV) plant in Malindi, Kenya.

Financial close of the $69 million project, located in Langobaya, 120 km northeast of Mombasa, triggered the start of construction on what will be one of the first IPP owned utility scale solar power plants in Kenya.

Electricity will be sold through a 20-year agreement with the national power company, Kenya Power.

In South Africa, the acquired assets include the Aries (11 MW), Konkoonsies (11 MW) and Soutpan (31 MW) solar farms, and the Klipheuwel wind farm (27 MW).

In a statement, the company said: "The transaction has strong synergy with Globeleq's existing assets and offers an opportunity for further operational improvements as well as delivering improvements to the existing social and economic development programmes."

Standard Bank acted as the sole mandated underwriter and arranger of the acquisition debt facility for the South African assets.

In Kenya, Africa Energy Development Corporation (AEDC), the project originator for the Malindi solar project, will retain 10 per cent ownership of the project. AEDC's partner, IDEA Power, will provide equity, project development and construction management experience.

CDC, the UK's development finance institution, as the mandated lead arranger, has sourced some $52 million in debt financing to fund the project, including $20 million from DEG, the German development finance institution.

The engineering, procurement and construction company, Sterling and Wilson Solar, is commencing with civil and electrical construction works. Land rights, environmental and local permits have been obtained. Construction will take around 12 months, with the plant beginning commercial operations in mid-2020.

■ Construction activity in South Africa's wind power market is set to peak at more than 1 GW in 2020-2021 thanks to the long-awaited signing of PPAs by the government and project developers in 2018, according to new research from Wood Mackenzie Power & Renewables. South Africa now has 2.1 GW of operational wind capacity. Around 130 MW of new capacity additions are expected in 2019.

Dubai eyes floating solar

Dubai is examining the possibility of using floating solar power plants to help it meet the objectives of the Dubai Clean Energy Strategy 2050 (DCES 2050).

Dubai Electricity and Water Authority (DEWA) has issued a request for proposals (RFP) for consultants to study, develop and construct floating solar photovoltaic plants in the Arabian Gulf.

The consultancy services include a feasibility study, the technical requirements for a floating solar photovoltaic plant, an environmental impact assessment report, a study of the marine requirements, and other necessary studies on setting up electrical transmission, a safety plan, and a seawater feasibility studies including tidal and system specifications, and system performance.

The DCES 2050 strategy aims to diversify the Emirate's energy mix as well as make it a global hub for clean energy and green economy. It has set a target of sourcing 75 per cent of Dubai's total power output from clean energy sources by 2050.

Saeed Mohammed Al Tayer, Managing Director and CEO of DEWA, explained that the project would continue Dubai's pioneering clean growth initiatives.

He said: "Dubai has been a pioneer in the implementation of programmes and initiatives that contribute to reducing the carbon footprint, launching the Mohammed bin Rashid Al Maktoum Solar Park: the largest single-site solar park in the world. Based on the independent power producer model, it has a projected capacity of 5000 MW by 2030."

Enercon and Enerjisa claim Turkish spoils

Enercon and Enerjisa are to build 1000 MW of onshore wind energy capacity in Turkey after winning contracts in the country's latest YEKA renewables tender.

The two companies will build four 250 MW onshore wind projects after successfully bidding in the tender – the second of its kind in Turkey. They will sign a 15-year power purchase agreement with Turkey's energy ministry under a power plant license that will run for 49 years.

The YEKA tender is part of plans by Turkey to significantly expand its renewable energy generating capacity and supply 65 per cent of its energy needs from domestic and renewable sources by 2023.

Enercon and Enerjisa beat bids from seven other companies in the reverse auction. Enerjisa offered the lowest price of $4.56 and $3.67 per kWh for power from the Aydın and Çanakkale sites, respectively.

German firm Enercon, meanwhile, offered the lowest price of $4 and $3.53 per kWh for the Muğla and Balıkesir sites, respectively.

Other bidders in the tender included Eze naat, klim Elektrik, Beyelik, Res Anatolia and Gem Wind Enerji.

The tender for the first YEKA project of 1000 MW was held last year in August, creating an investment volume of $1 billion. Eight consortia, including some of the world's largest turbine manufacturers, participated in the tender.

The tender resulted in a world record price of $3.48 per kWh offered by the winning Siemens-Trkerler-Kalyon consortium. The capacity will be installed in several regions: Sivas, Edirne, Krklareli and Eskiehir. The consortium will invest over $1 billion in the wind facilities.

As part of the 2023 vision, Turkey aims to generate 30 per cent of its electricity consumption from renewable resources. To achieve that goal, it plans to reach 34 000 MW of installed hydroelectric power, 20 000 MW of wind power, 5000 MW of solar power, 1000 MW of geothermal power and 1000 MW of biomass power capacity.

Turkey currently has just over 7000 MW of installed wind energy capacity.

Aggreko offers new Wärtsilä Modular Block

Medium speed engines an efficient solution

Wärtsilä launches Modular Block

Wärtsilä and Aggreko are joining forces to bring medium speed reciprocating engines to the temporary power market.

The two companies have signed a cooperation agreement to market Wärtsilä's new Modular Block engine concept to the rapidly growing market for mobile and temporary power solutions.

According to the two companies, medium speed engines will bring a "totally new efficiency dimension" to the power rentals market, resulting in savings in fuel consumption and operating costs, as well as reducing emissions.

Wärtsilä's Modular Block power solution – based on the company's medium-speed 32 and 34 family engines – can be installed in a matter of weeks, and can be expanded to accommodate increased energy needs.

Similarly, it can be dismantled and relocated to alternative locations as and when required, making it well suited to temporary power generation.

Commenting on the partnership, Jean Nabb, Director, Strategic Partnerships, Wärtsilä Energy Business, said: "Aggreko is the global leader in mobile, modular power, and the Wärtsilä Modular Block solution opens up exciting new opportunities both for stationary and temporary electricity generation of up to 100 MW."

"We recognise the growing market for distributed generation, and the increasing need for new thermal power solutions that are cost-comparable with permanent generation. We see a number of potential applications for Wärtsilä's Modular Block on projects of typically 5-10 year duration, with its ability to achieve high levels of efficiency, while still being redeployable," commented Stephane Le Corre, Strategy and Commercial Development Director, Aggreko.

Under the agreement, Wärtsilä will provide the technology and design for the core power generation equipment with Aggreko incorporating Wärtsilä's Modular Block enclosure and power generation within its Rental/Power Solutions sales offering.

Wärtsilä launched the Modular Block solution last month as a prefabricated, modularly configured, and expandable enclosure for Wärtsilä medium-speed engines. The technology will be easy to integrate with renewable energy and storage systems, and is ideal for providing grid stability and balancing services, it claims.

Statkraft boosts VPP with Statera portfolio

Statkraft says that a new 15-year partnership agreement with Statera Energy will boost its UK-based 'virtual power plant' (VPP) by 1 GW.

Statera, an independent power producer (IPP), will develop 1 GW of battery energy storage and flexible gas-fired power generation to integrate into Statkraft's VPP.

The VPP is the first of its kind in the UK and now has 1 GW of energy under management, integrating wind, solar, battery storage and gas. The additional capacity and flexibility brought by Statera will enable Statkraft to consistently match renewable power production with market demand within seconds and reliably integrate intermittent renewables into the UK Grid.

Duncan Dale, head of Statkraft's markets business in the UK, said: "Statkraft recognises the importance of flexible power generation for the provision of secure energy supply in the years to come until multi-day mass energy storage becomes economically viable. It is vital that any new generation capacity is highly efficient and ultra-flexible, like Statera's."

Statera, backed by global investment manager InfraRed Capital Partners, will develop and build the assets – including a 50 MW battery site that will be one of the largest of its kind in the UK. Statkraft will provide market optimisation, trading and risk management services to the assets.

"We have partnered with Statera because of their project development approach and relentless optimisation of the project design and operations," added Dale. "Everything about these projects suggests that new efficiencies can be made, which means lower carbon emissions and lower costs to the consumer. The energy market and the UK's transition to a low carbon future should benefit greatly from unlocking this potential."

Tom Vernon, Managing Director of Statera Energy, said that the deal would enable it to support the low carbon transition in the UK. "We have partnered with Statkraft because of its industry-leading trading capabilities and innovative approach to the future energy market," said Vernon. "The UK generation mix and electricity market design will continue to evolve rapidly in the coming years, becoming increasingly volatile and challenging to trade.

"Statkraft will optimise the increasing dependence that its renewable portfolio has on flexible generation and storage, to help balance the electricity system using Statera's assets for the next 15 years."

Ansaldo moves in on Russian market

Italian engineering firm Ansaldo will raise its profile in the Russian power market through a new joint venture with REP Holding, it has announced.

REP and Ansaldo have signed an agreement to jointly produce, modernise, repair and service high-power industrial gas and steam turbines in Russia.

A key focus of the joint venture company will be the localisation of production and service facilities, the companies said in a statement. It will offer three Ansaldo Energia gas turbine models in the power range from 70 to 340 MW, as well as two models of the steam turbines in the power range from 40 to 350 MW.

"Particular attention is going to be paid to the localisation of production and repair services for the 'hot' parts of gas turbines, which involves the most sophisticated technology," said President of JSC REP Holding Tagir Nigmatulin.

