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Flexibility must be "cornerstone" of future electricity markets, says IEA



Cozzi is expecting electricity to grow twice as much as energy demand

The expansion of renewables brings major environmental benefits but also a new set of challenges that policy makers need to address quickly, finds the recently launched World Energy Outlook 2018. **Junior Isles**

Power systems will need to make flexibility the cornerstone of future electricity markets in order to keep the lights on in a system that has higher variability in supplies. This was one of the key findings in this year's 'World Energy Outlook (WEO) 2018', the International Energy Agency's flagship publication.

According to the IEA, the issue is of growing urgency as countries around the world are quickly ramping up their share of solar PV and wind, and will require market reforms, grid investments, as well as improving demand-response technologies, such as smart meters and battery storage technologies.

With regards to electricity, the report

addresses three key questions: what will the future power sector look like as a result of the increasing share of renewables? What does the future of the other low carbon sources of electricity, mainly nuclear, look like? And thirdly, how much can the economy be electrified?

Laura Cozzi, IEA Chief Energy Modeller and Head of Division for Energy Demand Outlook said there "is no doubt variable renewables increase, and increase a lot. We are expecting electricity to grow twice as much as energy demand, with variable renewables such as wind and solar growing four times faster than electricity."

The IEA says that renewables have

"become the technology of choice" in power markets, making up almost two-thirds of global capacity additions to 2040, thanks to falling costs and supportive government policies. This is transforming the global power mix, with the share of renewables in generation rising to over 40 per cent by 2040, from 25 per cent today.

Cozzi commented: "This means that more than ever, we will be asking the electricity system to operate in a very different way. The system will have to move up and down to match supply and demand at all times; four times more than we are asking today.

"There are several [flexibility] options that we need to unlock. At low levels of wind and solar penetration,

like in the US, China and India, where wind and solar is less than 10 per cent of the generation mix, using current system flexibility is enough. This means adapting the operation of coal and gas plants. Other countries with a higher share of variable renewables, such as Germany and the UK, have already had to make some targeted investment to unlock more flexibility. For example, extending grids and making the grid smarter. Going forward, all countries will need to unlock more flexibility. This means markets will on the one hand need to provide electricity, and on the other hand value flexibility more, to ensure investments

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Finance to close energy access gap severely off-track

Finance required to close the electricity gap remains seriously short of what is needed to meet global energy goals by 2030, according to a new global report released by the UN's Sustainable Energy for All.

The 'Energizing Finance: Understanding the Landscape 2018' report analyses finance flows for electricity and clean cooking access in countries across Africa and Asia with the most significant access gaps. The report reveals alarming developments in several key areas of energy access finance that require urgent action to keep Sustainable Development Goal (SDG) 7 – affordable, reliable, sustainable and modern energy for all – within reach.

Research shows annual investment of \$52 billion is needed to meet universal electrification, yet finance commitments for electricity in the 20 'high-impact' countries – which

represent 76 per cent of those without electricity access – have barely increased, averaging just \$30.2 billion annually.

Of serious concern, finance for coal fired generation is increasing, at a time when the International Panel on Climate Change is issuing stark warnings about stalling progress on the Paris Agreement targets. In the countries tracked, annual commitments for coal plants almost tripled, growing from \$2.8 billion to \$6.8 billion.

"The good news is that renewables offer us a powerful opportunity to provide reliable and affordable clean electricity both through the grid and off-grid", said, Rachel Kyte, CEO and Special Representative of the UN Secretary-General for Sustainable Energy for All.

"The bad news is that we are not yet seeing a strong enough project pipe-

line or sufficient levels of public investment that will crowd in private finance to seize this moment of falling prices for revolutionary technology. Even more worrying is that at the same time we're seeing incremental increase in funding for renewable energy, investments in coal increased."

The 'Energizing Finance' research, conducted in partnership with Climate Policy Initiative, enables finance institutions and policy-makers to develop and implement strategies that can be scaled and refined to reach more people, more affordably, with clean and sustainable energy.

Of the 20 countries surveyed, 15 are in sub-Saharan Africa but worryingly, the report revealed that only 17 per cent (\$5 billion annually) of the total electricity finance tracked was allocated to the region – down 32 per cent from the last report.

Dr. Barbara Buchner, Executive Director, Climate Policy Initiative said: "Regions with the highest needs, like sub-Saharan Africa, are getting the smallest share, while we're seeing big gaps for some of the technologies with the most promise, like off-grid renewable energy. This should be a wake-up call to policy makers and investors who are working to ensure universal and sustainable energy."

She added: "The main thing is the policy gap and framework to give investors certainty, and having the risks that are specific to these countries covered. We have been looking at some new risk mitigation instruments that really could help bring in more private sector [finance] into some of these countries... for example, instruments that keep currency risks from being a big barrier to investors in some off-grid solutions."

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in energy storage, demand-side response are made in a timely manner to ensure the lights are always kept on. There is an urgency to deal with flexibility as soon as possible."

Turning to nuclear, the IEA said today nuclear supplies about 10 per cent of the world's electricity. Cozzi noted that this year is key for the industry since many developed countries will be facing the decision of whether to extend the lifetime of their plants. If markets like the US, EU and Japan, choose not to extend, it would see the share of nuclear in those markets fall from about 25 per cent in 2017 to just five per cent in 2040. This said Cozzi, would have "very clear consequences for electricity security, affordability and very importantly, decarbonisation".

She noted, however, that investment in nuclear was growing very strongly in countries like China, India and Russia. "It is a very bidirectional future for nuclear, depending on where you are on the planet," said Cozzi.

Electricity markets are also undergoing a unique transformation with higher demand brought by the digital economy, electric vehicles and other technological change. As part of its deep-dive into the electricity sector this year, WEO-2018 also examines what impact of higher electrification in transportation, buildings and industry. The analysis finds that higher electrification would lead to a peak in oil demand by 2030, and reduce harmful local air pollutants. But it would have a negligible impact on carbon emissions without stronger efforts to increase the share of renewables and low-carbon sources of power.

The IEA's Sustainable Development Scenario offers a pathway to meeting various climate, air quality and universal access goals in an integrated way. In this scenario, global energy-related CO2 emissions peak around 2020 and then enter a steep and sustained decline, fully in line with the trajectory required to achieve the objectives of the Paris Agreement on climate change.

But most emissions linked to energy infrastructure are already essentially locked-in. In particular, coal fired power plants, which account for one-third of energy-related CO2 emissions today, represent more than a third of cumulative locked-in emissions to 2040. The vast majority of these are related to projects in Asia, where coal plants are just 11-years-old on average with decades left to operate, compared with the 40 years average age in the US and Europe.

Dr Fatih Birol, the IEA's Executive Director said: "We have reviewed all current and under-construction energy infrastructure around the world – such as power plants, refineries, cars and trucks, industrial boilers, and home heaters – and find they will account for some 95 per cent of all emissions permitted under international climate targets in coming decades."

"This means that if the world is serious about meeting its climate targets then, as of today, there needs to be a systematic preference for investment in sustainable energy technologies. But we also need to be much smarter about the way that we use our existing energy system. We can create some room for manoeuvre by expanding the use of carbon capture utilisation and storage, hydrogen, improving energy efficiency, and in some cases, retiring capital stock early. To be successful, this will need an unprecedented global political and economic effort."

UK may have to rethink "flawed" Capacity Market

The UK may have to give greater consideration to other methods of securing electricity supply after an EU court ruling put its Capacity Market on hold. **Junior Isles**

The UK may be forced to rethink its approach to securing electricity supply following a European court decision to suspend its Capacity Market.

The UK's subsidy scheme for securing back-up electricity generation was suspended after the European General Court found that the payments system should be subject to a state aid investigation. It is the result of a claim brought by flexible energy technology solutions provider Tempus Energy, which argued that the current system favoured fossil fuels over other means of ensuring supply security.

Tempus argued that the Capacity Market favoured generation over demand-side response (DSR) as the former could apply for 15-year contracts, and DSR could only apply for a 1-year contract. It said that the Commission should have concluded that there were doubts that should have been formally investigated at the inception of the Capacity Market but were not.

Commenting on the ruling by the European Court, Sara Bell, CEO of Tempus Energy said: "A customer revolution is on the cards. This ruling opens the door for cheaper energy – greater use of demand-side innovation would change the way we use electricity in practice, and place customers at

the heart of the energy system for the first time."

Following the ruling, the UK Department of Business, Energy, and Industrial Strategy (BEIS) instructed National Grid to put the Capacity Market into a "standstill period" until further notice. BEIS says it is working closely with the Commission to aid the investigation and seek timely state aid approval for the Capacity Market.

Many industry experts support the ruling. Mark Hollands, Head of Energy Strategy, British Solar Renewables (BSR) Group said: "The decision to uphold Tempus Energy's claim was the correct one. The capacity market is flawed and needs restructuring with a balanced approach to all technologies, which is currently lacking." He warned, however, that the way the point has been made and the resulting suspension of the capacity market is "potentially damaging to investor confidence and the energy industry as a whole".

His sentiments were echoed by energy aggregator, Limejump. Erik Nygaard, CEO & Co-Founder, said: "While this result is not the scenario we would prefer nor is the ideal methodology for change as this ruling will have an immediate impact on many

of our customers with contracts and those who have been preparing for the next auction, we do see that this decision will force wholesale markets to embrace flexibility while increasing the adoption of innovative technologies.

"We also see this as potentially increasing the speed at which coal and gas generation is replaced with renewable resources and battery storage, which in turn could increase price volatility on the wholesale markets. Both of these results will benefit flexible assets in the long term."

Dr Alastair Martin, Chief Strategy Officer at demand response aggregator and business energy supplier, Flexitricity, com: "The Capacity Market answered a need for security of supply and fitted into a reasonably coherent package of measures across the electricity industry. Unfortunately, it contained one major flaw, which we, alongside other DSR companies, have ever since campaigned to rectify. This is the unfair treatment of DSR in comparison to fossil-fuelled generation.

"We urge government to see this ruling as an opportunity. If 15-year contracts are really needed, then these contracts should be open to all – this would improve competition and

keep the long-term price low. If long contracts are in truth unnecessary, then all capacity types should compete for one-year contracts. International experience and other features of the GB electricity market both indicate that single-year contracts can keep the lights on and the costs down perfectly well."

He added that if the government simply seeks state aid approval for the same Capacity Market as before, the hiatus in the industry could last longer. "The likelihood of refusal is high, now that the flaws in the Capacity Market are so visible. Government already knows how to fix the Capacity Market. Now is the time to come forward with a plan that recognises the capabilities of the new energy economy, harnessing DSR, storage, combined heat and power, and engaged customers."

A spokesperson at the BEIS said the government was "disappointed with this judgment" but added it "poses no issues" for security of supply. They added: "We have prepared for all outcomes, and we will be working closely with the commission so that the Capacity Market can be reinstated as soon as possible."

Centrica and RWE both said they were reviewing the judgment.

Moorside hopes might now rest with Kepco

Hopes for the UK's planned Moorside nuclear plant now appear to rest with South Korea's Kepco (Korean Electricity Power Company), after Toshiba announced that it was to liquidate NuGen, the company responsible for developing the project.

Following financial difficulties caused by its US nuclear engineering subsidiary Westinghouse, which filed for Chapter 11 bankruptcy protection last year, Toshiba had hoped to sell NuGen. In December last year, Toshiba named Kepco as a priority negotiation partner for the NuGen sale but Toshiba revoked that status in August this year as Kepco continued to delay its decision on becoming involved in the project.

Some analysts suggested the NuGen

liquidation may actually give Kepco more time to weigh the profitability of the £20 billion Moorside project before it makes a decision. Now that it is not under pressure from Toshiba to acquire NuGen, it is no longer in any rush in its negotiations with the British government.

One approach that is reportedly being discussed and under which the project could potentially move forward, is a regulated asset base (RAB) model in which the British government would bear part of the project costs while sharing in profits from power sales.

"My understanding is that the research and negotiations between the British government and Kepco to decide the RAB model structure are set

to finish in the first half next year," an industry source told independent Korean newspaper *Hankyoreh*.

"Once the Moorside nuclear power plant project rights have been recovered by the British government, it could begin selecting a new operation some time around the second half of next year," the source said.

Others, however, believe the high cost of building nuclear plants should persuade the government to abandon building new large nuclear projects entirely and pursue alternatives.

Dr Jonathan Marshall, Head of Analysis at the Energy and Climate Intelligence Unit (ECIU) commented: "The demise of plans for a new power station at Moorside should be seen as an opportunity, rather than a

risk. Shifting away from expensive, complicated technology towards cheaper and easier to build renewables gives the UK the opportunity to build an electricity system that will keep bills for homes and businesses down for years to come.

"UK offshore wind is already significantly cheaper than nuclear, with onshore and solar power offering even greater savings. The technology needed to shore up supply from variable sources is also getting more competitive, with storage one of the brightest lights.

"Cancelling Moorside does leave a gap in the UK's decarbonisation plans, but one that is more likely to be filled with the technologies of the future rather than the past."

EVs, solar and storage can bring benefits

Electric vehicles (EVs), solar and storage are coming together to unlock opportunities at commercial and industrial (C&I) sites and make electricity systems more flexible.

According to a recent study by Aurora Energy Research, EVs with technologies such as vehicle-to-grid (V2G) charging, energy storage systems and solar panels can enhance business opportunities at suitable sites – supporting a lower consumer price for electricity, reducing grid upgrade costs, compensating for lower utilisation rates or providing extra revenues from the capacity market

or ancillary services.

Aurora says that profitable business cases and positive returns for C&I charging applications can be identified in cases where users pay for the electricity they use. For example, supermarket car parks and motorway service stations in the UK could see a profitable business case by charging a premium of 5-6 pence/kWh above retail electricity prices, assuming high levels of utilisation.

Regulators and companies alike are making efforts to accelerate the deployment of such systems.

V2G made an important break-

through in Germany in late October when the Nissan LEAF was qualified for the regulatory requirements needed to provide primary power regulation. This means that the LEAF can be used as a reserve for the German electricity grid.

Electric cars such as the Nissan LEAF, with integrated bidirectional charging technology, could play an important role in stabilising the electricity grid. The LEAF is able not only to extract power from the grid and store it in its traction battery but, if necessary, can also feed power back. This is the V2G concept.

