

# THE ENERGY INDUSTRY TIMES

February 2013 • Volume 5 • No 12 • Published monthly • ISSN 1757-7365

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## Special Project Supplement

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# Limited role for renewables despite rapid growth



Flores-Quiroga: "we might see some surprising developments"

The latest global energy outlooks by two oil and gas giants say that renewables will continue to grow rapidly but will not be a large part of the long term energy mix. **Junior Isles**

Renewables will continue to be the fastest growing form of energy over the next several years but will not play a big role in meeting the world's growing energy demand, according to recent reports by oil and gas majors, ExxonMobil and BP.

Presenting ExxonMobil's *Energy Outlook 2040* at the World Future Energy Summit (WFES) last month, Morton Mauritzen said that the share of green and clean energy will rise six-fold but will still only represent 5.8 per cent of the global primary energy mix by 2040.

Updated each year, the *Outlook* analyses the trends that will shape global energy supply and demand over the

coming decades.

"We do not expect that solar, wind and biofuel will gain a larger share because these energy sources are not scalable," said Mauritzen, who overlooks ExxonMobil's operations in the United Arab Emirates.

He said the world population is expected to hit 8.7 billion people in 2040 and consequently, global primary energy demand will rise by 35 per cent in the next 30 years. "This huge increase in power demand can't be covered by alternative energy but only with fossil fuels as they are reliable, safe and accessible for all."

The report states that global electricity demand will grow by 85 per cent

over the *Outlook* period (2010-2040). While it acknowledges that renewables will grow substantially, it predicts that they will contribute less than 10 per cent of electricity generation.

Although the clean energy industry will grow at 6 per cent per annum, the most significant shift in the energy mix will occur when natural gas displaces coal as the second-largest fuel by 2025, said Mauritzen.

ExxonMobil forecasts that gas will emerge as the number one source for electricity generation by 2040, accounting for 30 per cent of global electricity generation compared to just over 20 per cent today.

Aldo Flores-Quiroga, the secretary

general of the International Energy Forum in Riyadh, Saudi Arabia, which is an association of the largest energy producers and consumers, said that whilst he agreed with Mauritzen that the importance of gas will rise, clean and green energy might gain a larger share than ExxonMobil is projecting.

He said: "Until 2040, innovation and research will intensify in solar and wind power, so we might see some surprising developments in that field for the mass production."

BP gave a more positive projection for renewables than ExxonMobil. The *BP Energy Outlook 2030* published

Continued on Page 2

## EU emissions trading scheme in disarray

The EU Emissions Trading Scheme (ETS), the cornerstone of the EU's drive to cut carbon emissions, is at risk of collapse after the European Parliament rejected a proposal to prop up carbon prices.

Prices fell to a record low of €2.81 per tonne following the vote but recovered slightly to €4.41 per tonne.

Permits have lost 85 per cent of their value from mid-2011 as economic pressures have led to over-supply. In 2005, when the ETS was first launched, carbon prices were nearly €30 per tonne.

EU climate commissioner Connie Hedegaard commented: "The recent events show that something has to be done urgently."

Bas Eickhout, Dutch member of the

European Parliament (MEP), said urgent action is needed to prevent the scheme from a total collapse. Just before the vote Eickhout called for "structural" solutions to support the EU ETS, including permanently retiring emissions allowances and not just back-loading the auctioning of allowances, in which they will be returned to the market in the later years of Phase 3 (2013-20).

Eickhout said: "Returning 900 million permits to the ETS at a later date would be like pouring water back into an already overflowing bathtub."

Before the vote, prices had fallen to €4.79 a tonne after Germany failed to sell carbon permits, triggering a crisis of confidence. Analysts are now question-

ing whether the market will survive.

Marcus Ferdinand of the Thomson Reuters Point Carbon research company said the European market was in "uncharted" territory. Per Lekander, an analyst at UBS, said in a note to clients that carbon permits were "worthless".

The problems in the EU ETS follow a crisis in the world's global carbon market, backed by the United Nations. Prices in the UN-system have fallen to just \$0.34 a tonne, down from more than \$20 a tonne in 2008. A panel set up by the UN to assess the mechanism concluded that the system had "essentially collapsed".