Ansaldo Energia will transfer the exclusive rights to use its technology to manufacture, sell and service gas turbines and steam turbines not only in Russia, but also in CIS and other countries agreed by the parties. The company will create its own chain of qualified local suppliers of components and materials.

"Ansaldo Energia is very enthusiastic and confident that the JV will be a win-win solution to provide the best equipment and services to clients in Russia and CIS", said the CEO of Ansaldo Energia Giuseppe Zampini.

Go Electric acquisition strengthens Saft in storage and microgrids

French technology group Saft is expanding its capabilities in the energy storage and microgrids business with the acquisition of Go Electric, a specialist in energy resiliency solutions.

Saft, a subsidiary of Total, has purchased 100 per cent of the share of Go Electric, a USA-based technology firm specialising in microgrids and renewables integration for commercial and industrial energy consumers.

The move will strengthen Saft's value chain capabilities in microgrid energy projects.

"This acquisition is an important step in Saft's strategy to accelerate the growth of its energy storage systems business. Saft is now able to expand its scope of expertise from battery design and manufacture to the deployment of integrated turnkey distributed renewable energy storage solutions that connect customer sites to the grid," said Philippe Sauquet, President Gas, Renewables & Power at Total.

Go Electric's microgrid power controller technology, combined with energy storage, plays a key role in enabling customer sites to 'keep the lights on' by islanding them from the grid should a power outage occur. The technology also helps to integrate higher levels of distributed renewable energy and reduce energy costs.

Go Electric's solution has been deployed in military microgrids and commercial sites across the US and Canada.

"Go Electric can accelerate its growth beyond North America and benefit from Saft's brand recognition and long-standing experience in providing high quality products in energy storage" said Lisa Laughner, CEO and co-founder of Go Electric Inc.

Hervé Amossé, Saft Executive Vice President Transportation, Telecom and Grid, added: "The current evolution in customer requirements is bringing energy storage into a new area of competitiveness and performance. With this Go Electric acquisition, we are expanding our technology portfolio for distributed renewable solutions and reinforcing our footprint in North America."

Doosan expands in USA

South Korean engineering company Doosan Heavy Industries & Construction is beefing up its capabilities in the US market through a cooperation agreement with Midland Cogen Venture (MCV).

The two companies have signed a memorandum of understanding (MOU) for cooperation in three key areas: the operation and maintenance of MCV's gas turbines; hybrid power generation that connects renewable energy such as wind power and energy storage systems (ESSs) with combined cycle power generation; and the application of gas turbines being developed by Doosan to current power plants.

The agreement follows an earlier long-term supply and service contract between Doosan Turbomachinery Services (DTS), a US subsidiary of Doosan Heavy Industries & Construction, and MCV for gas turbine core components.

Under that contract, signed in 2018, DTS will repair the core components of seven gas turbines at MCV's gas fired cogeneration power plant in Michigan, which is the largest of its kind in the US, and supply new components for them over the next six years.

Tenders, Bids & Contracts

Americas

Voith on point at Rapide-Blanc

Hydro-Québec has awarded Voith a contract for the replacement of six units at the Rapide-Blanc generating station in northern Québec, Canada.

Under the contract, Voith will install new turbines, generators and digital governors, and will also refurbish embedded turbine components at Rapide-Blanc, located on the Saint-Maurice River, 66 km north of La Tuque, Québec.

The new units will be more efficient and allow production of approximately 10 per cent more energy with the same amount of water. The components will be designed to last at least 70 years.

Kepco selected for Guam project

State-run Korea Electric Power Corp. (Kepco) says it has been selected as a preferred bidder for a Guam power plant by the Guam Power Authority.

If a contract is signed, Kepco will build and operate a 200 MW power plant in Dededo, northern Guam with its partner, Hyundai Engineering. Kepco would sell energy from the plant for 25 years.

Construction of the new power plant is due to start in May 2020, with commercial operations scheduled for October 2022.

Wärtsilä supports MSU modernisation

Technology firm Wärtsilä has been chosen to provide a flexible power generation solution at Michigan State University's (MSU) East Lansing campus in USA.

The company will provide three gas fueled Wärtsilä 34SG engines as part of a project to help the university to achieve its energy modernisation plans and support the growing need for efficient energy on the campus. The contract was awarded by The Christman Company (TCC), the main contractor for a project to modernise the campus' power generation system.

The Wärtsilä 34SG engines, operating on natural gas have a total power output of 28 MW. The flexibility and efficiency of the medium-speed Wärtsilä 34SG engines will help to modernise the campus generation system and increase its overall efficiency. The fast-starting capability of the Wärtsilä engines will also provide the balancing support needed to aid in the integration of intermittent solar energy into the system.

Casa dos Ventos places 445 MW Vestas order

Casa dos Ventos has placed an order to supply and install 106 Vestas V150-4.2 MW wind turbines for the Rio do wind project in the state of Rio Grande do Norte, Brazil.

The project will be Vestas' largest in Brazil and the second order Casa dos Ventos has placed with Vestas in less than six months. Vestas has developed a customised solution for the site's wind profile, including optimised towers and the V150-4.2 MW turbine's high capacity factor, offering very competitive levelised cost of energy for Brazil's free energy market.

The contract includes supply, installation and commissioning of the wind turbines, as well as a 20-year Active Output Management 5000 (AOM 5000) service agreement.

The project is expected to become operational during the second half of 2021.

Nordex bags 300 MW

The Nordex Group has signed a contract with the North American subsidiary of the French energy group Engie S.A. to supply and install 100 turbines of the AW3000 series.

The turbines are to be delivered in 2020 and installed in the 300 MW Prairie Hill project, near to the town of Mart in Texas. The project will use the AW140/3000 on an 82 m tower, which represents the largest swept area wind turbine available in the marketplace with a tip height below 500 feet.

Nidec to create Bahamas microgrid

Nidec ASI has won the tender for the creation of a microgrid on a tropical island in the Bahamas.

Nidec ASI will supply the electricity grid's entire control and management system, along with an energy storage system with a capacity of 2.5 MWh and a 700 kW rated power inverter.

The aim of the project, worth €1.5 million, is to reduce greenhouse gas emissions by 50 per cent by the year 2020 and, at the same time, decrease by 70 per cent the use of power generation from conventional sources.

Asia-Pacific

Wärtsilä signs Summit service agreement

Wärtsilä has signed two major maintenance management and operational advisory agreements with Summit Group, the largest independent power producer (IPP) in Bangladesh.

The seven-year agreements represent the biggest ever signed service deals, in terms of MW generation, in the Bangladesh energy sector.

The agreements cover two power plants in Gazipur, Dhaka, with a combined output of 464 MW. They will ensure the maximum availability of the installations, optimising operating costs, and delivering reliable supplies to Bangladesh's national grid.

Jan De Nul secures Formosa contract

Jan De Nul has been awarded a contract for the engineering, procurement, construction and installation (EPCI) of the foundations and subsea cables for the Formosa 2 offshore wind farm in Taiwan.

The 376 MW Formosa 2 project will have 47 Siemens 8 MW turbines on jacket foundations in water depths of up to 55 m. It is being developed by Macquarie Capital Ltd. and Swancor Renewable Energy Company Ltd.

Formosa 2 OWF is the third Taiwanese OWF contract for Jan De Nul Group. Jan De Nul Group will be responsible for the foundation design, fabrication and installation, as well as for the design, supply and installation of the subsea cables.

Construction works are planned to start in 2020 and the wind farm is scheduled to be operational by the end of 2021.

BHEL to build 135 MW of solar PV

Bharat Heavy Electricals Limited (BHEL) has won three major orders for the construction of a total of 135 MW of solar photovoltaic (PV) capacity in India.

BHEL will undertake engineering, procurement and construction (EPC) of solar farms in Maharashtra and Gujurat, valued at Rs520 crore ($96.3 million).

Europe

Simec, GE build strategic partnership

Simec Atlantis Energy has chosen GE's Power Conversion Business as the preferred supplier to deliver the electrical systems for the world's largest tidal stream turbine for the MeyGen tidal development in Scotland.

The contract will advance the MeyGen development into its second phase, known as project Stroma, adding 6 MW of capacity to the project. It will also enable both GE and Simec to promote their technologies ready for the deployment of full-scale arrays in the future.

GE's Power Conversion business will provide the tidal turbine generators, the power converters for conversion and smoothing of the irregular power before transmitting to the grid. GE has already started working with Atlantis de-risking the overall system using its extensive electrical systems knowledge and capability.

Located in the Pentland Firth, north of Scotland, the MeyGen project is the only commercial multi-turbine array to have commenced construction. It has been generating power into the UK grid for over a year.

Nordex wins 93 MW in Spain

Grupo Enhol has placed an order for 93 MW with Nordex for two new wind farms in Spain.

Nordex will supply and install 27 of its AW132/3465 turbines – 15 for the Cabanillas wind farm and 12 for the Ablitas project. Both wind farms are situated in the province of Navarra, northern Spain.

Turbine installation is scheduled to begin in March and commissioning is planned to commence in June 2020. With average wind speeds of 7 m/s the wind farms boast a capacity factor of between 42.5 and 45 per cent.

The order also includes a full service contract covering 10 years with an option to extend for a further 10.

DEME signs JDR

UK-based JDR Cables has signed a contract with DEME Offshore to provide inter-array cables and accessories for the SeaMade offshore wind farm in the Belgian North Sea.

