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Special Supplement

The new Zabrze multi-fuel power plant in Poland looks set to be a forerunner for smaller community-based CHP projects in the country and elsewhere.



Towards the tipping point

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Trump targets renewables in proposed budget cuts



Trump: proposing slash to energy efficiency and renewables budget

As many expected, US President Donald Trump's proposed 2019 budget slashes renewable energy funding but boosts support for advanced fossil fuel-based power systems. **Junior Isles**

US President Donald Trump has unveiled the budget request for fiscal year 2019 under which he is proposing to cut spending in the Office of Energy Efficiency and Renewable Energy (EERE) by more than 65 per cent. The budget called for the office funding to be cut by \$1.3 billion, compared to the level enacted for 2017, to \$696 million for fiscal year 2019.

The EERE is the US government's primary clean energy technology organisation. EERE works with many of America's best innovators and businesses to support high-impact applied research, development, demonstration, and deployment (RDD&D) activities in sustainable transportation,

renewable power, and end-use energy efficiency.

The office depends on funding to support early stage R&D on energy technologies, including new approaches to energy storage beyond current battery technologies.

A Department of Energy (DOE) official said the proposed budget reflects the success the bureau has had with electric vehicle batteries and wind and solar technologies.

"The biggest reason for that is the accomplishments that these individual programs have made," DOE under secretary Mark Menezes told reporters last month.

Menezes said the DOE is attempting

to refocus its mission on renewable energy and efficiency to aid technologies that have a low probability of success, but are highly risky to invest in, calling it a "more appropriate role for the government".

If approved, the Budget would also see the complete elimination of the Advanced Research Projects Agency-Energy (ARPA-E) programme.

ARPA-E is a programme that issues grants to energy startups from across the country. The programme was nearly discontinued in 2017, but Congress awarded it an additional \$15 million that ensured its survival for another year. While Trump's 2018 proposal ensures the DOE's overall

budget remains almost the same, it would cut the \$305 million required to keep ARPA-E afloat.

In contrast to last year's budget, the proposal calls for a more than 19 per cent boost to the fossil energy research and development office to \$502 million. Up by \$81 million compared to last year, the increased funding is aimed at improving the efficiency of advanced power systems based on fossil fuels like coal and natural gas.

The Information Technology and Innovation Foundation, a US-based research institute, said the cuts "would undercut progress toward cheaper,

Continued on Page 2

EU approves greater energy infrastructure funding

EU member states have backed a European Commission (EC) proposal to invest €873 million in 17 electricity and gas projects designed to accelerate the Union's transition to a low-carbon economy.

The funding will see eight projects in the electricity sector receive €680 million, while €193 million will go to nine projects in the gas sector. EU funding will come from the Connecting Europe Facility (CEF) – an allocation of €5 billion over six years (2014-2020) to help modernise and decarbonise Europe's energy infrastructure. The CEF granted €647 million to 34 projects in 2014, €366 million to 35 projects in 2015 and €707 million to 27 projects in 2016.

Highlighting the importance of the

investments to wider efforts to curb carbon emissions, Miguel Arias Cañete, Commissioner for Climate Action and Energy said: "An energy infrastructure which is fit for purpose is also essential for renewable energy sources to thrive and for delivering on the Paris Agreement on climate change."

A large part of the latest investment, some €578 million, will go towards the Bay of Biscay Interconnector, a 370 km long cable between France and Spain through the Bay of Biscay. The connection will help double electricity flows between the two countries and incorporate renewable energy across the Iberian Peninsula.

The new link will nearly double the interconnection capacity between both countries – increasing it from

2800 MW to 5000 MW, and will bring Spain closer to the 10 per cent interconnection target from the current level of 6 per cent, the EC noted.

"The construction of the Biscay Gulf France-Spain interconnection marks an important step towards ending the isolation of the Iberian Peninsula from the rest of the European energy market," said Cañete. "Only a fully interconnected market will improve Europe's security of supply, reducing the dependence of single suppliers and giving consumers more choice. An energy infrastructure which is fit for purpose is also essential for renewable energy sources to thrive and for delivering on the Paris Agreement on climate change."

Some €70 million will also be spent

on the 'SuedOstLink' in Germany, which will run a 580 km underground cable to connect wind farms in the north of the country to population centres in the south.

Commenting on the latest round of funding, Commission Vice-President for Energy Union Maroš Šefčovič said: "Once more we demonstrate that cooperation and solidarity pays off and that the Energy Union is becoming a reality with tangible impact on the ground. These are important projects with major cross-border benefits and by implementing them we strengthen energy resilience of EU Member States. The Connecting Europe Facility has yet again shown tremendous added value in the modernisation of the European economy."

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cleaner energy in the United States and damage the nation's prospects for global leadership in key growth industries of the 21st century".

The budget also cuts funding for the nuclear energy office by \$259 million below the 2017 level to \$757 million. The department handles research and development for advanced reactor technologies.

Funding for the Bureau of Ocean Energy Management (BOEM), the government's body in charge of responsible management of the development of US offshore energy resources, however, has seen little change overall.

The requested budget for BOEM's renewable energy activities under the budget proposal for the Department of the Interior (DOI) has been reduced by a little less than \$4 million compared to 2017, while BOEM's activities in conventional energy would receive about \$3 million more than in 2017.

Trump has requested \$179.3 million for FY 2019 for renewable energy, and offshore oil and gas exploration and development. The 2019 budget requests \$20.7 million for BOEM's renewable energy activities to support areas that include the siting and construction of offshore wind farms on the Outer Continental Shelf (OCS), as well as other forms of renewable energy such as wave and current energy.

Central to BOEM's renewable and conventional energy efforts are its Environmental Programs, for which the 2019 budget requests \$79.8 million. These funds support scientific research needed to inform policy decisions regarding energy and mineral development on the OCS.



Perry: prioritising "acceleration of transformative early stage research and development"

Commenting on the budget proposals, Rick Perry, US Secretary of State for Energy, said: "In order to fulfill the President's long-term goal of energy dominance we are prioritizing the acceleration of transformative early-stage research and development, relying on our world-class National Labs. This will advance everything from new clean energy technologies to Supercomputing."

The President proposed a total \$30.6 billion Budget for FY 2019 to the US Congress, a \$500 million boost from current levels. That included a nearly \$1.2 billion hike, compared to last year's request, for the National Nuclear Security Administration (NRA), to help pay for a revamp of the United States' nuclear weapons arsenal. In fact the NRA would receive nearly half of the budget (\$15.1 billion), while the Energy Program would receive just \$2.5 billion.

The budget is primarily a political document and is not likely to be embraced by Congress, but it represents a starting point for the administration on negotiations.

Analysis

Green shoots for Europe's utilities

The outlook for Europe's utilities is stabilising after recent years of turmoil, says **Pierre Georges**



European utilities are being supported by a more benign market environment and the effective plans by companies to adapt their business models and restore their balance sheets, according to a new report by S&P Global Ratings.

European utilities have been in a state of transformation for some years, moulded by the numerous technological revolutions taking place in parallel. Rapid developments in renewables, battery storage and service digitalisation have by their very nature pressured European utilities, which typically have long-term assets and long lead times for new projects. Consequently, the average sector rating has fallen from 'A' at the beginning of this decade, to 'mid-BBB' today.

But despite these pressures, both the regulated and unregulated markets are now mostly stable from a credit perspective. During 2017, many unregulated companies effectively underwent transformation plans, focused on de-risking their portfolios, improving

balance sheets and redeploying capital towards regulated or long-term contracted activities.

This year will likely see continuous appetite from institutional investors for utility assets. Last year, National Grid's sale of its 61 per cent equity stake in UK-based gas distribution networks raised £3.6 billion. Though this price includes a 50 per cent premium on the asset value, investors were not only drawn by the low-risk venture that enjoys inflation-linked prices and a stable regulatory framework, but also the availability of cheap money. Given this, increased merger and acquisition (M&A) activity should remain an industry trend this year.

Quantitative easing in Europe (or rather the prospect of its end) is another consideration. It could encourage utilities to sustain active liability management in order to reduce the cost of debt and to lengthen maturities. S&P therefore expects strong levels of bond issuances to be sustained during 2018

– which are ultimately supportive of cash flows, too.

Another consideration for the market is the regulatory focus on affordability and efficiency. As regulators' cost-efficiency targets become increasingly ambitious, there could be mid-term pressure on utilities that are outperforming today's less stringent targets.

Pressure may also come from the increasing use of benchmarking indicators. Their application enables regulators to set performance targets based on the sector's average – and even based on other utility sectors.

Further, regulatory changes in markets including France, Germany and Italy have reduced utilities' allowed returns. Such changes could shrink revenues in these markets at the beginning of their next regulatory period. That said, utilities in these markets can partly compensate thanks to other remuneration measures; among them, the rising use of regulatory incentives to enhance utilities' operational and

financial efficiency.

There are yet major uncertainties ahead for the sector, which bring both risks as well as opportunities. With this in mind, technological disruption will likely prompt further strategic actions. Here, renewables' increasing market penetration casts some doubt over the economic rationale of fossil fuel and nuclear assets. Bolstering renewables' cause is the advancement in battery storage – a technology whereby falling prices may accelerate its wider adoption. And increased disruption can be expected once electric vehicles enjoy a larger market share.

Notwithstanding a number of uncertainties ahead, Europe's utilities should remain on track. S&P expects de-risking and more defensive financial policies to feature more prominently as they navigate a continually transforming market.

Pierre Georges is Senior Director, EMEA Utilities, S&P Global Ratings.

Lords warn of Brexit threat to UK energy trade

- UK may be more vulnerable to supply shortages
- Risk of higher energy bills

Junior Isles

Brexit puts the UK's current frictionless trade in energy with the EU at risk, according to a House of Lords EU Energy and Environment Subcommittee report.

The EU is a key energy trading partner for the UK, supplying approximately 12 per cent of the UK's gas and 5 per cent of electricity. According to the report 'Brexit: energy security', the UK will need to continue to trade energy with the EU in order to meet demand, but if such trade takes place outside the Internal Energy Market it is likely to be less efficient. This creates the potential for higher energy bills, and leaving the EU could risk supply shortages in the event of extreme weather or unplanned generation outages.

The Committee urged the government to set out how it will work with the EU to anticipate and manage supply shortages, and to assess what impact

leaving the Internal Energy Market would have on the price paid by consumers for their energy.

The government is taking measures to avoid this worst case scenario but, given the risk to the UK's energy security if replacement provision is not in place in time, the Committee called on the government to ensure contingency arrangements are in place.

Lord Teverson, the Chairman of Committee commented: "The UK may be more vulnerable to supply shortages in the event of extreme weather or unplanned generation outages: this is because the UK may not be able to rely on EU solidarity arrangements or collaborative risk assessments."

"The risk of higher energy bills arises because outside the Internal Energy Market energy trading would be less efficient, and there may be a need to have more spare domestic capacity, both of which come at a financial cost."

The Committee also highlighted the impact of leaving the Euratom treaty

and called on the government to review the possibility of a Euratom-specific transition period separate from the wider Brexit process. "The risk of energy shortages only arises substantively in the event that the provisions of the Euratom Treaty are not replaced by the time we withdraw," said Lord Teverson.

The Committee stressed that the Euratom treaty is fundamental to the current functioning of nuclear energy generation in the UK. Failure to replace its provisions by the point of withdrawal could result in the UK being unable to import nuclear materials, bringing the UK's civil nuclear industry to a halt, it said.

"If the UK does not have a domestic safeguarding regime in place that has been recognised by the International Atomic Energy Authority by the time it leaves Euratom, it will be unable to trade nuclear material with any other signatory to the Treaty," said Lord Teverson. "In addition, some countries,

including the US, Canada, Japan and Australia, are legally unable to trade nuclear materials with a country until there is also a Nuclear Cooperation Agreement (NCA) in place between those two countries."

The UK currently has access to a number of NCAs via the Euratom Treaty, so these agreements will have to be re-established between those countries and the UK as an independent state.

A new paper published by Energy UK, called for a comprehensive energy and climate chapter to be part of any future trade agreement with the EU.

The paper, 'Brexit and future EU-UK energy relationship', identifies three main areas the future UK-EU energy relationship should be based on: to maintain a close trade relationship through regulatory alignment with the Internal Energy Market; maintain the Single Energy Market on the Island of Ireland and work closely together with the EU to tackle climate change.

Africa banks on solar PV

The African Development Bank (AfDB) has unveiled plans to support the development of 10 GW of grid-connected and off-grid solar projects in Africa's desert areas by 2020.

Under its Desert to Power initiative in the Sahel region, near the Sahara desert, the AfDB expects to ultimately provide about 250 million people with electricity. Around 90 million of those will be supplied through off-grid photovoltaic (PV) arrays.

The AfDB says the initiative will see

29.3 million people in Africa gain access to electricity by 2020, adding that last year alone 3.8 million people received electricity access through its initiatives. It also noted that the share of renewable energy in its energy portfolio has jumped to 100 per cent in 2017 from just 14 per cent back in 2015.

The bank is investing heavily in ways to help the estimated 640 million Africans who lack access to energy, while protecting them against risks

associated with climate change.

There is tremendous potential for solar PV across the entire continent. In early February Inspired Evolution, a specialised clean energy infrastructure and resource efficiency investment manager, announced it has invested \$36 million in Alten RE Developments B.V to develop, construct and operate utility-scale solar PV power stations across sub-Saharan Africa.

The partnership initially aims to

bring up to 500 MW of construction-ready, advanced and pre-permitted solar PV projects into operation. Three projects are at an advanced stage: the 45.45 MWp solar PV construction-ready Hardap Project, near Mariental in Namibia; the 51.5 MWp Kesses 1 Project in Kenya, expecting to reach financial close by May 2018; and the 125 MWp Middle Band Solar One Project in Nigeria, with a signed power purchase agreement and is moving towards closing.



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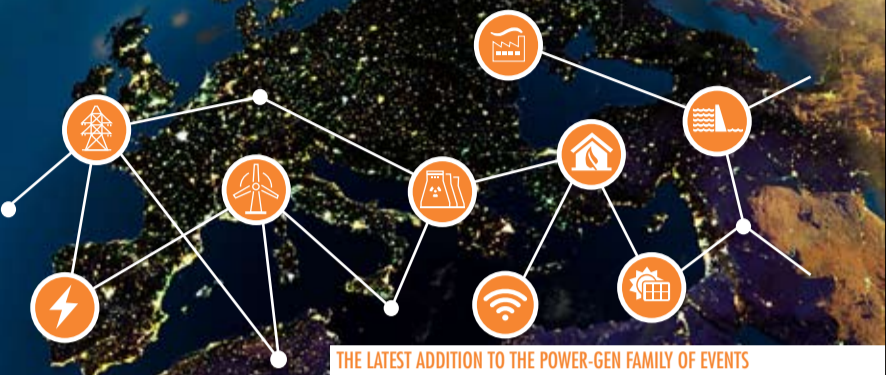
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Renewables continue march on fossil fuels

A strong development pipeline of projects will help to ensure continued growth in renewable energy generation in the USA.

Siân Crampsie

The USA now sources almost one-fifth of all its electricity from renewable energy thanks to the growth of wind and solar capacity and declining coal and natural gas generation.

A new report from Bloomberg New Energy Finance (BNEF) and the Business Council for Sustainable Energy shows that renewables provided 18 per cent of electricity in the USA in 2017. Renewable energy generation increased by 14 per cent in 2017, while fossil fuels, including natural gas and coal, declined eight per cent and three per cent, respectively.

The report – the sixth edition of the Sustainable Energy in America Factbook – said renewables capacity increased by 23 GW in 2017. Carbon emissions in the power sector fell 4.2 per cent year-on-year, bringing them to their lowest level for 27 years.

The report also highlights the economic impact of the clean energy sector, with the solar and wind sectors creating 98 650 new jobs between 2015 and 2016, and in total now employing an estimated 475 000 people. Jobs in the energy efficiency sector are also booming with a huge 2.2 million people involved in ensuring homes and businesses are properly insulated.

However the latest Solar Census report in the USA indicated that solar jobs declined slightly in 2017, possibly because of uncertainty over policy and trade disputes.

Solar jobs fell by 3.8 per cent in 2017, it said, marking the first fall in solar employment since the report was launched in 2010. The two leading states for solar jobs, California and Massachusetts, saw sharp drops of 14 per cent and 21 per cent, respectively. Solar jobs grew in 29 other states.

According to FERC, some 4.85 GW of large-scale solar capacity was added to the grid in 2017, a drop of almost 50 per cent year-on-year. In the

wind sector, additions dropped by 14.5 per cent year-on-year. The US closed 2017 with a cumulative installed wind power capacity of 89 077 MW, according to the American Wind Energy Association (AWEA).

FERC data also shows that just under 12 GW of new natural gas fired generating capacity started operating in 2017. It forecasts that net natural gas power capacity additions will reach nearly 82 GW by 2021, while around 20 GW and 5.5 GW of coal and nuclear capacity will be closed in that period.

Conversely, large-scale wind and solar power are to grow by 79.7 GW

and 47.1 GW, respectively, by 2021.

AWEA CEO Tom Kiernan said that the “American [wind energy] success story will continue” thanks to a large project development pipeline. Offshore wind energy is also set to start making a greater contribution, with five offshore wind projects in advanced development stages that will add 490 MW to the grid.