The market collapse came in spite of record levels of trading across the world's carbon markets in 2012.

Analysis from Bloomberg New Energy Finance (BNEF) shows that trading across the world's carbon markets was up 26 per cent on the previous year to reach 10.7 billion tonnes – equivalent to a third of the world's CO<sub>2</sub> emissions. Since 2010, trading activity in the world's carbon markets has increased steadily by around 25 per cent each year.

According to BNEF the dramatic rise in trading in UN offsets was due to the rush to issue and acquire UN offsets before the end of the year and to take advantage of record low prices. UN offsets are carbon credits from developing countries and former Eastern bloc countries (notably Russia and Ukraine).

Continued from Page 1

last month also forecasts that renewables will experience the fastest growth over the next several years, estimating that renewable energy production will grow from 4 per cent to 11 per cent by 2030. "Including biofuels, renewables are expected to have a higher share of primary energy than nuclear by 2030," said BP.

With regard to renewable power, renewables are expected to contribute to 27 per cent of the sector's growth through 2030. According to BP, the EU will initially lead growth in renewables. However, the U.S. and China will take the lead from 2020 to 2030.

A recent report from business intelligence providers GBI Research says the top 10 western European power markets will increase renewable installed capacity from 308.5 GW in 2012 to 466.9 GW in 2020, at a Compound Annual Growth Rate (CAGR) of 5.3 per cent.

Meanwhile, the International Renewable Energy Agency (IRENA) launched a new global renewable roadmap at an assembly held during WFES. IRENA believes that international efforts to double the share of renewable energy by 2030 are attainable but need to accelerate substantially if they are to be successful.

The REMAP 2030 process brings together experts and policy makers from across the globe to assess the gap between current renewable energy projections and targets set by the UN Secretary-General's Sustainable Energy for All initiative.

Initial results show that investment in renewable power generation, grid expansions, sustainable biomass and the use of renewable energy to generate heat needs to accelerate substantially to meet targets. Global renewable power generation will have to exceed annual expansion rates of more than 150 GW per year, compared to around 110 GW in 2011.



**Amin: the good news is that costs are falling**

"REMAP 2030 clearly maps the challenge we face in meeting international targets to double the share of renewable energy worldwide," said Adnan Amin, IRENA Director General. "The good news is that costs are falling, the technology is spreading, and countries across the world are implementing policies to make this happen. With the right political will, a world powered by clean, renewable energy is within our reach."

IRENA said that the cost of solar energy, for example, has dropped below the cost of diesel generation worldwide for communities living away from the electricity grid.

The public debate around renewable energy, however, continues to suffer from an out-dated perception that renewable energy is not competitive, forming a significant and unnecessary barrier to its deployment, claimed the organisation.

IRENA's *Renewable Power Generation Costs in 2012: An Overview*, analyses the costs and performance of 8000 medium- to large-scale renewable power generation projects.

# Obama warns on climate change

The re-election of Barack Obama as US president for a second term is good news for the global fight against climate change. **Junior Isles**

Recently re-elected US president Barack Obama issued a warning on climate change during his second inauguration speech. The warning signals that Obama is once again attempting to put a plan for tackling climate change back on the country's agenda.

During his speech Obama pledged to respond to what he called "the threat of climate change," saying the failure to do so would be a betrayal of the nation's children and future generations.

"Some may still deny the overwhelming judgment of science" that global warming exists, Obama said, "but none can avoid the devastating impact of raging fires and crippling drought and more powerful storms."

Environmental groups praised the mention of climate change, a topic virtually ignored during the presidential campaign. They said they would insist on Obama keeping his promise to make climate change a top priority in his second term.

Andrew Hoffman, director of the Erb Institute for Global Sustainable Enterprise at the University of Michigan, said Obama's focus on climate showed political backbone.

"He finally had the courage to acknowledge the words 'climate change,'" Hoffman said, adding that Obama and other administration officials have frequently used words such as green jobs or clean energy to describe energy policy, instead of the more politically charged term.

By singling out climate change, Obama indicates a willingness to take on an issue that he acknowledges was often overlooked during his first term. He is also setting up a likely confrontation with congressional Republicans who have opposed legislative efforts to curb global warming.

