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Europe's vision of building a grid capable of handling a large amount of renewables is looking increasingly realistic following the completion of testing of an HVDC circuit breaker under real network conditions.

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State aid wasting taxpayer money



Almunia: Britain "must clarify why state aid is needed" to build Hinkley Point C

The UK's strategy for attracting investment in low carbon technology, which is being watched closely by other member states, has come under fire in Brussels. **Junior Isles**

The UK's strategy for promoting both nuclear and renewables has been heavily criticised by the European Union. The country's ongoing energy market reform is being closely watched by other EU member states but Brussels is seeing its method of supporting nuclear and renewable technologies as a potential waste of money.

EU concerns that the subsidies that support them might be a waste of taxpayer money has thrown some of Britain's flagship renewable energy projects into doubt.

Difficulties in securing European Commission state aid approval threaten to delay the rollout of the first batch of Contracts for Difference (CFDs), a form of subsidy for renewable and nuclear projects designed to attract investment in low carbon generation. Under the CFD, if the market price for electricity is lower than an agreed 'strike price', the developer receives a top-up payment. If it is higher, the developer has to pay the difference.

According to people involved in the informal talks, concern in Brussels has

focused on an early form of CFD that the government wants to award to nine projects in April.

Brussels has informally warned the UK that the projects concerned appear to involve heavy subsidies that may be overgenerous and harmful to competition. A formal application for the schemes has not yet been submitted but Britain is being asked to provide more detailed information.

Britain revised its CFD plans after Brussels proposed to tighten its rules on offering state backing to established

low-carbon technologies. It brought forward competitive auctions and opened bidding to all low-carbon producers but these changes did not apply to the early CFDs.

The Department of Energy and Climate Change told the *Financial Times*: "We are currently engaged in negotiations with the European Commission to get state aid approval and there is nothing to report at this stage."

Brussels is also investigating the deal

Continued on Page 2

US calls for cooperation on emissions reduction

Chances of a global deal on climate change gained a boost last month as the US called on countries to jointly engage in reducing greenhouse gas.

Speaking in Indonesia at the end of a week-long visit to four Asian countries, including China and South Korea, State Secretary John Kerry said: "If we are going to prevent the worst consequence of climate change, especially in a place like Indonesia where you are at the front line on this threat, we need everybody to engage."

He asked Indonesia to step up cooperation in the effort and called on other nations to jointly take part in the works.

Earlier that week the US and China promised to cooperate more closely in combating climate change. China and the US are the biggest emitters of

carbon dioxide and other greenhouse gases (GHGs) attributed to causing global warming.

In a joint statement, the two governments said they will "contribute significantly to successful 2015 global efforts to meet this challenge". The statement re-iterated the two countries' agreement on steps to carry out commitments to curb output of GHGs.

Beijing and Washington launched the US-China Climate Change Working Group last year. They promised progress in five areas – reducing vehicle emissions, advanced electric power grids, capturing and storing carbon emissions, gathering GHG data and buildings efficiency.

In a separate report, the World Wildlife Fund (WWF) said China could

transition to an 80 per cent renewable electric power system by 2050 at far less cost than continuing to rely on coal. It said this could be done if appropriate policies and measures are taken, on condition that energy efficiency would improve aggressively.

As a result, China's carbon emissions from power generation could be 90 per cent less than currently projected levels in 2050 without compromising the reliability of the electric grid or slowing economic growth, the report said.

"I think this report is quite significant for China," WWF's China Climate and Energy Programme director Lunyan Lu told *Xinhua*.

Considering China has experienced 30-year fast economic development,

and serious environmental pollution and global climate change are threatening its future development, China is standing at a "cross road" for energy transition, Lu said.

"China must face the issue of energy transition. The biggest problem we mentioned (in the report) is political will," said Lu, as "no matter what energy structure China chooses, it will involve huge economic interests behind."

Lu said different energy sectors will fight on this issue but WWF hopes China can choose a way that really benefits its future generations. WWF will make further research on issues related to coal consumption and massive usage of renewable energy in China.

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between the UK government and French utility EDF for the construction of the Hinkley Point C nuclear power plant. It raised concerns about the CFD, saying the plant would have been profitable even without the £17.6 billion (\$29.4 billion) of taxpayer support being provided.

Joaquín Almunia, the EU's competition commissioner, said Britain must clarify why state aid is needed to build the plant.

In its initial analysis of the deal to build the first new nuclear reactor in the UK for a generation – published on the Commission website at the end of January – the European Commission was highly critical of the level of state aid.

Brussels has said that the deal may not be acceptable under EU state aid regulations, and risks substantially over-compensating EDF's Nuclear New Build Generation Company (NNBG), with aid to EDF ending up between £5 billion and £17.6 billion.

It argues the support may be unnecessary noting that “private investors are forecast... to invest in nuclear energy by 2027 and by 2030, respectively, in the absence of CfDs or Investment Contracts”.

The Commission also stated that the deal is expensive for the consumer. “The measure, moreover, could hardly be argued to contribute to affordability – at least at current prices, when it will instead and most likely contribute to an increase in retail prices.”

The UK has stressed that it needs the deal to keep the lights on but that argument has been refuted, with the Commission highlighting that the plant will not be operational before 2023.

There is concern that a support mechanism, which is specific to nuclear energy generation, might crowd out alternative investments in technologies or combinations of technologies, including renewable energy sources.

The Commission intends to make a final decision on the EDF contract before the end of the year.

Commenting on the Commission's report, Nick Molho, head of climate and energy policy at WWF-UK, said: “The suggestion by the European Commission that support for Hinkley Point C could crowd out investments in renewable energy, and would therefore do little to help decarbonise our energy system, is very concerning.”



Molho is very concerned about Commission's findings

Nuclear energy and renewables accounted for more than half of energy production in EU countries in 2012, according to Eurostat, the statistical office of the European Union. It also stated that between 2006 and 2012, gross inland energy consumption fell by 8 per cent.

Meanwhile, a recent report by the European Wind Energy Association showed that the amount of new wind energy capacity to come on line in the EU in 2013 also fell by 8 per cent compared to 2012. In 2013, 10 917 MW of wind generation was brought on line. However, wind remained the technology that was installed the most in 2013, with 31 per cent of total power capacity installations.

Light at the end of the tunnel?

Some of Europe's utilities are starting to see a way out of their financial woes, while others remain stuck in the doldrums.

Siân Crampsie

Efforts by European utilities to shore up balance sheets are starting to pay off.

Enel has cut net debt by €3 billion while Dong Energy says that an investment by Goldman Sachs hails the completion of the utility's financial turnaround.

Enel's debt had become a concern for investors but an asset disposal and cost-cutting scheme has trimmed it by seven per cent to €39.9 billion.

The Italian utility became Europe's most indebted utility after it took over Endesa in 2007.

Goldman Sachs has invested DKr8 billion (\$1.4 billion) for an 18 per cent stake in Dong, which says it

is expecting to return to profit in 2014 after two years of losses. The Danish government-owned energy company also attracted DKr5 billion from two Danish pension funds.

Dong's and Enel's financial woes are typical of Europe's utilities, which have been put under pressure by a fall in energy demand and an increase in subsidised renewable energy generation.

The result has been a significant drop in revenues from conventional power plant assets, and in Germany this has been exacerbated by the closure of some nuclear power plants.

RWE said in late January that the slump in profits from its power plant business would force it to make a €3.3 billion write down in its 2013 earnings. RWE also says that its Executive Board

members will forgo a total of €500 000 in their remuneration in 2014. “The company is in a very difficult situation. It goes without saying that we wish to make our contribution too,” explained CEO Peter Terium.

Net income at E.On fell by more than half in the first nine months of 2013, compared with the same period the year before. French utility GDF Suez has also warned it will write down European power assets.

GDF Suez has, however, been buoyed by its strategy of investing outside Europe and its Chairman and CEO Gerard Mestrallet said last month that this would continue because of the declining business environment in Europe.

At the end of 2013, GDF Suez had mothballed around 10 GW of capacity

and is reviewing a further 5 to 7 GW.

But most utilities have been forced to sell assets. Last month Iberdrola sold its 22.6 per cent indirect stake in the 462 MW Itapebi hydropower plant in Brazil to Brazilian firm Neoenergia. It has also sold a stake of just under five per cent of Energias de Portugal (EDP). The transactions are part of a €2 billion asset disposal programme.

Dong Energy in February sold half of its 50 per cent stake in the London Array offshore wind project to La Caisse de dépôt et placement du Québec, a Canadian pension fund manager. It said the move would enable it to continue investing in offshore wind, particularly its pipeline of two major projects in the UK and two in Germany.

Policy certainty proves key in country rankings

■ UK slips down renewables ranking ■ Poland tops conventional generation list

Junior Isles

Separate reports by PA Consulting and Ernst & Young (EY) show that clear and stable energy strategy combined with the right support schemes is key to attracting investment in the global power generation landscape.

PA Consulting Group's Energy Investment Map, which compares the potential rates of return and risks across technologies, revealed the changing energy landscape in 31 countries across Europe, Asia Pacific, the Gulf, BRICS and the US.

Analysing the renewables sector PA's Map shows that with the development of new offshore wind capacities progressing rapidly, Denmark has taken the lead from China and is expected to generate 50 per cent of electricity from wind by 2020.

Although China has dropped to third, the country remains a highly

promising market for renewables, due to government support that provides attractive pricing.

The Philippines' potential for new capacities and a robust market environment with feed-in tariffs for hydro, biomass, wind and solar projects, mean it has risen to second place in the index (from fifth) and is a key target for renewable energy investors.

Other countries appearing at the top of PA's ranking are Austria, Sweden and the United Kingdom.

Although the UK is high on the PA ranking, the latest country attractiveness report by EY showed that it has slipped to fifth place in the renewables attractiveness index.

According to EY's quarterly Renewable Country Attractiveness Indices (RECAI), a combination of prolonged policy uncertainty, news that mature technologies must compete for Contracts for Difference (CFD) from day

one, and a series of offshore wind project cancellations mean that the country has become less attractive in the eyes of investors.

At the same time, rapid solar market growth and a burgeoning offshore sector helped Japan to replace the UK in fourth place.

Ben Warren, EY's Environmental Finance Leader said: “The UK's fading appeal is the direct result of the lack of clarity on the government's long-term energy strategy at a time when energy security is a concern and investors are looking for commitment.”

In terms of conventional energy for 2014, according to PA Consulting's Map, Poland ranked top with vast coal and gas reserves, and has significant shale gas resources soon to be exploited, as well as a clear energy strategy though to 2030.

India, which previously ranked first, now ranks second but continues to

have increasing demand due to the country's economic growth. Ireland (3) and Turkey (4) are pushed up the ranking as demand for new conventional power capacities drives investment potential.

The biggest change is the Czech Republic, which ranks sixth compared to 18 in the last analysis. The country has completely phased-out renewable energy subsidies and plans to focus on coal, gas and nuclear power generation, creating opportunities for investments in conventional power.

Olaf Remmler, energy expert, PA Consulting Group says: “Investors in energy generation must contend with significant uncertainty, complex market and regulatory conditions and the rapid advance of renewable technologies. To make the right decisions, they need to understand the regulatory and economic factors affecting their projects and investments.”

India maintains solar stance

India says it will defend its stance that its policies are World Trade Organisation (WTO) compliant after dismissing US allegations that its solar energy programme discriminates against American companies.

Last month the US again challenged the domestic content requirement of India's solar mission, which requires solar power developers to use Indian-made equipment. It alleged that the requirement was discriminatory and against international norms, including WTO laws, and affects US solar

panel manufacturers.

India's Commerce Secretary Rajeev Kher argued: “The US already had a consultation with us on solar domestic content and now they have come in for a second-phase challenge. It is not a surprise... We will participate in the consultations. Our current policy is WTO compliant. We will defend it.”

He also pointed out that several US companies have won contracts in phase II of India's Jawaharlal Nehru National Solar Mission launched in 2010. “If you look at the phase-II contracts, you

will see that most of the contracts have gone to the American companies. They have participated in those bids and many of them have succeeded.”

In October, India approved measures for implementation of phase II of the Mission. For projects under phase II, US Trade Representative Michael Froman alleges that India is again imposing domestic content requirements, under which developers must use Indian-manufactured solar cells and modules.

India is vital to the US because it is the second largest export market for US

solar products and its national solar programme is set to grow 20-fold over the next decade. The national mission aims to add 20 000 MW of grid-connected solar power to the country's energy mix by 2022.

Just days after the US protest, India's Finance minister P. Chidambaram announced the setting up of four large solar projects. The four 500 MW projects to be built in 2014-15 are part of the national solar mission. The first phase of the mission added 1684 MW of grid-connected solar power.

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Vogtle deal boosts US nuclear industry

A loan guarantee for two new nuclear reactors in the USA is positive news but nuclear plants remain undervalued by the market.

Siân Crampsie

The US government has signalled its support for nuclear power by agreeing a long-awaited \$6.5 billion loan guarantee for a new nuclear plant being built in the state of Georgia.

The federal loan guarantee is the first in the USA for a nuclear power plant and will support the construction of two reactors at the Vogtle nuclear power plant.

Nuclear energy is part of US President Barack Obama's "all of the above" energy strategy but planned investment in long-term nuclear energy projects in the country has waned with the emergence of cheap shale gas over the last five years.

The dramatic fall in the price of natural gas has also put existing nuclear power plants in the USA at risk of closure.

Exelon and Entergy are among the US power generators facing pressure to close some of their nuclear plants as a result of competition from gas-fired power plants and renewable energy projects that receive fiscal support.

About 3.6 GW of nuclear generation capacity was retired in the USA last

year, compared with 4.5 GW of coal-fired capacity, according to the US Energy Information Administration.

Nuclear plants facing shutdown include San Onofre, operated by Edison International, Duke Energy's Crystal River, Entergy's Vermont Yankee, and Dominion Resources' Kewaunee.

Other nuclear plants thought to be at risk include Entergy's Pilgrim plant and Exelon's Clinton plant.

Marvin Fervel, President and CEO of the Nuclear Energy Institute (NEI) said in February that the closure of nuclear capacity shows that the market does not adequately value the reliability that the country's nuclear plants provide.

The new units at Vogtle will be co-owned by Georgia Power and its partners Oglethorpe Power Corporation, Municipal Electric Authority of Georgia and Dalton Utilities. Loan guarantees allow for greater access to capital markets and therefore result in lower-cost financing.

The loan guarantee is expected to save Georgia Power customers \$200 million on electricity costs, according to the NEI.

"The nuclear industry applauds the

Department of Energy and Southern Company for fulfilling the promise of the clean energy loan guarantee programme enacted by Congress in 2005," said Fervel. "The agreement demonstrates the Obama administration's recognition of the key role nuclear energy must play in a successful clean energy policy."

"The agreement with the DOE is an important milestone for the project and one that will create significant savings for our customers," said Paul Bowers, President and CEO of Georgia Power. "The Vogtle units 3 and 4 project is more than 50 per cent complete and, when fully operational in 2018, will help to secure the state's energy future and drive economic growth by providing needed energy for new homes and businesses across Georgia for the next 60 years."

The total impact on customer rates once the two new units are in service is currently projected to be between 6 and 8 per cent, substantially less than the 12 per cent rate impact originally contemplated for capital costs at the time of project certification in 2009. This is partly due to the loan guarantees, says Georgia Power.

USA debates coal rules

- DOE says CCS not yet ready for market
- New rules would lead to higher electricity prices

The US government is under pressure to rethink its proposed new source performance standards (NSPS) for new power plants.

The Environmental Protection Agency (EPA) published the proposed rules at the beginning of the year but the country's coal industry is concerned about the impact they would have.

The American Public Power Association (APPA) said that the rules would lead to higher electricity prices and "effectively preclude coal going forward as a resource for electricity generation".