In late October, Mitsubishi Electric Corporation announced that it has developed a technology for efficiently managing photovoltaic (PV) and other power generation systems and also the charging/discharging of EVs parked on company campuses.

By optimising the schedules for not only charging EVs but also discharging their power back into the company, as well as optimising the operation of PV and other power generation systems according to the price of electricity sold on the grid, Mitsubishi Electric's system enables companies to reduce their electricity costs.

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Coal switch helps drop in GHG emissions

■ Renewables and energy efficiency trump coal ■ Coal retirements accelerate

Siân Crampsie

Greenhouse gas emissions in the US power sector are falling thanks to a combination of fuel switching and reduced electricity demand.

According to the US Energy Information Administration (EIA), carbon dioxide (CO₂) emissions from the electricity sector have fallen by 28 per cent since 2005.

While a large portion of that decline is due to a switch away from coal as a fuel source in power generation, the majority is attributed to a reduction in electricity demand.

According to the EIA, reduced electricity demand has avoided 654 million metric tonnes of CO₂ from being

released. CO₂ emissions from the power sector reached 1.74 billion metric tonnes in 2017, the EIA says, the lowest since 1987.

The agency added that six out of the past 10 years have seen a drop in the demand for electricity, mostly in the industrial sector.

During the same time period, the lowering price of natural gas has shifted that form of electric production ahead of coal and other petroleum products.

The pace of fuel switching is set to continue with US coal fired power plant closures likely to reach record levels this year.

New analysis by the Institute for Energy Economics and Financial

Analysis (IEEFA) indicates that coal plant shutdowns are accelerating in the USA. Capacity retirements are likely to total 15.4 GW in 2018, with 44 units at 22 plants in over 12 states set to close.

"The competitive environment for coal fired power in the generation marketplace is becoming ever more challenging as the price of renewables continues to fall and as natural gas prices are expected to remain low for the foreseeable future," said Seth Feaster, and IEEFA data analyst and author of the report, which sees an additional 21.4 GW of coal fired capacity closing over the next six years.

States with imminent sizeable coal-plant closures include Florida, Indiana,

Kansas, Kentucky, Maryland, Minnesota, Missouri, Ohio, Pennsylvania, Tennessee, Texas, Virginia, West Virginia and Wisconsin.

While the US coal fired power fleet still had about 246 GW of capacity operating in July of this year, retirements already announced will cut that capacity by 15 per cent through 2024. Cost is the biggest force in the decline of coal, as renewables and gas fired generation are proving cheaper and more flexible, IEEFA said.

No new coal fired plants are being built in the USA, and most of the existing fleet is ageing, IEEFA added in its report.

The data indicates that the future of coal fired generating assets in the USA

is limited, leaving a question mark over US President Donald Trump's plans to revive the country's coal mining sector.

According to investment bank Lazard, the levelised cost of electricity from a new wind farm in the US is \$29-\$56 per MWh before any subsidies such as the federal Production Tax Credit, which can cut the cost of wind power to as little as \$14 per MWh. In comparison, the marginal cost of operating a coal plant is \$27-\$45 per MWh.

Utilities in the US are making the case to regulators that closing coal plant and replacing them with renewables, while also investing in energy efficiency measures, can cut consumers' bills.

Canada funds ocean economy drive

The government of Canada has committed C\$153 million (\$115.25 million) to a programme designed to harness the economic potential of the country's oceans.

The government funding will be matched by private sector investments and will fund the Ocean Supercluster, an initiative aimed at accelerating innovation and sustainable growth in ocean industries such as marine renewable energy, fisheries, oil and gas and shipbuilding.

The Supercluster will create more than 3000 jobs and add more than C\$14 billion to Canada's economy over 10 years, the government said. The initiative will bring together industry, academic institutions and not-for-profit organisations to exploit business opportunities in the Atlantic ocean economy.

In announcing the agreement, Navdeep Bains, the Minister of Innovation, Science and Economic

Development of Canada, noted: "Canada's oceans are a national treasure; they represent a unique opportunity for innovation, scientific research and sustainable business development."

The funding represents a potential boost for Canada's marine energy sector, which is already largely concentrated on Canada's east coast.

Emera, a former investor in Cape Sharp Tidal Venture, was one of the companies leading Ocean Supercluster's bid for funding.

The company pulled out of the Cape Sharp Tidal Venture earlier this year after its partner, OpenHydro, declared bankruptcy.

Cape Sharp had deployed a 2 MW OpenHydro tidal turbine at the Fundy Ocean Research Centre for Energy (FORCE) in Nova Scotia just days before OpenHydro's bankruptcy. The turbine remains in place but is not operating, according to Emera.

EGP embarks on Sao Goncalo build

Construction of one of the largest solar photovoltaic (PV) plants in South America is now underway in Brazil.

Enel Green Power says that it has started building the 475 MW Sao Goncalo solar park in Sao Goncalo do Gurgueia, in Brazil's northeastern state of Piaui. The Italian company has invested around \$390 million in the project, which will "contribute to the diversification and resilience of [Brazil's] energy mix", according to Antonio Cammisecra, Head of Enel Green Power.

Out of Sao Goncalo's 475 MW of installed capacity, 388 MW were awarded to the Enel Group in Brazil's

A-4 public tender in December 2017 and are supported by 20-year power supply contracts with a pool of distribution companies operating in the country's regulated market. The remaining 87 MW are expected to generate energy for the free market.

■ EDP Energias do Brasil SA is to sell 123 MW of small-scale hydropower plants in Brazil to Statkraft. The Norwegian firm will pay a total of BRL704 million (\$189.9 million) for EDP Pequenas Centrais Hidroelétricas SA, which owns Santa Fe Energia SA and seven other small hydro plants which are operating under concessions ending between 2025 and 2030, subject to regulatory approval.

OPG deal moves SMRs closer to commercialisation

Small modular reactor (SMR) firm NuScale is a step closer to commercialising its technology following an agreement with Ontario Power Generation (OPG) to support the vendor design review process.

NuScale says that OPG will support NuScale's vendor design review (VDR) application with the Canadian Nuclear Safety Commission (CNSC), an important step in the commercialisation of its SMR technology. "We are extremely fortunate to have OPG's valuable nuclear regulatory and utility expertise, and we know that they will be an incredibly helpful partner in our efforts to ensure that our new and innovative technology meets Canadian

regulatory requirements and customer needs," said NuScale Chairman and Chief Executive Officer John Hopkins.

NuScale is currently working on a service agreement to submit a VDR application with the CNSC. The goal of the VDR is to ensure the nuclear power plant design meets Canadian nuclear regulatory requirements and expectations, as well as Canadian codes and standards. After the service agreement is signed, NuScale and the CNSC will develop a project execution plan for the content and timing of the subsequent submittals. NuScale's technology is already the world's first and only SMR to undergo design certification application review by the

U.S. Nuclear Regulatory Commission.

Through the new agreement, OPG will offer expertise to support not only NuScale's Vendor Design Review application currently under development with the CNSC, but also the further evaluation of development, licensing, and deployment of the first NuScale power plant in Canada.

NuScale's SMR is based on light water reactor nuclear technology capable of generating 60 MWe. Its small, modular nature is designed to offer the benefits of carbon-free energy while reducing the financial commitments associated with gigawatt-sized nuclear facilities. The majority investor in NuScale is Fluor Corporation.

South America investigates geothermal potential

Latin America could boost its geothermal energy capacity with the help of funding from the Geothermal Development Facility for Latin America (GDF).

The organisation has awarded total funding of €13 million in a second of three funding rounds that will amount to €55 million in total. The €13 million recently allocated will support surface

studies and exploratory drilling for seven geothermal projects in Chile, Peru, Nicaragua and Guatemala.

According to GDF, its funding will help to catalyse €1.6 billion (\$1.84 billion) in future investment in geothermal development in Latin America.

Five geothermal projects will receive up to €600 000 (\$690 000) for surface studies in Chile, Peru,

Nicaragua and Guatemala. Two geothermal projects in Chile and Guatemala will each receive up to €5.8 million (\$6.7 million) for exploratory drilling campaigns.

A third call for applications for GDF funding is scheduled for this month. In total, GDF says its funding will help to support development of almost 900 MW of geothermal energy capacity.

Australia ramps up transition to new energy economy

Australia is now looking to exploit hydrogen, along with its growing activities in wind, solar and storage, as it moves to a cleaner energy economy. **Syed Ali**

Australia, a country well known for its dependence on coal, appears to be accelerating efforts to move towards a clean energy economy.

Last month in a significant move, the world's biggest coal exporter and second largest liquefied natural gas (LNG) exporter, said it wants to build its next big energy industry around exploiting solar and wind power along with brown coal to produce hydrogen.

Australia is seeking to supply what could be a \$7 billion market for hydrogen to China, Japan, South Korea and Singapore by 2030, according to a report carried out by consultants ACIL Allen for the Australian Renewable Energy Agency.

"Many of our traditional gas markets – Japan, South Korea – have adopted strategies that put hydrogen and ultimately renewable hydrogen at the core of their energy future. So we want to make sure we've got the capability of providing for that market," said

Western Australia's Regional Development Minister Alannah MacTiernan.

While initially just a fraction of Australia's LNG exports, which are forecast at A\$48 billion (\$35 billion) in 2019, hydrogen exports could grow the same way that Australia's LNG industry has over the past 30 years, according to ACIL Allen, the Australian government, and local gas producer Woodside Petroleum.

"The development of a hydrogen business is similar to the early days of the LNG business," said Shaun Gregory, Woodside's Executive Vice President for exploration and technology.

Output may start through the gasification of brown coal with the hydrogen and carbon dioxide separated out. Currently, hydrogen derived from coal gasification is cheaper to produce than from electrolysis of water using electricity from wind and solar.

The goal is to drive down the costs of a hydrogen cargo by 2030 to a level

that Japanese buyers would accept, said Australia's Chief Scientist Alan Finkel. This will happen as the cost of electrolyzers fall, along with the continuing reduction of wind and solar power, which is becoming increasingly popular.

Solar plus storage, in particular has been gaining traction, especially in southern Australia.

Last month, it was announced that the 25 MW/50 MWh Gannawarra Energy Storage System (GESS) in the state of Victoria has completed construction and began exporting electricity to the grid. The project is claimed to be the largest integrated solar plus battery facility in Australia and is among the largest in the world.

Notably it is believed to be the first time a utility-scale battery system has been retrofitted to an existing solar project, the Gannawarra solar farm, providing a new commercial model for other renewable and storage

facilities in Australia. The project was developed by a consortium comprising Australian renewable energy and storage company, Edify Energy, Tesla and EnergyAustralia and co-financed by Wirsol Energy.

Also in Victoria, in November UK battery storage specialist redT began operation of a hybrid facility that combines a vanadium redox flow battery with a lithium-ion battery at Monash University's campus in Melbourne. The 1 MWh installation is claimed to be the largest behind-the-meter C&I (commercial & industrial) energy storage facility in Australia.

Elsewhere, international infrastructure investor John Laing Group closed financing on its 174.9 MW Finley solar farm in New South Wales, which is being developed by Esco Pacific. The project is expected to be complete in late 2019.

At the same time as integrating energy storage, Australia is also looking

at transforming its grid to handle the challenge presented by the intermittency of wind and solar.

Last month NSW presented its Transmission Infrastructure Strategy as it seeks to prepare the grid for gigawatts of new capacity. The strategy envisages: increased interconnection capacity with Victoria, South Australia and Queensland; an expansion of the Snowy Hydro Scheme; more affordable energy through a focus on specific energy zones; and streamlined regulation and improved conditions for investment.

"There are A\$27 billion of new energy projects in the NSW pipeline but only 1 in every 20 projects can connect – it's time to change that," said the state's Energy Minister Don Harwin. These projects, the combined capacity of which is over 20 GW, include wind, solar, bioenergy, gas, coal plant upgrades and pumped hydroelectric storage.

NTPC eyes biomass co-firing at Indian coal plants



India's National Thermal Power Company (NTPC) is planning to start biomass co-firing across all its coal-based thermal power stations in an effort to reduce greenhouse gas emissions and cut pollution.

The aim is to co-fire surplus agricultural residue, creating an alternate market for its large-scale utilisation in power plants, while reducing carbon emissions from coal power plants.

NTPC is aiming to burn biomass like scrap lumber, forest debris, crop residues, manure and some types of waste residues along with coal to generate electricity. The company will soon start procurement of biomass pellets and torrefied biomass pellets and briquettes for co-firing across all its coal fired power plants and will soon float a tender.

Harminder Singh, Power Analyst at data and analytics company GlobalData, commented: "NTPC's decision to implement biomass-based co-firing at all its power stations is a bold move

that will help in curtailing air pollution. This follows the policy announced by the Ministry of Power in 2017, regarding biomass utilisation for power generation through co-firing in pulverised coal fired boilers. NTPC has already successfully used a 7 per cent blend of biomass for co-firing at its Dadri power plant."

He added: "With India's cities experiencing significant levels of smog in the winter months, it makes a lot of sense to co-fire this biomass along with coal in the coal fired power plants. On one hand, it will reduce the emissions from these power plants, and on the other, reduce the coal requirements of these plants, easing the pressure on coal sourcing."

According to GlobalData, NTPC has a total coal-based capacity of more than 40 GW and assuming all its power stations use 7 per cent biomass blend, the company itself can utilise 10-12 million tonnes of biomass, which is around one-third of the residue burnt.

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ASEAN steps up energy cooperation

ASEAN member countries commit to greater grid connectivity and developing renewables.

ASEAN countries recently said they will step up cooperation and share resources to ensure energy security through expanding power grid connectivity and developing renewable energies.

Ministers and deputy ministers in charge of energy of the ten member states of the Association of the South-east Asian Nations (ASEAN) made the commitment at the 36th ASEAN Ministers on Energy Meeting

(AMEM) and associated meetings held in Singapore in late October.

Speaking at the event, Singaporean Minister for Trade and Industry Chan Chun Sing said investments in power generation capacity and infrastructure will be needed to meet ASEAN energy demand, which has grown by 60 per cent over the past 15 years.

Chan stated that in addition to efforts by each nation, cooperation within ASEAN and between the grouping

and dialogue partners and international organisations like the International Energy Agency (IEA) and the International Renewable Energy Agency (IRENA) in energy investment and infrastructure finance will support the region's increasing energy demand and make ASEAN more attractive to investors.