JDR, part of the TFKable Group, will design, manufacture and deliver 78.1 km of aluminium core inter-array cables and a range of cable accessories, including repair joints and connectors. The company secured the contract after a competitive tender.

The inter-array cables will carry the electricity generated by the wind farm's 58 Siemens 8.4 MW turbines to an offshore substation for transmission to the offshore grid. The offshore wind power generated is transmitted by a 33 kV cable system with hang-offs and connector terminations for 128 cable ends. The cable will be assembled in JDR's Hartlepool facility, with delivery expected by the end of 2019.

International

Voith embarks on Burundi project

Voith has won an order to design, manufacture and supply the complete electromechanical equipment for a small hydropower plant known as Kabu 16 in Burundi. Voith's scope includes two vertical Francis turbines with a capacity of 10 MW each, valves, generators, the governor and automation system as well as the mechanical and electrical balance of plant systems.

The company will also supervise the installation and commissioning of the plant.

The order was placed in February 2019 by Angelique International Limited on behalf of the Ministry of Hydraulics, Energy & Mines of the Republic of Burundi. Construction works on the new plant are already in progress and are expected to be finished in autumn 2020.

LS C&S to build power grid in Kuwait

LS Cable & System (C&S) has secured a power grid construction project worth Won112.5 billion ($95 million) in Kuwait.

The company signed a contract with Kuwait's Public Authority for Housing Welfare to build a power grid in Al-Mutlaa, a new town currently under construction.

Located 40 km northwest of the nation's capital of Kuwait City, LS C&S will supply 400 kV extra-high-voltage cables and carry out construction work for the ground cables.

Ethiopia issues project RFPs

The Ethiopian government has issued invitations to 12 international companies to submit technical and economic proposals for two solar power projects.

The invitations are part of wider efforts in the country to increase the level of private sector participation in the electricity sector, and could be followed by requests for proposals (RFPs) for three hydropower projects and up to four more solar projects.

The Gad and Deucheto solar projects will have a combined capacity of 250 MW and are to be developed under a public private partnership model.

Other solar projects due to be offered in the future include Mekele, Wolenchiti and Worarso, which have a combined capacity of 500 MW.

Vestas seals 164 MW win in Ukraine

Vindkraft has placed an order with Vestas for the supply and installation of wind turbines for the 164 MW Myrnenska wind farm in southern Ukraine.

The project, located in the Kherson region, will feature 39 V150-4.2MW machines, with delivery starting in the third quarter of 2019. The contract includes supply, installation and commissioning of the turbines, as well as a 20-year active output management (AOM 5000) service agreement and a VestasOnline Business SCADA solution.

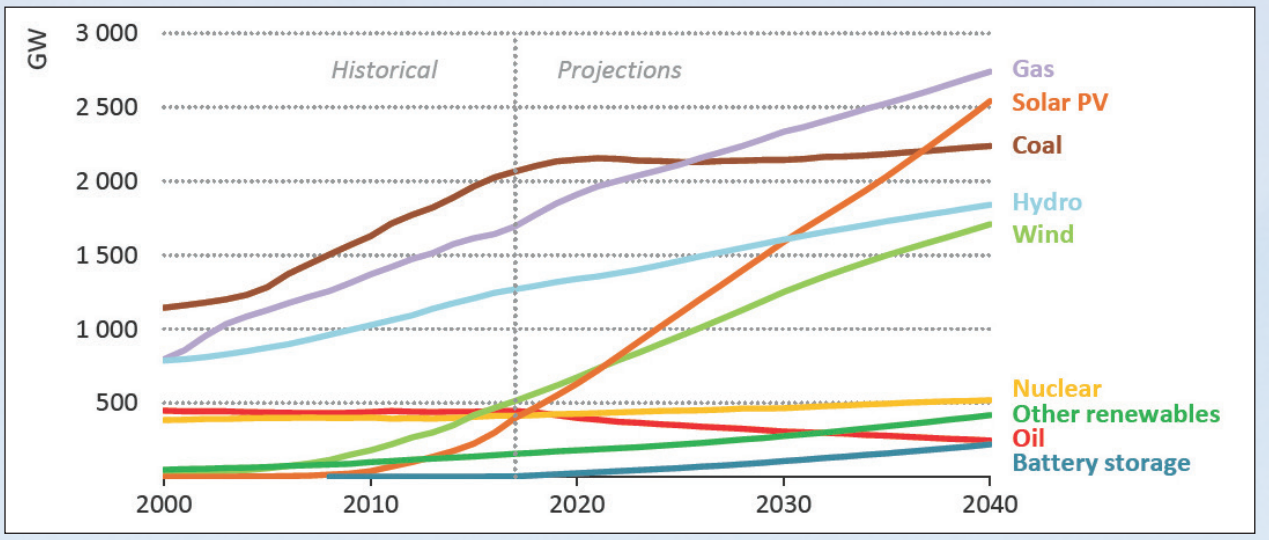
Enel wins in Russian tender

Enel Russia has been awarded the rights to develop a 71 MW wind farm in Russia in the country's latest renewable energy tender.

The Rodnikovsky wind farm will be located in the Stavropol region, with Enel Green Power (EGP), Enel's global business line dedicated to renewable energy, responsible for handling project development and construction.

Enel Russia's overall investment in Rodnikovsky will amount to approximately €90 million. The wind farm is due to start operating in the first half of 2024 and will sell its energy output in the Russian wholesale market, supported by capacity payments.

Installed power generation capacity worldwide by source in the New Policies Scenario



World Energy Outlook 2018, © IEA/OECD, Figure 8.15, page 346

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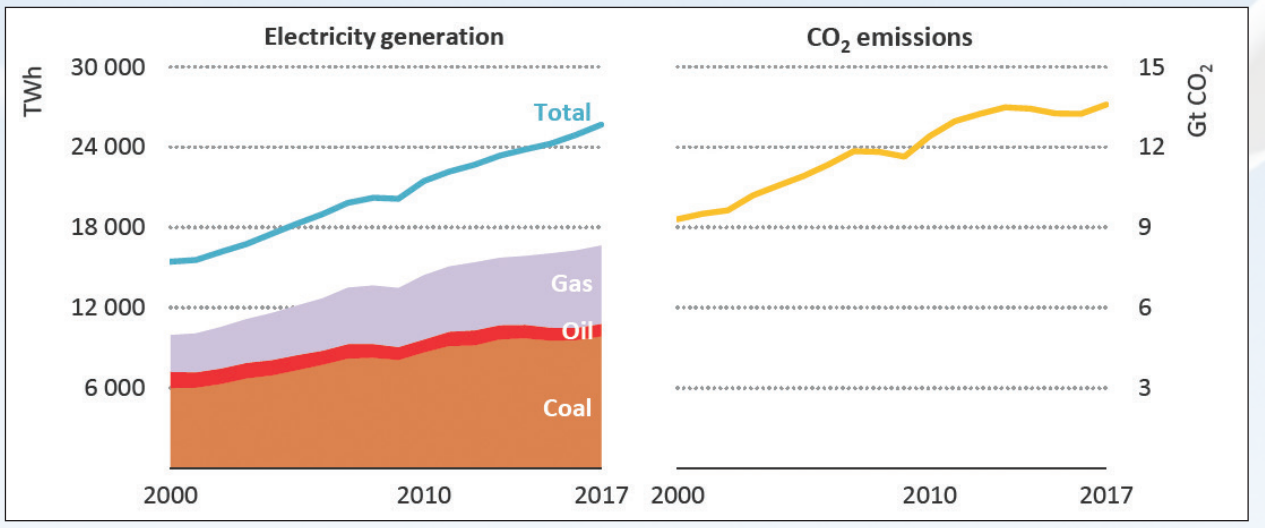
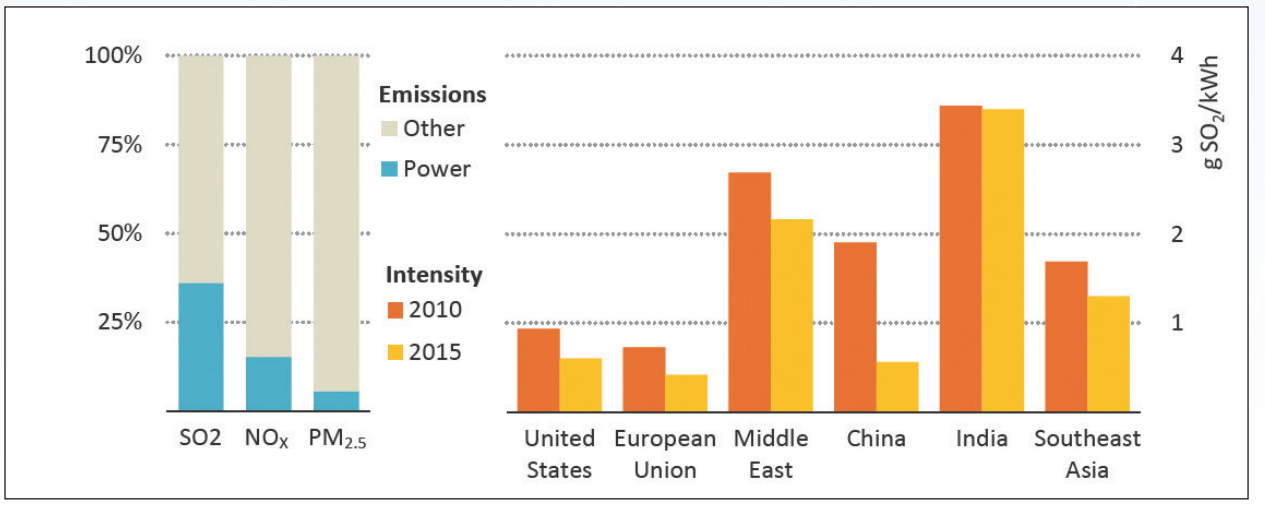
website: www.iea.org