The proposed rules would require any new coal-fired plants to use carbon capture and sequestration (CCS) technology to trap and store a portion of their emissions for up to 1000 years. The EPA says that this is realistic because clean coal plants with CCS are under development but APPA and other opponents argue that none of the projects cited by EPA in the USA are anywhere near operation.

Last month officials from the US Department of Energy told the House Energy and Commerce Committee that CCS is not yet ready for market and that early projects would cost \$70-

90/t of captured carbon – equivalent to a 70-80 per cent increase on the wholesale price of electricity. Second-generation demonstration projects would cost \$40-50/t, according to the DOE.

The Obama administration says that clean coal projects equipped with CCS would be eligible for loan guarantees as well as providing other forms of fiscal assistance.

The American Coalition for Clean Coal Electricity (ACCCE) says that the EPA is exceeding its authority under the Clean Air Act in trying to regulate greenhouse gas emissions. Laura Sheehan, senior vice president of communications for ACCCE said: "[The] hearing shed further light on how grossly underdeveloped CCS remains and revealed the staggering cost increases American consumers and manufacturers will face if future power plants are forced to operate under EPA's inane regulations."

Sheehan added: "DOE and EPA are wasting valuable taxpayer dollars by pursuing policies that will do nothing to build economic confidence and create jobs but everything to drive up energy costs and put hardworking Americans out of work."



Broadview signs Tres Amigas agreement

The proposed Tres Amigas 'superstation' in the US state of New Mexico has signed up its first customer, raising hopes that the project will be able to complete financing in the next few weeks.

Tres Amigas has signed a deal with Broadview Energy LLC to deliver wind energy from a proposed wind farm in New Mexico to California for 25 years.

The deal has been billed as a landmark agreement that will facilitate the development of the 500 MW wind farm as well as boost the delayed Tres Amigas project.

Tres Amigas is a \$550 million project to interconnect three US grids to boost energy security and enable the integration and sharing of renewable

energy resources.

Groundbreaking was originally expected in July 2012 but delays in financing have held the project up. Officials say that the project is 75 per cent financed and that the rest could be in place by the end of March. This would mean that construction could start in June 2014.

Construction would take place in three phases over eight years. Development of the project would encourage the development of more wind farms and other energy developments in the area, says Tres Amigas.

Broadview is proposing to develop its wind farm in two phases, the first of which would comprise 12 GE turbines. Its agreement with Tres Amigas stipulates that energy transmission

will start at the end of 2015.

Broadview's second phase development would involve installation of a further 188 GE wind turbines.

Once complete, Tres Amigas will enable 4750 MW of electricity to be transmitted between the Eastern, WECC and Ercot grids. It has negotiated agreements with Eastern and WECC.

Its first phase will cost \$429 million and would transfer 750 MW of energy between the Eastern and WECC grids.

The second phase will cost \$436 million and enable the transfer of 1500 MW of power between the Eastern and Texas grids. The final \$793 million phase would add more capacity to the link.

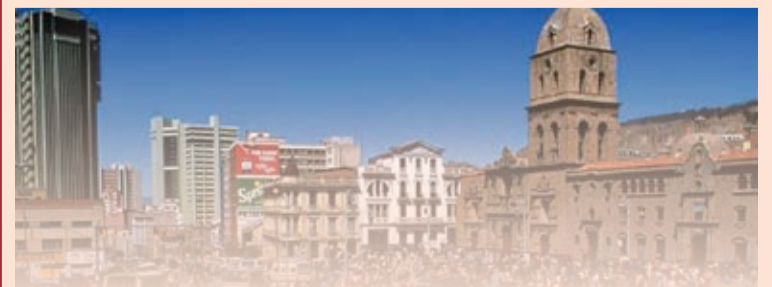
Rurelec wins Bolivian challenge

Rurelec has been awarded over \$35.5 million in compensation after an international arbitration tribunal ruled that the Bolivian government was unlawful in its expropriation of shares owned by the British firm in a Bolivian energy company.

The Hague-based tribunal upheld a complaint filed by Rurelec that the expropriation of its 50 per cent stake in Empresa Guaracachi SA breached an investment treaty between the UK

and Bolivia. Rurelec said that the ruling was "a vindication of the Rurelec management's efforts to obtain justice for its shareholders".

The Bolivian government nationalised all of the Bolivian generation interests of Rurelec in May 2010. The UK energy firm says that Guaracachi itself owes Rurelec a further \$5.5 million in the form of declared but unpaid dividends going back to the time before nationalisation.



The Bolivian government nationalised all of the Bolivian generation interests of Rurelec in May 2010



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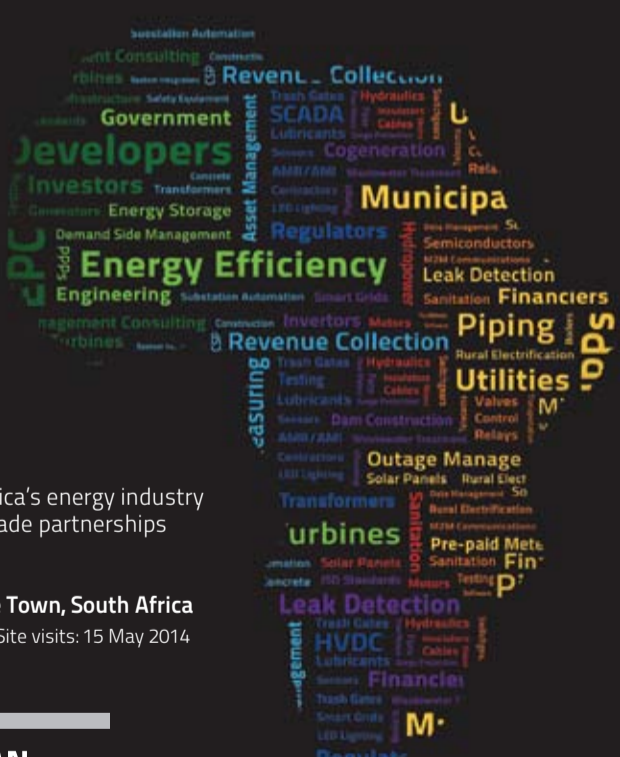
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Pakistan turning to coal and hydro to cut costs

■ Contract awarded for Tarbela extension ■ ADB OKs Jamshoro loan

| Syed Ali

Pakistan is planning new coal and hydropower plants in an effort to lower the cost of electricity production. The Pakistan Economy Watch (PEW) recently expressed grave concern over rising cost of power generation, saying it is one of the biggest problems, having the potential to bankrupt the country.

Pakistan has been facing rising oil prices and declining gas reserves as well as a tight foreign account situation, making the reliance on the import of oil to fuel power plants increasingly unaffordable. The country spends more than \$14 billion per year on importing oil, a major part of which is

used for power generation.

The government is therefore looking to use its indigenous coal and hydro resources to ease the situation. On February 17, the European Investment Bank (EIB) granted a €100 million long-term loan to the government for the construction of the 128 MW run-of-river Keyal Khwar hydropower project.

Meanwhile, following World Bank approval, the Water and Power Development Authority (Wapda) awarded a \$312 million contract to a consortium, comprising Voith Hydro of Germany and Voith Hydro Shanghai of China, for electro-mechanical works for the 1410 MW Tarbela fourth

Extension hydropower project.

The extension is part of a least-cost electricity generation strategy being implemented by Wapda. With annual benefits estimated at about Rs30.7 billion (\$494 million), the project is expected to pay back its cost in just three years.

In mid-February Ciner Group of Turkey agreed to immediately start work on a 660 MW coal fired power plant at Gadani, near Karachi. The National Engineering Services Pakistan (Nespak) is preparing a master plan and feasibility study for a \$14 billion power complex at Gadani that would include ten coal fired plants of 660 MW each.

The news came as Pakistan and

the Asian Development Bank (ADB) signed a loan agreement under which the bank will provide \$900 million for the Jamshoro coal fired power plant. The project, consisting of two new super-critical coal-fired units with the capacity of 2x600 MW, will be constructed in Sindh province.

Jamshoro was approved by the ADB's Board of Directors in December 2013 and is expected to be completed by December 2018.

Sindh Province will play a big role in meeting the country's energy needs. On 31 January Prime Minister Nawaz Sharif and former president Asif Ali Zardari jointly performed ground breaking at the \$1.6 billion

Thar coal power project.

Pakistan recognises it will also have to rely on energy imports to combat its chronic power shortages. It was reported last month that the government is close to signing a deal with Qatar, worth as much as \$2.5 billion a year, for the supply of liquefied natural gas (LNG) from the Gulf emirate for gas power generation.

Pakistan is also looking to import electricity from its neighbours. In early February, Medetbek Aitkulov, Director General of National Electric Network of Kyrgyzstan Company said Kyrgyzstan and Tajikistan were ready to export up to 5 TWh annually to Pakistan under the CASA-1000 project.

Australia to review renewables targets

Australia is to review its renewables targets as businesses complain about the impact on electricity costs. **Syed Ali**

Australia's government last month said it will review the Renewable Energy Target (RET) scheme's impact on retail electricity prices, a move that is expected to clear the way for the government to make significant changes to the scheme.

In a joint media release, Minister for Industry Ian Macfarlane and Minister for the Environment Greg Hunt said: "In particular, the review will consider the contribution of the RET in reducing emissions, its impact on electricity prices and energy markets, as well as its costs and benefits for the renewable energy sector, the manufacturing sector and Australian households."

The review's report will be provided to the government by the middle of the year, which will in turn be an important input into the Energy White Paper process.

The Australian Chamber of Commerce and Industry (ACCI), Australia's largest and most representative business organisation said RET is already imposing considerable costs on businesses and households.

It said the scheme now accounts for around 5 per cent of an average household's electricity bill and along with the carbon tax has left green schemes as the fastest growing proportion of consumers' energy bill over the past two years.

The Climate Institute, an environmental group in Australia, stressed, however, that the RET review should focus on a clear objective of the policy, that is, reduce Australia's emissions.

Just prior to the announcement the Climate Institute, an independent research body, said new greenhouse inventory data shows that Australia's

total emissions rose by 1.3 per cent in the year from September 2012 to 2013. Notably, emissions from electricity fell by 5.5 per cent, or 10 million tonnes.

"Electricity emissions continued their significant decline due to renewable energy and energy efficiency policies as well structural economic changes and the carbon price, the latter always intended to become a more major driver over time," said John Connor, CEO of The Climate Institute.

■ Australian utility AGL Energy has agreed to buy New South Wales state-owned power company Macquarie Generation for A\$1.5 billion (\$1.4 billion). The sale marks the start of a busy year for Australian privatisations, as strong demand for high quality assets coincides with tight government budgets and a need for major infrastructure spending.

China steps up renewables drive

The National Energy Administration (NEA) says China is aiming to increase the share of non-fossil fuels in its overall energy consumption to 10.7 per cent in 2014.

The feasibility of the target was supported by the recent report, *China's Future Generation*, prepared by the Energy Transition Research Institute (Entri) for the World Wildlife Fund (WWF).

By embracing conservation measures and renewable energy, China can transition to an 80 per cent renewable electric power system by 2050 at far less cost than continuing to rely on coal, says the report.

As a result, China's carbon emissions from power generation could be 90 per cent less than currently projected levels in 2050 without compromising the reliability of the electric grid or slowing economic growth.

The NEA noted that China's solar developers installed a record 12 GW of photovoltaic projects in 2013, and a booming market at the very end of

the year may even have pushed installations up to 14 GW. No country has ever added more than 8 GW of solar power in a single year prior to 2013, and China's record outstripped even the most optimistic forecasts of 12 months ago.

China's installed power capacity increased by 94 GW in 2013, according to recent NEA figures. Thermal power accounted for the bulk of the capacity growth, reaching 36.5 GW, followed by 29.93 GW from hydropower, 14.06 GW from on-grid wind power, 11.3 GW from on-grid solar power and 2.21 GW from nuclear.

■ According to a report by the Chinese Academy of Social Sciences (CASS), China's energy demand will account for 24 per cent of the world's total by 2035. CASS' *World Energy China Outlook (2013-2014)*, claims China's energy demand will grow by 2.23 per cent each year between 2011 and 2035, higher than the 1.9 per cent prediction for world energy demand by the International Energy Agency (IEA).

Japan eyes car batteries for energy storage

Sumitomo Corporation has developed and installed the world's first large-scale power storage system to utilise used batteries collected from electric vehicles (EV).

Over the next three years, the system will measure the smoothing effect of energy output fluctuation from the nearby "Hikari-no-mori," solar farm, and will aim to establish a large-scale power storage technology by utilising the huge quantities of used EV

batteries that will become available in the future.

The project has been selected as a model project for "Verification of the battery storage control to promote renewable energy" for the fiscal year 2013 by the Ministry of the Environment of Japan.

Sumitomo created the joint venture company, 4R Energy Corporation, in collaboration with Nissan Motor Co., Ltd. in September 2010, to address the

secondary use of EV lithium-ion batteries. The used EV batteries that will be recycled into this large-scale storage system have been recovered and have undergone thorough inspection and maintenance to confirm safety and performance. This prototype system (600 kW/400 kWh) consists of 16 used EV batteries.

The commercial scale storage system, built on Yume-shima Island, Osaka, began operating last month.

Bangladesh issues new Bibiyana tender

Bangladesh's government has floated the tender for a large gas-based power project in Bibiyana. For the first time, the Power Development Board (PDB) plans to use its own funds to finance the 400 MW South Bibiyana power project, which would be built in place of the cancelled Bibiyana-1 project with local company Summit.

Observers say this might be the last gas-based power project considering

the ongoing gas supply shortfall.

Bangladesh's struggling power sector received a boost last month when the Asian Development Bank (ADB) agreed a \$310 million loan. An ADB statement said the assistance is the second tranche of its \$700 million financing under an overall 1.6 billion multi-donor-supported project named Power System Expansion and Efficiency Improvement Investment Programme.

Europe News

Poland pushes forward with nuclear plans

- Owner's engineer tenders opened
- Hungary approves Russian finance

| Siân Crampsie

Poland is preparing to develop its first nuclear power plant after its government adopted a national nuclear power programme.

The national nuclear power programme sets out a regulatory environment, project schedule and investment framework for the construction of two nuclear power plants.

PGE EJ1, a special purpose company established by utility PGE to develop the projects, says it is now seeking technology and financial partners, and last month opened the tenders submitted in the owner's engineer selection process.

The development of nuclear power plants in Poland is seen as vital to the country's energy sector, which is heavily reliant on ageing coal fired power plants. The nuclear programme envisions the construction of two 3000 MW power plants, with the first operational by the end of 2024.

The Polish government is hoping to select a site for the nuclear plant development by the end of 2016 as well as sign the contract for the

construction of the first unit. It says that by 2030, Poland should have up to 6000 MW of nuclear generating capacity accounting for 17 per cent of electricity generation.

Development of a nuclear sector would also assure Poland's energy independence and limit its future dependence on Russia for energy supplies. The country has the largest reserves of coal in Europe and has traditionally been a net exporter of electricity to neighbouring countries such as the Czech Republic and Slovakia.

However in recent years exports have started to dwindle due to rising domestic energy demand. Poland is keen to exploit its shale gas reserves and its renewable energy potential alongside the nuclear programme.

Sites under consideration for the Polish nuclear plant programme include Choczewo and Gaski on the Baltic coast and Zarnowiec – a lakeside site in Pomerania. WorleyParsons is carrying out site characterisation, licensing and permitting for the project.

In February PGE said that Amec, Exelon, a consortium led by Mott

MacDonald and another consortium led by URS Polska and Tractebel had all submitted bids for the owner's engineer contract. PGE says it will award this contract in late 2014.

Other East European countries are turning to Russia to assist with the construction of nuclear capacity.

Hungary's parliament has authorised a deal with Russia to build two reactors at Paks.

Russia will loan Hungary up to €10 billion to help finance the construction of two Russian reactors at Paks, the first of which is due to start operating by 2023. Hungary will repay the loan – which will cover 80 per cent of the construction costs – over 21 years.