At the meeting, member countries agreed to increase grid connectivity to double integration capacity from the

current 5200 MW to 10 800 MW in 2020 and 16 000 MW after that year. Phase 1 of the Laos-Thailand-Malaysia-Singapore Power Integration Project, the first multilateral power agreement, started in January this year and has so far hit 15.97 GWh.

ASEAN nations signed a memorandum of understanding (MoU) with IRENA on renewable energy development and approved an action programme to realise this MoU, with a

view to supporting ASEAN in achieving the target of increasing the renewable energy share to 23 per cent by 2030. Renewables have now reached 12.4 per cent in the region's total energy mix. They also recognised "outstanding results" in energy cooperation such as reducing the region's energy intensity in 2016 by 21.9 per cent compared to 2005 levels, ahead of the targets of 20 per cent in 2020 and 30 per cent in 2030.

ABB pioneers electricity infrastructure technology in China

ABB announced that it is taking a key role in the world's first HVDC grid in China and also launched a new Technology Experience Center that will help demonstrate its solutions for transmission and distribution infrastructure.

The Zhangbei high-voltage direct current (HVDC) grid in the Beijing-Tianjin-Hebei area of China will enable the integration of remote wind, solar and hydro energy in a transmission ring that ensures optimisation of power flow.

The unique HVDC grid is designed by State Grid Corporation of China

(SGCC). ABB will supply several critical elements including an HVDC Light valve, wall bushings, transformer components, high-voltage capacitors and power semiconductor devices.

HVDC is a highly efficient technology for transmitting large amounts of electricity over long distances with minimal losses. Traditionally, they are point-to-point links, but the Zhangbei pilot project is unique because several stations are connected with each other in a network, optimising the use of renewables while ensuring reliability of power supply.

ABB, along with other local suppliers, is supplying key equipment for this milestone project, which will be the world's largest and most advanced Voltage Sourced Converter (VSC) HVDC system with four interconnected stations in a ring network, delivering up to 4500 MW of clean energy.

The company also announced that it has officially opened the ABB Technology Experience Center in the north building of ABB Xiamen Hub, Fujian province.

The centre, which represents an investment of around \$300 million, will

give customers the opportunity to experience first-hand ABB's pioneering technologies, from substation to socket through the ABB Ability platform of digital solutions.

Among the exhibits at the centre are demonstrations of ABB's cloud services and remote factory testing capabilities. There is also a smart lab and a segment sand table, which simulates electricity flows.

The smart lab, which is at the heart of the centre, enables customers to observe the performance of ABB products and solutions for industry, utilities and infrastructure under a range of

operational conditions. The technologies available for customer demonstrations include ABB's solutions in micro-grids, digital substations and distribution automation, industrial power supplies, transport, buildings and industrial automation.

China has terminated the levy of anti-dumping and countervailing duties on solar grade polysilicon originating from the European Union. The duties were in place since May 2014. The move comes in response to the EU lifting anti-dumping and anti-subsidy measures against Chinese solar panels in September.

South Korea caps operations of coal, oil power plants

South Korea has introduced a cap on the operation of some coal and oil fired power plants at 80 per cent for the first time, as most cities including its capital Seoul issued an air pollution advisory, its energy ministry said.

The measure kicks in when an air pollution advisory is issued and the concentration of fine particulate matter with diameters of less than 2.5 micrometres (PM 2.5) is expected to exceed 50 micrograms per cubic metre until the following day.

Seven coal fired power plants with a total capacity of 820 MW and four oil fired power plants with a combined capacity of 280 MW lowered their operations from 6 a.m. (21:00 GMT) to 9 p.m. on November 7th.

The government has introduced the

cap on a trial basis and plans to fully introduce it from 2019, according to a ministry statement.

South Korea, Asia's fourth largest economy, has been grappling with worsening air quality. The government halted operations of five old coal fired power plants from March to June to reduce air pollution.

Coal power generates about 40 per cent of the country's total electricity, followed by nuclear and gas. Last year, South Korea unveiled its power supply plan, with an aim to boost the share of renewable energy for power generation to 20 per cent by 2030, while scaling back dependence on coal.

More recently, the government signed an agreement with Denmark to deepen their ties on renewable energy

and new energy industries. At the end of October the two countries said they would be expanding joint projects, overseas marketing and technology development in the renewable energy, smart grid and energy storage system areas.

Also at the end of October, President Moon Jae-in announced a massive clean energy complex that will be built on reclaimed land in Saemangeum near the southwestern port city of Gunsan. The clean energy complex will have a total capacity of 3 GW. This includes a 1 GW offshore wind farm that will be built in waters outside a 33 km seawall at the site. "The world's largest solar power complex and a large-scale offshore wind farm will be built at Saemangeum," Moon said.

Vietnam still hooked on coal

The import of coal for electricity generation looks set to increase in the near future, said Deputy General Director of Electricity Vietnam (EVN) Ngô Sơn Hải.

Hải told the Coaltrans conference on emerging Asian coal markets in Hanoi

in November that the total power capacity by the end of 2017 was more than 45 000 MW, 38 per cent of which was coal fired power generation.

He also said total coal fired power capacity would reach 26 000 MW by 2020, accounting for 42.7 per cent of

the total and 55 300 MW by 2030, or 42.6 per cent.

According to the National Power Master Plan VII for 2011 to 2020 with a vision to 2030, coal fired power would comprise a big portion in the country's power supply.



The UK's energy industry believes the energy price cap will be ineffective and says that switching and energy efficiency measures would have a greater impact on bills.

Siân Crampsie

UK energy suppliers have given a mixed reaction to an announcement by regulator Ofgem on details of a forthcoming energy price cap.

Ofgem last month provided the market with details of the energy price cap, designed to prevent households from being overcharged for their energy.

It said that the cap would be set at £1137 per year for typical dual fuel customers, providing an average saving of around £76 per year, with some customers saving up to £120.

The cap will take effect from January 2019 and is expected to affect 11 million customers who are on poor value

tariffs. It will be updated twice a year to reflect wholesale energy prices, Ofgem said. It added that the measures would prevent energy suppliers from "feathering their nests".

The energy sector, however, has expressed concern about the impact of the price cap on smaller energy suppliers and on competition. Several small energy providers have ceased trading in the last year, including Spark Energy and Extra Energy, which both collapsed last month.

Trade group Energy UK noted that wholesale energy costs are rising steeply for energy suppliers in the UK and that long-term measures such as energy efficiency programmes would be

much more effective in controlling energy bills than a price cap.

"Wholesale costs have risen by well in excess of 30 per cent in the last year affecting energy companies large and small and, if this continues as current forecasts suggest, the cap will have to increase to reflect this," said Energy UK's Chief Executive Lawrence Slade. "So we must continue to encourage more customers to engage and benefit from the large savings that can be made by switching, which far exceed those delivered by the cap."

Slade added: "We must also look at ways to keep bills down on a lasting basis. Energy efficiency is by far the most effective way to do this over the

long term, saving the typical customer hundreds of pounds a year through reducing their energy use."

Jane Lucy, CEO and Founder of The Labrador, an energy switching website, said that the price cap would discourage competition and had led some suppliers to increase their prices ahead of the cap. "Price caps will never be the way to solve the UK's energy market as they undeniably reduce competition, promote lethargy and consequently, make consumers mistakenly believe that they are getting the best deal, when this is not the case," said Lucy. "With a third of dual fuel tariffs exceeding government price cap, it is undeniably apparent that the price caps

are having the opposite impact on the energy market, with suppliers considering it a target as opposed to a measure that protects customers.

"The only way we can ensure a competitive market is not solely with a price cap, but by enabling customers to switch energy providers with ease."

The UK government and the regulator have been trying to promote competition in the energy market, leading to the number of new entrants rising from 60 in 2017 to over 70 in 2018. Rising wholesale costs have been behind recent supplier failures and Ofgem says it plans to introduce new rules to make sure new entrants are financially more robust.

Poland marks return to wind investment

- 8 GW of offshore capacity by 2035
- Onshore auction awards 1 GW



Poland is set to boost its renewable energy capacity after the government announced plans to support the development of 8 GW of offshore wind energy capacity by 2035.

Poland's Energy Secretary, Grzegorz Tobiszowski, announced last month that the government was planning legislation setting out annual volumes for offshore wind capacity in the Baltic Sea.

The news came as the country launched a 1 GW onshore wind energy auction that marked a new phase in the country's renewable energy sector.

The auction awarded contracts to 31 bids from 23 developers at an average price of PLN 196.16 (\$51.6)/MWh, according to auction supervisor the Energy Regulatory Office (URE). Winners included E.On, Polish developer Potegowo Winery, state-controlled energy group PGE and German developer PNE.

Successful projects must be built within 30 months of the tender. Many

of the projects submitted for the auction are likely to have been shovel-ready projects that never reached the construction because of legislation enacted in Poland in 2016 that effectively blocked the development of new wind farms.

Poland's government announced in July that it would amend renewable energy laws to encourage new wind sector investments.

The move left developers scrambling to get previously shelved projects ready in time for the auction.

Auction prices came in at between €37 and €50/MWh. "These prices are extremely competitive," said WindEurope CEO Giles Dickson. "They're lower than we've seen in recent auctions in Germany and France."

"Prices were so low that the Polish government used only 55 per cent of the budget it had allocated for the auction. This means it can re-allocate nearly €2 billion for an additional 850 MW of capacity."

According to WindEurope, Poland could receive its first offshore wind power by 2025 through the 600 MW Polenergia Bałtyk III project being developed by Polenergia and Equinor.

The two companies are also jointly developing the 600 MW Polenergia Bałtyk II wind farm, scheduled to come online by 2027.

"The Polish Baltic Sea has enormous wind energy potential and it's great to see Poland beginning to tap into this and boosting their existing offshore wind supply chain," WindEurope Chief Policy Officer Pierre Tardieu said. "Poland should now include detailed plans on both on- and offshore wind in its National Energy and Climate Plan for 2030. The first draft is due by the end of 2018."

"With its onshore auction and plans for offshore wind, Poland is now sending a powerful signal to other countries in Central and Eastern Europe that being ambitious on wind energy makes economic sense."

RWE makes Claus C U-turn

Recovering wholesale power prices and new options in the European grid will enable RWE to reactivate its mothballed Claus C gas fired combined cycle power plant in Maasbracht, the Netherlands.

The company says that it now has an option to connect the 1300 MW power plant to the Belgian grid, and that this, together with the "positive evolution" of wholesale power prices, have made the plant's operation viable once again.

Claus C is one of the most modern power plants of its kind in the Netherlands. It was commissioned in 2012 but mothballed just two years later due to low wholesale power prices.

RWE says that it will make Claus C available to the Belgian power market, where a capacity mechanism is being introduced to assist the country with its decision to abandon nuclear energy by 2025.

Claus C will be made commercially available at the end of 2020, RWE said.

Brexit puts the brakes on investment

The United Kingdom's planned departure from the European Union in 2019 is making investors apprehensive about clean energy investment, according to EY's latest Renewable Energy Country Attractiveness Index (RECAI).

The UK has slipped down one position to 8th in the latest EY rankings, reflecting a marked slowdown in clean energy investment ahead of Brexit. EY says that concerns over the ability to secure a deal over Brexit will lead to increased uncertainty and higher risks for investors.

According to EY, Q3 renewables investment in the UK fell 46 per cent year-on-year amid speculation surrounding Brexit. One of the major concerns is how Brexit could impact

power exports to the EU as well as the price of imported power equipment.

UK electricity and gas trade with the EU27 is worth approximately €6 billion annually, with natural gas dominating trade. The UK relies predominantly on imports of gas from non-EU countries, including Norway, and LNG from sources such as Qatar. Imports of electricity from the EU account for around 7.5 per cent of total UK electricity consumption.

The UK is also relatively progressive in terms of climate policy and has seen rapid growth in renewables over the last decade as a consequence. The uncertainty around trade deals post-Brexit represents a significant risk factor for project developers that will lead to higher finance costs.

Enel signs agreement for 201 MW Kola project

Enel is moving forward with plans to expand its operations in Russia.

Italian energy company, Enel, has signed an agreement with the government of Russia's Murmansk region to build the 201 MW Kola wind farm.

Enel said in a statement that the project would help to promote the economic potential of Murmansk by creating new, high-tech generating facilities

and infrastructure. It would also help to diversify Russia's power generation resources, it added.

"As of today, the design has been completed, public hearings have been held in the village of Tumany, future connection to power systems has been ensured, and this project, undergoing

government expert review, is on the agenda. The project will be implemented in two stages: 80 and 120 MW," said Murmansk governor Marina Kovtun.

The Murmansk region, in Russia's northwest, has "obvious potential" for the development of wind energy due

to wind conditions comparable to those on the coast of Portugal, Enel said. Carlo Palasciano Villamagna, General Director of Enel Russia said that the government of Murmansk had been supportive, and that there were also possibilities in the region for the development of new innovative projects,

including installation of e-car chargers.

The Kola wind farm is one of two projects won by Enel Russia in a federal wind power tender.

Elsewhere in Russia, the company owns four combined cycle power plants with a total installed capacity of around 9400 MWe.



Turkey issues new YEKA plans

- Four 250 MW projects sought
- Tender will help revive Turkish wind sector

Turkey will boost its renewable energy capacity through a new 1 GW onshore wind energy tender.

The tender will be the third so-called 'Yeka' auction, designed to procure large volumes of renewable energy capacity. It is seeking proposals for four large-scale projects, each with a capacity of 250 MW, in the provinces of Balikesir, Canakkale, Aydin and Mugla, western Turkey.

According to a notice in the *Turkish Official Gazette*, the deadline for submitting bids is March 7, 2019. Successful candidates will be awarded 15-year power purchase agreements (PPAs).

Turkey's first 1 GW wind tender, held in 2017, was won by a consortium including Siemens Gamesa and local companies Kalyon Enerji and Turkerler Holding with a bid of \$0.0348/kWh. This latest tender has a bidding cap of \$0.055 per kWh.

In November Giles Dickson, CEO of trade body WindEurope, said that

Turkey's currency crisis has stalled investment in the country's wind energy sector, and that the government should take measures to reassure investors in the sector.

The Yeka auction will be run in March 2019. For each tender, the applicants must submit a minimum one-year bank guarantee worth \$2.5 million, partly or completely convertible to cash. The winners will be asked to offer a minimum 10-year bank warrant of \$12.5 million.