The US east coast states alone have committed to developing over 8 GW of offshore wind capacity by 2030. New Jersey leads the pack with a 3.5 GW offshore wind target by 2030, followed by New York’s 2.4 GW commitment.

Argentina ends dispute on 210 MW hydro plant

Argentina has given the go-ahead for the development of a 210 MW hydropower plant to progress.

The country’s President, Mauricio Macri, has ruled in favour of constructing the \$900 million Portezuelo del Viento hydropower project on the Rio Grande in Malargue, south of the province of Mendoza, located in central Argentina.

The decision comes after a dispute over the proposed project between five provinces that had held up bidding for the construction of the project.

“We have received news from the interior ministry. Finally, the president has issued his ruling in the dispute we had over the construction of Portezuelo del Viento,” said Mendoza governor Alfredo Cornejo on Twitter.

A row between the provinces erupted in late 2017 with four – Mendoza, Río Negro, Neuquén and Buenos Aires –

approving it and La Pampa opposing it. The ruling by the President brings an end to the dispute and will enable the call for bids process for the construction of the dam to start.

The Portezuelo del Viento facility will include a roller-compacted concrete dam and will help water management, boost tourism as well as supply power.

Argentina is also building two other dams at the 1740 MW Kirchner-Cepernic hydro complex on Santa Cruz River in the province of Santa Cruz.

The government approved this project in August 2017.

■ Vestas and Argentine firm Vientos de Necochea will start the construction of a 38 MW wind farm this month. The Necochea wind farm will consist of 11 wind turbines and secured a contract in round 1.5 of Argentina’s RenovAR renewable energy programme.

Fire deepens Puerto Rico woes

- Blackout hits ten municipalities
- PREPA prepares for privatisation

An explosion and fire at a substation in Puerto Rico has set back the US territory’s efforts to fully restore power supplies more than five months after Hurricane Maria devastated the region.

The island’s Electric Power Authority (PREPA) said that the fire threw much of northern Puerto Rico into darkness on February 11, with some of the 10 affected municipalities remaining without power for 24 hours. Officials said the explosion knocked two other substations offline and caused a total loss of 400 MW worth of generation.

The blackout came as PREPA and the government of Puerto Rico continued efforts to restore power supplies

to 400 000 customers who have been in the dark since Hurricane Maria hit the island.

The storm destroyed two-thirds of the island’s power distribution system and caused up to an estimated \$94 billion in damage.

The disaster has highlighted the poor state of the island’s energy infrastructure and thrown the financial problems of PREPA into the spotlight.

In January Puerto Rico Gov. Ricardo Rosselló announced plans to privatise PREPA, which relies on infrastructure nearly three times older than the industry average. A month later a federal judge rejected a request for a \$1 billion loan for PREPA to help keep the utility afloat.

PREPA has warned that it may have to start rationing electricity and reduce personnel if it cannot access funding. It has already reduced working hours for its staff, according to reports.

PREPA is worth roughly \$4 billion but carries \$9 billion in debt. It has long been criticised for political patronage and inefficiency, and recently faced accusations of corruption. There are concerns about the impact that privatisation would have on energy bills, but Gov. Rosselló has said that the sale of assets would help to transform the island’s crumbling infrastructure into a “modern” and “efficient” system.

Gov. Rosselló added that the privatisation would take place in three phases over the next 18 months.

Chile unveils coal phase-out

Chilean President Michelle Bachelet says that the country will not build any new coal fired power plants without carbon capture technology, and will look to replace existing coal capacity.

Bachelet announced that Chile’s Ministry of Energy has secured an agreement with major utilities over the plans, which will bring Chile in line with a group of other nations pledging to end coal use.

Environment Minister Marcelo Mena said that the deal marked “the beginning of the end of coal”.

Coal generates around 35 per cent of Chile’s electricity supplies. The country’s electric power generators’ association, Asociación de Generadoras, whose members include AES Gener, Colbún and Engie, said it would form a working group to develop a schedule and the conditions for the phase-out of coal.

The UK and Canada are leading an international campaign to phase out coal fired generation and have so far signed up 24 other countries, including France, Mexico and New Zealand, as well as eight sub-national govern-

ments and 24 companies.

In January, the Paris-based International Energy Agency (IEA) praised Chile for the progress it has made in recent years on the institutional and policy reforms that have made it a major destination for solar and wind energy developers.

In its latest report on Chile, the IEA said that new legislation has encouraged investment in generating capacity across the electricity sector and that the enhanced role of the state in effective energy planning has helped boost project development.

President Macri backed construction





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Offshore wind accelerates Taiwan's renewables plans

Taiwan's plans to grow its renewables power sector received a boost with the recent announcement that nine developers looking to build offshore wind farms have qualified for offshore environmental permits.

The developers, offering 10.5 GW of offshore wind capacity in total, will now compete for 5.5 GW of offshore wind contracts, 3.5 GW of capacity to be selected for feed-in-tariffs (FITs) and the rest to be awarded at an auction in May.

According to Scott Hsu, Business Development Director at K2 Management, this means that all the developers selected through both schemes will sign their contracts by the end of June 2018.

"This is an exciting development for the offshore market in Taiwan – the original offshore wind target was 3.5 GW before the auction scheme was introduced, so to see a 5.5 GW commitment from the government, the industry and stakeholders, with a commercial operation date (COD) of 2025, is fantastic," Hsu said.

The news came as German utility Energie Baden-Württemberg (EnBW) said it had acquired a 37.5 per cent stake in three offshore wind projects.

Meanwhile, Siemens Gamesa Renewable Energy announced that it has intensified its activities in preparation for the offshore business in the country. After a first agreement with Taiwan International Ports Corporation (TIPC) in December, last month the wind turbine manufacturer signed a further Memorandum of Understanding with Yeong Guan Energy Technology

Group to collaborate on the development of an offshore wind supply chain in Taiwan.

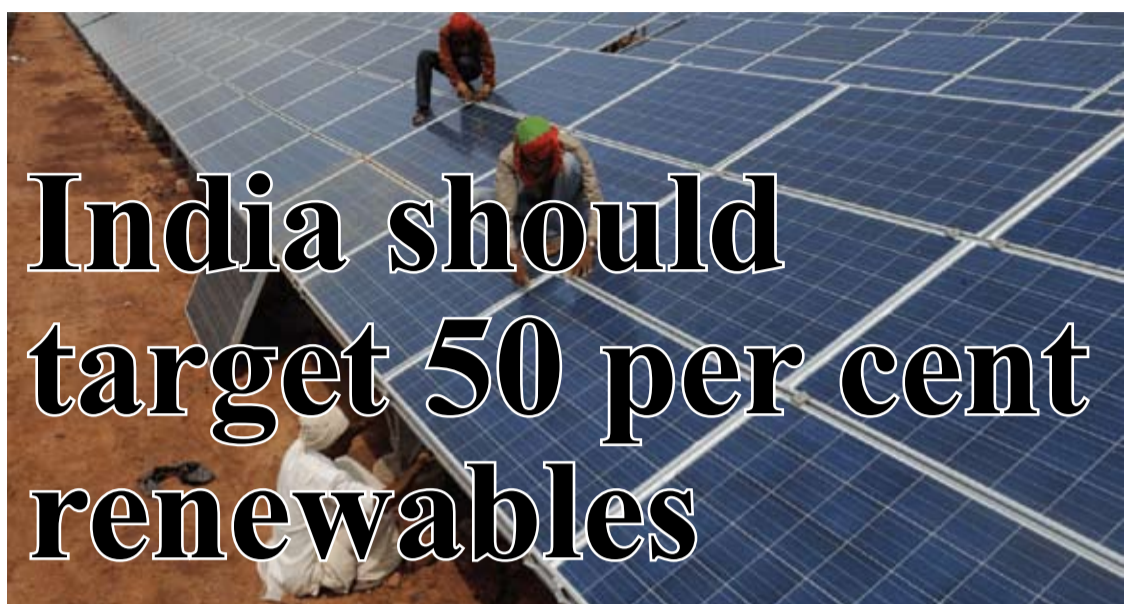
Of the nine developers offshore that secured environmental permits, four are local and the rest are European. Notably, Ørsted, the world's biggest offshore wind developer has four projects located 35 to 60 km off the Changhua coast with the total capacity of approximately 2.4 GW.

In line with its activities in the country, Ørsted recently said it will set up a megawatt-scale storage pilot project in Taiwan. The installation will be located in Changhua County and will use lithium-ion battery technology. Development of storage is key in any plans to optimise the use of renewables, and the company also announced that it has established a unit focused on storage and solar in the country.

Solar power is part of Taiwan's plan to accelerate the development of renewable energy in the nation and meet the government's goal of phasing out nuclear power by 2025.

In February state-run Taiwan Power Co (Taipower) held a groundbreaking ceremony for a new 100 MW solar power plant at the Changhua Coastal Industrial Park, with company officials saying they expect the plant to start operations before the end of the year at the earliest.

In a separate development, at the start of February home appliance supplier Tatung Co. said its board has approved a plan to construct an 80 MW solar power plant in the Tainan Chi-Gu Fishery and Solar Special Zone, boosting its total capacity to 120 MW.



India should target 50 per cent renewables

- Renewables could hit 200 GW by 2022
- Solar milestone reached four years early

Syed Ali

India should aim for 50 per cent of its power generation capacity from renewable sources by 2030 on the back of technological advancements in solar and wind energy, according to Coal Minister Piyush Goyal.

"With technological advancements in solar power and large turbines in wind energy, the country should strive for 50 per cent generation capacity from renewable sources by 2030," Goyal said while addressing the 7th Indian Energy Congress.

He also said the country is set to exceed the target of 175 GW in renewable energy and touch 200 GW by 2022.

At the end January, it was revealed that the nation achieved its 20 GW cumulative solar capacity milestone four years ahead of schedule. According to the latest India research report by green energy market tracker Mercom Capital, utility-scale cumulative installations now stand at approximately 18.4 GW, with rooftop solar accounting for another 1.6 GW.

In an effort to accelerate progress toward meeting its target of having 60 GW of installed wind energy capacity by 2022, last month the government invited tenders for 2000 MW of wind power projects. The present wind power installed capacity in the country is nearly 32.5 GW.

The Power and renewable energy

minister, RK Singh, had in November announced the break up of his action plan for completing 28 GW of wind auctions by FY20, leaving a margin of two years to complete the projects by 2022. According to that agenda, another 1.5-2 GW of wind tenders can be expected in the ongoing fiscal.

■ One of China's biggest solar panel makers, LONGi Solar will invest nearly \$309 million in India in the wake of US protectionism and India's anti-dumping measures threat. The company's total financial investment will include \$240 million in construction investment and \$68 million in working capital, to double the capacity in Andhra Pradesh from 500 MW to 1 GW.

China restructuring effort gains momentum

China's efforts to streamline and restructure its state-owned enterprises (SOE) gained further momentum on after the State-Owned Assets Supervision and Administration Commission (SASAC) cleared the proposed merger of China Nuclear Engineering and Construction and China National Nuclear Corp.

The merger is part of the government's plan to streamline the SOE sector. The effort, which has been ongoing since 2015, is aimed at making businesses more profitable.

The plan will reduce major state-owned enterprises under direct super-

vision of the SASAC from 117 in 2012 to 97.

Strategic restructuring of China's state-owned enterprises in equipment making, coal, power, communication, and chemical engineering sectors will accelerate this year, according to experts.

Joseph Jacobelli, a senior analyst of Asian utilities at Bloomberg Intelligence in Hong Kong, said that he expects China's SOEs to see more mergers as the government overhauls the sector.

"The announced merger comes as no surprise and we can definitely ex-

pect more among other state-owned energy enterprises. It is a process that will be ongoing at least over the next two to three years, but the question is while the entities will be bigger, how will they be able to take advantage of synergies and reduce costs and become more efficient?"

The merger between CNEC, China's sole nuclear power engineering firm, and major nuclear power producer CNNC, is expected to create an entity with combined assets of more than Yuan 620 billion (\$99 billion) and a workforce of almost 150 000, according to Reuters' calculations.

World's largest 'virtual power plant' to be built in South Australia

A new 'virtual' solar power plant will be built in South Australia (SA) following a deal between the state government and Tesla.

The South Australian government reportedly plans to use rooftop solar panels on up to 50 000 households to generate power, which will then be stored in batteries located in each building. These batteries will then be 'linked' with the help of smart meters to form a 'virtual power plant that can inject electricity into the grid when needed.

Each home involved in the network will have a 5 kW solar panel system and 13.5 kWh Tesla Powerwall 2 battery with combined potential capacity of 250 MW.

The SA government plans to install the panels and batteries in several stages over the course of the next four years.

SA is at the forefront of the country's clean energy efforts, which is gaining momentum. The Australian renewable energy regulator recently released new information revealing that the country is well on track to meet its 2020 clean energy targets.

Australia has said that at least 33 000 GWh of its electricity will come from renewable energy sources by 2020. For the target to be met, it has been estimated that roughly 6000 MW of clean energy projects would need to be announced and built between 2016 and 2019.

Myanmar eyes LNG for new capacity

Myanmar is planning to double the supply of electricity in the country over the next two years with power generated by liquefied natural gas (LNG) to meet an expected domestic shortfall, local media reports said.

The Ministry of Electricity and Energy issued a Notice to Proceed to investors in four gas projects, which will collectively add 3000 MW of power to the national grid by 2020.

Three projects, one each in Kan Pauk in Tanintharyi Region, Mee Laung

Gaing in Ayeyarwady Region, and Ahlone in Yangon Region, will involve LNG imports, while the fourth, in Kyaukphyu, Rakhine State, will be for natural gas. It is the first time the government has allowed the importing of LNG into Myanmar.

Myanmar currently produces only around 3000 MW of electricity, and will need at least 6000 MW to function efficiently by 2020-2021, according to the Ministry of Electricity and Energy.

Energy transition at risk, new study finds

Renewable energy generation continues to rise but the future of the energy transition is fragile.

Siân Crampsie

A new report into the state of the EU electricity sector has found “worrying failings” in the energy transition.

The review – published by Sandbag and Agora Energiewende – notes that although more electricity was generated by renewables in Europe in 2017 than coal, emissions reductions have stalled and the growth in renewables is markedly uneven.

Wind, solar and biomass generation surpassing coal is “incredible progress”, says the report, not least because coal power generation was more than twice that of wind, solar and biomass just five years ago.

In 2017, renewables accounted for over 30 per cent of electricity generation in Europe for the first time. However Germany and the UK have accounted for 56 per cent of the growth

in renewables in the last three years, the report says.

“EU renewables growth has been increasingly reliant on the success story of wind in Germany, the UK and Denmark, which has been inspiring,” said Matthias Buck, Director of European Energy Policy, Agora Energiewende. “If all countries in Europe engage in this, 35 per cent renewable energy by 2030 is entirely possible.”

The report also notes that electricity consumption has risen for a third consecutive year in the EU, reflecting a revival in Europe’s economy and indicating that Europe’s energy efficiency efforts are insufficient.

Power sector carbon emissions for last year, however, remained unchanged, the report’s authors have estimated.

Europe’s current policy on energy efficiency needs strengthening, Sand-

bag has suggested. “With electricity consumption rising for the third year, countries need to reassess their efforts on energy efficiency,” Dave Jones, Energy Analyst at Sandbag said. “But to make the biggest difference to emissions, countries need to retire coal plants. We forecast Europe’s 258 operational coal plants last year emitted 38 per cent of all EU ETS emissions, or 15 per cent of total EU greenhouse gases.”

Five EU nations – the UK, France, Italy, the Netherlands and Portugal – have so far committed to phasing out coal fired electricity generation. However, Eastern European countries “are sticking to coal”, the report says. The debate in Germany, Europe’s largest coal and lignite consumer, is ongoing and will only be decided in 2019.

Overall, wind solar and biomass rose

to 20.9 per cent of the EU electricity mix, up from just 9.7 per cent in 2010. The report projects that renewables could provide a third of Europe’s electricity in 2018, and by 2020 renewables may account for 36 per cent of Europe’s power demand – up from 20 per cent in 2010.

According to WindEurope, a record 15.7 GW of new wind energy capacity was added to Europe’s grid in 2017. New wind farm installations were up 20 per cent on 2016 and beat the previous 2015 record of 12.8 GW. Onshore wind capacity grew by 12.5 GW and offshore wind by 3.1 GW.

Last year was also a record year for new investments in future wind farms, WindEurope said. As much as 11.5 GW worth of projects reached Final Investment Decision: 9 GW in onshore wind and 2.5 GW in offshore.

However the value of these invest-

ments at €22.3 billion (€14.8 billion onshore and €7.5 billion offshore) was 19 per cent down on 2016. WindEurope says that the figures indicate uncertainty in the industry.

“Despite the strong figures the medium and longer term outlook for wind is uncertain,” said Giles Dickson, WindEurope CEO. “The transition to auctions has been messier than we hoped. And crucially we lack clarity from many governments on their ambitions for renewables post-2020.”

“Countries need to start clarifying how much wind energy they want to deploy in the future.”