Financing for Poland's new nuclear plants is unclear, however. PGE has formed a consortium with copper miner KGHM Polska Miedz SA and power utilities Tauron Polska Energia SA and ENEA to develop the programme but the parties have not yet agreed on equity. The Polish government has said it will not provide finance for the project and PGE is likely to seek finance from export credit agencies and commercial debt.

Offshore wind set for slow down

Europe's offshore wind energy sector saw record installations in 2013 but growth levels will be short-lived, according to the European Wind Energy Association (EWEA).

The industry group says that 418 offshore turbines came online in 2013, adding a record 1567 MW of new capacity to the grid.

However it believes that project delays and a reduced number of new project launches will lead to a decline in installations in 2016.

EWEA believes that policy uncertainty in key offshore markets such as the UK and Germany is the cause of the projected slowdown. It says that there are currently 11 projects under

developers more than halved last year.

"An ambitious decision on a 2030 renewable energy target by the Heads of State in March would be the right signal to send to the offshore wind sector that Europe will develop its massive offshore wind potential for green growth, jobs, industrialisation, technological leadership and CO₂ reductions," added Wilkes.

Scottish Renewables obtained figures from offshore wind developers with projects in Scottish waters about their investments in Scotland during 2013. These suggest £28.9 million was spent in 2013 compared to £63.6 million in 2012.



construction in Europe, down from 14 this time last year.

"Installations are likely to plateau until 2015, followed by a decline as from 2016," said Justin Wilkes, Deputy CEO at EWEA.

EWEA's figures are backed by data from Scottish Renewables, which shows that investment in Scotland's offshore wind industry by major

Richard Cockburn, Renewables Partner at law firm Bond Dickinson said the economics of offshore wind and the maturing of the UK's offshore wind sector was tempering enthusiasm for projects. "Businesses are looking afresh at the figures underpinning their projects and making hard-nosed decisions about the future of those projects," said Cockburn.

Germany debates energy future

- Capacity mechanism questioned
- Merkel reforms EEG

German Chancellor Angela Merkel's ambitious plans to transition the country to renewable energy have hit more obstacles.

The country's finance minister Wolfgang Schäuble has expressed concerns about the costs and impacts of Germany's green agenda, while a plan to cut subsidies for renewable energy technologies has come in for heavy criticism.

Schäuble has called for Germany to rebalance its policies because of the impact that renewable energy is having on energy costs and therefore Germany's international competitiveness.

His comments at a meeting of EU finance ministers highlight concerns

raised by business groups and energy companies in Germany since Merkel took the decision in 2011 to close the country's nuclear plants early.

However, a plan to reduce the impact of renewables on energy prices developed by Energy Minister Sigmar Gabriel has also been criticised.

Gabriel wants to reform the country's Renewable Energy Sources Act (EEG) and has proposed an annual reduction in subsidies for wind generators and other renewables, and removing the exemption of self-generators from paying towards the costly renewable energy subsidy scheme.

Major industrial sites that generate their own electricity are currently

exempt from paying into the renewable energy support scheme but this would change under Gabriel's proposals. Paying into the scheme would add around 6.24 euro cents/kWh on to the cost of their electricity.

Removing this exemption would not only reduce the burden of paying for renewables but would also bring the EEG into line with EU law.

The cost of supporting renewable energy in Germany is currently around €22-24 billion, according to Gabriel. The brunt of this is carried by domestic and small commercial consumers.

Merkel has also run into opposition in the state of Bavaria, which has threatened to block the construction of

new power lines needed to transmit energy from wind farms in northern Germany to the south of the country.

Lawmakers in Bavaria say that there are concerns about the visual impact of the proposed power lines, the first of which is Südlink, an 800 km power line running from the offshore wind farms of Schleswig Holstein to Bavaria.

TenneT and EnBW recently published details of the Südlink route.

Energy companies in Germany are also debating the merits of creating a capacity mechanism.

While some believe that capacity payments should be introduced to ensure that baseload capacity is available, other energy companies say

that the move would be unnecessary, particularly when the market is oversupplied.

Several European countries, including the UK and France, are preparing to implement capacity markets. Germany is already making capacity payments to some power plants that are seen as essential for energy security.

Natural gas fired plants in Germany are currently unprofitable because of low energy demand and competition from subsidised renewables. Utilities in Germany have been mothballing unprofitable capacity and there are concerns that capacity margins would be too low if energy demand started to rise.



Algeria, Morocco tout mega-projects

Algeria and Morocco are ramping up electricity generating capacity in the face of growing energy demand.

Algeria last month awarded \$4 billion of contracts for the construction of new combined cycle power plants to South Korean and Spanish firms, while Morocco is approaching investors for a large-scale solar power project in the disputed Western Sahara.

Sonelgaz has awarded a consortium of Daewoo International Corp., Hyundai Engineering & Construction Co. and Hyundai Engineering Co. a contract to build two power plants. It has also contracted Samsung C&T to build a further two new power plants.

Spain's Duro Felguera (DF) has won an order to build one power plant. The new power plants will have

capacities ranging from 1200 MW to 1600 MW.

Morocco is planning to build five solar power plants with a combined capacity of 2000 MW, some of which will be located in Western Sahara. European banks and multilateral lenders such as the World Bank, the European Investment Bank and the European Union are unlikely

to finance projects in Western Sahara – a dispute that Europe is neutral over.

However *Reuters* reported that Morocco's foreign minister said investors from Japan, China and the Gulf region had already been recruited.

Morocco is a net energy importer but wants to develop renewable power to reach 20 per cent of its energy supply

in ten years, up from eight per cent now.

Saudi Arabia's Acwa Power International won the \$1 billion contract for the first solar plant, which is scheduled to start operating next year in Ouarzazate with a capacity of 160 MW. It awarded the construction to a consortium of three Spanish companies – Sener, Acciona and TSK.

Nigeria ramps up power investment

Nigerian President Goodluck Jonathan says that Nigeria needs to invest \$10 billion in the next five years to add 5000 MW of capacity to the grid.

The country has established a Power Sector Intervention Fund (PSIF), seeded with N300 billion (\$1.82 billion) of federal government money, aimed at providing cheap long-term funds to power sector developers and leveraging investment from the private sector.

The federal government last month signed a \$350 million deal with GE to support the construction of small-scale power projects across Nigeria. The agreement would help boost power supplies in industrial zones.

Uche Orji, head of the Nigerian Sovereign Investment Authority, said that one unnamed private equity group in the US had already agreed to put forward \$2 for every \$1 invested by the state fund.

Nigeria has one of the lowest per capita national power supplies in the world, with a viable installed capacity of about 3200 MW. The use of privately owned generators adds as much as 40 per cent to the cost of

doing business.

The economy is growing rapidly, however, and the government has recognised the need to harness the country's abundant natural gas supplies to support growth.

Money from the PSIF will also go towards boosting the liquidity of a bulk trading agency set up as an intermediary between electricity generating and distribution companies in the first phase of a \$2.5 billion power privatisation programme.

The privatisation programme last year saw the government hand over legal control of 15 state-owned electricity companies to new private owners. A second phase of the programme is now under way with the government selling 80 per cent of its stake in 10 generating companies.

The government estimates that meeting its target of 20 000 MW of installed capacity by 2020 will require \$3.5 billion of capital a year.

The deal with GE will help to kick-start investment in Nigeria's power sector and get new capacity on-line quickly. The agreement follows a \$1 billion deal signed by GE in Nigeria last year.

Ormat celebrates Kenya project

Ormat says that it has achieved commercial operation of a new geothermal power plant in Kenya three months ahead of schedule.

Completion of plant 3 at the Olkaria III geothermal complex in Naivasha brings the total capacity of the site to 110 MW. Power from the plant is sold to Kenya Power and Lighting under a 20-year power purchase agreement.

The Olkaria III complex was financed with a \$310 million debt

facility provided by the Overseas Private Investment Corporation (OPIC). In November 2013, Ormat drew down the remaining \$45 million available under the project finance debt facility for the completion of Plant 3.

"In less than one year, we've completed construction of two additional plants and, over the course of five years, more than doubled the facility's generating capacity," said Dita Bronicki, Chief Executive Officer of Ormat.

Wind developers seek new growth regions

China, Africa and Latin America are key growth markets in the global wind sector while Europe continues to "dither" over policy, says GWEC.

Siân Crampsie

The pace of wind energy development in established markets such as Europe and North America is slowing, according to the Global Wind Energy Council, which last month released annual data for the sector.

Cumulative global wind energy capacity reached 318 137 MW in 2013, but the annual market saw a 10 GW drop to 35 467 MW of installations, says GWEC.

The drop was largely due to a drop in US installations caused by a hesitant US Congress at the end of 2012. China and Canada saw exceptional growth in 2013.

"While the policy hiatus in the US hit our 2013 figures hard, the good news is that projects under construction in the US totalled more than 12 000 MW at year end, a new record," said GWEC Secretary General Steve

Sawyer. "European installations were off by a modest 8 per cent, but with an unhealthy concentration of the market in just two countries – Germany and the UK."

Policy uncertainty in Europe and interest in renewable energy in non-OECD countries has led to a steady stream of new markets opening up for developers. China's return to growth has been welcomed by the industry along with the government's decision to increase the wind target for 2020 to 200 GW.

"Non-OECD markets are pretty healthy on the whole, and there is a steady stream of new markets emerging in Africa, Asia, and Latin America," commented Sawyer. "With the US apparently back on track, at least for the next two years, the main challenge is stabilising the European markets, both onshore and offshore, which have been rocked by political

dithering over the past few years."

According to Dii, the international alliance for desert power, there is large market potential for onshore wind in the Middle East and North Africa.

Wind speeds in MENA are favourable at more than 8-10 m/s at 50 m height and several countries in the region have set ambitious wind energy targets – 2000 MW in Morocco, 1500 MW in Libya, 7200 MW in Egypt and 5000 MW in Saudi Arabia.

According to GWEC, Africa added 90 MW of wind in 2013 but the industry group is expecting the region to "boom" in 2014, led by South Africa, Egypt, Morocco, Ethiopia, Kenya and Tanzania.

In South America, Brazil booked 4.7 GW of new projects in 2013, and Mexico's electricity sector reform is set to "ignite" the market in the coming years, says GWEC.

Dewa to pilot region's first Sterling engine CSP plant

Dubai Electricity and Water Authority (Dewa) is to pilot the Middle East's first Stirling engine concentrated solar power (CSP) plant.

The utility provider has announced a memorandum of understanding with Sweden's Cleanenergy and Al Futtaim Carillion, a joint venture between Al Futtaim and the UK construction services firm Carillion, to build a trial project for the technology.

The project is a key part of the emirate's plan to increase the use of renewable energy. "Our long-term plan is to deploy more large-scale solar installations in Dubai and the test plant will function as an important learning tool for this," said Saeed Mohammed Al Tayer, Dewa's Chief Executive.

A Stirling engine CSP system generates electricity directly from the heat produced from solar power.

The plant will consist of 10 units with a total capacity of 110 kW, enough to power about 10 households.

Dewa's announcement came two days after it unveiled a model of Dubai's Dh10 billion (\$2.7 billion) Mohammed bin Rashid Al Maktoum Solar Park at the *World Future Energy Summit* in Abu Dhabi.

The park is expected to generate 1000 MW upon completion in 2030.

Middle East eyes petcoke-to-power

Circulating fluidised bed boilers are growing in size and performance, as their ability to burn a wide range of fuels make them increasingly attractive. Now the Middle East is also looking at how this technology can bring multiple benefits to its power industry and potentially its oil refining sector.

Junior Isles



Unlike anywhere else in the world, the Middle East has a strong dependence on oil – predominantly diesel, crude oil and heavy fuel oil (HFO) – for electricity production. About 30 per cent of the electricity generated in the region depends on oil fuels, which is nearly four times higher than the rest of the world. Looking forward to 2020, with GDP growth forecasted to average 4-5 per cent per year and power demand expected to grow at 5-10 per cent per year, the region will continue to depend heavily on oil unless alternative non-oil energy solutions are adopted.

One option that appears to be economically attractive is to use petroleum coke (petcoke) as fuel/feedstock in an advanced circulating fluidised bed (CFB) boiler to generate power. Foster Wheeler has performed an economic evaluation of this solution for a refinery in the Middle East, with some impressive results.

The Kingdom of Saudi Arabia (KSA), being the largest and fastest growing power market in the region, is a good example of the energy challenges facing many countries in the Middle East.

Over the last 11 years, total electricity consumption grew 91 per cent in

the Kingdom with residential consumption more than doubling during this period. Due to rapid growth in power demand, KSA's electricity supply infrastructure is struggling to meet summer peak loads. Temporary power shortages during the highest peak load periods are not uncommon.

To keep up with expected future power demand growth, KSA's power capacity is projected to nearly double from around 62 GW to 108 GW by 2020. The Kingdom has therefore targeted an ambitious average annual capacity addition of 5.8 GWe/yr over the coming years. To put this into perspective, India (a country of more than 1 billion people historically growing at 7-8 per cent GDP) added a total of 5.4 GWe/yr of power capacity over the 2002-2007 period.

Today about 55 per cent of the power generated in the KSA is from oil fuels. Notably, the Kingdom is moving away from building large HFO-to-power projects as it plans to diversify its energy sources by increasing the use of natural gas, renewables and implementing a nuclear programme that could see 16 reactors constructed over the next 20 years. Nevertheless, there will still be a heavy reliance on oil to produce the

bulk of the power needed in 2020.

In addition to reducing its dependence on oil, using petcoke as a fuel and feedstock for power generation offers several other strategic benefits. For example, it: improves fuel security for the region since petcoke is a byproduct of oil refining; increases refinery efficiency and economics; and creates a source of new jobs in the refining, petrochemical, power and construction sectors.

Foster Wheeler's petcoke-to-power concept, known as PetroPower, can be used to produce power and steam. It utilises two key technologies: delayed coking, which extracts additional light petroleum products from refinery residues; and CFB technology to convert the solid petcoke from the delayed coking unit (DCU) into steam and power.

Robert Giglio, Vice President of Strategic Business Development and Strategy, Foster Wheeler Power Group, said: "It's a pretty straightforward concept, which has been proven; others have done it."

The delayed coking process converts refinery residues into additional gases and liquids: C1-C2 coker gas; liquefied petroleum gas (LPG); naphtha to be processed and blended

into gasoline; light coker gas oil (LCGO) to be processed and blended into diesel; heavy coker gas oil (HGCO) suitable for downstream hydrodesulphurisation (HDS), hydrocracking (HC) or fluid catalytic cracking (FCC) to produce transportation fuels.

Globally there are more than 170 refineries across 37 countries with operating cokers. Despite the Middle East's crude oil reserves, refineries in the Middle East and Africa account for only about 3 per cent of the total global coking capacity today. This is beginning to change. As petroleum producing nations in the region pursue plans to become major exporters of petroleum products, complex refinery projects with DCUs are underway in Saudi Arabia, Oman, and Abu Dhabi.

It is projected that by 2015, coking capacity in the Middle East will triple from its current level and grow at 25 per cent per year on average between 2014-2020, the highest rate in the world.

With more than 4 million bpsd (barrels per stream day i.e. production when the refinery is running at normal output) installed and more than 30 new units designed in the last five years, Foster Wheeler says it has

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designed more delayed cokers worldwide than any other technology provider. The flexibility of Foster Wheeler's Selective Yield Delayed Coking process (SYDEC) process allows a wide variety of crude oil residue qualities to be economically processed to distillates and petcoke, achieving high levels of decarbonisation and removal of metals from the residue feed and yields of clean liquid products.

Meanwhile, CFB boiler technology has been proven for its ability to efficiently, cleanly and reliably convert petcoke into high value steam and power. It is ideal for petcoke since its long burning process ensures complete combustion of the low volatile petcoke and captures a high level of the petcoke's sulphur (typically 5-7 per cent) during the combustion process. The vigorous mixing of the fuel, limestone and ash particles during the low temperature fluidised process allows the CFB to cleanly and efficiently burn almost any combustible material while minimising the formation of NO_x and optimising the capture of SO_x as the fuel burns.