Earlier in 2017, Turkey held its first Yeka tender, awarding 1 GW of solar photovoltaic (PV) capacity to a consortium of Kalyon and Hanwha Group with a bid of \$0.0699/kWh.

The country has set a goal of deploying 20 GW of wind power capacity by 2023. According to WindEurope, renewable energy will account for 30 per cent of supplies in Turkey, helping to reduce the country's dependence on imports of energy.

Oman solar project marks new phase for renewables

Plans to build a 100 MW solar photovoltaic (PV) plant in Oman signify a step change for renewable energy in the Sultanate, Petroleum Development Oman (PDO) has said.

The oil company has awarded a contract to build the solar plant at Amin, southern Oman, to a consortium led by Japan's Marubeni Corporation. It will purchase the entire power output from the solar farm, making the project the first in the world to have an oil and gas company as the sole wholesale buyer of electricity from a solar project.

Construction will start in January 2019 and the site will span 4 km².

The project will be structured as an IPP under the terms of the power purchase agreement for a period of 23 years from the scheduled commercial operation date, which is planned for May 2020.

The consortium – comprising Marubeni with partners Oman Gas Company SAOC, Bahwan Renewable Energy Company LLC and Modern Channels Services LLC – will build, own and operate the facility and then transfer it back to PDO.

Auctions boost East European wind markets

New auction schemes for wind energy in Eastern Europe, Russia and the Caspian will help to drive growth in the region's wind markets.

A new report from Wood MacKenzie Power & Renewables indicates that the region will see an annual growth rate of nine per cent in its wind sector over the next decade, adding a total of 16 GW of new installations to the grid.

"The development will be largely driven by the implementation of auction schemes in Russia and Kazakhstan and proposed auctions in Poland and Ukraine," said lead author Sohaib Malik, market analyst.

Wind power auctions have fast become a favoured policy tool of Eastern European countries as they follow a global trend of moving away from feed-in tariff (FIT) schemes. In other markets globally, such auctions have led rapid growth, with Brazil and Saudi Arabia being two examples.

Auction mechanisms can also help to drive down energy and technology costs.

Malik added: "Poland will be picking back up as a dominant market in the region soon after the enactment of favourable amendments introduced to

the renewable energy act in July 2018, which will allow the previously permitted, but halted, wind projects to participate in auctions. This development gives a major boost to the Polish onshore wind market."

A maturing wind project pipeline in Russia, Ukraine and Kazakhstan will support the medium-term market outlook. Russia will experience "immense" growth between 2021 and 2024 as developers are required to connect most of the 3.2 GW of awarded capacity during this period, Wood MacKenzie said.

Ukraine, on the other hand, will have transitioned from the feed-in tariff (FIT) regime to auctions by the end of 2019, which will create more competition between developers to help reduce the cost of wind power.

"We expect significant coal decommissioning in Hungary, Poland and Romania after 2020 due mainly to an ageing fleet and stricter emissions regulations," Malik said. "As wind power becomes more competitive due

to reductions in technology costs and environmental benefits, it will be in a strong position to displace this coal power capacity in EU member states across the region."

In the future, an interplay of continued growth in those leading regional markets, as well as the emergence of small, new wind markets such as Armenia, Azerbaijan, Georgia and Slovakia, will ensure long-term growth prospects for the region as a whole.

Malik said: "Traditionally a rather small region where developers added 142 MW of new wind capacity in 2017 in three markets, Eastern Europe will grow by more than two-fold over the next 10 years."

Only regulatory uncertainty poses a risk to this positive forecast, which can be mitigated by proactive measures by the relevant governments. To ensure that awarded wind power capacity is ultimately commissioned, governments in Eastern Europe will have to streamline permitting and grid integration regulations.

Eskom planning battery installations

South African utility Eskom is planning to install battery energy storage projects in order to help boost renewable energy capacity and strengthen the grid.

The company is reported to be planning up to 800 MWh of energy storage installations in the next 12 months and has secured financing from the African Development Bank (AfDB) as well as the World Bank.

A second project phase could see a further 640 MWh of battery storage projects installed across the country

by December 2021.

According to the AfDB, the first phase of the project will see grid-scale batteries installed at 47 sites. The facilities will be located close to existing renewable energy projects in four provinces: Eastern Cape, Northern Cape, Western Cape and Kwa-Zulu Natal.

The sites have been selected to support the integration of renewables and increase the stability of the distribution network. Most of them will be existing Eskom substation sites, the

company said.

Last month Eskom released a draft of its Transmission Development Plan, indicating projects to expand its power grid by over 6500 km over the next decade.

Eskom has added 700 km of new lines to its grid over the last 12 months. Its Transmission Development Plan also includes projects to develop cross-border transmission lines to neighbouring countries Namibia, Botswana, Zimbabwe, Mozambique, Swaziland and Lesotho.

Business sector seeks green growth backing from governments



The business and industrial sectors can play a major part in combatting climate change, but only with strong government support, leaders say.

Siân Crampsie

The business and industrial sectors are putting increased pressure on governments to make investments in climate-friendly technologies more palatable.

Last month, over 100 organisations called on European governments to make renewable energy investments easier, while RE100 said that some 155 multinational companies are now signed up to its pledge to source 100 per cent of energy needs from renewable sources.

According to the RE-Source Platform, a European alliance representing clean energy buying, corporate

renewable power purchase agreements (PPAs) worth 6 GW have already been signed in Europe, including 2 GW in 2018 alone. RE-Source wants policymakers to remove all regulatory and administrative barriers to corporate sourcing of renewable energy to enable more corporates to invest directly in renewable energy and establish PPAs.

"We call on governments to set the right policies to fulfil our ambition to live within the limits of the planet," said Pia Heidenmark Cook, CSO of IKEA Group, which has set an ambition to be climate positive by 2030.

RE-Source said that its declaration would send "a strong signal" to poli-

cymakers in Europe. Its members include Microsoft, Google and IKEA. "As the world's largest corporate buyer of renewable energy, we are dedicated to doing our part to scale renewables in Europe," said Marc Oman, Senior Energy Lead from Google. "Expansion of corporate PPAs can be a major driver in Europe's renewable energy transition."

According to a new report published by RE100, its member companies sourced 72 TWh of renewable power in 2017, an increase of 41 per cent compared with the preceding year. "If RE100 were a country, it would be the 23rd largest in terms of electricity use, ahead of Egypt and just behind

Thailand," stated the report.

The report states that 37 out of RE100's member companies sourced over 95 per cent of their electricity from renewables in 2017, and almost half of the members achieved more than 50 per cent. This is not only ahead of the global average of 26.5 per cent, but also ahead of leading countries such as Spain (33.7 per cent) or the United Kingdom (26 per cent).

The average target year for RE100 members to become 100 per cent renewable is 2026, and more than three in four companies aim to get there by 2030.

The private sector power usage accounted for two-thirds of the world's

electricity demand last year, the report notes. RE100 members have a total combined revenue of more than \$4.5 trillion which is over 5 per cent of global GDP.

In November the Energy Transitions Commission (ETC), a group of business leaders tasked with seeking solutions to sustainable economic growth, said that although cutting emissions will impact GDP, they would be outweighed by the benefits of avoiding climate change.

The ETC believes that curbing emissions will help some companies to become more competitive. They will require the support of government policies, however.

Trojan deal combines battery brands

A deal to combine two leading US battery manufacturing firms will create one of the world's largest energy storage providers, the companies say.

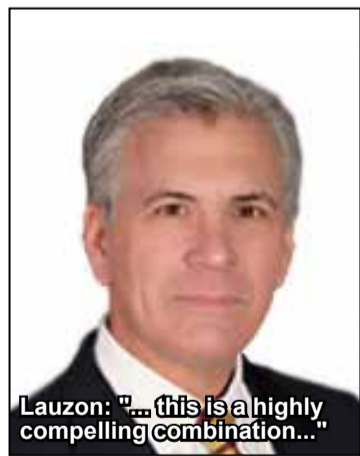
Charlesbank Capital Partners says that it has reached a deal with KPS Capital Partners to sell its Trojan Battery Company, a leading manufacturer of deep-cycle energy storage solutions.

The deal will see Trojan combined with C&D Technologies, a subsidiary of KPS and a manufacturer and supplier of battery systems for a wide variety of applications. Combined, the two companies will have over \$1 billion in revenues, eight manufacturing facilities and a presence in every major region around the world.

Trojan CEO Neil Thomas said that the deal would "secure the company's future and position it for even greater success".

Thomas added: "The synergies between Trojan and C&D will create a global leader in energy storage solutions with two iconic brands, quality products and the ability to supply advanced battery technologies to customers around the world".

"Given C&D and Trojan's complementary portfolios of global manufacturing plants, markets and products, this is a highly compelling combination with tremendous strategic value and an exciting multi-segment growth opportunity," said Armand Lauzon, Chief Executive Officer of C&D.



Lauzon: "...this is a highly compelling combination..."



- Advent closes purchase of GE unit
- GE sets up further asset sales

Distributed power company Innio says it is well-positioned to play a key role in the global gas engine sector and to become an integral part of the energy transformation after completing its spin-off from GE.

The company last month re-launched after Advent International completed the \$3.25 billion purchase of GE's distributed power business and says that its two main brands – Waukesha and Jenbacher – give it a proven track record in reciprocating engines in the distributed power generation and gas compression businesses.

According to Advent, Innio is well-positioned in the \$5 billion global gas

engine sector, with growth anticipated to be a mid to high single-digit rate per annum, driven by the rising demand for affordable, reliable and sustainable solutions for power generation and gas compression near or at the point of use.

"This is an exciting time to emerge as a stand-alone energy company," said Carlos Lange, President and CEO of Innio. "With the continued growth of renewables across the globe and the increased emphasis on energy efficiency, Innio is well-positioned to be a key enabler and integral part of the energy transformation."

Advent inked the purchase of GE's distributed power business in June

2018. GE has also announced plans to sell its lighting systems company Current as part of its plans to raise cash and reduce debt.

Current is being purchased by American Industrial Partners, a private equity group, for an undisclosed price.

GE set a target of making \$20 billion of divestments after carrying out a comprehensive business strategy review earlier this year in response to poor performance in several of its industrial business units, including power generation.

It has also sold its industrial solutions business to ABB and its healthcare software unit to Veritas Capital.

Alpha Energy, ME SOLshare partnership targets off-grid communities

Off-grid communities look set to benefit from a new partnership between decentralised grid technology company ME SOLshare and Alpha Energy, part of the Alpha innovation facility established by Spanish multinational telecoms giant Telefónica.

The collaboration will see the companies work to better understand how data can be used to evolve peer-to-peer microgrids, with the ultimate goal of delivering clean and reliable power to the next billion people.

ME SOLshare is looking to expand its microgrid technology – the SOLbox IoT meter – that enables communities to share and monetise energy. The SOLbox IoT meter, which allows

peer-to-peer electricity trading between off-grid households, is already connected to solar panels in Bangladesh. Alpha Energy, meanwhile, says its mix of power systems engineering and AI data analytics capabilities will enable the companies to work to enhance the efficiency of low voltage, peer-to-peer microgrids.

Dr. Sebastian Groh, Managing Director of ME SOLshare, said: "Having already established the world's first peer-to-peer solar energy platform for off-grid households in Bangladesh, we want to take our SOLboxes to communities all over the world."

"The aim is to create efficient and dynamic local energy markets that

empower households and encourage solar entrepreneurship. We see this partnership with Telefónica's Alpha Energy team as a crucial step towards creating a viable alternative to inefficient national grids that frequently fail to serve populations."

Alpha Energy, meanwhile, sees great potential in analysing actual user data from off-grid distribution systems as a means of validating technology development and gaining insights from user behaviour. This will allow the development of products and technologies that are more flexible to the needs of communities not connected to reliable grid systems.

Headed by former NaturEner COO

Candace Saffery Neufeld, Alpha Energy was established to explore new business opportunities for Telefónica within the experimental energy sector.

She said: "At Alpha Energy we see decentralised distribution systems as an exciting space that can be evolved through innovative controls and storage, applied intelligence and better understanding of user behaviour. Our partnership with ME SOLshare is focused on enhancing our shared understanding of these systems that they have started to implement across Bangladesh. Ultimately, our aim is to provide clean and reliable power to billions of people around the world."

Alpha Energy says that Bangladesh,

with more than 4 million homes with standalone solar systems, is a unique market in that "it has some of the key ingredients" that it needs to work on for peer-to-peer microgrids.

"We see some really big technology opportunities in emerging markets and having a place that already has a penetration of standalone solar systems, gives us a place to test quicker," said Saffery Neufeld.

While Alpha Energy says it does not have a particular market focus, it is looking for representative markets. "We have found that about 2.7 billion people have less than six hours of reliable electricity per day. So from that perspective, the market is huge."

10 | Tenders, Bids & Contracts

Americas

PG&E orders SF₆-free GIS

Pacific Gas & Electric (PG&E) has placed an order with Siemens for SF₆-free dead-tank circuit breakers and gas-insulated switchgear (GIS).

The equipment is destined for California's 115 kV high-voltage grid. Siemens said in a statement that the order was a "major step forward" for its SF₆-free portfolio.

The order comprises dead-tank circuit-breakers for 72.5 kV and 115 kV as well as GIS for 115 kV. These circuit breakers use vacuum interrupters for switching functions and treated air known as "clean air" as the insulating medium.

The first delivery will take place in mid-2019. The project will help PG&E to cut greenhouse gas emissions from its operations.

FACTS boost in Brazil

ABB has signed a contract worth around \$20 million with Furnas Centrais Elétricas S.A. to supply electrical systems that will enable existing alternating current (AC) lines to transmit higher levels of power to the densely populated Southeast of Brazil.

The installation is located close to Brasilia, Brazil's capital. It will boost transmission capacity while improving power stability using ABB's Flexible Alternating Current Transmission Systems (FACTS) technology.

RES wins Montague contract

Avangrid Renewables has selected RES to build the 200 MW Montague wind farm in Gilliam County, Oregon, USA.

The construction contract represents Phase I of the overall 404 MW Montague wind farm and will consist of 56 Vestas wind turbines.