“The wind industry won’t invest in Europe’s economy if the market prospects are not there. Countries now have the chance to turn their National Energy and Climate Plans into investment brochures by committing to ambitious wind volumes.”

UK auction shuts out new gas capacity

- Record low clearing prices
- Ireland completes first CM auction

The latest capacity market auctions in the UK have cleared with record low prices, and signalled a shift away from the use of coal and new natural gas-fired capacity to build security and flexibility in the electricity system.

The UK held two auctions in the last month, securing 50.4 GW of capacity at a clearing price of £8.40/kW for delivery in 2021-22, and a further 5.8 GW of capacity at £6/kW for delivery in 2018/19.

The auctions are the basis of the UK’s capacity market, designed to ensure energy security in winter months and fill the gaps left by inherently intermittent wind and solar power.

The clearing prices of the auctions were well below the £18-£22.50/kW year range of previous auctions and served to exclude the prospect of new natural gas fired capacity.

However, more than 86 per cent of the capacity that won contracts came from existing gas and nuclear power stations, many of which are due to retire in the next two decades. A further

10 per cent of the winning capacity came from interconnectors.

N-ERGY managing director David Bowman said that the results of the auctions indicated that there is a lack of consistency in government policy, given its clean growth strategy and commitment to phasing out coal.

Dr. Jonathan Marshall, Energy Analyst at the Energy and Climate Intelligence Unit (ECIU) said that the results showed that “there is clearly more than enough capacity on the grid, and that we can keep the lights on even without resorting to the oldest and most toxic form of power generation”.

Following the auctions, EPH, owner of the 2 GW Eggborough coal fired power plant in Yorkshire, said that it would close the plant because of its failure to secure a capacity market contract.

Eggborough has been generating electricity for more than half a century. After it shuts, there will be just six coal plants left in the UK, as North-

ern Ireland’s last coal power plant is also due to close in May after it failed to win a contract in Ireland’s new capacity market.

AES said it was disappointed that Kilroot would have to close when the new all-island Integrated Single Electricity Market (I-SEM) begins operating on May 23.

I-SEM is replacing the current Single Electricity Market and is designed to deliver increased levels of competition as well as encouraging greater levels of security of supply. The capacity market auction was the market’s first and procured capacity for May 2018-September 2019.

In all, Ireland’s auction awarded 9066 MW of capacity, over half of it existing gas turbine capacity.

Enel said that its new advanced energy services division Enel X, through its US demand response services company EnerNOC, Inc., was awarded the delivery of 217 MW of demand response resources in Ireland’s auction.

Germany readies for new offshore wind tender

The country’s Federal Network Agency (Bundesnetzagentur) has outlined the rules of the second competitive offshore tender, setting a deadline for bids of April 3, 2018.

The tender volume includes 1550 MW of capacity as set out in Germany’s Offshore Wind Energy Act, plus 60 MW of capacity that was not awarded in the first call for tenders held in April 2017. There is a quota of 500 MW for projects in the Baltic Sea.

The maximum subsidy rate for which bidders can compete has been

set at €0.10 (\$0.13) per kWh or €100 per MWh. In the first offshore wind tender, the cap was set at €0.12/kWh, although three of the four winners actually placed zero-subsidy bids.

The capacity procured in the auction will be operational after December 2020. The tender will be eligible for offshore wind farms that were consented before August 2016, or that have advanced approval status.

According to Duetsche WindGuard, offshore wind energy capacity reached 5387 MW at the end of 2017.



Parliament building: Germany has outlined rules for the second competitive offshore tender

Wind sector remains strong in spite of policy 'gaps'

Challenges remain for developers and suppliers in the global wind market, but growth and opportunities are forecast to remain strong, analysts say.

Siân Crampsie

The global wind energy market is likely to attract \$100 billion per year of investment globally to 2025 thanks to favourable government policies and falling technology prices, according to a new report.

Frost & Sullivan says that globally, wind energy capacity additions will remain strong, with markets such as China, the USA, Germany and India leading investments, as well as the prospect of new investment in Brazil, France, Spain and the UK.

Other driving factors include corporate sourcing of renewables, Frost

& Sullivan says in its report, *The Global Wind Power Market*, while market actors could also benefit from a range of new disruptive technologies, such as data analytics and predictive modelling.

According to Frost & Sullivan, by the end of 2016, more than 80 countries had installed wind farms and about 26 countries, representing every region, had more than 1 GW in operation. The world's ageing asset base is also creating opportunities in the services market, which is predicted to be worth \$24.97 billion by 2025, up from \$9 billion in 2016.

Challenges remain in the market for

developers and owners, however, including issues with electricity grid integration, withdrawal of government subsidies, political instability and curtailment of wind projects, Frost & Sullivan says.

According to the Global Wind Energy Council (GWEC), policy gaps in some countries will continue to stunt growth in wind energy.

Nevertheless, the 2017 wind market remained above 50 GW, thanks in part to strong levels of capacity additions in Europe and India in particular.

Total wind energy installations in 2017 hit 52 573 MW, GWEC says,

bring total cumulative installed generating capacity to 539 581 MW. Installations in China fell by 19.5 GW in 2017.

"The numbers show a maturing industry, in transition to a market-based system, competing successfully with heavily subsidised incumbent technologies," said Steve Sawyer, GWEC Secretary General. "The transition to fully commercial market-based operation has left policy gaps in some countries, and the global 2017 numbers reflect that, as will installations in 2018."

Falling technology costs are continuing to have a real impact on the

market, GWEC says. Auction prices for wind energy have come in as low as \$0.02-0.03/kWh in markets such as Mexico, India, Morocco and Canada. In the offshore sector, an auction in Germany attracted subsidy-free bids.

The falling prices are presenting another challenge for developers, with profit margins being squeezed throughout the supply chain, GWEC says. "But we're fulfilling our promise to provide the largest quantity of carbon-free electricity at the lowest price," said Sawyer. "Smaller profit margins are a small price to pay for leading the energy revolution."

Oman marks Miraah success

The first four blocks of one of the world's largest solar thermal plants are now operating in Oman and delivering steam for enhanced oil recovery (EOR) at the Amal West oilfield.

Petroleum Development Oman (PDO) and its partner, Glasspoint Solar, have officially inaugurated the 1021 MWth Miraah solar plant and said that the success of the project would help Oman cement "its position as the regional leader in energy convergence, uniting renewable and conventional energy industries".

The Miraah solar project will eventually consist of 36 blocks, each comprising curved mirrors housed in a greenhouse. The mirrors track the sun and focus sunlight on a stationary boiler tube containing water. The concentrated sunlight heats the water to produce high-pressure steam, which can be used to help extract Oman's heavy and viscous oil.

The four blocks currently operating have a total capacity of over 100 MWth and produce a total of 660 t/day of steam. The steam feeds directly into PDO's existing thermal EOR operations, providing a substantial portion of the steam required at the Amal oilfield in southern Oman.

A further eight blocks are on track to be delivered in early 2019.

When complete, Miraah will save 5.6 trillion Btu of natural gas each year, which can be used for higher

value uses in Oman boosting economic growth. The project dwarfs all previous solar EOR installations and is more than 100 times larger than a pilot project built by GlassPoint for PDO in 2012.

"Deploying solar on Oman's oilfields to reduce the industry's natural gas consumption has a significant and lasting economic benefit for the sultanate," said Salim bin Nasser Al Afi, undersecretary of the Ministry of Oil and Gas.

"The project, which stands to be among the largest solar projects in the world, has contributed to developing local Omani talent in the renewable energy field and created job opportunities for local companies," added Al Afi. "We look forward to exporting our knowledge and expertise to the rest of the world as other progressive oil and gas producers follow in PDO's footsteps."

Raoul Restucci, managing director, PDO, said: "For our company, Miraah represents an important step in our journey to become a fully-fledged energy company, as well as placing the sultanate firmly on the global renewable energy map with this pioneering project."

PDO has also expressed an interest in adding wind energy to its portfolio and is currently exploring the potential for a 10-20 MW wind farm in the south of Oman.

Kenya seeks nuclear consultant

Kenya has started the process of identifying potential locations for a nuclear power plant.

The Kenya Nuclear Electricity Board (KNEB) has announced it is searching for a consultant to undertake a location study and develop the terms of

reference for the selection of sites.

KNEB is expecting to narrow its search to two or three suitable potential sites within about three years, it said. It is also in the process of developing a regulatory framework for the construction and operation of nuclear

energy capacity.

Kenya relies on hydropower and geothermal energy for the bulk of its electricity supplies and is keen to develop nuclear capacity in order to boost capacity and improve the reliability of supplies.

Nigeria sets out transmission expansion plans

Nigeria is planning to boost investments in its transmission and distribution grid in order to improve power supplies.

The country's government has taken delivery of a new strategy document – developed by Fichtner with the backing of the World Bank – that outlines a 20-year transmission expansion master plan.

It hopes that the master plan will help it to alleviate power shortages in the country, which are being caused in part by "stranded" generating assets, i.e., power plants that are available but unable to distribute energy to consumers because of problems with the grid.

Installed capacity in Nigeria stands at around 7000 MW, but the 180 million-strong population suffers daily power cuts.

According to the transmission master plan, Nigeria's power generation grew by just 6.3 per cent in the last 40 years. However, installed capacity is expected to reach 28 000 MW by 2035, up from around 7000 MW at present.

It says that in 2020, 2025, and 2030, Nigeria should be generating 10 000 MW, 15 000 MW, and 23 000 MW, respectively.

The country's grid needs to develop in unison with capacity additions, the plan says, while the Transmission Company of Nigeria (TCN) needs to plan for the addition of large generating assets such as the 3050 MW Mambilla hydropower plant.

The government expects power production capacity to increase to 8600 MW this year. TCN is in the process

of deploying 1400 MW of transformer capacity across the country, it said.

Nigeria also plans to improve distribution capacity and is looking to partner with private sector companies to invest in mini-grid projects.

Last month the government said that it hoped to start construction of the \$5.8 billion Mambilla hydropower project in the eastern Mambilla region this year once the loan terms with China's Export-Import Bank had been agreed.

The Chinese lender is expected to finance 85 per cent of the costs of the project. China Civil Engineering Corp. will build the 3050 MW power plant over five years. The facility will include four dams measuring 50-150 m high, and 700 km of transmission lines.

Multi-fuel CHP in the community

Multi-fuel combined heat and power plants are becoming part of the move towards renewable-based distributed generation. The new Zabrze project in Poland looks set to be a forerunner for smaller community-based projects in the country and elsewhere. **Junior Isles**

The move towards distributed generation is gathering momentum, largely driven by the falling cost of wind and solar photovoltaics (PV) along with advances in battery-based energy storage.

But, although leading the way, wind and solar are not the only distributed energy resources (DERs) that are increasingly playing a part in the evolving energy landscape. Fuel flexible plants that can burn biomass-only or a mix of solid fuels to generate both heat and power for high fuel efficiency are also becoming an increasingly popular option, especially for community district heating or industrial installations. These multi-fuel plants utilise renewable fuels and are fully dispatchable, avoiding the intermittency and energy storage issues faced by wind and solar plants.

Boosting energy efficiency is one of the pillars in the EU's Clean Energy Package. In its recent vote on revisions to the Package, the European Parliament recognised the role of high efficiency cogeneration, or combined heat and power (CHP), in delivering energy efficiency, cost effective decarbonisation and empowering domestic and industrial consumers. Moreover, high efficiency cogeneration was identified as a key solution to improve the sustainability of biomass.

Today, CHP produces 11 per cent of Europe's electricity and 15 per cent of its heat. According to COGEN Europe, with the right framework, the share of cogeneration in electricity generation could double by 2030.

Poland is a good case-in-point of a market that is beginning to realise the potential of biomass-based CHP. In terms of district heating capacity, at 56 000 MWth, Poland is second only to Germany within the EU. Three quarters of this is in the form of simple hot water systems fuelled by coal. Although the remaining 25 per cent are true CHP systems, only a handful use carbon-neutral fuels.

There is therefore huge scope for



The Zabrze multi-fuel combined heat and power plant will begin commercial operation this year

small-scale CHP plants – in the 50-300 MWth range with an electrical output of 10-100 MWe – that burn biomass or even a combination of biomass and other solid fuels.

Sumitomo FW is nearing completion of a project in Zabrze that could pave the way for a wave of new small-scale, low carbon, CHP plants in the country and indeed around the world.

Robert Giglio, Senior Vice President, Strategic Business Development of Sumitomo SHI FW, said: "Since renewables have taken off, you can see DG – whether it's a solar panel or windmill – spreading all over the world. This [distributed CHP] is the same type of plant but just with a different technology. But the big difference between this and a

wind or solar plant, is that it is generally a larger-scale form of DG that is dispatchable."

At 145 MWth and 75 MWe, the Zabrze CHP Plant (ZCP) will soon become the largest of a new generation of fuel-flexible CHP plants built in Poland. Located in Upper Silesia in southern Poland, ZCP will supply electricity and heat for about 70 000 homes in the municipalities of Zabrze and Bytom.

The project also includes a new 10 km-long heating pipe network that will interconnect the two municipalities. Construction of ZCP began in June 2016. Commissioning is scheduled for the end of this year but could begin as early as this summer.

The new €200 million project was developed and will be owned and operated by Finland-based Fortum Zabrze S.A. It will replace the existing Zabrze CHP plant, which is the oldest of Fortum's plants in Poland. Operating since 1897, the basic fuel fired in four steam boilers is hard coal from local coal mines in Upper Silesia. These have a total production capacity of 62.9 MW of electricity and 174.2 MW of heat.

The new installation will see the current boilers, built in the 1950s, replaced by a boiler island that is being constructed by Sumitomo FW under a turnkey contract, which includes the design, supply, construction, and commissioning of the plant. In addition to the new CHP plant and pipe network, two new peaking boilers were constructed within each municipality as part of the project. When ZCP is commissioned, the new peaking boilers will revert to backup service.

Giglio noted: "Poland has always

been heavily dependent on coal, and decades ago built hundreds of small coal fired plants to produce heat and steam but by today's standards these plants are old and dirty. So the government is providing incentives to replace them with clean and sustainable multi-fuel plants firing biomass and waste in addition to coal."

Commissioning of the plant will mark an important milestone in Poland's effort to lower carbon emissions from its power plant sector.

As stated in the Ministry of Economy's Energy Policy of Poland until 2030, decarbonising the power and heat generation network is an important part of the country's energy policy framework. The policy statement requires increased diversity in the country's fuel mix – particularly with carbon neutral fuels – increased efficiency through CHP development, while simultaneously reducing CO₂ emissions.

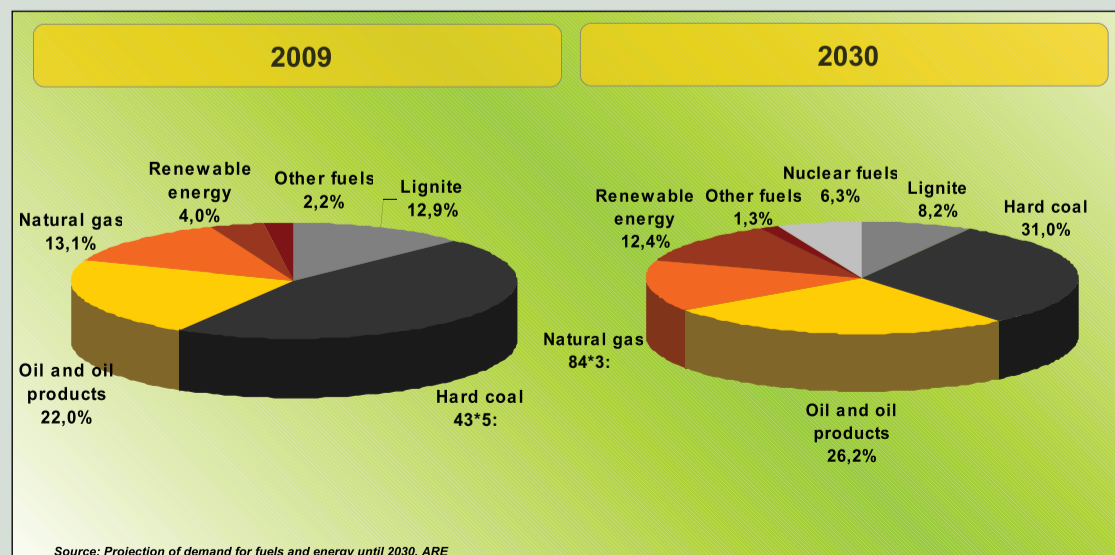
This policy statement and recent EU Directives makes it unlikely that any new coal-only plants will be constructed in Poland in the future. It will be a massive turnaround for a country that produces 83 per cent of its electricity and 87 per cent of its heat from domestic coal and lignite.

Indeed, the publication shows that the share of hard coal for primary energy demand falls from 45.7 per cent in 2009 to 31 per cent in 2030, while demand for lignite falls from 12.9 per cent to 8.2 per cent.

Renewables and nuclear take up most of the slack in meeting primary energy demand, with renewables going from 4 to 12.4 per cent during the period and nuclear going from zero today to 6.3 per cent in 2030.