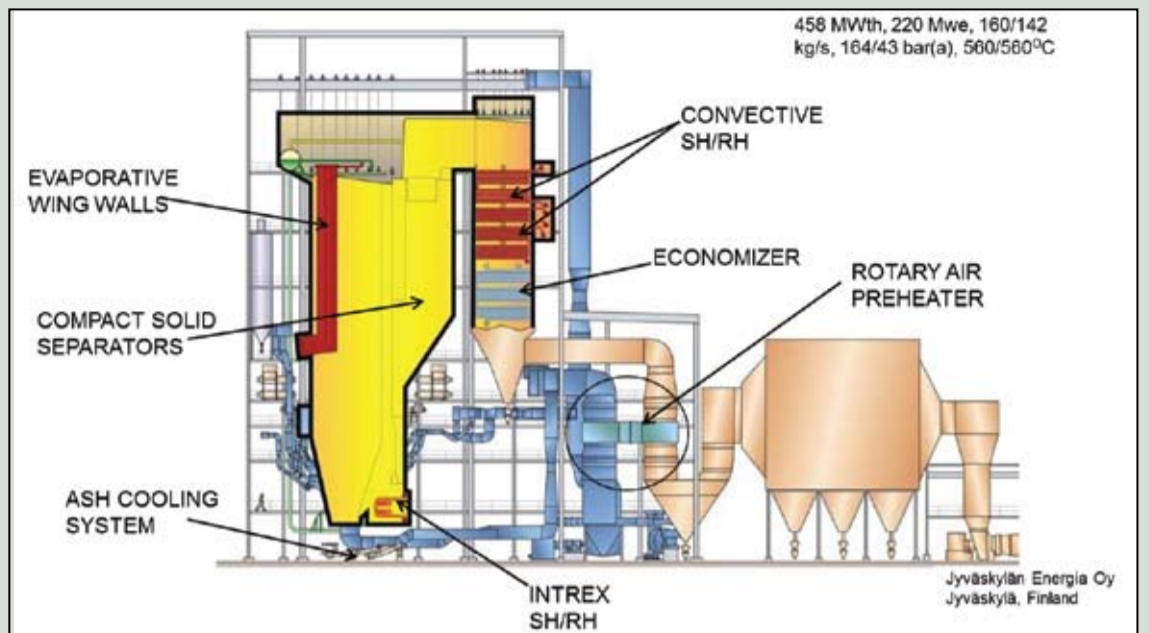
The combustion temperature is well

plant efficiency.

The technology advance to once-through supercritical (OTSC) units was first demonstrated at the 460 MWe Łagisza plant in Poland, which entered commercial operation in 2009. Since its startup, the plant has operated on a range of bituminous coals and has demonstrated a LHV net plant electrical efficiency of 43.3 per cent. Another supercritical CFB project is also underway in Russia. This is a 330 MWe CFB unit designated Novochoerkasskaya GRES No. 9. The boiler, which is the first of its kind in the country, is capable of combusting a wide selection of fuels including anthracite, bituminous coal and coal slurry.

Foster Wheeler is currently taking the next evolutionary step in the design and scale-up of its CFB boilers at the Samcheok Green Power Plant in South Korea. These are the most advanced supercritical circulating fluidised bed boilers in the world, capable of co-firing a wide range of coals with biomass.

The once-through ultra-supercritical (OTUSC) CFB boilers utilise advanced vertical tube low mass flux



is a high sulphur fuel (2-4 per cent sulphur).

Instead of blending distillates (diesel and kerosene) to upgrade VR to HFO

convert about 45 per cent of the VR into high value distillates and gases.

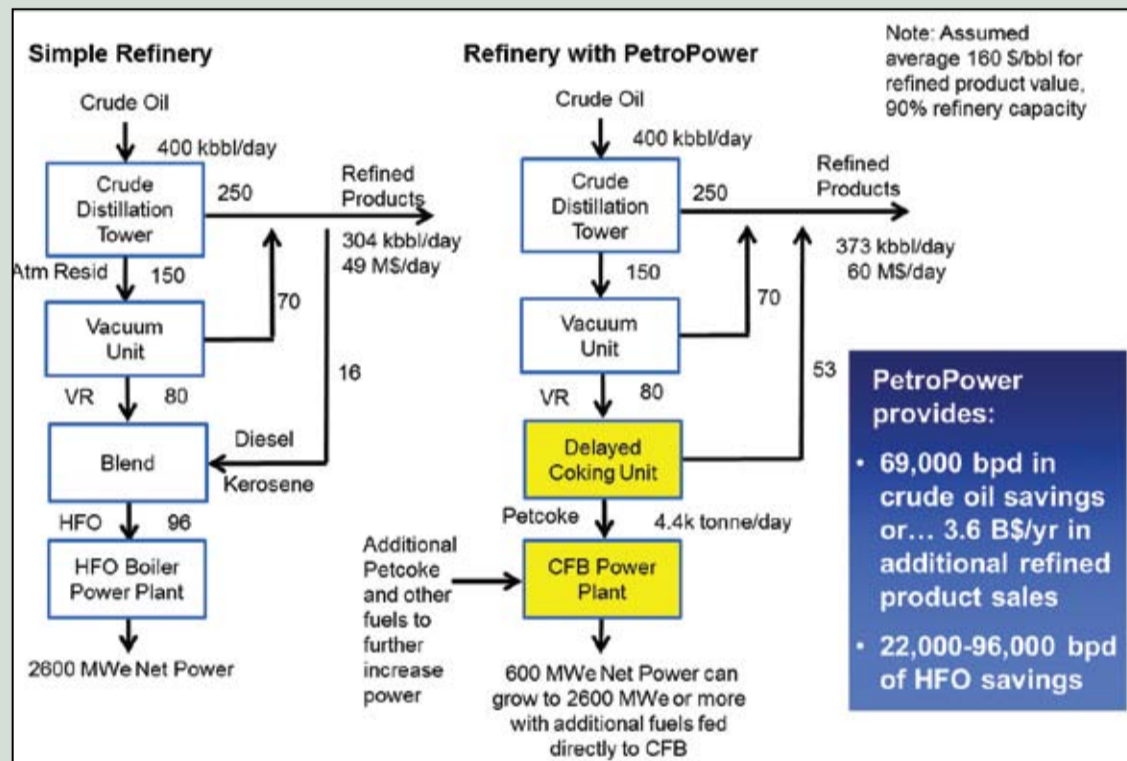
Foster Wheeler made a comparison between a conventional 400 kbpd refinery linked to a HFO power plant and one that utilises PetroPower technology, where the refinery equipped with the DC technology produces petcoke instead of HFO. In this configuration Foster Wheeler calculates there is a 23 per cent boost in high value liquids and gases compared to the typical refinery configuration.

By applying an aggregate market value to the refined liquids and gases at 160 \$/bbl, according to Foster Wheeler's calculations, the PetroPower configuration produces \$11 million more refined products each stream day than the conventional HFO refinery.

Giglio noted: "On an annual basis, assuming a 90 per cent on-stream factor, this works out to be an astounding \$3.6 billion dollars per year." Comparing the electricity production cost for both configurations shows that with reasonable assumptions the PetroPower configuration can produce power at less than half the cost of a HFO power plant. This, says Foster Wheeler, is primarily due to the dramatic difference in the international value of HFO (80 \$/bbl) vs. the petcoke (\$60/t or \$11/BOE).

For a consistent economic comparison, both the HFO and PetroPower plants produce 2600 MWe of net electrical power. Additional petcoke was supplied to the PetroPower plant from domestic or imported petcoke markets at the same 60 \$/tonne market

Foster Wheeler's circulating fluidised bed steam generating technology



Comparison of typical refinery vs. one with PetroPower configuration

below the melting point of the fuel's ash, allowing the CFB to minimise the corrosion and fouling issues experienced in conventional boilers. For petcoke with high levels of metals (vanadium, nickel, sodium, potassium), CFB technology has demonstrated years of reliable and low maintenance operation.

Foster Wheeler has more than 46 units (5000 MWe) of CFB boilers operating in the world today that fire petcoke as their primary fuel. The largest operating petcoke fired power plant in the world today is located in Louisiana, USA, equipped with 2 x 330 MWe Foster Wheeler CFBs producing 660 MWe of electric power. Foster Wheeler is now offering single unit CFB designs up to 800 MWe capacities with advanced vertical tube supercritical steam technology.

Supercritical steam conditions represent a physical point just above the vapour/liquid equilibrium phase of water. When the steam pressure reaches above the critical pressure of 221.2 bar two-phase mixtures of water and steam cease to exist, and as the temperature of the water rises above 374°C the water behaves as a single supercritical fluid allowing the fluid to absorb much more heat resulting in significantly improved overall power

Benson evaporator technology, which is more efficient and easier to build and maintain than conventional spiral-wound supercritical boiler technology.

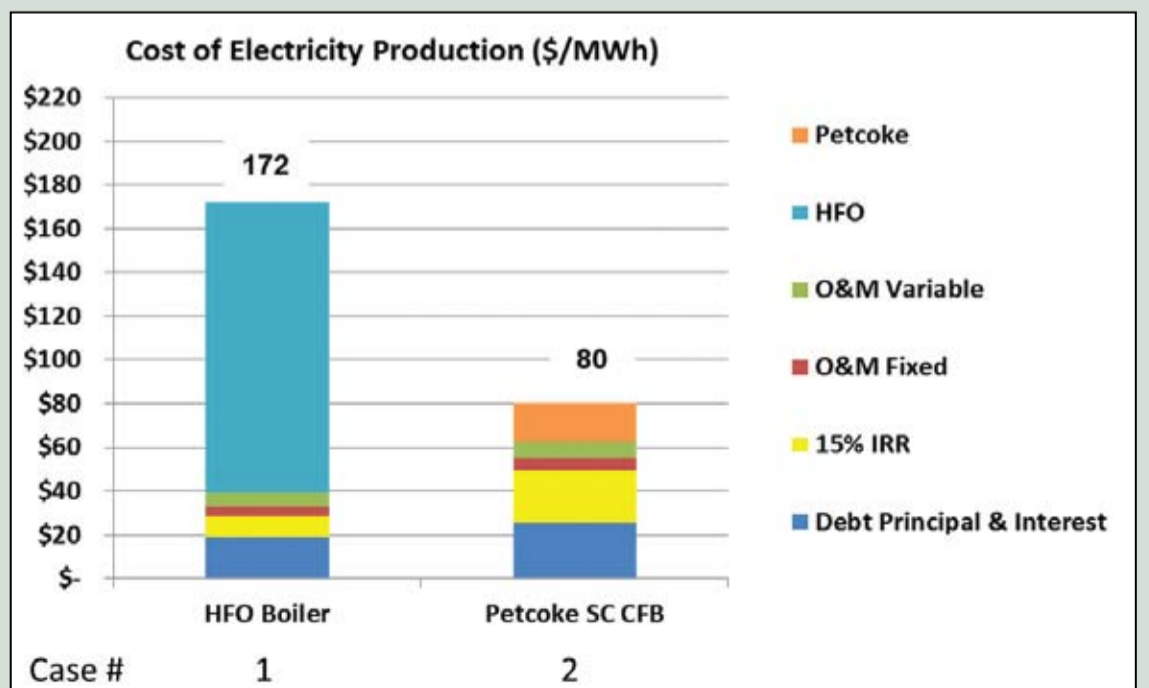
Under a contract awarded in 2011, Foster Wheeler will design and supply four 550 MWe (gross) ultra-supercritical boilers producing steam at 600°C for the first phase of the project. The first phase (Units 1 and 2) will be configured as two blocks, with each block having two boilers feeding into a single 1100 MW steam turbine.

According to the schedule, start-up of the Unit 1 boilers is planned for June 2015, six months prior to starting commercial operation in December 2015. The planned start-up of the boilers in Unit 2 is July 2015, with commercial operation scheduled for June 2016.

Middle East refineries can benefit from PetroPower whether sub-critical, supercritical or ultra-supercritical CFB boilers are used.

A typical refinery in the Middle East uses a two-step atmospheric and vacuum distillation process, which produces a heavy vacuum residue (VR) byproduct. The VR has limited uses and is typically blended with distillates, such as kerosene and diesel, to produce heavy fuel oil (HFO), which

(which consumes about 20 per cent of the refinery's high value distillate products), the PetroPower concept uses delayed coking technology to



Comparison of electricity production cost for both configurations

Special Project Supplement

value assumed for the petcoke produced by the refinery, which is based on the current market price for petcoke delivered to the region.

The economic comparison is completed (see Table) by adding the value for the additional refined products to the electricity generation savings to obtain a total \$5 billion annual value from the PetroPower configuration as compared to the conventional refinery configuration.

Since the PetroPower option requires a capital investment of about \$2.3 billion for the delayed coker and CFB power plants, above that of the typical refinery/HFO power plant case, the analysis shows a payback period of just five months. Further, by deducting the \$2.3 billion capital investment from the 10-year net present value (NPV) of the annual \$5 billion value, this works out to a compelling \$24 billion NPV after deducting the cost of the initial investments.

Foster Wheeler notes that “these results show an astonishing value proposition” for the PetroPower configuration. It should also be noted that the analysis assumes that only 80 per cent of the additional sales of refined products translates into additional profits for the refinery since additional opex and capex would be needed to operate the DCUs and refine its light products.

A significant contributor to this result is the very large difference between the market value of solid and liquid fuels which has ballooned over the last 10 years.

The first signs of the predicted strong growth in delayed coking technology in the Middle East are already being seen in the KSA, where two new refineries configured with DC technology are under construction.

A typical refinery capacity in the Middle East can process 400 kbpd of heavy crude and by adding delayed cokers could produce roughly 6000 tons per day of petcoke.

The petcoke could be utilised to produce electricity for internal needs or could be simply sold to the export petcoke market. A technical economic evaluation was made that compared the economics of several plant configurations: two purely for power production from the petcoke with case 1 utilising PetroPower technology and case 2 utilising integrated gasification combined cycle (IGCC) technology. Evaluations were also made for configurations producing both power and hydrogen. The economics of simply selling the petcoke to the export market were also assessed.