Southern awards Reading turbine contract

Southern Power has awarded Siemens Gamesa Renewable Energy (SGRE) a contract to supply 62 wind turbines for the Reading wind farm in Kansas, USA.

SGRE will supply 48 of its SG3.4-132 and 14 of its SWT-2.3-108 wind turbines and has also signed a 20-year service and maintenance agreement for the wind farm.

Asia-Pacific

Vestas secures Dundonnell contract

Vestas has received an order to build the 336 MW Dundonnell wind farm in Australia.

The Danish company will supply, install and commission 80 of its largest wind turbine units – the V150-4.2 MW – as well as take care of electrical balance of plant infrastructure at the Dundonnell site in the state of Victoria. It has also secured a 15-year service agreement for the project, which is due to be completed in the third quarter of 2020.

The project is owned by New Zealand-based Tilt Renewables and secured a license under the Victoria Renewable Energy Auction Scheme.

Prysmian develops Singapore grids

SP Power Assets Limited has awarded Prysmian Group a €33 million contract for the design, supply, installation and commissioning of two high voltage power systems to connect the Rangoon and Paya Lebar substations in

Singapore.

The power transmission system comprises 44 km of HVAC (High Voltage Alternating Current) underground 2000 mm² 230 kV cables with a seamless corrugated aluminium sheath and related high voltage accessories.

Prysmian will also supply its monitoring system using the Group's proprietary PRY-CAM technologies. This consists of a PRY-CAM Grids permanent monitoring system for the automatic acquisition, processing and classification of PD (Partial Discharge) signals and spot temperatures, designed for remote monitoring of three-phase strategic assets.

Delivery and commissioning of this project is scheduled for 2020.

Ørsted awards Changhua substation contract

Ørsted has awarded a contract worth more than TWD 7 billion (\$227.7 million/€200 million) to Taiwan Cogeneration Corp (TGC) for the construction of two onshore substations for the first 900 MW of the Greater Changhua offshore wind project in Taiwan.

Onshore works are expected to start in the second quarter of 2019, subject to a final investment decision, the Danish offshore wind developer said.

The engineering, procurement, construction (EPC) contract also covers the construction of cable corridors, landfalls and transition joint bays.

Europe

Siemens supports E.On SF₆-free goals

Siemens is to supply E.On Sweden with SF₆-free high voltage products for installation at a substation in southern Sweden.

The order comprises six bays, including circuit breakers for 72.5 kV and 145 kV as well as 145 kV instrument transformers. The products are from the so-called 'blue portfolio' and will support E.On Sweden's goal of a sustainable SF₆ gas-free power transmission system.

The equipment will be deployed at the Fårhult project site located in southern Sweden close to Västeråker. It will deliver high-performance operation at extreme temperatures as low as -55°C without a heating system.

The Fårhult substation is an important hub in the local power grid. "Using no SF₆ is one way to support our goal of using less greenhouse gases in grid operation," said Mats Andersson, Director Regional Grid at E.On Sweden.

GE Grid wins Inch Cape contract

GE Grid Solutions has won a contract to design, supply and install the high voltage equipment for the Inch Cape offshore wind project in Scotland.

The company will provide the project's onshore substation near Cockenzie and offshore high voltage substation platform, as well as the electrical system design and manufacture of primary equipment components, including the main transformers.

GE Grid Solutions will work collaboratively with a consortium of NKT and Boskalis Subsea Cables & Flexibles, who will deliver and install an export cable system for the 784 MW Inch Cape project.

Inch Cape will feature up to 72 turbines installed 15 km off the Angus coastline in Scotland. Construction is expected to start in 2020.

Vestas secures Finland order

Vestas has secured an order from CPC Germania for the 50 MW Lakiakangas II wind farm in Finland.

The wind farm will consist of 12 of Vestas' V150-4.2 MW turbines with a 135 m hub height optimised to the site's wind conditions. CPC Germania has signed a long-term power purchase agreement (PPA) with a third party that enables the wind park to be financed without state subsidies.

The contract includes supply, installation and commissioning of the wind turbines, as well as a 20-year service agreement. The project will feature VestasOnline Business SCADA solution to lower turbine downtime and optimise the energy output.

Turbine delivery is scheduled for the first half of 2019.

Faroes plan tidal plant

Swedish marine energy developer Minesto has signed a collaboration agreement with the main power generator and distributor on the Faroe Islands, SEV, for the installation of two tidal energy generators.

Minesto will install two DG100 tidal turbine units and sell the electricity generated to SEV through a power purchase agreement. The company said in a statement that the project will play a significant role in the Faroe Islands' transition to 100 per cent renewable energy by 2030.

SEV will also provide required infrastructure such as grid connection and resources for consenting processes. Site development is in progress and a site has been identified in Vestmannasund, a strait in the north west part of the Faroe Islands.

Installation of the first DG100 unit is planned for late 2019 or early 2020, with the following unit to be installed in 2020. The project will be financed through a mix of equity and resources from Minesto and SEV together with public funding grants.

MHI Vestas wins Northwester 2 contract

Parkwind has awarded MHI Vestas Offshore Wind a contract to supply and install 23 of its V164-9.5 MW wind turbine units at the Northwester 2 offshore wind farm in Belgian waters.

The 219 MW facility will be built 50 km off the coast of Ostend in the North Sea. The contract also includes a 15-year service agreement. Turbine installation is slated to start in late 2019.

Northwester 2 is owned by Parkwind and Sumitomo Corporation. The facility has already reached financial close, securing financing from the European Investment Bank, BNP Paribas Fortis and Sumitomo Mitsui Banking Corporation, among others.

Ørsted awards Hornsea 2 cable contract

Nexans has won a contract worth over €150 million to help Ørsted deliver the Hornsea 2 offshore wind farm in the UK North Sea.

Nexans will supply over 200 km of 245 kV cross-linked polyethylene insulated (XLPE) near-shore export cable for Hornsea 2, located 89 km from the coast of Yorkshire, NE England.

The 1.4 GW offshore wind farm will be the largest in the world when it starts operating in 2022.

To bring the electricity produced by the windfarm onshore, the project will be equipped with Nexans three-core HVAC submarine cables. These 245 kV XLPE cables will be part of the near-shore section of the export

circuits linking the wind farm's reactive power substation to the onshore substation. The circuits will comprise three individual near-shore export cables and will follow a similar route to the Hornsea 1 offshore wind farm.

RES takes on Castlecraig

Asset management firm NTR has awarded RES a contract to operate the Castlecraig wind farm in County Tyrone, Northern Ireland.

The ten turbine, 25 MW wind farm located near Drumquin, represents the first time the two businesses have worked together in project operations and follows the successful construction of the wind farm by NTR supported by RES as construction manager.

During the contract period, RES will provide asset management, high voltage operations, financial management, control centre operations from its 24/7 facility in Glasgow, engineering and reporting services to NTR.

In total, RES now manages 414 individual turbines across 37 wind farms in the UK and Ireland, working with 10 different owners.

International

Tanzania cancels renewables tenders

Tanzania Electric Supply Co Ltd (Tanesco) has cancelled three tenders for renewable energy generation projects, according to reports.

The state-owned utility was due to hold tenders for solar and wind power projects in October, but announced in November that it had cancelled them and was working on the next course of action.

The tenders were to call for up to 200 MW of solar energy in Dodoma, Singida, Shinyanga, Mwanza, Simiyu and Iringa regions, and up to 200 MW of wind energy in Singida, Njombe and Dodoma regions.

Uzbekenergo signs up MHPS for O & M

Uzbekenergo, Mitsubishi Corporation and Mitsubishi Hitachi Power Systems (MHPS) have signed a memorandum of understanding to collaborate in a comprehensive service and maintenance programme for Uzbekenergo's power plants.

The deal will further strengthen the cooperation between MHPS and Uzbekenergo based on the O&M agreement they concluded in 2015.

The agreement will initially apply to four power plants, two that are already operating and two that are under construction. MHPS will provide long-term parts supply for the gas turbines at the power plants, and will also provide advanced O&M technology to Uzbekenergo through IoT-based O&M training of the power provider's engineers.

EGP awards Oyster Bay turbine contract

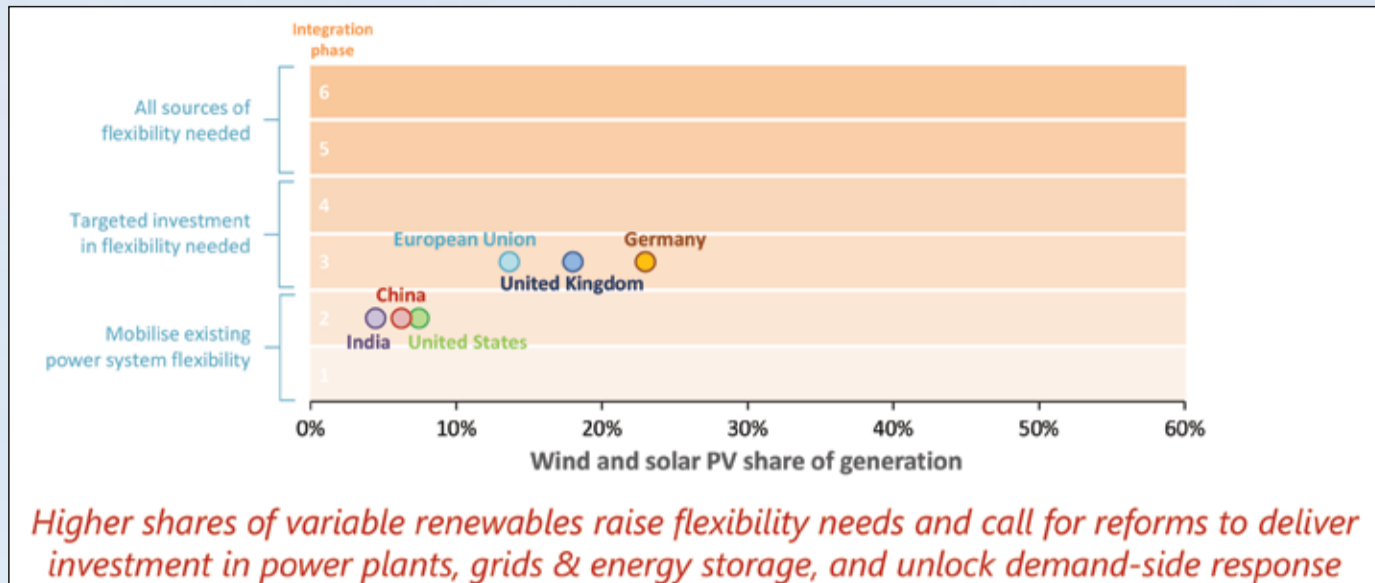
Enel Green Power has awarded Vestas a contract to supply, install and commission the turbines at the 148 MW Oyster Bay wind farm in South Africa.

The wind farm, located in the Eastern Cape province, will have 41 units of V117-3.45 MW turbines in 3.6 MW Power Optimised Mode, on 91.5 m tall towers. The project will feature a Vestas SCADA solution to reduce turbine downtime and optimise energy output.

Enel and Vestas have also signed a five-year Active Output Management 5000 service agreement. Turbine delivery and installation is scheduled for the second half of 2020.

