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Negotiating climate change rule book could take years

Shamanov wants a clear set of rules

Climate change talks in Bonn indicate that implementing the Paris Agreement could be a painstaking process. **Junior Isles**

Negotiating a detailed rule book for the Paris Agreement for limiting global warming could take years, in the worst case, delegates said at climate talks on implementing the pact.

Certainly the recent UN climate change talks, May 16-26, in Bonn, Germany, indicate that it will be a difficult road ahead. During the meeting, Russia set itself at odds with a drive by China and the United States for rapid ratification of the Paris Agreement to slow climate change when a senior official said that Moscow first wanted a clear set of rules.

A UN rule book would include how countries will report and monitor promised curbs on emissions and ways to adapt to changes in the climate such as more floods, heat waves, storms and rising sea levels.

Russia was among 175 nations to sign at a ceremony in April in New York, but questioned the plan in a rare sign of disagreement about its implementation.

Oleg Shamanov, Russia's chief climate negotiator, told *Reuters*: "The core issue to create the landscape conducive to joining, is the development of the book of rules."

He said it took almost five years to produce rules for the UN's 1997 Kyoto Protocol, which obliged about 40 industrialised nations to cut emissions. "We are hoping that it can be much faster this time," he said.

So far, 16 nations have ratified the agreement, accounting for just 0.03 per cent of emissions. China and the US, the world's two largest greenhouse gas emitters say they plan to sign the Paris Agreement this year and almost all other nations say they will ratify as soon as possible – before the rules are in place.

The Agreement can still enter into force without Russia, because it requires at least 55 nations representing 55 per cent of global greenhouse gases to gain legal force. Russia, the number three emitter, only accounts for 7.5 per cent.

Mexico's Foreign Minister and incoming head of the UN Climate Change Secretariat, Patricia Espinosa, said it was not impossible that the accord could enter into force in 2016 but

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Asia will continue to drive global emissions, says EIA Outlook 2016

The *International Energy Outlook 2016* (IEO2016) recently released by US-based Energy Information Administration (EIA) paints a disconcerting picture for global greenhouse gas emissions.

In the IEO2016 Reference case, global energy-related carbon dioxide (CO_2) emissions are projected to increase by one-third between 2012 and 2040, largely driven by increased energy use in countries outside of the Organization for Economic Cooperation and Development (OECD).

Notably, the continuing increase in total emissions occurs despite a moderate decrease in the carbon intensity (CO_2 per unit of energy) of the global energy supply.

Most emissions growth will be seen in non-OECD Asia, where energy consumption is growing most rapidly. The outlook forecasts that world energy consumption will grow by 48 per cent between 2012 and 2040. Non-OECD Asia, including China and India, accounts for more than half of the total increase in energy consumption over the projection period.

In the Reference case world energy-related CO_2 emissions increases from 32.3 billion metric tonnes in 2012 to 35.6 t billion in 2020 and to 43.2 t billion in 2040. The Reference case estimates do not include effects of the recently finalised Clean Power Plan (CPP) regulations in the US, which reduce projected US emissions in 2040 by 0.5 billion metric tons.

Non-OECD Asia accounts for about 59 per cent of the growth in world CO_2 emissions during the outlook period. China's emissions grow by an average of only 1.0 per cent/year, but they still account for 41 per cent of the total increase in non-OECD Asia emissions. India's CO_2 emissions increase by 2.7 per cent/year, and emissions in the rest of non-OECD Asia increase by an average of 2.3 per cent/year, accounting for 30 per cent and 29 per cent, respectively, of the total non-OECD Asia increase in CO_2 emissions.

Much of the growth in emissions is attributed to continued reliance on fossil fuels, even though the energy landscape is rapidly changing. By 2040, coal, natural gas, and renewable energy sources provide roughly equal shares (28 per cent-29 per cent) of world electricity generation – a significant change from 2012, when coal provided 40 per cent of all power generation.

Hydropower and wind are the two largest contributors to the increase in world electricity generation from renewable energy sources, together accounting for two-thirds of the total increase from 2012 to 2040. Hydropower and wind generation each increase by about 1.9 trillion kWh in the IEO2016 Reference case.

Worldwide electricity generation from nuclear power increases from 2.3 trillion kWh in 2012 to 4.5 trillion kWh in 2040, as concerns about energy security and greenhouse gas emissions support the development of new nuclear generating capacity.

EIA has tried to incorporate some of the specific details of countries' Intended Nationally Determined Contributions (INDCs) in the IEO2016 Reference case. It notes, however, that a "great deal of uncertainty remains with regard to the implementation of policies to meet stated goals".

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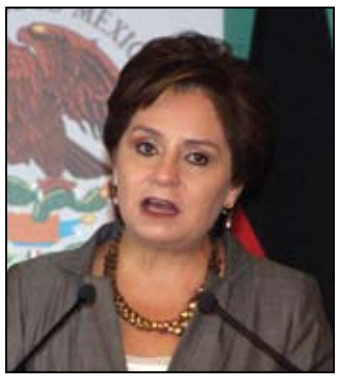
that "this kind of ratification takes time".

She also expressed hopes that US Republican presidential candidate Donald Trump will drop calls for a renegotiation if elected. Trump has made it clear he is "not a big fan" of the Paris accord and that "at a minimum will be renegotiating those agreements".

Trump has said in the past he believes global warming is a concept that was invented by China to hurt the competitiveness of US business. Many backers of the accord



Espinosa will be "respectful of everybody who has a role to play in any country"

have expressed disappointment at Trump's call.

Commenting on Trump's threat, Espinosa said she would be "respectful of everybody who has a role to play in any country" but at the same time will seek to build momentum for action.

Espinosa said the Paris deal was a hard-won compromise by more than 190 nations. "It would not be easy for anybody to just say 'I want to renegotiate this'. Renegotiation is really not a scenario that in a multilateral process you can see as something feasible."

Christiana Figueres, the outgoing executive secretary of the United Nations Framework Convention on Climate Change, also says renegotiation will be difficult for Trump.

Figueres, who steps down in July after six years, said: "As we all know, Donald Trump relishes making very dramatic statements on many issues, so it is not surprising, but it is highly unlikely that that would be possible."

She told journalists at the Carbon Expo event in Cologne, Germany: "An agreement that has been adopted by 195 countries would require 195 countries to agree to any new negotiation."

Figueres said if the 55 nations ratify the agreement, it could come into force as early as 2017. It would then be even harder for the US to pull out, as rules state any nation wanting to leave has to wait four years from the date of the agreement's entry into force – the length of a US presidential term.

At the close of the Bonn meeting, Mohamed Adow, Christian Aid's Senior Climate Advisor, said: "In Bonn countries made progress on developing a way forward around emissions, adaptation and how nations would be held accountable, but the real progress needs to be made later this year."

Looking forward to the next UN gathering in Marrakesh, Morocco, in November, he added: "Marrakesh needs to be seen as the Renewables COP. It offers an enormous opportunity to shift the conversation from grand political rhetoric to the implementation of short-term concrete actions, which will keep the agreed temperature goals of 1.5°C and 2°C within reach.

Oil and gas majors seek clean energy opportunities

- Shell unveils New Energies
- Total acquires Saft battery storage

Junior Isles

Global oil and gas majors are putting a greater focus on renewables in an attempt to cushion the impact of low oil prices.

Dutch company Royal Dutch recently announced the creation of a new division called New Energies, through which the oil and gas giant will invest in wind energy, along with its hydrogen, biofuels and electrical activities, The new unit is expected to be officially unveiled on June 7th.

New Energies has $1.7 billion of capital investment attached to it and will be run alongside the Integrated Gas division under executive board member Maarten Wetselaar. The offshore wind sector will be a key focus of the new division. The company recently submitted a bid, together with major Dutch offshore wind players – Eneco and Van Oord – to build the first two offshore wind farms in Dutch Borssele Zone.

Oil and gas companies are well equipped to compete in the offshore wind sector. Having an existing supply chain familiar with working on large-scale projects at sea could be an important advantage. Dong Energy and Statoil, which were primarily operating in the oil and gas sector, have already established themselves as big offshore wind players.

Aad Correljé, an energy expert from the Technical University of Delft said: "Large-scale wind farms at sea should not be much of an issue for such businesses, since they are good in dealing with big, technologically complex projects, and they know how to deal with governments."

The news came as Shell published a report analysing the measures required for international climate targets to be met. In the report's foreword, Shell's CEO Ben van Beurden, wrote: "We know our long-term success as a company depends on our ability to anticipate the types of energy that people will need in the future in a way that is both commercially competitive and environmentally sound."

Experts at London-based think tank, Chatham House, recently warned international fossil fuel firms they will need to transform their operations or face a "brutish and short" end within 10 years.

A recent research paper called 'International Oil Companies: The Death of the Old Business Model' by Paul Stevens, a fellow at Chatham House, the Royal Institute of International Affairs detailed the effect of the change in the global energy business environment on major oil companies.

According to Stevens, the major international oil companies such as BP, Chevron, ExxonMobil, Shell and Total face a gloomy future, as the business model on which they have been relying "is no longer fit for purpose" and need to diversify. "An apparently obvious area in which to diversify is renewables and green energy," he said.

Total is also taking further steps to take advantage of the opportunities offered by the clean energy transition. In early May, it signed a deal to buy battery manufacturer Saft. The French oil company said the acquisition would accelerate its development in the fields of renewable energy and electricity.

Total and Saft said they had signed a joint agreement for Total to launch a tender offer at €36.5 per Saft share, valuing the group at €950 million.

Patrick Pouyanné, chairman and chief executive of Total, said: "The deal will allow us to complement our portfolio with electricity storage solutions, a key component of the future growth of renewable energy."

In April, Total announced the creation of a gas, renewables and power division, saying it wanted to become a "leader" in renewables and electricity storage within 20 years.

GE strengthens turnkey capability with Doosan HRSG acquisition

A deal under which GE Power will acquire the heat recovery steam generator (HRSG) business of Korean-based Doosan Engineering & Construction (E&C), could see the US company become more active in the turnkey power plant business.

In announcing the $250 million deal, GE said the acquisition will help it meet the growing demand for its combined cycle gas turbine (CCGT) power plant solutions, which utilise HRSG technology, and continue to expand its customer offerings. The deal follows GE's acquisition of Alstom's HRSG technology last year.

Commenting on the move, Steve Bolze, President and CEO of GE Power said: "With the Alstom acquisition, we are now offering full power plant solutions and seeing an even greater demand for our highest-efficiency HA heavy-duty gas turbine plants.

"The Doosan Engineering & Construction HRSG acquisition will help us meet our forecasted growth and better manage costs by increasing our global manufacturing capacity and further complementing our existing HRSG technology. We're also gaining a talent pool that is one of the best in the world."

Doosan E&C HRSG has been a supplier to both GE and Alstom and has a long history as an Alstom licensee. Upon completion of the sale, Doosan E&C HSRG will be integrated into GE Power's Gas Power Systems business, which already includes Alstom's legacy HRSG business.

"We're seeing HRSG demand that is more than double historical averages," said Joe Mastrangelo, President and CEO of GE Gas Power Systems. "Our investment in Doosan Engineering & Construction HRSG will bring us cost-effective, vertically integrated manufacturing and engineering capacity that will allow us to be faster and better as we ramp to meet customers' needs."

Doosan has three advanced manufacturing facilities, including one in Korea and two in Vietnam. Doosan E&C HRSG will be integrated into GE's Gas Power Systems business over the next 12-18 months and will expand its manufacturing capabilities for HRSG projects globally.

Notably, the ability to supply HRSGs gives GE the ability to deliver all the major components of a CCGT plant and build turnkey CCGT projects. Commenting on the possibilities, GE spokesperson Melissa Quesnel said: "Our portfolio has strengthened across the entire plant to include turnkey capabilities. We specialise in providing the power island, which includes gas turbines, steam turbines, generators, HRSGs, condensers and key BOP equipment, while working in close relationship with consortium EPC partners. In addition, GE will offer the turnkey power plant including the EPC scope for selected projects."

According to Doosan E&C its HRSG business will be sold along with its assets and debts to GE by the end of July.

Doosan E&C has been seeking to sell the lucrative business as part of efforts to enhance its overall financial health. In the face of the prolonged slump in construction, Doosan E&C has been pushing for business restructuring including asset sales.

Court ruling has implications for EU Member States' energy policy

A recent EU court ruling on Germany's renewable energy law could have significant implications with regards to the degree of influence the Commission has on Member States' energy policy, according to legal experts.

The European Court of Justice's (ECJ) General Court has ruled that Germany's 2012 Renewable Energy Act (EEG) involved State aid, dismissing Germany's action against the Commission.

The court dismissed the action, which had been brought by Germany against a Commission decision by which it classified as State aid (a) the support for undertakings producing electricity from renewable energy sources (aid which the Commission nevertheless approved) and (b) the reduction in the EEG surcharge for certain electricity-intensive undertakings (aid which it for the most part approved).

Given that a number of EU Member States are considering support to large energy projects, this judgment is particularly relevant in providing guidance on when it is necessary to notify the Commission of state aid measures, say legal experts.

Rahul Saha, Managing Associate at King & Wood Mallesons said: "The judgment highlights the necessity for Member States to carefully consider the state aid implications of all major energy policy revisions and assess the compatibility of the measure with the 2014 Commission Guidelines on State aid for environment protection and energy."

The EEG 2012 laid down a scheme to support undertakings producing electricity from renewable energy sources and mine gas ('EEG electricity'). That law thus guaranteed those producers a price higher than the market price. In order to finance that support measure, it imposed an 'EEG surcharge' on the suppliers to the final customers, which in practice was passed on to the final customers.

Saha commented: "In enacting EEG without notifying the Commission, the German government relied on the PreussenElektra case, where the ECJ found that statutory provisions requiring electricity suppliers to purchase electricity produced from renewable energy at minimum prices was not State aid. However, the General Court distinguished the PreussenElektra case, finding that in that case the funds in question were not under public control and did not include a State monitored compensation scheme."

Obama targets fracking emissions

President Obama continues to push forward with his green energy initiatives in spite of further delays to the Clean Power Plan.

Siân Crampsie

Tackling emissions from shale gas operations has become the latest element of US President Barack Obama's wide-ranging plans targeting climate change.

The US Environmental Protection Agency (EPA) has finalised new regulations demanding that oil and gas producers curb leaks of methane from fracking rigs.

The rules will initially apply to new wells drilled for shale gas extraction, but the EPA is also planning regulations that will affect existing wells.

The American Petroleum Institute (API) said that the new regulations would be costly and harm the shale gas revolution that has helped to reduce carbon emissions and lower energy prices.

"The industry is already leading the way on methane reductions because it is good for the environment and good for business," said API Vice President of Regulatory and Economic Policy Kyle Isakower. "Even as oil and natural gas production has risen dramatically, methane emissions have fallen, thanks to industry leadership and investment in new technologies.

"It doesn't make sense that the administration would add unreasonable and overly burdensome regulations when the industry is already leading the way in reducing emissions. Imposing a one-size-fits-all scheme on the industry could actually stifle innovation and discourage investments in new technologies that could serve to further reduce emissions."

The regulations are the latest step in Obama's Clean Power Plan, which aims to reduce greenhouse gas emissions from US power plants to 32 per cent below 2005 levels by 2030.

Last month the initiative suffered another delay after a US court said it would not hear a case challenging the legality of the Clean Power Plan until September 2016.

The Court of Appeals for the District of Columbia Circuit had been due to hear the case in June, and the delay means that a decision on the case will not be possible until after the November 2016 Presidential election.

Earlier this year the Supreme Court ordered the EPA to halt work on the Clean Power Plan while the legal case was ongoing.

A group of 27 US states is challenging the Clean Power Plan.