For the power production-only

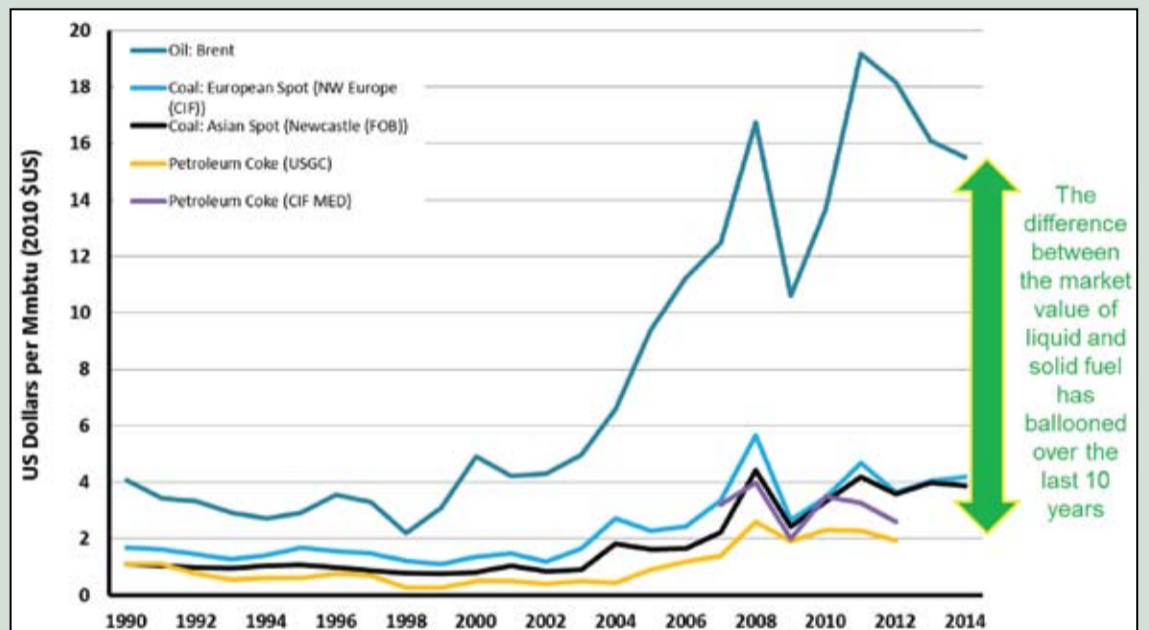
The largest operating petcoke fired power plant in the world today is located in Louisiana, USA. Equipped with 2 x 330 MWe Foster Wheeler CFB boilers, it produces 660 MWe of electric power



Comparison of investment results between a typical refinery vs. one with PetroPower configuration

Case	1	2
Refinery and power plant configuration	HFO boiler	DCU+Petcoke SC CFB
Profit from additional sales of petroleum products (bn\$/yr) ¹	Base	3.2
Savings in electricity production cost (bn\$/yr)	Base	1.8
Additional refinery profit + power cost savings (bn\$/yr)	Base	5.0
Additional refinery investment (bn\$)	Base	1.0
Additional power plant investment (bn\$)	Base	1.3
Additional refinery + power plant investment (bn\$)	Base	2.3
Investment payback period (years)	Base	0.4
Investment 10-year NPV @10% discount rate (bn\$)	Base	24.3

Note¹ IHS CERA Energy Scenarios



Price history of oil, petroleum coke and coal (according to Foster Wheeler in-house data)

cases, the evaluation showed that the PetroPower plant (case 1) provides the highest value use for the petcoke due to the lower investment cost, full consumption of the 6000 tpd of petcoke from either refinery and higher efficiency over the IGCC plant (case 2).

The results show that the PetroPower solution (case 1) could reduce or displace the HFO consumption by about 29 000 bpsd. This represents the

greatest saving in HFO as compared to all other options studied, since the total amount of petcoke produced at each refinery could be fired in supercritical CFB power plants at the highest efficiency.

This was not the case for the IGCC solution, which could not be sized to consume the full 6000 tonnes per day of petcoke from either refinery due to the limited sizes of commercially available combustion turbines. This resulted in a residual stream of petcoke, which was sold to the export market instead of being used to produce electricity. This in turn reduced the savings or displacement of HFO to 22 000 bpsd.

The PetroPower solution has been proven at several sites. A scheme has been operating at the Talcahuano refinery in Chile, where Foster Wheeler has built a 12 000 bpd delayed coker facility and a 74 MW cogeneration plant. The facility has been in operation since 1998 and, according to Foster Wheeler, between September 17, 2011 and January 5, 2013, ran continuously for a record 467 days.

“Although not integrated, they are doing the same thing at the CLECO Madison power plant in Louisiana,” said Giglio. “CLECO buys the coke from local refineries on the Gulf Coast and use it to produce 600 MW of power. The refineries have delayed coking units but instead of the facility being next to the power plant, the coke is barged from the refinery to the power plant. The same thing is also being done at the 600 MW JEA Northside plant in Florida.”

The plants being considered in the Middle East would be even larger, at 2 x 500 MW each. Giglio argues, however, that this does not present any real challenge.

“We are comfortable with this. The CLECO plant is a 2 x 330 MW petcoke facility and we have demonstrated a 460 MW unit on coal in Poland. But because of the way the process works, we don’t see a significant technical risk to increase the unit size by about 10 per cent and fire 100 per cent petcoke. We could build two 550 MW supercritical boilers on a single 1100 MW turbine, like the units we are building in South Korea. Alternatively, we could build three 330 MW units like the ones operating at CLECO and JEA. So scale-up risk is very manageable.”

While scaling up the technology will not be an issue, Giglio accepts that one challenge in implementing the technology in the Middle East is likely to be cultural. There are no petcoke or coal fired power plants in the Saudi Arabian Peninsula, and most power generators are familiar with handling gas and liquid fuels as opposed to solid fuels like petcoke.

The other major challenge will be the price of electricity, which due to heavy energy subsidies in many Middle Eastern countries, is about half the price of that in the US.

Giglio remains positive, however. “I can’t say which way it will go but we are hopeful. All of the studies and discussions are showing that petcoke-to-power is a very valuable and viable option for the Middle East.”



FW PETROPOWER PLANT IN TALCAHUANO, CHILE HAS BEEN SUCCESSFULLY OPERATING FOR OVER 15 YEARS

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Companies News



GE is preparing for a predicted shift in the market from centralised power plants to distributed generation, writes **Junior Isles**

GE is moving to take advantage of a predicted growth in demand for distributed power generation equipment.

At the end of February, company executives gathered in Jakarta, Indonesia, with business and government officials to announce the launch of GE Distributed Energy, a new business that combines three product lines – aeroderivative gas turbines, Jenbacher gas engines and Waukesha gas engines.

Explaining the move, Lorraine Bolsinger, President & CEO of the new GE Distributed Energy Business said: “Bringing the three businesses together will give us the advantage of scale. We can now take advantage of technology investment, whereas in the past there were three lesser scale businesses fighting for investment in technology. We now have a global commercial footprint; before, there were three independent sales forces each going in with one product they could sell. Today we have a vast array of technologies to meet the customers’ needs. We are also bringing together our three service franchises so we can leverage our footprint.”

According to GE, distributed generation – often classed as up to about 100 MW – represents 33 per cent of today’s global power capacity additions. The company says this will rise

to about 42 per cent in 2020. A White Paper released at the launch also claims distributed power will grow 40 per cent faster than global electricity demand between now and 2020.

The new business, headquartered in Cincinnati, Ohio, employs 4500 people and plans to invest \$1.4 billion over the next four years to “refresh and invest” in its products to meet the growing market demand.

John Rice, Vice Chairman and President & CEO, GE Global Growth & Operations, said: “The investment that we will be making will make sure that we are on top of every technology that will be required to meet the market’s needs in the best ways possible – that is: low cost, highly efficient and in the most environmentally responsible way. We know that these smaller power generation units are key to solving the problems the world has today and providing electricity to the millions that don’t have it in Indonesia.”

Indonesia was chosen as the location for the announcement of the launch due to its “strategic importance” to GE.

As a country of more than 17 000 islands, engine- and gas turbine-based power plants are often the only solution for meeting power needs in rural areas. The country has a target of improving its

electrification from around 75 per cent today to about 95 per cent in 2025. It is also turning to gas in an effort to reduce its use of expensive imported diesel.

Speaking at the announcement, Susilo Siswoutomo, Vice Minister of Energy and Mineral Resources of Indonesia, said: “We have to build about 6000 MW/y – whether from coal, gas or renewables – through 2025. The backbone will be coal and gas, as we would like to reduce our dependence on oil. GE will make a good partner; they are developing distributed power, which is suitable for Indonesia.”

GE also announced several agreements during the launch including: two memoranda of understanding (MOU) with Clean Power Indonesia and state power company PLN for the development and deployment of its integrated biomass gasification system; two gas engine supply and service agreements with Navigat Energy to provide 100 Jenbacher engines that will provide 330 MW of power at a number of independent power plants; an agreement with Green and Smart Sdn Bhd to provide a solution for waste-to-power; and an MOU with PLN Enjiniring to develop a “virtual pipeline power generation” pilot project in remote islands of Indonesia.

Pension fund invests in London Array

- Dong sells 25 pc stake
- Forewind cuts back Dogger Bank

Siân Crampsie

A Canadian pension fund has paid around \$1 billion for a one-quarter share in the world’s largest offshore wind farm.

Caisse de Depot et placement du Quebec has bought half of Dong Energy’s 50 per cent stake in the London Array offshore wind farm in the Thames Estuary. The project’s owners – which also include Masdar and E.On – have also announced that they will not proceed with Phase 2 of the wind farm.

Caisse says that the £644 million deal was an opportunity to invest “in a quality asset in a growth-driven sector”. It added that it expects “to generate attractive returns for many years ahead” from the 630 MW wind farm.

Last month the owners of London Array said that they would not proceed with a planned expansion of the project after reviewing their respective portfolios. They said in a statement that the technical challenges and environmental uncertainties around the second phase of the project were too great.

In particular they would have to wait up to three years for the results of a survey on the impact of phase 2 on birds.

The announcement came as Forewind cut the development potential of the Dogger Bank offshore zone in the UK from 9 GW to 7.2 GW.

The sale of the London Array stake was an important element of Dong Energy’s financial action plan that aims to revive the company’s balance sheet and prepare it for a number of

new investments.

“Farm down of our ownership shares in wind projects is a central part of our business model and our strategy is to continuously enter into partnership agreements with industrial and financial partners to extract part of the value creation from our projects, share the risk in our portfolio and attract capital to be able to continue to invest in new offshore wind farms,” said Samuel Leupold, Executive Vice President of Dong Energy Wind Power.

Dong will continue to provide operation and maintenance services to the London Array project.

Forewind said in a statement that its revised plans for Dogger Bank have been made following more than four years of surveys and assessments. It had been exploring the potential for up to eight offshore wind energy projects, but has revised this to six 1.2 GW projects.

Its decision to scale back the potential size of the site follows other offshore wind project cancellations in recent months.

Trade group RenewableUK insists that the UK’s offshore wind project pipeline remains healthy. “We’re maintaining our global lead, with more capacity installed in UK waters than the rest of the world put together,” said Nick Medic, RenewableUK’s Director of Offshore Renewables.

“What we’re seeing now is a leaner, fitter, trimmer offshore wind sector with more streamlined projects,” added Medic.

Juwi targets Australia

Juwi says that it will be able to take advantage of growth opportunities in Australia, New Zealand and the South Pacific regions after purchasing a controlling stake in Qi Power.

Brisbane-based Qi Power specialises in providing solar energy solutions in remote areas, including remote mining operations. Its knowledge of technical and commercial requirements in the Australian renewable energy sector will help Juwi to successfully penetrate that market.

Juwi is the world’s second largest engineering, procurement and construction (EPC) contractor and developer of solar photovoltaic (PV), wind and bioenergy projects. Its purchase of a controlling stake in Qi Power marks its entry to the Australian market.

Juwi believes that Australia’s renewable energy potential and high power costs make it a key market and it plans to target remote energy users as well as provide EPC services to grid-scale utility projects.

Insolvency hurts small investors

Thousands of small investors in Germany are facing losses after a renewable energy firm they invested in collapsed.

Prokon filed for insolvency after reports in Germany’s media questioned its financial position, leading investors to withdraw their capital.

The German company, which operates over 50 wind farms in Poland, raised nearly €1.4 billion by selling “profit-participation certificates” to around 75 000 retail investors through television advertising campaigns.

It denied reports that its profits did not match its interest payments and

said that its projects were “unconventionally financed”. Politicians in Germany have called for greater protection for consumers.

Prokon’s profit-participation certificates did not give its investors any say in how the company was run but its marketing campaigns promised yields of up to eight per cent.

Accounts published on Prokon’s website show that between January and October last year it paid out interest of €67.2 million, double its earnings before interest, tax, depreciation and amortisation for the same period.



A new joint venture integrating the thermal power businesses of two Japanese giants has started operating.

Mitsubishi Hitachi Power Systems is planning to compete with industry leaders such as GE and Siemens and has set a target of ¥2 trillion (\$19.6 billion) in sales by 2020.

This compares with the ¥1.1 trillion in combined sales from the thermal

power operations of Mitsubishi Heavy Industries (MHI) and Hitachi Ltd.

The new company’s President, Takato Nishizawa, said that the integration would “enhance” its product line-up “including mainstay gas turbines as well as boilers and smoke extraction systems”. He added that the relevant Mitsubishi and Hitachi offices in the United States and China would be integrated over the next year

while the offices in Japan will be maintained to deal with growing demand for power generation systems.

The company will aim to win turnkey power plant contracts as well as orders for individual products such as turbines. It employs 23 000 workers globally.

MHI owns 65 per cent of the joint venture and Hitachi holds the remaining 35 per cent.

10 | Tenders, Bids & Contracts

Americas

Posco signs Peru deal

Posco Engineering & Construction has signed a \$300 million deal with Peru's Samay 1 SA to build a 720 MW gas-fired power plant in Mollendo.

Posco will build the plant on an engineering, procurement and construction (EPC) contract basis. The firm says it is the first Korean firm to win a power plant construction order in Peru.

Construction of the plant, at a site approximately 1000 km south of Lima, is expected to take 26 months.

Canada orders FACTS

ABB has won an order worth around \$60 million from Hydro-Québec to replace vital components of its ultra-high voltage transmission system that helps transport clean hydroelectric power from north to south Quebec.

As part of the order, ABB will upgrade two Static Var Compensators (SVC) located at the Albel substation, about 500 km north of Montreal, that provide fast-acting reactive power compensation for the 735 kV electricity network. The upgrades are scheduled to be completed by 2016.

"This upgrade will significantly extend the life of the SVCs and substantially reduce electrical losses," said Claudio Facchin, head of ABB's Power Systems division.

Tri-Technic orders Saft battery system

Saft has won an order from Tri-Technic for the delivery of two Intensium Max 20M (IM20M) battery containers for the Fort Hunter Liggett grid energy storage system.

The Fort Hunter Liggett energy storage unit was designated as a "Net Zero" pilot installation by the US Department of Defense (DOD) and is a key part of plans to develop a secure microgrid at the base.

The contract marks Saft's first large battery energy storage system (BESS) installed in a DOD facility. Its two IM20M containers are each rated at 500 kWh and connected to the grid through two 630 kW clean power converters, which ensures that the energy source is able to operate at optimum levels while maintaining power in the event of a utility power outage.

The project construction began in August 2013 and was scheduled for completion in February 2014.

Alstom signs Haliade deal

Alstom has announced a contract to supply five Haliade 150-6 MW offshore wind turbines for Deepwater Wind's 30 MW Block Island pilot wind farm located off the coast of Rhode Island, USA.

The project will be one of the first offshore wind farms in the USA and will be the first to feature Alstom's Haliade 150-6 MW – the largest turbine installed in offshore waters today.

Alstom will manufacture the Haliade units and provide 15 years of operation and maintenance support for the Block Island wind farm. The Haliade has a 150 m-diameter rotor that provides an energy yield that is 15 per cent better than existing offshore wind turbines, says Alstom.

Asia-Pacific

Wärtsilä to build largest engine plant

Wärtsilä has been awarded a contract to supply Indonesia's largest ever engine based power plant. The turnkey

contract has been placed by PT Indonesia Power, a subsidiary of the state utility PT Perusahaan Listrik Negara (PLN) (Persero).

The 200 MW power plant will be powered by 12 Wärtsilä 50DF dual-fuel engines running primarily on natural gas. It will be constructed by a consortium with Wärtsilä as the lead partner together with PT Pembangunan Perumahan (Persero) Tbk (PT PP), one of Indonesia's largest construction contractors.

The power plant is scheduled to be partially operational by the end of December 2014, and at full output by the end of May 2015. The electricity produced will be fed to the Bali grid.

Separately, two loan agreements have been signed to finance two PLN gas power plant projects. The Arun and Bangkanai projects include the procurement of 35 Wärtsilä 34SG gas fired engines and will have a total output of 339 MW. Wärtsilä announced the power plant contracts in October 2013.

Power Grid strengthens UHV grid

ABB has won orders worth around \$56 million from Power Grid Corporation of India Ltd. to supply power transformers and shunt reactors for substations being built to support the country's ultra-high voltage (UHV) transmission grid development.

India is investing in its ultra-high voltage network to strengthen its power transmission grid. ABB will supply fourteen 500 MVA, 765 kV UHV single-phase auto-transformers at greenfield substations being constructed in Kanpur and Varanasi.