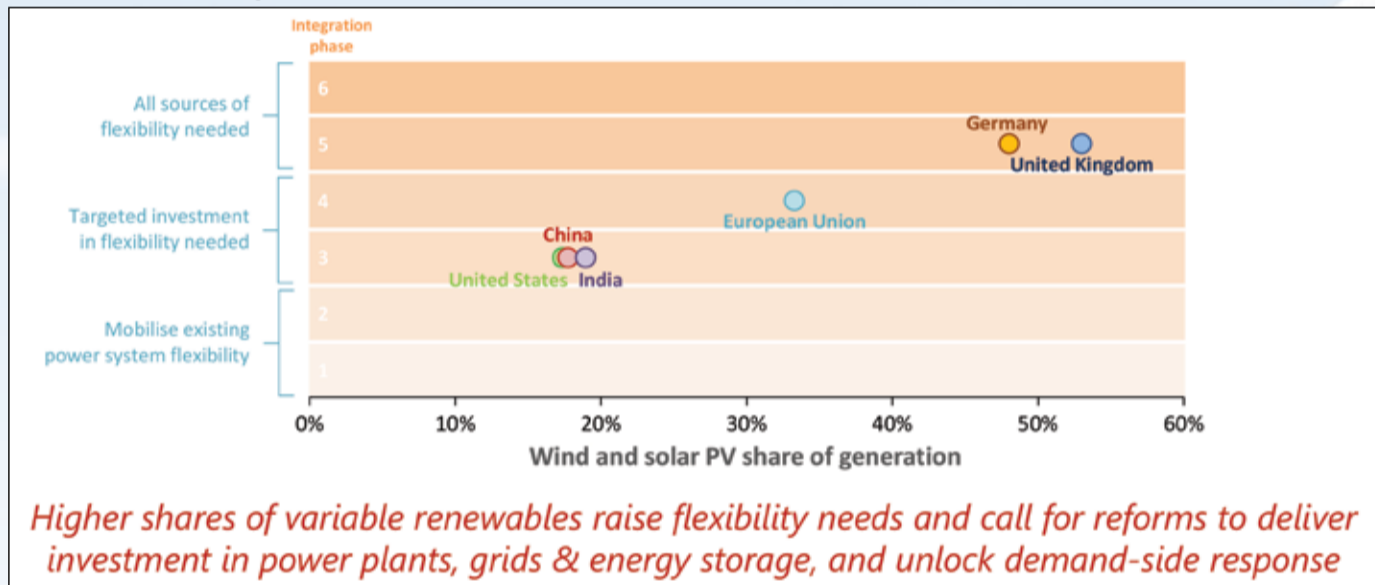


Phases of integration with variable renewables share, 2017

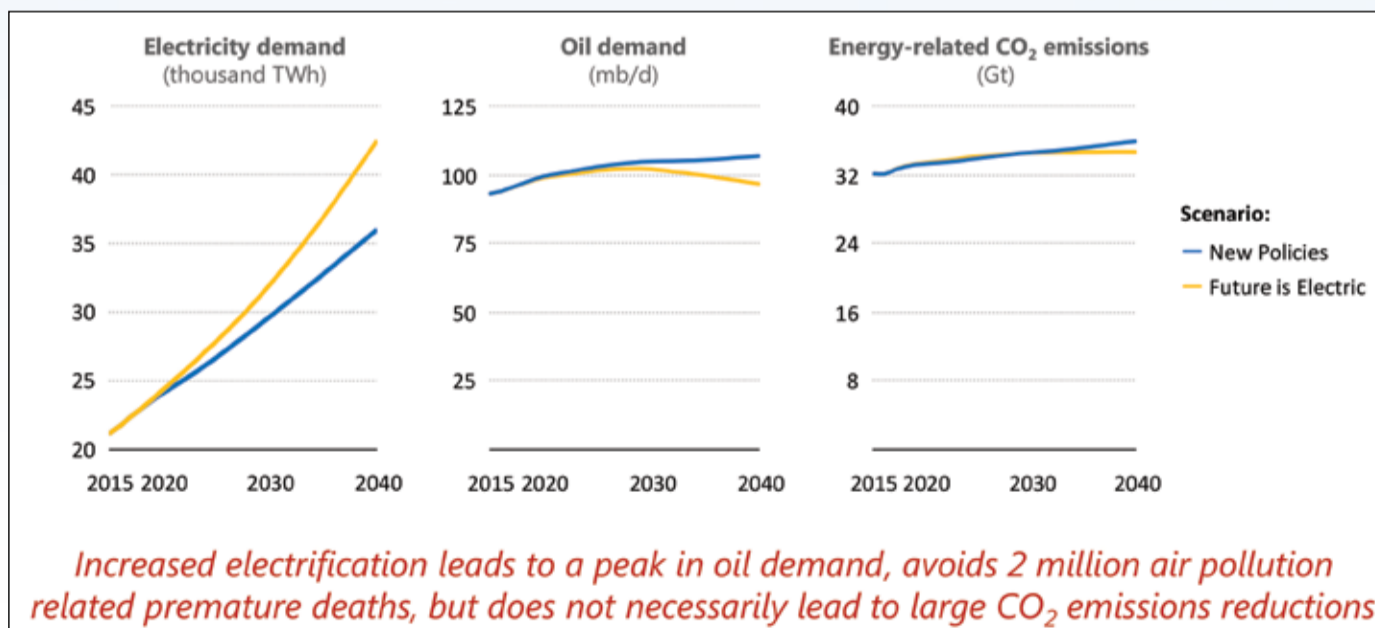


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 website: www.iea.org

Phases of integration with variable renewables share, 2017



What if the future is electric?



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Oil

Crude price falls as supply grows and demand fades

- Riyadh suggests cutting production
- Surge in supply encouraged by sanctions on Iran

Mark Goetz

Crude oil prices have fallen 25 per cent since early October and supply is back at the glut level. In the midst of a number of complicated factors, it is unclear what course oil producers will take to boost prices and bring the market back to what they consider 'in balance'.

Saudi Arabia-led Opec and its 10 non-Opec allies, led by Russia, are to meet in Vienna in early December to discuss what measures to take with regard to over-supply and reduced prices. Riyadh has already suggested cutting production as was done in 2017 in order to remove some 3 million extra barrels per day coming onto the market. A balanced market only came back early this year and oil prices were on the rise, but now there is again too much oil for prices to be where producers want them.

Saudi Arabia is happiest with oil prices at \$80/b or better, and for Russia the higher the better, as both economies depend on oil sales.

Besides over-supply, oil producers

are also facing a slip in demand, particularly in China, which is in the midst of a trade war with the US. The trade dispute is being viewed as encouraging an overall decline in global economic performance, which has shown itself in significant drops in daily trading on the New York Stock Exchange during the course of November.

Saudi Arabian Energy Minister Khalid al-Falih said in mid-November that production cuts of some 1.4 million b/d were needed, stating that his country would likely cut output by 500 000 b/d. With Brent crude selling below \$65/b and West Texas Intermediate (WTI) at under \$55/b, Opec and its friends are facing further declines if production continues at the current rate.

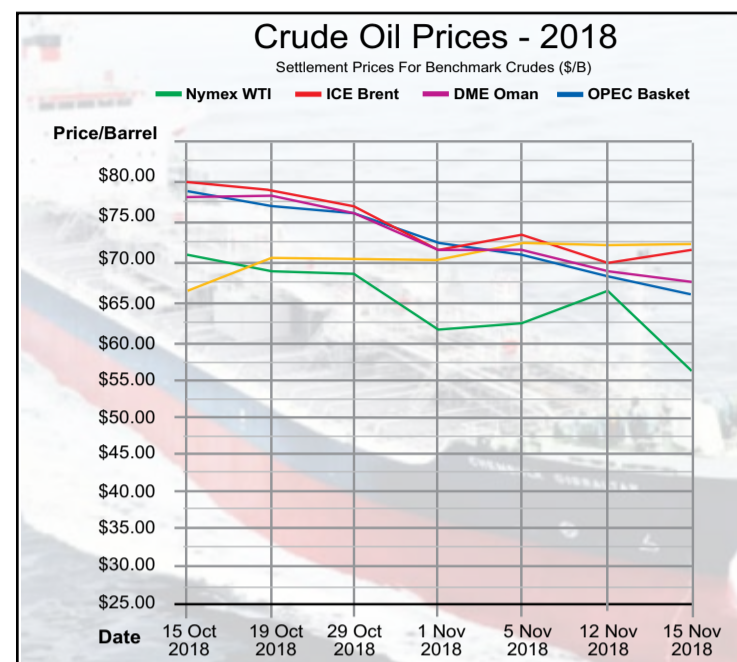
The new surge in supply has been encouraged by the re-imposition of US sanctions on Iran. Washington pulled out of the Iran nuclear accord earlier this year and warned that sanctions were coming, leading Iran's customers to find new suppliers. Many turned to Saudi Arabia, which US President Donald Trump had asked to increase

production so there would be no shortage of supply. Riyadh boosted supply as requested, but in October prices began to slip as Iranian crude remained on the market.

When oil sanctions took effect against Iran in early November, the US granted six-month waivers to eight of Iran's largest customers, namely China, Japan, South Korea and India, which it originally said it would not do. With a large volume of oil on the international market, plus Saudi Arabia and Russia both producing at more than 10 million b/d, and the US producing at that volume, prices have gone from a point where they were considered too high by many, to the worrisome lows.

Also contributing to the increase in oil supply is production from Libya, which is now back at over 1 million b/d, and Iraq, which has begun to export crude through its northern pipeline route through Kurdistan.

President Trump, however, has expressed his pleasure with low oil prices, which translate into lower



retail prices at the US pump. Prior to the US Thanksgiving Day holiday, and in the midst of the controversy over the murdered Saudi journalist Jamal Khashoggi, Trump thanked Saudi Arabia for the low oil prices, comparing them to a tax break.

Trump has failed to consider evidence of the involvement of Saudi Crown Prince Mohammed Bin Salman in the murder of Khashoggi, but members of Congress are reported to be considering action against Saudi Arabia. Should Congress force some action against Riyadh, the Saudis could respond with cuts that would force prices up. But that could in turn see more production from US shale oil producers whose output is driven by price.

It should be recalled that high production levels by US shale producers in

2013 forced prices down and prompted Saudi Arabia to turn on the taps in an attempt to force shale oil producers out of the market with very low prices. The US producers managed to survive, however, and Saudi Arabia, Opec and non-Opec producers were forced to cut output in order to get the market back in balance.

But US shale oil producers have kept at it. The US is now the largest oil producer in the world. According to the US Energy Information Administration (EIA), US oil production averaged 11.4 million b/d in October this year, down slightly from September levels that fell due to hurricanes in the Gulf of Mexico. The EIA forecasts US crude output to average 10.9 million b/d in 2018, up from 9.4 million b/d in 2017. Production in 2019 is forecast to hit 12.1 million b/d.

Gas

Putin, Erdogan mark arrival of TurkStream gas pipeline

Russia and Turkey have marked the completion of part of the TurkStream pipeline, a project that both the EU and the US oppose.

David Gregory

At a recent meeting in Istanbul, Russian President Vladimir Putin and Turkish President Recep Tayyip Erdogan marked the completion of the 930 km Black Sea section of the TurkStream gas pipeline project. The dual pipeline is to have a capacity of 31.5 billion cubic metres (bcm) per year when operational by the end of 2019.

One string of the pipeline system will deliver another 15.75 bcm annually to Turkey, which is already a large consumer of Russian gas, and the other string will head towards Southeast Europe, probably the Bulgarian border, although Athens has recently approached Moscow to take the onshore section through Turkey to Greece and is lobbying for support in Brussels.

Bulgaria will be the likely destination, and from there the pipeline is to continue to Serbia, Hungary, Slovakia and on to the Central European Hub in Austria. That is roughly the same route

that Russia had planned to take with its South Stream gas pipeline, which was cancelled in 2014 when the EU refused to allow the project because Russia would not comply with EU rules regarding third-party access.

By crossing the Black Sea, South Stream was conceived by Moscow as a way to bypass troublesome Ukraine, through which much of its gas exports travelled. It would also act as a counter to the EU-backed Southern Gas Corridor (SGC), which also makes its way to Europe through Turkey from Azerbaijan. The second component of the SGC, the Trans Anatolian Natural Gas Pipeline (TANAP), connects with the Trans Adriatic Pipeline (TAP) at the Greek border and from there passes through Albania to Italy. It comes into operation in 2019-20 with a capacity of 10 bcm/year.

Once Moscow abandoned the South Stream project, Putin approached Erdogan with the concept of TurkStream. And instead of the subsea pipeline

landing in Bulgaria, an EU member, TurkStream would land in the European side of Turkey and make its way to the European border from where European customers could draw Russian gas. Once that begins, Russia, or state-owned gas company Gazprom, will begin to reduce the volume of gas shipments through Ukraine.

During the ceremony in Istanbul, Putin sought to dissuade any hint of political motive behind TurkStream saying: "Such projects, and TurkStream in particular, are not aimed against anybody's interests. These projects are solely constructive. They aim to expand relations between states, to create stable conditions for economic developments and to improve the well-being of our countries' citizens in this way."

The Europeans and the US have expressed their opposition to TurkStream, arguing that it is unnecessary because of the working system in Ukraine and also as a way of expressing political support for Kiev. Russia is also seeing

opposition to Russia's Nord Stream II project in the Baltic Sea, which stretches from Russia to northern Germany. Some Eastern European countries, particularly Poland, see Nord Stream as Russia's attempt to bypass them and isolate them from the European grid.

The dual pipeline Nord Stream became operational in 2011-12 and has a capacity of 55 bcm/year. Meanwhile, Russia has begun to lay Nord Stream II, which will also have a 55 bcm/year capacity, giving Russia the ability to deliver 110 bcm/year. The US has threatened to enact sanctions that would impact Nord Stream II and with a new Congress starting session in January that remains a possibility.

South Stream was originally meant to transport 63 bcm/year and TurkStream was initially spoken of with that capacity, but for now only two pipelines make up the system and only 15.75 bcm/year will be able to enter Southeast Europe. However, two more pipelines could be added in future.

Turkey bought around 29 bcm of Russian gas in 2017, with most of that arriving via the Blue Stream gas pipeline across the Black Sea that started working in 2003. The balance arrived in western Turkey through Ukraine and Bulgaria.

For Turkey, TurkStream is seen as a means to enhance its importance to Europe as both the SGC and TurkStream will deliver natural gas to Europe through its territory. When both lines are in operation, there could be 25.75 bcm of gas crossing into Europe over the Turkish border. By the end of the next decade, SCG capacity could expand significantly, especially if Turkmen gas enters the SGC through a link across the Caspian Sea.

What Ankara wants now is for gas produced in the East Mediterranean to enter Europe overland through its territory, but Cyprus, Israel and Egypt, all of which are at odds with Turkey for various reasons, are making different plans.

A fast approaching singularity

According to recent research by Wood Mackenzie, the sustainability tipping point – the point at which the world shifts from the age of oil and gas to the age of renewables – is less than 18 years away.

TEI Times

Two drivers underpin the pace of the global energy transition – renewables and electrification, mainly the use of electric-based technologies in transportation. According to a report – ‘Thinking global energy transitions: the what, if, how and when’ – released by Wood Mackenzie in October, the convergence of the two will usher in ‘the age of renewables’. What’s more, it will happen within two decades.

The prediction that this tipping point – or ‘point of singularity’ as Wood Mackenzie calls it – could come as soon as 2035, demonstrates that the pace of the global energy transition (GET) is perhaps much faster than many think and that companies will be operating in a new world much sooner than many believed possible.

According to Wood Mackenzie’s research, nearly 20 per cent of global power needs will be met by solar or wind by 2035, displacing the equivalent of roughly 100 billion cubic feet per day of gas demand. Similarly, upwards of 20 per cent of all miles travelled globally by cars, trucks, buses and bikes will use electric motors rather than gasoline or diesel.

The reasons for this are clear. Solar, wind and storage have a high disruptive potential in power markets, and can be applied nearly anywhere across many geographies. Other renewable technologies like hydro, tidal and geothermal are more limited in their application. Similarly, the electrification of transport has potential for widespread impact.

The electrification of heating and industrial processes promises further deepening of these trends. Wood Mackenzie says these are only just moving from conceptualisation to design phases across some power systems, primarily in Europe. It says that future revisions to its forecasts are likely to include the impact of deeper penetration of heat pumps, resistance heaters, metal fabrication via induction heating and more – all of which promise to substitute fossil fuel use with electricity.

Solar and wind currently account for 7 per cent of the global power market but the success of these technologies is better revealed by looking locally. Solar and wind (shown as light blue circles in the chart) already provide 20-50 per cent of generation in many regional power systems, some of which are quite large. The state of South Australia, ERCOT (Texas, US), CAISO (California, US), the Iberian Peninsula power grid (Spain and Portugal), and the German grids are leaders. Other

power systems such as Elia (Belgium), SPP (across 13 central US states), TenneT (Netherlands), and WECC (Western US) are in the 15-20 per cent range.

Unsubsidised wind and solar projects around the world are beginning to beat fossil fuel technologies on cost. As a result, more systems are now looking to integrate renewables. Saudi Arabia, the epicentre of the oil world, as part of its Vision 2030, plans for 200 GW of solar by 2030. For context, total Saudi power generation capacity currently amounts to 70 GW. Asian power systems, namely the five grids in India and three in China, are also preparing to build more solar and wind capacity.

