

# THE ENERGY INDUSTRY TIMES

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China is taking on the role of global leader on combatting climate change as the US alienates itself from the international energy community. **Junior Isles**

With Donald Trump absent from the recent World Economic Forum in Davos, Switzerland, China's President Xi Jinping took the opportunity to voice his country's readiness to take the global leadership role on climate change.

President Xi placed a strong emphasis in his speech on climate change, especially the need to stick with the international Paris Agreement.

As the first ever President of China to attend Davos, President Xi said: "The Paris Agreement is a hard-won

achievement... All signatories should stick to it rather than walk away from it, as this is a responsibility we must assume for future generations."

Commenting on President Xi's address just ahead of Trump's inauguration, Li Shuo, Senior Global Policy Advisor, Greenpeace East Asia said: "As Mr. Trump drops President Obama's climate legacy, Mr. Xi might well establish one of his own. 2017 presents a real opportunity for China to rise to the challenge of responsible climate leadership. Having moved

from climate villain to a reluctant leader in five short years over the first half of this decade, it's reasonable to expect China to become a true leader by its end."

While China remains the world's largest emitter of carbon dioxide (CO<sub>2</sub>) its growth in emissions has levelled off, and emissions dropped in both 2015 and 2016. It plans to meet its goal of peaking emissions by 2030 at the latest. China has a clear goal of reducing 'emissions intensity' (the volume of emissions produced rela-

tive to economic activity) more than any other major economy. Notably it is already exceeding most of its low-carbon energy and decarbonisation targets and has made its 2020 targets more ambitious.

In early January the government announced it would invest \$361 billion in renewable power between now and 2020.

While China needs to invest in clean energy to tackle severe air pollution at home, it also sees decarbonisation as a

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## Falling cost is spurring renewables deployment

Falling cost, driven by innovation in technology and policy, is spurring renewable energy deployment and bringing a multitude of socio-economic benefits, according to a new report released by the International Renewable Energy Agency (IRENA).

The publication titled 'REthinking Energy 2017' states that global investment in renewables has steadily grown for more than a decade, rising from less than \$50 billion in 2004 to a record \$305 billion in 2015.

Launching the report Adnan Z. Amin, IRENA's General Director, said: "Renewables are gaining ground by nearly every measure... We are seeing more and more countries hold auctions to deploy renewables, and as variable and distributed sources of renewables take-on a greater role, regulators have implemented changes to enable grid integration at scale."

The International Energy Agency (IEA) also noted that renewable energy continues its inexorable rise and

that it is here to stay. Speaking at the *Abu Dhabi Sustainability Week (ADSW)* in January, Fatih Birol, Executive Director at the International Energy Agency said: "Renewables are getting cheaper. Last year, more than 50 per cent of all new capacity additions globally was renewables. Renewable [energy] is not just a romantic story, but a real business."

The IRENA report states that solar PV will grow the fastest in terms of capacity and output. The Middle East will be a hotspot for new renewable capacity, in particular solar.

Last month, the United Arab Emirates announced plans to invest Dirhams 600 billion (\$163 billion) in projects to generate almost half the country's power needs from renewable energy sources.

Dr. Thani Ahmed Al Zeyoudi, Minister of Climate Change and Environment for the United Arab Emirates said that while coal would not disappear, nearly half of the nation's energy

should come from renewables in 2050.

According to its "Energy Strategy 2050" unveiled in January, the UAE's energy mix by 2050 will comprise 44 per cent renewables, 38 per cent gas, 12 per cent clean fossil fuel generation and six per cent nuclear.

In June last year Dubai announced plans to build the 1000 MW Mohammed bin Rashid (MBR) Solar Park by 2030. The project is set to be the world's largest on a single plot on completion and will set a record-low bid price for solar power generation of US 2.99 cents/kWh.

Last month, the Dubai Electricity and Water Authority (DEWA) and Abu Dhabi's renewable energy company Masdar said they were starting construction of the 800 MW phase three of the \$13.6 billion project. The engineering, procurement and construction (EPC) contract was announced at the *ADSW*.

DEWA also issued a Request for Proposal (RFP) to all qualified bidders for

a 200 MW concentrated solar power (CSP) Plant, the fourth phase of the MBR Solar Park.

The project supports the Dubai Clean Energy Strategy 2050, which aims to diversify the energy mix so clean energy will generate 7 per cent of Dubai's total power output by 2020, 25 per cent by 2030 and 75 per cent by 2050.

Identifying the opportunity the region presents, at *ADSW* the "French Efficiency - Clean Energy" regional Club for the Middle East was officially launched. According to Jean Ballandras, National Coordinator for Renewable Energy, the club will offer countries in the region a "one-stop shop" when cooperating with France on renewable projects.

Several Middle Eastern countries - including Kuwait and Qatar - are trying to shift away from their economic and domestic energy reliance on oil, after prices fell by over 50 per cent last year.

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big economic opportunity. Its pursuit of clean energy development and deployment is therefore a central part of the country's economic growth strategy.

According to the International Energy Agency, renewables will be the largest single source of power capacity growth in the next five years, growing 42 per cent by 2021. As the cost of renewable energy falls rapidly – now comparable to that of electricity from fossil fuels and sometimes cheaper – China has positioned itself to drive a huge



**Dr Geall: Chinese firms are increasingly well positioned**

portion of this growth.

Matching economies of scale with early stage investment in R&D is now paying dividends. This combined with innovative finance mechanisms has enabled China to secure a considerable competitive edge in clean energy. The country is investing across emerging markets that traditional western institutions consider too risky.

For example, Chinese companies were behind overseas merger and acquisition activity in clean energy and related infrastructure to the tune of well over \$32 billion in 2016 alone. With this comes strategic influence over the default energy sources of the future.

Dr Sam Geall, Research Fellow at the Science Policy Research Unit (SPRU) at University of Sussex, United Kingdom and Executive director of chinadialogue.net, said: "China's ambitious policies on decarbonisation have underpinned huge cost reductions in renewable energy, transforming the landscape of technology and innovation. Given policy uncertainty in the United States, Chinese firms are increasingly well positioned to benefit from the commercial opportunities in store as the world shifts away from fossil fuels."

While China takes advantage of the global clean energy transition, the US looks set to lose out under the current Trump administration. Between 2012 and 2015, China has added 1.8 million jobs in renewables, compared with 157 000 in the US.

The International Renewable Energy Agency (IRENA), of which both the US and China are members, has shown that with a global doubling of renewable energy by 2030, US GDP would increase by up to 1.8 per cent (some \$301 billion based on 2013 data) and employment in renewable energy would increase to between 1.1 million and 1.4 million over business as usual.

■ In January the US State Department made \$500 million grant payment to support the United Nations climate fund. The US has now contributed \$1 billion to the Green Climate Fund dedicated to advancing low-emission, climate-resilient development, with the goal of keeping the global temperature increase below 2°Celsius. Pledging to provide \$3 billion to the Fund, the US is left with \$2 billion owing to the Fund. Future payments may be cancelled under President Trump.

# Quality issues cast cloud over Hinkley C

Further Investigations by French nuclear regulator ASN into issues related to quality and documentation of nuclear reactor components made at a factory operated by Areva could have a knock-on effect on the UK's new Hinkley Point C nuclear plant. **Junior Isles**

Fresh concerns have been raised over the timeline of the UK's planned Hinkley Point C nuclear power plant following news that the French nuclear regulator ASN plans to probe further into potentially faulty nuclear reactor components manufactured at a factory operated by Areva.

At the start of January, Julien Collet, deputy director of the ASN, said he wanted to "go much further" with investigations into Areva's components, including one probe into the falsification of documents that certified the quality of certain parts.

The announcement is the latest development in investigations initiated by the ASN last year.

In June investigators said that some steel components – notably parts used in steam generators – made at Areva's Le Creusot factory had excessive carbon levels, which could make them vulnerable to cracking.

It followed an announcement in May that Areva had found evidence suggesting employees had doctored quality assurance documents relating to many different nuclear reactor components made at Le Creusot for up to 40 years.

The investigations led to the temporary closure of 18 reactors operated in France by EDF. Now ASN wants to look more closely at the issue.

Collet said: "We need to be assured that this problem of high carbon concentration is settled for all types of equipment, not just the steam generators. There are other components that could be concerned by the same problem... we want to go deeper."

In addition, the results of an investigation by EDF at Flamanville will be delivered to the ASN in the coming weeks. The regulator will then analyse the findings and issue a report in the first half of this year. The Flamanville

project currently under construction is identical to that proposed for Hinkley Point C.

The investigation could therefore have a knock-on effect on Hinkley C, since it will be the same technology, and has led to further calls for a stop to a project that has already seen extensive delays.

The Stop Hinkley Campaign is calling on EDF Energy to stop all work on Hinkley C at least until the French nuclear industry gets a clean bill of health.

It said in a statement: "Any significant problems with the reactor vessel could be catastrophic for EDF, however, as re-doing this important piece of the plant would mean restarting much of the construction work, which is already billions of euros over budget and several years late."

The ongoing situation is causing widespread international concern.

David McIntyre of the US Nuclear Regulatory Commission said it was troubled by the revelations about the doctored documents at Le Creusot, which has supplied some components to US nuclear power plants.

While noting that there was no indication that doctored documents had led to any safety issues, he said: "Proper quality assurance and documentation are important to our confidence in the safety of the components in nuclear reactors."

■ Jesse Norman (Parliamentary Under Secretary of State, Minister for Energy and Industry) has asked the UK's independent nuclear regulators, the Office for Nuclear Regulation, and the Environment Agency, to begin a Generic Design Assessment of the Chinese-designed UK HPR1000 reactor. The reactor designed by China General Nuclear is being proposed for a new nuclear plant at Bradwell.

## Toshiba woes threaten UK nuclear plans

The threat of huge losses at Japanese electronics and nuclear giant Toshiba has thrown Britain's nuclear power plans into doubt.

At the end of December Toshiba said its US nuclear subsidiary, Westinghouse Electric, might have to write off "several billion US dollars" in connection with the acquisition of CB&I Stone & Webster, a US nuclear power plant builder, that it bought from Chicago Bridge & Iron (CB&I) in 2015.

The company's announcement that it was facing a loss of Yen500 billion (\$4.3 billion dollars immediately wiped 40 per cent off the value of its shares before partially recovering.

Toshiba said it is considering raising capital and will seek financial support from its main banks.

Toshiba owns a 60 per cent stake in the planned £10 billion NuGen nuclear power project in Moorside, Cumbria, which aims to supply power for about 6 million homes from 2025.

Justin Bowden, the GMB union's national secretary for energy, commented: "It needs to be established as soon as possible whether or not the collapsing Toshiba share price, in particular in relation to its Westinghouse operation, has any implications, and if so what these are for the extremely important Westinghouse project."

Toshiba's problems come after Nu-

Gen said it was in talks with potential investors for the Cumbria site, with a final investment decision due in 2018. It is potentially a blow to the government after ministers had described 2016 as a "year for the industry to look back on" following backing for Hinkley Point C.

The development came shortly after the UK and Japanese governments signed a Memorandum of Cooperation strengthening cooperation across civil nuclear activities.

With large nuclear plants typically dogged by delays and cost overruns, the UK is also looking at the potential of small modular reactors (SMRs).

In late January Rolls-Royce said it

was about to begin a major programme to develop and commercialise its SMR technology, after Sheffield-based Nuclear AMRC confirmed that it is to join with Rolls-Royce, AMEC Foster Wheeler, Nuvia and Arup to bring a design proposed by Rolls-Royce to the UK market.

Last year, Rolls-Royce announced that it is proposing to develop a modular reactor capable of producing 220-440 MWe depending on its configuration. The SMR will be designed specifically to be built and commissioned in factories, with a reactor module some 16 m high and 4 m in diameter – small enough to be transported on a truck, train or barge.

## Storage seen as "game changer" as utilities look for greater grid flexibility

New ways of storing electricity will be a "game changer" as the amount of variable renewable generation grows, driving the development of more flexible grids.

In its latest edition of the 'Rethinking Energy' report the International Renewable Energy Agency (IRENA) estimates that battery storage for electricity could increase from less than the current 1 GW to 250 GW by 2030.

IRENA points out that the growth in variable renewable energy generation, especially solar, will be the main driver. Both Europe and the US have seen a growing need for storage as the growing deployment of renewables

puts pressure on grids.

Leonie Greene, STA Head of External Affairs at the Solar Trade Association (STA) based in the UK recently noted that solar power "has turned the grid on its head".

She said: "It provides unique opportunities for energy consumers of all types to take control of their bills and produce their own energy, sitting at the heart of a smart, flexible energy system."

Responding to the UK regulator Ofgem's call for evidence on 'A Smart, Flexible Energy System' the STA said cheaper, cleaner energy is possible, if government removes barriers to storage and places stronger incentives on

network operators.

Experts point out, however, that storage is only part of the solution. Energy Internet software company AutoGrid recently stated: "... despite the fact that energy storage costs continue to fall, we still need to dramatically improve energy storage project economics through intelligent software if we hope to truly accelerate energy storage adoption."

The company recently launched its AutoGrid 3.0 flexibility management solution for demand response (DR) management, distributed energy resource (DER) management and virtual power plants (VPPs).

Abhishek Bahl, General Manager,

AutoGrid Europe said that flexibility management is increasingly becoming a key focus for electric utilities, with the main driver being the growth of renewables.

"The increasing penetration of renewable generation – large scale wind and other distributed energy sources like rooftop solar and distributed storage such as electric vehicles – is causing some interesting challenges as utilities look at how to survive in this non-centralised distributed energy world."

AutoGrid estimates that within ten years the total addressable market for flexibility management software will be more than \$21 billion.

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The USA's new President has stopped short of decisive action on the Clean Power Plan but hopes to expand production of domestic oil and gas.

Siân Crampsie

US President Donald Trump says that increasing domestic energy production will boost the US economy and free the country from dependence on foreign oil.

The newly inaugurated President has outlined an energy plan that aims to reduce the cost of energy and maximise the use of domestic resources. He has pledged to revive the USA's coal industry, which, he says, "has been hurting for too long", but says he is aware of the need for "responsible stewardship of the environment".

Trump's "America First" energy plan includes a commitment to eliminating "harmful and unnecessary" policies such as the Climate Action Plan, as well as other "burdensome" regulations that have stifled domestic energy production.

"I will cancel job-killing restrictions

on the production of American energy, including shale energy and clean coal, creating many millions of high-paying jobs. That's what we want, that's what we've been waiting for," said Trump.

In the run-up to his inauguration, 24 state attorneys-general, together with Vice President Mike Pence and congressional leaders asked Trump to kill the Clean Power Plan by issuing an immediate executive order declaring it to be unlawful and prohibiting the US Environmental Protection Agency (EPA) from enforcing it.

Although Trump has stopped short of this action, his new energy plan and his stance on energy and the environment during the presidential campaign have alarmed environmentalists. Sierra Club executive director Michael Brune called the energy plan "a shameful and dark start to Trump's Presidency" and "an historic mistake on one

of the key crises facing our planet".

Just days into his presidency, Trump signed executive orders expediting the permit process for two controversial pipelines: the Dakota Access pipeline, which would carry oil from North Dakota, through South Dakota and Iowa to be shipped out of Illinois, and the Keystone XL pipeline, which would bring oil from Canada to Nebraska.

He has also been criticised for his appointment of former Texas governor Rick Perry to lead the Department of Energy, and of Oklahoma Attorney General Scott Pruitt to head the EPA.

Pruitt is widely seen as a climate skeptic and has sued the EPA 14 times in order to attempt to block federal air and water pollution regulations.

In his energy plan statement, Trump says that "protecting clean air and water ... will remain a high priority" and says he will "refocus" the EPA's role.

## Dong, Eversource deal shows growing confidence in US offshore wind

- US utility buys stake in 1 GW proposals
- Deal backs Massachusetts wind plans

Dong Energy has brought New England utility Eversource on board to help it develop its proposed Bay State offshore wind farm in a move that demonstrates growing confidence in the USA's offshore wind industry.

Eversource acquired a 50 per cent ownership interest in the Bay State wind farm to be built approximately 25 km off the coast of Martha's Vineyard, and which could have a capacity of up to 1000 MW.

It is the latest of several recent positive developments in the US' offshore wind sector.

Last year the states of New York and Massachusetts announced plans to support offshore wind industry developments, and the offshore wind sector in the country celebrated in December 2016 with the opening of Block Island, the country's first offshore wind farm.

New York has developed an offshore wind master plan that includes directives from state governor Cuomo to make leasing areas available and to carry out studies into rapid and cost-effective ways of boosting renewable energy capacity.