■ US companies including Facebook and Microsoft are backing a new alliance aiming to increase electricity generation from renewable sources. The Renewable Energy Buyers' Alliance will help companies secure deals for wind and solar power, with the aim of adding 60 GW of capacity to the US grid by 2025. The alliance is led by the environmental groups Business for Social Responsibility, the World Resources Institute, the World Wildlife Fund and the Rocky Mountain Institute, with support from about 60 companies.

Energy crisis deepens in Venezuela

Venezuela's government has declared a state of emergency in response to a continued energy and economic crisis in the country.

President Nicolas Maduro last month instigated a 60-day state of emergency just weeks after implementing a system of rolling blackouts across the country and imposing a two-day working week for government employees.

The power shortage is the result of a chronic drought that has affected water levels at the Guri dam, the country's main source of electricity. The impact of the power shortages on Venezuela's economy have been compounded by the decline in oil prices.

Maduro announced power rationing in late April in 18 of Venezuela's 24 states, although the blackouts are reported to now be affecting the whole country, including the capital, Caracas. The state of emergency also gives the government the authority to shorten the working week in the private sector and to nationalise factories.

Maduro's government has blamed the El Niño weather phenomenon for the drought, and has pinned the blame for the economic crisis on other countries, including the USA.

Water levels at Guri have fallen to just over 241 m, according to state utility Corpoelec. If levels drop below 240 m, the firm may have to shut down units at the plant.

The 8900 MW Guri hydropower plant on the Caroni River meets around 60 per cent of Venezuela's electricity demand.

Mexico prepares for second auction

Mexico's energy ministry is preparing to hold a second auction for long-term electric power supply this summer.

The auction will follow on from the first auction, held in March, which generated 227 bids from 69 groups including Enel Green Power, Jinko Solar, Acciona and SunPower.

The format of the next auction will be the same, according to the ministry, with firms competing for long-term contracts with state utility CFE. It will again focus on renewables, but will also take into account the differences in the cost of generation in different regions so that power is purchased where the grid most requires it.

The first auction awarded 1800 MW of wind and solar capacity, equivalent to 85 per cent of the energy on offer, spread between 12 solar plants and six wind farms. Bidders in the second auction will present technical and economic proposals in early August, and winning bids will be announced in September.

The new auctions are a key part of Mexico's new energy sector reforms, designed to attract investment to the oil and gas and power sectors.

Argentina kicks off renewables tender process

Argentine President Mauricio Macri has launched a renewable energy programme that he hopes will attract up to $2 billion of investment.

RenovAr is a national programme that will help Argentina to reach a goal of generating 20 per cent of its electricity needs with renewable energy by 2025.

It has been kick-started by a tendering process, called Ronda 1, for the supply of 1000 MW of renewable energy.

It specifically calls for bids for the development of 600 MW of wind, 300 MW of solar, 65 MW of biomass, 20 MW of small hydropower and 15 MW of biogas capacity, and will be overseen by Cammesa, the Argentine system operator.

Developers submitting winning bids will be able to sign 20-year power purchase agreements with Cammesa, which will publish the final rules of the tender process at the beginning of July. Bids are due to be submitted by August 22, 2016.

The government hopes RenovAr will enable Argentina to add 10 GW of renewable energy capacity to the grid by 2025.

"We are calling on companies to invest in this process," Macri said during the launch of the RenovAr programme. "Today, less than two per cent of the energy we consume comes from renewable energy."

Sun shines on Chilean solar

■ SunEdison sells PV plants
■ Camarones approved

Chile is continuing to increase its solar energy capacity in a bid to boost energy security.

Environmental authorities in the country's northernmost Arica region have approved an environmental impact assessment for a 105 MW solar thermal project, while energy firm Colbun has signed a deal to acquire the energy generated by two large-scale solar photovoltaic (PV) parks.

The $800 million Camarones solar thermal power plant is being developed by Spain's Elecnor and will comprise an array of heliostat mirrors reflecting sunlight onto a tower containing molten salts. The project will supply baseload energy to Chile's northern SING power grid via a 13 km, 220 kV transmission line.

Elecnor also built the 394 MW Agua Prieta II solar thermal combined cycle gas turbine hybrid project in Mexico.

Camarones joins the Atacama 1 and Atacama 2 thermal-photovoltaic hybrid solar projects in Chile under development by Spain's Abengoa.

In May, Colbun agreed to purchase 200 GWh/y from SunEdison under a 15-year power purchase agreement covering a planned 100 MW PV farm that will connect with the central SIC grid.

SunEdison and Colbun have also signed an agreement that will see the Chilean generator buy two solar PV plants from SunEdison, which recently declared bankruptcy.

That deal covers the 145 Olmué and 57 MW Santa Sofia plants, both of which are in development and will be connected to the SIC grid.

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~ Jan 19, 2016, Viet Nam News
"Myanmar targets 17-fold rise in coal-fired power"
~ Jan 18, 2016, The Financial Express
"India gets $1b loan from ADB for renewable energy transmission, grid expansion"
~ Jan 12, 2016, Asian Power

Highlights:

- Assess the outlook on power generation capacity expansion, especially ***Indonesia, Myanmar, Vietnam, Philippines***, etc
- Macro-economic & financiers' appetite for the power infrastructure investment
- **Post-COP21** – Shift on the energy sources for new/existing power plants in Asia, and promising growth for renewables in the region?
- What's ahead for coal & nuclear in Asia?
- Prioritized efforts on transmission grid expansion & efficiency upgrading
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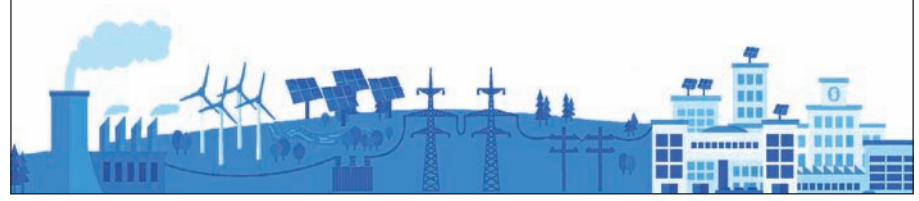

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Session 3 - Game Changers: Critical Developments Shaping the Electricity Revolution: Panel Discussion
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Warnings on Asia coal use

Asia's continued use of coal fired generation will use up the global carbon budget, eliminating any chance of keeping global warming to the 2°C limit. **Syed Ali**

The World Bank (WB) has warned that the use of coal fired power generation in Asia is threatening to undermine climate change efforts.

During a two-day gathering of government and corporate leaders in Washington, USA, World Bank President Jim Yong Kim said: "Plans to build more coal fired power plants in Asia would be a disaster for the planet and overwhelm the deal forged at Paris to fight climate change."

In the US and much of Europe, coal use is in sharp decline but there is still strong demand for coal in South Asia and East Asia, where a significant portion of the population still has no access to electricity.

The WB said countries in south and southeast Asia were on track to build hundreds more coal fired power plants in the next 20 years – despite promises made in Paris to cut greenhouse gas emissions and shift to a clean energy future. China, India, Indonesia and Vietnam alone account for three-quarters of new coal fired power plants expected to be built around the world in the next five years.

Yong Kim warned: "If Vietnam goes forward with 40 GW of coal, if the entire region implements the coal-based plans right now, I think we are finished."

Halting coal fired plant construction and making it affordable and practical for countries to replace fossil fuels with clean sources of energy such as wind and solar was the prime focus of the two-day meeting, and the WB's new mission. The WB said in April it would devote 28 per cent of its spending to climate change projects.

John Roome, the Bank's senior climate change official said: "If all of the business-as-usual coal fired power plants in India, China, Vietnam and Indonesia all came online, that would take up a very significant part – in fact almost all – of the carbon budget. It would make it highly unlikely that we would be able to get to 2°C."

Climate targets will be further threatened by Japan's plans for increased coal use. In May, a study compiled by Oxford University's Smith School of Enterprise and the Environment, urged Prime Minister Shinzo Abe to reconsider plans to invest in coal fired generation following the reduced use of nuclear power post-Fukushima.

The study says the plan takes Japan's energy policy in the opposite direction to other developed nations and condemns the country to growing environmental risk.

All but one of Japan's nuclear reactors, which previously met 29 per cent of the national energy demand, remain shut down, with the shortfall met by increased reliance on oil, gas and coal.

Ben Caldecott, the report's lead author, said current plans to build 49 new coal fired plants and 28 GW of additional capacity cannot be economically justified, and would exceed the capacity required to replace the retiring fleet by 191 per cent.

The resulting overcapacity, combined with increasing competition from solar and other renewable sources, creates a risk that assets amounting to about 25 per cent of power companies' market capitalisation could become "stranded" – subject to premature write-downs or conversion to liabilities.

The report presents three scenarios, all forecasting that Japan's power companies faced combined write-downs or devaluations of at least $50 billion.

"This highlights the risk of continuing to proceed with the planning and development of new coal fired power plants in Japan," said the report.

World Bank supports Indian solar

India moved closer to achieving its rooftop solar PV target with the approval of a $625 million loan from the World Bank (WB). The WB also approved a co-financing loan of $120 million on concessional terms and a $5 million grant from Climate Investment Fund's (CIF) Clean Technology Fund. The project will finance the installation of at least 400 MW of grid connected rooftop solar photovoltaic (GRPV) across the country.

India plans to harness its solar potential to increase solar PV capacity to 100 GW by 2022. Onno Ruhl, World Bank Country Director in India commented: "This project will support this target, by providing financing to some of the 40 GW of solar PV which will be placed on rooftops."

■ At the end of April, the Minister of New & Renewable Energy, Piyush Goyal, announced India has attracted Rs 90 841 crore ($14 billion) over the last three financial years in renewable energy investments.

Goyal: India has attracted $14 billion in the last three years

PSALM yet to confirm assets to be privatised

The Philippines' Power Sector Assets and Liabilities Management Corp. (PSALM) has yet to list the inventory of power assets up for sale this year, as discussions with the relevant agencies continue.

Under the Electric Power Industry Reform Act of 2001, PSALM is tasked with privatising the power assets, liabilities and contracted capacities of state-owned generator National Power Corp. (Napocor).

Among the power generating assets that are yet to be privatised are: the 850 MW Sucat thermal power plant; the 200 MW Mindanao coal fired plant; the 982 MW Agus-Pulangi hydropower complex; the 40 MW security capacity of the Unified Leyte Geothermal Power Plant (ULGPP) and the bulk capacity of the ULGPP itself.

Notably, PSALM said the Agus-Pulangi hydropower complex, which provides more than half of Mindanao's current electricity capacity, is unlikely to be privatised this year. The facility is tentatively scheduled for privatisation in 2017.

With regards to the Mindanao coal fired plant, PSALM said it is awaiting the go-ahead from the DOE. Lourdes Alzona, President and Chief Executive Officer, PSALM said: "We are continuously consulting the DOE with regard to power demand-supply outlook in Mindanao before further presentation to the PSALM Board will be made this year."

The PSALM Privatization Bids and Awards Committee has yet to convene to discuss the next steps for the sale of the decommissioned Sucat plant.

PSALM earlier declared the second round bidding for the structures, plant equipment, auxiliaries and accessories of the Sucat plant as a failed bidding after the three qualified bidders did not meet the reserve price set by the PSALM Board.

Meanwhile, in late April Meralco PowerGen Corp. (MGen) said it is looking for partners to build new power plants including coal, gas, wind and hydropower to meet its 3000 MW target portfolio.

China to boost energy storage

- Energy storage capacity to reach 14.5 GW
- MoU signed to build 1000 MW of solar thermal

China is expected to raise its power storage capacity by 10-fold to 14.5 GW by 2020 as it attempts to cut massive waste from renewable energy projects, according to a report by the China Energy Storage Alliance.

China is the world's largest wind and solar power producer. GlobalData recently predicted the country's installed wind power capacity will more than treble from approximately 149 GW in 2015 to over 495 GW by 2030.

Some regions, however, are estimated to be wasting more than 40 per cent of the power from these sources because of technical restraints and bottlenecks in the grid. The problem is being compounded by slowing power demand growth.

Expanding its storage capacity will help China make better use of its renewable energy sources. The country currently has 105 MW of storage capacity – a 110 per cent increase over the previous five years. This, however, represents just 1.7 per cent of total generation capacity by 2015, according to the report.

The projected increase in storage does not include pumped storage and is based on manufacturers' orders, said the report.

China has also set a target of adding 10 000 MW of concentrated solar power (CSP), or solar thermal projects, over the next five years. Solar thermal technology typically uses thermal energy storage to improve the dispatchability of intermittent solar.

Last month SolarReserve LLC, a leading global developer of utility-scale solar power projects with proprietary advanced solar thermal energy storage technology, and Shenhua Group Corporation, Ltd., a key state-owned enterprise in the People's Republic of China, signed a Memorandum of Understanding (MOU) to build 1000 MW of solar thermal projects in China.

Kevin Smith, SolarReserve's CEO said: "Our 1000 MW partnership with Shenhua is at a scale that will lead to substantially lower costs while contributing clean and renewable energy to China's growing power needs. This is just part of China's target to build 10 000 MW of CSP over the next five years."

Fracking decision hailed as turning point for the UK

Questions as to the commercial future of fracking in the UK remain unclear in spite of recent developments.

Siân Crampsie

Commercial-scale fracking will not yet go ahead in the UK even though planning consent has been granted for the extraction of shale gas at a well in northern England.

North Yorkshire County Council has granted planning permission for Third Energy to produce shale gas from an existing conventional gas well in Ryedale. The decision is the first approval of fracking at the planning level in five years in the UK and was welcomed by the wider oil and gas sector but made in the face of vocal opposition by environmental groups.

Third Energy said the approval was "a huge responsibility" rather than a victory. The site will be used to see if the rock below is suitable for large-scale exploitation, and the firm noted that it would not be able to start operations at the site straight away.

"Don't expect to see any activities on site in the near future," said Third Energy CEO Rasik Valand. "We have conditions from both the planning authority and the Environment Agency to discharge. There are other consents and notifications required prior to receiving final consent from the Secretary of State.

"Then there is the normal commercial and project management work, such as the letting of contracts and ordering of long lead items."

Valand added: "The purpose of this application is to establish if the gas seen in some samples in this hybrid sandstone shale formation can be made to flow, at what process conditions and for how long. If this flows then we will need to assess how it performs for some months before making any conclusions."

The UK government is keen for shale gas operations to get underway in the UK to boost economic growth and enhance energy security. However the UK shale gas sector remains in the early stages of development and dozens more exploratory wells will be required across licensed areas to determine the commercial viability of the resource.

In 2015 the UK's onshore oil and gas licensing round awarded 93 onshore licenses for 159 new blocks. Firms such as Ineos, Cuadrilla and IGas are now in the process of developing sites and will have to go through the same procedure as Third Energy did in Yorkshire to gain planning consent.

Richard Black, director of the Energy and Climate Intelligence Unit (ECIU), said: "As we see from protests... and from opinion surveys, the public is not supportive, and the economics remain unclear – so whether commercial fracking ever goes ahead is still an open question.

"Other issues also remain open. Last year, the Commons Environmental Audit Committee said fracking is incompatible with our climate change targets, and the government hasn't been able to show they're wrong. If leakage rates are above a few per cent, gas burning turns out to be worse than coal for climate change, and yet the government hasn't set a maximum permissible leakage level."

"The government and shale gas players may see the North Yorkshire decision as a turning point, but shale will not develop in the UK as quickly as it has in the US," said Peter Kiernan, Lead Energy Analyst at the Economist Intelligence Unit. "The regulatory environment is more stringent and there will still be considerable local opposition to fracking in many areas where planning applications are made.

"Furthermore, until more drilling occurs the production potential of shale gas in the UK will not be properly known. In the UK shale gas story, it is still early days."