Meanwhile, EU legislation calls for

Demand for primary energy by carrier (%), 2009 and 2030. Source: Ministry of Economy



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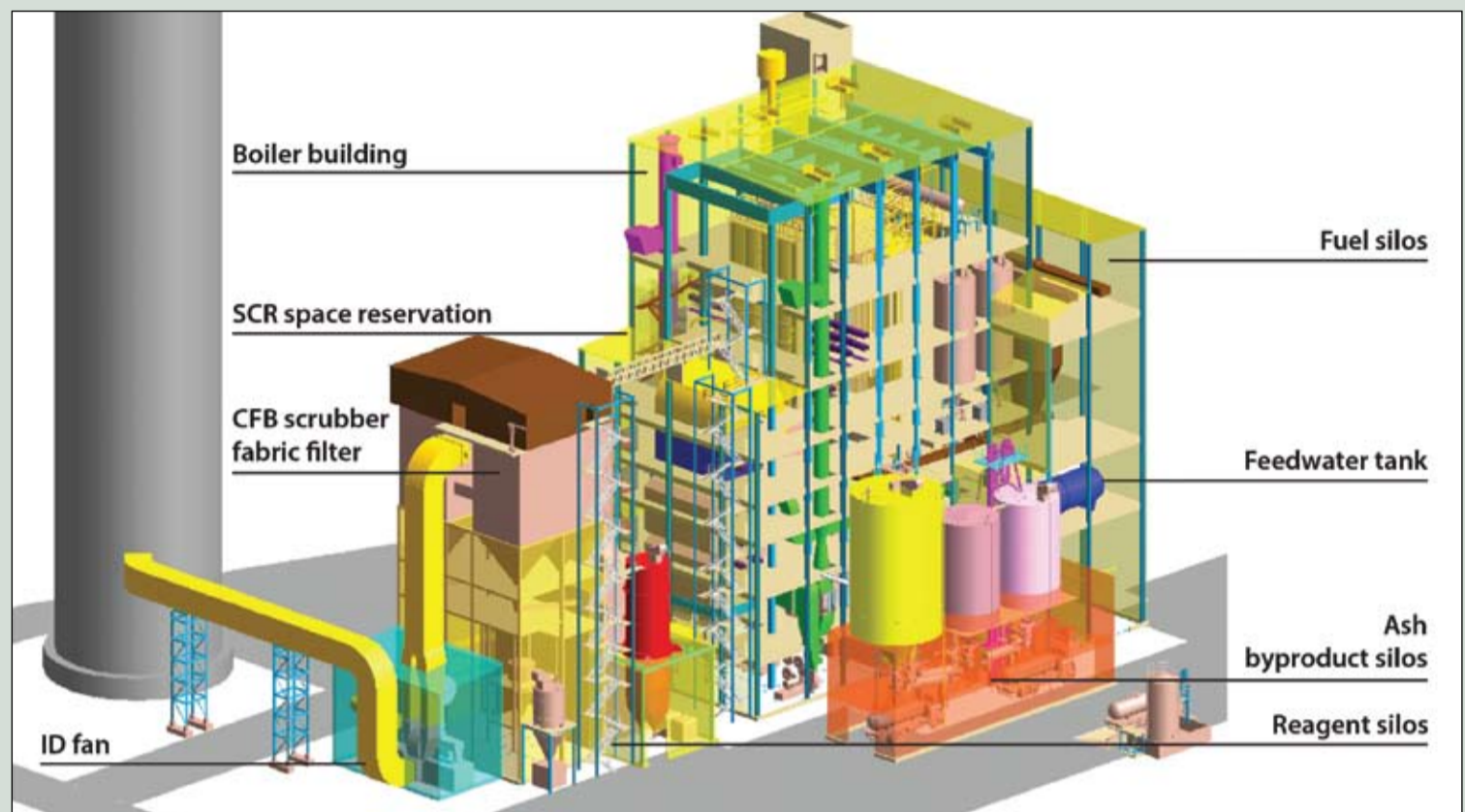
member states to increase the amount of energy consumed for power generation from renewable sources to 20 per cent by 2020. At the same time directives on waste management and use such as the Waste Framework Directive (WFD) 2008/98, set rules for waste separation and recycling, reuse, and limits disposal of waste materials. New EU rules state that refuse derived fuels (RDF) with a heating value greater than 6 MJ/kg cannot be landfilled in the future.

Indeed waste could become an important energy resource. In Poland, waste materials are already collected and sorted, including metals separation, by recycling programmes. Burning this fuel cleanly is being encouraged through the Industrial Emissions Directive (IED) 2010/75, which requires CO₂ emissions from industrial activities, such as CHP plants burning RDF and biomass fuels, to remain under 550g/kWh to be eligible for support through EU capacity market mechanisms. This means the CO₂ limit in future CHP systems can only be met by burning a mixture of coal and biomass or RDF.

The new ZCP plant will demonstrate how replacing aging coal fired district heating plants with an integrated fuel flexible circulating fluidised bed (CFB) CHP plant burning coal, RDF, bio-sludge and biomass mixtures can be a good solution. It increases overall scale and energy efficiency of the district heating network, produces dispatchable electricity, ensures CO₂ emissions remain below winter package limits, and meets WFD RDF/biofuels reuse requirements.

Waste recycled fuels when burned locally also reduce transportation costs and emissions while extending the life of the landfill. There are also a variety of CHP production and other renewable energy financial incentives for early adopters that can add to a plant's bottom line economics.

It is a solution that Giglio says is being seen in other markets around the world. "They are going to what I call organic energy solutions that are locally sourced and locally delivered. Communities – towns, villages, rural, suburban areas – have an energy need. They need heating and electricity; they might have a factory in a town that needs steam, and they develop their own 'closed loop' energy solution.



"They build a plant that can burn locally sourced waste materials, e.g. from a local factory or paper mill, to meet their energy, heat and steam needs. In hot climates, it could also meet their cooling needs."

Sourcing local biomass, waste, or even local coals, can increase energy security in countries and communities. For example, the CHP plant would be more reliable than sourcing power from an unstable grid, or if a country was dependent on importing a particular fuel. "If a market for this fuel becomes tight, you might have to pay a premium or you might not be able to get the fuel at all," noted Giglio. "These closed loop solutions protect communities from import fuel market risks."

ZFC will be able burn a wide range of locally sourced fuels, and equally importantly, it will do it cleanly.

"The old grate-type or stoker boilers could do this combination burning but with high emissions and low efficiency," said Giglio. "The new

generation of CFB plants can do it cleanly and efficiently by capturing the pollution during the process."

The CFB's fuel flexibility is rooted in its unique flameless, low-temperature combustion process. Unlike conventional pulverised coal (PC), stoker or oil/gas boilers, instead of an open flame, circulating solids are used to achieve high combustion and heat transfer efficiency to burn a wide range of fuels. The fuel's ash does not melt or soften which allows the CFB to avoid the fouling and corrosion problems encountered in conventional boilers.

From an environmental aspect, the low temperature CFB combustion process minimises NO_x formation and allows limestone to be fed directly into the furnace to capture SO_x as the fuel burns. In most cases, selective catalytic reduction (SCR) and flue gas desulphurisation (FGD) are not needed for NO_x and SO_x control. This dramatically reduces plant construction, operating cost and water

consumption while improving plant reliability and efficiency.

ZFC is initially configured to burn 0-100 per cent domestic hard coal with 0-40 per cent RDF, thus satisfying the WFD and IED requirements. This is equivalent to firing about 200 000 tons of RDF per year in the plant's CFB boiler. The fuel supply system is designed with separate day silos and chain conveyors that supply each fuel to the CFB boiler's front and rear walls.

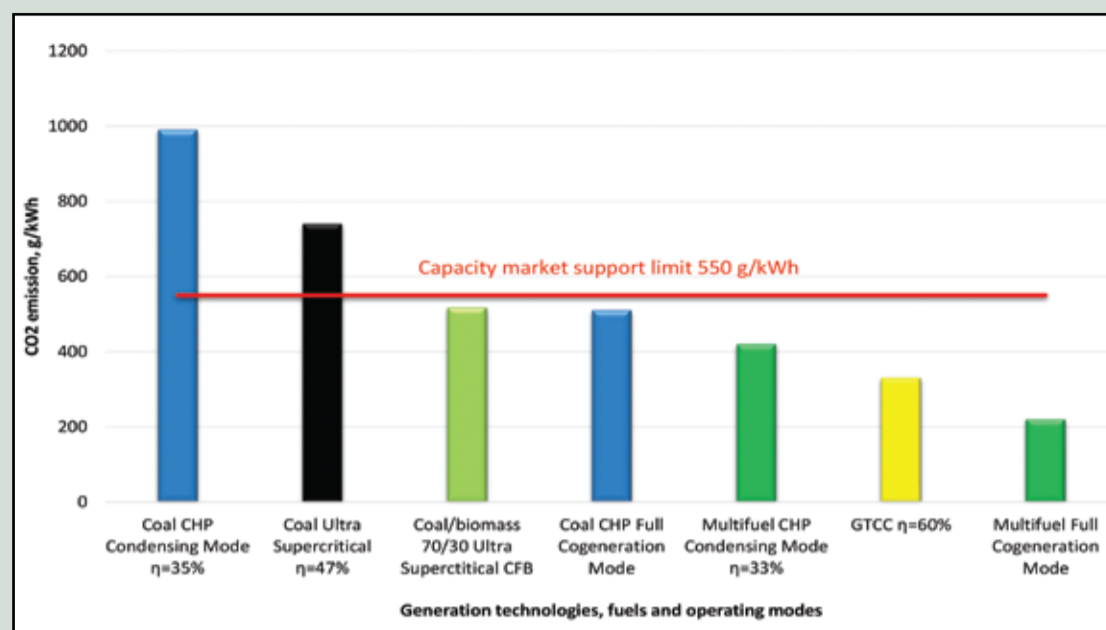
There are also provisions in the plant design to add the capability to burn 0-100 per cent biomass (including agro biomass) and 0-60 per cent coal slurry. Agro biomass includes energy willow, agro pellets (agricultural byproducts from straw: wheat, barley, rye, oat), palm kernel shells (PKS), sunflower pellets, corn chips, shea nut cake, and olive cake. By combusting these locally sourced residential and industrial wastes, the facility cuts the region's CO₂ emissions and at the same time reduces the

Multi-fuel capability: ZFC will efficiently combust a wide range of coal and RDF mixtures, while remaining under SO₂ and NO_x emissions limits. The plant will also have provisions to burn biomass and coal slurry



A conceptual drawing of a small-scale CHP CFB plant designed to burn mixtures of locally available fuels

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The multi-fuel CHP plant shows a much better CO₂ performance than a coal fired CHP unit and rests well below not only the national average, but also below the upper limit of eligibility for support through the capacity market mechanism

amount of waste material. Since 2016, landfill of any waste product with a LHV of more than 6 MJ/kg has been prohibited in the EU.

The plant's SO₂ and NO_x emissions will remain well below the IED requirements of 150 mg/Nm³ when burning design coal and biomass mixes using only furnace limestone injection and SNCR, respectively. When firing RDF, it meets the current WID (Waste Incineration Directive) and LCP BAT (Large Combustion Plant, Best Available Techniques) rules ratified on April 28, 2017 that require compliance by 2020 and define the emission limits for many other pollutants.

These pollutants are removed by an external flue gas cleaning system consisting of a CFB scrubber (for SO₂, HF, and HCl removal) and a pulverised activated coal injection system (for heavy metals, TOC, furan, and dioxin removal). Particulate emissions from the stack are controlled by a four-compartment pulse jet fabric filter. Provisions for more stringent emissions limits were also considered in the boiler design, such as space to accommodate a future SCR catalyst and excess capacity designed into the external flue gas cleaning system.

ZFC will have an estimated annual production of approximately 730 GWh of heat and 550 GWh of electricity. Full thermal load represents 270 t/h of steam flow at 92 bar and 536°C with a feedwater temperature

of 242°C.

For a CHP plant that is also being used to handle municipal waste, ZFC is fairly large; only a few sites in Poland would be suited to a plant of this type and size. Many of the municipalities have smaller energy and/or waste handling requirements and would therefore be better suited to a smaller installation. Future plants of this type in Poland are therefore likely to be the trend.

Many (55 per cent) of the country's district heating systems are small or middle sized, with a steam capacity between 10 and 200 MWth supplied from grate hot water heaters fired by hard coal. Existing plants average 25-30 MWth heating load. If an average size "small" district heating system is considered to be 26 MWth, this size CHP plant is applicable to hundreds of municipalities in Poland.

Such a plant would be a scaled-down version of ZFC, producing about 41 t/h of steam at 67.5 bar[a]/490°C over a load range of 40-100 per cent. An extraction-condensing steam turbine will produce 10.9 MWe with a maximum district heating capacity of 26 MWth when supplied with 140°C feedwater temperature. The boiler can also utilise higher steam parameters (90 bar, 520°C).

Based on these design parameters, the small multi-fuel CHP plant would have an annual production of 74 GWh of electricity and 76 GWh of heat. A yearly average fuel mix of 50 per cent

coal, 40 per cent RDF, and 10 per cent bio-sludge equates to an annual consumption of 22 800 tonnes of coal, 32 200 tonnes of RDF and 16 300 tonnes of bio-sludge. The plant would use the same emission control technology as ZFC, and so would similarly limit pollutants produced from the burning of these fuels. Notably, the example 26 MWth CHP plant produces CO₂ emissions that are more than 50 per cent less than the national average for coal fired district heating plants.

In addition to having the ability to burn a range of fuels cleanly, small-scale CHP plants have a number of other advantages.

Local power plants create local jobs, and such a CHP installation requires more operators to run the plant and sort and prepare fuel than would be needed for a package boiler or engine-based facility.

There can also be a good economic case for this type of plant. Because of the recycled waste fuel they burn, some of these CHP plants can compete in the energy spot market against large centralised coal plants. Further, since many of the main components can be modularised and built off-site, both the construction costs and time to build can be kept down. But much depends on the specifics of the site and its operation.

Giglio explained: "The economics get more complicated with these types of plant. When you look at a coal plant, the economics are strongly based on the price of the coal, capital cost of the plant and the selling price of electricity. But these [CHP] plants depend on multiple fuel sources. And for trash, you are paid to take the trash – it's called a tipping fee – which needs to be high enough to make the economics work... but much depends on how much you pay for the other fuels – the coal and the biomass – and the logistics of getting the trash to the plant."

He noted, however, that the value of these small-scale CFB CHP plants is not just about economics; it is about value to a community. Giving an example, he explained: "A paper mill typically builds a cogeneration plant on site to convert its waste wood into steam and power needed to run the mill. This is just that same type of thinking, but extended beyond the mill for the benefit of the nearby town, which would be connected to the same heating and power system. It's like extending an industrial captive power application to a municipal or community level."

He noted that producing power and steam from burning waste in small-scale plants will always be more expensive than burning natural gas or coal in large power plants.

"For these small CHP plants, the fuels are very variable and unique to the region or community and the plant is custom-designed for each application. It's not like a big coal plant, where you take a cookie-cutter approach – by building the same plant repeatedly to squeeze all the cost out of it. But when you look at it holistically – in terms of environmental, energy security and the community needs – it offer high value."

Giglio is therefore confident in the market prospects for distributed multi-fuel CHP plants, citing a number of areas where they could be utilised. "Developing countries are a good example," he said. "India, for example has many villages – many of which are not connected to the grid – but yet they have these waste fuels and local fuels available to them; so it's a solution there. It's a solution for Eastern Europe, where the concept works well for small industrial towns. Other countries like Bangladesh and countries in Africa, which are prime for this solution, don't have policies as progressive as in Poland but they are coming."

There will certainly be more opportunities as environmental pressure grows and countries move away from large centralised coal plant. Sumitomo FW is seeing a growing need for these organic energy solutions in countries like South Korea and Japan, where power demand is strong and costs are high due to import fuel.

In Korea, this approach is being encouraged on a larger scale, where similar plants are being built of up to 100 MWe. Sumitomo FW's Dangjin plant started as a coal/biomass plant – capable of burning 100 per cent of either fuel – but now no longer burns coal due to new environmental laws. The plant now only burns locally sourced recycled wood as well as wood pellets and PKS imported mainly from Indonesia.

With waste becoming a growing problem in many countries, the deployment of plants able to convert waste to energy is likely to grow over time. Certainly small-scale plants that can integrate heat, power production, waste recycling with the ability to burn carbon-neutral fuels is an elegant solution to the challenges facing communities now and in the coming years.

The Dangjin 1 Biomass Power Plant now only burns locally sourced recycled wood as well as wood pellets and palm kernel shells



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- ▶ Turn-key boiler and AQCS islands
- ▶ Long term service partnerships

Industries Served

- ▶ Power
- ▶ Industrial
- ▶ Combined heat and power
- ▶ Waste-to-energy

Companies News

Ormat signs deal for US Geothermal

Ormat Technologies is aiming to boost its portfolio in the USA with the acquisition of US Geothermal Inc. for a cash sum of around \$110 million.

Israel-based Ormat says that it has signed a definitive agreement with US Geothermal and that the acquisition will add to both its operating portfolio and its development pipeline in the USA.

Under terms of the agreement, US Geothermal shareholders will receive \$5.45 per share in cash. US Geothermal operates geothermal power projects at Neal Hot Springs, Oregon, San Emidio, Nevada and Raft River, Idaho. These facilities have a combined designed net output of 45 MW and currently generate approximately 38 MW net.