Massachusetts last year passed an energy bill requiring utilities to enter into long-term contracts for 1600 MW of offshore wind from 2027.

"New England is setting the pace for a national clean energy future with its proven track record in energy efficiency and bold clean energy goals," said Jim Judge, President and CEO of Eversource Energy. "Our partnership with Dong Energy on Bay State Wind represents a significant opportunity to help make those goals a reality and we look forward to delivering this renewable and reliable source of power to customers."

A partnership with Eversource gives Dong a strong local partner in the project, the company's first offshore wind farm outside European waters. It was awarded the site area by the US Department of Interior in 2015.

"Offshore wind is a reliable home-grown energy source that can be delivered at scale to Massachusetts residents and businesses," said Thomas Brostrom, General Manager for Dong Energy Wind Power US Inc. "New England's water depths and wind speeds are similar to those in Europe and provide attractive conditions."

Dong and Eversource said in a statement that they "are committed to playing a central role in bringing their companies' respective expertise and successes to bear" to help Massachusetts meet its renewable energy goals.

## Chile's renewables investment gains momentum

Investment in Chile's renewable energy sector is growing as the country looks to expand its installed solar generating capacity.

Environmental authorities in the country have approved the \$535 million, 446 MW Elena solar project planned by Spain's Iberólica. The approval comes just weeks after approvals were issued for a further 13 energy projects that will require investments of \$1.37 billion.

Several more projects, worth a combined \$474 million, are awaiting approval, according to CNE, the national energy commission.

Iberólica's Elena solar project comprises two solar farms, each with a capacity of 223 MW in Chile's Antofagasta region. They will connect to the northern SING power grid

via an 18.6 km, 220 kV transmission line.

Other recently-approved projects include eight power plants with a combined installed capacity of 462 MW, and four transmission projects.

They form a key part of plans by Chile's government to boost generating capacity to meet rapidly rising demand, as well as improve energy security.

Approved generation projects include WPD's 270 MW Malleco wind farm and the 95 MW Santa Marta de Marchigüe solar photovoltaic farm planned by Andes Mainstream.

Projects recently submitted for approval include Andes Mainstream's 220 MW Santa Ana wind farm, and the Llanos de Potroso and Los Libertadores solar PV parks.



- 7 GW of new capacity forecast in 2017
- Duke completes Brazil sale

Generating capacity in Brazil is continuing to grow in spite of fears of a supply glut amid a prolonged economic recession.

Regulator Aneel says that the country will add around 7 GW of capacity to its grid in 2017, on top of the 9.5 GW commissioned in 2016. Installed capacity in Brazil now stands at over 149 GW, according to the Brazilian mining and energy ministry.

Data from energy planning agency EPE shows that electricity use year-on-year dipped 1.2 per cent in November 2016, with demand from the commercial sector eroded by poor economic growth. Electricity demand in 2015 fell by 2.1 per cent compared

to 2014.

Aneel expects 4 GW of hydropower capacity and 2.4 GW of wind energy to be added to the grid in 2017.

It said that 2016 was a record year for capacity additions, with 5 GW of new hydropower, 2.5 GW of wind energy and 1.7 GW of thermal capacity added.

The rapid growth in Brazil's electricity sector has attracted new entrants to the market. Chinese firms in particular have put aside concerns over the country's economic recession to gain a foothold in what they see as a key target market.

At the end of December 2016, Duke Energy completed the sale of its in-

ternational business in Brazil to China Three Gorges Corp (CTG) for approximately \$1.2 billion.

The sale includes ten hydropower plants with a combined generating capacity of 2090 MW.

The firm has also reached an agreement with I Squared Capital, a global infrastructure investment manager, over the sale of Duke's remaining Latin American business, which includes power generation and transmission assets in Peru, Chile, Ecuador, Argentina and Central America.

That portfolio includes over 2300 MW of hydro and thermal generation, 730 km of 220 kV transmission lines and natural gas processing facilities.

# China Five Year Plan maintains clean energy focus

■ Government to invest \$360 billion in renewables ■ 104 planned coal plants suspended

Syed Ali

China's latest Five Year Plan demonstrates its continued efforts to cut pollution by increasing its use of renewables while reducing its dependence on coal fired generation.

Under the plan, Yuan2.5 trillion (\$363 billion) will be invested in renewable energy by 2020 – an investment that will create more than 13 million jobs in the sector, the National Energy Administration (NEA) said.

The NEA said installed renewable power capacity including wind, hydro, solar and nuclear power would contribute to about half of new electricity

generation by 2020. Following the publication of the Plan, the State Oceanic Administration of China, the country's maritime authority, also proposed measures to increase the application of tidal, wave, ocean thermal energy conversion (OTEC).

As China continues to deploy wind and solar, costs have come down leading the National Development and Reform Commission (NDRC) to announce that solar power tariffs could go down by as much as 19 per cent in 2017 while wind tariffs will see a 15 per cent cut from 2018 on.

The reduced tariffs will better reflect lower production costs NDRC said,

adding that the cuts will help save Yuan6 billion (\$860 million) annually. China also revised its solar target for 2020, lowering its ambitions from 150 GW to a minimum of 105 GW.

China has set itself a goal of 15 per cent renewable energy generation by 2020 and to reduce carbon dioxide emissions by 1.4 billion tons. This will help it meet its climate change commitments and, more immediately, help it tackle high pollution in many of its major cities and provinces.

With more than half of the nation's installed power capacity still being coal fired generation over the same period, the Chinese government is

taking dramatic steps to comply with the coal capacity target laid out in the latest Five Year Plan.

The NEA recently announced that 104 planned and under construction coal power projects – with a total capacity of 120 GW – have been suspended. Around 54 GW of suspended capacity comes from projects already under construction in 13 provinces.

Under the Plan, the government committed to a coal capacity cap of 1100 GW, which is still a significant increase on the 920 GW capacity the country currently has. The number of coal power projects in the pipeline would have taken that figure to 1250 GW.

Notably, at the end of December companies running 605 Chinese coal fired power plants were fined a total of Yuan328 million (\$47 million) by the country's economic planning agency for breaching environmental rules and falsifying data to claim green subsidies.

■ General Electric Co (GE) recently announced that it is targeting a larger market share in China's offshore wind-power industry. Jerome Pecesse, President and CEO of GE's renewable power division said China's new installed capacity of renewable power has each year represented 40-50 per cent of the total volume worldwide.

# India may fall short of solar target

India is looking increasingly unlikely to reach its target of 100 GW of solar capacity by 2022. As of December, the country's total solar capacity amounted to 9 GW and according to clean tech consultancy Mercom Capital, it will add another 9 GW in 2017.

With six years left for India to achieve its goal, the government recently said that 25 states together fell short of meeting new capacity targets by some 2000 MW.

"Considering the actual renewable purchase obligation level specified by the state electricity regulatory commissions for the year 2016-17, it is estimated that 25 states/UTs [Union Territories] require over 2030 MW solar power capacity to fulfil the solar purchase obligation," the Ministry of New & Renewable Energy said in a recent document.

As part of its Intended Nationally Determined Contributions (INDC) – documents submitted to the UN that detail

steps countries will take to limit global warming – India has committed to source 40 per cent of its electricity from non-fossil fuel sources by 2030.

However, observers have accused the government of being too ambitious in its renewables targets. Vibhuti Garg, a power sector expert at the International Institute for Sustainable Development, a Canada-based environmental non-profit organisation, said India's renewable energy targets are "highly optimistic and not realistic".

In October 2016, renewable energy made up 15 per cent of India's installed electricity production capacity, up from 13.1 per cent in August 2015, according to government data. To achieve its targets, India must add 130.76 GW of renewable energy over the next six years, an average of 21.7 GW per year or, three times the capacity it added in 2016.

Financing and an inadequate electricity infrastructure are seen as the

main obstacles to achieving the targets. The country needs \$100 billion in asset financing for renewable energy over the next six years, according to report by Bloomberg New Energy Finance (BNEF).

Abhishek Jain, senior programme lead at Council on Energy, Environment and Water (CEEW), a New Delhi-based research organisation commented: "If financing is achieved, the targets are achievable."

India plans to install 160 GW of solar and wind generation over the next five years and the additional transmission capacity needed to accommodate the growth in intermittent renewable energy is a stumbling block.

Last month the Indian Union Ministry of New and Renewable Energy dropped plans to construct what would have been the world's largest solar power project in Leh of Jammu and Kashmir state because of high transmission costs.

# Australia urged to back "next generation" coal plants

Australia should turn to the next generation of coal fired power stations to generate more domestic electricity, according to a key federal minister.

Hitting back against environmental groups that oppose the use of coal, Resources, Minister Matt Canavan said ultra-supercritical coal fired power stations could fill a gap in local energy supplies, arguing that Australia could embrace a technology used in Japan and China.

Senator Canavan said it was "well within the bounds of reason" to look at new technology that could use coal to generate electricity with a 40 per cent cut in greenhouse gas emissions.

"I think that's something we've got to look at. People expect us to provide reliable power and any government worth their salt would be doing that," he told *The Australian*. "We cannot pour our economy through 100 per cent renewables – we will not have jobs in aluminium and other manufacturing industries if that happens."

With the Hazelwood station in Victoria's Latrobe Valley about to close, Senator Canavan said Australia had to consider how to replace its old coal-fired power stations and should put the technology on the agenda.

Ultra-supercritical coal fired power plants operate at higher temperatures and pressures to increase efficiency by around 15 per cent compared with conventional sub-critical coal plants but environmentalists reject the "clean coal" claims.

The Australian Conservation Foundation (ACF) said "low emission" coal fired technology is an "unrealistic fantasy" that would cost billions and set back genuine efforts to tackle

global warming.

ACF's economist Matthew Rose said: "It is hard to imagine a company that would be prepared to build these huge white elephants, just waiting to become stranded assets... In contrast, investments in new renewable energy, which has zero fuel cost, will still be useful and productive in decades to come."

It is a view that appears to be increasingly being adopted by power plant owners. In January EnergyAustralia, which owns two of the largest coal-fired power stations in the country, announced it would sign agreements to buy around 500 MW of power from new wind and solar energy projects across eastern Australia.

EnergyAustralia Managing Director Catherine Tanna said the foundation contracts, worth an aggregate \$1.5 billion, would underpin significant investment in new renewable energy developments.

EnergyAustralia's programme will contribute toward the Australian Government's Renewable Energy Target to have 23 per cent of total energy in the national electricity market provided by renewable sources by 2020.

■ Fotowatio Renewable Ventures (FRV), a leading global developer of large-scale solar power plants and part of Abdul Latif Jameel Energy, has secured a pioneering funding agreement for a new solar energy farm in Queensland, Australia. The \$200 million agreement for the Clare Solar Farm makes the project the first utility-scale facility in Australia to secure financing without an additional government grant, highlighting the competitiveness of solar energy in the country.

# South Korea moves to curb pollutants

South Korea says it will shut down 10 aging coal fired power plants by 2025 as part of its efforts to cut greenhouse gas emissions and curb fine dust. The news marks a distinct shift towards less polluting generating sources.

Making the announcement, the Ministry of Trade, Industry, and Energy said: "It marks the first time that coal power plants in South Korea will be shut down. It represents a resolve to

establish the low-carbon and environment-friendly electricity source."

The government will spend some Won203.2 billion (\$130 million) shutting the old plants and says it will also replace environmental facilities at 43 other coal plants in the initiative, at a cost of Won11.6 trillion (\$9.67 billion) by 2030.

The move will help reduce the amount of pollutants from coal plants

from 174 000 tons last year to 48 000 tons in 2030, added the ministry.

The announcement came shortly after the government lifted all the regulations that had prevented the start of work on its largest wind power plant complex. It is expected that the 99.2 MW project in the Saemangeum region will now break ground this April and be completed in June next year.





Germany's plans for competitive renewable energy auctions will enable a more measured approach to the *Energiewende*.

Syed Ali

Germany's plans to introduce a competitive auction process for the deployment of renewable energy meet European state aid guidelines, the European Commission has ruled.

The decision means that the German government can move ahead with its amendments to the EEG law on renewable energy, which include plans for the development and promotion of offshore wind energy.

The Commission said that the amended EEG would enable the steady deployment of renewable energy while maintaining competition in the energy market.

"Competitive bidding processes support the deployment of renewable

energy whilst keeping electricity costs at bay for consumers," commented the EU's Competition Commissioner Margrethe Vestager.

Germany announced last year plans to organise separate auctions for different renewable energy technologies. From the start of 2017, auctions will be organised to select offshore wind installations, onshore wind installations above 750 kW, solar installations above 750 kW and biomass and biogas installations above 150 kW. Each auction will be limited to a specific technology.

The amendments have been made in response to concerns over the impact of rapid renewable energy deployment on the German electricity grid and energy market. The Commission said in

its ruling that that specific auctions for each technology would ensure a more cost-efficient result than a bidding process in which all or several technologies compete.

The Commission also said that Germany has agreed to test different auction designs that incorporate grid integration costs.

Recently released data shows that the share of renewable energy in Germany's electricity consumption rose to 32 per cent in 2016, a slight increase from 31.5 per cent in 2015.

According to the German Association of Energy and Water Industries (BDEW) and the Centre for Solar Energy and Hydrogen Research Baden-Wuerttemberg (ZSW), generation from offshore wind turbines rose 57 per cent year-on-year in 2016, while pumped storage hydro increased by 13 per cent over the same period. Onshore wind generation grew six per cent over the same period.

Germany is planning to hold auctions for a total of 2.92 GW of offshore wind

energy capacity this year. In 2016, 818 MW of offshore wind capacity went on line in Germany, bringing the country's total offshore wind capacity to 4108 MW.

According to the Working Group for Offshore Wind Energy (AGOW), the German Wind Energy Association (BWE), the Offshore Wind Energy Foundation, VDMA Power Systems and the WAB Wind Energy Agency, Offshore wind energy installed capacity is expected to grow by a further 1400 MW in 2017, followed by a steady average of around 1000 MW per year until 2019.

The momentum in the offshore sector will slow, however, due to targets set in the auctions set for 2017.

Spain is to hold a new renewable energy auction in the first quarter of 2017. Up to 3 GW of capacity will be auctioned, according to a regulatory proposal issued by the government. The auction will be technology neutral and projects will be expected to start operating by the end of 2019.

## Greece progresses on electricity restructuring

Greece has made further progress in restructuring its electricity sector as part of an agreed economic bailout programme secured in 2015.

The shareholders of power utility Public Power Corp (PPC) have approved the transfer of a 51 per cent stake in power grid operator ADMIE to the state and existing private shareholders.

The spin-off was a major term in the international bailout scheme agreed in the wake of the country's debt crisis. However, Greek banks have said that the spin-off – which is cost-free – will harm PPC's finances.

Separately, PPC has sealed a deal with China's State Grid International Development (SGID) to sell a 24 per cent stake in Admie for €334 million. The Chinese company won an international tender in October 2016 and the complex sale process was completed in record time, PPC chairman and CEO Manolis Panagiotakis said.

In January PPC's extraordinary shareholders' meeting was postponed when National Bank, Piraeus Bank, Alpha Bank and Eurobank, which have extended a €2.2 billion syndicated loan to PPC, sent a letter to the utility and the finance ministry, saying the sale of the 51 per cent stake without any proceeds would harm PPC.

The banks relented, however, after being given guarantees worth at least €300 million, enabling them to look more favourably on PPC's ability to service its debts.



Panagiotakis: Chinese sale completed in record time

## Europe backs Drax biomass conversion

British generator Drax is to proceed with conversion of a coal-fired generating unit to biomass after receiving approval from the European Commission under state aid rules.

The unit at Drax power station in northern England will be the third to be converted and will have a generating capacity of 645 MW on completion of the project, Drax said.

The Commission has examined the UK government's plans to provide state aid for the conversion, as well as the impact of the conversion on the biomass and wood pellet markets.

The converted unit will operate exclusively on wood pellets sourced mainly from the United States and South America.

The EU Commission noted that the

project's contribution towards the growth of renewable energy outweighed any possible distortions of competition caused by the UK government's backing.

Drax Power CEO Andy Koss said: "The energy challenge facing the UK is how to replace the contribution currently made by coal. Biomass technology is proven, ready to go and ideally placed to help the country transform to a low carbon future with reliable, secure and affordable renewable power.

"With the right support from the government, we could upgrade the remainder of the power station to run solely on biomass and provide up to eight per cent of the UK's total electricity from sustainable sources."

## ETI calls for more offshore wind research

■ Masdar buys Hywind stake ■ Blade technology can cut costs

More research and development into floating foundations for offshore wind would enable the UK to open up better offshore wind resources for development, experts say.