European markets slip down investment ranking

- Gains made by Chile, Brazil and Mexico
- Dudgeon partners close finance

Emerging markets across Latin America, Africa and Asia are competing with Europe for renewable energy investment capital thanks to a growing appetite for renewable technologies and increasingly stable regulatory regimes.

The latest edition of EY's Renewable Energy Country Attractiveness Index (RECAI) shows that scaled-back renewable energy ambitions in Europe are causing key markets such as the UK, Germany and France to lose ground to countries such as Chile, Brazil, Morocco and the Philippines as destinations of choice for financial firms backing green projects.

Emerging markets now represent half of the countries in the 40-strong EY index, with four African nations in the top 30. Just ten years ago, only China and India were attractive enough to compete with developed markets for renewable energy investment.

In the latest EY index, the USA, China and India have held their places at the top, while Germany, France, Canada, Japan and the UK fell.

The UK is now 13th in the index, its lowest ever position, thanks to the government's "non-committal, if not antagonistic, approach to energy policy," EY says in its RECAI report. It adds that the UK's energy policies "go against the grain of almost universal global support for renewables" and are "arguably jeopardising UK energy security".

The UK's renewables sector was given a boost last month, however, with news that the developers of the 402 MW Dudgeon offshore wind farm had arranged £1.3 billion of long-term financing for the project with a consortium of international banks and financial institutions.

Statoil, Masdar and Statkraft said that the speed at which the partners were able to close financing – within six months – illustrated the energy industry's confidence in the long-term potential of offshore wind, and the increasing sophistication of financing models available to the sector.

"It is also a testament to the project's commercial competitiveness, smooth execution, and the growing investor appetite for utility-scale renewable energy," commented Halfdan Brustad, Chairman of Dudgeon Offshore Wind Limited.

Trade body Renewable UK said that the deal proves that the UK is "the go-to destination for offshore wind investors".

EDF pressured on Hinkley plans

- Impact on EDF balance sheet raises concerns
- Former CFO called for FID delay

EDF and the French government have sought to reassure British lawmakers that they remain committed to developing a new nuclear power plant at Hinkley in spite of continued uncertainties over cost, scheduling and technology.

French economy minister Emmanuel Macron last month wrote to British MPs ahead of an energy select committee meeting at which EDF CEO Vincent de Rivaz appeared. Both Macron and de Rivaz have said that a final investment decision (FID) on the project will be taken after EDF completes consultations with its central works committee.

De Rivaz told the select committee in May that "no project is as ready [as Hinkley]" but refused to guarantee that it would be delivered by 2025 as anticipated.

However, concerns were raised last month by French energy minister Ségolène Royale about the impact of the £18 billion project on EDF's already stretched balance sheet.

The French government in April agreed to lead a €4 billion capital increase in EDF to help improve its financial profile. Moody's ratings agency has downgraded EDF, however, saying that EDF's plan to shore up its balance sheet would not be enough to fully counter the financial pressure it faces.

EDF's former Chief Financial Officer, Thomas Piquemal, had fought for the final investment decision (FID) to be delayed by at least three years.

It recently emerged that engineers at Areva may have falsified vital safety reports on parts supplied to reactors in France and possibly elsewhere.

The falsified documents came to light after a serious anomaly was detected in the reactor pressure vessel at the Flamanville EPR project in France, which is itself six years behind schedule and €7.2 billion over budget.

Hinkley also looks likely to miss its target start-up date of 2025, as EDF's construction schedule indicates that the project will take 9 years and 7 months to build from the final investment decision.

EDF recently said the cost of the two reactors planned for Hinkley could be £2.7 billion higher than previously expected. It says that the existing £18 billion estimate contained contingency planning for general cost overruns and that the extra £2.7 billion was to ensure the project was completed in the event of an extraordinary or catastrophic event.

EDF is building Hinkley with a Chinese partner, CGN. Any increased costs would impact CGN's financial commitment to the project and cause further delays.

- First power from a proposed new nuclear plant in Cumbria is now not expected until the end of 2025, a year later than had been planned, developer NuGen has said. NuGen is planning to build three reactors with a combined capacity of 3.8 GW near Sellafield but recently published consultation documents show a slightly revised timetable for the project.

Paris Agreement will drive hydropower growth

- Climate agreement will drive growth
- Pumped storage plays vital role

Hydropower resources will continue to play a vital role in enabling the uptake of clean energy systems, the International Hydropower Association (IHA) says.

In its *2016 Hydropower Status Report*, IHA says that 33.7 GW of new installed hydropower capacity was commissioned in 2015, including 2.5 GW of pumped storage. At the end of 2015, the world's total installed hydropower capacity reached 1212 GW, including 145 GW of pumped storage.

Richard Taylor, CEO of IHA, said that the international hydropower sector was becoming more "dynamic" and was evolving alongside the growth of solar and wind power. "The value of pumped storage is becoming more appreciated worldwide," Taylor added.

In its report, IHA notes that China continues to dominate the market for new hydropower development, adding 19.4 GW of capacity in 2015. Brazil added 2.5 GW, Turkey 2.2 GW, India 1.9 GW and Vietnam 1 GW.

IHA also believes that the new climate agreement reached in Paris last year would help drive further hydropower growth. Advanced hydropower control technologies are said to be enabling renewable hybrids such as the 850 MW Longyangxia solar park in China, which is connected to one of four turbines at the nearby 1280 MW Longyngxia hydropower plant.

The report also concludes that hydropower is becoming increasingly important in Africa, while the rise of renewable energy capacity was giving pumped storage capacity greater value in energy markets.

Pumped storage hydropower accounts for over 97 per cent of global energy storage capacity, and is continuing to grow. IHA noted that China has more than 27 GW of pumped storage hydro under construction, while Japan and the USA are expanding existing pumped storage hydro plants.

New pumped storage projects are being discussed in Egypt, Chile, Indonesia, Morocco, Turkey and Vietnam, IHA said.

Electricity demand drives MENA power sector investments

Governments in the MENA region are prioritising investments in the power sector because of rapidly rising electricity demand, according to a new report.

Apicorp Energy Research says that in the period 2016-20, the region will need to invest $334 billion in the power sector. Of this, $198 billion will be needed to add 147 GW of generating capacity to the grid, while the rest should be invested in T&D.

Electricity demand in MENA has grown rapidly because of population growth, urbanisation, industrialisation and low electricity prices, and greater demands are being placed on electricity generation, transmission and distribution systems, Apicorp says.

While a slight slowdown in the region's economy is expected in 2016, population growth will continue and Apicorp therefore estimates that MENA power capacity will need to expand at an average annual pace of eight per cent from 2016 to 2020.

This corresponds to additional power generating capacity of 147 GW over that period. Apicorp believes that 96 GW of new capacity additions are already in execution in MENA, equivalent to $117 billion of investment.

According to Apicorp, the GCC represents 47 per cent, or 148 GW, of current MENA power generating capacity. Despite this, the GCC will require $85 billion for the addition of 69 GW of generating capacity and another $51 billion for T&D over the next five years.

But declining oil revenues mean that GCC governments can no longer continue to support the provision of cheap power. Subsidy reforms announced earlier this year are part of a programme aimed at liberalising energy prices over the medium term.

Saudi Arabia leads the drive to make the necessary capacity additions by 2020. Estimated capacity stood at around 80 GW in 2015, with SEC representing around 60 GW. Apicorp estimates that the country will need to invest $71 billion to increase capacity to 114 GW. Saudi will meet rising demand with 28 GW of capacity already in the pipeline. Major projects include the 3.1 GW Yanbu 3 plant, expected on line in 2016, and the 2.6 GW Shuqaiq plant.

The UAE needs to invest $34 billion to meet the 17 GW capacity addition needed over the medium term. The country experiences periodic blackouts and hopes to alleviate this by integrating the seven emirates natural gas-distribution networks. The UAE is pushing strongly to diversify its energy sources in the power mix.

Kathu solar thermal plant will help ease power shortages

A100 MW solar thermal power plant in South Africa, which is due to start construction shortly, will be a key part of the country's efforts to increase its generating capacity and counter electricity shortages.

Energy firm Engie last month signed a 20-year power purchase agreement (PPA) for the Kathu solar project in Northern Cape province, making it possible for construction to begin.

Kathu Solar Park is a greenfield concentrated solar power (CSP) project using parabolic trough technology and a molten salt storage system that allows 4.5 hours of thermal energy storage. It will be developed by Engie alongside a group of South African investors comprising SIOC Community Development Trust, the Investec bank, Lereko Metier and the Public Investment Corporation.

The Kathu project, which will start operating in late 2018, is funded by a mix of debt and equity. The debt is funded from a club of South African banks, including Rand Merchant Bank, Nedbank Capital, ABSA Capital, Investec and the Development Bank of South Africa.

National utility Eskom said in May that it had been able to avoid load shedding for more than nine months, and that it was "progressing well" with its power plant maintenance programme.

Plant performance and availability has been steadily improving, the utility said, highlighting that one evening in mid-May it recorded 37 067 MW of available capacity, against a forecast demand of 27 387 MW during the evening peak period.

Capacity additions are also playing a key role in Eskom's performance improvements. The utility says that the Ingula pumped storage hydropower scheme is on track to be fully commissioned in 2017, Medupi will be fully commissioned in 2020 and Kusile will be fully commissioned in 2022.

Jordan to connect to GCC grid

Jordan is hoping to benefit from a project to connect its electricity grid with that of the Gulf Cooperation Council (GCC) countries.

Jordan last month signed a memorandum of understanding (MOU) with the GCC Interconnection Authority (GCCIA) to join the grid via Saudi Arabia. The countries will now embark on a series of technical meetings before finalising a deal, after which the project would take one to two years to complete, according to local reports.

Jordan's Ministry of Energy and Mineral Resources told local reporters that the project would cost JD170-200 million ($240-282 million), and would be an important step forward in plans to boost regional cooperation.

Linking with GCC countries will help Jordan to reduce energy costs and give it access to excess electricity generating capacity in Saudi Arabia.

Saudi Arabia's installed capacity stands at around 80 GW but its peak load is around 63 GW.

Electricity demand in Jordan is rising at around 6.5 per cent annually and the country imports about 97 per cent of its energy needs.

Solar developers compete in UAE tenders

- Competition drives down costs
- Adwea pre-qualifies bidders

Strong competition to develop large-scale solar energy projects in the United Arab Emirates is helping to cut the cost of energy.

Developers bidding to develop 800 MW of solar energy capacity in Dubai bid as little as ¢2.99/kWh – 15 per cent lower than a previous record set in Mexico earlier this year, according to Bloomberg New Energy Finance.

Similar competitive tenders in Peru and Chile have also set low prices for solar this year.

The bidders in Dubai's tender have not been officially named, although regional business publication *MEED* reported that they included Masdar Abu Dhabi Future Energy Co., Spain's Fotowatio Renewable Ventures BV and Saudi Arabia's Abdul Latif Jameel.

In April, First Solar, Enel and EDF were among the groups of developers approved to bid for a new solar power plant in Abu Dhabi.

The Abu Dhabi Water and Electricity Authority (Adwea) has pre-qualified 34 companies for a 350 MW photovoltaic (PV) park in Sweihan, 120 km east of Abu Dhabi city. Adwea will hold a 60 per cent stake in the project, which will be structured as an independent power project (IPP).

Although Adwea has completed around ten IPPs and independent integrated water and power projects since 1999, Sweihan marks the first time that the emirate's utility has undertaken the development of a renewable energy project.

Abu Dhabi Water and Electricity Company (Adwec) said that the plant would reduce some of the reliance on natural gas used to meet domestic power demand.

Putting the brakes on quicksilver

Further tightening of power plant emissions in Europe will force coal fired plants to adopt new air quality control technology. A new power plant being built at the Turów site in Poland will be the first to adopt a state-of-the-art emission control system that will drastically reduce NOx, SOx and dust emissions, as well as mercury. **Junior Isles**

Kozienice 11: another MHPSE project in Poland that is nearing completion

Poland has the largest coal reserves in Europe. According to Euracoal, in 2012 hard coal reserves totalled 19.1 billion tonnes, while brown coal or lignite production reached 64.3 million tonnes (18.2 Mtce), nearly all of which was used by mine-mouth power plants.

With the availability of what is a cheap, abundant and domestic fuel, the country sees coal as crucial to both its economy and energy security. Poland depends on coal for 90 per cent of its electricity needs and although it has plans to increase its use of renewables, it intends to continue to meet the bulk of its growing electricity demand through the continued use of coal fired generation.

The continued use of coal, however, has its challenges, especially in Europe. With air quality control (AQC) legislation and EU climate change goals putting pressure on coal fired power plants, Poland is therefore adopting state-of-the art technology to comply with increasingly strict EU policy on plant emissions.

The country is already experienced with high efficiency supercritical coal fired plants and is now constructing a new plant that is claimed to be the first to adopt the new requirements contained in the proposed BAT (Best Available Techniques) Reference documents (BREFs) with regards to removal of NOx, mercury and other regulated pollutants like dust and SO_2.

The new power plant, known as Turów Unit 11, is being built at the Turów mining and generation complex in the community of Bogatynia in southwest Poland. The 450 MW unit is located on the existing power plant site, which has six generating units with a combined installed capacity of some 1500 MW.

Turów power station is owned by state-owned power company, Polska Grupa Energetyczna (PGE), which awarded the contract for Turów Unit 11 to MHPSE in July 2014, following a public tender. Under the contract, MHPSE is to supply the steam generator, all the flue gas cleaning equipment, piping, turbine/generator and instrumentation and control and will also place the power plant into service. Consortium partners Budimex SA (Poland) and Técnicas Reunidas, S.A. (Spain) are responsible for construction/erection, cooling tower, general electrical engineering, steel structures, ducts and some balance-of-plant.

MHPSE's scope accounts for about 60 per cent of the order valued at 3.25 billion Zloty net (about €800 million). Notably, the initial contract did not include technology for the BREF requirement on mercury, NOx and other regulated emissions.

According to MHPSE, Turów is the first it has seen where the operator is sensitive about the NOx and mercury issue and chose to address it at a very early stage.

Thomas Schmitz, Proposal Manager, MHPSE, explained: "We signed the contract for the power plant itself without the BREF requirement. Since the project was still in the early phase when the client learned of the coming BREF requirement, it decided it would be easier and cheaper to build the plant to comply with the BREF requirement now rather than retrofit later."

The new plant is being built in a very narrow area where there were three old cooling towers. According to Schmitz this, combined with the availability of reasonable quality fuel and the power capacity of the boiler, made pulverised coal fired technology a better choice than circulating fluidised bed boilers, which PGE also has at the site.

Turów Unit 11 will burn lignite from the adjacent mine. Such mine-mouth setups are ideal where lignite is the fuel, since lignite is high in water content and not economical to transport.

The lignite has a calorific value in the range of 8-11 MJ/kg. It has a sulphur content of up to 1.3 per cent, ash content of up to 22 per cent, chlorine of up to 0.03 per cent and mercury content in the range of 0.16 ppm.

Raw lignite is brought to the station by conveyor belts before being crushed and kept in a common storage area. From there it is fed to bunkers at the boilers, where special beater mills, which comprise a pre-crusher and crushing wheel, grind the lignite into a powder before it is blown into the boiler.

Due to the high moisture content of the lignite, the boiler has to be sized larger than if hard coal was being used. For example, although the electrical power of the boiler is less than half the 1075 MW Kozienice Unit 11 currently being built by MHPSE, it still has similar physical dimensions. The Turów Unit 11 boiler is 114.3 m high, compared to 104 m at Kozienice Unit 11.