Fossil fuels in electricity generation (left) and CO_2 emissions from power generation (right), 2000-2017



World Energy Outlook 2018, © IEA/OECD, Figure 7.34, page 321

Share of 2015 power sector pollutant emissions (left) and SO_2 intensity by region (right), 2010-2015

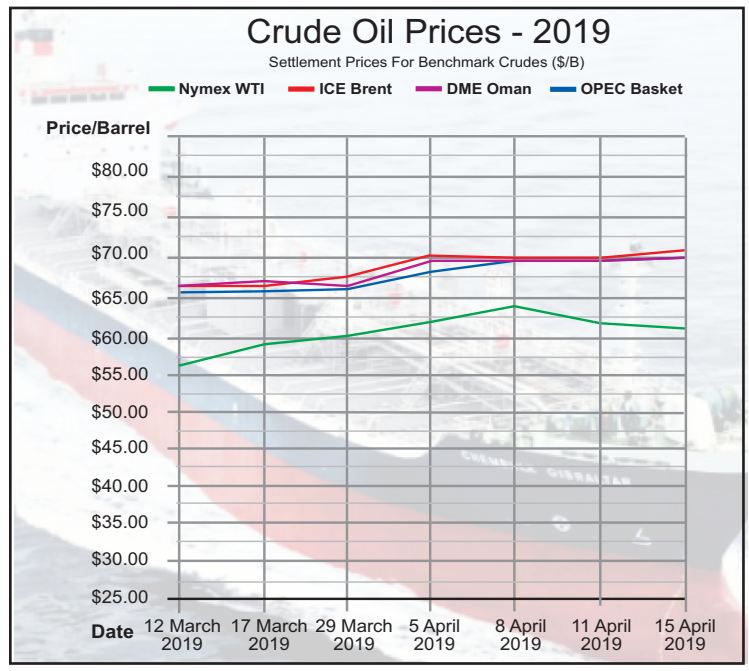


World Energy Outlook 2018, © IEA/OECD, Figure 7.35, page 322

Source: World Energy Outlook 2018

Oil

IEA lowers 2019 oil demand forecast as Mid-East tension rises



- Crude prices slip despite Opec+ cuts and Iran sanctions
- US has biggest impact on oil output, according to BP Statistical Review of World Enegy

Mark Goetz

A dimmed economic outlook brought about by slackening world trade led the Paris-based International Energy Agency (IEA) to lower its growth in demand estimate for crude oil in 2019 to 1.2 million b/d in its latest monthly *Oil Market Report*.

"World trade growth has fallen back to its slowest pace since the financial crisis 10 years ago," the IEA said, citing a report from the Netherlands Bureau of Economic Policy Analysis. Demand grew only by 0.3 million b/d during the first quarter of this year, the lowest since the fourth quarter of 2011. OECD countries showed a significant decline in demand of 0.6 million b/d across all sectors and due to a variety of reasons, the IEA said. Oil demand saw better circumstances in the non-OECD world where demand rose by 0.9 million b/d during the first quarter.

Global demand growth is forecast to rise to 1.2 million b/d in the second quarter and reach 1.6 million b/d during the second half of this year. The IEA forecast crude demand growth of 1.4 million b/d in 2020.

Opec also forecast lower oil demand due to ongoing trade disputes. Opec, which meets in Vienna in late June or early July with its non-Opec allies to decide on whether to extend its production of 1.2 million b/d, said in its monthly report that world oil demand would rise by 1.14 million b/d this year, a reduction in its previous forecast by 70 000 b/d.

Opec produced 29.88 million b/d during April, the report said, and the call on Opec crude for 2019 will average 30.52 million b/d.

Despite the Opec+ production cut, sanctions against Iranian and Venezuelan oil, and fighting in Libya that risks output there, crude oil prices slipped by $9-10/b between late May and mid-June. Booming crude output in the US and other non-Opec countries encouraged the slump in price.

Supply and prices have come to be a new concern following the attack on two tankers in the Gulf of Oman that were targeted with mines in mid-June. This follows an attack on four tankers in the UAE port of Fujairah several weeks previously. The US has accused Iran but has yet to determine how to respond. Tehran denies any responsibility for the attack.

More worry on a larger scale came through the new *BP Statistical Review of World Energy 2019* in which the energy giant warned that carbon emissions continue to rise, keeping the world on an unsustainable path. The data compiled in the report suggests that during 2018, global energy demand and carbon emissions from energy use grew at their fastest since 2010/11, "moving even further away from the accelerated transition envisaged by the Paris climate goals," BP Group CEO Bob Dudley said in his introduction of the Review.

Weather-related effects were the main cause in the growth of carbon emissions, Dudley said. "The acceleration in carbon emissions was the direct result of this increased energy consumption," he said. "Yet another year of growing carbon emissions underscores the urgency for the world to change."

Still, oil continues to be the world's primary fuel. Oil consumption rose by 1.4 million b/d, or 1.5 per cent, in 2018, according to the Review. Nearly all the increase in oil consumption was taken up by China and the US. Global oil production increased by 2.2 million b/d in 2018. The average price for Dated Brent crude oil in 2018 was $71.31/b. Much of the increase in the growth in demand for oil has been driven by the petrochemical industry, the report said.

The US, by far, made the biggest impact on global oil output. Almost all of the 2.2 million b/d net increase in output was accounted for by the US, setting a record for any country in any year, the Review said. Since 2012 and the onset of the tight [shale] oil revolution, US production, including NGLs, has increased by over 7 million b/d, which is broadly equivalent to Saudi Arabia's crude oil exports. This is "an astonishing increase which has transformed both the structure of the US economy and global oil market dynamics," the Review said.

Gas

Natural gas primed to play bigger role in global energy

Natural gas is showing itself to be the fuel of the future and in 2018 it set a new record for gas demand.

David Gregory

Gas faces competition from the expanding use of renewables and also has yet to force coal from its position as a prime fuel for power generation. Nonetheless, according to the new annual report on natural gas, *Gas 2019*, published by the International Energy Agency (IEA), demand for natural gas will grow by 1.6 per cent annually until 2024.

Total world natural gas production increased to 3868 billion cubic metres (bcm) during 2018, according to the *BP Statistical Review of World Energy 2019*, released last month, an increase of 5.2 per cent over 3678 bcm in 2017. Global gas consumption increased by 5.3 per cent in 2018 to 3849 bcm compared with 3654 bcm in 2017, according to the Statistical Review.

The IEA's Gas 2019 reported that demand for natural gas rose by 4.6 per cent in 2018, accounting for almost half of overall energy demand growth. The US saw the greatest increase in demand growth, the IEA said. The switch from coal to gas in the US was responsible for half of that increase, which was encouraged by a colder than average winter and hotter than average summer, pushing demand for electricity. According to the Statistical Review, US gas consumption rose to 817 bcm, up by 10 per cent over 739 bcm in 2017.

Gas production in the US, driven by a boom in shale, or tight, gas output, saw US gas production jump by 11.5 per cent in 2018 to 832 bcm, compared to 746 bcm in 2017. The burgeoning production of shale gas in the US is pushing the start of an LNG industry in the US that is expected to expand throughout world markets.

The US exported 28.4 bcm of gas in the form of LNG in 2018, an increase of 65.4 per cent from 17.2 bcm in 2017, according to the BP Review.

Until 2024, gas demand will be driven by Asia Pacific, accounting for 60 per cent in growth in demand, according to the IEA report, and of that, China will be the main driver for gas demand growth, accounting for some 40 per cent of total global demand over the next five years. The IEA put growth in China's demand at nearly 18 per cent, in line with BP data, which put growth in China's consumption in 2018 at 283 bcm, up by 17.7 per cent over 2017 consumption of 240.4 bcm.

China is working to clean up its polluted air by switching from coal to gas and in doing so is pushing demand for LNG. The US and Canada both promise to be big suppliers of LNG to China, but the current trade dispute between the US and China could damage the opportunity if it continues.

The US and China will lead production growth up to 2024, the IEA said, accounting for some 50 per cent of the increase. But most of China's output will be needed to meet domestic demand. Such will be the case with other gas producers in South Asia. The US, Australia and Russia will together account for the vast majority in gas exports growth up to 2024.

According to the IEA, the LNG market is destined to undergo profound changes over the next five years. The report said China and India will emerge as major buyers of LNG and Europe will see increasing LNG imports. The IEA said Australia will pass Qatar as an LNG supplier in 2022. (Qatar is planning to expand its LNG production capacity from 77 million tons per year currently, to 110 million t/y over the next few years.) The US will overtake Australia as largest global LNG supplier in 2024.

The IEA notes that gas demand in Europe will remain flat in the coming years, but that gas production in Europe will decline by 3.5 per cent annually. This is due to a phase out of production at Holland's Groningen field and declining output in the North Sea.

According to BP, total Europe gas production (including Ukraine) amounted to 250.7 bcm in 2018, a decline of 4.8 per cent from 263.2 bcm in 2017. Consumption in Europe amounted to 549.0 bcm, down 2.1 per cent from 560.4 bcm in 2017.