Electric vehicles, by contrast, have captured just 1 per cent of the total car market by stock. Yet EVs are beginning to exhibit similar trends to those seen in renewables markets a few years back (blue circles in the chart). Norway, supported by huge investment initiatives, is approaching double-digit market share for EVs (stock), with upwards of 35 per cent of annual new car sales electric. Other markets will surely follow Norway’s lead. With rapid technology growth, supportive policy frameworks and large numbers of new models expected to enter the market within the next few years, EVs are preparing for the mainstream (across various transport segments).

According to Wood Mackenzie, these different early trajectories of renewables and EV adoption reflect the natural pace and order of how the GET will unfold. Renewables growth is a necessary precursor to any future transport electrification. Success in the former will inevitably boost the rationale for the latter. While electrification is expected to be narrower in geographical scope over the forecast period (developed countries and key and large Asian economies like China), both these trends are nevertheless global forces in earnest.

There is, however, a range of factors that might accelerate or slow the process.

The first is renewables cost-competitiveness. Solar photovoltaic (PV) costs have fallen a staggering 80 per cent since 2010. More mature technologies like onshore wind have seen costs fall about 30 per cent over the same period. The reports notes, “there is plenty to suggest that continued renewable energy cost declines is likely”. Module cost reductions, advanced materials, blade design, mono-crystalline technologies and string inverters for solar are

notable examples.

Offshore wind technologies are seeing rapid cost declines with newer and larger turbines. As costs fall, so uptake will accelerate, the report predicts. Meanwhile, carbon markets are springing up across the globe, albeit in a somewhat fragmented manner, tilting the playing field in favour of clean energy solutions.

Another factor is breakthrough of batteries. Battery storage brings with it the promise of providing a reliable backstop to the issue of intermittent renewable power generation. Battery costs, similar to solar, are now 80 per cent lower than 2010 levels; even the most aggressive of scenarios from only three or four years ago did not predict this to happen until 2035. New battery chemistries and sub-chemistries, and an array of competing technologies are emerging. Renewables plus storage and hybrid technologies are increasingly entering the mainstream. As costs come down, batteries should make deep inroads across the world.

Meanwhile, improving battery storage technology is, in turn, helping EVs to reach their potential, with cost and ‘range anxiety’ increasingly becoming peripheral concerns. With EVs emerging as a practical and viable solution for local air pollution concerns, some countries (mostly in Asia and Europe) are moving towards outright bans of new internal combustion engines between 2030 and 2040. Deeper decarbonisation efforts could require 40-60 per cent of new car sales to be electric by 2035. If autonomous EVs and ride-sharing really take off, achieving these higher levels becomes possible in a relatively short time.

Grid-edge technology could also accelerate the process. Alongside batteries, grid-edge technologies will likely facilitate the integration of decentralised forms of generation (solar rooftops, local battery storage, electric vehicles) with centralised sources (gas, nuclear) enabling the development of the power grid of the future. And market participants are changing their behaviour too.

Companies, cities, state and federal actors are directly procuring more and more renewable power – for example, to run offices or manufacturing facilities. This increasingly clears the way for renewables capacity to be added more quickly and across various power systems globally.

Wood Mackenzie’s report notes that equally, there are plenty of barriers that could impede progress towards the singularity.

Already on a collision course in some renewable-rich regions, reliability issues remain legitimate concerns. On one hand, 60 to 70 per cent of energy needs can be met through renewables during some days, but at other times, the grid relies heavily – if not completely – on ‘dispatchable’ fossil fuels. Access to fast charging of electric vehicles, if not managed, could adversely affect reliability.

EV affordability and charging infrastructure could also be an obstacle. Lithium carbonate prices have increased 30 per cent year-on-year and cobalt by 100 per cent.

The raw materials supply chain is responding, boosting production of cathode materials in Chile and Australia. Non-core lithium producing countries like Portugal and Zimbabwe are coming into focus. Chinese supply responses are reducing local

lithium carbonate prices. Still, considerable uncertainty remains, especially for cobalt. Battery prices may not come down as fast as hoped, slowing the adoption of EVs. More short term, consumer acceptance of EVs and the development of charging infrastructure are also factors to watch, says the report.

Rapid growth in renewables, EVs and grid-edge technologies are likely to create a host of yet unknown cyber security risks. Singular hacking events could also slow the pace of transition.

Policy drag could be a factor too. The sluggishness of countries to formulate legislation or regulations could slow the arrival of the singularity. US pullback from the Paris Agreement is the obvious example.

Shifting economic opportunities within countries could also create unknown policy drags. This is already playing out in Argentina, home to large lithium deposits. Strong economic growth in the northwest region could backfire electorally for President Mauricio Macri. This is because, with one exception, lithium deposits are found in provinces controlled by the opposition Peronist movement. Other factors such as job losses and tax revenue impacts could also create further policy drag across the board.

Whether the change happens faster or slower than predicted, the report notes that companies across the energy sector have begun to prepare for change, and some have already made significant strategic moves.

Broad-based energy providers – including Ørsted, Engie and GDF Suez – are fully transitioning away from fossil fuels. The European oil and gas majors have begun to invest in new energy, as have Shell and Total across the electricity value chain. Statoil has changed its name to Equinor, reflecting its new approach to energy provision. National oil companies in Latin America and Asia are beginning to invest in the new energies space.

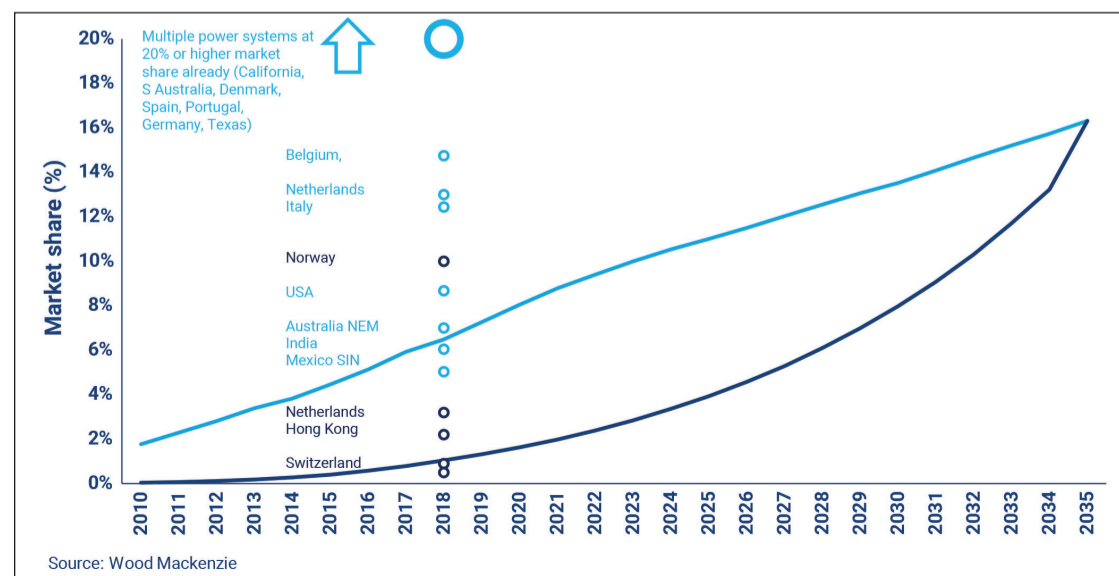
Car manufacturers are increasingly focusing on electric manufacturing lines as well as investing in mobile and stationary storage for power generation. Private and public R&D investment into storage technologies is increasing exponentially, given its central role in this transition.

Investment across the raw material chain for batteries, especially lithium and cobalt, is also multiplying. A new ecosystem of incumbent and new market players involved in charging equipment, charging software and management is ongoing. Private equity and venture capitalist funds are emerging outside of asset finance and public markets. And, says Wood Mackenzie, “all of this is happening years before the singularity occurs”.

The report concludes that the energy transition is ongoing. Energy market disruption is a probability, likely inevitable. There will be winners – and no doubt high-profile losers.

“The next 15 years of the transition will be critical to study, prepare and plan,” said Prajit Ghosh, Wood Mackenzie’s Head of Global Strategy, Power & Renewables. “To prosper in the new energy reality, companies and investors will need to understand the future opportunities across the rapidly changing energy landscape, while remaining in touch with the evolving oil, power and metals markets.”

Total market share of renewables (solar, wind) and electric vehicles (% of total market size)



CHP and the new energy world – a winning combination



Pikunic: adopting distributed energy technologies can significantly reduce emissions and make a positive impact on the economy at the same time

The inherent efficiency of combined heat and power (CHP) allows operators to wring every last drop of useful energy from their fuel. Despite this, CHP uptake has been relatively limited to date. Now though, increased demand for energy efficiency in commerce and industry and the growth of distributed power systems is boosting the case for CHP. Coupled with advances in new technologies like fuel cells and storage, the value proposition for CHP is rapidly becoming more attractive.

According to a recent report from Wiseguy Reports MRC, the global combined heat and power market accounted for some \$640 billion in 2017. With an anticipated growth rate of 5 per cent over the forecast period, this figure is expected to reach more than \$996 billion by 2026. Government programmes and incentives for clean energy and increased use of natural gas to generate power are some of the factors driving market growth, the report notes.

Similarly, the market for micro CHP systems is also expected to see rapid expansion.

Emerging demand for continuous and reliable power supply from residential and commercial establishments is a key driver pushing the 2-10 kW micro CHP market, finds Global Market Insights, Inc. in its latest analysis. It concludes that by 2024 this market alone could cross \$13 billion, up from \$2 billion in 2017.

Again, pointing to climate change concerns, increased demand for energy security and government policy as major factors propelling micro CHP market growth, Global Market Insights cites zero interest rate loans, tax rebates, and financial assistance among the available incentives introduced by regulators to promote the adoption of these systems. “Favourable government measures to enhance the deployment of green technologies along with strict gov-

The uptake of combined heat and power (CHP) has been relatively limited to date. Recently, however, coupled with advances in new technologies like fuel cells and storage, its value proposition is rapidly becoming more attractive. **David Appleyard**

ernment norms pertaining to carbon emissions will further augment the industry dynamics,” the report concludes.

An example comes from the UK, where in April this year Triple Point Heat Networks Investment Management, was appointed as delivery partner for the UK government’s Heat Networks Investment Project (HNIP). Over the next three years the programme aims to deliver £320 million of government support to individual projects across England and Wales as part of the HNIP main scheme. In addition, the programme is looking to leverage around £1 billion of private and other capital in order to provide “much needed scale to the market”.

The UK has set out legally binding targets to reduce greenhouse gas emissions by at least 80 per cent by 2050 from 1990 levels, and by 57 per cent over the 2028-2032 period. In the Clean Growth Strategy, the government set out three illustrative pathways for meeting the 2050 target, each including a significant role for heat networks, for instance providing 17 per cent of heat demand in homes and up to 24 per cent of heat demand in the non-industrial business and public sector buildings. Of course, not all heat networks use CHP, but they do nonetheless represent a significant potential market.

More broadly, mega trends like increasing urbanisation and the clean energy transition – manifesting as a widely distributed energy generation system increasingly dominated by variable output renewables like wind and solar – are key long-term drivers for CHP.

While the benefits of expanding heat networks and CHP capacity are well proven, there are nonetheless further measures required to maximise on the potential for CHP. For example, research by the UK’s Energy Technologies Institute (ETI) shows that nearly half of the UK’s heat demand could be met by heat networks, which, they say, should therefore play a much larger part, especially in higher density buildings.

However, as Rebecca Sweeney, Programme Manager at the ETI, comments: “To make this a reality we see a need for operational frameworks to be developed by the UK central and devolved governments to support the demonstration, knowledge transfer and skills development in the heat sector.”

In Germany every town with a population of over 80 000 has at least one heat network. In the UK, heat networks currently only provide two per cent of space and water heating,” notes Sweeney.

The ETI has now developed eight route maps that could reduce the capital cost for infrastructure in heat networks by 30-40 per cent, it claims. Finding that it is possible to reduce

the capital costs needed to deploy heat networks at scale, the ETI says that the cost of the UK’s low carbon transition could be cut by £3 billion if such a programme were adopted.

Alongside the largely positive market and policy developments technology is also playing its part in building an economic case for CHP.

For example, new analysis from Centrica shows that new energy technology could meet more than half of the UK’s 2030 20 per cent carbon reduction targets for the healthcare, industry and hospitality sectors. The three sectors collectively represent some 27 per cent of total UK emissions.

In its ‘Powering Sustainability’ report, released in October, Centrica highlights the opportunity for distributed energy technologies such as storage, on-site generation and energy efficiency to deliver an 11 per cent saving across these sectors.

The report’s estimates suggest that the deployment of distributed energy solutions in just 50 per cent of organisations across the three could achieve annual savings of 9 million tonnes of CO₂ equivalent. According to Centrica, for example, the National Health Service is targeting a 64 per cent reduction in emissions from 1990 levels by 2030. The assumed technology split to achieve these cumulative savings from 2017 to 2030 sees more than 90 per cent of the gains derived from energy efficiency measures including CHP. A similar figure is reported for industry and again Centrica points to CHP as a key enabling technology in achieving their 11 per cent emissions reduction target.

The report highlights biogas CHP – combining the efficiency benefits of CHP with a carbon-neutral fuel supply – a technology of particular interest to food and drink manufacturers and agri-businesses with access to organic food waste. Attractive economic returns are possible with ready markets for power and potentially heat too, whilst also offsetting carbon emissions.

Commenting on the analysis, Jorge Pikunic, Managing Director of Centrica Business Solutions, said: “This report shows how by adopting distributed energy technologies, we can significantly reduce emissions and make a positive impact to the economy at the same time.”

At the core of many CHP systems lies a reciprocating engine running on gas or liquid fuels. Robust and reliable, such systems are a well proven solution in many applications. Now though, more conventional CHP systems are being coupled with emerging technologies like fuel cells or storage capacity and advanced controls to gain still more carbon savings whilst maximising individual asset value.

An example of this kind of hybrid development is currently under con-

struction in Lempäälä, in southwestern Finland. Energy company Lempäälän Energia is leading the development of the LEMENE smart grid project, which will supply approximately 50 businesses in the industrial district of Marjamäki as well as street lighting. In all, the Marjamäki industrial area covers about 300 hectares along one of the country’s busiest highways near Tampere.