Michael Wende, Head of AQC Systems, MHPSE, explained: "Because lignite has a high water content, the flue gas volume flow is quite high compared to a hard coal fired power plant. This means the boiler has to be larger. Also the burners have to be designed and arranged to fire lignite. So there are a lot of details that are

different to Kozienice."

Turów Unit 11 is a once-through Benson design. The steam conditions in the boiler are typical of MHPSE supercritical designs. Using guarantee coal, it is capable of generating 1275 t/h of live or superheated (SH) steam and 1061 t/h of reheat steam (RH). Live steam temperature is 600°C at a pressure of 271 bar. RH steam conditions are 610°C at 51 bar.

This gives the unit a net power output of 450 MW and an electrical efficiency of 43.4 per cent. The addition of the new cleanup technology to the BREF requirements will have only a minor impact on the boiler performance. Using guarantee coal, net power output will be 447.5 M and net efficiency will be 43.1 per cent.

Inside the boiler, there are a total of 18 wall-fired burners arranged on three levels, with each mill feeding three burners. These are MHPSE's RS burners, designed to burn lignite. Unlike rectangular-shaped jet burners used in the past by MHPSE and other companies for burning lignite, these are circular in shape to improve the mixture and combustion of the lignite. These burners serve to reduce NOx emissions to 200 mg/Nm^3.

This would have been sufficient to satisfy the emission values specified by the Industrial Emissions Directive (IED). As Bernd Vollmer, Head of Process Engineering and Design, AQC Systems, MHPSE, explained: "The original contract was based on the emission values specified by the IED i.e. 200 mg/Nm^3 NOx, 150 mg/Nm^3 SO_2, and dust of 10 mg/Nm^3. These could be achieved by standard AQCS equipment for lignite fired power plants e.g. for NOx using primary methods, only but then the client asked us to re-evaluate the impact of BREF. The major issues were the drastic reduction of NOx and the new upcoming emission limits for mercury."

In addition to lowering SO_2 and dust emissions to 75 mg/Nm^3 (monthly average) and 5 mg/Nm^3, respectively, the new draft BREF documents require a NOx limit of 85 mg/Nm^3, i.e. a reduction of more than 50 per cent. According to Vollmer, for this type of boiler, this NOx level can only be achieved through the use of SCR technology. There are also new values for chlorine and fluorine, which, says Vollmer, can be achieved by improvements to the flue gas desulphurisation (FGD) equipment. But the BREF requirements called for the development of new SCR technology.

"Improving the FGD to tackle chlorine and fluorine was a no-brainer," he said. "We also had room to add one electrical field to the ESP [electrostatic precipitator] to improve its performance to reduce dust. But the need for a new SCR for NOx reduction also gave us the opportunity to tackle mercury emissions. It will be the first-of-a-kind in Europe for lignite."

The health hazards associated with mercury, have long been recognised. With electricity generation from coal accounting for around 50 per cent of the emissions of the element commonly known as quicksilver, the power sector significantly tightened the limits on mercury emissions in recent years.

Whereas no or relatively moderate limit values apply in Europe, with the exception of The Netherlands (limit values of 3 µg/Nm^3 and below), in the USA, mercury emissions from existing (bituminous coal) plants have already been limited to 1.2 lb/TBtu by the MATS (Mercury Air Toxics Standards).

Mercury is liberated from its compounds during combustion. Elemental mercury is thus present as a gas in the high-temperature region (above 1200 °C) of the boiler.

As it passes through the downstream sections, it can be oxidised if the flue gas composition is favourable (usually to $HgCl_2$ or $HgBr_2$). This oxidation is important because the resulting mercury products are not only water-soluble, but they are also adsorbed more efficiently, e.g. by fly ash. Oxidation is promoted by a sufficiently high concentration of halogens (chlorine or bromine).

The goal is to produce an oxidised form of mercury, either $HgCl_2$ or $HgBr_2$ because these species are water-soluble and can be removed in a downstream FGD unit or with conventional activated carbon. Furthermore, the adsorption efficiency on fly ash is more favourable. By comparison the removal of elemental mercury requires the use of doped grades of activated carbon, which are much more expensive.

Oxidation of residual elemental mercury in the SCR unit is very efficient, provided there is an adequate halogen concentration in the raw gas. This requires catalyst beds with a good activity and the lowest possible stoichiometric excess of NH_3 (NH_3 slip). Catalyst beds that have been specially developed for mercury oxidation achieve an even better ratio between mercury oxidation efficiency and halogen concentration.

MHPSE was able to combine all the knowledge within the MHPS Group – especially in Japan – with its experience in designing catalysts for mercury oxidation, to develop an SCR system that would reduce NOx and pre-treat mercury so it can be oxidised and removed in the FGD.

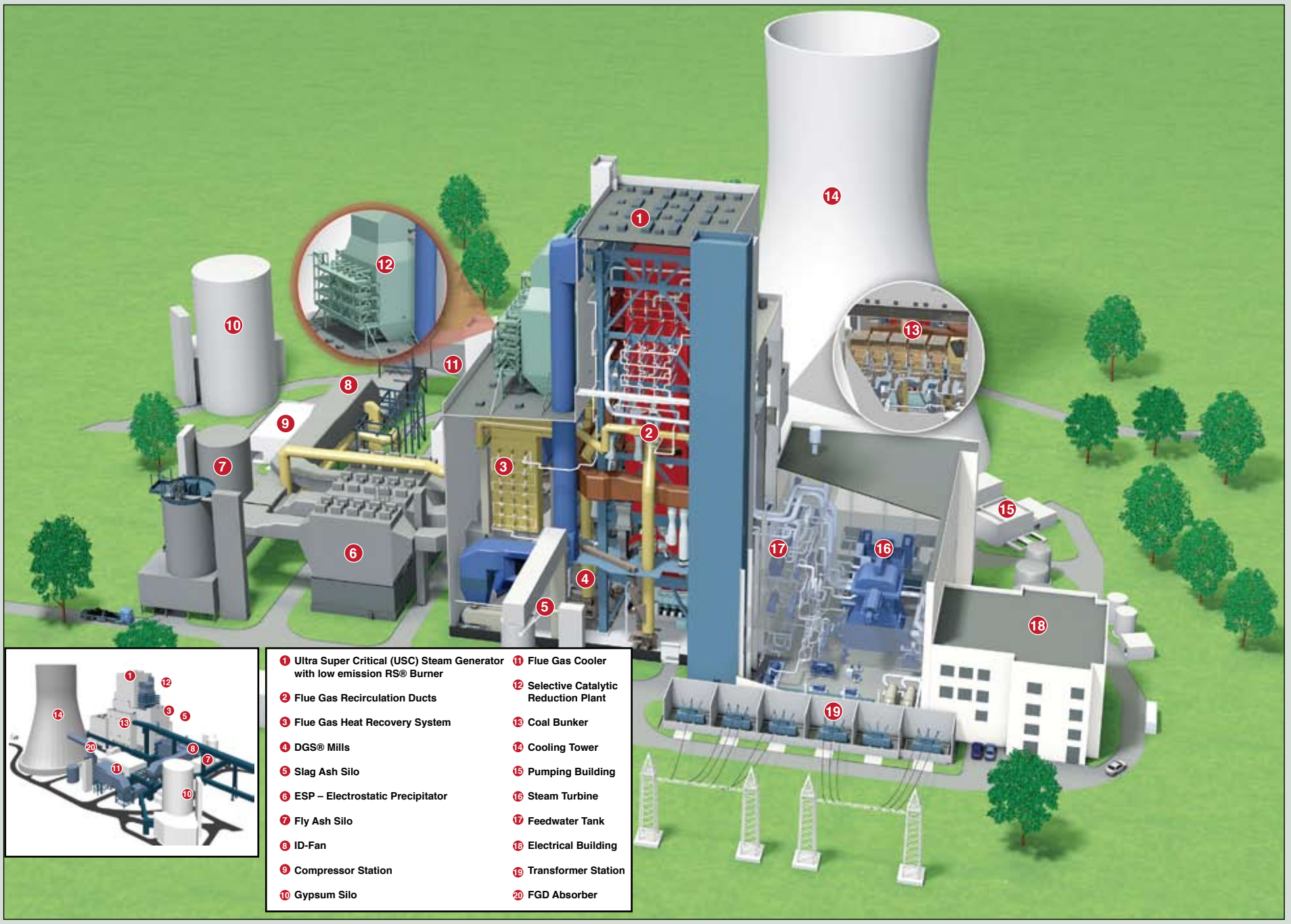
Certainly the NOx reduction together with the mercury oxidation is the novel aspect of the project. When the mercury is oxidised, it can then be removed in the wet FGD.

"When you have metallic mercury, it is very hard to remove it in the flue gas," said Vollmer. "Normally it passes through the FGD and is emitted to the atmosphere."

Another aspect in the oxidation of mercury is the content of halogens in the flue gas. Normally halogens are needed to oxidise the mercury. Chlorides are present in coal and lignite but the level is usually low in power stations. While this is good for the boiler, in that it avoids corrosion, a higher concentration of chlorine is needed to oxidise the mercury.

Although the chlorine must not be so high as to cause boiler corrosion, it needs to be higher than what is present in the lignite for Turów. The extra chlorine will come together with the ammonia that is needed for NOx reduction. Here, ammonium chloride solution is injected directly

The Turów 450 MWe lignite-fired power plant. MHPSE used its knowledge and experience in designing catalysts for mercury oxidation, to develop an SCR system that would reduce NOx and pre-treat mercury so it can be oxidised and removed in the FGD



Performance parameters for guarantee coal (Without BREF / with BREF)

Net power (MW) output (Guarantee fuel)	450 MW (net) / 447.5
Net Efficiency (%)	43.4 / 43.1
Availability	90.9 % in the 1st year / 90.9 % in the 1st year 92.0 % in the 2nd year / 92.0 % in the 2nd year
Min. load for operation with coal (%)	40 / 40
Emissions	
SO_2 (mg/Nm³dry, 6% O_2)	150 / 75 (monthly average)
NOx (mg/Nm³dry, 6% O_2)	200 / 85 (monthly average)
Dust particles (mg/Nm³dry, 6% O_2)	10 / 5 (monthly average)

Main boiler design parameters

Type	Benson once-through steam generator
Fuel	Lignite
Fuel Input (MWth restricted)	1037
Steam flow (t/h)	1275 (SH) 1061 t/h (RH)
Steam temperature (°C)	600 / 610
Steam pressure (bar)	271 / 51
Flue gas (Mio. Nm³/h)	1.053
Combustion chamber dimensions (m)	16.406 x 16.406
Overall boiler height approx. (m)	120

into the flue gas duct.

"So the ammonium chloride is used for simultaneous NOx reduction and the oxidation of the mercury," noted Vollmer.

The last stage of the flue gas treatment system is the FGD, where the oxidised mercury is removed from the flue gas. Vollmer noted that ionic mercury can be effectively removed by water but the process can result in its re-release again back into the flue gas. To avoid this, MHPSE has developed a special control system, known as ORP (oxidation reduction potential) control. The system allows the captured mercury to be kept in the FGD.

Vollmer added: "As a safeguard we can add some agent, normally used in the wastewater plant for mercury removal, to the FGD."

While the principle chemical reaction is the same as that for bituminous coal – ammonia is injected into the flue gas and with the aid of a catalyst the NOx is separated into water and nitrogen – Vollmer noted that the high ash content in lignite requires special attention when designing the catalyst.

"There are other trace elements that nobody in the industry has long-term experience with. There is no operational experience of lignite SCR systems at large combustion plants," he said. "For the high ash content, we have special plate-type catalysts that are shaped different to other catalysts such as honeycomb catalysts, which are suitable for flue gas with high ash loading."

To gain deeper experience with lignite, MHPSE has test rigs at another lignite power plant and is also doing some testing at the Turów site to evaluate the behaviour of catalyst material in the flue gas of lignite power plants.

"This will give us some kind of certainty to make the final composition of the catalyst material with regards to the requirements we have to meet. The catalyst development is ongoing," said Vollmer. "We have a number of references for bituminous coal and the special catalyst design for mercury oxidation. So we will use the experience from bituminous coal and do some tests to optimise the composition of the catalyst material [for lignite]. We are doing this with our colleagues in Japan."

With the development and testing, MHPSE says it will be ready for widespread commercial application.

Wende said: "PGE approached us in the middle of last year during the basic engineering phase so the implementation of the BREF technology could be done at this stage to save on effort and cost. For other clients that have not done this, we are ready to help them upgrade their plants to meet the new BREF requirements."

Looking forward, Wende said the next step will be to look at using its TRAC SCR technology for lignite and bituminous coal applications. While most of the bituminous coal fired power plants already have SCRs, he says that the required measures are clearly defined. "It's a very cost-effective solution for mercury reduction," he said.

A paper from the European Power Plant Suppliers Association (EPPSA) presents a cost comparison of the different mercury reduction technologies. The report concludes that catalyst replacement offers one of the cheapest methods of reducing mercury, in terms of both opex and capex.

EPPSA notes that most mercury control projects are retrofit projects, where the necessary process steps for mercury control have to be fitted to the existing equipment in the most economical way. It also points out that the choice of mercury control technology is mainly influenced by the type of fuel (high/low halogen content in coal) and the plant configuration.

Vollmer commented that lignite plants that do not have a great need for NOx reduction, currently face a challenge in terms of mercury reduction and that there is no standard solution. "We have found that these plants all handle mercury differently. You cannot assume that a particular technology is needed when retrofitting a lignite power plant. Each case has to be studied. You have to take measurements to determine how the plant is behaving with regards to mercury and then select the most appropriate from the different technologies available."

The first version of the BREF papers was drafted in April last year. The latest draft was circulated in October but it is assumed the final values will not change. As it stands, it is clear that all existing coal fired plants in Europe plants will have to take action to meet the upcoming BREF requirements.

"Turów is the first to act," said Wende, "but all of the others will have to examine their current situation and then investigate what they have to do to meet the requirements or shut down the units if it's too expensive to retrofit."

With the Notice-to-Proceed given in December 2014, the project is currently in the engineering phase. Civil works are under way and engineering documents are being updated with respect to the BREF requirements. The next steps will be detailed equipment design and manufacture and purchasing of equipment.

The next major milestone is completion of the first boiler column in April 2017, followed by boiler pressure tests in November the following year. Six months later will see first ignition with oil. First firing of the boiler with coal is scheduled for August 2019 and first steam to the steam turbine will take place a few weeks later. The plant will then be synchronised to the grid in September, 2019.

The trial run of the unit is scheduled to start in spring 2020 and signing of the official commissioning report is expected in April 2020.

The significance of Turów Unit 11 to both MHPSE and the industry are clear. It is one of three EPC projects, that MHPSE currently has under way and with a total investment volume of nearly €1 billion, it is clearly an important project for the company – both in terms of revenue and technology. Vollmer calls it a "technological milestone" for the company when considering the future business it expects will result from the BREF documents.

He concluded: "We are first movers. It is the first lignite fired power plant with an SCR for NOx and mercury reduction and it's very important to show the industry that it's possible.

The Boxberg-R lignite-fired power station, in operation in Germany since 2012, is similar in capacity and size to the Turów project

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Dong looks to future expansion

Dong continues to bet on offshore wind as it outlines a major new listing of its shares.

Siân Crampsie

Danish energy giant Dong Energy has set out its initial public offering (IPO) in a move to help the firm carry out its plans for future expansion.

The IPO, which is likely to be one of the largest in Europe this year, will see a base offering of between 15.1 and 17.4 per cent of the existing shares in the company through a partial sell-down by the current shareholders, other than employee shareholders. The Danish government will retain a 50.1 per cent stake in the business after the listing.

Dong said the IPO will create a strong platform as it continues "to lead the transformation of the energy system". Henrik Poulsen, CEO of Dong Energy said: "We have constructed 22 offshore wind farms, and hold a market share of 26 per cent of globally installed offshore wind capacity. Our continued profitable growth towards 2020, which will more than double our installed capacity, is supported by a robust and highly visible offshore wind build out plan."