US Geothermal is also developing projects at the Geysers, California; a

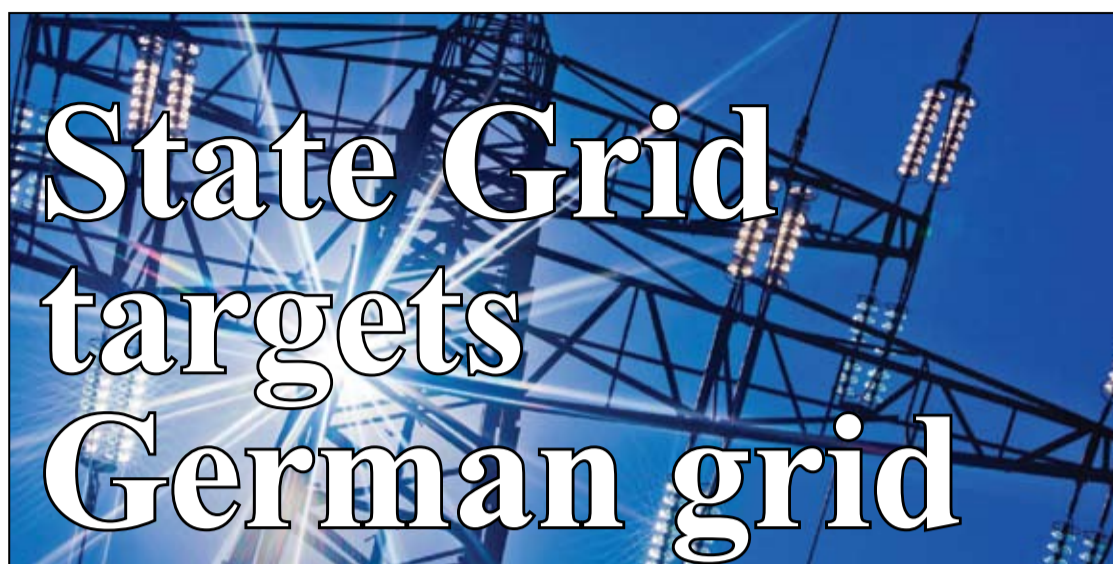
second phase project at San Emidio, Nevada; at Crescent Valley, Nevada; and the El Ceibillo project located near Guatemala City, Guatemala.

Ormat Technologies CEO Isaac Angel said: "This acquisition significantly broadens and diversifies our operations in the US, expanding our presence into Idaho and Oregon and giving us additional opportunities as we evaluate US Geothermal's development pipeline."

"We are confident we can leverage our unique core capabilities to improve generation and efficiency at the existing plants, utilising our expertise and proprietary technology. Finally, we have identified operational and financial synergies, efficiencies and cost reductions, based on US Geothermal's current revenue level, enabling us to improve the profitability of these operations."



US Geothermal operates geothermal power projects at Neal Hot Springs, Oregon, San Emidio



Elia will decide by mid-April whether to exercise an option to up its stake in 50 Hertz.

Siân Crampsie

Belgian transmission network operator Elia is assessing the possibility of increasing its stake in 50 Hertz after China's State Grid Corp said it was in talks to buy up to 20 per cent of the German network company.

Elia owns 60 per cent of 50 Hertz while Australian fund manager IFM holds the remaining 40 per cent. IFM confirmed in December 2017 that it was in talks with State Grid over the sale of a 20 per cent stake, triggering Elia's right to buy another 20 per cent stake in 50 Hertz.

Elia says that it has until mid-April to make a decision on whether to exercise its pre-emption right and that it is in the process of assessing the possible transaction.

50 Hertz is one of Germany's four

high-voltage power transmission grids, the others being Amprion, TenneT IPO-TTH.AS and Transnet BW. Elia's 60 per cent stake in 50 Hertz is worth around €3.2 billion.

50 Hertz has welcomed the approach by State Grid, which is the world's largest electricity company and the second most valuable company in the world after US retailer Walmart.

50 Hertz Chief Executive Boris Schucht said the Chinese investment would spur the company's efforts to make the German grid fit for the current build-up of renewable energy generation.

"We want to make progress in this area with an expanded group of partners," Schucht told the German business newspaper *Handelsblatt*. German newspaper reports indicate that the transaction could be completed by the summer of 2018.

However the proposed transaction has raised concerns in Germany over the sale of critical infrastructure assets to overseas interests.

State Grid owns much of China's electricity grid and has recently bought into grid operators all over the world, including Brazil, Greece and Italy.

In 2016, the Australian government blocked the sale of controlling shares in AusGrid to State Grid and another Chinese firm, Cheng Kong Infrastructure Holdings, citing national security concerns and State Grid's supposed close ties to the Chinese government and intelligence services.

50 Hertz has a key position in Germany's energy transition as it is responsible for transporting a growing amount of electricity from German wind farms in the Baltic Sea to the onshore power grid.

DSME exits wind business

South Korea's Daewoo Shipbuilding & Marine Engineering Co. (DSME) has withdrawn from the wind power business after selling its debt-ridden wind power subsidiary DeWind.

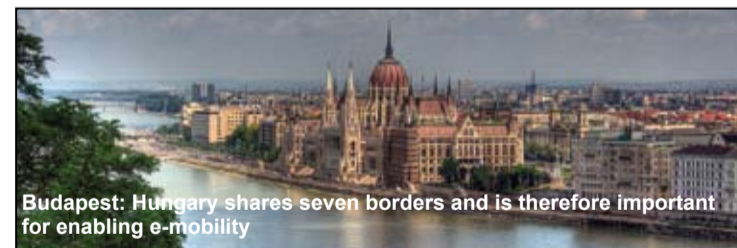
The Korean company said at the end of January that it had sold DeWind Frisco LLC and KODE Novus I LLC to an unidentified US private equity fund for \$1.5 million.

DSME bought DeWind in 2009 for 140 billion won (\$130.6 million) to gain a foothold in the wind power business, a promising high-growth sector for shipbuilding and engineering firms at the time. But hit hard by the global financial crisis, DeWind struggled from a drought of new orders and remained in the red after the acquisition.

DeWind's net loss of Won18.2 billion (\$170 million) in 2010 snowballed to Won106.1 billion in 2016, forcing the parent company to consider a pullout.

DSME announced in a statement it would acquire the Won85.7 billion debt under a guarantee agreement with creditors Export-Import Bank of Korea and Woori Bank.

Fortum agrees on EV network for Hungary



Budapest: Hungary shares seven borders and is therefore important for enabling e-mobility

Fortum Charge & Drive is set to support the installation an extensive electric vehicle (EV) charging service network in Hungary after reaching a deal with Hungarian NKM National Utilities.

National Utilities is planning to install the national EV charging network and has tasked Fortum Charge & Drive with providing a cloud-based SaaS (software as a service) solution to administer and operate the network.

National Utilities is currently identifying the right locations for the first 100 charging stations and is likely to cooperate with suitable hosts, such as fuel stations, municipalities, hotels, parking houses and retail outlets, Fortum says.

The initiative is part of a major drive in Hungary to reduce CO₂ emissions

and improve the air quality.

"Hungary is an important country for enabling E-mobility in Central Europe, due to the fact that it shares a border with seven countries," said Michael Warner, International Sales Manager of Fortum Charge & Drive. "There will be a lot more long distance travel between countries with the arrival of many new longer range electric vehicles in 2018, as promised by the majority of car manufacturers."

"With this in mind it is important that an extensive network of charging stations is deployed in Hungary and operated by a professional operator. NKM have expressed their motivation to be a forerunner in e-mobility in Hungary and we are looking forward to supporting their growth and sharing the lessons learnt from the Nordic markets."

Moixa partners with Itochu

- Itochu to market GridShare
- Japan key international market for Moixa

Battery company Moixa has secured funding from Japanese trading house Itochu that will help it to fund its international expansion.

Itochu has invested £5 million in Moixa and has also agreed a strategic partnership deal with the UK-based firm to market its GridShare software in the Japanese battery storage market.

Moixa's GridShare software uses artificial intelligence to optimise the performance of batteries. It can also manage large fleets of devices to help support solar generation, control vehicle charging and function as virtual power plants, delivering services to the electricity network.

Itochu will include GridShare in its own battery products and will also

work with Moixa to market GridShare to the major energy storage brands that Itochu supplies with battery chemistry.

Itochu will have sold over 6000 units of "Smart Star" home battery systems through its distribution network in Japan by the end of March 2018. It says that GridShare will be included as standard on its products by mid-2018 and that the technology will save customers money by using artificial intelligence to optimise the performance of their battery based on their patterns of behaviour, the weather conditions and market prices.

Japan had over 125 000 energy storage systems in 2016. Moixa and Itochu forecast that this will exceed 500 000 in 2020. Japan also has the

world's third largest fleet of electric vehicles, and is the world's fourth largest solar market.

Moixa has already seen success in Japan, securing an investment in 2017 from Tokyo Electric Power Company (TEPCO). Simon Daniel, CEO of Moixa, said that the deal with Itochu was a "real opportunity" for expansion in Japan.

"GridShare optimises the performance of home batteries by learning patterns of household energy use and solar generation, and adjusting to local weather and energy price signals," said Daniel. "It can also help customers make more money by using their spare battery capacity to provide services that help utilities and electricity networks balance supply and demand."

10 | Tenders, Bids & Contracts

Americas

MHPS announces first JAC win in Brazil

Mitsubishi Hitachi Power Systems (MHPS) has celebrated its first win in Brazil for its M501 JAC gas turbine.

MHPS will supply the JAC technology for installation in the Vale Azul II project, a 466 MW combined cycle power plant selected in Brazil's recent A6 auction. The plant will provide efficient base load power with low variable cost for 25 years, starting in 2023.

Power purchase and gas supply contracts have yet to be signed for the project, according to MHPS. The plant will be owned by a special purpose entity with shareholding by MHPS, MH Power Systems Representatives America Latina and Vale Azul Energia Ltda.

Greensmith wins Massachusetts hybrid

Origen Energy USA has awarded Greensmith Energy a contract to provide an energy storage solution for a solar photovoltaic facility in Sterling, Massachusetts, USA.

Greensmith Energy will deliver the 1 MW/2 MWh energy storage system using LG Chem batteries and Sungrow inverters. The resultant hybrid system will allow the PV installation to better handle peak loads and provide secure, reliable electricity supply to the grid.

Greensmith will deliver the turnkey solution and project on a fast-track basis, with the facility expected to be operational by the end of this month.

Asia-Pacific

NTPC bags Bangladesh supply contract

India's National Thermal Power Corporation (NTPC) has won a tender to supply 300 MW of electricity to Bangladesh for 15 years.

The Bangladesh Power Development Board (BPDB) had invited tenders for short-term and long-term supply of 500 MW power from India, with financial bids opened in early February.

NTPC said that its subsidiary, NTPC Vidyut Vyapar Nigam (NVTN), emerged as the successful bidder in both the short term and long term tenders for 300 MW of power. It added that the supplies are likely to start in June 2018 after the commissioning of a 500 MW HVDC interconnection project between India and Bangladesh.

Enel X triples in Japan

Enel X has won a contract to deliver 165 MW of demand response resources for a group of Japanese Utilities.

Through its US subsidiary, EnerNOC, Enel X will manage electricity demand from large industrial and commercial customers connected to the utilities' grids, informing those customers when the network needs them to reduce their power consumption. The balancing reserve created will help the utilities to increase grid stability.

The award confirms Enel as the largest independent demand response aggregator in Japan and triples its virtual power plant capacity in the country.

This recent tender is part of Japan's market liberalisation effort and a transitional step towards a market for ancillary services, which is expected to be in place by 2020.

MHPS wins Thai order

Mitsubishi Hitachi Power Systems (MHPS) has been awarded a contract for the supply of turbines and equipment for a 5300 MW natural gas fired power plant project near Bangkok in Thailand.

The project consists of two combined cycle power plants located in Chonburi and Rayong provinces. They are being developed by Independent Power Development (IPD), a joint venture between Thailand's independent power producer (IPP) Gulf Energy Development Public Company and Mitsui.

Under the turnkey engineering, procurement and construction (EPC) contract, MHPS will be responsible for the supply of eight M701JAC gas turbines for the two gas turbine combined cycle (GTCC) power plants. It has also signed a long term service agreement (LTSA) for the plants, which will be commissioned in 2021 and 2023.

Vestas contracted for Mukdahan wind farm

Winchai Co Ltd has placed an order with Vestas for the supply of 13 wind turbines for the Rom Klao wind farm in Mukdahan, Thailand.

Vestas will supply its V136-3.45 MW wind turbines for the project, with a hub height of 162 m. It will supervise turbine installation and also provide a SCADA solution.

The V136-3.45 MW turbine features Vestas' advanced aerofoil design and is ideal for generating energy in Thailand's low wind conditions, said Winchai chairman Prompong Chairisawatsuk. The turbine towers will be the highest in Asia.

Turbine delivery is expected by the end of 2018, with commissioning expected in the second quarter of 2019.

L&T bags 200 MW solar deals

L&T Construction has won contracts to build two solar parks in India with a combined capacity of 200 MW.

L&T will build a 100 MW PV farm in Tamil Nadu for Indian power group NLC India Ltd., and another 100 MW facility in Rajasthan for SB Energy One Pvt Ltd.

The deals are worth a combined \$92 million.

Europe

Jan De Nul wins Borkum contract

Senvion has awarded Jan De Nul a contract to install wind turbines at the 203 MW Trianel Borkum II (TWB II) offshore wind farm in Germany.

Jan De Nul will install 32 Senvion 6.33 MW turbines and provide offshore mechanical completion works at the site, located 40 km north of the island of Borkum.

Jan De Nul is also in charge, under a separate contract, of installing the HVAC export cable for the TWB II project.

The TWB II wind farm will be constructed throughout this year and is scheduled for commissioning by the end of 2019.

The wind farm is the second phase of the Trianel Windpark Borkum offshore wind farm, which has been operational since 2015.

ABB strengthens Polish market

ABB has been selected by Poland's national transmission system operator Polskie Sieci Elektroenergetyczne SA (PSE) to deliver its Ability Market

Management System (MMS), a state-of-the-art software solution.

The contract represents the first installation in continental Europe of the MMS, which will provide a detailed network model of and support the safe, reliable and efficient operation of PSE's national power network and its interface within the European energy market.

Poland's transmission network is interconnected with most of its European neighbours. These connections enable Poland to participate in the European electricity market, but also expose its national power system to variable electricity flows between countries, which can result in power irregularities, disruptions and outages.

PSE SA's decision to upgrade its systems by implementing the MMS solution will facilitate its efforts to integrate with the European network and better manage its domestic electricity market. ABB's MMS will help to balance national electricity demand and supply in real-time while maximising capacity utilisation of the country's transmission network.

SGRE to supply offshore giant

Siemens Gamesa Renewable Energy (SGRE) has won its largest ever order for an offshore project with a contract to supply wind turbines for Ørsted's 1386 MW Hornsea Project Two.

SGRE will supply its SG 8.0-167DD wind turbines for the project, located in British waters 89 km from the coast of eastern England. The wind farm will be the world's largest when commissioned in 2022.

The new SG 8.0-167 DD is equipped with a rotor that is 167 m in diameter. The blades, which are 81.5 m long, deliver an 18 per cent wider swept area and 20 per cent more annual output than its predecessor, the SWT-7.0-154.

ABB strengthens German grid

ABB has won an order worth around \$45 million from German transmission system operator TransnetBW to upgrade a substation in Philippsburg, in the southwest German state of Baden-Wuerttemberg.

Under the contract, the existing air-insulated switchgear (AIS) will be replaced by a compact 380 kV gas-insulated switchgear (GIS). The project is an important part of Germany's efforts to strengthen and improve the flexibility of its electricity grid as it implements its green transition plan.

International

MAN and BWSC boost Benin supplies

A consortium of MAN Diesel & Turbo and BWSC has won a contract to build the new 127 MW Maria Gleta power plant near the city of Cotonou, Benin.

The plant will be equipped with seven 51/60DF gensets, due for delivery during 2018, and will use natural gas as its main fuel. It forms a key part of the government of Benin's plan to revive economic development in the country, and is due to start operating in the first half of 2019.

"To date, only 30 per cent of the people of Benin have access to electricity, which is why the project is of great importance to increase national prosperity and to support the country's growing economy," said Waldemar Wiesner, Head of Region MEA for the Power Plants business at MAN Diesel & Turbo.

EPP awards Toktogul contract

JSC Electric Power Plants (EPP), the major state-owned power generation company in Kyrgyzstan, has awarded a turnkey contract for the modernisation of the Toktogul hydropower plant to a joint venture of GE Hydro (France) and GE Renewables (Switzerland).

The Asian Development Bank (ADB)-backed project involves the installation of new generating units at Toktogul to improve the plant's safety, efficiency, reliability, and availability.

The plant, located on the Naryn River in the Jalal-Abad Province, is Kyrgyzstan's largest and most important hydropower plant. The modernisation will increase its capacity to 1440 MW.