The IEA also noted that gas market prices in major regions is converging. Differences in regional prices have sharply decreased since the final quarter of 2018, especially between Asia and Europe, because of well supplied markets. It said the expansion of LNG will likely encourage greater price convergence, but that without further investment in LNG capacity, a tight supply market could lead to a return to higher regional price differentials.

The energy sector is one of the biggest targets for cyber criminals who want to harm organisations or individuals. In order to understand how hacker attacks can be so successful, it is important to take a step back and look at the current developments in the energy field and how they are being exploited.
Yuval Porat

Time to rethink cyber security

With everything from transportation and communication, through to manufacturing and healthcare relying on energy – and particularly electricity – it's not surprising that the whole industry is one of the biggest targets for criminals who want to harm organisations or individuals.

You may recall the incident in 2015 when the Ukraine power grid suffered a cyber attack. It all happened very quickly. Workers at the Prykarpattyaoblenergo control centre were about to finish their shift when one employee realised that the curser on his computer started to move on its own. The hackers had managed to take over control of the power grid. Around 30 substations were switched off and hundreds of thousands of citizens were suddenly without electricity for hours. This type of activity marks a new era of threats to the energy sector through a new channel: cyber crime.

Since this incident, there have been several attacks on critical industry, such as the recent infiltration of an electrical grid in the US. In this case, the hackers gained access by using seemingly simple methods such as phishing emails and malware that was planted on frequently used websites. Often the victims don't even realise that they have been hacked until they get the ransom demand or notice that information has been leaked.

Porat: Innovations like smart grids turn a whole power grid into a data network that just needs to be accessed through one of the various entries

But instead of becoming a sitting duck, waiting for an attack, what companies need to do is to learn more about their "new" enemies and prepare themselves, because it is not a question of "if" but rather "when" a similar attack will be deployed with more devastating effects.

In order to understand how hacker attacks can be so successful, it is important to take a step back and look at the current developments in the energy field and how they are exploited by criminals, because it's those new trends that affect the evolving approach of cyber criminals.

In the context of the transformation from nuclear and coal-based generation to renewables, digitisation plays an important role. Smart grids that are tipped as the future of the industry, with many remote stations being interconnected but not necessarily running the same operational protocols due to them being managed by disparate organisations.

This move from typically one or a few large, well-funded, nationalised institutions to the new trend for potentially numerous smaller, decentralised organisations opens the door for a new wave of threats. Only one weak spot in the system can give cyber criminals access to highly sensitive data or worse, enable them to disrupt or shut down a whole system. As an increasing number of power plants and grids are part of the digital network, it is crucial for these institutions to be aware of these new risks.

There are a few notable cyber crime trends. Criminals have always been early adopters of new technology and the ongoing digitalisation in every sector has provided them with many new targets. It only takes one look in the newspapers to see it's not only an ever-increasing number of these attacks but also that the nature of cyber attacks has changed drastically.

Today cyber crime is crippling the operations of global organisations and some of the trends we are seeing are more than alarming. For example, 48 per cent of the businesses that were a victim of a hacker attack in the past 12 months identify at least one attack per month – an alarmingly large number. Moreover, many studies have shown that more than half of the companies are not prepared to defend a cyber attack.

While technology continues to evolve, so do the strategies and skills of the cyber criminals. When we talk about hackers today it's important to keep in mind that these criminals are far from being the hoody-wearing stereotype of a hacker who works from a dark basement as often shown in movies. It is, in fact, a well-funded, highly profitable and innovative industry that is being inspired and fed by governmental capabilities.

As a result, cyber attacks have reached a new level of sophistication: not only do hackers bring a wider and deeper research base than ever before, they also plan attacks precisely and over a long term period. Thanks to the use of greater technological innovation, they are able to exploit unprotected layers, including the employees.

Additionally, they can orchestrate multi-dimensional attacks, which means the attack targets hardware, software, end-points, servers and human operators.

Moreover, the cyber crimes are no longer just tactical approaches but have, in fact, switched to strategic attacks that are not purely focusing on stealing money anymore. They are often state-level attacks that aim to disrupt processes and cause chaos.

These attacks range from malware on websites or in email attachments (phishing emails) to side channel attacks (SCAs), which aim at extracting secrets and information from a chip or a system. For this attack, the hackers use the analysis of physical parameters such as electromagnetic emission or execution time. This type of cyber attack allows criminals to even break robust encryption.

It's fair to say that in our digital world no organisation is immune from becoming a victim of a cyber attack but companies in the critical infrastructure, such as the energy sector, need to be especially aware that their data and assets are an attractive prospect to cyber criminals.

If you bring the ongoing changes and trends of these two sectors together and converge them, it becomes clear that the threat level has never been higher. Overall, here is a sector with extremely sensitive data that is unprotected – being decentralised now, it has more weak spots than ever. Further, the increasing skills of cyber criminals who can exploit the digitised and decentralised service provisions, means the energy sector has to look at both issues.

Connecting the energy industry to a digital network provides cyber criminals with a huge amount of targets. Innovations like smart grids turn a whole power grid into a data network that just needs to be accessed through one of the various entries. Hackers could not only come into possession of data about the electricity, the machines or the energy company itself but also of detailed information regarding the energy consumption of companies and households. This valuable data is an important, attractive asset, which can be used by attackers to threaten both security and privacy.

Being decentralised means the energy sector does not have one large pool of resources to invest in cyber security as larger organisation would. However, even significant investment in cyber security is no longer effective against new threats. The truth is that there is currently a patchwork of different cyber security solutions designed to target specific parts of the organisation's system.

For example, one programme for email screening, another to block pop up ads that may contain viruses, etc. Further, these are all designed for a different time in cyber criminality and often do not address the more new, devastating attacks sophisticated hackers are undertaking.

The lack of an up-to-date, integrated system means that if one aspect fails to update with patches and bug fixes it becomes an entry point that leaves the whole system unprotected on the hardware and software levels

The mission is therefore to create a paradigm shift. It is essential to create a holistic security solution that covers all modern IT components. By redesigning the hardware and the software, starting at the most fundamental level, it is possible to implement security by design – a fortress that keeps all the sensitive data safe from internal as well as external threats.

As well as technical threats, it is important to create a solution that addresses the human factor. It needs to be a security system that provides a superior user experience. If the technology is too complex to use, employees will try to make their lives easier by sidestepping it.

Therefore, the cyber security industry needs to encourage legislators, regulators, customers and organisations to be part of this paradigm shift and to create a unique approach to cyber security that will keep companies, their systems, data and ultimately also people safe and secure. This is clearly no small challenge, but with the right approach and expertise, we can prevent a hacker-initiated blackout.

Unlike many action movies, we don't have to wait until it's too late. Companies can be one step ahead of cyber criminals as long as they face the new threats and take the respective measures by building not only walls around the property but also cyber walls around the data treasures.

Yuval Porat previously worked in international cyber intelligence before co-founding his own cyber security company, Kazuar.

Best practices to keep the industry safe

As the sector matures on its cyber security journey, operators of essential services must demonstrate that they have embraced particular cyber security principles in their business and have taken proportionate, informed and balanced steps to meet the outcomes expected.
Nigel Stanley

The head of the National Cyber Security Centre (NCSC) said recently that a major cyber attack on the UK's critical national infrastructure (CNI) is a matter of "when, not if." A country's electricity generation and supply infrastructure is, unfortunately, a natural target for such an attack due to its importance to our daily lives and the economy.

With transmission and distribution control systems being increasingly interconnected through the use of smarter, IP-based hardware and software, the sector is no longer immune from the attention of bad actors determined to disrupt this critical infrastructure. As the cyber threat to the UK CNI evolves and grows, it is incumbent on all those in this industry to think beyond regulatory requirements, and to manage the business risk of cyber security-related threats. This is because when it comes to the electricity sector, cyber risks don't just involve network security, but human safety.

A sustained failure of the electricity grid could cause potentially devastating consequences. From transport, to health services, to food security, virtually every element of critical infrastructure is dependent on the grid. Thus, the World Economic Forum 2019 identified cyber security in the electricity industry as a risk affecting the entire ecosystem. To address this risk, cyber security controls need to be considered using a people, process and technology approach, to ensure that all aspects of cyber security are addressed in a cost-effective and proportionate way.

Like many other industries that use operational technology such as SCADA and industrial control systems, the transmission and distribution sector is vulnerable to increasing cyber security attention from bad actors, be it hacktivists or nation state advanced persistent threats.

Many existing transmission and distribution systems use a communications infrastructure based on serial networking technology, which was not originally designed with cyber security in mind. For example, bad actors could modify data on automation systems to trip circuit breakers. The interconnected nature of these systems can produce common vulnerabilities across the industry and result in malicious software or attacks impacting the entire sector.

Whilst efforts are in place to retrofit cryptographic primitives into these protocols the reality is that they remain open to attacks against their confidentiality, integrity and availability. The tripping of circuit breakers can cause disruption for a long period of time and in extreme circumstances result in premature aging of the components in a system. As transmission and distribution networks become digitally enabled through IP-based networking, hardware and software that were once a closed network becomes increasingly more open to those interested in subverting it.