These substations, will receive power from the neighbouring states of Jharkhand and West Bengal, and distribute it in the northern Indian state of Uttar Pradesh (UP) to meet growing demand in the region.

Korea orders Siemens ST

Siemens Energy has received an order from South Korea for the delivery of a two-cylinder steam turbine with an associated generator for the Seagull power plant in Gunsan, western South Korea.

The 250 MW Seagull cogeneration plant is being built by eTEC E&C for Gunjang Energy Co. Ltd. and will provide heat and electricity for the public grid. Siemens' scope of delivery includes a two-cylinder steam turbine set with reheat capability, consisting of an SST-800 turbine and a double-flow SST-500 turbine, as well as an associated SGen6-100A generator. Both steam turbines will be arranged on one shaft and drive the same generator.

The order is part of the Seagull power plant's fourth expansion phase to ensure a reliable power supply in the region around Gunsan.

US firm wins Myanmar order

APR Energy has won a contract to build a 100 MW power plant in Myanmar.

The deal is the first power generation agreement signed by a USA-based company with the government of Myanmar since the lifting of sanctions in 2013. The plant will be built in Kyaukse and will tap the region's large natural gas reserves for fuel.

APR says the power plant will be based on its mobile gas power modules and will provide a medium-term solution to Myanmar's growing power needs while the country develops its long-term power infrastructure.

Europe

UK project orders ReneSola panels

ReneSola is to supply 13 MW of its Virtus and Virtus II polycrystalline solar modules to Low Carbon, a UK-based renewable energy developer.

Low Carbon is building a ground-mounted solar photovoltaic (PV) power plant on 63.5 acres of land in Wiltshire, southwest England. Delivery of the modules started in February and was due to last for five weeks.

ReneSola's modules for the solar farm were to be sourced from warehouses in Poland and India.

Dong selects Vestas 8 MW unit

Dong Energy has chosen Vestas as the preferred supplier of wind turbines for its Burbo Bank offshore wind farm extension project.

Dong selected Vestas' V164-8.0 MW unit for the project after a competitive tender process and is subject to the wind farm being awarded a Contract for Difference under the UK's EMR tariff support scheme, and to the parties agreeing on a detailed supply agreement.

The Burbo Bank extension project will have a maximum capacity of 258 MW and will be located 7 km off the west coast of England. Construction could start in 2016.

BWSC orders ST for Brigg

Alstom has signed a contract with Danish power plant specialist Burmeister & Wain Scandinavian Contractor A/S (BWSC) to design and supply a 45 MW Geared Reaction steam turbine (GRT) for the Brigg renewable energy plant in the UK.

The Brigg power station, which is expected to be operational from early 2016, will be primarily fuelled using locally sourced straw but will also burn wood. This is the second contract signed between the two companies for a GRT in a UK biomass power station, following an agreement last year on the 15.8 MW wood-fuelled Lisahally scheme in Northern Ireland.

Voith to equip Austrian plants

Vorarlberger Illwerke AG has placed orders with Voith Hydro for the supply of two pumps and a pump turbine for pumped storage hydropower projects in Austria.

The Obervermuntwerk II and Rellswerk hydropower projects in Montafon, Vorarlberg will play an important role in balancing the European grid as more renewable energy is commissioned, particularly in neighbouring Germany.

At Obervermuntwerk II, Voith will supply and commission two 170 MW storage pumps, while at Rellswerk it will supply a 13 MW, 3-stage pump turbine, complete with bearing oil supply system, as well as assembly and commissioning services.

EDF extends UK reactor lives

EDF has signed a major deal with Doosan Babcock that will enable the French firm to extend the lifespan of seven of its eight nuclear power stations in the UK.

Under the so-called lifetime enterprise agreement (LEA), Doosan Babcock will support the ongoing operation of the power stations and deliver projects to support life extension. The

contract covers Dungeness B in Kent, Hunterston B in North Ayrshire, Hinkley Point B, Hartlepool, Heysham 1 and 2 in Lancashire and Torness in East Lothian, which together have an output of 7550 MW.

Commenting on the announcement, Cameron Gilmour, Doosan Babcock's Nuclear Service Director said: "Doosan Babcock has a long history of supporting EDF Energy in the UK nuclear sector. The LEA is the result of close collaboration and a great deal of planning from both our companies, and will give EDF Energy access to a range of specialist skills and technologies that will support its UK power generation strategy long into the future."

International

Siemens wins Soma Kolin ST order

Siemens Energy has won an order from China's Harbin Electric International Company Ltd. (HEI) for the supply of two steam turbines for the Soma Kolin power plant in Turkey.

The 510 MW lignite-fired power plant is being constructed in the city of Soma in Turkey's western province of Manisa, where there are large lignite reserves. Siemens is supplying two Model SST5-5000 HM-N steam turbines with the associated auxiliary and ancillary systems.

HEI is building the Soma Kolin plant for Turkish firm Hydro-Gen Enerji Ithalat Ihracat Dagitim ve Ticaret A. S. The steam turbines will be delivered between August 2015 and January 2016, and the plant is scheduled to commence commercial operation in April 2017.

ABB boosts Mozambique grid

ABB has won an order worth around \$20 million from the Aarsleff-Seth joint venture to supply engineered equipment packages for two new substations in Mozambique.

The project will extend the grid and will also reinforce the network through the rehabilitation and expansion of nine existing transmission substations. ABB's project scope includes the design and supply of engineered packages for the high-voltage air-insulated switchgear (AIS) substations.

Demand for reliable power in Mozambique is growing at a rate of 10 to 15 per cent per annum, thanks to industrial growth and economic development. Currently, the national power grid supplies around 5000 MW of electricity, with more than 90 per cent of the capacity owned and operated by Electricidade de Mozambique (EdM).

Siemens to service Baiji plant

Siemens Energy has signed an agreement to perform service and maintenance at the 600 MW Baiji gas power plant, located in the Salah al-Din governorate in Iraq.

Under terms of the contract signed with Iraq's Ministry of Electricity, Siemens will supply and deliver spare parts for the Baiji power plant's four SGT5-2000E gas turbines as well as perform significant upgrades, remote monitoring and diagnostic services, and field service for an initial period of four years.

The upgrades include the major overhauls of the SGT5-2000E turbines with Siemens' 3-dimensional blades and vanes (Si3D). The integration of Siemens Si3D blades and vanes provides the plant with optimal technical and economic benefits.



Oil

Heavy winter pushes crude over \$100/b

- Commercial stocks plummeted by 1.5 million b/d in 4Q13
- Even European demand inched up in 2H13

David Gregory

A heavy winter in North America during January and February created strong demand for refined heating fuels and natural gas in the US, pushing the price of West Texas Intermediate (WTI) crude above \$100/b in February and reducing stocks to their lowest point in some years.

At mid-month the price of WTI was around \$103/b and Brent was above \$110/b. Predictions of more winter weather for the rest of the month led to forecasts of a continuing tight market as inventories declined.

The US Energy Information Administration (EIA) noted in its February *Short Term Energy Outlook* that cold temperatures had tightened supplies in the East and Midwest where supplies were already low.

It said that while the average spot price of North Sea Brent fell by around \$3/b from December to January, cold temperatures tightened

heating oil supplies and helped to drive up retail prices.

In an analysis of oil market prices, the *Wall Street Journal* said another factor boosting the crude market has been the opening of the southern portion of the Keystone XL pipeline system, which has expanded the ability for crude to reach refiners on the Gulf Coast, where it can be processed into products and exported.

"As more products refined from domestic crude reach the global market, traders believe the value of the US benchmark will rise to be closer to that of its global Brent counterpart," the February 19 report said, adding: "The distance between those two contracts has been nearly cut in half since the start of the year, standing at \$7.16 as of [February 19] settlements."

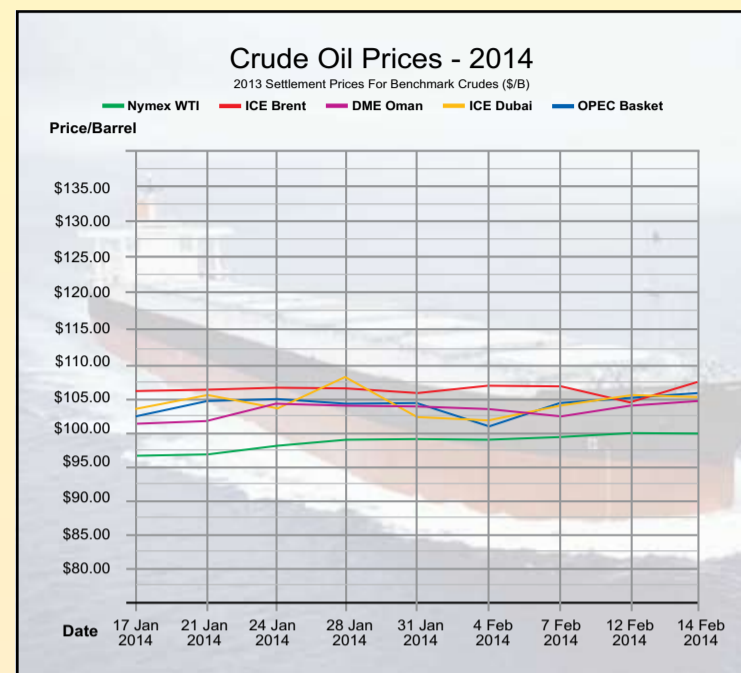
Rising US crude production and the return of Libyan oil to the market had led analysts to predict a looming oil glut, but in its latest *Oil Market Report*, the International Energy Agency (IEA)

remarked that forecasters and market observers "have been warning of an oil glut and price slide for months." The Polar Vortex and other factors have scuppered that scenario.

"Far from drowning in oil, markets have had to dig deeply into inventories to meet unexpectedly strong demand," the IEA said. "OECD commercial stocks plummeted by a whopping 1.5 million b/d in 4Q13 (137 million barrels in total), the steepest quarterly decline since 1999, bringing their deficit to the five-year average to more than 100 million barrels for the first time in nearly 10 years."

At the end of 2008, stocks stood at their lowest since 2008, the IEA said. "While there are good reasons to expect the market to rebalance in the next few months, a glut is looking increasingly elusive," it said.

According to the IEA, the tight market stems from a "surprising" robustness of global oil demand, especially from the OECD. It reported a



"recent resurgence" of OECD demand growth.

"Far from continuing its previous downward trend as expected in the second half of 2013, OECD demand bounced back, jumping by 370 000 b/d in 3Q13 and 300 000 b/d in 4Q13," the IEA said, adding that this more than compensated for weaker-than-expected demand from emerging market economies. "Even European demand inched up in 2H13," the agency said.

The agency said global demand for 2013 averaged 91.3 million b/d and forecast demand for 2014 at 92.6 million b/d. Demand in the Americas averaged 30.6 million b/d in 2013 compared to 30.0 million in 2012. It forecast 2014 demand in the Americas at 30.9 million b/d.

Supply, on the other hand, has been disappointing it said, chiefly because of problems within Opec. It said the

fall in Libyan production during the second half of 2013 amounted to some 170 million barrels from the market and that "high hopes" for Iraqi production failed to materialise" as it could not sustain its April 2013 peak of 3.24 million b/d, falling back to average 3 million b/d during 2H13. Furthermore, concern that political unrest could erupt in Venezuela encouraged worrisome trading in the oil market.

The IEA said that at this time of year it is common for market participants to worry about excess supply or the perceived need for Opec production cuts, but in the current market, those thoughts would be misplaced.

The agency said the market needs to replenish exceptionally low stocks and that Opec will need to produce above its anticipated "call" of 30 million b/d during the second half of 2014 if "badly depleted" inventories are to be rebuilt.

Gas

Cameron terminal license advances US LNG export

The US Department of Energy has awarded its sixth gas export license, as the shale boom heralds a change in the international dynamic of energy politics.

Mark Goetz

The US advanced its nascent natural gas export sector with the licensing of the Cameron LNG export terminal owned by Sempra Energy. This is the sixth license that the US Department of Energy has awarded.

Around another 20 applications for LNG export projects are awaiting government approval. The American Petroleum Institute (API) and a number of US Congressmen are urging the Department of Energy to speed up its processing of those applications.

In a statement released on February 11, Sempra Energy announced that the US government had issued a conditional authorisation for its Cameron LNG subsidiary to export domestically produced LNG from a planned facility in Hackberry, Louisiana, to countries that do not have a free trade agreement with the US.

The license allows Cameron LNG to export 1.7 billion cubic feet per day (cf), or 12 million tons per year, for a 20-year period. Following a final investment decision, construction of the project could get underway this year with a view to first exports in 2019.

Anticipated natural gas exports from the US in the form of LNG are viewed by many as a game changer for the industry. The abundance of shale gas resources and the high volume of production have made gas an economic commodity and there looms the prospect that US LNG will impact LNG prices that are linked to the high price of crude oil. Gas importers are looking to organise and have contracts that were made before crude prices rose to their current heights changed to reflect gas prices in the US range, which has been less than \$5 per million Btu.

The gas boom is already having an impact on the US economy, which

appears to be slowly coming out of recession, and a larger impact is expected to come once the US puts more reliance for domestic energy purposes on gas and moves resolutely into LNG export mode at the end of this decade.

Furthermore, US LNG exports are seen as having a significant impact geopolitically, especially in Europe and Asia, which have respectively relied on Russia and the Middle East for supplies. Although Australia sees US LNG as competition in the Far East, ultimately, the appearance of new sources of supply on the market will strengthen demand and widen the use of natural gas, especially if it can be bought at reasonable prices that should, in theory, encourage the economies of purchasing countries.

As Sempra Energy's CEO Debra Reed said in the company statement announcing the license: "Exporting natural gas will lead to the creation of

thousands of new jobs and economic growth here in the US and enable our partners to deliver domestically produced natural gas to our allies abroad and to the world marketplace."

With the issuance of the Cameron license, the US government has now authorised the export of around 8.5 billion cfd – the equivalent of some 65 million tons per year.

Chienere Energy, the first US company to receive a LNG export license for its Sabine Pass LNG project, announced in December that its subsidiary Corpus Christi Liquefaction had signed with Bechtel Oil, Gas and Chemicals Inc, two lump sum turnkey contracts for the engineering, procurement and construction of LNG trains at its Corpus Christi, Texas, LNG export project, the fourth project to receive US licensing.

The plant is now awaiting further approval from the Federal Energy

Regulatory Commission (FERC) and a final investment decision.

Currently, Qatar, the world's largest producer, has a capacity to export 77 million tons per year. Australia has invested some \$70 billion in LNG export plants that will match or exceed Qatar's capacity. Canada is also planning to launch an LNG export industry. Huge gas discoveries have been made off the East African coast, prompting Tanzania and Mozambique to also plan multi-train LNG export facilities. Even tiny Cyprus in the East Mediterranean is looking to develop its own offshore resources for LNG export.

While it is impossible to predict, should it prove to be possible to viably produce LNG at prices below current rates, the LNG market will be there for decades to come, and in the process it will change the international dynamic of energy politics.