The UK's Energy Technologies Institute (ETI) has reported that greater emphasis on floating foundations would also help to bring down offshore costs.

After ten years years of research, development and demonstration into offshore wind, the ETI has also recommended that more work should be carried out to develop bigger and more durable turbine blades that can be assembled close to site to reduce operational costs.

In waters less than 30 m deep, fixed foundations offer the most cost-effective solution, but in waters more than 50 m deep, floating foundations would provide the lowest cost solutions.

De-risking floating solutions would encourage offshore wind developers to consider such foundations in deeper waters, as well as examine opportunities in deeper waters currently

considered uneconomic.

Experience with floating wind foundations is currently limited, but interest is growing.

Last month Masdar agreed to purchase a 25 per cent stake in Hywind, a major floating offshore wind demonstration project off the east coast of Scotland. The 30 MW project is due to start operating in late 2017 and has been developed by Norwegian firm Statoil.

In a separate development, Dounreay Tri, developers of a floating offshore wind demonstrator off the north coast of Scotland, recently awarded a construction contract to Global Energy Group.

That project will comprise two turbines generating a total of 10 MW. Hexicon, the firm behind Dounreay Tri, hopes that planning permission will be granted by March 2017.

ETI also believes that development of larger turbine blades will also make a difference to the cost of energy, but factors such as how they are constructed are also important.

"If industry can find routes to more repeatable manufacture of bigger turbine blades – such as in 'kit form' close to site – it could lead to even further cost reductions as well as opening up export market opportunities," said Andrew Scott, ETI Offshore Renewables Programme Manager.

"But there is also a continued need for the sector to learn by doing. The industry needs to increase its practical experience through even further deployment, development and demonstration of new technologies and learn from this to contain operational costs."

The UK's Carbon Trust has launched a global competition aimed at reducing financial losses from cable damage during offshore wind farm construction. The innovation contest hopes to find ways of monitoring the condition of subsea cables to ensure that they are not damaged during the load out and installation process. Between 2002 and 2015, cable faults during the construction phase resulted in £144 million in insurance losses in the UK.

## International News

# Firms collaborate to push hydrogen agenda

Energy, industrial and transport companies have called on governments to support hydrogen as a clean fuel with a bright future.

Siân Crampsie

The heads of 13 industrial and energy firms have called for greater long-term ambition for the use of hydrogen in the transition to a low carbon economy.

Convened on the sidelines of the World Economic Forum in Davos, Switzerland, the Hydrogen Council is thought to be the first initiative of its kind and brought together major firms including Alstom, Air Liquide, Linde and Total.

One of the initiative's key aims is to

position hydrogen as a clean fuel with a key role to play in the energy transition, and it will also accelerate investment in the development and commercialisation of the hydrogen and fuel cell sectors.

"The 2015 Paris Agreement to combat climate change is a significant step in the right direction but requires business action to be taken to make such a pledge a reality," said Benoît Potier, CEO of Air Liquide and Chair of the 'Hydrogen Council'. "The Hydrogen Council brings together some of the world's leading industrial, automotive

and energy companies with a clear ambition to explain why hydrogen emerges among the key solutions for the energy transition, in the mobility as well as in the power, industrial and residential sectors, and therefore requires the development of new strategies at a scale to support this."

Creation of the Hydrogen Council was initiated by Hydrogen Europe, which says that investments in the hydrogen and fuel cell sectors currently amounts to €1.4 billion/year.

Acceleration of this investment level will be possible "if the key stake-

holders increase their backing of hydrogen as part of the future energy mix with appropriate policies and supporting schemes," the Hydrogen Council said. It has called for governments to back the hydrogen sector with actions and initiatives of their own.

"Our call today to world leaders is to commit to hydrogen so that together we can meet our shared climate ambitions and give further traction to the emerging Hydrogen ecosystem," said Potier in Davos.

Other founding firms include Daimler, Honda and Toyota, whose Chair-

man Takeshi Uchiyamada said: "The Hydrogen Council will exhibit responsible leadership in showcasing hydrogen technology and its benefits to the world. It will seek collaboration, cooperation and understanding from governments, industry and most importantly, the public."

The Hydrogen Council said its partners would share data and research to make hydrogen technologies profitable, as well as work on international standards to help speed their adoption. Cost reduction is another key aim, said the partners.

## Scatec bags partners for Nova Scotia solar project

- Norfund backs Scatec's plans
- Financial close targeted in 2017

Scatec Solar has secured investment in a proposed solar farm in Nigeria that will boost the country's generating capacity by 100 MW.

Scatec has signed a joint development agreement (JDA) with Africa50, an African infrastructure fund, and Norfund, the Norwegian Investment Fund for Development Countries. The agreement will help it move forward with development of the 100 MW Nova Scotia power plant located in Dutse in the Northern Nigerian state of Jigawa.

Africa50 is backed by the African Development Bank and more than 20 African states. The JDA is a strong signal of the commitment by Nigeria to develop clean energy projects, Scatec said.

"With the government of Norway taking a direct investment role through Norfund, significant regional and Nigerian ownership through Africa50, and the track-record of Scatec Solar, this offers one of the most solid partnerships for solar PV projects globally," said Scatec Executive Vice President Terje Pilskog.

Apart from the three equity investors, the American Overseas Private Investment Corporation (OPIC), Islamic Development Bank and the African Development Bank are expected to be senior debt providers for the project. International Finance institutions say the key to successful investment is the Nigerian state's issue of project documents that provides necessary investor confidence and the formulation of a clear roadmap to sustainability in the energy sector.

In July 2016, the Nova Scotia project signed a 20-year PPA with Nigerian Bulk Electricity Trading (NBET). Located on 200 hectares of land, the project has strong fundamentals with high solar resources and direct access to the transmission grid through a simple connection route, Scatec said.

The consortium will continue to work with CDIL, a Canadian renewable energy development company focused on Africa, and BPS, a Nigerian strategic consulting, to move the project from the pipeline phase and achieve financial close in 2017 and commercial operations in 2018.

## Egypt makes progress on new CCGTs

Three new combined cycle gas turbine (CCGT) power plants are poised to start operating in Egypt, and will increase power supplies in the country by 3200 MW.

The Beni Suef, New Administrative Capital and Borollos power plants will eventually add 14 400 MW to Egypt's grid and are being developed by Siemens under a contract with the Egyptian Electricity Holding Company (EEHC).

Siemens announced at the end of

December 2016 that it had energised two substations that would transmit electricity from the Beni Suef and Borollos plants, while local reports cited sources at Egypt's Ministry of Electricity as saying that six units at Beni Suef were undergoing tests ready for commercial operation.

Local media also reported that one 400 MW unit at both Borollos and New Administrative Capital were preparing for commercial operation.

According to Siemens, the Etay El-

Baroud and Maghagha GIS substations will help deliver 2500 MW of power to the national grid. The facilities are a key part of efforts to upgrade the country's network.

Under Siemens' contract with EEHC, it is due to deliver up to 4.4 GW in an open cycle configuration by the end of 2016, and 14.4 GW in combined cycle configuration by mid-2018.

It is also deploying 2000 MW of wind energy capacity, and building a total of six GIS 500 kV substations.

## Ukraine outage confirmed as cyber attack

Ukraine's grid system was the target of a sophisticated spear-phishing cyber attack when it suffered an outage in December last year, experts have confirmed.

Customers in the country were left without power for an hour in the event, which has again highlighted the need for the energy sector to take steps to protect critical infrastructure.

"Cyberattacks against energy infrastructure are here to stay, and the industry needs to incorporate defense into standard operating procedure," said Tim Erlin, Senior Director, Product Management at Tripwire. "When attackers can cause an outage, we're not talking about data protection; we're talking about human safety."

"There's more to learn about this attack buried in the logs and other data

that's been collected. The investigation is far from over, and while the headlines may fade, industry professionals should be diligent in learning all they can in order to better defend their own organisations."

The cyber attack is the second to affect Ukraine's power grid after a massive December 2015 power outage affecting about 230 000 people, which was later blamed on the Russian government.

The most recent attack occurred at a transmission facility and was not as far-reaching, but suggests that hackers could be using Ukraine as a test-bed for larger attacks on other targets, according to Jonathan Sander, VP of Product Strategy at Lieberman Software.

"The old expression is wrong – light-

ning can strike twice," said Sander. "The Ukrainian power grid has been struck again by cyber bad guys in part because it seems they are using it as a test for bigger things later and in part because the attack was so subtle that nothing could likely have stopped it."

According to Sander, hackers stole administrative credentials that gave them high level access with admin rights, enabling them to formulate a very convincing spear-phishing attack.

"That type of spear phishing only works when you have the intelligence from the inside to craft it just right," said Sander. "With the perch of a high power user, they were able to be a spy implanted at a place where everything was open to see and therefore make an attack that works too well to be stopped."



The green light to proceed with a state-backed capital injection – subject to conditions – is a major step forward in France's plans to revive its nuclear energy sector.

| Siân Crampsie

The European Commission says that France's restructuring plan for its nuclear energy industry will pave the way for a "viable" and sustainable future for Areva.

The Commission has given its approval for the French state to plough up to €4.5 billion into Areva, a move that will enable the firm to restructure and refocus its business on uranium mining and nuclear fuel.

The EU Competition Commissioner Margrethe Vestager said that the capital increase and rescue plan would not

unduly distort competition. "[The] decision paves the way for a viable future for Areva based on a sustainable restructuring plan," said Vestager.

The approval of the proposed capital increase has two conditions – the approval of the sale of Areva's reactor business to EDF, and a positive outcome on nuclear regulator ASN's safety tests on the Areva-designed reactor under construction at Flamanville, France.

The European Commission has also approved a bridging loan to Areva by the French state of €3.3 billion, to tide it over until the capital increase can

take place.

Of the proposed cash injection, up to €2.5 billion will go to NewCo, the firm which will operate all of Areva's fuel cycle operations, and the remaining €2 billion will go to Legacy Areva SA, whose operations will include the troubled Olkiluoto 3 nuclear reactor project in Finland. Areva says that it has received offers from strategic investors amounting to a further capital increase of €500 million in NewCo.

Reuters reported last month that these strategic investors include Japan's Mitsubishi Heavy Industries and JNFL.

In a further move towards its restructuring, Areva has completed the sale of its stake in offshore wind firm Adwen to Spain's Gamesa.

Gamesa and Areva formed Adwen in March 2015, with both companies investing €200 million and holding 50 per cent stakes. The companies reached an agreement in September 2016 for the sale of Areva's stake to Gamesa for €60 million. The deal forms part of the merger agreement between Gamesa and Siemens.

Areva and Gamesa received commitments from the French government that Adwen's 8 MW wind turbines will

be used for projects offshore France totalling 1.5 GW, on condition that the turbines are built in France.

"This sale is part of the transformation plan undertaken by Areva to refocus its business on nuclear fuel cycle activities. Commitments made as part of the tender process for offshore wind farms in France will remain borne by Adwen," Areva said in a statement.

Adwen was the second largest wind turbine manufacturer in Europe in 2015, with a market share of 18.2 per cent of grid connected capacity, according to the statistics published by WindEurope.

## SunEdison ready for sale to Chinese

SunEdison has settled a dispute with one of its own former subsidiaries that will enable it to go ahead with the sale of its solar materials business to a Chinese firm.

SunEdison reached a \$150 million deal with China's GCL-Poly Energy in August 2016 to sell certain assets and technologies used in the production of solar cells.

However, SunEdison Semiconductor, a company spun-off by the bankrupt renewables developer in 2014, objected to the sale, claiming a stake in the intellectual property up for transfer.

According to bankruptcy court documents SunEdison, its creditors and SunEdison Semiconductor have struck a deal that should allow the sale to proceed.

SunEdison Semiconductor Ltd. has also settled \$40 million in claims

against SunEdison, while receiving a \$2.7 million settlement.

The sale of its technologies is a key part of SunEdison's reorganisation following its decision to file for bankruptcy protection in April 2016.

Last month its yieldco, TerraForm Power, sold 365 MW of solar energy capacity in the UK.

The portfolio – made up of 24 operating solar power projects around the United Kingdom that TerraForm took control of from its parent company in 2014 and 2015 – has been purchased by Vortex. Vortex is a renewable energy platform managed by EFG Hermes' private equity arm, in which Malaysian firm TNB holds a 50 per cent stake.

The transaction is valued at \$580 million, TerraForm said.

TerraForm is not part of SunEdison's bankruptcy proceedings.

## DCNS creates new energy division

- OpenHydro becomes part of DCNS Energies
- Technip lends support

Naval firm DCNS is expanding in the marine energies market with the launch of a new business unit.

DCNS Energies will focus on the industrial and commercial development of three marine energy technologies: in-stream tidal turbines, ocean thermal energy conversion and floating offshore wind.

OpenHydro, the tidal turbine business purchased by DCNS in 2013, will become part of DCNS Energies. The new unit's activities will be supported by a €100 million equity investment from DCNS and SPI, a fund managed by Bpifrance.

The new venture will also be

supported by Technip and BNP Paribas Développement, and is a signal of the belief in the potential success of tidal technology, DCNS said.

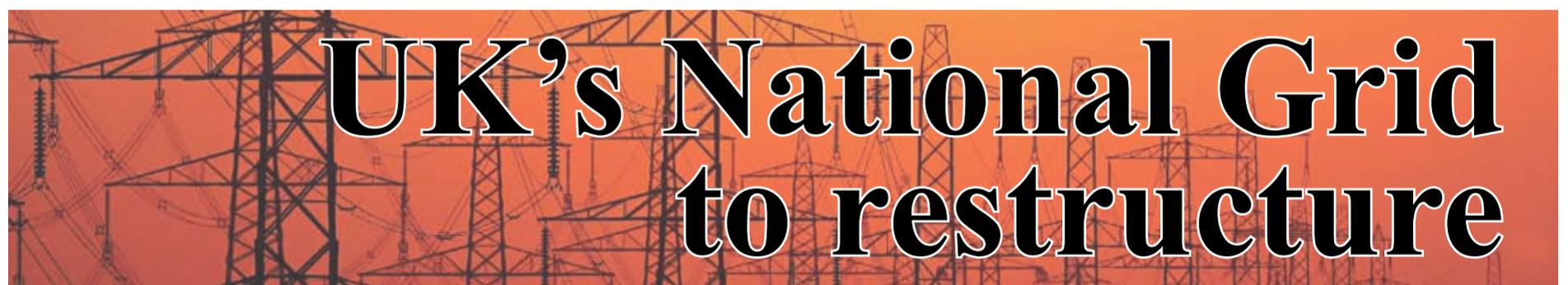
"We have serious assets with which to succeed on this market: renowned experts, advanced technology, turn-key offers covering the lifetime of projects, and an expanding portfolio of sites," said Thierry Kalanquin, CEO of DCNS Energies. "The creation of DCNS Energies is a boost for the entire industrial sector that will follow this development."

DCNS added that the new business would seek to build on the progress made in the maturation of tidal

technology. Technip will support DCNS Energies with its expertise in engineering and management of complex marine projects.

SPI said that DCNS Energies would take key positions in development projects and would be "a promising first mover".

■ Atlantis Resources is expanding its business to include tidal lagoon, tidal barrage and offshore wind projects alongside its core tidal stream expertise. It has launched an internal division – Atlantis Energy – that will seek project opportunities and develop assets on behalf of infrastructure funds, investment banks and private developers.



- NG retains system operator role
- Rooftop solar investment with Sunrun

UK transmission grid owner National Grid is to restructure its business to provide greater separation of its system operator role from the rest of its business.

The move follows a review by the government of the firm that owns and operates the high voltage electricity grid in England and Wales and falls short of taking away the system operator role altogether.

Business and energy secretary Greg Clark said that the proposed new structure would help to boost investor confidence in the UK energy industry and remove any concerns over potential conflicts of interest within National Grid.

National Grid will implement a structure with a distinct system operations unit, with separate employees, board and offices from the rest of

the firm. The split could pave the way for a total separation in the future.

Dermot Nolan, chief executive of Ofgem, said: "Having a legally separate system operator will allow it to take on a more proactive role in managing the system and working with others, while mitigating any conflicts of interest."

One area of concern among the firm's critics is National Grid's abil-

ity to charge generators for access to its grid while at the same time having complete operational control. Its interconnector business is also in competition with domestic sources of power generation.

The new structure is set to be implemented in 2019 following a formal consultation.

Last month National Grid made its first move into solar power with a \$100

million investment in the rooftop solar sector in the USA.