GE and Marinus secure Ghana waste gas pilot

GE Power and Marinus Energy have announced plans for a pilot waste gas-to-energy plant in Ghana that will reduce gas flaring and generate secure and flexible power supplies.

The Atuabo Waste to Power independent power project will capture isopentane gas that would otherwise be flared and use it to generate electricity using GE's TM2500 gas turbine technology.

The power plant will be the first of its kind in Ghana and will be the first TM2500 power plant in Sub-Saharan Africa to use Isopentane gas as a fuel source.

In the first phase, Atuabo will convert the Isopentane fuel into up to 25 MW of power. As additional gas is brought onshore, the plant is expected to add on additional gas generating units up to a capacity of 100 MW.

Additional Isopentane fuel will eventually be stripped off an offshore gas supply and processed at Atuabo by the Ghana National Gas Company. The gas turbine will start on lean gas and transfer to the Isopentane mix over time, and the power plant is intended to operate at base load throughout its life.

ACWA wins 300 MW solar tender

Saudi Arabia's Renewable Energy Project Development Office (REPDO) has announced that Saudi energy group ACWA is the final winner of the 300 MW solar tender it launched in February.

ACWA had been shortlisted along with a consortium formed by Japanese trading company Marubeni Corp., Khaled Ahmed Juffali Energy & Utilities Limited and Axia Power Holdings BV for the final phase of the tender in early January.

The Sakaka solar photovoltaic (PV) project is the starting point of an ambitious Saudi national renewables programme that aims to produce 9.5 GW of renewable energy by 2023.

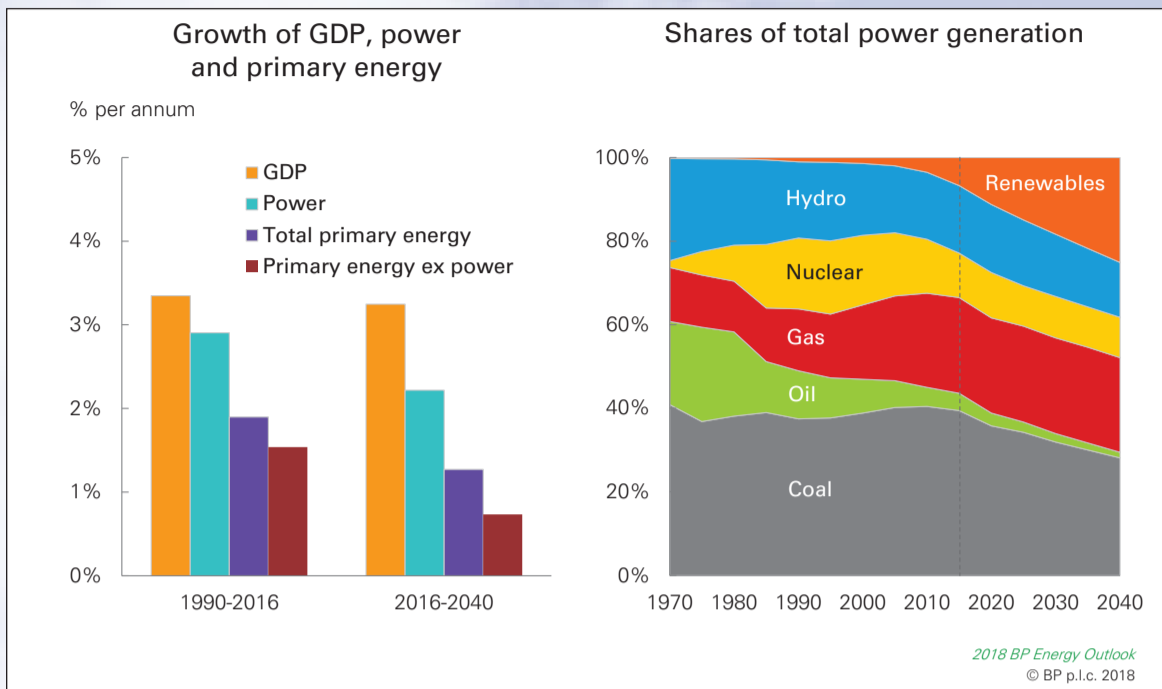
Located at Al Jouf, over an area of 6 km², the Skaka plant has an investment value of \$302 million (SAR1132 million). The project is expected to create job opportunities for more than 400 people.

ACWA submitted the second-lowest bid, an LCOE of SAR0.08872 (\$0.0236) per kWh, while French energy giant EDF placed a bid of just 0.06697 SAR (\$0.0178) per kWh.

However EDF's bid was not shortlisted for the final phase, REPDO said. It added that ACWA would now sign a 25-year power purchase agreement for the 300 MW Sakaka project with the Saudi Power Procurement Company (SPPC).



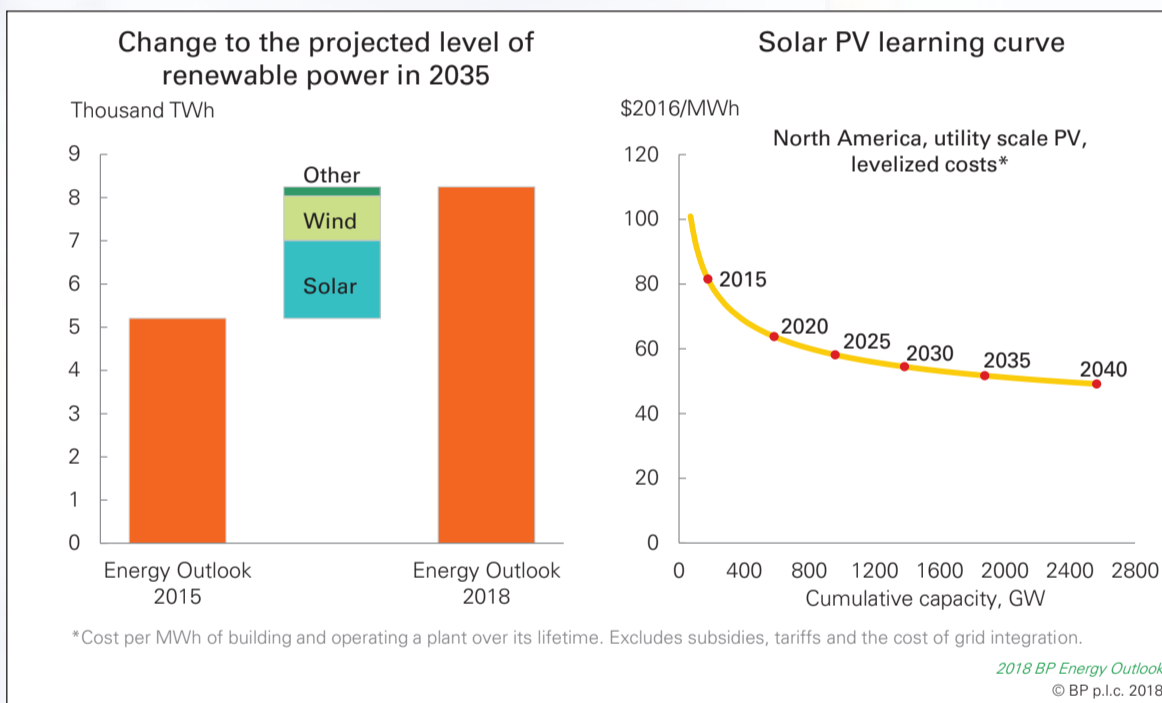
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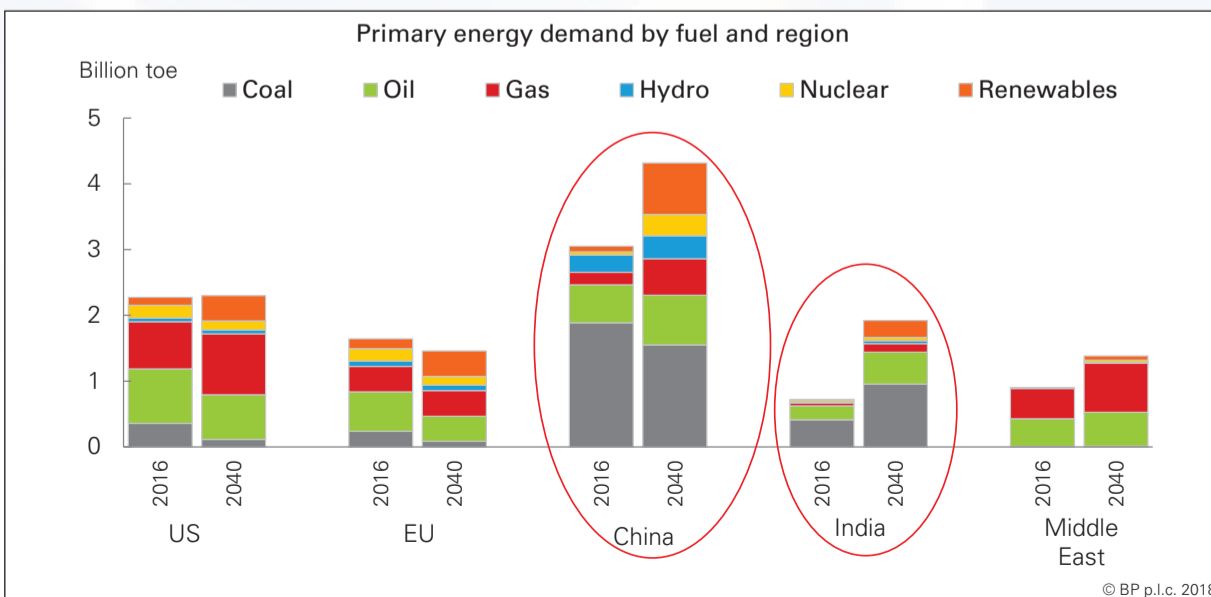
2018 BP Energy Outlook, page 46 © BP plc ,

The outlook for renewables



2018 BP Energy Outlook, page 96 © BP plc ,

Differences in the fuel mix across regions



2018 BP Energy Outlook, Presentation slides page 11 © BP plc



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Oil

Market will rebalance in mid-2018

- Saudi Arabia and Russia planning long-term cooperation
- Higher oil prices could inspire shale-producing countries

David Gregory

Crude oil prices have been on the rise for the last couple of months and in recent weeks touched the \$70/b mark. That steady rise in prices combined with a decline in crude stocks in developed countries has led Opec and its non-Opec partners to conclude that the oil market will rebalance in the middle of this year after four years of a global surplus.

Opec expects to see supply and demand come into balance this year and hopes to capitalise on that by continuing the programme it has pursued with non-Opec countries, namely Russia, by restraining production, thus forcing a decline in crude stockpiles and moving prices into a \$70-\$80/b range.

Saudi Arabia is reported to need oil prices at this level in order to steady its economy as Saudi Crown Prince Mohammed bin Salman reforms the country's economy in line with his

Vision 2030 plan and the planned initial public offering (IPO) of Saudi Aramco shares. High oil prices will make the valuation of Saudi Aramco higher, thus the sale of 5 per cent of the company as planned will provide the prince with the funds needed to produce the desired result of a reshaped Saudi economy.

To this end, Saudi Arabia and Russia are reported to be planning a long-term cooperation in an effort to keep the oil market in a manageable state close to their liking. Russia, too, is happier with a higher price of oil. Vladimir Putin is expecting re-election again in March's presidential election and a steady economy will help on that score.

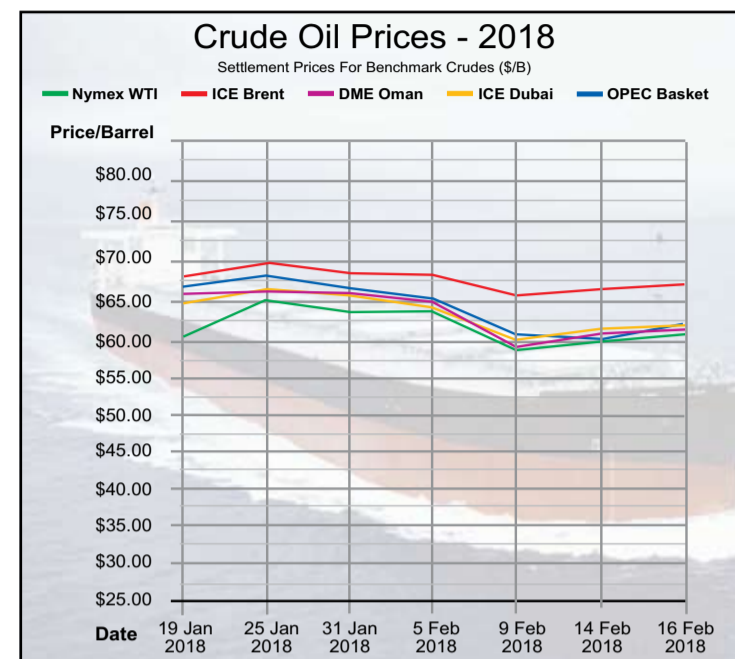
Opec and the 10 non-Opec members, who have since late 2016 participated in the programme to cut 1.8 million b/d of crude oil from the market in order to eliminate huge stocks, are now devising a plan for an alliance that will extend beyond the end of

2018 when the output reductions were due to stop, Subhail al-Mazrouei, the oil minister of the UAE and current holder of Opec's rotating presidency said in mid-February.

Whatever strategy that alliance might adopt, it will have to keep in mind the ambitions of US shale oil producers and the fact that oil prices should not be allowed to rise to where they again invite a crisis as oil producers have witnessed this decade.

US shale oil production is expected to push US crude output to more than 10 million b/d this year, but the US is not the only country in the world with large shale resources. While the challenge of US shale to Opec and its partners is squarely on the table, high oil prices could inspire other countries with shale potential that have yet to get fully with the programme to do so.

According to Mazrouei, an alliance between Opec and non-Opec would ensure adequate investment in the oil industry in order to maintain market



stability in the future. Analysts have argued that the fall in crude prices was cutting into upstream and infrastructure investment that would ultimately result in a severe shortage of crude as the market rebalanced, provoking a demand for crude that could not be met, pushing prices higher.

No specific price table has been mentioned, but officials are keen that it be high enough to warrant sufficient investment in the industry.

Mazrouei is reported as saying that Opec is anxious to see a restoration of the oil market and to cooperate with all countries, even shale oil producers, to ensure that there is adequate oil supply in the market. Yet it was Saudi Arabia's attempt to force shale oil producers out of the market in 2014 that led to the oil glut and the collapse in oil prices.

Meanwhile, in its February *Oil Market Report*, the International Energy

Agency (IEA) acknowledged a modest tightening in the oil market balance but said its message remained unchanged from its previous report: that during 2018, the fast-rising production of the non-Opec countries, led by the US, is likely to grow by more than demand. It pointed out that the upward rise of oil prices had stalled, due to profit-taking, corrections in markets, and the fact that fundamentals for the early part of 2018 look less supportive of prices.

Its forecast for demand growth remained at 1.6 million b/d for 2017 and 1.4 million b/d for 2018.

The IEA said that US shale producers are experiencing a second wave of growth "so extraordinary that in 2018 their increase in liquids production could equal global demand growth". It said oil countries with shut-in production are facing a renewed challenge to their market share.

Gas

Contention over discovery offshore Cyprus, Noble Partners sign contract with Egypt

In February, some positive developments in the East Mediterranean finally made way for the region's players but events showed just how contentious the issue of developing the region's hydrocarbon resources is going to be.

Mark Goetz

After years of waiting for a new era of offshore drilling to get under way and several disappointing wells, Cyprus reported in early February that Italy's Eni, in a 50-50 partnership with France's Total, made a gas discovery in Block 6, which is located southwest of the island. The gas resource at the Calypso well is estimated at up to 8 trillion cubic feet (226 billion cubic metres) and possibly more.

In August 2015, Eni discovered the giant Zohr gas field in Egypt's Shorouk Block. The Zohr gas resource is estimated at 30 tcf (850 bcm) and lies just a few miles from the Egyptian-Cypriot maritime border. That discovery prompted Cyprus to launch a new licensing round that resulted in new acreage being licensed to Eni, Total and ExxonMobil/Qatar Petroleum in April 2017.

In the late summer of last year, Total drilled a well in Cyprus Block 11 near

the Zohr discovery. That well proved disappointing, showing gas but not of a commercial quantity. The recent discovery at the Calypso well suggests that Cyprus has turned a page.

"This discovery confirms the presence of a petroleum system and of a carbonate reservoir, as we expected, and, of course, a linkage with Zohr. That is, they share the same geological and geophysical features," Cypriot Energy Minister Yiorgos Lakkotrypistold the media in Nicosia.

When the Saipem 12000 drillship finished at Calypso, it headed to Cyprus Block 3, southeast of the island to spud the Cuttlefish well. However, Turkish warships prevented the drillship from reaching its destination.

The Calypso discovery is excellent for Cyprus and its gas industry aspirations, but angers Turkey, which seeks to control the exploitation of hydrocarbons in the island's offshore territory and objects to the Republic of Cyprus' exploration programme on

the grounds that it excludes the Turkish-Cypriot administered area in north Cyprus, which is under Turkish military occupation. Turkey insists that Turkish-Cypriot rights are being violated and demands exploration stop until a solution to the 44-year-old Cyprus problem is reached.