Arguably one of the most significant and publicly disclosed cyber security attacks on electrical transmission systems occurred in December 2015 when Ukraine's power system had a wide area power outage that affected over 200 000 customers. Subsequent detailed reporting and analysis revealed that the attack was started by malware from phishing emails with compromised Microsoft Office files as attachments. These were delivered several months prior to the attack. Numerous users opened the attachments and were immediately compromised.

As part of this reconnaissance phase, power grid operations were monitored, no doubt to understand how the system worked and which vulnerabilities could be exploited. During the actual attack HMI (Human Machine Interface) workstations were hijacked by the attackers and a number of circuit breakers opened, resulting in power cuts. Power grid operators could reportedly see the attackers moving a mouse across the screen and switching off circuit breakers whilst being unable to intervene.

At the end of the attack some files were deleted from the system. As the attack progressed, the grid call centre was subjected to a denial of service attack severely hampering the response to the incident. Power was only restored following manual intervention across the affected substation estate.

In a separate case, in February 2019 a US energy company received a $10 million fine from the regulator North American Electricity Reliability Corporation (NERC) for nearly 130 violations of the Critical Infrastructure Protection (CIP) standards. While a majority of the violations found by NERC were classified as moderate, medium or serious, the agency's assessment said the violations "collectively posed a serious risk to the security and reliability of the BPS [Bulk Power System]".

Stanley: the initial starting point must be for an organisation in the sector to understand their specific cyber security regulatory requirements and the related business risks they face

The findings included: a lack of management engagement, support and accountability relating to CIP compliance; disassociation of compliance and security that resulted in a deficient programme, lack of implementation, and ineffective oversight and training; a lack of communication between management levels and a lack of awareness about the state of security and compliance; confusion regarding ownership of tasks, and poor asset and configuration management. These findings may appear basic but they have a very profound impact on the way that operations are managed.

As the sector matures on its cyber security journey, the initial starting point must be for an organisation in the sector to understand their specific cyber security regulatory requirements and the related business risks they face.

In the UK, this includes the EU Directive on Network and Information Systems (NIS Directive), which came into force in May 2018. Under these rules, operators of essential services must demonstrate that they have embraced particular cyber security principles in their business and have taken proportionate, informed and balanced steps to meet the outcomes expected.

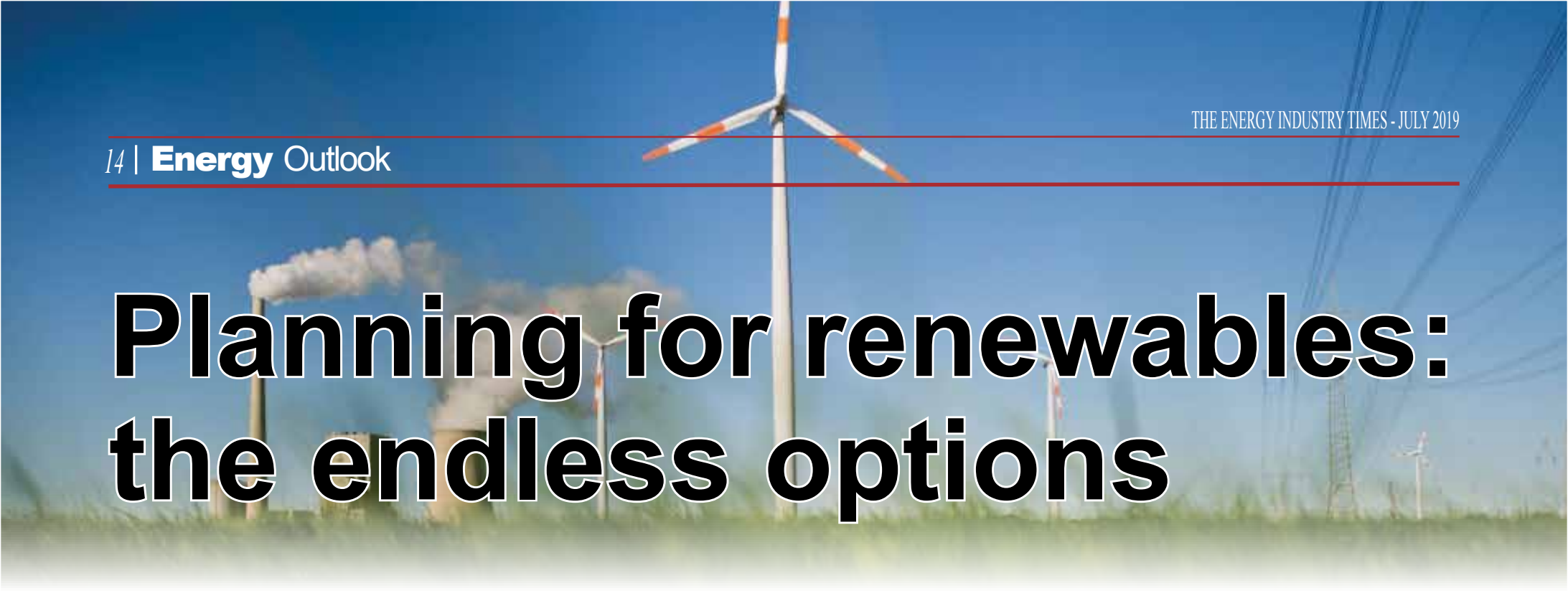
A first step should be to understand the implications of a potential cyber attack. There are many risk models available to help with this, but an initial risk triage should be conducted to assess the overall situation before in-depth analysis starts. It is important that risk reviews are then conducted on a regular basis. The precise frequency of this will vary on the business but it is not unusual to be assessing risk on an almost continual basis as the cyber security threat picture can change minute-by-minute.

There are four key tasks that should form part of best practices. These are:

- *Strong cyber security governance and leadership.* Carrying out good cyber security hygiene and applying well known cyber security controls can go a long way to securing an infrastructure. These measures include: strong cyber security governance and leadership, coupled with employee, contractor and supply chain engagement to educate and inform these groups of the cyber security risk and empower them to act as the frontline in defence of the organisation alongside technical monitoring and preventative tools.
- *Asset discovery and identification*. Before systems can be managed there is a need to understand exactly what systems are in place and their appropriate role within the transmission and distribution system. A prioritised list of assets should be created based on their relevance and criticality to the business. In this process, lateral thinking is crucial – for example, an attacker turning off a less-protected air conditioning system could result in overheated components and lead to system failure.
- *Identity and access management.* Policies and procedures should be structured to ensure that the right people or systems get to interact with the correct systems with the correct privileges. A principle of least privileges should be implemented such that the people or systems requesting access only see what they are entitled to and no more. Separation of systems should take place so that essential systems and assets are separated from those that are non-essential or could otherwise act as an attack route. The implementation of a tiered architecture with control zones and conduits such as the Purdue Enterprise Reference Architecture is considered best practice in many instances.
- *Incident response.* Regular threat assessments need to be undertaken and a mechanism to apply appropriate and proportionate controls in response to such threats needs to be implemented. This should be combined with an intelligence and threat sharing process with relevant government agencies and transmission/distribution sector specific communities. This must be a timely and iterative process as new threats frequently emerge. Lastly, ensure that there are plans to respond to events and incidents. These plans should quickly identify the likely nature of an event and determine a suitable course of action. Response plans should be rehearsed on a regular basis and post-action reports used to improve subsequent responses, policies, procedures and plans.

The rise of internet-connected operational technology systems presents the traditional control system engineer with a challenge. While there is a business benefit to adopting connected devices for cost-saving measures, such as predictive maintenance, it can also open up a series of safety-critical hardware and software to intervention by hackers. The good news is that mitigating cyber security issues across the energy industry is not an overly complex, costly or challenging task. Good basic cyber security hygiene can address many of the risks and challenges involved.

Nigel Stanley is Global Chief Technology Officer, Industrial Cyber Security, at TÜV Rheinland. He is a specialist in cyber security and business risk with nearly 30 years' experience in the IT industry.



Planning for renewables: the endless options

As the grid transitions to renewable energy, technologies continue to emerge to handle its intermittency. Although gas fired generation is likely to be a critical part of the energy matrix in this respect, some utilities have latched on to other newer technologies. But all offer pros and cons.
Megan Parsons

Limited options make for easy decisions. Back in the day, energy markets were one-size-fits-all, with grids simply functioning to deliver one-way power flows. Generating capacity was designed to cover peak demand on that single hottest (or coldest) day. The entire industry was slow to adapt and slow to change because it didn't need to.

Fast forward to today. A surge of distributed, mostly renewable energy resources, is disrupting the norm.

Before intermittent renewable resources gained traction in the early 2000s, traditional energy resource planning primarily focused on the lowest cost of electricity. The formula was fairly straightforward: determine the cost to install a power plant with a life expectancy of 30-40 years; the cost of fuel to operate it; and how often it would be dispatched. The biggest variable was figuring out how much fuel would cost over the next 20-30 years. This was before renewable energy resources emerged on the scene.

Beginning in the early 2000s, the cost for wind power started to drop significantly, thanks mostly to government backing in many countries. With tax credits and other incentives available, developers and utilities began to jump onboard. Then, in 2010, solar photovoltaic costs began a rapid descent – what was $4 per watt in 2014 is now projected to be $0.70/W by 2020. These cost declines have been roughly parallel in both the US and in Europe.

Parsons: Both old and new technologies will be needed as the world moves toward higher and higher percentages of renewables

But wind and solar generation do not always align with customer demand, meaning renewable penetration will produce diminishing returns if a viable storage market or other source of backup power supply fails to emerge.