The company has formed a partnership with Sunrun to sell solar power systems to homes and businesses, and develop products and services for a power grid adapting to a new model of small-scale local generation. Among their offerings will be a new package that provides a battery for domestic energy storage.

# Uruguay enhances its wind credentials

The Pampa wind farm is the largest in Uruguay. Its recent commissioning is a major milestone in the country's journey to reaching 1.5 GW of wind capacity by the end of this year. **Junior Isles**



**The Pampa wind farm is the largest in Uruguay**

With a population of less than 4 million people, Uruguay can be regarded as a relatively small country. Yet when it comes to wind energy, it has big plans. About six years ago it launched an initiative aimed at growing its wind power generating capacity from scratch to some 1.5 GW by the end of this year. This would see Uruguay assume the status of number one in the world in terms of wind capacity per capita – even ahead of the likes of Denmark.

Under the plan, wind will join hydro as the main generating source – each representing about 40 per cent of the generating mix – with the remaining 20 per cent coming from thermal power stations and other sources. The move will help Uruguay reduce its dependency on commodities such as gas and oil, and at the same time boost its environmental credentials.

The country recently took a significant step closer to its wind target with the commissioning of what is its biggest wind farm to date. Completion of the Pampa wind farm in December took Uruguay well past the 1000 MW installed wind capacity mark. Using 59 Nordex wind turbines, the plant adds 142 MW to the grid, bringing the country's total wind generating capacity to around 1300 MW by the end of 2016.

Completion of the Pampa wind farm is in many ways the high point of an energy transformation that began almost a decade ago. The transformation of Uruguay's energy mix began during the first term (2005-2010) of President Tabaré Vázquez, with the renewable energy plan

really kicking off in earnest in 2011. Under a type of auction scheme being conducted by state utility UTE, bids for new wind capacity were accepted based on price and other factors such as local content.

By all measures, the process has been very successful. For the last three years, prices of \$63/MWh have been the norm – a level that would be considered very competitive in Europe even today.

Commenting on the country's strategy to boost wind capacity, Vincent Riedweg, Managing Director, Nordex Energy Uruguay S.A., who led construction of the Pampa project, said: "Wind resources are very good and it is considered to be a perfect match for hydropower because of the storage capacity of hydro. Also, studies show that the wind and rain regimes are completely uncorrelated. When there's a lack of rain there is not necessarily a lack of wind and vice versa. So the utility considers it a good mix to have roughly 40 per cent wind, 40 per cent hydro and 20 per cent from other sources."

Nordex has played a key role in Uruguay's wind strategy from day-1, having installed the country's first turbine in 1999. Today it has installed a total of 309 MW in four different wind farms: Juan Pablo Terra (67 MW), Florida (50 MW), Melowind (50 MW) and Pampa (142 MW).

Pampa was the ideal location for the largest of these projects for several reasons. It is located in the largest and thinly populated Department of Tacuarembó in the heart of the country, at a site that enjoys mean

wind speeds of 7.9 m/s.

"The wind resource was the most important driver behind the project's location. It will give the plant a load factor of about 49 per cent. Certainly wind farms can have capacity factors above 40 per cent but 49 per cent is definitely on the high side," noted Riedweg. "Also, it is in the north of the country where there is not a lot of generation, so the wind farm might help stabilise the network grid in the region. There is also a medium voltage line crossing the wind farm, which made the network connection very easy."

Pampa was built by Nordex under a turnkey contract that saw it supply and install 59 N117/2400 wind turbines. It was a complete package, including the steelworks and electrical substation. In addition to the supply of the turbines, Nordex was responsible for civil and electrical works (through subcontractors), installation and commissioning of the turbines and connecting them to the grid.

Nordex also helped with arranging talks to help finance the project. "We helped to bring German export credit agency Euler Hermes into the game and helped to find a financing partner," said Riedweg.

The financing of the project was quite interesting. In the past, private companies that took part in the bidding process have developed most of the wind projects in the country. Pampa, however, was developed by UTE, which allowed a different approach.

About 70 per cent (\$224 million) of the \$320 million project was funded

by KfW IPEX-Bank and Bayerische Landesbank. Notably, however, the remaining nearly \$100 million was raised from a public share issue arranged through a finance vehicle set up by UTE. By purchasing \$20 million of the public shares and opening up the funding to the general public, UTE was able to cover about 30 per cent of the total project costs. This public "buy-in" approach not only raised money but was also a shrewd PR move.

"Everybody was able to buy shares in the wind farm. In addition to generating huge interest from the public, it also brought a great deal of positive attention for renewables in what is a small country," said Riedweg.

It is an approach that UTE plans to replicate going forward. "They plan to do it for other projects," noted Riedweg. "They have already used the same mechanism for a 70 MW project and plan to do the same for a third one this year."

While Nordex's willingness to help in arranging financing and its long-standing history in the country were important, Riedweg stresses that the N117/2400's technical capability was the key factor in securing the contract.

"They had a long relationship with Nordex. A Nordex N29 turbine installed at the University of Montevideo at the end of the 1990s, is the only wind turbine that many people knew. It's an anecdote but it contributed to the reputation of the company. But the main thing was that they liked the machines, the technology."

According to Riedweg, the

## Special Project Supplement

N117/2400 offered the best load factor of the competition at the time. "When we launched the machine in around 2013/14, we were probably 6-12 months ahead of the competition. With the high load factor we were able to offer the best cost of energy. There was also good feedback on the machine's reliability."

The N117/2400 has been specially developed for low-wind sites. With a rotor diameter of 117 m and a swept area of 10 715 m<sup>2</sup>, the N117/2400 is one of the most efficient IEC 3 turbines in its class. According to Nordex, in typical low-wind regions, it will achieve over 3500 full-load hours. At Pampa, the turbine's high load factor will see the wind farm yield an expected 640 GWh of electricity per year.

The N117/2400 is the result of over a decade of ongoing technical enhancements to the multi-megawatt platform.

The rotor consists of three rotor blades made of high-quality glass fibre-reinforced polyester, a hub, slewing rings and drives for adjusting the rotor blades. A pitch system is used to control and optimise output. The variable-speed rotor enhances the aerodynamic effects and reduces the wind load on the system. If necessary, each rotor blade can be locked in any position by means of an innovative locking system to facilitate servicing.

The three redundant and independently controlled rotor blades can be set at full right angles to the rotation direction for aerodynamic braking. In addition, the hydraulic disc brake provides additional support in the event of an emergency stop.

The wind turbine has two anemometers. One anemometer is used for controlling the turbine, the second for monitoring the first. All operational data can be monitored and checked on a control screen located in the switch cabinet or via an external laptop. The data and signals are transmitted via ISDN for remote monitoring and the operator can download all key data for the turbine from the internet. The necessary communications software and hardware is supplied by Nordex.

The drive train consists of the rotor shaft, the gearbox, an elastic coupling and the generator.

Nordex equips the turbines with a two-stage planetary gearbox with a spur gear stage or with a differential gearbox. The gearbox is fitted with a cooling circuit with variable cooling output. The gearbox bearing and tooth engagement are kept continuously lubricated with oil.

The generator is a double-fed asynchronous machine. Nordex has been using this type of generator with variable-speed turbines successfully for many years. The main advantage is that only 25-30 per cent of the energy produced needs to be fed into the electricity grid via a frequency converter. The deployment of this generator/frequency converter system thus cuts the total cost of the wind power system.

The gearbox, generator and converter of the turbine each have independent active cooling systems. The cooling system for the generator and frequency converter is based on a cooling water circuit, while the gearbox is cooled by an oil-based system. This ensures optimum operating conditions in all types of weather. A separate cooling system room at the rear of the nacelle facilitates access to the cooling units and ensures optimum performance of the individual systems.

The nacelle consists of the cast machine frame, a welded generator frame, a steel structure for the crane system and for supporting the nacelle housing and the nacelle housing itself, which is made of glass fibre-



reinforced plastic. Ergonomically designed, it is spacious and thus service-friendly.

The nacelle features two redundant wind direction sensors to continuously monitor wind direction. If the permissible deviation is exceeded, the nacelle yaw is actively adjusted by means of up to four geared motors.

When installing the machines, care has to be taken to ensure the blades and yaw are used in the most optimised way for energy production.

Convinced of the turbine's technical capability, UTE first began discussing the project with Nordex around the end of 2013 and the deal was closed by the end of 2014. Riedweg recalls: "At that time we were executing the Juan Pablo Terra project with them and we received the Notice to Proceed on Pampa in March 2015."

Pampa is a huge site, covering some 70 km<sup>2</sup>. In the first instance, this called for the construction of 42 km of roads in and around the wind farm to supplement the existing public roads.

As the EPC contractor, with responsibility for all the coordination and handling the environmental issues, Nordex had its work cut out. "It was not easy dealing with the environmental issues," said Riedweg.

"We also had to source and procure some equipment, including some key equipment like transformers, from local manufacturers. This meant we had to support them with engineering, certification and the quality process. There was a lot of work to do in terms of getting some constructors up to speed. At one point we also had to step in to do additional coordination after one of our sub-contractors faced bankruptcy in the middle of construction. Everything that could go wrong went wrong. There was flooding in April, which closed the site for more than two weeks. There were a lot of challenges."

And with the general public being a significant shareholder, everything was under the spotlight. Riedweg added: "We attracted a lot of attention. Some we wanted but some we would have liked to avoid."

The challenges were compounded by the tight timeline – around 20 months to erect 59 turbines, build the substation and complete the balance-of-plant (BOP). This was around 6-7 months shorter than the Amakhala wind farm in South Africa, which with 56 turbines was Nordex's previously biggest project.

"The consequences of having a very tough timeline, was that we had to do BOP and erection in parallel. So there was a lot of coordination to do," said Riedweg. "We were finishing a platform, bringing a crane, constructing a turbine, running the cables underground and connecting everything the next day."

It all required careful planning,

beginning about one year ahead of the start of construction.

Actual construction on site began in August 2015, with concrete for the first foundation being poured in early November and the first turbine completed in January 2016. At points during construction, three main cranes

BOP, it was fairly intense." In spite of the numerous challenges, turbine erection went pretty much to plan.

According to Riedweg, it took just eight months to erect the entire wind farm, with as many as 12 turbines being erected per month at the peak of activities. Like at Amakhala, a "star-

**The turbine blades were shipped to the port of Montevideo before being transported to the site**



were employed plus a set of auxiliary cranes doing pre-erection. With erection being carried out on four different fronts (three main cranes and one set of auxiliary cranes) and BOP in parallel, it called for a coordination team of about 40 people. At the peak of construction, close to 500 people were working on site.

Riedweg commented: "With three main cranes erecting turbines plus the

lift" technique was used, wherein all three blades are assembled at the base of the tower and the whole "star" lifted to the top of the tower and connected to the nacelle. This has become Nordex's standard method of installation. "We only do single blade installation when the wind is too high, or it is not possible to erect the rotor on the ground, or on higher towers," commented Riedweg.

**Turbine blades being transported to site by road: 42 km of roads had to be constructed in and around the wind farm**

**Nordex's scope also included construction of the substation**



## Special Project Supplement



**Turbine tower erection went smoothly in spite of the challenging schedule**

If erection itself was straight forward, commissioning was trickier. According to Riedweg, the main difficulty was in commissioning due to difficulties in securing a grid connection. With a medium-voltage line already running to the centre of the wind farm, the good news was there was no line

explained Riedweg.

He added: "We had to be extremely coordinated with the utility so they could inform customers of the coming supply cuts and minimise the duration of the cuts. There was significant pressure for commissioning the substation because any fault in



**A nacelle being installed at the top of a tower**

Riedweg explained: "In Uruguay there can be some time between commissioning and commercial operation because of the acceptance criteria. But while you are doing commissioning, you still receive 80 per cent of the tariff for the energy produced.

"Since December we have been providing an availability guarantee to the client because we have a 10-year maintenance contract on this project"

He pointed out that maintenance will be performed by Nordex and not sub-contracted out, as is sometimes the case with its competitors.

"We do as much as we can internally with our own technicians. On a wind farm of that size, we currently have six full-time technicians located on site and plan to recruit two more this year. We also have a team in Montevideo providing some back office support and technical emergency support to the site. It's a decent sized organisation."

The resources that Nordex is putting into the Pampa project reflect its importance to the company. Not only is it currently the biggest wind farm in Uruguay, it is expected to remain the biggest for the foreseeable future. As well as being a landmark project for the country, it also sets a new milestone for Nordex. "It is the biggest project that Nordex has built so far," noted Riedweg.

In terms of geographic importance, it provides a platform for Nordex to further strengthen its position in the region. Outside of Brazil, which Nordex considers separately from its Latin America efforts due to its size and separate operation the company has there, Nordex is looking to build on its success in Uruguay.

Riedweg commented: "Uruguay was the first market for Nordex in South America and we have a nice

base there. Out of the 1.5 GW that will have been installed by the end of this year, we will have 309 MW – roughly 20 per cent."

He added that Pampa is already being used as the reference for securing other business. "We have been bringing other clients to the site to show them how we operate and what we do," said Riedweg.

It all ties in with Nordex's joint venture with Spain's Acciona Wind Power – a venture that is already bearing fruit. Two deals were recently closed in Argentina – La Castellana (97 MW) and Achiras (47 MW).

"To my knowledge, we are the first to announce projects in Argentina. We have been able to enter the market very quickly because of the experience we gained in Uruguay combined with a very good product offering for the markets in Latin America," said Riedweg.

Argentina is one of two big markets in the region that Nordex will be targeting going forward. "The market is opening up following the election last year," noted Riedweg. Mexico, where Acciona has already been particularly successful, is the other main focus.

He said Nordex would also be building some projects in Peru and Chile would be next. He concluded: "Although Chile has been slow for us, it will be an important market further down the line. It ran some auctions last year but for construction in 2020/21."

By the time the likes of Chile is ready to add new wind capacity, there would have been several years of operating experience at Pampa and other projects in the region, placing Nordex in a good position to expand its ever-growing Latin American installed base.



**Turbine blades were assembled on the ground before being "star-lifted" to the top of the tower**

to build. However, as this was the only line to the north of the country, shutting it down would result in 100 000 people losing supply in two cities.

"When we erected the first turbine we had no grid connection, which caused some hiccups. It meant we had to do a lot of pre-commissioning to make sure that when the grid was switched on, we could commission as many turbines as quickly as possible,"

the substation could potentially trigger a fault in the line.

"We had to have 24/7 monitoring and supervision on site so we could react quickly when there were technical issues."

Following connection of the last turbine to the grid on December 15, 2016, Pampa is now going through a period of operational and grid compliance tests.

**As many as 12 turbines were erected per month at the peak of activities**



**Pampa was ready to transmit its full 142 MW to the grid in December 2016**

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## Tenders, Bids & Contracts

### Americas

#### Longroad buys Vestas components

US renewable energy developer Longroad Energy Holdings LLC has purchased wind turbine components for over 600 MW of projects from Denmark's Vestas Wind Systems.

Longroad said it will use the components as part of projects within its own pipeline and schemes currently owned by other developers. These projects should be completed by the end of 2020.

#### Areva to upgrade TVA equipment

Areva NP has signed a multi-million dollar agreement with the Tennessee Valley Authority (TVA) to provide fleet-wide nuclear refuel equipment upgrades.

Areva NP will upgrade existing refuelling platforms, manipulator cranes, fuel transfer systems and used fuel bridge components. This modern equipment will help operators increase efficiency, strengthen performance and reduce time when receiving, moving and storing nuclear fuel.

Areva NP will complete this work at Sequoyah Units 1 and 2, Watts Bar Unit 1 and Browns Ferry Units 1, 2 and 3, representing three pressurised water reactors and three boiling water reactors.

#### ABB wins Belo Monte link

ABB has won an order worth around \$75 million to supply advanced converter transformers for the Belo Monte 800 kV ultra-high-voltage direct current (UHVDC) transmission link in Brazil.

The 2518 km link will transmit clean power generated in the north of Brazil, from the Xingu substation, to the Rio substation in the southeast. It will be capable of transporting up to 4000 MW of electricity – enough to meet the needs of around ten million people.

ABB will supply fourteen 400 MVA, 400 kV converter transformers and other related equipment.

### Asia-Pacific

#### Sembcorp signs BOT

Sembcorp has signed a build-operate-transfer (BOT) agreement with the government of Myanmar for the Myingyan power plant.

The 225 MW gas fired power plant will be built in the Mandalay region and will supply energy to the Myanmar Electric Power Enterprise under a long term power purchase agreement. It was approved by the Myanmar Investment Commission in early 2016.

Sembcorp will build the power plant and operate it for 22 years.