Earlier this year, Turkey issued a navigational warning (Navtex) reserving a huge area southeast of the island for military training with the intent of obstructing exploration work. The Saipem 12000 was halted 50 km short of its well target location by Turkish warships. Diplomatic efforts on the part of Italy, the European Union, the US and Cyprus failed to convince Turkey to allow the drillship to proceed amid warnings by Turkey's president, Recep Tayyip Erdogan, that Turkey would not allow the Greek-Cypriot republic to continue with its exploration.

After waiting for the expiry of the Navtex on February 22, the Saipem

12000 made another attempt to reach its desired location, but was again thwarted by Turkey. The drillship moved to the Morocco offshore on February 23, where it had further contractual obligations.

During the standoff in Cypriot waters, the partners in Israel's offshore Tamar and Leviathan gas fields, Noble Energy and Delek Group, announced they had signed an agreement worth \$15 billion with Egypt's Dolphinus Holdings to provide it with 64 bcm of gas over a 10-year period.

This deal has been in the works for several years, but political and legal problems prevented it moving ahead. Egypt recently passed a law allowing private companies to import gas, besides that, a resolution of a legal dispute between Egyptian state-owned energy companies and an Israeli pipeline firm is soon expected, and that may smooth the delivery of Israeli gas to the Egyptian firm.

It has yet to be decided how the gas

will be delivered to Dolphinus; it may be through the EMG pipeline involved in the legal suit or perhaps the Arab Gas Pipeline (AGP), which would transport the gas through Jordan.

Days after the announcement of the Israel-Egypt deal, Cypriot Energy Minister Lakkotrypist said that negotiations between Cyprus and Egypt for the delivery of gas from Cyprus' Aphrodite gas field would likely result in the signing of a contract very soon.

Noble and Delek, plus Shell, are partners in Aphrodite, which lies close to the Israeli fields. It has been suggested some time ago, that a deal between Cyprus and Egypt would result in the construction of a pipeline from Aphrodite to Egypt's Nile coast. Israeli gas could then be transported to Egypt via the Aphrodite field. This would serve Noble's and Delek's fields.

This year promises to be an important one for the East Mediterranean. It is hard to say what will happen, but it's likely that many things will.

Towards the tipping point

A new report published by Lloyd's Register looks at the degree to which renewable energy has gained traction throughout the world and what needs to happen to accelerate it. The research illuminates the outlook for renewables and highlights the technologies that are expected to deliver the greatest impact.

Karl Ove Ingebrigsten

If there were doubts that renewable energy sources can compete with oil, natural gas and coal in power generation, developments in the past two years should have dispelled them. According to the International Energy Agency (IEA), 2016 was a record year for renewable energy projects, which provided two-thirds of new global power capacity.

This continuing growth of solar and wind capacity in many parts of the world, and the increasing incidence of projects involving low or no subsidies, have led some observers to proclaim the arrival of a 'tipping point' for renewables.

But basing this sort of assertion on individual projects is a risky move. After all, every project has its own circumstances and economics, and these can differ – sometimes considerably – even within the same country. Nonetheless, tipping-point predictions do provide an indicator of the progress made to date and what is still required to reach the point where renewables overtake fossil fuels in each country's energy balance.

This 2018 edition of the Lloyd's Register *Technology Radar* provides an industry perspective on the challenges that need to be overcome for renewables to become the primary form of energy consumed in countries. The analysis, conducted by Longitude in November and December 2017, is based on a Lloyd's Register survey of 792 executives working in the renewable energy sector.

As a group, executives are cautious about expectations of when renewables will overtake fossil fuels but at the same time are optimistic that technology innovation in different fields will have a sizeable impact in the next five years on the performance of renewable energy generation, transmission and storage. They also note that it is important not to underestimate the cumulative impact of a series of less dramatic process improvements – especially those powered by digital technologies.

The survey returned several key findings. The first is that the tipping point is still in the future. In our 2017 study, a majority of renewable sector executives believed that parity was being reached. This year we asked them to predict where it would be reached first and when. Despite recent advances, many argue grid parity for major renewable energy sources is still several years away for most countries. The industry expects parity for solar to be achieved earliest in China (2022/23), and for wind earliest in Germany (2024).

Despite subsidies and technology advances, high costs remain a barrier to reaching parity and to faster renewables growth. A majority of

survey respondents, 62 per cent, say that high costs remain the primary argument against pursuing renewables in their country.

Another major inhibitor to the growth of renewables, and to their greater attractiveness to utilities, is a lack of storage at an affordable price. Excluding cost, the most frequently cited obstacle by survey respondents to the growth of renewables in their country's energy mix is the slow development of storage technologies.

These obstacles mean that even if grid parity comes soon, a decisive shift in the energy balance towards renewables will take longer. Taken together, renewable sources are expected to surpass fossil fuels in countries' energy mixes first in Europe and North America (by 2025), in the Middle East by 2028, and in Asia Pacific and Africa in 2033 or later.

The *Technology Radar* also finds that achievement of grid parity is not by itself enough in most countries to tilt the energy balance decisively in renewables' favour. Issues with grid connection, transmission and storage often combine to limit the impact of individual projects.

Recognising that the worldwide march of renewable energy is slower than popularly assumed should not, however, lessen appreciation of its progress, or of the role that technology innovation has played in propelling it forward.

Technology advances can indeed change the equation. Continued technology innovation could accelerate progress towards achieving grid parity. Most of the attention is on advances in solar and storage technologies that could have a big impact on performance, although these may take time before having the desired impact on cost.

A series of improvements in solar-panel design, for example, have made considerable contributions in recent years to the cost-competitiveness of solar PV. And expansion of electrochemical battery capacity – in both grid and residential systems – has also helped solar PV's growth. In offshore wind, advances in materials such as composites have increased the efficiency of turbine blades, which has in turn helped to improve wind's economics.

In the next five years, industry experts expect innovation to predominantly take the form of incremental improvements.

In wind energy, for example, boosts to scale and optimised processes will be more influential in improving performance and cost-efficiency than breakthrough technologies. Larger offshore turbines and rotors, for example, and streamlined installation and maintenance practices (with the



Karl Ove Ingebrigsten: the tipping point is still in the future

help of analytics) are expected to improve wind farm economics.

In solar power, too, it is improvements in existing technologies rather than new breakthroughs that will have the greatest impact on performance in the short and medium terms. In the longer term, perovskite cell technology offers the opportunity to move away entirely from silicon in the production of PV cells, which promises greater efficiency.

Notably, digitalisation is seen as a key driver for performance improvement in renewable energy generation and transmission. For example, companies are looking to use predictive analytics, demand management and even machine learning to improve the operational performance and economics of energy transmission.

Our 2017 study identified blockchain, the distributed ledger technology that underpins cryptocurrencies such as bitcoin, as a potential disruptor of energy transmission and distribution. This latest survey finds respondents expecting the blockchain impact on transmission to be felt within the next five years.

The digitised and decentralised nature of blockchain makes it a suitable technology for use within small scale energy systems. Among blockchain's potential applications is in enabling microgrids through the regulation of peer-to-peer consumer transactions.

David Eyton of BP, now a major investor in the renewables market following its recent \$200 million investment in Lightsource, Europe's largest solar development company, sums up the general industry feeling that "digital is incredibly important" noting that, for this reason, BP is currently investing heavily in digital technologies such as blockchain. Eyton goes on to raise the possibility that the "monstrously inefficient" current energy systems could be improved by the "enormous and positive impact" of technologies such as blockchain.

We are heartened by not only the optimistic outlook but also the measured and realistic approach that is displayed throughout the results and insights in the research.

Traditionally, the elephant in the room in discussions of renewable energy has been policy change. However, industry executives believe the improving economics of solar and wind is reducing the scope for policy changes to obstruct renewables growth.

Recent evidence may be found in the US. Renewable energy capacity there continues to grow in spite of the current administration's retreat from COP21 and domestic commitments to combatting climate change. Indeed, in large parts of the world policy appears to be diminishing as a decisive driver or inhibitor of renewable energy growth.

The sector's continuing investments in technology innovation help to explain this. In Europe, North America and parts of Asia, it is continued technology innovation that is doing the most to build the case for renewable energy – a view that is supported by most of our survey respondents.

This is not entirely the case in developing countries, where government support for renewables is often weak. In the survey, for example, many more Middle East respondents than those from other regions cite government policy as a renewables growth inhibitor in their countries.

Government policy, of course, affects energy markets in many different ways, not least through decisions on subsidies for different energy sources. In most countries, few investors will look at a major renewable energy project without considering the financial support that the government may or may not be providing for it.

This study makes clear that there is some distance to go before the economic case for renewable energy becomes unassailable. The costs of technology innovation, for example, remain high, both in the development phase, as in the case of energy storage, and the asset construction phase, particularly when it comes to deployment. In some cases, the costs of innovation can act to limit operational cost reduction. At the same time, digital technologies should make a significant contribution to reducing operational costs for renewable energy developers as well as for utilities.

As technology innovation brings grid parity closer for renewable energy sources, then, it is also bringing closer the day when renewable projects can be judged purely on their commercial merits. When that happens regularly, the tipping point will almost surely have been passed.

Karl Ove Ingebrigsten is Director of Lloyd's Register's Low Carbon business and author of the 'Technology Radar 2018' report.

In which country do you think the following renewable energy sources will reach grid parity with fossil fuels first, and in which year?*

Offshore wind		Onshore wind		Solar PV		Solar CSP	
Country	Year	Country	Year	Country	Year	Country	Year
Germany	2024	Germany	2024	China	2023	China	2022
UK	2024	US	2024	US	2024	Spain	2024
US	2025	Denmark	2028	Germany	2028	UAE	2024
Denmark	2025	Sweden	2033	Denmark	2033	Australia	2025
Sweden	2033	Finland	2038	Sweden	2038	US	2025

* The countries shown enjoyed the highest frequency of survey responses as the most likely to reach grid parity first. The years shown are the mean year of the prediction for each country.

Controlling wind farms for maximum returns

In a bid to wring out every last dollar of lifetime value from their assets, wind turbine owners are placing ever more emphasis on optimised O&M and life extension support strategies. As a result, increasingly sophisticated wind turbine controls are now a clear focus for future development in the wind industry.

David Appleyard

Conventionally, wind turbines are ‘point and shoot’ devices. Designed to align themselves to the optimum angle of attack for maximum power generation, such machines operate as isolated entities.

However, commercial wind farms both on and offshore are typically positioned in arrays of multiple machines. With their huge swept area, a spinning wind turbine rotor produces downwind wake effects, such as turbulence. Depending on the wind direction, that effect can impinge on neighbouring downwind machines, reducing their output and potentially increasing fatigue loading.

As Giuseppe Ferraro, Business Lead, DNV GL – Energy, explained: “There is an effect on the machines that are down wind. The wake effect can have a significant impact.”

Researchers have been considering these wind farm-wide effects in their control strategies for some time, with a view to asset optimisation. By fully understanding the whole wind farm and its interactions, proponents of this approach argue that it will not only increase wind farm outputs, but may also reduce troublesome elements such as fatigue loading, and thereby deliver a consequent impact on life extension.

“Rather than just looking at the single machine we look at how the whole wind farm operates and then try and define an optimum for the wind farm. The definition of the optimum is not just energy capture, it’s also going to be defining the effect of the operational strategy on the life of the asset,” said Ferraro.

Megan Smith, Offshore Wind Manager at the UK’s Carbon Trust added: “We can run quite a few scenarios in various different models to understand whether the overall output is increased by, for example, de-rating the front row of turbines, one of the most talked about options.” Adjusting the pitch angle of the blade can decrease energy extraction, allowing more wind to flow through. This directly affects the downstream wake.

Smith also noted: “That’s not the only way to actively manage the way the wind flows through a wind farm. For example, running the turbines to divert the wake away from the turbine directly behind it.”

Enabled by advances in ICT and sensor technology, together with concepts like big data analysis, the advanced controls approach signals an increasingly mature approach to asset optimisation. For instance advanced wind farm control strategies can offer bespoke set points to suit specific customer operational and business requirements.

This is emphasised by Ferraro: “We are defining what we call the optimum function that can be tailored to the specific needs of the owner or operator. To understand whether they want to maximise energy generation or if they want to get

a balance, maximising energy generation at the same time as safeguarding the life of the assets.”

According to Smith the increase in yield capture through control strategies could translate to savings beyond solely the increased output, by affecting the whole economics of the wind farm. “The cost to build an offshore wind farm is not insignificant, therefore maximising energy yield from existing and future structures further increases the economic competitiveness of the technology,” she noted.

As various operational models and strategies have emerged and been subjected to analysis and simulation, evidence is mounting that significant benefits exist. Currently, a number of trials are under way in a bid to validate those models. For instance, the UK’s Carbon Trust has announced a new project to conduct full-scale trials at an operational offshore wind farm.

Part of the Carbon Trust’s Offshore Wind Accelerator programme, the trial, which was announced in December 2017, is backed by EnBW, E.ON, innogy, Statoil and Vattenfall, and delivered with DTU, ECN, Frazer-Nash Consultancy and Windar Photonics. The €2.3 million Wind Farm Control Trials (WFCT) will aim to demonstrate these new control strategies to improve energy yield and reduce operational and maintenance costs.

However, such strategies may also present engineering issues too, for example by producing asymmetrical fatigue loading on turbine components. Smith said: “Fatigue loads is one of the many potential downsides of control strategies. That isn’t a definite downside, but we need to be very careful that by implementing control strategies we’re not unduly increasing the load on a component to the point that it causes more harm than good by further understanding exactly what loads and load cycles are likely on various components.”

According to the Carbon Trust, pitch and yaw-based control strategies would together result in a 0.5-3.5 per cent increase in farm-wide energy yield. In addition, the move could possibly enable load reductions of up to 50 per cent for certain wind turbine components.

Elements such as foundations and bearings will see reduced fatigue and thus required maintenance. The full-scale trials are expected to begin this year at a yet-to-be-determined wind farm and full results are expected in 2019. The project has received grant funding from the European Union’s Horizon 2020 research and innovation programme.

“Models that have been developed with the access to real data, suggest that actually the wind farm output can be fairly significantly increased. Around 1 per cent is not an unreasonable figure for increasing yield and that extra 1 per cent is a lot,” said Smith.

The full-scale programme builds on a cluster of promising research undertaken by various groups, such as FP7 ClusterDesign, FLOW programme, and the US National Renewable Energy Laboratory (NREL).

Indeed, NREL has also moved to physical trials of advanced control algorithms with two industry partners, NextEra Energy, Inc., and Ystrategies, Inc., under a cooperative research and development agreement announced in late 2016.

They are conducting the first commercial tests of NREL-developed modelling and optimisation software designed to allow wake steering of individual turbines. The trials are being conducted at the Peetz Table Wind Energy Center (PTWEC), in Colorado.

NREL suggests that wind farms sacrifice up to 20 per cent of their gross energy production to wake losses, a major issue for any commercial venture. “Annual energy production has always been a focus for the wind industry,” said Dan Brake, Senior Director of renewable engineering at NextEra Energy, in a statement. “The industry recognises waking contributes significantly to lost revenue. Wake steering technology is expected to allow turbines to operate more efficiently based on the energy already available in the wind.”

Based on NREL’s Wind-Plant Integrated System Design & Engineering Model (WISDEM) platform, engineers and plant officials can individually monitor each turbine with a top-down view of the entire plant, modelling its wind inflow, grid integration, operational expenditures, and overall cost of energy.

Clean technology venture capital company Ystrategies provided financial support for the project, which has also been backed by a US Department of Energy Office of Technology Transitions Technology Commercialization Fund grant. NextEra Energy Resources is a subsidiary of NextEra Energy, Inc., which operates an installed capacity of more than 12 GW of wind.

Engineers expect to see the plant’s energy production increase by a few per cent.

NREL researchers Paul Fleming and Jennifer Annoni have also led a 2016 field test performed in collaboration with Envision Energy to implement wake steering at an operating commercial offshore wind farm in China.

“This campaign provides a first indication that wake steering can be used to raise energy capture at commercial wind farms,” said Fleming.

Using NREL wind farm models like Simulator fOr Wind Farm Applications (SOWFA), a computational fluid dynamics model, and FLOW Redirection and Induction in Steady State, an engineering model, researchers assessed wake dynamics and yaw control optimisation to demonstrate the benefits of wake

steering for commercial wind farms.

“Wind farm control is garnering interest across the industry now, and field validation is important to mature the technology. However, field validation of wind farm control strategies is challenging,” Fleming said in a statement. This is a point echoed by Ferraro who said: “You need to validate the wind farm control in the field and that is something that is probably going to be the next stage in terms of development.”

More sophisticated condition-based controls that are defined with system-wide understanding are fully anticipated to have a significant impact on the levelised cost of energy (LCOE) for wind turbines. However, greater understanding of machine interactions may also have an impact on array design too.

Ferraro observed: “Wind farm control can be used to have an effect on how you design the wind farm. We use simulation tools to validate the combination of wind farm layout and wind farm control techniques at the pre-construction phase. The advantage is that we can now take energy capture and loading implications into account and find the optimum during the development stage.”

Currently, a collaboration between NREL and GE Global Research is running SOWFA high-fidelity simulations of a Midwest US wind farm and comparing the simulation output to measured data from a real wind farm. They aim to better understand flow physics of the installation so that future wind farms can be more optimally designed.