The offer shares will be admitted to trading and official listing on Nasdaq Copenhagen and distribution of the offer shares is expected on the first day of trading on June 9th.

Dong earlier this year reported a sharp increase in operating profit, while in April, ratings agency Moody's affirmed Dong's long term Baa1 ratings.

Moody's said that Dong's current strong financial profile would give it financial flexibility as the company continues its planned investment programme, and noted the firm's position as a leading offshore wind developer with a growing portfolio of operating wind assets under stable regulatory regimes.

Moody's gave Dong a negative outlook, in part because of a likely deterioration in Dong's financial profile over 2016-17.

Moody's said that Dong's partnership model, whereby partners in major projects make a contribution to finance, had helped it to diversify risk and reduce its reliance on third party debt.

Dong has completed 3 GW of offshore wind farms, and over the next five years is scheduled to bring on line a further 3.7 GW, including major projects such as the Walney Extension and Hornsea project.

"Over the past decade, Dong Energy has established a world-leading position in offshore wind, which accounted for 75 per cent of our capital employed at the end of 2015," said Poulsen.

In 2016, Dong expects to make gross investments in the region of DKK18-21 billion ($2.7-3.15 billion). For 2017-2020, the total gross investment programme is expected to be DKK 60-70 billion.

Atlantis eyes expansion in Scotland

Atlantis Resources has expanded its development portfolio after completing its buyout of Scottish tidal project assets from ScottishPower Renewables (SPR).

The deal, announced in December 2015, was finalised through Atlantis' subsidiary, Tidal Power Scotland Limited (TPSL), which has issued new ordinary shares to Scottish Power Renewables as payment for the assets.

As a result of the transaction, TPSL has acquired development rights for 110 MW of projects in Scotland, including the seabed rights, grid access and consents for the 10 MW Sound of Islay project.

ScottishPower Renewables will hold a six per cent stake in TPSL and a seat on the TPSL board. Also included in the sale were the development rights for the 100 MW Ness of Duncansby project, which lies immediately to the east of Atlantis' flagship 398 MW MeyGen project in northeast Scotland.

The two projects sold were valued in December 2015 at £6.6 million. The assets include lease agreements with the Crown Estate, while the Sound of Islay site has also secured a grid connection offer and construction consents from Scottish ministers.

Atlantis is aiming to achieve financial close on the Sound of Islay project in 2016.

In March this year Atlantis returned two lease agreements to the Crown Estate following a strategic internal review of its portfolio of tidal energy projects. The leases were for the Anglesey Skerries site in Wales and the Kyle Rhea site in Scotland.

Reducing the company's portfolio would enable Atlantis to focus its resources on its most developed sites, Tim Cornelius, CEO of Atlantis, said in March.

Gamesa closes NEM Solutions deal

Gamesa has closed an agreement with CAF and Tecnalia to invest in NEM Solutions, giving it a stake in the predictive maintenance specialist.

Gamesa signed a deal in 2015 with CAF and Tecnalia to buy their 35 per cent and 15 per cent stakes, respectively, in NEM. It now shares ownership on a 50-50 basis in the firm with CAF, a train manufacturer.

The deal will reinforce Gamesa's strategic position in wind turbine maintenance technology and will take the data mining already being performed by Gamesa across its maintenance fleet "to the next level" by anticipating potential incidents, Gamesa said.

NEM's technology platform, known as Aura, analyses millions of data points generated by equipment under maintenance and creates a model that defines normal operating conditions. Based on this benchmark, it predicts the future performance of each machine, diagnosing potential equipment incidents precisely and proactively using artificial intelligence, .

In the specific case of Gamesa, the systems developed by NEM will use the 16 billion data inputs generated and sent daily by the close to 16 000 turbines under its maintenance (20 600 MW) to the company's remote control centre in Sarriguren (Navarre, Spain).

Utility downgrades reflect low power prices

Moody's has downgraded its ratings of EDF and Engie, reflecting both group's prolonged exposure to low European power and energy prices.

Moody's downgraded Engie to A2 with a stable outlook, and placed EDF at A2, with a negative outlook.

The downgrade of EDF follows an announcement by in April that the French government would lead a €4 billion capital increase in the group to help improve its financial profile.

EDF is also planning a number of other measures to reduce debt and boost its balance sheet, including asset sales and maintain a policy of giving shareholders the option of taking dividends in shares rather than cash.

Moody's said, however, that the action plan would "will not be sufficient to fully offset the pressures resulting from a low power price environment combined with a significant investment programme". Moody's said one-year forward baseload power prices in France fell by 21 per cent in the last 12 months to around €30/MWh currently. The agency said that a prolonged period of low power prices will affect EDF given its exposure to market-exposed generation activities, which it estimates account for approximately half of EDF's EBITDA.

EDF's rating also takes into account the firm's planned capital expenditure on key nuclear energy projects and the €2.5 billion acquisition of a majority share in Areva NP.

Moody's said that the negative outlook was the result of risks associated with the execution of EDF's action plan, the fact that power prices are at a level that currently would not allow the group to cover the required investments and earn a return on those, and the incremental risks associated with the Hinkley Point C nuclear power station project in the UK.

Engie has also put in place a three-year transformation plan that includes a €1 billion cost reduction programme and a €15 billion portfolio rotation programme.

However Moody's said that the group's improved business risk profile would not be sufficient to "fully offset credit metrics" that it expects.

"European gas prices have declined by 22 per cent in the past six months, whilst power prices in Belgium and France have declined by 29 per cent and 25 per cent, respectively, over the same period," said Paul Marty, Vice President at Moody's.

"A prolonged period of low prices will affect Engie given its partial exposure to commodity-linked activities, which account for around 30 per cent of Engie's EBITDA.

"These include the group's Energy Europe and Global Gas and LNG divisions, which accounted for 14 per cent each of group EBITDA in 2015 and are exposed to merchant power generation and oil and gas prices."

Oracle boosts utility services with Opower acquisition

Digital giant Oracle is planning to bolster its utility services business with the $535 million purchase of Opower.

The purchase of Opower will create the largest provider of cloud services to the utilities industry, and will enable Oracle to offer the most complete cloud platform for the entire utility value chain, from meter to grid to end consumer, Oracle said.

It believes that utilities need modern cloud-based solutions to engage with and retain customers, digitalise customers' experiences, and manage energy savings programmes.

Oracle's utilities division currently offers a suite of operational applications and cloud services for global utilities that automate core operational processes. Opower, meanwhile, offers customer engagement solutions that help to improve customers' experiences and reduce operational costs.

Opower's customers include Exelon, National Grid, E.On, EDF and Pacific Gas & Electric.

Americas

Siemens wins Panda LTSA

Siemens has been awarded a 23-year long-term service and maintenance agreement for the upcoming Panda Hummel station, a 1124 MW combined cycle power plant in Pennsylvania, USA.

The agreement includes coverage of scheduled maintenance activities, programme management, and parts for the plant's three SGT6-5000F gas turbines. It also includes inspection services for the SST6-5000 steam turbine, the three SGen6-1000A air-cooled generators within the gas turbine packages, and for the hydrogen-cooled SGen6-2000H generator as part of the steam turbine package.

Scheduled to begin operations in 2018, the Panda Hummel Station will supply power to more than one million households in the Mid-Atlantic region, including Philadelphia and New York City. It will operate on Marcellus gas-fuelled natural gas.

Gamesa to supply turbines in Brazil

Gamesa is to install 136.5 MW of wind capacity at the Babilonia wind complex in the Brazilian state of Bahia.

The firm will supply 65 of its G114-2.1 MW turbines to the project and will be responsible for transport, installation and commissioning. Delivery of the turbines is scheduled to begin at the end of 2017, while the facility is slated for commissioning during the second half of 2018.

In addition, Gamesa will maintain the turbines for the first five years.

Mainstream and Senvion sign Chile deal

Mainstream Renewable Power has concluded a contract with Senvion for the supply and installation of 93 wind turbines for two wind farm projects in Chile.

The Sarco and Aurora wind farms are owned by Aela Energia, a joint venture between Actis (60 per cent) and Mainstream Renewable Power (40 per cent).

For the Sarco wind farm in the Atacama region of northern Chile, Senvion will supply 50 Senvion 3.4M114 turbines with a hub height of 93 m. The 170 MW wind farm will be completed in spring 2017.

For the Aurora wind farm in the Los Lagos region in the south of Chile, Senvion will supply 43 of its 3.0M122 turbines with a hub height of 119 m. Upon its completion in spring 2017 the wind farm will have a total rated output of 129 MW.

Siemens to expand Bolivia plants

Siemens has signed binding agreements with Ende Andina SAM of Bolivia to expand three existing thermal power plants.

The contracts follow the signing of a memorandum of understanding (MOU) in 2015 and cover the Termoelectrica del Sur, Termoelectrica de Warnes and Termoelectrica Entre Rios power plants. In total, Siemens will expand their combined capacity by 1000 MW, the German firm said.

Siemens' scope of supply comprises 14 SGT-800 gas turbines, 11 SST-400 steam turbines with condensers, 22 steam generators and the instrumentation and control system SPPA-T3000.

TSK, a Spanish industrial group, will be responsible for civil works, balance of plant, delivery of high-voltage substations, as well as for the mechanical and electrical erection of the projects.

Asia-Pacific

Wärtsilä supplies 60 MW

Wärtsilä has signed contract to supply two 30 MW power plants to an industrial firm in Bangladesh.

The two orders each include three 34SG engines running on natural gas and will be installed at sites near Dhaka owned by the Meghna Group of Industries (MGI). MGI said that the new plants would improve the availability and reliability of power supplies for its operations.

The equipment will be delivered in late 2016, and the plants are scheduled to be fully operational in early 2017.

Korea Western Power preferred for PNG hydro

A consortium led by Korea Western power has been selected as the preferred bidder for a hydroelectric power generation project in Papua New Guinea.

The $600 million project was launched via international tender in February 2016 and comprises construction of a 180 MW hydropower plant on the Ramu River.

Korea Western Power formed a consortium with POSCO Daewoo, Daelim Energy and Hyundai Engineering. The project is the largest private investment-based national project in the history of Papua New Guinea.

Gamesa signs for 198 MW in India

Gamesa has received orders for the delivery of 198 MW of wind turbines for four projects in the Indian state of Karnataka.

The Spanish company will deliver a total of 62 of its G114 2 MW Class S turbines to the wind farms, the first of which is scheduled to be delivered in March 2017.

Europe

Italy orders microturbines

Capstone Turbine Corporation has received an order for a C1000 Signature Series microturbine to upgrade a local district heating facility in northwest Italy.

The natural gas-fuelled C1000S microturbine will be installed in a combined heat and power (CHP) application to produce primary power and superheated water at over 80 per cent efficiency. The 1 MW microturbine will operate in dual mode, which allows customers to operate independently of, or with, the grid in a load sharing capacity.

The facility, which is located at an elevation of 2000 m, is owned and operated by an energy service company (ESCO) in Genoa, Italy.

Shetland seeks power solution

Scottish Hydro Electric Power Distribution (SHEPD) has issued a formal Invitation to Tender (ITT) to 14 businesses and organisations which are competing to provide all or part of a new energy solution for the island distribution network in Shetland.

A new energy solution is needed to meet the needs of SHEPD's customers in Shetland after Lerwick power station comes to the end of its operational life. As the network is not currently electrically connected to the Great Britain mainland, the island system needs to be capable of meeting local demand at all times, peaking in winter at around 47 MW.

Tenders are being invited under 4 lots and could include thermal power plants, renewable generators, demand side management systems, electricity storage devices or cable connections.

Bidders have until October 2016 to respond with detailed proposals.

A2SEA signs contract for Hornsea

Dong Energy has contracted A2SEA to play a key role in the construction of the 1.2 GW Hornsea One offshore wind farm.

A2SEA has announced that its purpose-built installation Vessel, Sea Installer, will be deployed to install some of the 174 turbines at the project, located 120 km off the coast of northeast England.

Sea Installer will also provide installation services to two further large-scale offshore wind developments in the UK: Dudgeon and Burbo Bank Extension, A2SEA said.

Emerson automates UK WTE plant

Emerson is to provide the control systems for a new waste-to-energy (WTE) power plant in Yorkshire, UK.

The plant, which will also incorporate biogas and recycling facilities, will produce 28 MW from 320 000 tons of waste, exporting enough energy to the National Grid. Emerson will develop the plant's automation design as well as provide installation, commissioning, start-up, and onsite operator training services.

Emerson's Ovation distributed control system will monitor and control the plant's boiler, flue gas treatment and balance-of-plant processes and equipment.

Construction is expected to be completed in 2017, with the plant fully operational in 2018.

ABB provides transformers for Walney

ABB is to provide 40 transformers for the wind turbines to be installed at the Walney Extension offshore wind farm in the Irish Sea.

ABB received the order from MHI Vestas, which is supplying the turbines for the 660 MW project. The western part of this extension, for which ABB will supply the transformers, will account for half of the new capacity i.e., 330 MW.

The 9.7 MVA, 34 kV transformers will be installed inside the towers of the turbines, which at 8 MW, are the most powerful wind turbines in the world.

Siemens seals turbine order for East Anglia One

Scottish Power Renewables has concluded a deal with Siemens for the supply of 102 wind turbines for the East Anglia One offshore wind farm.

The contract includes a five-year service agreement and will be worth up to one-third of the overall £2.5 billion project investment. It is also the largest contract in Europe for offshore wind turbines, Siemens said.

East Anglia One will use Siemens' 7 MW turbines with 75 m-long blades that will be fabricated in Siemens' new factory in Hull, England.

International

MAN builds Saudi power plant

MAN Diesel & Turbo has received an engineering, procurement and construction (EPC) contract to build a power plant for the Arabian Cement Company (ACC) in Saudi Arabia.

The 40 MW plant will be equipped with two 18V48/60 TS engines and will provide power to a cement factory in Rabigh, 120 km north of Jeddah, at the Red Sea coast. The plant will be operated on heavy fuel oil (HFO) and diesel oil.

Construction of the agreed first phase of the power plant is scheduled for 2016/17. The plant's capacity will be increased to a total of 120 MW by two additional phases of construction which will see a further four engines installed.

ACWA Power, Mitsui consortium awarded Oman project

Oman Power and Water Procurement Company SAOC (OPWP) has awarded a consortium led by Mitsui & Co., Ltd., ACWA Power, and Dhofar International Development and Investment Holding Co. SAOG (DIDIC) the 3219 MW Ibri Sohar-3 power generation project.

Ibri Sohar-3 is the largest single tendered independent power project in Oman. It will comprise two natural gas fired combined cycle power plants of 1509 MW and 1710 MW, located at Ibri and Sohar in Northern Oman. Mitsui is the lead investor and the managing member of the project, owning 50.1 per cent of the project, with ACWA Power having a further 44.9 per cent of the shares and DIDIC, five per cent.

Both plants will be owned and operated under a 15-year power purchase agreement with OPWP, and will be connected to the Main Interconnected System ("MIS") in the Sultanate of Oman.

Siemens receives order for Bahrain substations

Bahrain's Electricity and Water Authority (EWA) has placed an order with Siemens to upgrade the country's 400 kV network.

Siemens will supply, install and commission three 400/220 kV substations, including the control and protection systems and cable re-routing, as part of a project designed to improve the reliability of Bahrain's electricity transmission grid.

The substations will be installed in Hidd, Riffa and Umm Al Hassan and will be completed within two years.

Siemens signs LTSA for Umm Al Houl

Siemens has been awarded a 25-year long term service agreement for the planned Umm Al Houl combined cycle power plant in Qatar.