#### Siemens order for Castle Peak

Siemens has received an order from Castle Peak Power Company Limited (CAPCO) for the delivery of a power block for a new combined cycle unit at the Black Point power station in Tuen Mun, in the northwest of Hong Kong.

The order is the first from Hong Kong for Siemens power plant components for 20 years. It includes the delivery and commissioning of the power block, with a single-shaft configuration, comprising an SGT5-8000H gas turbine, an SST5-5000 steam turbine, a water-cooled SGen5-3000W generator manufactured in Germany as well as the SP-PA-T3000 control system.

The new plant will have an installed capacity of 550 MW. It will help Hong Kong to achieve its target of increasing gas fired generation to around 50 per cent of the fuel mix for power generation by 2020.

#### Ace contract for Wärtsilä

Wärtsilä will supply a 150 MW Smart Power Generation plant to Ace Alliance Power Limited, a special purpose company owned by the Summit Group of Companies in Bangladesh.

The order comprises eight Wärtsilä 50 engines and one Wärtsilä 32 engine. The contract includes the engineering and equipment with additional advisory services for the plant's installation, testing and commissioning, as well as on-site staff training.

The equipment is scheduled to be delivered during the second half of 2017, and the plant is scheduled to be operational in early 2018.

#### Sri Lanka purchases power

The government of Sri Lanka has announced plans to purchase additional power generating capacity from the private sector through an open international competitive bidding process.

It will purchase a total of 60 MW. The new capacity will be installed at a minimum of three locations to ease the transmission constraints that have arisen in the Central and Southern provinces.

#### Nordex wins down under

Nordex Group has signed a contract to supply 22 AW125/3000 turbines for the construction of the first phase of the Mount Gellibrand wind farm in Australia.

The 66 MW project is located near Colac, in western Victoria, where wind speeds average 7.2 m/s. The turbines are especially designed for medium wind sites and will be installed on 87.5 m tubular steel towers, which will be built in Victoria.

Start-up of the wind farm is scheduled for 2018, after which Nordex will service the turbines for two years.

#### Transmission deal for ABB

ABB has teamed up with India's national electricity grid operator Power Grid Corporation of India Limited (Powergrid) to deliver the Raigarh-Pugalur 800 kV ultra-high-voltage direct current (UHVDC) transmission link that will connect Raigarh in central India to Pugalur in the southern state of Tamil Nadu.

The 1830 km link will be among the longest in the world, capable of transmitting 6000 MW of power. The two-way link will integrate thermal and wind energy for transmission of power to high consumption centres located thousands of kilometres away, supporting electricity demands in the south, when wind strength is low, and transmitting clean energy to the north, when there is excess wind power.

The total project value is worth more than \$840 million and the balance will be executed by ABB's consortium partner BHEL (Bharat Heavy Electricals Limited), a leading Indian public sector company.

The project is expected to be completed in 2019.

### Europe

#### Nexans selected for East Anglia One

ScottishPower Renewables has chosen Nexans' submarine cables to carry energy onshore from its new 714 MW

East Anglia One offshore wind farm in the UK.

The new wind farm, due to be finished in 2020, will be made of up 102 wind turbines installed around 50 km from the shore. Nexans will supply and install two 85 km 3-core submarine cables with embedded fibre optics, as well as accompanying accessories, for the wind farm in the North Sea. The contract is worth more than €180 million.

Nexans will type test, manufacture and then install the high voltage cables and accessories at the 300 km<sup>2</sup> site. The turnkey contract includes a pre-installation survey and cable protection by burying. Delivery of the cables will begin in Summer 2018.

#### Emerson to convert Lynemouth

EPH Lynemouth Power has awarded Emerson a contract to help convert the 44-year-old coal-fired Lynemouth power station to biomass firing.

When the conversion is complete in late 2017, the plant, near Newcastle in the United Kingdom, will be fuelled by approximately 1.4 million tons of wood waste per year, supplying the national grid with up to 390 MW of low-carbon electricity.

Emerson will be responsible for demolition, engineering, installation, start-up, commissioning and coordination of work among multiple suppliers and contractors.

#### Global to build floating offshore wind demo

Global Energy Group has been selected by Dounreay Tri to build a floating offshore wind demonstration power plant off the coast of Scotland.

The Dounreay Tri facility will be a two-turbine, wind farm using floating foundations deployed 9 km off the Caithness coast. The prototype installation will put Scotland at the forefront of developing floating offshore wind turbine technology, Dounreay Tri said.

Global Energy Group will carry out the works at its Nigg Energy Park facility in the Scottish Highlands. Dounreay Tri is aiming to commission the 10 MW wind farm in 2018. It hopes to secure planning permission and consents from Marine Scotland and Scottish ministers by the end of March 2017.

#### MHI Vestas lands largest order

Dong Energy has placed an order with MHI Vestas Offshore Wind for the 450 MW Borkum Riffgrund 2 project in Germany.

The order is the largest ever secured by the wind turbine firm, and includes a five-year full-scope service with an availability guarantee, ensuring optimised performance of the wind power plant with maximum power output.

The order is the third from Dong Energy for the V164-8.0 MW turbine, following Burbo Bank Extension (258 MW) and Walney Extension (330 MW) and brings the order pipeline with DONG Energy to over 1 GW.

When fully commissioned in the first half of 2019, Borkum Riffgrund 2 will be one of the largest offshore wind farms in Germany.

#### McPhy wins Energiedienst tender

McPhy Energy, which designs, manufactures and integrates hydrogen equipment for the energy and industrial sectors, has won the call for tenders issued by Energiedienst, the

hydroelectricity specialist from Baden-Württemberg, Germany.

McPhy Energy will help Energiedienst to set up a green hydrogen production facility at the site of its Wyhlen hydroelectric power plant, supplying it with a 1 MW hydrogen generation unit. It will also manage this facility's maintenance under a long-term contract and will support Energiedienst to monetise its production for applications in industrial markets, as well as zero-emission mobility and injection into gas networks.

This project for a green hydrogen production facility, which will be delivered at the end of 2017, is part of the renewable energy storage programme based on hydrogen technologies launched by the German foundation ZSW.

#### GE Hitachi supports Swedish programme

GE Hitachi Nuclear Energy (GEH) has been awarded a three-year contract by OKG AB to support the dismantling of two reactors at the Oskarshamn nuclear plant in Sweden.

The contract covers the segmentation of reactor pressure vessel internals for Oskarshamn Units 1 and 2. The work, which will include dismantling, cutting and packing the reactor internals for final disposal, will begin in January and continue through 2019.

### International

#### GE to add 2 GW to Iraq

GE has secured more than \$1.4 billion in orders from Iraq's Ministry of Electricity to set up power plants and provide technology upgrades and maintenance services.

The US technology giant has signed agreements that will add over 2 GW of power and secure the delivery of approximately 1.75 GW of existing power to the national grid.

The contract includes the construction of the Samawa and Dhi Qar power plants, adding 1500 MW to the grid. GE will initially install four 9E gas turbines in simple cycle at each site by 2018, then later convert the plants to combined cycle operation.

The Power Up Plan will also see GE add over 580 MW to the national grid through upgrade and rehabilitation works at four power plants, and carry out maintenance on a fleet of 9E gas turbines installed in six different power plants in Iraq.

GE has also been working with regional and international institutions to facilitate financing to help the government of Iraq execute these and other projects. Since 2016, GE has helped the country secure \$2 billion in financing for projects in the energy sector leveraging its global sourcing capabilities coupled with its strong relationships with lenders.

#### Oman names procurement consultant

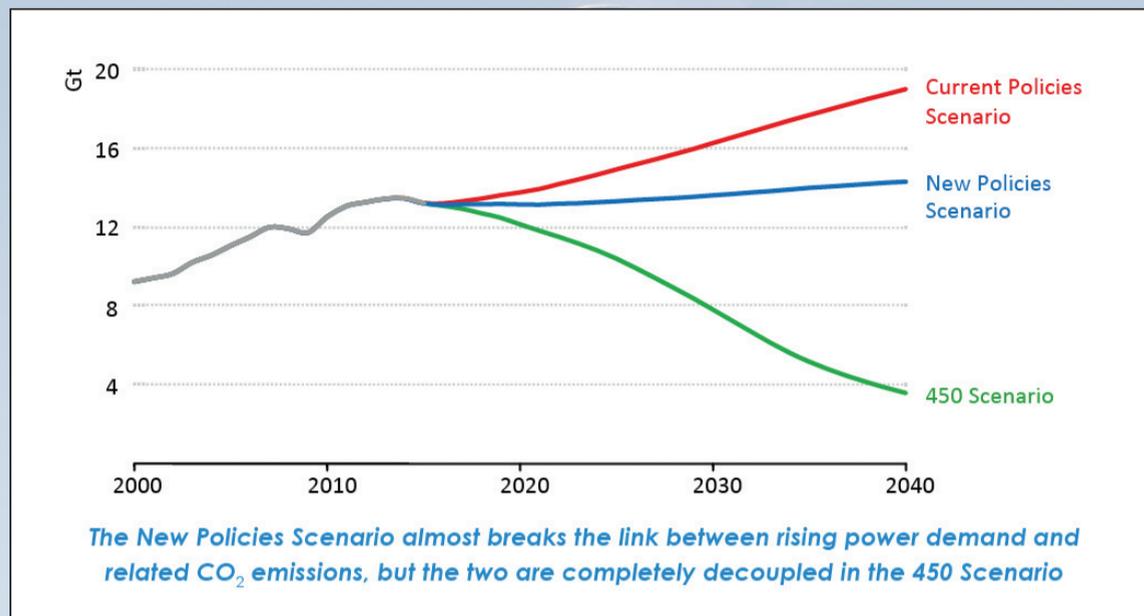
The Oman Power and Water Procurement Company (OPWP) has selected Atkins Power and Renewables to provide technical advisory services for the development of the Sultanate's 'Power 2021 Procurement Cycle'.

The consultancy contract centres on the procurement of a new Independent Power Project (IPP) of a minimum capacity of 800 MW to help meet forecast power demand requirements of 2021.

OPWP, as the sole procurer of all new power generation and water desalination capacity, is overseeing the procurement of this new IPP, which is proposed to be set up within the Main Interconnected System (MIS), serving much of the northern half of the Sultanate.



### Global CO<sub>2</sub> emissions from fossil fuel combustion in the power sector by scenario



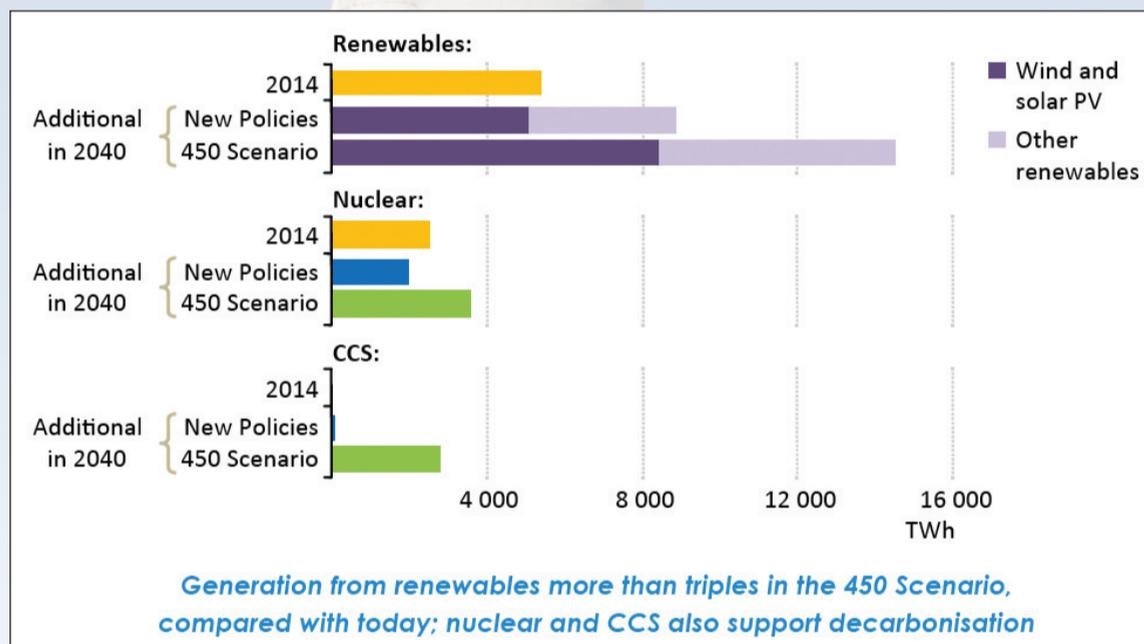
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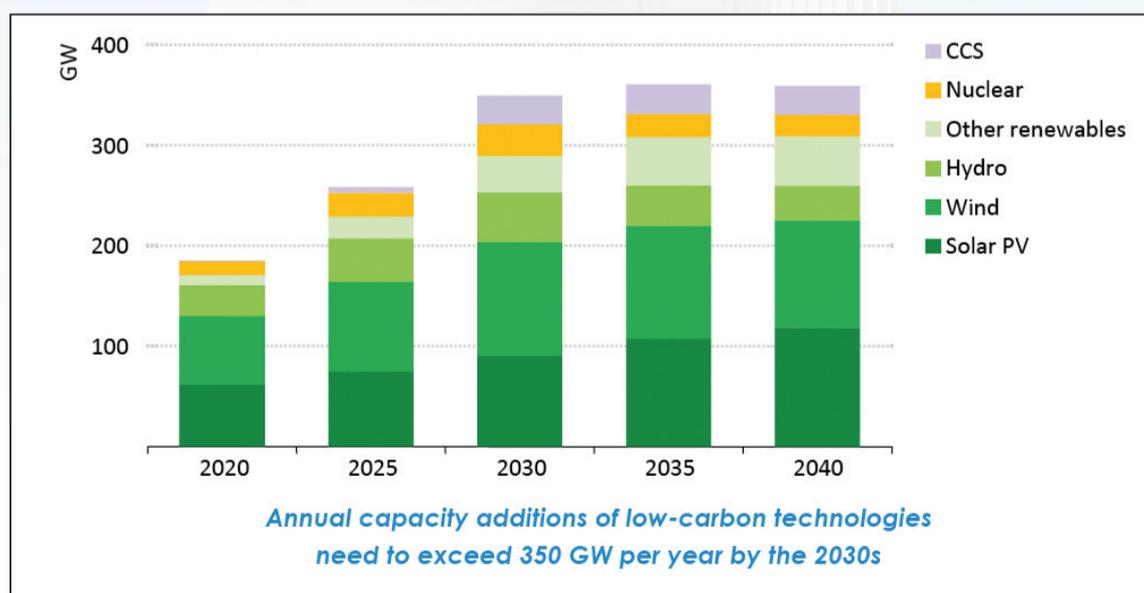
World Energy Outlook 2016, © IEA/OECD, Figure 6.4, page 250

### Growth in generation to 2040 by low-carbon technology in the New Policies and 450 Scenarios



World Energy Outlook 2016, © IEA/OECD, Figure 6.5, page 252

### Global annual capacity additions of low-carbon technologies in the 450 Scenario,



World Energy Outlook 2016, © IEA/OECD, Figure 6.6, page 253

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## Oil

# US shale is wild card in Opec cutback plan

- Production cuts have entered “probation period”
- Shale rig count rising

David Gregory

As Donald Trump prepared to take the oath of office for the US presidency last month, crude oil prices were averaging around \$55/b as it became clear that Opec members were beginning to comply with the agreement they reached at the end of November to cut production by 1.2 million b/d during the first six months of 2017.

Hurting from two years of low oil prices, Opec members, with the exception of Nigeria and Libya, and 11 non-Opec producers, particularly Russia, made a rare agreement to cut production in an effort to see the price increase. On that promise, crude oil prices have started to rise.

The latest monthly oil market report released by the International Energy Agency (IEA) on January 19 said the production cuts “had entered their probation period and it was still too soon to see what level of compliance would be achieved.” Opec production, which now excludes Indonesia, averaged 33.09 million b/d during December, down from a record high in November by 320 000 b/d, with Saudi Arabia taking the lead, according to

the agency. “Early indications suggest a deeper Opec reduction may be underway for January, as Saudi Arabia and its neighbours enforce supply cuts,” the IEA report said.

But the IEA also forecast higher crude production among non-Opec states during 2017, predicting that supplies would rise by 385 000 b/d during 2017 as higher prices in anticipation of the production cut “stimulate increased investment in the US.” The IEA said recovering light tight oil – known also as shale oil – production underpins 320 000 b/d in total US output this year. Added output is expected from Brazil, China, Canada and Colombia during 2017, the report said.