Powered by a 4 MW solar photovoltaic array, an 8.1 MW biogas-fuelled engine and a battery to even out temporary fluctuations in energy production, it will feature a fuel cell-based CHP system too.

Two Convion C50 fuel cell systems, each featuring 24 fuel cell stacks from manufacturer Elcogen, will supply an additional 116 kW_e. The Solid Oxide Fuel Cell (SOFC) stack operates at 650°C and produces 3 kW DC – fuelled by hydrogen derived from reformed natural gas.

Featuring a combination of low-carbon energy generation, storage and smart controls to provide a self-sufficient district energy solution, the LEMENE system will operate mainly as part of the public electrical grid but can also operate as a supporting reserve system for the public grid, or independently off-grid as required.

Lempäälä Energia CEO Toni Laakso explains: “The LEMENE smart grid will feature a variety of smart technologies that will respond to changing electric demand, enabled by automation solutions adapted to the micro-grid. An important part of the project is to secure energy availability as renewable energy production varies.”

Lempäälän Energia Ltd has also signed an agreement with Siemens AG for the supply of an intelligent medium-voltage network, network automation system and electricity storage system.

The smart grid project has been earmarked by the Finnish Ministry of Economic Affairs and Employment (MEAE) as a key development in helping the country achieve its national decarbonisation targets for 2030 and is one of 11 key energy projects to get a share of €39.7 million in MEAE investment. LEMENE received €4.97 million.

Fuel cell system integrator Convion CEO Erkkö Fontell commented: “The project is a unique example of a future power solution, where requirements for energy efficiency, power security and sustainability are met.”

These three goals are well suited to the inherent capabilities of CHP, whatever the core technology. With growing recognition among policy makers, falling costs, new financing opportunities and a growing range of complimentary distributed energy and power technologies now available, it would seem that combined heat and power is at last ready to take its rightful place among the clean energy technologies of the future.

The 4800 MW Beni Suef power plant is part of Egypt's massive megaproject completed in just 27.5 months

H-class technology bridges Egypt's energy gap

Since achieving what was at the time a new world record in combined cycle plant efficiency at the Irsching plant in Germany, Siemens has set numerous benchmarks with its H-class gas turbine. **Junior Isles** recently visited the Beni Suef power plant in Egypt to witness what is another milestone in the technology's deployment.

In 2014, Egypt was suffering from a chronic energy deficit, with a huge gap between generation and demand – in the region of 5 GW. When things came to a head following an almost total blackout, the government accelerated the construction of the 650 MW Ataqia gas fired combined cycle plant. Encouraged by the success of this accelerated project, in 2015 the government took an even bolder decision – to sign an agreement to develop what became known as the 'Megaproject'.

The plan would see Siemens and its local partners, Orascom Construction and Elsewedy Electric, build three huge 4.8 GW combined cycle gas turbine (CCGT) plants at Beni Suef, Burullus and New Capital for Egypt Electricity Holding Company. As part of the megaproject, Siemens will also deliver 12 wind parks with up to 600 wind turbines and a capacity of 2 GW. At a combined cost of €8 billion – with the three CCGT plants accounting for €6 billion of that total – the 16.4 GW megaproject represents the biggest ever order in Siemens' history.

But it is the three CCGT plants that are the most impressive aspect of the megaproject: the plants are the biggest of their kind in the world; utilise advanced H-class gas turbine technology and were built in record time.

Gas for the projects will come from the Zohr gas field discovered in

2015. Some 1 billion ft³ (bcf) of gas from the field is expected to come on stream by the end of this year and produce 2.7 bcf/day by the end of 2019. The Zohr field will certainly provide a cheap source of gas for the three massive combined cycle plants, which will be the most efficient in the country.

Beni Suef, Burullus and New Capital all have an almost identical design, with the exception of plant cooling. While Beni Suef and Burullus both use wet cooling, New Capital, due to its desert location, uses air-cooled condensers. These condensers are the first of their kind in Egypt and are claimed to be the largest in the world.

Each of the three plants comprises four 1200 MW combined cycle blocks in a 2-on-1 configuration, i.e. two SGT5-8000H gas turbines, each with its own generator and heat recovery steam generator (HRSG), with steam from the HRSGs feeding a single steam turbine with its own generator. This means there is a total of 24 gas turbines, 24 HRSGs, 12 steam turbines and 36 generators.

Each plant will have an electrical efficiency of over 61 per cent, which will ensure best possible plant economics. The more than 61 per cent efficiency of the CCGT blocks is significantly higher than the electricity system average and is expected to save around \$1.3 billion per year in

natural gas. High efficiency also ensures low emissions. At base load, guaranteed values for NO_x and CO emissions are 25 ppm and 80 ppm, respectively.

The high efficiency of the combined cycle blocks can be largely attributed to the H-class advanced gas turbines, which form the heart of the power blocks.

The SGT5-8000H is a single-shaft machine of single-casing design. It is one of the world's most powerful gas turbines in commercial operation, designed to deliver about 400 MW in simple cycle operation and over 600 MW in combined cycle operation.

In combined cycle mode, exhaust gas from the gas turbine, at a temperature of about 630°C, is fed to a three-pressure HRSG. The HRSG is a Benson-type boiler also supplied by Siemens.

The HRSG supplies 107 kg/s of high pressure (HP) steam at 589 °C and pressure of 178 bar[g]; 122 kg/s of reheat steam (RH) at 585°C/34.5 bar[g] and 11 kg/s of low pressure (LP) steam at 247 °C/4 bar[g]. Steam from the HRSG is combined with expanded RH steam so total flow to the steam turbine is 133 kg/s.

Steam from the HRSG is fed to a 400 MW steam turbine that features a HP section and a combined intermediate pressure/low pressure (IP/LP) section.

Construction of the plants was a huge task. A single combined cycle power plant block with a capacity of 1200 MW typically takes approximately 30 months. For the Egypt megaproject, Siemens built 12 of these blocks in parallel in record time and connected them to the grid – 14.4 GW in just 27.5 months.

This called for close collaboration between Siemens and its partners from the beginning. Although Siemens had the largest share (62 per cent) of the contract and was consortium leader, it was paramount that the companies worked seamlessly.

While Siemens had total responsibility for the manufacture, delivery, installation of equipment and commissioning of the plants, the tremendous work and effort of managing civil works and construction was down to the local partners.

Orascom Construction and Elsewedy Electric were therefore responsible for all site preparation work – Orascom for Burullus and New Capital, and Elsewedy for Beni Suef. This meant the companies were in charge of tasks such as fencing, site levelling and piling where

necessary; and subsequent civil works, which included concreting, steel erection and construction.

Coordinating the construction, manufacture, delivery and installation of all the equipment for the three projects was no small task. According to Siemens, managing the whole process was a huge logistical challenge from start to finish. Some 400 000 freight tons were imported to the sites from all over the world, with 7000 containers being delivered to each site.

To achieve the record-breaking schedule – which saw connection of the first 4.8 GW to the Egyptian grid in 18 months – work had to start before the official contract signing, i.e. during the last phase of negotiations, which was a very short phase.

Once the contract for the 24 gas turbines was confirmed, notice was given to the Berlin factory that it would have to work around the clock to meet the delivery schedules.

With each gas turbine and steam turbine having its own generator, the delivery of 36 generators meant Siemens had to call on both its generator factories in Muelheim, Germany, and Charlotte in the US. Twenty of the generators were manufactured in Muelheim and 16 were manufactured at the Charlotte factory. At the same time, Siemens had to manufacture the 24 HRSGs.

All of this work and planning culminated in achieving the milestone of first power to the grid in January 2017. The total 14.4 GW was connected to the grid in June the following year, fulfilling the promise that Siemens made to the Egyptian government back in 2015.

With Beni Suef fully handed over to the customer in September, Burullus was scheduled to complete acceptance tests and handover in November. New Capital is scheduled for full hand over in December.

Forecasts show the megaproject will provide enough power to meet demand up until 2022/23. Emad Ghaly, CEO, Siemens Egypt noted: "With the commissioning of the 14.4 GW, Egypt's electricity challenges will be solved for the foreseeable future."

Summing up his feelings on the project during the press visit to Beni Suef, Karim Amin, CEO Global Sales, Power and Gas, Siemens, said: "The project really is a dream come true, not only for the [power] industry but also for the people around this area – the shops that are growing and the economy that is developing."

H-class advanced gas turbines form the heart of the power blocks





Junior Isles

Dumb doesn't do it

The three Ds—Decarbonisation, Digitalisation and Decentralisation—is one of those popular catch phrases in today's power and energy sector. Certainly the decarbonisation trend is irreversible, continued digitalisation is highly likely and the pace of decentralisation is accelerating.

It is generally believed that the three Ds are creating a fourth D: disruption—at least to utilities in Europe. Yet it is a belief that was questioned at this year's European Utility Week (EUW).

Speaking at the opening keynote session, Albert Cheung, Head of Analysis at Bloomberg NEF, acknowledged that the growth of wind and solar has been phenomenal, that electric vehicles will also witness a rapid uptake in the coming years and

that carbon markets have died and risen again. And while these are all drivers of the three Ds, he did not believe they would necessarily disrupt Europe's utilities.

"Lots of things have changed over the last few years but through all of this, have utilities actually faced disruption? Basically, six out of the top ten utilities from ten years ago are still in the top ten. That's not what disruption looks like."

He stressed that although the energy mix and the electricity sector will look very different in 2050, it does not mean utilities are being disrupted.

"We can see that the future will look very, very different from the past but does that mean utilities are being disrupted or not? The most useful way to think about this is to go back to the

idea of disruptive innovation versus sustaining innovation."

He explained that disruptive innovations change the basis of competition, so that: first, the things you are good at do not really matter any more; and second, there is a new thing that matters, and someone else is structurally better than you at it.

Cheung used Kodak as an example, where the advent of digital photography made the company's dominance of photographic film irrelevant. Again using Kodak as the example, he pointed out that Kodak was also not

In the distribution systems in medium and low voltage, we are talking 10-15 per cent. Our energy networks have been dumb and that is not going to help us address decentralisation."

Digitalisation is certainly a prerequisite for decentralisation and the all-electric world, which many think we are moving toward. Thomas Zimmermann, CEO Siemens Digital Grid, followed on by outlining the company's ongoing efforts in the Internet of Energy (IoE) for the connection and managing of data from generation, transmission and distribution assets,

"Our energy networks have been dumb and that is not going to help us address decentralisation."

structurally the best at delivering digital devices and software.

To explain sustaining innovation, Cheung referred to Bob Kerns, the inventor of intermittent windscreen wipers. He said: "Today it seems easy now but back then, Ford and GM and Chrysler couldn't do it. This guy invents it in the back of his garage and what happens? All of the engineers at the auto companies copy his idea, put it in their cars and Bob Kerns spends the rest of his career trying to sue them for patent infringement."

"The point is, sustaining innovations happen all the time and it doesn't matter if the innovation is super-hard to do. What matters is, does it really change the basis of competition? For car manufacturers, it turns out that being really good at windscreen wipers didn't matter. What mattered is still being good at producing engines and doors, etc. So when it comes to utilities, we have to think about what are the things that might bring disruptive innovation and what are the things that might sustain the industry and the structure that we have today."

Decentralisation of energy is an obvious example. The question is: in 2050—assuming there is much more decentralised energy from the growth of wind, solar and virtual power plants (VPPs) etc.—will it be disruptive or sustaining to utilities? And according to Cheung, this will depend on what will really matter when it comes to winning at decentralised energy.

"If you believe that it is having great VPP software and analytics, great IoT and connectivity solutions, the best AI for forecasting and optimisation, then maybe it is disruptive, because there is no reason why utilities have a structural advantage in those areas."

"But if you think the decentralised energy world will give advantage to companies that really understand power markets, are good at trading and have a good asset portfolio and really understand the networks, then maybe decentralised energy is sustaining. Maybe it's not disruptive at all."

Whichever, you case you believe, it's all the same for the equipment manufacturers and solution providers who will therefore continue to facilitate the new energy world, regardless of whether utilities are disrupted or not. Beyond doubt, grids have to become more intelligent.

At a press conference on the sidelines of EUW, Cedrik Neike, Member of the Managing Board, Siemens AG, noted that digitalisation and smart networks will be needed to cope with decentralisation.

He said: "The complexity that is coming through this is pretty amazing. In Germany 100 per cent of the big transmission lines are being digitised.

distributed energy sources and devices like smart meters, inverters for photovoltaics, e-mobility assets, storage systems and microgrids.

IoE, connectivity and digitalisation, however, bring challenges. In the same way that networks can no longer be dumb, organisations and utilities need to be smart about how they handle the proliferation of a growing number of internet connected devices on the network. And cyber security has to perhaps be at the top of their agendas.

On a scale of one to ten, in terms of importance in an increasingly decentralised and digital world, Anjos Nijk, Managing Director of the European Network for Cyber security (ENCS) rates cyber security as "almost a ten".

He said: "For me, security is really an enabler for making smart grid innovations happen... the innovations needed for the transition cannot be done without implementing security in the right way. For example, during the election in the Netherlands, the voting computers appeared insecure, which forced us to go back to pencil and paper. So innovation was held back due to security. If there is a major incident in the roll-out of smart grid technology, this might urge the regulator to say: 'we cannot afford this to happen'. And this is why security is very important in this whole thing."

He pointed out that while securing connectivity at the edge of the grid is important, for example in the roll-out of electric vehicle charging infrastructure, where he said a lot of work is being done, Nijk also stressed that compromise of larger critical equipment deeper in the grid could cause blackouts.

Globally there are big differences in the appreciation of the seriousness and handling of cyber threats. "I think Europe is more sophisticated than the US, and is pretty advanced in terms of smart grid innovations," said Nijk. "But inside Europe, there is also quite a difference between member states, both in terms of the status of the grid and how security is approached."

The ENCS says it has made significant progress in standardising how countries address cyber security on a systems basis and from an organisational perspective. "A lot of harmonisation still needs to take place but we have made pretty good progress in the last couple of years," said Nijk.

As such efforts continue and the three Ds continue to cut deeper, what is certain is that companies, organisations and governments have to be smart about how they approach the new energy world. We may not know how or if the three Ds will lead to disruption of utilities but what we do know, is that another three Ds will always ring true: Dumb Doesn't Do it.