The agreement covers the plant's six SGT5-4000F gas turbines, four SST5-4000 steam turbines, ten SGen5-1200A generators including instrumentation and controls service for a period of 25 years. It also provides for an electrical and a resident engineer to be located on-site.

The long-term service agreement is designed to improve the operating capabilities, flexibility and profitability of the Umm Al Houl power plant by boosting efficiency, reliability and availability throughout its entire lifecycle.

The new power plant will be located 15 km south of the capital Doha, adjacent to Qatar Economic Zone. With a total electrical output of 2.5 GW, and up to 136 million imperial gallons (618 million litres) of drinking water per day, the plant will deliver almost one quarter of the nation's installed power generating capacity.

Commissioning of the first phase is scheduled for 2017, with commissioning of the entire complex scheduled for mid-2018.

Oil

Crude prices rise although Opec production climbs

- Market expected to remain well supplied
- Opec production highest since August 2008

David Gregory

Crude oil prices have been steadily climbing for several weeks, but (as of mid-May) they have yet to punch through the $50/b mark. However, market watchers are expecting crude to move into the $50/b range soon and perhaps hit $60/b before the end of summer.

Not long ago pundits were predicting that prices would stay low – around $40 – for the considerable future, but events have shown just how unpredictable the oil market can be. Once oversupplied by 3 million b/d, the glut appears to be not so worrisome to producers as political and economic events, and the forces of nature have now also dealt themselves into oil market fundaments – but that is not to say that the upward price trend will continue.

A huge forest fire in Alberta Canada, and now Saskatchewan provinces has forced a shutdown of some 1.2 million b/d of oil sands production, and political situations in Nigeria and Libya, and Venezuela's collapsing economy have cut into Opec production. Other Opec members, however, have been there to take up the slack – particularly Iran and Iraq. Iran's production in April hit 3.56 million b/d, almost at the pre-sanctions level, and Iraqi output, including that from autonomous Kurdish region, averaged 4.36 million b/d in April, according to the Paris-based International Energy Agency (IEA).

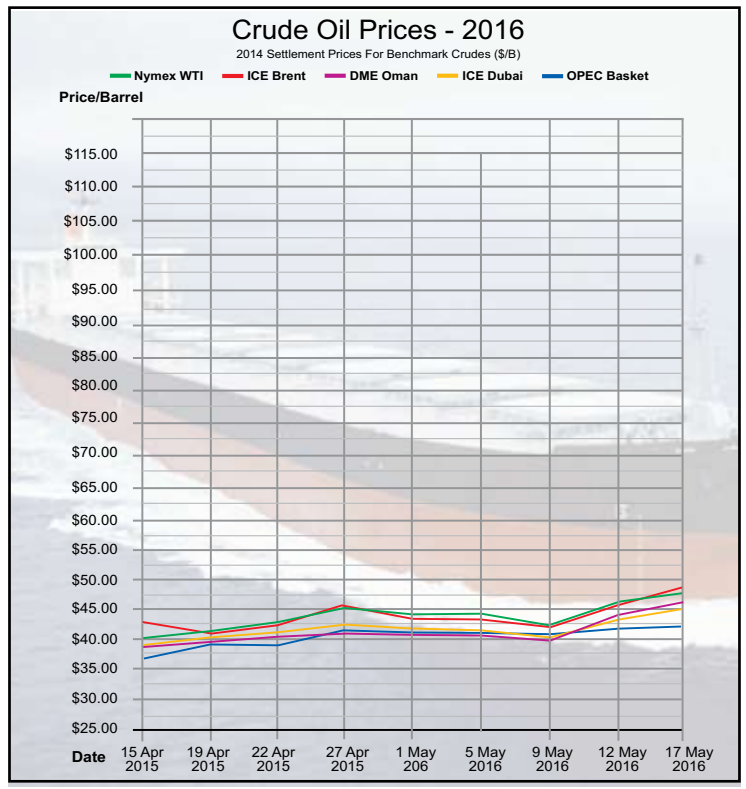
Political and infrastructural problems in Nigeria have created considerable reductions in production and led to several exporters declaring *force majeure*. Militants in the southern oil producing regions are sabotaging and in some cases attacking oil infrastructure and production sites. Nigeria's output declined to 1.62 million b/d in April, the lowest since August 1994, the IEA said in its latest monthly report.

For Libya, it is hard to say when the North African country can expect to see a return to 1.6 million b/d production, but recent moves by the different governments in mid-May suggest that exports from the eastern port of Marsa el-Hariga have resumed. Now the internationally recognised, UN-US-EU-backed Government of National Accord (GNA), headed by Fayez al-Sarraj, must consolidate its control over the country's oil fields and export terminals.

In recent weeks Libya crude production has fallen to around 200 000 b/d, according to some reports. Opening the eastern ports of Ras Lanuf and Es Sider could boost exports by 600 000 b/d.

Venezuela's economy is in serious trouble as the government finds itself crunched by months of low oil prices and years of subsidies. Venezuela's oil output has slipped over the last three months from 2.37 million b/d in February to 2.33 million b/d in April, and analysts are suggesting that production could continue to slide and forecasts for the overall economy are not favourable.

Meanwhile, non-Opec crude supply is declining and some of this can be attributed to Saudi Arabia's, and hence Opec's, policy to defend market share rather than price. Falling oil prices have taken their toll on US shale oil producers and some have been forced into bankruptcy, but there is no solid indication that should the price of oil increase, shale oil production in the US would not come back and again play a role in moderating rising prices.



US oil production averaged 9.4 million b/d in 2015, according to the US Energy Information Administration (EIA), and in its latest monthly report the EIA forecast that US production will average 8.6 million b/d in 2016 and 8.2 million in 2017. But it will be some time before the market begins to see any shortage of oil. Global stocks are growing and the market is expected to remain well supplied until sometime in 2017.

Global supplies rose to 92.2 million b/d during April, according to the IEA, and Opec production averaged 32.76 million b/d, the highest since August 2008. Iran, Iraq and the UAE have increased production and are expected to keep pushing for higher output. Saudi Arabia appears to be holding production steady at 10.19 million b/d, but it has the capacity to boost this to 12.2 million b/d and it remains to be seen if it intends to expand production in the midst of its Middle East rivalry with Iran, and also how it applies its oil sector towards plans to move to a non-oil based economy.

Gas

Saudi Arabia looks to a new uncertain world

Saudi Arabia has appointed a new Minister of Petroleum and is looking to sell a portion of Saudi Aramco as it moves to adjust to a new world.

Mark Goetz

When Saudi Arabia retired its long-serving Minister of Petroleum Ali al-Naimi in April and announced that it would transform its economy away from one based almost entirely on oil into a diversified, multi-faceted one, it called for a double take.

Although long in coming, the surprise move is a sign of the times and reflects not only the thinking of the 30-year-old Saudi Crown Prince, Mohammed bin Salman, son of the current ruler King Salman, but also Saudi Arabia's utter need for economic reform.

Under the country's 'Vision 2030', the largest oil company in the world, state-owned Saudi Aramco will have a fraction of itself privatised through an initial public offering (IPO) that will likely put 5 per cent of the company on domestic and international markets.

Saudi Aramco, considered the most valuable company in the world, has never been evaluated and estimates of its true worth range from $1.5 trillion to $10 trillion. Prince Mohammed, who also heads Saudi Arabia's Supreme Petroleum Council, said he expects the valuation of Aramco to be at least $2 trillion. Money raised from the IPO is to be put into a fund that would be used to diversify the economy and contribute to the expansion of the private sector.

Some say Saudi Arabia has little choice, the collapse of the oil price, from $115/b in mid-2014 to around $30/b earlier this year, has taken its toll on the country.

Prices began to slide when former oil minister Naimi announced that Saudi Arabia would defend its market share rather than the price of oil and turned up production. This has indeed forced many high-cost producers out of the market.

Future Saudi oil policy is expected to remain on its current track of maintaining market share, and as part of the Vision 2030 programme, the country intends to boost its use of renewable energy to reduce domestic use of crude and products in order to have more available for export.

The programme calls for an "initial" target of 9.5 GW of renewable energy by 2023 in the first stage of the programme. The programme is to be carried out through the King Salman Renewable Energy Initiative and will require new regulatory frameworks and the involvement of the private sector.

To cope with falling revenues, Saudi Arabia has had to dip into its financial reserves. Reports out in mid-May say Riyadh is preparing its first international bond sale. Some analysts warn that with oil prices still under $50/b, the reforms will not come fast enough to stave off some serious economic pressures, considering that the state relies on oil sales for about 80-90 per cent of its revenue. Others look at its reserves and natural resources and see Saudi Arabia successfully managing the coming challenges.

In March the International Monetary Fund (IMF) estimated that Saudi Arabia has foreign reserves of $570 billion, enough to see it through several more lean economic years, but it needs to be noted that between March 2015 and March this year, Riyadh used $100 billion of those foreign reserves to cover domestic expenses. Clearly the state's largess has its limits.

Unemployment among the young is a serious problem and subsidies on water, electricity and fuel have been cut in an effort to address budget deficits. The word 'taxes' comes up from time to time, but it is a concept that could take the Saudis some time to digest.

Saudi Arabia's future will depend on the success of the fundamental restructuring of its economy and by extension, its society. But analyses of Saudi Arabia predict that this will not be an easy task as it attempts to establish functioning and accountable government institutions.

Saudi Aramco, under its new President and CEO Amin Nasser, will hold a key role in how this plays out. The IPO may provide Saudi Arabia with the injection of capital it needs to balance budgets and provide investment for launching a vitalised private sector.

The dismissal of Ali al-Naimi as oil minister and his replacement by Saudi Aramco chairman Khalid al-Falih was not a complete surprise. Falih had for some time been seen as the minister in waiting and with the launch of the reforms and the creation of a new Ministry of Energy, Industry and Mineral Resources the change in leadership was appropriate.

It will, of course, seem strange not to think of Naimi when one thinks of Saudi oil and Opec.

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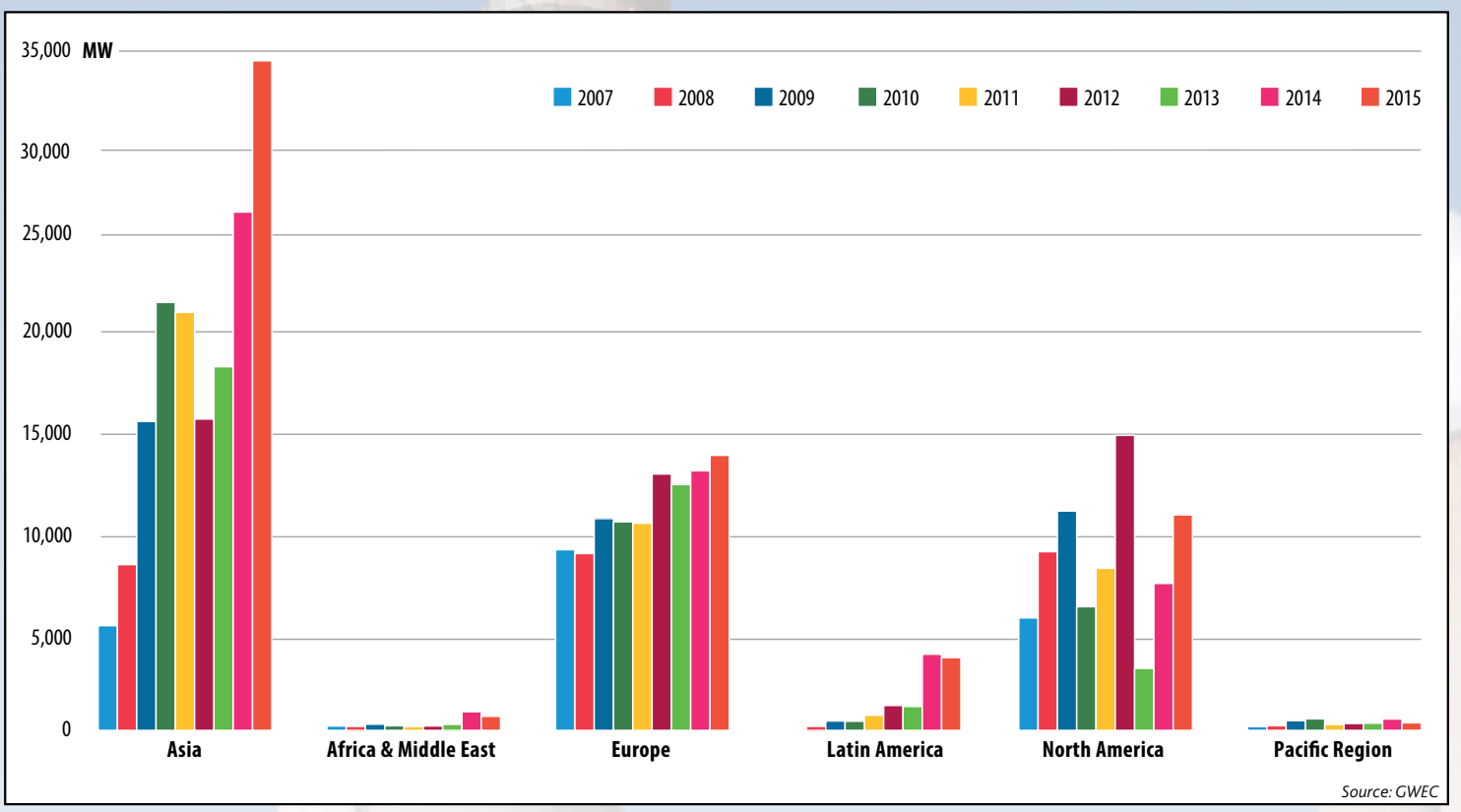
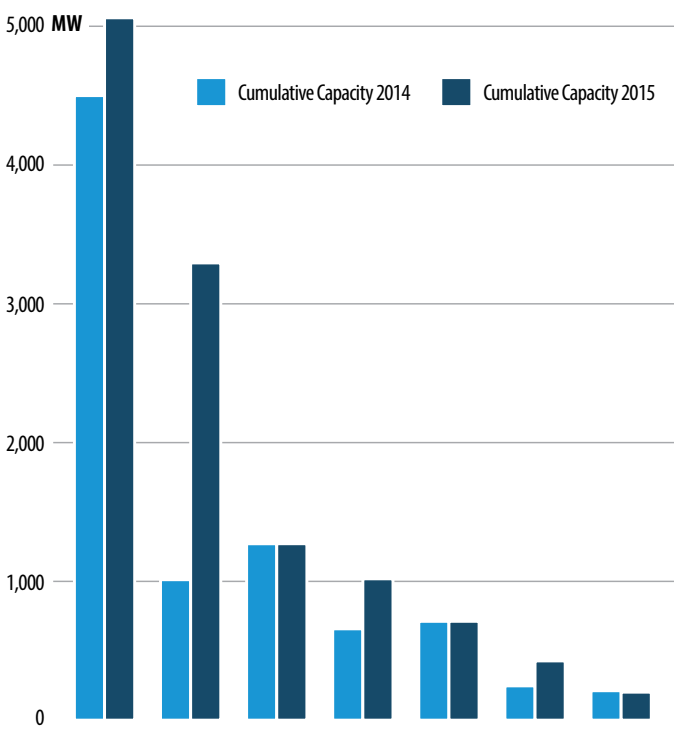
Annual installed capacity by region 2007-2015

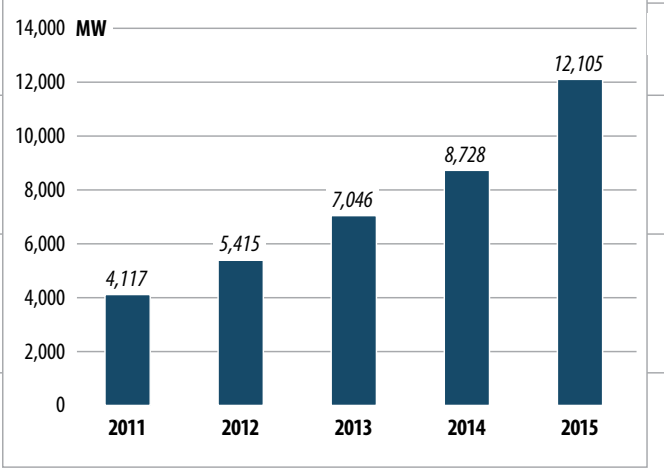


Source: GWEC

Global cumulative offshore wind capacity in 2015



Annual cumulative capacity (2011-2015)



	UK	Germany	Denmark	PR China	Belgium	Netherlands	Sweden	Japan	Finland	Ireland	S Korea	Spain	Norway	Portugal	US	Total
Total 2014	4,500	1,012	1,271	658	712	247	212	50	26	25	5	5	2	2	0.02	**8,728**
New 2015	566	2,282	0	361	0	180	0	3	0	0	0	0	0	0	0	**3,392**
Total 2015	5,061	3,295	1,271	1,018	712	427	202	53	26	25	5	5	2	2	0.02	**12,105**

Source: GWEC

Source: Global Wind Report Annual Market Update 2015, published by the Global Wind Energy Council

Still looking for the money

The cost of nuclear new build continues to be prohibitive but this has not deterred some countries from striving for a way to keep the technology in the generation mix. **Junior Isles** report.