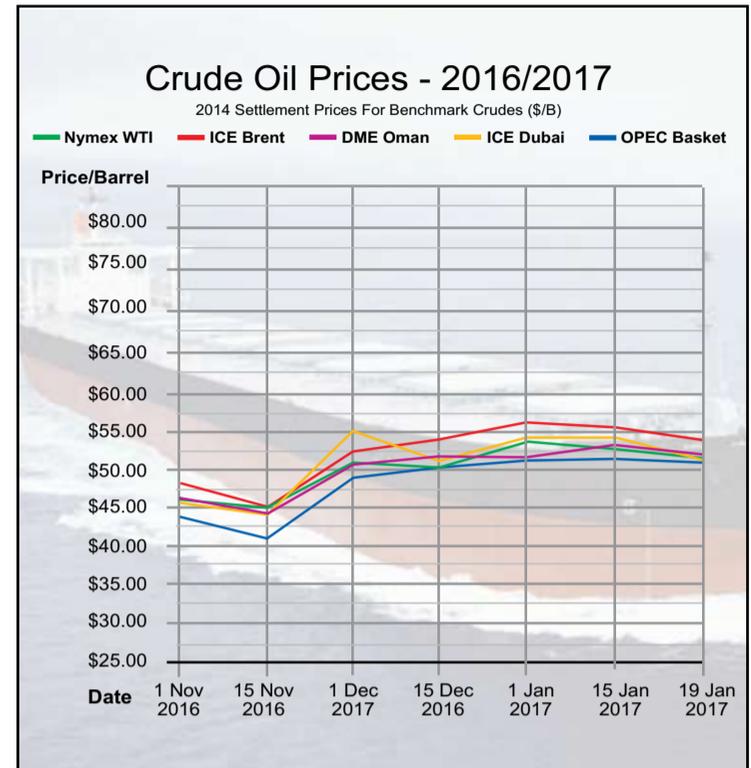
Throughout his election campaign Trump spoke of putting America first and making the US energy independent. As with the Opec and non-Opec probation period, it is still too early to tell how the new US administration will shape its energy policy, but US domestic oil and gas production will likely receive encouragement from Team Trump.

Speaking at the Global Economic Forum in Davos, Switzerland, IEA Executive Director Fatih Birol

predicted that US shale oil production would step in to fill any gaps that the Opec and non-Opec cuts might produce and that this would lead to oil prices declining again.

“As a result of the increase in prices, we are going to see a substantial amount of oil pouring into the market from the United States,” Birol said. “I would expect that we see a rebalancing of the markets within the first half of the year, but what I want to say [is] that we are entering a period of much more volatility in the market.” Birol said that with an oil price at \$56 or \$57 per barrel, there are a lot of shale oil plays in the US where it would make perfect sense to produce.

This is what many analysts have been saying for well over a year. Saudi Arabia took the decision to flood the oil market in 2014 in order to force prices down and subsequently force high-cost producers like shale oil out of the market. But while the plan worked to a certain extent and forced many US firms to cease production or into bankruptcy, shale oil producers have learned how to adapt and remain in the game even if it has been on the sidelines. As oil prices have in recent months begun



to come back, a prime indicator of shale oil activity, the rig count, has also come back.

“Not only is the rig count rising,” the IEA said in its monthly report, “but recent reports tell us that the productivity of shale activity has improved in leaps and bounds. Whether it be shorter drilling times or larger amounts of oil produced per well, there is no doubt that US shale industry has emerged from the \$30/b oil world we lived in a year ago much leaner and fitter.”

US crude output averaged 8.95

million b/d during the first week of this year, the higher averaged since April 2016. The US rig count numbered 529 in early January, compared to a 2016 low of 316.

It will be mid-February before any numbers are available that reflect whether the Opec/non-Opec production cuts are taking hold and reducing stockpiles, and in the meantime, the oil price will do what it always does – react to a variety of statements by officials and market indicators that capture a trader’s attention for a limited time.

## Gas

# East Mediterranean gears up for new phase in New Year

Real work in the East Mediterranean Sea is scheduled to get started during 2017, bringing the region out of a period that has involved a lot of preparation for the future but little exploratory and development work.

Mark Goetz

Things should get busy in the East Mediterranean Sea in the near future. Greece’s Energean Oil & Gas announced last month that it would develop its newly-acquired Tanin and Karish gas fields offshore Israel using a floating production storage and off-loading (FPSO) unit. Energean in December received approval from the Israeli authorities to purchase 100 per cent of the two fields, which were discovered by US explorer Noble Energy in 2011 and 2013, respectively. Together they hold an estimated 2.4 trillion cubic feet of natural gas and 25 million barrels of condensate. Energean agreed to pay \$148 million plus royalties for the licenses.

Noble and its Israeli partner Delek Group were forced to sell the two fields as part of the Israeli government’s Gas Framework Strategy, which was devised in order to resolve regulatory issues that had held up further development of the Tamar field and also the giant Leviathan field where

the resource is estimated at 22 tcf.

Over the next couple years, Energean will invest \$1.3-1.5 billion in the fields, which will supply gas to Israel’s domestic market.

This year is expected to see further development of the Tamar gas field, which is proving Israel with some 60 per cent of its electricity, and a final investment decision (FID) on the Leviathan field. While an important commercial export agreement has been made to sell 45 billion cubic metres (bcm) of gas to Jordan’s National Electric Power Company (NEPCO) over 15 years, it awaits ratification from Jordan’s parliament, where there is opposition to the proposition of buying gas from Israel.

During the last year there has been considerable speculation about Israeli – and Cypriot – gas being exported to Egypt where there are two idle LNG plants that are unable to secure supplies of Egyptian gas because of the growing demand for gas in that country. Those plants, with a combined capacity of 12.2 million tons per year,

could provide Israel and Cyprus with the export option they are seeking, provided markets for the LNG materialise. Letters of Intent and other initial documents have been signed by the companies and branches of governments paving the way for the plan, but solid commercial agreements remain elusive.

That plan could be complicated by whether Egyptian gas production recovers sufficiently in the near term to allow the country to return to the role of gas exporter. It was reported in the Egyptian press last month that Italy’s Eni had received approval from the Egyptian government to export gas produced at its giant Zohr field and other gas assets in Egypt through the idle LNG facility at Damietta, in which Eni holds a 40 per cent share.

Eni’s discovery of the 30 tcf Zohr field in August 2015 shook up the entire East Mediterranean. Exploration work had fallen into something of a slumber as low oil prices forced companies to trim down and avoid speculative investments. Domestic politics

in Israel had brought offshore work to a halt as legislators argued over industry regulations, and drilling had stopped in Cyprus following the drilling of two dry wells there by Eni in mid-2014. The lack of a functioning government in Lebanon had brought a licensing round launched in 2013 to a stop for want of two government decrees approving the licensing model and block demarcations.

Even Egypt, which was forced to start imports of LNG in 2015 due to a lack of supplies resulting from failed government policies, made adjustments to encourage investment. It now expects to be energy sufficient again by 2020.

Zohr, with a resource of 850 bcm, is the largest discovery ever in the Mediterranean, and the fact that it was found in a carbonite geological stratum that was not considered promising now makes the region even more interesting to companies.

Laying just a few miles south of the Cypriot maritime border, Zohr prompted the Cyprus government to

launch its third licensing round in early 2015 and in December it announced the preferred bidders for the three blocks tendered: ExxonMobil/Qatar Petroleum for Block 10, Eni (which already holds Blocks 2, 3 and 9) for Block 8, and Eni/Total for Block 6.

Total, which was awarded Block 11 in February 2013, will drill its first well offshore Cyprus during the first half of this year, and Eni will return to resume its suspended drilling programme offshore Cyprus during the second half. Total’s well is targeting the same Zohr geology in a location just north of the Egyptian well.

A licensing round opened by Israel last November tendering 24 blocks will close in March and preferred bidders are expected to be named by mid-year. In Lebanon, now with a working government, the cabinet has approved the two crucial decrees and is now working on a hydrocarbon tax law that once passed will enable the country to proceed with a new bidding round that is expected to generate considerable attention.

# Developing incentives for greater flexibility

Aggregators, integrated utilities and end users need to define their strategy to seize the business potential that demand side management (DSM) offers as a flexibility solution. However, understanding the needs and constraints of DSM providers is required in order to design the market in a way that will facilitate and increase flexibility activation.

**Kurt Baes and Florence Carlot**

**Baes: The value proposition needs to combine the additional revenues with proactively managing complexities and risks**



Aggregators, energy suppliers and electricity network operators have demonstrated in a few European countries their willingness to rely on end users' flexibility to respond to grid needs. So far, this has been done with great success but it is still somewhat limited in scope.

Demand-side management (DSM) is a flexible solution to ensure security of supply, which can bring tremendous value to transmission-system operators (TSOs) and an additional source of revenue to other market players. However, understanding the needs and constraints of DSM providers is required in order to design the market in a way that will facilitate and increase flexibility activation.

The technical functionality is straightforward – aggregators, industrials and even households can provide additional capacity and energy to the market, and be remunerated for it, by adjusting energy demand when external signals are received.

Two types of external triggers typically create DSM activity: electricity system supply conditions and electricity market prices. We identify four main mechanisms as the pillars of the DSM market.

- Wholesale and balancing markets: access to energy markets to sell/buy energy during high or low price periods.

- Grid and retail tariffs can vary depending on the time of day or season. Shifting consumption away from high-tariff periods can generate savings for industrials and households.

- System services: primary, secondary and tertiary control services agreed between DSR providers and TSOs are designed to ensure security of supply.

- Capacity markets: sufficient capacity in the market is guaranteed through contracts established before the target delivery period, with remuneration based on the capacity made available.

There is no wrong or right mechanism. Generators, aggregators and end users can choose to activate their flexibility based on a price or a system-need trigger. They will favour one mechanism over another, depending on their risk appetite, capabilities, and overall ability to deliver.

Even though there is an advantage for participants in DSM to secure additional revenues through contracts, they can be significantly penalised in case of non-delivery – a risk that should be minimised by aggregator interventions.

By contrast, with a price-incentivised response, load is adapted to market or network price signals showing risk of market exposure or imbalance costs. Participants will not receive any payment as such – their reward is in avoided costs, which can be high. However, for industrial players the ability to reschedule production processes in line with grid or energy tariffs is not guaranteed.

Risk monetisation is not the only factor when flexibility providers are select one DSM product over another. Indeed, time response, duration of activation, load direction (up or down), frequency of activation per year and availability of load are conditions which can constrain participation in

the provision of DSM. For instance, a high number of activations over the same year, especially if in quick succession, will create increasing pressure on the production operations for an industrial and potentially offset a larger portion of the avoided costs than desired. Appropriate valuation of the applicable mechanism is required in order to compensate the related costs and therefore to ensure an appropriate level of participation.

The majority of markets have developed DSM mechanisms, though at very different paces.

The US, supported by state regulators, is undeniably the leader in incentivising DSM providers to participate in the market. Selected European markets have also embraced the importance of facilitating their access to the energy market to ensure security of electricity supply.

With many energy systems “under stress”, DSM penetration can and should be further stimulated. It not only helps TSOs to manage their networks more effectively (e.g., deferred reinforcement capex, decreased network losses, reduction in costly temporary isolated generation), but also enables utilities, aggregators and electricity users to capture extra value in the struggling electricity markets.

Unlocking this value-add requires various initiatives at different levels. Our experience and interactions with TSOs, aggregators and industrials allow us to recommend four initiatives to increase participation in DSM:

1. *Facilitating access to the DSM market.* Access to the DSM market must be facilitated via attractive and fair market mechanisms in order to improve the participation of end users and prevent discrimination between actors along the energy value chain. This is one of the key barriers in those markets in which DSM penetration is low. The main actions here for TSOs and regulators should be:

- Treat demand-side management on equal and transparent terms with generation in the provision of ancillary services and in capacity markets, and design specific mechanisms for DSR providers (i.e. and not to adapt mechanisms that were once designed for generation asset owners)

- Rationalise the number of mechanisms to limit overlaps and therefore cannibalisation, as well as to limit their proliferation. Today, it is often difficult for demand-side providers to identify which products are suited best to their operations

- Create viable and tailored products that enable aggregators (and their users) to unlock the real potential of demand response in the market

- Appropriately incentivise risks taken by utilities and industrials

- Develop specific value propositions to be put forward to the regulator if room for demand response in the market has not yet been created via regulation

- Create alignment between market players on the baseline methodology to be used to calculate the available load reduction of a given resource to respond to a need for flexibility;

2. *Teaching and helping industrials.* Although the benefits for industrials are real, much more flexibility can be unlocked. For example, United



**Carlot: battery storage is gaining more and more popularity**

Utilities, a UK Water company, stated that it expects to make £5 million in revenue from DSM by 2020 by reducing power usage, including turning off pumps at its treatment works. REstore, a European aggregator, stated that primary reserve capacities can earn €180 000/MW per year in Belgium. Key actions to take (by TSOs, regulators, aggregators, utilities) are:

- Inform and educate industrials about additional revenue streams via demand response and the economic value proposition. Indeed, industrials active in the steel, paper, food & beverage, water treatment, glass and other industries have high interests in reducing their consumption or shifting it to another time. Total, ArcelorMittal and Tereos are examples of high-energy consumers which became DSR providers

- Support companies in identifying adjustable manufacturing processes that are able to free up flexibility in the market when required

- Develop and tailor DSM products and mechanisms that are adapted to a company's operations to its risk appetite and the expected benefits;

3. *Incentivising and triggering DSM activation through real-time price signals.* Real-time price signals are required to incentivise and trigger DSM activation, but also need to integrate and reflect those activations. This is in the hands of the market manager, typically driven by TSOs:

- Implement time-of-use tariffs to incentivise shifting of consumption

- Design wholesale markets (day-ahead and intraday markets) capable of sending real-time price signals for unlocking flexibility when required;

4. *Collaboration of aggregators and energy suppliers.* Partnerships between aggregators and energy suppliers can bring high added value, although their implementation will only be possible in the absence of conflicts of interest. Aggregators' DSM technical knowledge and their capacity to advise industrials on shifting or reducing the consumption of the production assets associated with existing energy supplier customer portfolios work together to the advantage of the

industrial player. They ease market access for it and enable optimal leverage of the know-how each party brings to the table.

In addition to the above recommendations, infrastructural and technical solutions in support of demand response can be envisaged to facilitate reactivity and availability of assets.

We distinguish battery storage as one of the domains that is gaining more and more popularity across the energy value chain, and can be part of the answer to decrease risks on the DSM provider side and increase responsiveness. Alternatives such as distributed generation and electric vehicles are other means to bring generation up or demand down to satisfy grid constraints. Positioning and subsidies from the EU and regional regulators are expected by various market parties in Europe, and should be part of the solution to facilitate and increase demand response usage in grid balancing.

In conclusion, TSOs need to design and propose a range of simple mechanisms adapted to their real needs, and to DSR providers' constraints and expectations in terms of incentives, with limited impact on operations and certainly not acting as a penalty for the DSR provider. Another critical activity here is to educate the market accordingly.

At the same time, however, aggregators, integrated utilities and end users need to define their strategy to seize the “DSM business potential”. The value proposition needs to combine the additional revenues (upside) with proactively managing complexities and risks (technical and business constraints). In this, an open-minded exchange with grid operators and regional regulators should aim to then converge into a clear setting out of the requirements to facilitate DSM deployment in regional markets.

*Kurt Baes is a Partner in Arthur D. Little's Brussels office and responsible for the Operations Management Practice in Benelux; Florence Carlot is Manager at Arthur D. Little, Brussels Area, Belgium.*

# Redefining grid efficiency

Once treated as separate domains, IT and OT are now intersecting to enable more efficient and reliable utility operations.

Vincent Petit

If a utility operator in the last quarter of the 20th Century were to see into the future and catch a glimpse of today's energy technology, they would no doubt be amazed by the proliferation and complexity of different systems within utility infrastructures.

However, it's likely they would also be disappointed by the lack of progress in the information systems and operational tools to accommodate new digital technologies. Progress has been made, but utilities are still some way off achieving digital transformation. Take enterprise resource planning (ERP) systems for example – we are still using the systems that were installed in the 1990s to manage physical assets, resulting in limited access to the data modelling capabilities offered by modern power automation systems.

So how fast can utilities move in replacing enterprise systems? Utilities that embrace change too quickly risk investing in technologies that can quickly fail, or can experience short-term reductions in operational efficiency. While those that are too slow off the mark will fall behind the rapid pace of technology deployment and end up maintaining obsolete equipment with archaic systems at a higher cost and risk of failure.