Enter lithium-ion batteries (LIB). Coincidental to the rise of renewables, Tesla has helped propel the electric vehicle (EV) market, driving innovation and cost reductions in LIB technologies. Since 2012, the global LIB manufacturing boom has reduced prices by 70 per cent, according to IHS Markit. As prices are projected to continue to decline, the global deployment of these batteries, as stated in a recent report by GTM Research, is anticipated to grow by 55 per cent each year for the next five years.

In California and Hawaii, utilities have started to feel the heat from solar's rapid popularity increase and strong renewable policy mandates. Generation planners now have to account for abrupt power supply transitions. This requires closer integration with transmission planners, more outreach with ratepayers, and more focus on flexibility rather than simply determining the lowest-cost peaking capacity.

In the US, integrated resource planning is being redefined, with some states requiring more engagement with their customers during the integrated resource plan development, including a rigorous evaluation of distributed generation resources. There's a real need to look holistically at transmission and distribution planning when preparing for generation as well, but there are few established best practices in how to do that. With unclear rules, the entire US utility industry is starting to look at the early adopters. But even they don't have all the answers yet.

In July 2017, American Electric Power (AEP), an Ohio-based electric utility that plans to add more than 3 GW of solar and more than 5 GW of wind power capacity to its portfolio by 2030, announced a plan to build the largest US wind farm in the western panhandle of Oklahoma. Dubbed the Wind Catcher, this 2 GW project was slated to provide 9 TWh of wind energy annually to customers in Arkansas, Louisiana, Oklahoma and Texas.

But its $4.5 billion price tag proved to be too much and last year Texas utility regulators rejected the project, citing a lack of benefits for ratepayers. Obstacles included a lengthy 350 miles of transmission line needed for delivery of electricity to end users.

One takeaway from the AEP experience is we can't just be focused on busbar cost anymore. We have to look at delivery cost as well as the value of location in this new power supply equation. Economies of scale captured with large central stations have made the most sense in the past, but in the new utility model, there's a lot of locational value to be unlocked in bringing more renewables and power supply to a system.

No single technology, at this point in time, does everything we need. With all alternative generation sources, the economics are completely different, and none provide the same level of support to the grid.

Policymakers in both the UK and US are encouraging utilities to evaluate storage in their integrated resource planning. But it is difficult to go all-in without specific regulation around how energy storage facilities will be compensated. Planners can't wait for regulation to be finalised, energy storage costs to further decline, or technology risks to be realised through research and development or pilot programmes. In the meantime, as aging fossil fuel plants are retired, electric utilities are turning to a more efficient fossil fuel: natural gas.

Much like wind and solar, natural gas is abundant and cost-effective while also checking the boxes for grid stability and reliability. In the US, natural gas is expected to continue as the primary electricity generation resource for at least the next decade. Moreover, gas is expected to become even more predominant as more and more coal fired capacity is retired.

One thing we're doing during the integrated resource planning process is helping utilities realise the economic benefit of faster-response, gas fired generation technologies. In some markets, smaller aeroderivative and reciprocating engine technologies are attractive because they have a small footprint, can quickly respond to load demand, and can be placed near load pockets to offer highly reliable capacity.

In Denton, Texas, a medium-sized city located near Dallas-Fort Worth, city leaders opted to build a 225 MW gas fired reciprocating engine plant as a bridge to allow them to meet a goal of grid stability while working toward an eventual goal of 100 per cent renewable energy.

Low-cost, high-efficiency gas is an important component as the grid transitions to renewable energy, keeping reliable power flowing to customers. There have been great strides within the gas turbine market, increasing efficiency, reducing emissions and lowering cost for reliable gas generation. The already highly efficient gas turbines can follow load demand much more effectively and efficiently than they could just ten years ago.

Though natural gas is likely to be a critical piece to the energy matrix in many countries for years to come, it's far from the only option that can handle the intermittency of renewables. Technologies continue to emerge, and some utilities have latched on to static VAR compensators (SVCs), static synchronous compensators (STATCOMs), capacitor/reactor banks, flywheels, and battery or pumped storage. But as newer technologies, all offer pros and cons.

Synchronous condensers are another possible avenue. Though not a new technology, they represent a hybrid solution for balancing the intermittency of renewable sources by offering reactive power support, a role previously played by large central-station generators.

A synchronous condenser is a DC-excited synchronous machine that makes use of increasingly plentiful renewable power to overcome mechanical losses, converting that energy into much needed reactive power, inertia and system short-circuit current. These services are essential for everything from charging transmission lines to starting large motors, riding through faults, and enabling the proper operation of critical protection devices on distribution lines to consumers.

Both old and new technologies will be needed as the world moves toward higher and higher percentages of renewables as it is unlikely we can ever build enough wind, solar and other renewable energy sources to offset the current fossil generation fleet. Right now, globally, we have 6.6 TW of generating capacity. If the entire globe were to transition to 100 per cent renewable power, it's projected that we would need to quadruple our capacity to 28.7 TW. And it's not just changing and building out renewables, it is completely changing our generation mix. For us to move toward a renewable future, we will need more flexible generation.

Whether it's a large wind farm or solar panels on a residential roof, renewables are making a profound mark on the energy landscape – although no one knows yet what to do with recycled batteries or scrap solar. But what is known is that the range of potential options associated with renewable energy is shaking up the energy market as it exists today.

If it is in the direction of significantly more renewables, it will be best practice – and financially worthwhile – to have a robust integrated resource plan in place, one that provides utilities with a holistic view that includes energy's endless options.

Megan Parsons is Renewable Energy Development Manager at Burns & McDonnell

Higher efficiency improves solar economics

As solar modules move to higher power outputs, 158 mm wafer sizes could become the new standard.

Junior Isles speaks to JinkoSolar's Dr Alex Li about what the company's move to a larger standard wafer size means for the industry.

Much has changed in the solar industry in recent years – advances that have seen solar farm sizes increase and levelised cost of energy (LCOE) from those farms reach grid parity in many countries.

With China being a global leader in the sector, Chinese companies are playing a key role in the progress of solar panel technology.

Dr Alex Li, Ph.D in Photovoltaics Engineering and Head of Technical Service, Asia Pacific (APAC) at JinkoSolar, commented: "About two years ago in Australia, people were typically only building 5 MW solar farms; these days, 200 MW farms are being discussed. There's been really rapid change and rapid growth in the industry.

"What we are trying to achieve is how to ensure solar, as a relatively new technology, reaches grid parity and becomes competitive with traditional forms of generation such as coal fired plant or hydro."

The price of solar power has fallen by around 90 per cent over the last 10 years. This, says Dr Li is largely down to two factors: "Number one is the power output, driven by efficiency. Higher power means you can reduce the balance-of-system (BOS), such as trackers and other components, not including the panels.

"But I would say the most important thing is economy of scale. Ten years ago manufacturers were only producing 100 MW each year. Today, all the tier 1 manufacturers are producing 10 GW/year but the profit is the same. So the unit price has been driven down.

"China has been the major contributor to the PV industry when it comes to mass production, able to do very high density mass production in a single manufacturing facility. The silicon maker, wafer maker and cell maker are all next to each other so that you an access those technologies and technology developments in a relatively efficient way."

JinkoSolar recently announced that it was switching high volume production capacity for its PV panels from polycrystalline to premium monocrystalline. It also said its new Cheetah module is now combining a bigger size wafer with half-cut cell technology. In what it claimed to be an industry's first, the new Cheetah module will now use a 158 mm wafer as its new standard size.

Dr Li says moving to the larger wafer size is important for end users – both residential and utilities – as it allows higher power output in a cost effective way. Having a higher output panel, he stressed, is a way of achieving a better return on investment for solar projects, thus making them more attractive for financial investors.

"When I first joined Jinko two years ago, people were talking about a 320 W panel. This means you would need five panels to build a 1.6 kW system. Today, with a 400 W panel, you only need four panels," he said. "This means you can reduce the cost of the mounting system significantly. You can also reduce installation cost, etc. When you are talking about a 100 MW solar farm, using a 400 W panel will reduce the balance of system (BOS) cost significantly."

Launched about one year ago, the Cheetah 410 W module set a new standard for a commercially mass-produced panel output. "It was the first time in history that a single PV panel could reach 400 W. Now other major suppliers are following the trend of moving towards highly efficient mono technology," said Dr Li.

According to Jinko, it was able to move to a 158 mm wafer, from the traditional 156 mm size, without any major upgrade of its existing manufacturing facilities. "This means we were able to increase the power of the modules without increasing manufacturing cost significantly. So this was a cost-effective technology development."

The decision to base its modules on what it calls "premium" monocrystalline instead of poly-crystalline was also ultimately based on economics. Dr Li says, these premium mono-crystalline panels have a different cell structure to standard mono-crystalline modules and have 2-3 per cent higher efficiency.

Mono-crystalline solar panels have the highest efficiency rates, currently in the 20 per cent region, since they are made out of the highest-grade silicon. They also have a long lifespan, typically 25-30 years. Traditionally, however, they are more expensive. By contrast, poly-crystalline panels are less efficient, around 13-16 per cent and typically have a slightly shorter lifespan of 23-27 years. However they are traditionally cheaper.

But the economics of the two technologies has been changing. "About 30 years ago, in the early days of the PV industry, the price difference between poly and mono was very big, almost 200 per cent," said Dr Li. "So back then, and even just 10 years back, people favoured poly because of cost. But both are reliable technologies."