Advanced controls may also have a role to play in supporting grid integration of variable output renewables like wind by feeding into opportunities for grid ancillary services such as frequency response and balancing.

“Because you will be in a position to control the reactive power voltage in terms of substation control but also in terms of active power control, you will be in a position to provide fast frequency response and curtailment when needed, but also ramping and voltage control,” said Ferraro.

Perhaps key to the uptake of advanced controls is their applicability to the existing turbine fleet. Set turbine input parameters are altered, modifying behaviour of an already sophisticated machine. Physical modifications are not required. Smith said: “It’s important to note that these control strategies can be applied to any wind farm, not just new. We can retrospectively apply these strategies.”

Ferraro concluded: “I think having the capability of controlling what’s happening and not only from the energy stand point but also on the loading side, is where wind farm controllers will go. We’re not saying that the people that used to design wind farms in the past did it wrong. What we’re saying now is that we can look at a wind farm as a whole power station.”

Coal seams can be a clean energy resource

Botswana is eyeing its coal deposits as a resource for meeting its growing power demand, but its climate change commitment means the coal will not be burned directly in new coal fired plants. Junior Isles explains.

Botswana, like many countries in Southern Africa, suffers from a chronic shortage of energy, which has a crippling effect on the country's ability to develop. This, combined with the country's commitment to the Paris Climate Change Agreement, has led to a project that could see the utilisation of the country's coal deposits – but not for coal fired power generation.

Tlou Energy Limited has received a Request for Proposal (RFP) from the Botswanan government to develop up to 100 MW of power from coal bed methane (CBM). The project is the most advanced in Tlou's portfolio and will support last year's decision by the government to include this relatively clean source of energy as part of the plan to combat the country's power deficiency.

Botswana, located just north of South Africa, has a population of about 2 million people. It has a power requirement of about 650 MW. This should be met by three power plants – the 90 MW Orapa power station and a 105 MW installation in Francistown, which both run on diesel, and the Morupule B coal fired plant. Although with a nameplate capacity of 600 MW, Morupule B is only capable of producing 200-300 MW. This means the country is essentially dependent on dirty diesel generation and expensive power imports from South Africa.

While the country has plenty of coal, as a signatory of the Paris accord, it cannot build any coal fired plants going forward.

Commenting on the situation, Colm Cloonan, Chief Financial Officer of Tlou Energy said: "They will be looking at cleaner sources of power, like solar and our coal bed methane... A CBM project would have less than 50 per cent CO₂ emissions compared to coal fired project."

As CBM is typically over 90 per cent methane, it can be burned in widely available gas engines without the need for engine modifications or exhaust clean-up.

But the decision to opt for CBM instead of building coal fired plants is not only dictated by climate change commitments; it is also a case of economics and technical feasibility.

"The coal we would extract our gas from is quite deep. The economics of digging it out of the ground and using it for power generation just doesn't stack up. The outcrop we extract our gas from is called the lower Morupule coal. It is the same coal seam that is very close to Morupule, which is close to the surface – perhaps 50-100 m deep – but as the seam goes west, it starts to deepen. The coal we extract is typically 400-700 m below ground," said Cloonan. Extracting from this depth, he added, would effectively be "underground mining" and would not be considered – regardless of economics.

CBM extraction involves drilling a vertical well to intersect the coal seam deep underground. Another well is drilled about 1 km away, which is turned horizontally as it hits the seam. This well is then drilled horizontally through the seam to intersect with the first vertical well.

"Essentially, you have two wells in the ground connected with a [lateral] hole," said Cloonan.

Coal at this depth is under pressure from the layers of rock above. The pressure traps methane and water in the seam but the drilled vertical well reduces the pressure at the point of intersection and causes this methane and water to be released through small holes in the coal. A pump is used to first pump water from the coal until the whole area is dewatered. Once all the water is pumped out of the formation, the methane gas will flow up through the vertical production well.

It is then a case of assessing how much methane gas can be extracted from the well, how long it will flow for and the quality of the gas. This all goes into the economic modelling of the project. But predicting how much

gas will come from an area is not an exact science; estimates are largely based on experience.

"CBM is a relatively new industry in Botswana, although there are players in the region that have done it," said Cloonan. "Our founders, and in particular our managing director, have been involved in CBM for over 30 years in Queensland, Australia, which is the epicentre of CBM development... having been very successful with their project in Queensland, they looked at various basins around the world and settled on Botswana as the ideal location. The indications from the coal seemed quite good."

A number of core holes were drilled to take coal samples for assessment in a laboratory. This would reveal characteristics such as the levels of methane and nitrogen in the coal, its permeability and, therefore, how easy it would be for gas to flow from the coal.

Cloonan said: "Based on this assessment, you would then drill further core holes in the region to develop the area and figure out how much gas is potentially in the field. All data has to be independently certified before we can have a commercial project."

Last year, mining consultants SRK Consulting certified how much gas was in the ground at Tlou's operations. According to assessments, the Lesedi Project has an enormous Contingent Gas Resource of 3.9 billion cubic feet (bcf) of 2P (Proved plus Probable) and 261 bcf of 3P (Proved plus Probable plus Possible) gas reserves and huge upside potential still available over its project area, which covers approximately 8300 km².

Tlou is the only company in Botswana with CBM gas reserves in place and the only one with environmental approval for field development. It was granted a Mining Licence last year, allowing it to develop, produce and sell CBM gas.

In fact the company is already producing power from CBM. "We have actually been producing power from CBM since last year to run our equipment in the field. Effectively the wells generate gas for their own equipment," said Cloonan.

Although this power is not for commercial sale, it shows that the proposed Lesedi project would face no technical challenges. The Lesedi development is actually one of two project areas – Lesedi and Mamba – next to each other. The Mining Licence is in the Lesedi area, which is the more advanced of the two areas.

Tlou plans to initially install generators to produce up to 10 MW of power, as well as a transmission line for connection to the grid 100 km away at Serowe.

"The initial plan is to start with small scale, 1 or 2 MW, engines," said Cloonan. "The beauty of CBM is that as we build-out the field and add more wells, we can add engines for additional megawatts. The first 5 MW might be from five 1 MW engines; once they are installed the next 5 MW might be from one 5 MW engine. The 1 MW engines could then be used for further [incremental] build up."

This means the power project can be kicked off without a huge amount of upfront capital investment. According to Cloonan, the project could be up and running for around \$20 million. "This gets us to the grid; then as we collect revenues, we can continue to develop the field and sell more and more power into the grid." This not only reduces Tlou's risk but also reduces the requirement from the government to commit to too large a power purchase agreement.

Tlou is also considering adding solar as another option after installing the first 10 MW of power. "If we put in 66 kV transmission lines, with the ability to carry 20-25 MW, we could easily add on 10 MW of power just by installing solar panels. It is a relatively small capex to install solar panels and would bump up our generating capacity quite quickly."

Beyond around 25 MW capacity, Tlou would have to look at installing additional transmission capacity. We could add another 66 kV line on the existing poles; we have also been speaking with Botswana Power Corporation (BPC), who would like to see a 220 kV line run from our field to a place close to Mahalapye. We would look at this once we are generating revenues and at a point where we are looking to significantly expand the fields."

First power from the project into the grid is expected 24 months after Tlou secures approval in the form of a power off-take agreement with the BPC or another potential power off-taker within the Southern Africa Power Pool. Project construction time includes construction of the power lines, drilling in the fields and dewatering wells, etc.

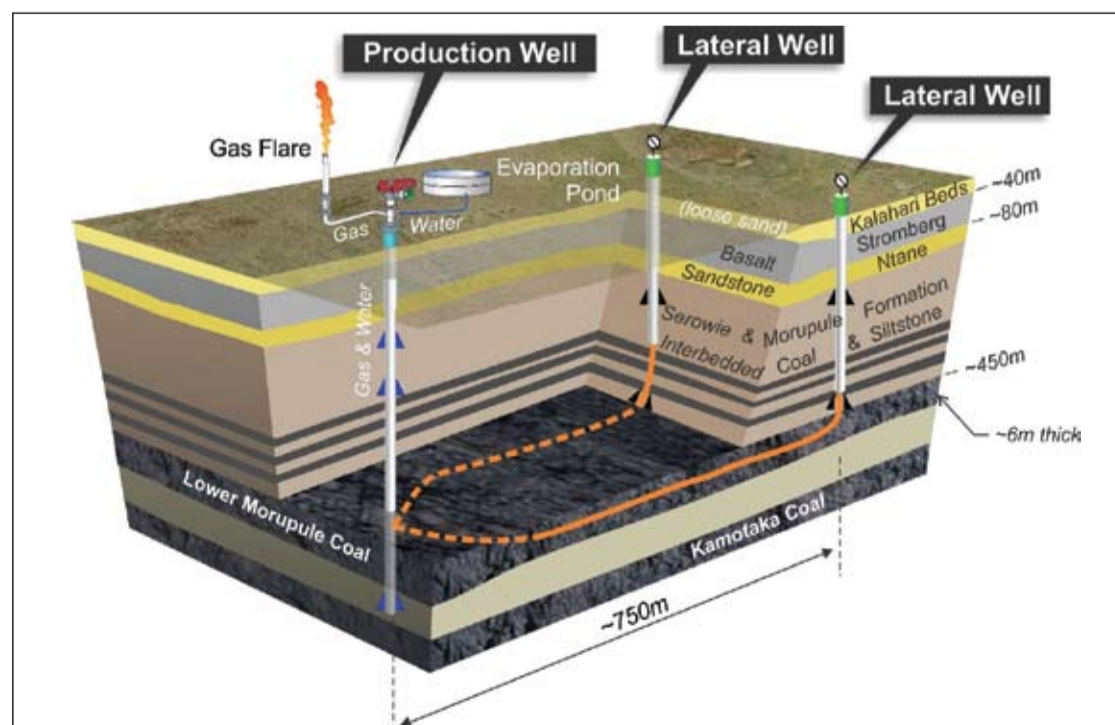
"We are talking to the Botswana government, who recently asked us to re-tender. We are also speaking to other groups in the region and potentially, we could have an off-taker in place before the end of the year," said Cloonan. "In the meantime we will still be developing our project, including the development wells and additional core holes to add more gas resources. Even if we didn't get an off-take agreement for, say, a year down the line, we'd still be well entrenched for getting power into the grid in roughly two years' time."

And even if there is no off-take agreement in a year or so, Cloonan is confident that the acute need for power in the region will see the project go ahead at some point, as power could be wheeled through to other countries.

He concluded: "The demand for power in the region is phenomenal. The Botswana local market, at 650 MW and growing, has sufficient demand to make sizeable revenues in any case, but regionally there is about a 6000 MW deficiency in the Southern Africa Power Pool – Zambia, Zimbabwe, Namibia are all desperately in need of power as well. So there are numerous options for selling the power."

"We think we are pretty well placed but it's not a foregone conclusion. It takes a lot of hard work but we will persevere and think, with time, we will definitely have a very viable project on our hands."

CBM extraction involves drilling vertical and horizontal wells deep underground to release gas trapped in the coal seam



ET is here



Junior Isles

BP's annual *Energy Outlook* always makes interesting reading. But perhaps the most notable aspect of this year's instalment is the terminology it uses for its reference scenario – the 'Evolving Transition' (ET).

The ET scenario assumes that government policies, technology and social preferences continue to evolve "in a manner and speed seen over the recent past".

More interestingly, however, it appears to be an official acknowledgment that the transition to a world where fossil fuels will have a smaller role in the energy mix is not only well under way, but is the most likely future scenario.

Yet the company still made an attempt to play down its significance. It

stated: "For ease of explanation, much of the Outlook is described with reference to the 'Evolving Transition' scenario. But that does not imply that the probability of this scenario is higher than the others. Indeed, the multitude of uncertainties means the probability of any one of these scenarios materializing exactly as described is negligible."

It also emphasised that none of the scenarios are predictions; instead, they are modelled scenarios based on a range of different inputs. "These scenarios are not predictions of what is likely to happen or what BP would like to happen. Rather, they explore the possible implications of different judgements and assumptions by considering a series of "what if" experiments," said BP.

As one of the world's largest integrated oil and gas companies, BP no doubt has to be cautious in presenting any outlook. With its share price largely dependent on the prospects for its oil and gas operations, it has to be careful to balance this against a future where renewables are the dominant energy source.

Spencer Dale, Group Chief Economist, said: "We are seeing growing competition between different energy sources, driven by abundant energy supplies, and continued improvements in energy efficiency. As the world learns to do more with less, demand for energy will be met by the most diverse fuels mix we have ever seen."

According to the *Outlook*, more than 40 per cent of the overall increase in energy demand is met by renewable energy. It also notes that renewable energy grows over 400 per cent, jumping from a four per cent share of the primary energy mix in 2016 to a 14 per cent share in 2040. This is a noticeable increase from the previous *Outlook*, where BP saw renewables jumping from three per cent to 10 per cent of the primary energy mix between 2015 and 2035.

This strong growth, it says, is enabled by the increasing competitiveness of wind and solar, noting that subsidies are gradually phased out by the mid-2020s, as renewable energy is increasingly able to compete against other fuels. China is the largest source of growth, adding more renewable energy than the entire OECD combined, with India becoming the second largest source of growth by 2030.

Yet careful to keep a positive slant on the future of what is the lion's share of its current business, BP says that by 2040, oil, gas, coal and non-fossil fuels each account for around a quarter of the world's energy.

Oil demand grows over much of the outlook period, although it plateaus in the later years. All the demand growth comes from emerging economies. The transport sector continues to dominate global oil demand, accounting for more than half of the overall growth. Most of the growth in energy demand from transport, which flattens off towards the end of the outlook period, comes from non-road (largely air, marine, and rail) and trucks, with small increases from cars and motorbikes. After 2030, the main source of growth in the demand for oil is from non-combusted uses, particularly as a feedstock for petrochemicals.

Natural gas grows strongly over the period, supported by increasing levels of industrialisation and power demand in fast-growing emerging economies, continued coal-to-gas switching, and increasing availability of low-cost supplies in North America and the Middle East. By 2040, the US accounts for almost one quarter of global gas production, and global LNG supplies will more than double. The sustained growth in LNG supplies greatly increases the availability of gas around the world, with LNG volumes overtaking inter-regional pipeline shipments in the early 2020s.

Coal consumption does not change over the outlook period, with falls in China and the OECD offset by increasing demand in India and other emerging Asian economies. China remains the largest market for coal, accounting for 40 per cent of global coal demand to 2040.

So the general picture the *Outlook* paints is that coal flatlines, while oil and gas remain resilient. Here BP is consistent with its previous outlooks,

and broadly in line with others from organisations such as the International Energy Agency (IEA).

Notably, however, the *2018 Outlook* is a lot more bullish on the outlook for renewables. Compared to last year's edition, the level of renewable energy is over 15 per cent higher in 2035.

"The outlook for renewables has been materially increased in recent years, reflecting stronger policy support and quicker than expected falls in costs, particularly for solar energy," the report states. Graphs comparing *Energy Outlooks* of 2015 and 2018 show projected levels of renewable power in 2035 of just over 5000 TWh and about 8000 TWh, respectively (see page 11).

In the ET scenario, global solar power in 2035 is more than 150 per cent higher than in the base case of the *2015 Energy Outlook*. It says this reflects solar costs falling faster than anticipated, noting that solar energy is "now projected to be widely competitive by the mid-2020s – 10 years earlier than previously expected".

According to BP, the more rapid decline is partly due to faster technological gains, but also reflects stronger policy support, which enables solar energy to move more quickly down its 'learning curve'. The increases in solar energy are in China and India, where renewables receive significant levels of support over the medium term.

In the ET scenario, solar costs continue to follow the learning curve and the *Outlook* shows module costs falling by around 24 per cent with every doubling of cumulative capacity. The report shows the rate of decline of \$/MWh cost slowing over the outlook period, as it takes longer to double the cumulative capacity and as module costs fall as a proportion of total costs.

The latest *Outlook* shows renewables to be the fastest growing energy source in power (7.5 per cent per annum), and will account for over 50 per cent of the increase in global power generation in 2040. With power accounting for nearly 70 per cent of the increase in primary energy demand, this is significant.

It will see a material shift in the mix of fuels used in power generation, as renewable energy gains share more quickly than any energy source in history – increasing from 7 per cent today to around a quarter by 2040.

Interestingly, BP's outlook for renewables growth in the ET scenario is toward the top of the sample outlooks; perhaps not what one would expect from an oil and gas major. Many organisations publish long-term outlooks, and the differences between them reflect areas of uncertainty.

Notably, BP also has a 'Renewables push' scenario where renewables account for more than 90 per cent of the growth in power demand over the outlook period, with the share of renewables in power reaching over 40 per cent by 2040, compared with 25 per cent in the ET scenario.

This, combined with the changing projections for renewables, suggests that the ET scenario is more likely than BP might be comfortable admitting. BP has repeatedly underestimated the rise of renewables. This year's outlook is the seventh in a row to raise projections for wind and solar energy.

But comfortable or not, the green transition is happening faster than most have predicted and in two decades will be more entrenched than some may have hoped for. Like it or not the energy transition is here, and it is here to stay.