New, improved systems that make the most of the Internet of Things (IoT) innovation will allow utilities to manage their networks in a much more flexible manner; and key international standards adopted by the industry will facilitate this implementation. Modern electric utilities have acquired multiple software systems to manage operational assets and support their key business processes.

At the core, the convergence of information technology (IT) and operational technology (OT) systems offers a means to support future-ready integrated business processes. Data

integration will be the cornerstone of the future of distribution utility business. It's the core component of digitised mechanisms for asset management, grid operations and more.

Once treated as separate domains, IT and OT are now intersecting to enable more efficient and reliable utility operations, directed and empowered by data. Open and interoperable solutions, including Schneider Electric's EcoStruxure platform, connect until now siloed software and equipment using IoT technology to manage collected, aggregated, cleaned and enriched data to create value and optimise utility operations.

OT represents a broad category of physical infrastructure components and associated software that utilities depend on. It encompasses communication capabilities used to monitor and operate automated electrical equipment in real-time, as well as advanced simulation to guide crews in the field. OT systems also include the software implemented in control centres and power generation management systems.

In contrast, IT encompasses all the related software and networking gear that allow machines to exchange information directly with humans, often within seconds. These include the likes of enterprise resource planning (ERP), customer information systems and billing, geographic information systems (GIS), and customer relationship management (CRM) systems.

Beyond IT/OT systems convergence and IoT deployment, information-level interoperability is absolutely crucial to enable interactions within and among systems that haven't previously communicated with one another, with a wider variety of data, more components, and more applications.

Stronger, more efficient, and better automated distribution grids will rely on internationally recognised standards in terms of data models, data integration, and open data and communication for smart grids and grid edge technology. It will also support the increasing need for data exchange with other actors involved in the power ecosystem, including TSOs, distributed generation operators, aggregators, and prosumers. For this reason alone, standardised data models and interfaces belong at the core of a utility's business.

For many utilities, there may be some confusion as to where to start with IT-OT integration. Three key aspects should be addressed for a modern asset management and operation strategy:

1. *Create an architecture blueprint.* By nature, the grid is an integrated system. Therefore, IT-OT systems designed to represent the grid to operators, planners, and engineers must be integrated. Utilities must follow a well-thought-out architecture blueprint ahead of starting the implementation, which focuses on:

■ Mapping business processes to data and user workflows for greater flexibility through workflow management software. This can bring the vertical silos found in many utilities together in order to connect multiple

software applications to support robust and successful cross-vertical business processes

■ Leveraging the ubiquitous presence of the Internet for data monitoring and collection, to enhance scalability. From information systems in the enterprise to smart devices deployed in the grid, the observation of the network has never been easier. However, the process of asset data management can be complex due to multiple industry standards and regulations. Scalable tools across data sources and automated data filtering is required to ease the process and free up operator time

■ Tapping into multiple data sources for improved visual situation awareness and usability. User interfaces are required to deliver more dashboards and graphics to present an overview of the situation, as well as identifying where more detail is needed. Interfaces can be fed by multiple data sources to display past trends with present patterns, alongside the ability to simulate the future state of the system.

2. *Commit to accurate network modelling.* Accurate network models are essential for better operations, improved operator performance, the safety of switching operations and crew works, and optimisation of the overall grid. When an outage occurs or an emergency switching operation is imminent, grid operators need an accurate network model. Model architecture must therefore include a design where a central master network model (hosted by the GIS) is shared and updated across all operational systems, including the SCADA, DMS, and OMS.

The advantage of data modelling is that it provides a way to uniquely associate a physical component to the data, which helps to avoid ambiguity when exchanging information between applications. It also provides a way to associate labels and apply rules to help manipulate data.

The process of maintaining a 'single truth' of the network is implemented through a workflow and the interoperability of the network model exchange is achieved thanks to CIM standards. Data integrity is essential for this and the necessary steps must be taken to better share and make sense of data, across all IT and OT systems.

Distribution utilities benefit not only from deploying IT, OT and IoT technologies that adhere to interoperability standards, but also leveraging the comprehensive set of open standards for the power business, which has been developed by the IEC TC57 committee. These standards are essential for interoperability and sustainability, and leverage both IEC 61850 and CIM as the two main pillars, which were initially created for substations and the grid.

Their semantic data model is extensible and agnostic from the communication network. This is a key pillar for an efficient and sustainable integration and analytic development, and is complemented by IEC 62351 for cyber security.

3. *Facilitate secure communication.* An integrated IT-OT world consists

of a federation of networks that combine private and public infrastructure, and integrate standards-based, open technologies such as IP with existing proprietary, legacy solutions. This integrated group of interdependent communications systems will grow and evolve, and while interoperability standards have flourished, security continues to be a significant topic.

With one connected network from smart devices to control centre and key enterprise information (including confidential customer data), architects must be well versed in cyber security protocols, standards, and compliance rules. It is also critical that the software and systems used have been designed per the highest cyber security software engineering standards. There are also services available that assess the vulnerability state of the smart grid and control systems, recommending mitigating actions.

Of course, the new grid-edge world of utilities, with thousands of new endpoints outside the sphere of physical control of the utility, does not make securing the grid an easy task. A comprehensive approach that considers the entire network, targeting security, patch management, and compliance, is needed to succeed in this evolving and mixed environment.

Having addressed these three key aspects for a modern asset management and operation strategy, getting the timing right is important for a smarter tomorrow.

The architects of utility IT-OT systems will have some tough choices to make between upgrading legacy systems or replacing them with newer, better systems. Prior to the advance of middleware, utilities had implemented point-to-point interfaces, which led to an unmanageable system because of too much interdependency.

Now the proliferation of adapters/web services has created a level of complexity difficult to manage by the utility's IT department and sometimes not performing enough for the requirement of real-time operation. Enabling a new type of IoT framework that connects intelligent devices with real-time control, open software and analytics and services increases collaboration with all the actors in tomorrow's grid ecosystem to help the entire system work more efficiently.

Globally, the need for reliable power has never been greater, but equally the established way energy is delivered is under threat. IoT technologies have enormous potential for building a cleaner and more reliable grid and they are available to adopt today.

Fortunately, the digital transformation of utilities is helping us get there. IoT can become both a comprehensive framework and guiding path toward implementing new and innovative digital technologies to increase the flexibility of grid operations and make the entire grid ecosystem, including the operator, more efficient and reliable.

Vincent Petit is SVP of Energy Automation at Schneider Electric



Petit: getting the timing right is important for a smarter tomorrow

# Taking the risk out of solar PV

The cost of solar PV has fallen dramatically in recent years but as governments reduce feed-in tariffs, developers will need to look at ways to reduce risk.

Vic Wyman

The future looks bright for solar photovoltaic (PV) projects as system costs have fallen by more than 70 per cent since 2008 and look likely to continue falling, even as efficiency and reliability have increased.

Yet as the economics of PV and other renewable energy projects improve, governments will feel freer to reduce their support, such as capital subsidies, feed-in-tariffs (FITs), feed-in premiums, tax credits and tradeable green electricity certificates.

For example, the fixed power prices of FITs give renewables a low risk exposure, by shifting the cost of output variability on to grid operators and fossil-fuel generators. Some believe, however, that to spread the pain and control costs, governments are likely to switch increasingly to other forms of support.

Swiss Re Group is a leading wholesale provider of reinsurance. Its view is that generators will likely be exposed to greater [electricity] market risk.

rodents; modules damaged during installation; module output cut by the failure of bypass diodes or junction boxes; flooding; vandalism or theft of modules; sunlight blocked by new buildings nearby; and module soiling by dust, bird droppings and pollen.

Numerous factors could negatively influence the operation of a PV plant and could lead to a reduction [in] or, in the worst case, to complete yield losses, according to German firm Solare Datensysteme (SDS), which makes the Solar-Log PV monitoring system. It said the failure of one or several inverters, cable damage, errors during installation or reductions from one or several modules due to dirt and grime are only just a few examples.

Yet PV history has been too short to provide enough long-term performance history to assess risks and costs, including risk mitigation costs. However, the two-year Solar Bankability project has been developing PV project risk assessment methods,

typically invest large pension funds for the long term, might demand low risks and steady long-term income, which could require regular and expensive plant maintenance. Engineering, procurement, and construction (EPC) contractors want short warranties, no extra guarantees and low operating costs. A utility might trade some PV profit against a larger share of renewables in its portfolio, whereas home owners and other retail investors might mix profit with environmental and self-reliance aims.

Risk reduction could include insurance, typically for construction risks, poor weather and business interruption, although the latter might be covered by a plant's operation and maintenance (O&M) contractor.

Caroline Tjengdrawira, Solar Bankability's technical manager commented: "Europe needs to build knowledge and understanding of the technical, and consequently the financial, risks over the lifetime of the PV system and come up with targeted recommendations in order to increase the trust of the investors."

Swiss Re believes the world is unlikely to tackle climate change without a huge increase in PV funding. It said new investors and sources of financing are needed to deploy these relatively immature technologies on a larger scale, noting that attempts by plant owners to sell debt or equity will add to the demand for finance.

To quantify costs, Solar Bankability, a project funded by the European Commission's Horizon 2020 programme, has collected data from more than 700 PV plants with a total 420 MWP capacity. Those plants have about 2.4 million components, including about 2 million PV modules and 12 000 electrical inverters. Solar Bankability has also analysed repair and maintenance costs from more than 3500 European insurance claims.

One difficulty has been that PV component manufacturers and plant operators usually keep their performance data secret. Any data from the early days of PV plants may also be poor or poorly understood.

Solar Bankability addressed problems at all project stages, including: component development and testing; planning; transportation and installation of parts; O&M; and decommissioning. "All these risks should be clearly defined. You can save a lot of money if you apply the right mitigation measures," noted Ulrike Jahn, Senior Expert, TÜV Rheinland Energie GmbH and Solar Bankability partner.

To produce practical results, Solar Bankability focused on four types of PV plants; residential (10 kWp or below), commercial (10 - 250 kWp), industrial (250 - 1000 kWp) and utility plants (above 1000 kWp).

Applying a cost priority number (CPN) to rank risks, it found the dominant risks for modules, for example, included: breakage of PV cell glass; potential-induced degradation; and "improper" installation as a result of mishandling, damage to module frames and bad clamping of modules. Falling module prices, the difficulty of repairing modules and the invalidation of manufacturers' warranties if repairs are carried out often makes module replacement the favoured option, says Solar Bankability. However, warranties usually do not cover the cost of installing replacements.

Past studies have found that inverters are the main source of PV system

failures. Modules typically have 20 to 25 year warranties, with a guarantee of 80 per cent efficiency in the final year, but inverters do not last that long on average and will have to be replaced or repaired at least once during a PV plant's lifetime. Solar Bankability notes that integrated circuits and optical components will on average last for 10 years, with electronic components such as bus capacitors, switches and printed circuit boards all being affected by high thermal and electrical stresses.

Utilities' large PV plants might have as many as 3500 micro-inverters/MW, which Solar Bankability says are at risk of failure because of daily temperature cycling, as well as presenting an O&M challenge. Badly installed cabling and the use of many different types of connectors and poor quality cable ties are high risks, it adds. Failures of sun tracking systems, data acquisition systems, medium- and low-voltage cabinets and transformers could all mean large losses of output and large replacement costs.

Citing a 2016 study Solar Bankability says that PV plant fault correction costs increase exponentially – by a factor of 10 at each step of a project. Therefore, overall costs can be cut by preventing defects during initial design and planning, typically through testing and qualification of components and design reviews. It adds that even residential and small PV systems should use qualified/certified EPC firms able to match components to location, humidity and altitude and to understand load-profiles for self-consumption or PPAs.

Solar Bankability puts overall plant operating expenses at about €65–75/MWh/year, with insurance at €4 - 6/kWp/year. TÜV Rheinland Energie suggests that the best combinations of three preventative measures (component testing, design reviews and EPC qualification) could reduce a reference plant O&M cost of €104/kW/year by 90/kW/year.

Mauricio Richter, PV Expert R&D at Belgian consultancy and software firm 3E, and Solar Bankability partner, says that the best combination of mitigation measures could improve LCOE by four per cent.

Plant owners must weigh the cost of different O&M options against the risks. Plants need less attention than conventional power plants, yet even the low-technology measure of cleaning modules is often a condition of manufacturers' and installers' warranties, according to the UK firm Clean Solar Solutions.

However, the effects of lack of maintenance and poor design and construction in the past are becoming evident in today's ageing PV plants.

Vassilis Papaconomou, the new head of the O&M Task Force of trade association SolarPower Europe and Managing Director of Italian O&M firm Alectris said: "Such adverse effects are heavily impacting the generated revenues of solar assets and creating a lot of headaches for investors and lenders."

"O&M was considered as a 'checkbox' to achieve financing and was initially perceived as a burden by the EPC contractors, a pure cost centre for the owners and a formal necessity from the lenders."

A best O&M practice guidelines, including for activities such as claims management, training and health and safety issued by SolarPower Europe will go some way to helping developers.

## Mitigation measures with medium, low and high cost scenarios

Mitigation measure	Medium costs	Low costs	High costs
Component testing of PV modules	€3/kWp (€0.15/kWp/year)	€1/kWp (€0.5/kWp/year)	€10/kWp (€0.5/kWp/year)
Design review and construction monitoring	€20/kWp (€1/kWp/year)	€10/kWp (0.5 €/kWp/year)	€40/kWp (€2/kWp/year)
Qualification of engineering, procurement, and construction firms	€3/kWp (€0.15/kWp/year)	€1/kWp (€0.05/kWp/year)	€10/kWp (€0.5/kWp/year)
Advanced monitoring system	€2/kWp/year	€1/kWp/year	€3/kWp/year
Basic monitoring system	€0.5/kWp/year	€0/kWp/year	€1/kWp/year
Advanced inspection	€2/kWp/year	€1/kWp/year	€3/kWp/year
Visual inspection	€1/kWp/year	€0.5/kWp/year	€2/kWp/year
Spare part management	€10/kWp (€0.5/kWp/year)	€2/kWp (€0.1/kWp/year)	€20/kWp (€1/kWp/year)

Source: Solar Bankability

The USA's production tax credit, for example, exposes projects to competition and has led developers to sign power purchase agreements (PPAs) to ensure a predictable income. In capacity auctions, successful developers receive their bid prices. Swiss Re warns, however, that the developer needs to have a very good understanding of their expected construction and operating costs, and mistakes can prove very costly.

PV installations could be unable to sell their output because of inadequate grid capacity, as building grid transmission lines typically takes decades.

Projects also face many technical risks, from design through to decommissioning, including: PV cell glass broken by hail; cabling damaged by

to pin down the economic impact of failures on the levelised cost of electricity (LCOE) and on PV business models.

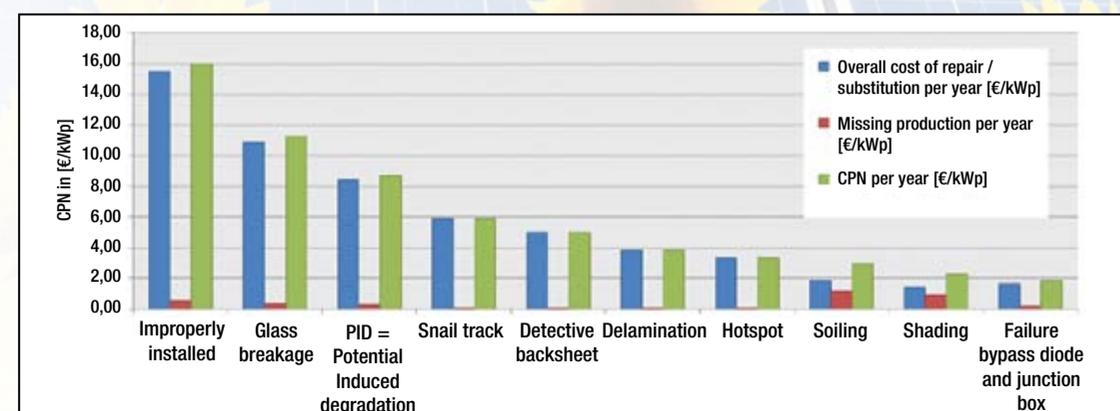
The project, which ends in February 2017 and is funded by the European Union's Horizon 2020 research and development programme, has been developing a framework for calculating planning uncertainties and a commercial risk modelling tool that it says is a world first.

However, the approach must allow for the different risk appetites and assessment approaches of investors, lenders and insurers.

According to Swiss Re, investors might demand long equipment warranties, performance guarantees, low capital costs, low operating costs and long lifetimes. Insurers, which typi-

## Top 10 risks for PV modules of all systems. The cost priority number (CPN) rates risk and is the sum of the other two parameters.