The meltdown at Fukushima in 2011 has not deterred all nations from building new nuclear plant. According to the World Nuclear Association 31 countries around the world still have plans for new reactors – 65 (representing nearly 70 GWe) are under construction, 173 (182.42 GW) are on order or planned and 337 (379.2 GW) are proposed.

Notably, most of the capacity coming on line will be in Asia. The outlook for new nuclear in Europe, however, remains less certain. While nuclear can help the EU achieve its climate change and energy security goals, new build projects face tremendous challenges – perhaps the biggest being the huge capital investment required.

Forsström: Fennovoima did not want to take the risk of using first-of-a-kind technology

According to the Energy Information Administration's (EIA) recently released International Energy Outlook 2016, nuclear capacity is projected to grow 2.4 per cent annually, nearly doubling by 2040. The EIA also says most of the increase will come from countries outside the Organization for Economic Cooperation and Development. For example, the report sees 9.6 per cent average growth in China, adding 139 GW from 2012 to 2040.

In April, meanwhile, the European Commission published its Nuclear Illustrative Programme (PINC) – the first presented by the Commission after the Fukushima Daiichi accident. It also predicted nuclear growth through 2040, while giving a more detailed picture of Europe and the investment required.

The report notes that there are 129 nuclear power reactors in operation in 14 EU Member States, with an average age close to 30 years. New build projects are envisaged in 10 Member States, with four reactors already under construction in Finland, France and Slovakia. Other projects in Finland, Hungary and the United Kingdom are in the licensing process, while projects in Bulgaria, the Czech Republic, Lithuania, Poland and Romania are at a preparatory stage.

The PINC report estimates that €350-450 billion would have to be invested in new plants to replace most of the EU's existing nuclear capacity. It is an eye-watering amount of investment – money that is not easy to come by, especially in Europe's deregulated markets.

Speaking at the 11th *Annual Platts European Nuclear Conference* in London in May, Mats Ladeborn, Vice President Fleet Development, Vattenfall and Member of Foratom Executive Board said: "In Sweden, from the financial perspective it's not feasible at all. I cannot see a market model today that can support new nuclear in this really tough short term market thinking of today… the only investments that are around today are those that are subsidised."

Others argue, however, that money can be found if a project makes economic sense for investors, and long-term thinking is adopted.

In December 2013 Finnish co-operative Fennovoima and JSC Rusatom Overseas, subsidiary of Russia's Rosatom, signed the plant supply contract for the 1200 MW Hanhikivi 1 nuclear power plant. Fennovoima's Project Director Minna Forsström recently commented on the project and its financing. Speaking on the sidelines of the conference she said: "The money is around but it's about making profitable investments."

The Fennovoima story, however, is a bit different to many. Fennovoima was established by a group of more than 40 Finnish companies and municipalities in need of long-term energy supply at a stable price.

The cost estimate for Hanhikivi 1 is €6.5-7 billion (including, e.g., financing costs and waste management). About a quarter of the costs during the construction phase (2014-2024) will be financed with the owners' equity (Voimaosakeyhtiö 66 per cent and RAOS 34 per cent), and the rest through debt financing, all of which Rosatom is responsible for obtaining. Of the debt financing, about €2.4 billion is from Russia's National Welfare Fund. About €1 billion of this has been withdrawn.

The provision of financing, the fact that Rosatom is a part owner, the use of proven technology and an electricity price that was in line with open market prices, have all combined to deliver what seems to be a project that is developing smoothly. Following a relatively short negotiation and development period, construction is due to start in 2018, as soon as the construction licence is granted.

"It was the whole package – the technology, the price, financing and the reliability of the supplier," said Forsström. "There are many challenges with nuclear projects, so the supplier needs to be really motivated. Being an owner is the best motivator. Also we did not want to take the risk of using first-of-a-kind technology. We have seen the challenges at Olkiluoto 3 in Finland."

What Fennovoima did right, was to clearly define the business model with Rosatom from the outset and set the limitations that had to be met. "We spent [only] nine months negotiating with the Russians to make the business case, setting things like the target [electricity] price of €50/MWh, which had to be met in order for the shareholders to invest."

It has probably helped that all parties were acutely aware that the Finnish government does not hand out subsidies for nuclear power.

Certainly the UK could learn a few lessons from Finland. Although only 400 MW bigger in output, the UK's proposed Hinkley Point C will cost three times as much and consumers will pay more than twice as much for electricity from the plant. And despite Chinese financing and continuing assurances from the UK and French governments, EDF is yet to make a final investment decision (FID) on the project – several years after its initial proposal.

Hinkley C would have been more attractive if the UK government had opted for proven technology. Hinkley will use Areva's EPR reactor. None of these have as yet been built and the units under construction at Olkiluoto in Finland and Flamanville, France, are hugely behind schedule and over budget. No doubt if Hinkley had a much lower price tag, negotiations would have been faster and it is likely that a FID would have been reached by now.

Regardless, it remains difficult to build new nuclear plants in a purely private sector model – without any kind of state aid such as subsidies (e.g. for low carbon electricity), feed-in tariffs, capacity guarantees, state insurances or direct financing by the state – for several reasons.

Firstly, the LCOE for projected new nuclear generation ranges between €40 and €100/MWh (depending on the schedule delay and/or cost overruns and the discount rate). At the end of 2015 the average pan-European base load wholesale electricity price was less than €45/MWh. In the UK it was the highest at almost €60/MWh, in Poland about €40/MWh and in Finland €30/MWh.

Michael Kruse, Partner and head of the Central European Energy & Utilities at Arthur D. Little said: "Since market prices and LCOE are very close, the risks of building a nuclear power plant that is not profitable is very high. Since the market prices are very uncertain at present, it is difficult to justify the investment without any kind of guarantees."

At Hinkley EDF is guaranteed an off-take price of £92.50/MWh for 35 years, giving EDF sufficient stability in its business case, yet it still hesitates in making its FID. "This," said Kruse, "shows how difficult it is to enter into an investment, which will cover a lifetime of 60 to 80 years."

It seems as if there can be no projects without Russian or Chinese investment. This is not only because they seem to be the countries with cash to invest, but also because such investments align with their long-term interest.

Kruse noted: "At Fennovoima, for example, in my opinion Rosatom has become a shareholder not because it wants to invest into a nuclear power plant, but rather because of Russian state industry politics. If Rosatom proves it can build a nuclear plant in a Western country, it is a strong reference for them to sell their technology. At the same time, Fennovoima could not secure sufficient funding for the plant and needed an investor like Rosatom. The Chinese have similar ambitions."

Kruse believes the investment challenge can only be overcome if market conditions are "set right", which means higher electricity prices in the long-term and stable market conditions until nuclear has reached its break-even. He notes that it could also be argued that electricity markets malfunction by definition and require state involvement to ensure security of energy supply. "If it is generally accepted that the state supports the construction of NPP it will of course also overcome the obstacle for the operators," he said.

Some argue that nuclear generation is not needed at all, since it can be substituted by a combination of gas, wind, PV, geothermal, biomass, waste and hydro. However, those technologies also require state support since the current and predicted market wholesale prices are lower than their LCOE.

Indeed the advent of renewables is another challenge for nuclear. The growing amount of renewables in the grid has already damaged the business case for base load coal and gas fired plants in many parts of Europe.

"It will also become more difficult to ensure full utilisation of nuclear plants," said Kruse. "The traditional role of a nuclear power plant to provide base load power is declining.

"Advanced nuclear like small modular reactors (SMRs) might change this in the future, but this does not help the current projects which are based on technologies which have been developed in the 1980s/1990s (like the EPR)."

Still, this is an approach that the nuclear industry continues to explore. Looking well into the future, Dr. David Kingham, CEO of Oxford-based UK SME Tokamak Energy, described to delegates at the London conference what could in many ways be the Holy Grail for nuclear – an SMR based on fusion.

The technology uses high temperature superconductors to allow fusion to occur in a compact device (see *TEI Times,* February 2016, p15). One of the devices at the lab has operated for 29 hours. The challenge remains to get more energy out than has been put in, which has never been achieved for fusion, but Dr Kingham remains hopeful.

"There is a target to do that by 2025. We are confident of making good progress in the next two or three years. We will then need to raise tens if not hundreds of millions of pounds." He acknowledges this will be a big challenge, especially in the UK. Still, Tokomak Energy has raised £10 million in private investment and "is aiming to raise another £10 million in the next year or so". Notably, the Institution of Mechanical Engineers has become an investor in the last year.

So it seems that indeed there is still money out there for nuclear, regardless of challenges that sometimes appear insurmountable.

Extracting value from offshore wind

Hywind wind farm illustration.
Image courtesy of Statoil

Plans for testing the viability and economic potential of integrated energy storage and offshore wind are at the heart of Statoil's innovative Hywind project.

Siân Crampsie

Statoil's plans for the installation of a floating offshore wind farm in Scotland took a major step forward last month when the UK's Crown Estate agreed to grant the firm a seabed lease for the project.

The 30 MW demonstration project is expected to start operating in 2017 and will comprise five 6 MW turbines floating in waters off the coast of Peterhead, Aberdeenshire. It is a key part of global efforts to develop floating offshore wind energy technology that could be used in deep coastal waters around the world.

But as well as helping to commercialise floating offshore wind, Statoil plans to use the Hywind project for another purpose: to demonstrate the economic case for coupling offshore wind energy with large-scale energy storage.

The Norwegian energy giant has drawn up plans for a second project entailing the construction of a battery storage unit at the Hywind project. The firm signed a memorandum of understanding (MoU) with the Scottish government, Scottish Enterprise and the Offshore Renewable Energy (ORE) Catapult in March and is now looking for external funding to help finance the project, known as Batwind.

Batwind will comprise a 1 MWh lithium ion battery unit coupled to the Hywind wind farm and the grid. Statoil believes that the pilot project will not only show how battery storage can mitigate the intermittency and optimise the output of offshore wind farms, but also demonstrate how energy storage could extract more value out of offshore wind energy resources.

According to a recent report from the Carbon Trust, widespread deployment of energy storage solutions could help the UK to realise significant cost savings by making the country's electricity system more flexible, optimising the use of existing generation assets and reducing the need for investment in new power plants. On a system-wide basis, the Carbon Trust believes that up to £2.4 billion of costs could be saved by 2030 if regulatory hurdles were overcome.

For a wind farm operator, energy storage can perform a variety of functions, including 'capacity firming', i.e., mitigating the fluctuations in output experienced with intermittent renewable energy resources. This, according to Dan Spencer of renewable energy technical consultancy firm OST Energy, is a key factor for operators of large-scale offshore wind farms.

"A primary advantage [of storage] for offshore wind developers will be the ability to firm up their capacity," said Spencer. "It has the potential to put them in a position where they can surpass coal and nuclear assets in terms of their generation of energy. This would be a swing in their favour and would be the next big step for offshore wind."

Another key benefit, according to Spencer, is the opportunity for wind farm operators to reduce their exposure to balancing costs – penalties paid by generators when they fail to provide to the system the energy they said they would. This can be a particularly large risk for wind energy generators without other types of plant (e.g. gas) in their portfolios.

Firming up capacity and having more control over the timing and level of a wind farm's output would also have other benefits for offshore wind farms, including the ability to 'time-shift' the release of energy to periods of peak demand when energy is of greater value, provide grid services such as frequency regulation, and reduce generation curtailment.

These benefits help to optimise the use of renewable energy, with the added benefits of reducing reliance on fossil fuel plant and reducing the costs of offshore wind, says Statoil.

"[Batwind] is not about the development of battery technology but understanding the combination of energy storage and offshore wind," says Sebastian Bringsvaerd, Batwind Project Manager at Statoil. "The project is not innovative in terms of battery technology – we selected a lithium ion unit with a 1 MWh capacity with the ability to discharge its energy in 30 minutes so that we could test a range of potential value drivers, including reducing balancing costs and arbitrage around peak energy prices."

As Bringsvaerd explains, as different batteries are suited to different functions, the Batwind project would ideally use more than one battery to demonstrate the different value drivers. However in the first phase of the project, Statoil will be able to use the battery to investigate optimal ways of extracting more value out of wind energy, and could investigate other types of battery at the project in later phases.

"We really want to learn about and understand the function of energy storage in the energy system so that we can replicate [Batwind] and scale it up in other places," Bringsvaerd explained.

According to both Bringsvaerd and Spencer, an important element of the learning process will be developing the battery control software. "This is the biggest thing," said Bringsvaerd. "We have to improve the battery control system and also combine it with wind forecast data and grid data so that we can use the storage in the most optimal way."

"There is a lot of work ongoing at present into the battery software [management systems] because these will be key to delivering value," added Spencer.

According to OST, battery technology costs are falling, thanks in part to the growth of the electric vehicle (EV) market, but other barriers to the deployment of batteries for energy storage exist, a fact highlighted in the recent Carbon Trust report.

The Carbon Trust says that market structures in the UK are currently incompatible with energy storage deployment, making it hard for investors to see a clear business case for the technology. Part of the problem is that the benefits of energy storage are split across different network stakeholders, and it is hard for a single stakeholder, e.g., a wind farm operator, to see a clear price point advantage for storage solutions.

But Statoil sees other possibilities for combined offshore wind and energy storage technologies, most notably in small island systems and offshore oil and gas platforms.