12 | Energy Industry Data

Global installed wind power capacity (MW) – regional distribution

	End 2012	New 2013	Total (End of 2013)
AFRICA & MIDDLE EAST			
Ethiopia	81	90	171
Egypt	550	-	550
Morocco	291	-	291
Tunisia	104	-	104
Iran	91	-	91
Cape Verde	24	-	24
Other ⁽¹⁾	24	-	24
Total	1,165	90	1,255
ASIA			
**PR China	75,324	16,100	91,424
India	18,421	1,729	20,150
Japan	2,614	50	2,661
Taiwan	571	43	614
South Korea	483	79	561
Thailand	112	111	223
Pakistan	56	50	106
Sri Lanka	63	-	63
Mongolia	-	50	50
Other ⁽²⁾	71	16	87
Total	97,715	18,228	115,939
EUROPE			
Germany	31,270	3,238	34,250
Spain	22,784	175	22,959
UK	8,649	1,883	10,531
Italy	8,118	444	8,552
France	7,623	631	8,254
Denmark	4,162	657	4,772
Portugal	4,529	196	4,724
Sweden	3,746	724	4,470
Poland	2,496	894	3,390
Turkey	2,312	646	2,959
Netherlands	2,391	303	2,693
Romania	1,905	695	2,600
Ireland	1,749	288	2,037
Greece	1,749	116	1,865
Austria	1,378	308	1,684
Rest of Europe ⁽³⁾	4,956	832	5,737
Total Europe	109,817	12,031	121,474
of which EU-28 ⁽⁴⁾	106,454	11,159	117,289
LATIN AMERICA & CARIBBEAN			
*Brazil	2,508	948	3,456
Chile	205	130	335
Argentina	142	76	218
Costa Rica	148	-	148
Nicaragua	146	-	146
Honduras	102	-	102
Uruguay	56	4	59
Caribbean ⁽⁵⁾	191	-	191
Others ⁽⁶⁾	54	-	54
Total	3,552	1,158	4,709
NORTH AMERICA			
USA	60,007	1,084	61,091
Canada	6,204	1,599	7,803
Mexico	1,369	623	1,992
Total	67,580	3,306	70,885
PACIFIC REGION			
Australia	2,584	655	3,239
New Zealand	623	-	623
Pacific Islands	12	-	12
Total	3,219	655	3,874
World total	283,048	35,467	318,137

1. Israel, Jordan, Kenya, Libya, Nigeria, South Africa
2. Bangladesh, Philippines, Vietnam
3. Bulgaria, Cyprus, Czech Republic, Estonia, Finland, Faroe Islands, FYROM, Hungary, Iceland, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Norway, Romania, Russia, Switzerland, Slovakia, Slovenia, Ukraine.
4. Austria, Belgium, Bulgaria, Cyprus, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, UK
5. Caribbean: Aruba, Bonaire, Curacao, Cuba, Dominica, Dominican Republic, Guadalupe, Jamaica, Martinique
6. Colombia, Ecuador, Peru, Venezuela

Notes: * Projects fully commissioned, grid connections pending in some cases
 ** Provisional figure
 Project decommissioning of approximately 374 MW and rounding affect the final sums

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The future of energy utilities

Companies operating in the electricity sector are at a crossroads. While the future of the utility business is impossible to predict, there are some possible futures and business strategies that utilities should adopt to survive in the new paradigm.

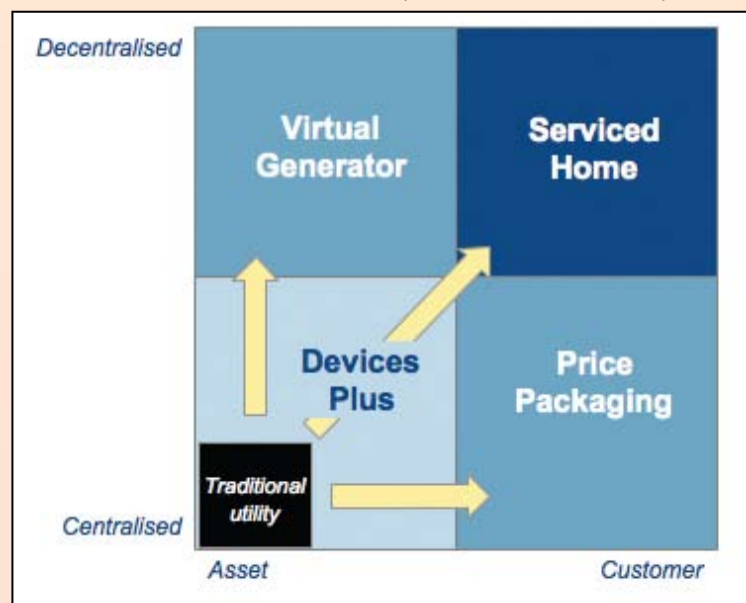
Market conditions in the energy utility sector, at least in Europe, are the most challenging in living memory. The centralised, integrated giants, which emerged from waves of central planning and international consolidation, now see their historical business model challenged by several factors including competition, political initiatives, regulation and structural changes. Furthermore, technological change creates additional challenges in areas such as smart meters, micro-generation and distributed generation.

However, challenges can often stimulate innovation. Utilities have the opportunity to use the current crisis to reinvent themselves, innovating in technologies, products, services and business models to fundamentally change the value proposition they offer to customers. While the future of the utility business is impossible to predict, there are some possible futures and business strategies that utilities should adopt to survive in the new paradigm.

For a variety of reasons, companies operating in the electricity sector are at a crossroads. The business model which has served them and their customers for over 50 years seems unlikely to be suitable for the next 10 years, let alone the next 50, at least in liberalised markets. The attraction of the traditional vertically integrated electricity utility, for example, based on very large scale centralised generation technologies such as coal, lignite, nuclear and gas-fired plant, seems very low today.

According to Eurelectric's *Utilities: Powerhouses of innovation, May 2013* report, the profit pool in conventional generation reduced by 10 per cent between 2011 and 2012, while decentralised generation has grown capacity significantly in the last decade. The combined market value of E.On and RWE, two of the largest conventional generators in Europe, has fallen by 76 per cent since 2008. A return to the market conditions of that high point seems very unlikely. The Fukushima accident with all its attendant regulatory consequences, the economic crisis, the difficulties of new nuclear plants (in cost and schedule terms) have all

Two key dimensions will define the future strategic positioning of energy utilities. Within this framework Arthur D. Little sees at least four potential approaches



taken their toll on the industry participants' appetite to invest.

It is clear that in order to "keep the lights on" over the next 5-10 years, industry, together with governments need to adapt. It is extremely important, in order for Europe to remain economically competitive, for it to have a stable, fairly priced supply of power (and heat), enabling it to compete with North America (which is benefitting from low prices due to shale gas), the Far East, the BRICs and others.

How can companies active in the utility sector re-invent themselves so as to once more create shareholder value? How can they change their business models, pursue commercial and technical innovation and deliver excellent service to customer as well as superior returns to investors?

In considering new business models, utilities will need to review the appropriate blend of capital-intensive assets versus asset-light activities such as energy trading and retailing. It's quite possible that there will be a new round of "disintermediation" within the industry, with firms moving beyond the traditional vertically-integrated utility model into one of a number of more specialist niches, focusing on activities which they can perform well, while partnering and/or making acquisitions to help reach their strategic goals.

We see two key dimensions that will define the future strategic positioning of energy utilities:

- Centralised vs. decentralised generation technologies – will companies retain a focus on large centralised generation assets or transition to a varied mix of decentralised technologies?

- Asset focus vs. customer focus – will energy utilities continue to focus on "upstream" generation and distribution of power using traditional assets, or transition to a customer focused business where energy supply is only one of a suite of services provided?

Within this framework we see at least four potential approaches:

- Devices plus: expand the current offering to include device manufacture supply, service and control – i.e. take direct control of smart grid/home elements giving greater control and allowing better value capture.

- Price packaging: energy as a service – move from a commoditised charge per kWh model, to a telecoms-like fee for access model (monthly charge) based around tailored packages depending on the needs and demand profile of the customer (flexible user, high energy power user, weekend user, etc.).

- Virtual generator: mixed model "virtual power plant" generators, coupled into smart grid – embrace rather than fight decentralisation and couple diversified generation assets with smart grid/home devices to create district level automated power communities.

- Serviced home: customer-centric packaged home services provider – ambitious sideways expansion into the provision of entertainment, security and monitoring services; moving into domains traditionally associated with telcos and entertainment companies.



White: utilities are reducing the capital-intensity of their business, preferring to invest in value-adding assets such as smart meters



Ingham: the flow of energy becomes two-way with the utility no longer in sole control

Reacting to the changes in the market, energy utilities have already begun to evolve their business models and adapt to the new realities. Across Europe some firms such as E.On and Centrica are moving to a position as "customer-centric" champions. They see their future as being a trusted supplier of a package of essential services for household customers. In addition to traditional service offerings, such as heat and power, they are offering home security, equipment maintenance contracts, plumbing services, etc.

They are reducing the capital-intensity of their business, preferring to invest in value-adding assets such as smart meters and other means of getting closer to their customers. The data from smart metering should, if managed and analysed well, allow utilities to understand their customers much better and target products and offers more successfully.

On the generation side, change to the decentralised model involves a major shift in philosophy and technology deployment, since in the decentralised world a utility must act as a partner, coordinator and supporter of numerous localised networks of distributed generation, which may or may not be linked to the wider grid. Further, the relationship with the con-

sumer also changes significantly, since the flow of energy becomes two-way with the utility no longer in sole control.

As a priority, energy utilities need to be thinking about how they will strategically position themselves in the new reality, and the actions they need to be taking now to make that change a success.

In order to develop and successfully execute a robust strategy in the new paradigm, energy companies must have:

- A clear and well communicated vision and strategy for future position, based on sound analysis of the value creation potential and competitive positioning of the business under different options

- A well-defined technology strategy, which underpins the business strategy and which clearly identifies the technology capabilities that a company must master and the actions needed to attain that mastery

- A clear roadmap of actions to move the business from where it is today to the desired future state.

Nick White is Managing Partner, Energy Practice Leader UK, at Arthur D. Little in London. Kirsty Ingham is Principal at Arthur D. Little, also based in London.

What's in store for storage?

There is a growing acceptance that there is a distinct need for energy storage but question marks remain on how to unlock the multiple revenue streams from the benefits it can offer. **Junior Isles**



Jones says it is time to stop talking and get on with it

A study by Pöry shows that in broad terms energy storage does not stack up if it cannot access all revenue streams from the benefits it provides

Energy storage has been around for a long time but has only enjoyed limited penetration at grid scale. Although this is partly due to the limited size of storage systems (with the exception of pumped storage hydro), it is perhaps more down to the difficulty that potential investors have in making an economic case for the technology.

However, as the world makes greater use of renewables to reduce carbon emissions, there are signs that the industry is gaining momentum.

Andrew Jones, Managing Director of Europe, Middle East and Africa, S&C Electric Company and a member of the Electricity Storage Network (ESN) noted: "The one region that isn't being directly driven by carbon reductions, is Africa, where it is more cost-effective to get electricity for remote communities by energy storage than building grids."

According to Jones, based on the last two years there is an estimated €900 million of storage projects in the R&D stage, being built or already constructed in Europe. "This is a lot more than people expected," he says, "but almost all of these have been funded to prove or improve technology pilots. Very few have been targeted to see how money can be made from them. There are only three or four, that I'm aware of, that were designed to commercially stand on their own two feet."

Storage has many network benefits and potentially multiple value streams, such as frequency response, fast reserve, capacity payments and arbitrage opportunities in the wholesale market.

Legislation, however, prevents many of those value streams being considered in Europe. The Third Energy Package attempts to split, generation, transmission and distribution. However, energy storage straddles all three, which poses problems in accessing revenue streams. For example, a network operator can defer investment in assets but will not benefit from selling ancillary services or energy into the market. This weakens the business case for TSOs seeking to implement storage.

Speaking at an energy storage conference in London recently, Mike Wilks, Director at Pöry Management Consultants, responsible for networks and smart energy, also noted that a number of benefits such as infrastructure avoidance are not easily accessible. "They are not something that the storage provider can readily tap in to. Take that away and suddenly the pic-

ture looks a lot more pessimistic."

Nevertheless, in many cases it can still make sense. Speaking at a recent workshop on energy storage in Brussels, Jones argued: "One of the questions I am always asked is: 'why is storage so expensive?' And I always reply: 'too expensive for what?' We have a project in the UK, which the regulator has given dispensation to accept a range of benefits. As a result, it is €8 million more cost effective to do storage than to build another substation."

With renewables located in the south and load in the north, Italy faces a problem of providing ancillary services around primary and secondary reserve. Jones noted: "The Italian regulator decided that storage was a more effective solution than building transmission lines to get more redundancy and stability into the system."

Terna Storage, a subsidiary of Terna, Italy's largest transmission system operator, is therefore investing more than €300 million in 75 MW of storage (525 MWh for 7 hours discharge) – claimed to be the largest battery storage project in the world. Terna's project will use a mixture of battery technologies but 35 MW will come from sodium sulphur (NAS) batteries. Notably, this will be the first large scale NAS storage system to be installed on the European grid.

Germany, meanwhile, has been looking at storage to help tackle issues arising from the amount of PV solar coming onto the grid. Struggling to keep up with network investment, the government has attempted to incentivise storage through subsidies to the tune of €80 million per year. The move is aimed at persuading owners of PV installations to store excess electricity instead of feeding it into the grid, therefore reducing the need to reinforce the grid.

According to Jones, the move has been a failure. "It has not been popular for two reasons. Germany's [solar] feed-in-tariff (FIT) effectively fights against the [storage] subsidy, so you lose the FIT. Also, the complexity of the application, compared to a solar installation, made people not interested in doing it. Germany is now discussing whether storage subsidies should be at grid level."

While Europe continues to struggle with regulatory obstacles, the situation in the US is much more positive due to government stipulations on requirements for storage.

In October last year, the California Public Utilities Commission (CPUC)

became the first state to adopt mandatory energy storage procurement targets. The programme is aimed at maintaining grid reliability as the state moves toward a target of 33 per cent of generation from wind and solar by 2020 in an effort to reduce greenhouse gas emissions

Under the programme, California's three major investor-owned utilities (IOUs) – Southern California Edison, Pacific Gas & Electric, and San Diego Gas & Electric are required to collectively procure 1325 MW of energy storage capacity by 2020.

Storage will be at the domestic, distribution and transmission levels. The Commission has also decided to split the market in terms of storage providers but adopting a preference for projects developed by third parties. Utilities can provide up to a maximum of 50 per cent of the storage needed, while third party providers must have a minimum of 50 per cent of the storage needed. Storage capacity and related services will then be sold to an IOU.

Some prerequisites have been set. Third party suppliers must have at least one year's experience. As large scale pumped storage (above 50 MW) will not count towards targets, battery

other green technologies. I think we are moving towards getting this by the summer. Secondly, they need to address the issue of who owns it [storage]. At the moment, the thinking is that third parties, as opposed to network companies, should own it. We believe the network companies should own more, at least initially, because they will act quicker."

The other key message is a 2000 MW target by 2020. This represents just 5 per cent of the renewables that are planned to be in place by then. Jones sees this as "a moderate target" that would stimulate the kind of investment that is now being experienced in California.

The UK government may, however, be reluctant to accept the target. Jones explained: "Some may see it as market intervention but our counter-argument is that you have intervened in renewables, smart meters and electric vehicles and set targets as part of the strategy. An intervention in storage will be just 1 per cent of the total spend on the network between now and 2020. We have had a Renewable Obligation and now a Contract for Difference obligation. Maybe now there could also be a flexibility obligation, in which any technology that provides

Already around 500 bids have been submitted for 50 MW storage projects

technology with durations over four hours is being favoured. The initiative is proving a tremendous success. Already around 500 bids have been submitted for 50 MW storage projects.

Elsewhere, New York's system operator has determined energy storage is the best option – technically, economically and environmentally – for providing frequency response compared to having large amounts of spinning reserve.

If New York follows California's example in setting targets for energy storage it can only have a positive impact on the industry. "It will create a market that will bring costs down," said Jones. "We are also seeing investors that are prepared to invest in projects at an IRR that is comparable with onshore wind in the UK."

Going forward, the fundamental challenge facing storage, at least in Europe, is improving the economics versus other options such as flexible generating capacity.

The UK believes the capacity market will create opportunities for storage but the likelihood is that it will only help conventional generators that are struggling to make money from existing assets. Jones believes the government is beginning to recognise this noting that "it now accepts that something else needs to be done".

UK Energy and Climate Change Minister Greg Barker recently said: "Storing energy will become increasingly important in the move towards a low carbon economy, and has the potential to save the energy system over £4 billion by 2050."