As the industry has evolved, however, the price gap has become very small and according to Dr Li, the trend is towards mono crystalline panels. "If you calculate the capex of the entire system – including not just the module but the inverter, tracker DC cable and all the civil works – a 400 W mono now has a lower capex than a 320 W poly. This is a milestone and indicates that poly will probably start to phase out for the first time in the history of PV."

He believes that when looking at the technology development roadmap, there will be "no way back" for polycrystalline panels. "Poly does not have too much room to improve. If you spend $1 million in a poly development, you would probably get a 0.1 per cent increase in efficiency but if you spend that in a mono technology development, you would get a 0.2 to 0.3 per cent increase in efficiency, said Dr Li. "This is why many investors now choose to invest in mono technology development rather than poly."

For manufacturers, the change from poly crystalline cell production to mono will be painful but may be inevitable. "It will be challenging because manufacturers will want to make use of existing facilities for as long as possible. But at some point, when they can no longer make a profit, they will be forced to upgrade their manufacturing facility to produce premium mono solar cells."

Indeed, it will be an increasingly likely shift judging by the falling LCOE delivered by advancing technology. A financial analysis by JinkoSolar of a Cheetah 158 mm, high performance mono cell versus a standard poly-crystalline cell reveals an LCOE of 3.49 /kWh versus 3.55 c/kWh.

Meanwhile, Dr Li says JinkoSolar will continue to upgrade its technology in a cost-effective way. "Next year or in the very near future, we will be offering a major technology development for the solar PV community. Already this year, we launched a bifacial technology with a transparent backsheet. Because it allows electricity to be generated from both sides, you can generate more energy from the same area of land."

He forecasts that next year it will have modules with power outputs in the region of 450-460 W from a single panel. These, he says, will have an efficiency above 20 per cent.

Looking forward, Dr Li adds that new technology will have to be affordable, reliable in the field and durable. He concluded: "From a financial point of view, if we want to make sure that your financial investment is secure. Together with power, reliability and durability, we also have to ensure that the solar panel performs as predicted from day-one – that is JinkoSolar's mission for the entire PV community."

How the economics stack up

Cell technology	Industrial standard 156 mm cell	Jinko Cheetah 158 mm cell
Module Type	**Industrial standard performance poly series**	**Cheetah high mono series**
Module power(W)	330	400
Analysis results		
LCOE (¢/kWh)	3.55	3.49
IRR (%)	9.35	9.56
Project overall cost ($/Wp)	0.7500	0.7438
BOS cost ($/Wp)	0.5000	0.4588
Inverter cost ($/Wp)	0.0793	0.0771
Mounting structure cost ($/Wp)	0.1024	0.0845
Other material and construction cost ($/Wp)	0.3183	0.2972

Dr Li says polycrystalline technology will probably start to phase out "for the first time in the history of PV"

Increasing conversion efficiency

In early June, JinkoSolar Holding Co Ltd said it achieved maximum conversion efficiencies of 24.38 per cent and 24.58 per cent, respectively, for its Cheetah size cells and N-type photovoltaic (PV) cells.

The Chinese Academy of Sciences undertook the testing of the cells in March, JinkoSolar said in a statement, claiming the efficiencies are the highest in the world.

JinkoSolar also said its 72 version monocrystalline module has reached peak capacity of 469.3 W during tests conducted by German safety standard authority TÜV Rheinland. The tests were carried out in May.

The company has tied up with advanced R&D centres globally to create a joint research platform for solar products. In January, it announced an efficiency of 24.2 per cent for a large-area N-type TOPCon monocrystalline silicon solar cell.

Junior Isles

Differentiating between zeros and loopholes

Some would argue that setting even more ambitious targets, although you are failing to achieve the current ones, smacks of fantasy. Yet this is what the UK is looking to do by legislating "net zero" emissions by 2050. Likewise, the EU is now discussing whether to follow the UK's example.

The story so far does not instil much confidence. Global emissions hit a record high last year and most countries including Belgium, France, Germany and the UK are set to miss their 2020 carbon targets. A recent EU assessment also found that the bloc is not on track to meet its 2030 target to draw 32 per cent of electricity from renewable sources, because countries' individual energy policies are insufficient to meet the collective goal.

A report by the International Energy Agency last month served only to add to the pessimism. Of the 45 energy technologies and sectors assessed in the IEA's latest 'Tracking Clean Energy Progress' report, only seven are on track for reaching climate, energy access and air pollution targets. These latest findings follow an IEA assessment published in March showing that energy-related CO_2 emissions worldwide rose by 1.7 per cent in 2018 to a historic high of 33 billion tonnes.

Cartoon: jemsoar.com

Based on progress so far it is understandable why many would see introducing "net zero" legislation as nothing more than flight of fancy of an outgoing Prime Minister under public pressure from activists and looking to leave a positive legacy.

Yet past failures should not necessarily dictate future ambition. And the global energy transition is indeed accelerating as the economics of technologies such as wind, solar and storage become more favourable.

A report last month by BloombergNEF (BNEF) gives reasons to be cheerful, and perhaps some confidence that net zero emissions by 2050 might be more than a pipedream.

In its New Energy Outlook 2019 (NEO), BNEF forecasts that deep declines in wind, solar and battery technology costs will result in a grid nearly half-powered by the two fast-growing renewable energy sources by 2050.

The report notes that Europe transitions furthest and fastest. By 2040, renewables make up 92 per cent of the electricity mix, with wind and solar accounting for 80 per cent. Cheap renewables, flexible demand and batteries shift the European power system away from fossil fuels and nuclear to one built around variable renewables and emissions-free energy.

Notably, by 2050 renewables provide 96 per cent of generation and Germany's emissions are 97 per cent below what they are today. The UK, meanwhile, adds 228 GW of wind and solar by 2050, as well as 27 GW of batteries, and renewables provide 89 per cent of generation.

According to the Outlook, the US electricity system continues to replace aging coal and nuclear with cheaper renewables and gas, which becomes the country's premier source of power generation. Coal and nuclear are pushed out by age and economics, such that by 2050 both technologies have almost disappeared from the electricity mix. Utility-scale batteries for peaking purposes grow in significance from around 2035, supporting renewables penetration, which reaches 43 per cent in 2050. In that year, emissions are 54 per cent lower than today.

China, the world's largest carbon emitter along with the US, sees peak coal generation and emissions in 2027, as the world's biggest electricity system reaches 37 per cent renewables penetration. China continues to be the largest market for wind and solar, which together grow from 8 per cent to 48 per cent of total generation by 2050. By that time, China has 1.3 TW of solar PV and 1.2 TW of wind installed – equivalent to 17 per cent of all PV and a third of all wind power installed globally. Nuclear, the only base load CO_2-free technology remains important for China and sees four-fold growth to 182 GW by 2050.

Shortly after the UK announced it would be the first to make its net zero commitment legally binding, there was some good news on the country's direction of travel.

For the first time since the Industrial Revolution, Britain is obtaining more power from zero-carbon sources than fossil fuels. National Grid revealed that clean energy (nuclear, renewable and clean electricity imports) has moved ahead with 48 per cent of generation, against 47 per cent for coal and gas. The rest comes from biomass burning. It said that over the past decade, coal generation has plummeted from 30 per cent to 3 per cent.

While this and the new legislation are welcome – as is so often the case in government policy – the politicians have given themselves a get out-of-jail card, or two.

The net zero target comes with a noteworthy proviso: it will depend on whether other countries are following suit. A review within five years will assess whether other countries have adopted similar goals – and if they have not, it would give the UK the opportunity to lessen its ambition.

Environmental groups have understandably criticised this as a major "loophole". Also, the term "net zero" clearly indicates the government acknowledges it may not be able to achieve the goal that environmentalists are really pushing for – 'actual zero' carbon emissions. "Net zero" means that any remaining emissions could be balanced by schemes to offset an equivalent amount of carbon from the atmosphere, such as planting trees or through purchasing international carbon offsets.

"It is disappointing that the government has ignored its climate advisers' recommendation to exclude carbon offsets – as well as caving into Treasury pressure to review the target in five years' time," said Craig Bennett, head of Friends of the Earth.

Perhaps it is disappointing, yet wholly understandable. The UK is willing to lead the battle on tackling climate change but is not willing to be that single drop in the ocean, legally culpable for what is a global responsibility. Further, with Brexit looming and a weakening economy, its government has to be mindful of spending and how much it can burden taxpayers.

Chancellor Philip Hammond warned Theresa May that her net zero by 2050 plan will cost the UK "well in excess" of £1 trillion. This would currently equate to over $1100/year for every UK taxpayer for the next 30 years. Arguably, it's a small price to pay for our planet – if you are not already on the bread line.

But it is no small task. BloombergNEF says the power sector will, at least until 2030, contribute its share toward keeping global temperatures from rising more than 2°C. However, there is heating, transport and industry to consider – decarbonising these will be much more challenging.

"We should be honest that it is a huge industrial undertaking, and it will have significant cost," said Dieter Helm, Professor of Energy and Economics at Oxford, who welcomed the new plan. "These are enormous industrial activities, there is nothing in history that looks like this outside of wartime."

Perhaps that is how governments need to look at the issue. The battle against climate is a war and when going to war, countries seem to have few reservations on how many zeros are attached to the price tag.