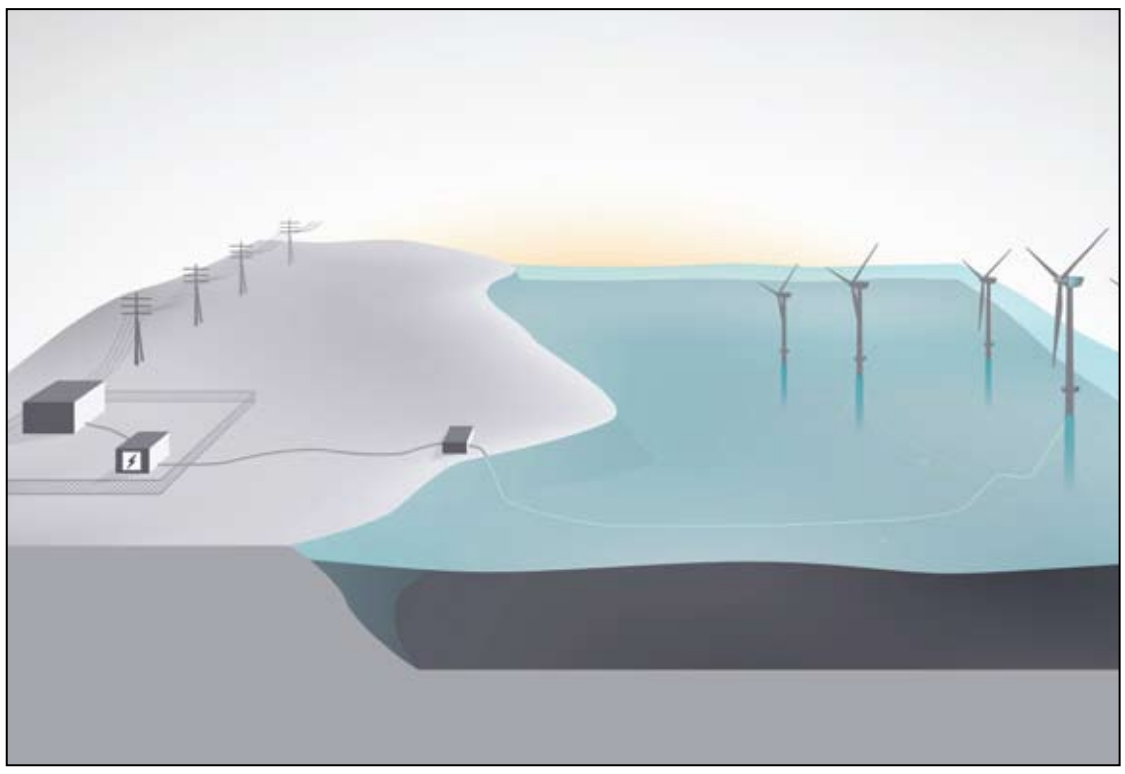
Of the latter, Bringsvaerd believes that there are substantial savings to be made. "Offshore platforms may use two or three gas turbines to provide enough power and backup capacity for the rig to function. You could replace one or two of these turbines with a wind turbine coupled with a battery, leaving a single gas turbine as a backup."

A recent report from Navigant Consulting indicated that islands and isolated grids would be a key market for energy storage systems for renewable energy integration (ESRI). "With few exceptions, islands and isolated grids are expected to lead the market in the near term due to higher renewables penetration and little to no interconnections with neighbouring grid systems to balance instability," said Anissa Dehamna, research analyst at Navigant.

Statoil's Batwind is not the only offshore wind-battery storage project in development; last year Deepwater Wind proposed installing two lithium ion batteries to complement its proposed 90 MW Deepwater One offshore wind farm. Deepwater expects the energy storage solution to eliminate the need for larger, costly transmission cables and support New York governor Andrew Cuomo's targets for renewable energy.

Construction of the project could begin as early as 2019, with commercial operations by 2022.

Batwind will comprise a 1 MWh lithium ion battery unit coupled to the Hywind wind farm and the grid



A touching collaboration

The use of 3D visualisation is gaining popularity during the design stages and reviews of constructability of projects. Aveva has launched a new visualisation platform that integrates information management to improve collaborative decision-making throughout the life of digital assets. **Vic Wyman** explains.

Tough trading conditions during the last 12 months have forced capital-intensive industries such as the power sector to slash costs. This has seen greater use of 3D visualisation systems that help companies in areas such as the design, constructability and maintainability of their assets, and generally improve their business operations.

Engineering and information management software company Aveva has now made it easier for users to exploit digitised asset information to improve collaboration and decision-making across their organisation.

Known as Aveva Engage, the system seamlessly combines powerful whole-model visualisation with immediate contextually-filtered access to validated, relevant documents and information. This enables users to substantially improve collaborative decision-making in all stages of the asset life cycle. It can call up any associated asset information for any tagged object with the simple touch of a screen.

However, users might need a compliant boss to get to grips with the Engage system on a preferred huge touch screen such as the 84-inch Microsoft unit, which costs £20–22000 (around $35 000).

Aveva's Vice-President Solution strategy, Rick Standish, nevertheless says that Engage is being used on screens costing a tenth of that.

Engage, launched this year, is suitable for a range of users, from designers to owner-operators, of oil and gas, nuclear and other plants.

It allows users to move through 3D models, overlaying schematics, equipment drawings, diagrams, layouts, etc. and pulling up information about the equipment by touching the screen, to inform decision-making. "That is where we have really made a breakthrough: taking information from the operations systems and the construction systems and putting that quite simply in context in the 3D model," said Standish.

Although Engage is being used in new nuclear power plant projects in the UK, he noted that it is "useable for relatively small projects as well". Some UK customers are combining 3D models with background information typically to check mechanical integrity, overlaying inspection information to plan maintenance and to determine isolation procedures.

Other Aveva software, and particularly its power plant product Aveva Net, can capture information in existing systems for use with 3D systems and Engage. Standish explained: "That usually involves being non-intrusive, not trying to change how those systems work and how those work practices inside a company evolve. It can be as simple as converting a 3D model into an Engage format that gives you a high-performance and touch-screen experience."

He claims that Aveva has an "agnostic attitude to data", using a gateway to extract and combine relevant information from multiple sources to support decision-making.

Standish points out that the most obvious use of Engage is during capital expenditure (capex) investment design stages and reviews of constructability.

With a model open on a screen, the user can touch the screen to call up a small window showing the approved information sources and call up the documentation behind a particular part of the model, or the assets or design base behind it. Engage could be used typically to check plant clearances, access, assembly sequences, etc. when reviewing the design or constructability of the design.

Standish says that for plants densely packed with equipment, such as nuclear power stations, Engage can show sections through the model and remove areas for better visibility. "That's really what sets it apart from other visualisation platforms, the ability to really choose the detail, overlay the construction sequences in there and then look at how we can bring that data from the context management systems behind it."

Apart from Engage's benefits for project management, it can also help to ensure security, says Standish, typically by aggregating layers, which provide a high-security classification when combined, while allowing users to look at the fine detail in a plant. In the nuclear sector, one customer is using Engage to plan access routes for workers, who can walk through 3D models to understand which areas are closed off.

It is also possible to use an avatar to walk through a design, turning valves, operating switches, running through shut-down procedures and so on. "It depends how far you want to go," noted Standish.

Engage can link models to risk registers to allow users to show compliance with risk regulations, to allow projects to be audited, to show why a part was positioned like that, how previous projects tackled that problem, why that part was specified, etc.

What Aveva refers to as 'thematic queries' allows the checking of external design data, with colour coding and highlighting of models, to allow design changes and even to show where a specific manufacturer's parts have been used or even a specific purchase order.

"So it's very useful when you're doing risk analysis, or you've got a battery isolation or a maintenance procedure, said Standish. "It's easy to see where the elements are or to highlight specific zones where there are higher or more important safety conditions that are to be taken into consideration."

Standish claims that regulators, particularly in the nuclear sector, are becoming increasingly accustomed to seeing data presented like that: "This is a major driver for us to continue down this path as the regulators become more accustomed to seeing information presented in this manner.

Engage gives users the ability to choose the detail, overlay the construction sequences and then bring the data from the context management systems behind it

It's more likely to become a compliance element, to the safety integrity level 3."

Aveva's biggest challenge has been persuading potential users of the benefit of using and maintaining 3D models for plant operations rather than just for capital investment. The firm is also working on applying Engage to existing "brownfield" plants that either have no 3D models or out-of-date models, by superimposing asset information and laser scans, without having to do it manually.

"How can we integrate laser scanning into the decision support?" said Standish. "That's something that we are looking to introduce in 12 or 18 months' time."

Today's relatively cheap laser-scanning systems could allow a plant operator to highlight the differences between what they think they have on site and what is really there. That could allow automation of the walk-throughs needed before major upgrades or repairs can be carried out.

Aveva began developing Engage nearly three years ago, as it was updating its Integrated Engineering and Design system to make graphical representation of an asset "clearer and more photo-realistic for the designer". That led to work to give users an "immersive" experience without reducing the model. "You retain all the model detail and intelligence," noted Standish.

Advances in processing offered the possibility of interacting with a whole plant model using touch screens for the immediate retrieval of design information.

Standish explained: "The visualisation systems are really focused on just the representation of 3D and over time they've become progressively more feature-rich and have really wandered into the domain of design tool specialists in capex and operations. Similarly things like information portals based on data warehousing and document management require knowledge of the asset structure."

Engage is claimed to add value by being a decision-support platform accessible to a wide range of non-expert users. Standish says that familiarity with touch-screens on smart phones or tablets allows users to access complex and technical information "without the steep learning curve of visualisation systems or of warehouse portals".

He claims that Aveva has anecdotal stories of initial users of Engage reaping large benefits. "We have seen major design changes," he noted.

Engage costs the equivalent of a 3D design suite while the cost of the information management system to gather data is equivalent to that of document management, but overall costs depend on the use, says Standish. A remediation of a brownfield site might need up to 18 months of work, for example, while a simple revamp might only need a couple of months of work. He said: "It depends on the data you want to capture. It's not really to do with technology."

Over the next few years, Aveva hopes to consolidate many of its software products and information systems into a single touch screen decision-support system that can be embedded in work-flows.

One benefit touted for Engage is the opportunity for close collaboration, particularly in sectors such as the oil and gas business where several sites often work on models. Most nuclear projects are run on single sites for security reasons but being able to conduct reviews around a large touch screen has huge advantages in the accessibility of data and being able to produce safety cases and meet regulatory requirements.

Standish thinks that technology developments will allow more of that. "The collaborative nature of projects will improve," he said. He points to the need for energy companies to respond to low energy prices by getting more out of their data and the possibility of owner-operators also more easily owning their data and more effectively running their operations.

"Once you get over nervousness about security on these major structural or design projects there will be much more collaboration and the technology is there to support it," said Standish.

Engage might just lead to a marriage of different interests.

Engage can show sections through a model and remove areas for better visibility

Junior Isles

Very much the same, but different

A lot can change in nine years, even if it often feels as if things are much the same.

In late May, DNV GL launched its '*Technology Outlook 2025*' an update on its last viewpoint published in 2011. At the launch, Jørge Aarnes, Head of Strategic Foresight, DNV GL, mused: "Nine years may not seem like tomorrow but if you look back to 2007, to get an idea of the timeframe, most of you can probably recall what car you had, what mobile you had, what husband or wife you had..."

Indeed when it is put in that context, you begin to get a feel of how much technology has changed but in what remains a largely familiar world. Pre-2007 there was no iPhone – yet it becomes increasingly difficult to imagine a time before Apple's flagship product.

The 2025 Outlook is what DNV sees as "its way of looking into the crystal ball". Like any outlook, it is not an exact science but gives a realistic idea of what might lie ahead in the not so distant future.

While many of the trends are the same as in the last report, the rate of those developments is accelerating more rapidly. Essentially, the world in 2025 will largely be recognisable but there will be a 'funnelling' or focus on certain technologies – those that are seen as game-changers.

Aarnes noted: "The main difference between this and the last outlook, is there was much broader coverage in the previous outlook. Convergence of these trends is also more pronounced than the previous version."

Cartoon jemsoar.com

The world is becoming increasingly connected and intertwined; technologies applied in the healthcare and automotive sectors, for example, are seeing applications in energy and other industries. "The adoption across sectors is happening much faster," noted Aarnes.

DNV GL says there are four main areas that will drive technology integration at a global scale: policy and regulation; climate change; digitalisation; and sustainable use of resources. In the power sector specifically, DNV GL believes the first two will be the most influential.

Marcel Eijgelaar, Research Officer, Energy, at DNV GL, said these drivers will be responsible for 10 technology trends in the power sector. While the trends come as no surprise, he noted that "for the first time, these trends are coming together". For example, climate change is accelerating the trend towards more renewables, which goes hand-in-hand with more energy storage and a greater need for demand response management and smart grids. Eijgelaar added: "For the time, you are also seeing the business case [for these technologies]."

The first trend, he says, is the ongoing electrification of energy demand due to the ease with which electricity can be converted into other energy sources. This has been the case since the first electric streetlight replaced the old-fashioned gas lamp. Today we are seeing it being increasingly used as the energy source for transport.

The second trend is in the development of new materials. These are crucial for areas ranging from solar panel coatings and new battery chemistries to power electronics for power converter technologies, as well as cheaper permanent magnets for (direct drive) wind turbines and composites for the blades.

The third trend DNV identifies is in power grids, where logic will be used to actively control the grid in order to maintain stability and power quality.

Turning to generation, wind energy will continue to grow rapidly. Offshore, wind turbines continue to grow in size and are being deployed in deeper water. Further developments in turbine technology and higher manufacturing volumes are driving down cost both offshore and onshore. Eijgelaar noted that in many areas onshore wind delivers the lowest cost energy.

It is a similar story in solar, where the trend is a steep rise in the application of PV systems. With a downward cost-curve and improving efficiency, solar PV has shown exponential growth almost since the start of grid-connected deployment. According to DNV GL, in 1980 global cumulative capacity was in the region of 5 MW, by 2025 it predicts that figure will be nearer 10 000 GW. At the same time, mass production has cut the cost of solar modules per watt-peak by 10 per cent a year on average since 1980. Costs, once around €20/Wp 35 years ago, could be €0.3-0.4/Wp by 2025.

Number six in DNV GL's list of technology trends will be in electricity storage, more specifically batteries. Over the next decade, the company expects a steep decline in battery prices and a correspondingly rapid increase in home energy storage solutions.

DNV GL predicts there will also be a greater uptake of Demand Response Management (DRM). This is potentially the most economic measure to create flexibility in response to variations in wind and solar generation. DRM is performed by controlling customer demand directly (dispatchable DRM) or by issuing a time-of-use price, rewarding customers that respond to this (non-dispatchable DRM).

Both methods have pros and cons but DNV GL says technological developments are starting to make DRM solutions possible that combine the benefits of both without the drawbacks. By 2025, DNV GL predicts DRM will be "an indispensable service" to prosumers, and as such will provide retailers and aggregators with a tool to differentiate their services in new ways.

This essentially ties in with another trend – smart energy producing buildings. According to DNV GL, energy producing buildings will be the standard for new residential properties in many industrialised countries. Interestingly it says that while developments in solar and storage may suggest that buildings will go "off grid", the opposite is more likely to occur. Buildings have the potential to become energy hubs and therefore an important asset in supporting grid management.

DNV GL also predicts that by 2025 sensors will be ubiquitous in the grid. These will provide real-time data and allow grids to be "self-thinking", with features such as self-configuration for resilience and reduction of losses, self-adjustment for voltage variations, and automatic dispatch demand response to avoid capacity problems.

The last of the trends that DNV GL forecasts is the advent of hybrid grids. According to the outlook, in 2025 hybrid grids will emerge where HVDC grids will be embedded in conventional AC networks.

DNV GL also gives a couple of scenarios for the state of the energy sector in 2025. In a scenario where there is a weak push from policy and regulation, it forecasts, for example, that global solar PV will be less than 1 TWp; wind will be less than 1 TW, with limited growth in offshore wind; and uptake of EVs will be less than 20 million.

With a strong policy push, solar PV is forecasted to be close to 3 TWp; wind will be more than 2 TW, with moderate growth offshore and there will be more than 80 million EVs.

These ten technology trends are not written in stone and are by no means unfamiliar, but the indication is that they will continue. How far along the road we will be by 2025 is anyone's guess. What DNV GL is certain of, however, is that the rate of change will accelerate much more rapidly than we have seen in the past – more of an evolution than a revolution.

The power and energy sector will never move as fast as the mobile phone industry but hopefully it transitions faster than the rate at which one changes husbands or wives. I struggle to remember what phone I owned in 2007. Fortunately, the rest is still fairly familiar.