Source: Solar Bankability



# Redefining wave power

The opportunity presented by wave power is significant. **TEI Times** reports on the WaveBoost project, a three-year innovation programme targeting significant improvements in the reliability and performance of wave energy converters.

**CorPower Ocean's wave energy converters comprise a buoy on the surface of the sea that is connected to the seabed by a taut mooring line, and which absorbs energy from the combined surge and heave motion of the waves. A pneumatic pre-tension module runs between the mooring line and the buoy, creating a system with high natural oscillation frequency that is smaller and lighter than conventional gravity-balanced converters**

From a eureka moment in the bath to the observation of an apple falling from the tree, inspiration often strikes at the least expected moments. For Dr. Stig Lundbäck, a cardiologist from Stockholm, it was the pumping mechanisms of the human heart that led to his idea for a viable wave energy converter.

A serial inventor and holder of more than 100 patents, Lundbäck understood the gap between a good idea and a feasible technology. He eventually secured the support of InnoEnergy – the innovation engine for sustainable energy.

“We were immediately interested because wave energy remains the last great untapped source of cost-effective renewable energy,” says Kenneth Johansson, InnoEnergy’s CEO in Stockholm. “Although we have seen commercially viable technologies for harvesting tidal energy emerge, realistic solutions for taking advantage of wave energy are much rarer. Dr Lundbäck’s concept was a significant advance on other technologies, so we arranged for our business coaches and technology experts to evaluate it both technically and economically.”

The opportunity presented by wave power is significant. More predictable, consistent and controllable than either wind or solar power, with the right infrastructure in place, it could be a sustainable alternative for supplying base load power. It also has a very low impact, that neither disturbs aquatic life nor spoils the coastal view that prompts so much ire from the public.

Wave power also fits within the new energy framework being created by distributed energy resources and off-grid applications. Although major utilities, particularly those with extensive offshore wind portfolios, are likely to be the major developers of wave energy farms, single installations can also serve more remote, smaller island-based or coastal communities – and even tourist resorts – particularly in developing economies.

“Studies show that wave energy is five times more concentrated than wind and 10 times more concentrated than solar. In fact, wave energy could supply 10 per cent of global energy demand – or four times the installed capacity of nuclear energy today. That wave energy has not achieved its potential is our big opportunity,” said Johansson.

“Anyone concerned with developing wave energy in Europe will look to the Atlantic coast of France, Spain and Portugal, or the waters around Scotland and Ireland and see enormous possibilities – but until now, have not seen the technology to harvest it.”

The possibilities inherent in wave energy is what has driven the product development of CorPower – from an initial concept to the creation of a company that is preparing to launch a complete prototype system later in 2017. Following positive assessments of the initial technology by InnoEnergy and various external experts, CorPower Ocean has been able to develop the wave energy converter concept into a practical, feasible and competitive product.

Patrik Möller, CEO of CorPower Ocean explained the challenges of bringing a viable wave energy technology to market: “Many smart people have tried to develop wave energy converters, but to date no one has succeeded in making it a commercial product. The challenge is to have a device that is robust enough to survive a tough ocean environment while generating enough revenue over time to make it a viable business case.

“To date, most concepts have either failed the durability test – they couldn’t cope with storm conditions – or their size and weight made them too expensive compared to their energy output.

“The more we explored, we realised there was a significant and principle difference in the way the CorPower device can harvest wave energy and overcomes these reliability problems. In 2012 when we took

the idea to wave energy research centres like WavEC Offshore Renewables in Lisbon and NTNU in Trondheim, they agreed that we were on to something. We have been working with their research groups ever since.”

CorPower Ocean’s wave energy converters comprise a buoy on the surface of the sea that is connected to the seabed by a taut mooring line, and which absorbs energy from the combined surge and heave motion of the waves. A pneumatic pre-tension module runs between the mooring line and the buoy, creating a system with high natural oscillation frequency that is smaller and lighter than conventional gravity-balanced converters.

While CorPower was developing the product, researchers at Trondheim University invented an innovative phase control technology, which CorPower and NTNU agreed to co-develop. Known as WaveSpring, the patented control system makes the buoy inherently resonant over a broad range of wave periods. It amplifies the motion of and power capture from regular waves, while allowing the system to be naturally ‘de-tuned’ during storm conditions. Tank testing has shown that the buoy can survive waves of up to 32 m without excessive load on the structure. This significantly improves the system’s ability to survive in harsh conditions and so lengthens its productive lifecycle. After proving the WaveSpring technology with CorPower, the NTNU inventor Jörgen Hals Todalshaug joined the company as Lead Scientist.

In addition, a proprietary, highly durable drive train is responsible for transforming amplified linear motion into rotation motion. Because the cascade gear divides a large load onto a number of smaller gears – much like a planetary gearbox – it is capable of providing high-power density. As a result, CorPower avoids the poor efficiency associated with the hydraulic power drive trains that typically feature in wave energy converters, as well as large and expensive linear generators that reduce competitive devices’ power rating.

To eliminate the peaks and troughs of power supply, the buoys incorporate a dual set of flywheels/generators that provide power absorption and temporary energy storage. These generators and the power electronics behind them are based on standard components used in the offshore wind industry. Finally, a programmable logic controller is located inside the device to allow the buoy to operate autonomously, while an interface enables remote control and data acquisition by onshore engineers over fibre and a radio-link.

Tests show that the technology delivers optimal performance at sea-depths between 50 and 100 m.

According to Möller, CorPower’s success can also be attributed to its development approach as well as its innovative technology: “We are one of the first wave energy companies to strictly follow a structured verification approach set by the IEA-OES and Wave Energy Scotland. We started on a small scale to prove the reliability and performance of the different pieces of the technology and gradually scaled up, securing funding for further tests as we went

along.

“Historically we’ve seen many developers ramping quickly to full-scale devices being tested in the ocean – where such devices typically haven’t survived or have shown poor power performance. That’s been a painful learning in this sector. There are no short cuts – you can’t build and scale before basic principles of hydrodynamics, system stability and robustness have been proven.”

In accordance with this philosophy, the CorPower device has been through a number of iterations since the first bench-top prototypes were developed. The concept was first validated in 2012 on a 1:30 scale model with €500 000 funding. Wave tank and HIL tests were performed with WavEC, NTNU and KTH on 1:16 to 1:3 scale prototypes, with a further €1.7 million.

CorPower has just started dry testing a half-scale device in a custom-built test environment that emulates wave impacts on the device to prove reliable operation up to full storm and mechanical loading. In the second half of the year, ocean testing will begin at EMEC’s Scapa Flow site in Orkney, with project partners Iberdrola, EDP, University of Edinburgh, WavEC and EMEC. After completing this Stage 3 programme the company aims to start work on the next Stage 4 pilot together with leading partners of the sector.

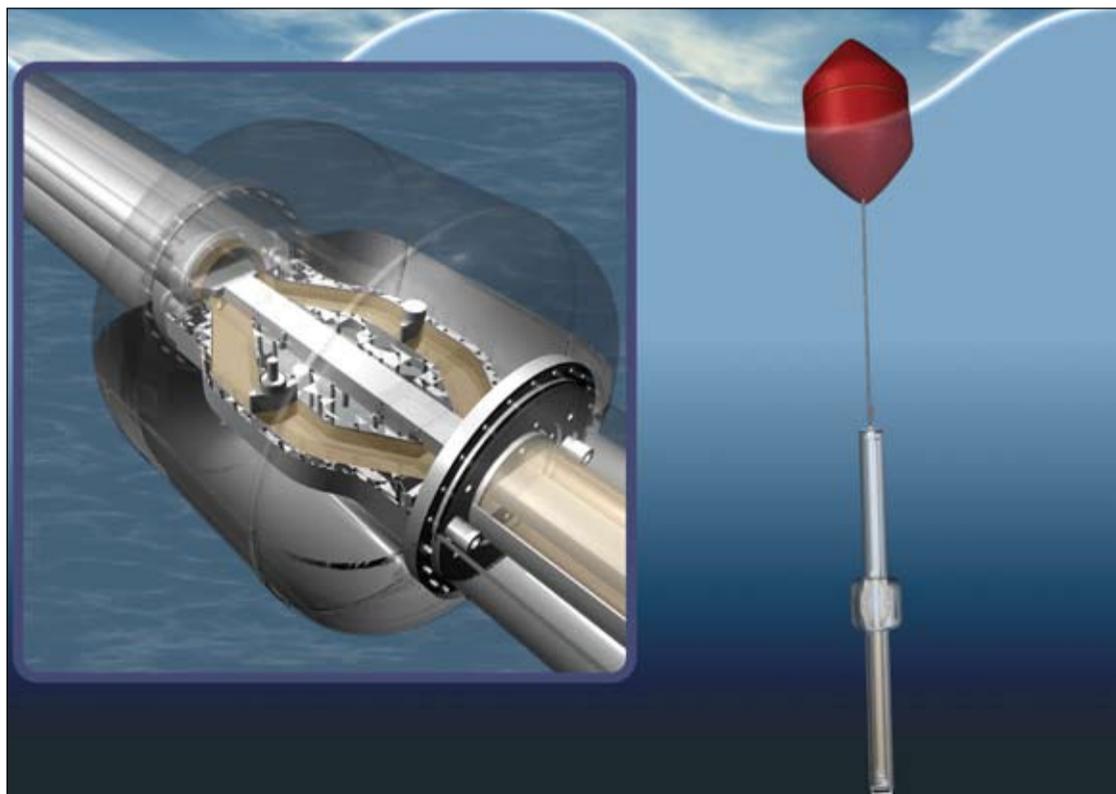
Throughout the Stage 3 programme, CorPower has attracted funding from the Swedish Energy Agency and Wave Energy Scotland, in addition to InnoEnergy. A new programme named WaveBoost, supported by EC’s Horizon 2020 funding, was recently started to further develop innovative concepts that can be introduced at the point of market introduction, without disrupting the architectural design that has been tested.

Möller is confident about CorPower’s prospects: “All the testing and prototyping shows that the technology can generate five times as much energy per tonne and three times as much energy per force compared to previously known solutions to harvest wave energy. We’ve also been able to design it to be robust, compact and significantly lighter than traditional models, so installation, service, maintenance and decommissioning are much easier – giving a low OpEx per kilowatt.”

Möller acknowledges that developments in subsea power cabling and related technologies in both the offshore wind and oil and gas sectors, are also contributing to an increasingly favourable technological and commercial environment for wave power.

“There is an extent to which we are piggy backing on the developments made in offshore wind,” he explained. “But the trajectory is very different. Wind turbines have been optimised over 30 years to achieve 10 megawatt hours per tonne of device. Our device aims to show a similar level of structural efficiency within five years. We anticipate that this will allow the technology to be competitive with most advanced wind and solar implementations after reaching a moderate installed base, and better than nuclear, oil and coal.”

If all goes according to plan, 2017 could be the year that wave energy finally comes in from the deep.





Junior Isles

# Master of the tide or master of disaster?

Against all the odds, Donald Trump finally made it into the Whitehouse – still sounding his clarion call to “make America great again”. While his mantra might be understandable, some of the methods he is proposing to achieve his objective are questionable at best.

Under former President Barack Obama, the US had largely won the respect of the global community in terms of its energy policy and championing the climate change drive. That all looks set to change under President Trump. Global leadership on tackling global warming now seems more likely to come from countries that would have just a few years ago been seen as unlikely candidates.

The recent World Economic Forum in Davos, Switzerland, highlighted just how much the landscape has changed in terms of climate leadership. Speaking as the first Chinese President to attend the summit, Xi Jinping showed how China is increasingly taking a global leadership role in combatting climate change.

While Trump stayed away, President Xi took the spotlight and, without directly mentioning him by name, urged climate change naysayer President Trump to keep the US in the Paris Agreement.

During his speech he said: “The Paris Agreement is a hard-won achievement... All signatories should stick to it rather than walk away.”

If Trump follows through with his threats to “rip up” the Paris Agreement, it will only leave the way open for China to further strengthen its growing

climate leadership position.

China is already home to five of the top six solar panel manufacturers and five of the top 10 wind turbine makers. In early January, it pledged to invest Yuan 2.5 trillion (\$360 billion) in renewable energy through 2020 to reduce greenhouse gases.

Certainly China’s air quality is playing a role in government planning but its clean energy ambitions extend beyond its own borders. In 2016 China spent a record \$32 billion on renewable projects abroad.

According to Bloomberg New Energy Finance, its total investment in renewable energy reached almost \$88 billion, the highest in the world and one third more than the US. Further, the green transition has boosted employment. *Reuters* reports green technology investment will spark the creation of 13 million Chinese jobs. By contrast, roughly 10 million jobs across all industries have been created in the US since the 2008 recession.

These are numbers that President Trump should take note of. Christian Aid’s International Climate Lead, Mohamed Adow urged him to follow his business instincts and not “squander America’s hard fought pro-climate diplomacy”.

He said: “Donald Trump is always telling us how smart he is. Well the smart thing to do on climate change is to listen to the scientists and businesses and ensure America is ready to capitalise on the growing low carbon revolution that will help make it great again. If he doesn’t he will hand the next industrial revolution to

America’s economic rivals.

“China is snapping at America’s heels and is ready to take its mantle as the most pro-active, low-carbon superpower.”

He argued that it is in America’s interest for President Trump to take climate change seriously. Apart from the economic benefits, a recent study by the University of Massachusetts showed that parts of the US are expected to warm much faster than the global average.

Climate change is a top tier geo-strategic issue and the international community needs to be united in its commitment to tackle it. Carbon is not a typical ‘commodity’ that is produced and consumed in the same geographic area. This is one of the reasons we need a global solution.

Speaking in Davos at a special debate on carbon markets, Douglas L. Peterson, President and Chief Executive Officer, S&P Global said: “Carbon is not like many other products. It can be produced in one place but the impact – the ‘consumption’ so to speak – goes into the air and it becomes a global issue.”

It is for this reason that many argue that a global carbon price – in the region of \$40-50 per tonne of CO<sub>2</sub> – is needed to induce the right behaviour.

At the same debate, Catherine McKenna, Minister of Environment and Climate Change said that “putting a price on pollution” instead of “putting a price on carbon” has worked well in Canada.

She said the Paris Agreement was a signal to the markets, observing that addressing climate change was not just

an obligation but also an opportunity.

McKenna noted: “The conversation is no longer limited to the NGOs and governments. It has gone far beyond that. It’s now the business sector, financial institutions, etc.”

“I have had so many bilaterals with businesses and companies who are saying ‘yes we have an internal price on carbon’. Many good companies are looking at how they find opportunities but also how do they manage risk... I see this as a huge opportunity, so that’s why Canada has stepped up. Pricing pollution is a way to actually prepare our economy to make it more attractive for investors. I’ve actually had so many companies come to us and say ‘we like what’s going on in Canada’ because you’re providing certainty to the market.”

It is a far cry from the noises that have been made by President Trump, who is doing little to ease the concern of international clean technology investors. His isolationist rhetoric on trade prompted President Xi to say: “Pursuing protectionism is like locking oneself in a dark room. While wind and rain may be kept outside, that dark room will also block light and air. No one will emerge as a winner in a trade war.”

Indeed, his protectionism will do nothing to help the US take advantage from the burgeoning clean technology sector. In an interesting report, the UK’s *Guardian* newspaper interviewed more than a dozen leading global voices on climate change in the run-up to Trump’s inauguration.

“The best way to make America great again is by owning the clean technologies of the future,” said Michael Liebreich, who has advised the UN and World Economic Forum on energy. “Not only will this create countless well-paid, fulfilling jobs for Americans, but it will also lock-in the US’s geopolitical leadership for another generation.”

Meanwhile, John Schellnhuber, a climate expert who has advised Angela Merkel, the Pope and the EU said: “I would say [to Trump], if you want to make China great again, you have to stay the course you have promised.”

President Trump, who has called global warming a hoax created by the Chinese, appears to have softened his stance a little since his election win, saying there is “some connectivity” between human activity and climate change. However, he also claimed climate action was making US companies uncompetitive.

Above all President Trump has to realise we live in an interconnected world and that he cannot turn back the clock; the clean energy surge is in full flow.

He may want to build “a big beautiful wall” along the Mexican border, which may stop the less determined potential immigrants but that will not hold back climate change. New data released last month revealed that temperatures rose to their hottest on record for the third year in a row in 2016 and that global temperatures have already soared more than 1°C since pre-industrial times – halfway to the 2°C considered a crucial ceiling under the Paris deal.

King Canute once demonstrated that he had no power to hold back the tide. President Trump will no doubt find the same applies for climate change.