For storage to really take off, however, market design will need to change. The ESN is working with the Department of Energy and Climate Change (DECC) on this but Jones admitted: "We are finding it very hard. It's too easy for government to avoid any decisions on storage – they respond better to the pressure from the generation lobby."

The ESN has some simple messages. "The first," says Jones, "is a single point of contact within DECC, so we can have the same status as the

flexibility could participate."

As a technology, energy storage is still in its infancy. Due to its maturity, battery-based systems are the most widely used. Other technologies, however, are breaking through. Some, such as liquid air technology and isentropic pumped-heat electricity storage, will be better suited than batteries for systems bigger than 20 MW.

Notably, last month the UK government awarded more than £8 million in funding for a liquid air energy storage (LAES) project being built by Highview Power Storage in collaboration with recycling, renewable energy and waste management company, Viridor. In addition to providing 5 MW/15 MWh of energy storage, the LAES plant will convert waste heat to power using heat from the on-site landfill gas engines (see *TEI Times*, June 2013). The project is scheduled to be operational by mid 2015.

Although technology development is important, in the near term, the commercial debate will take over from the technology focus.

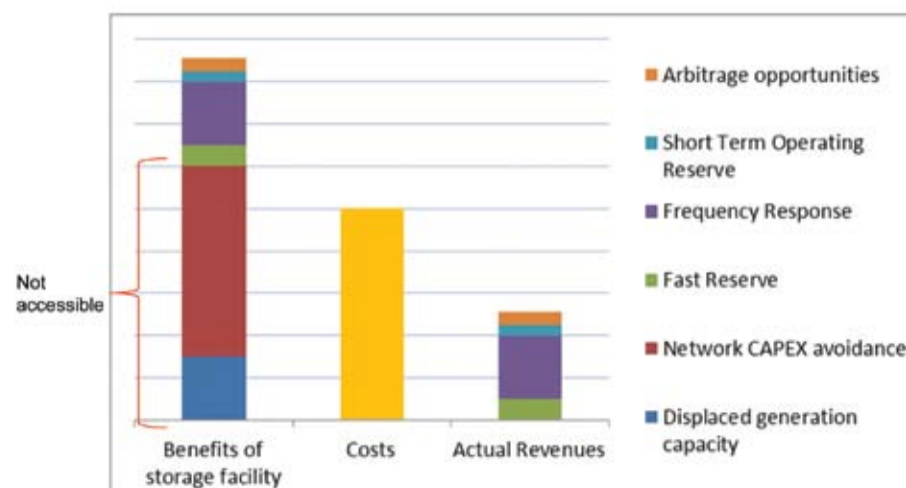
Many believe storage does not need subsidies, yet it could benefit from some sort of short term support until there is a market design that enables all the potential revenue streams to be tapped. This will allow systems, especially emerging technologies, to be installed so their commercial value to the grid can be demonstrated.

As Wilks noted: "Just as we've thrown money at wind, CCS [carbon capture and storage], and at other solutions for flexibility, maybe there's just a little loose change that we could spare for storage. This would give it that little push to get the momentum, so it's there when we need it at 2 or 3 GW as part of the flexibility mix."

The future is bright for storage but in Europe its success ultimately depends on governments making the changes to market design.

"I can see this happening, as it has in other markets," said Jones. "There is now a much wider recognition that storage has a role to play. Now it's time to just get on and do, and let's stop just talking about it."

Costs and Benefits of example storage facility



Technology

Meshed DC grids move closer

Europe's vision of building a grid capable of handling a large amount of renewables is looking increasingly realistic following the completion of testing of an HVDC circuit breaker under real network conditions.

Junior Isles

Last year saw significant breakthroughs by both Alstom and ABB in the development of high-voltage DC (HVDC) circuit breaker technology. The technology deemed essential for the development of meshed DC networks took another step forward recently with the announcement that Alstom has completed testing of its HVDC breaker technology under actual network conditions.

The tests mark the final stages of work headed by French grid company RTE for the operation and protection of DC grids under Europe's TWENTIES research project.

Launched in April 2010, the TWENTIES ('Transmission system operation with large penetration of wind and other renewable electricity sources in networks by means of innovative tools and integrated energy solutions') project is aimed at helping the EU achieve its renewable targets. Co-funded by the European Commission's FP7 programme, various experiments and tests are taking place across Europe that will culminate in the implementation of six large scale demonstrations.

These demonstrations are aimed at removing the barriers to integrating more wind power (from both on-shore and offshore) and other renewables into the grid by 2020 and beyond, while maintaining the network's present level of reliability and performance.

Alstom's latest series of tests consisted of reproducing real operational constraints of a high-voltage DC transmission grid, and complete the previous positive results observed with the prototype in Alstom's Villeurbanne testing facility in March last year (see *TEI Times* May 2013).

Essentially they validate the equipment's behaviour under actual operating conditions, at a voltage that is high enough to carry power over long distances. In particular, they

demonstrated the breaker's resistance to standard lightning impulse voltage, to transient currents exceeding 10 kA, and to heating caused by permanent current and by overload current.

All tests were witnessed by an RTE representative and by representatives from an independent RTE-mandated test laboratory in Lyon. The latest test, validating the power switching performance, was conducted on November 29, 2013, in the presence of representatives from RTE, Red Electrica España, TenneT and a European Commission Project Officer.

Stephan Lelaidier Alstom Grid R&D Vice President noted: "Our tests prove this equipment can be installed in a network operating under normal network conditions. For example, we have shown it can withstand the dielectric conditions of the 320 kV network. Thermal tests have also been done for currents of 2000 A as well as for over-current conditions over 3000 A for 2 minutes."

The circuit breaker is a key component in protecting a power grid in the event of a short-circuit. While the technology has long existed for breaking alternating current, until recently there has been no way of effectively interrupting direct current in high voltage networks.

As operators make increasing use of DC technology to deliver power efficiently over long distances, as well as to stabilise grids that are seeing a growing supply of power from renewable and intermittent sources, there has been a growing need for a breaker that is able to interrupt direct current.

Breaking DC is not as easy as breaking AC as there is no point where the current passes through zero. Also, when there is a short circuit, current rises much faster in a DC circuit than in an AC circuit. This means that any breaker has to act very fast.

Alstom's DC breaker has three



The prototype was put through its paces at the Villeurbanne testing facility

main components: a mechanical part, which acts as a fast disconnector; a second part that comprises an arrangement of power electronics components; and thirdly, a surge arrester.

The fast mechanical switch and the power electronics are, according to Alstom, the most important innovations.

Although he could not reveal design details, Lelaidier says the DC breaker is based on "some branches in parallel". He noted: "It uses power electronics in the main branch, which sees the current in the network, to break the current. The other branches then see the main current. Everything is monitored in terms of time. When there is no current in the main branch, a fast mechanical switch in the main branch is opened. A surge arrester is used to evacuate the energy resulting from breaking the current."

Following successful testing at 20 kV last year, the original plan was to test the breaker at 180 kV and 7500 A. These latest tests, however,

The most important challenge, however, was to create and certify the test setup and test devices. "It was completely new so we had to create some control equipment to make the link between the test device and test setup, and the prototype to be tested," said Lelaidier. "We had planned to do this between May and September/October and had to overcome some issues but it was very well managed and we were almost on time."

Before DC breakers can move to the next stage of development, the industry has to specify more clearly how they will be deployed. In addition to ultimately enabling the construction of DC meshed grids, DC breakers will be used in a variety of applications. This means the necessary specifications will change depending on their application.

"Specifications can change depending on the parameters of the grid. So the parameters have to be defined so we can be more precise in the specification of the product," said Lelaidier.

We have to do some optimisation of some of the components and construction... there is some work to do in order to make it an industrial version...

were instead carried out at the transitory interruption voltage of 160 kV.

Lelaidier noted: "It is not exactly 180 kV but this is not that important. What is important, is that the voltage was more than 320 kV divided by three, to show that in theory it could be installed on the 320 kV network. Also, the 7500 A is what we call the prospective current – the current that would have appeared if the equipment were unable to interrupt. The effective level of current interrupted was around 5300 A."

The interruption of the current was achieved in less than 2.5 ms, the same as the previous test. When including the total extinguishing of current across the grid, the time performance is less than 5.5 milliseconds because the energy to be extinguished in the surge arrester was much higher. "The pre-clearing time, which is the time to stop the current rising, and is the real performance of the breaker, was the same as before," explained Lelaidier.

Some new challenges surfaced in this latest series of tests. Compared to last year, the higher current and voltage resulted in larger equipment. "Instead of a small prototype it was now quite a significant prototype, which we had to build in a much bigger place," noted Lelaidier. "We also needed a larger team to monitor the quality of the [power electronics] components and assembly."

Alstom also says there is still some optimisation to be performed in terms of technology. "We have to do some optimisation of some of the components and construction. This is a prototype and there is some work to do in order to make it an industrial version for the future."

The speed of development will depend on this optimisation and how fast the community can define the input parameters for the specifications. Work on defining the parameters is continuing under the TWENTIES programme as well as through other programmes such as Best Path, which is a continuation of the TWENTIES project. Alstom says it plans to work with RTE and other potential customers to define more precise input parameters for the specification of the breaker.

"There is ongoing work at the standardisation level on this topic," noted Lelaidier.

While manufacturers such as Alstom and ABB have demonstrated the actual technology, clearly there is still plenty the industry has to do before a commercial DC breaker can be introduced to the market.

"Today we could put the product we have on the network as a pilot but to have a commercial product could take maybe three years. We will optimise and build a 320 kV breaker once we have more precise input data for specifications," concluded Lelaidier.

Lelaidier: tests prove this equipment can be installed in a network operating under normal network conditions



CAD drawing of Alstom's HVDC circuit breaker





Junior Isles

Where you lead...

Where you lead, I will follow... It is often heard in prayer and there are many similar verses in the Bible. It has long been one of the pillars on which Europe has built its renewables church. In the righteous war on climate change, Europe has taken the noble stance that if it takes the lead on emissions reduction, with renewables playing a central role in its effort, then the world will follow.

The European Commission's recent 2030 White Paper on climate and energy shows that its faith in renewables has been shaken. The Commission wants a binding target to reduce carbon emissions by 40 per cent from 1990 levels by 2030. Notably, it is also proposing that renewables will need to provide only 27 per cent of EU energy by 2030, and while the target will be binding at EU level there will be no mandatory targets for member states.

The White Paper is due to be discussed in the coming months and like a modern day rift between the Gentiles and Pharisees, it is a debate that looks set to split the house of Europe.

Just two weeks after the Commission's proposal the European Parliament rejected what some called the Commission's one-legged policy, in favour of ambitious climate and energy policy. It again voted in support of three binding 2030 targets for renewables, greenhouse gas (GHG) reductions and energy efficiency.

CEOs from the renewable energy sector recently discussed the potential impacts of the Commission's climate and energy blueprint and whether Europeans should continue to support renewable energy.

"The target for 2030 must be higher. It's like in real-life; without targets there is no pressure"

Speaking at the 2030 Europe Business press conference, Jean-Marc Armitano, CEO, RES Med, part of the RES Group said that relying on the CO₂ target alone is not enough for several reasons.

He explained: "Firstly, it would be

reliant on short term price signals versus long term targets. This would stem investment in renewables, which have the biggest potential for cost reduction in the long run. It would also be counter-productive in achieving the ultimate goal of carbon emissions because there is a serious risk of early fossil fuel or nuclear lock-in. Thirdly, a CO₂-only target ignores the wider benefit of renewables, for example, job creation... an ambitious renewable energy target with emission reduction [target] would also reduce long term energy costs for the consumer."

danger of a lack of ownership of a pan-European renewables target, as some countries will no doubt rely on others to do more to achieve the overall goal.

Hans-Dieter Kettwig, Managing Director at Enercon said: "The target for 2030 must be higher. It's like in real-life; without targets there is no pressure." He believes that without a tough binding target, utilities will revert to their traditional approach to generation. He also believes a softening on renewables sends out the wrong signal to the rest of the world.

"What is the signal?" he asked. "That we started but now we are shaking because it may or may not work?"

Signals are important, as is leading by example but not all believe in the same scripture. Speaking at the first Energy Forecast conference in Brussels Krysstof Bolesta, Principal Advisor on energy to the Polish Ministry of Environment questioned the EU's leadership role and criticised its entire approach of target setting.

"We [Europe] are on track to reduce emissions as we agreed but we are by no means a global leader because no one is following us. We didn't sign a global deal in Copenhagen," he said.

Bolesta looked to the US as an example of a more sensible strategy. "It's very simple. It's about growth, local jobs and energy independence."

It sounds much like the argument of the renewables supporters. But there is a difference – reduction of emissions is merely a welcome side effect as opposed to the main policy driver.

He said: "It seems that they [the US] have learned from their mistakes. I see them investing in solar because it gives local jobs for construction, and indigenous gas for electricity. Have we learned from our mistakes?"

Bolesta pointed to the negative economic effects of being led by GHG and renewables targets. "Based on the impact assessment from the Commission, there are few countries in Europe that will grow relatively quickly. If you plot the costs for 2030, you see that countries marked green will be most exposed to EU policy. It seems we have not learned from our mistakes. GHG is leading our energy and climate policy and if we sign up to this policy, we will choose to stay on this path of expensive energy. It seems we don't have a strategy; we just have a culture of target setting, and struggle to answer how to meet these targets."

Bolesta was challenged by one delegate on his statement that no one is following Europe but remained adamant, saying: "We can have a long discussion on leadership but I will never change my mind. What China does, they do very skilfully; what the US does, they do almost by accident, so I don't think we can qualify what actually happens on emissions reduction worldwide as following the European example."

"As part of the COP team in Warsaw, sometimes it was quite sad to see that the EU is not part of the deal anymore. Very often it's China, the US, India and other developing countries that actually make deals. We still have a lot of knowledge on how to make climate policy but we choose to be so radical, that some people don't want to talk to us anymore."

If Bolesta is right, then Europe's belief perhaps becomes more of a prayer. It is clear that the European Commission's faith is faltering, and it is now looking to sing from a hymn sheet that is maybe more in line with the rest of the global congregation.

Keep the faith, believe in the fruitfulness of renewables, spurn the devil CO₂, or damned we shalt be!



According to the European Renewable Energy Council (EREC) and the European Wind Energy Association (EWEA), which jointly facilitated the meeting, an ambitious renewable energy target would create 570 000 more jobs and save €260 billion in fossil fuel imports compared to a GHG-only approach.

Rafael Mateo, CEO of global renewable power developer Acciona Energia also noted that Europe needs more renewables to improve energy independence. He said Europe is spending more than €1 billion a day on oil and gas imports and thus has limited control over the price of energy.

Like all of his panel members, he was concerned about the effect of changing policy on the sector.

"For investors, stability is more important than incentives. And this means long term legal and regulatory frameworks, stable rules, stable contracts, no regulatory surprises in the middle of an asset's lifetime. Investors are asking for a single European policy, not 27 policies," he said.

It was a point echoed by Denis Cochet, Senior Vice-President, Alstom, who stressed the importance of stable policy, not just for renewable investment but also for the network upgrades that will be necessary.

"The grid was built half a century ago with centralised fossil fuelled plants. It is very clear that it needs to be upgraded and better interconnected to encourage flexibility, balancing and improve security of supply – regardless of the source of energy," said Cochet.

The Commission says around €140 billion will be needed up to 2020, to refurbish the high voltage grid, build smart grids and develop energy storage. This is big money. If the investment that is needed for power generation is also taken into account, the sector will require several hundred billion euros. Cochet argues, that it will be money well spent.

"Better interconnected grids bring big benefits. It will reduce the need for peaking power. It will also improve competition in the electricity market, which is better for the consumer at the end of the day if prices decrease. But if we want all of this investment to come, we need a stable legal framework that we can rely on."

Renewable proponents argue that ambitious and binding targets at the national level are essential. Certainly without national targets there is the