Obama failed in his first term to get a climate change bill through Congress. Efforts for a new bill would trigger major resistance in Congress, especially

in the Republican-controlled House.

Environmental leaders are counting on Obama to set tough limits on carbon pollution from coal fired power plants and to continue federal investments in renewable energy sources.

During his speech, the president pledged to boost renewable energy sources such as wind and solar power, along with more traditional energy sources such as coal, oil and natural gas.

"The path towards sustainable energy sources will be long and sometimes difficult. But America cannot resist this transition. We must lead it," Obama said.

On January 1, the outgoing Congress approved a one-year extension of a subsidy for wind power, boosting an industry bracing for a drop in activity.

The industry is still waiting to see how much new generation will be installed with the encouragement of the credit and how much demand there will be to support makers of components such as wind towers and blades.

A recent report released by The Pew Charitable Trusts said private investment, manufacturing and deployment of renewable power have been held back because of the lack of a long-term, consistent energy policy. Revenue in the global clean energy sector could total \$1.9 trillion from 2012 to 2018, the Pew report said.

"US industry has the capacity to be a leader, provided we have the right policies in place," said Phyllis Cuttino director of Pew's Clean Energy Program. "It's time for Congress to support a comprehensive energy strategy by delivering long-term certainty for businesses and investors in renewable power."

The report urges Congress and the administration to establish a clean energy standard to guide deployment and investment, increase investment in energy research and development, and renew incentives for domestic clean energy manufacturing.

## Smog clouds China's clean energy efforts

- Invested \$67.7 billion in clean energy in 2012
- Unconventional gas can help cut dependence on coal

China emerged as the world leader in clean energy investment – despite the recent smog crisis in Beijing.

Last month Beijing reported its worst levels of PM2.5 particles since the government began taking measurements early last year. As visibility plummeted, schools cancelled outside activities and authorities advised residents to stay inside.

In response to the crisis Beijing will strengthen its efforts to tackle PM2.5 and slash the density of major air pollutants by 2 per cent this year, the municipality's acting mayor said.

The city also plans to cut its coal consumption.

Reducing dependence on coal will be key to tackling the smog crisis, which overshadows the country's transition to a cleaner energy mix.

Electricity generated from clean energy resources in China rose 28.5 per cent year-on-year in 2012. China generated 1.07 trillion kWh of electricity from clean energy resources, accounting for 21.4 per cent of the country's total electricity output, the State Electricity Regulatory Commission (SERC) said.

According to Bloomberg New Energy Finance, China regained the top spot as the world's leading investor in renewable energy. The country invested a record \$67.7 billion last year, up 20 per cent from 2011.

China also hopes that a substantial increase in the use of natural gas will help reduce its dependence on coal and is looking to exploit shale gas resources that could potentially be larger than even the US.

Peter Kiernan, energy analyst at The Economist Intelligence Unit warned, however: "There are several

geographical, regulatory and infrastructure-related barriers to shale gas development in China that make government targets of annual shale gas output of between 60 and 100 bcm by 2020 unrealistic.

"The shale gas phase in China has only just begun, but in addition to renewables the development of unconventional gas can still play its part in reducing China's over-dependence on coal for electricity generation, a problem which is having significant environmental and economic consequences."

## France offshore wind tender boosts industry jobs

The French government's call for tenders for the construction of €3.5 billion (\$4.57 billion) worth of offshore wind farms will provide a welcome boost to Europe's wind turbine manufacturing sector.

The investment would likely support 10000 industrial jobs, and is the second offshore wind farm project launched by the government, according to the office of the French Energy Minister Delphine Batho. The wind farms, which will have an installed capacity of 1000 MW, are planned for construction near Treport, in northern France, and near the Noimoutier and Iles d'Yeu islands on the Atlantic coast.

The French government in April last

year awarded contracts for four wind farms, representing an investment of around €7 billion.

A venture between state-controlled utility Électricité de France and Danish company Dong Energy Power was chosen to build and operate three of the wind farms off the Atlantic and Channel coasts, using wind turbines made by Alstom.

A group owned by Spain's Iberdrola SA and EOLE-RES SA was chosen to build and operate a fourth wind farm located offshore in northern France with a plan to install wind turbines made by Areva.

Last month Alstom launched the construction of its first two offshore wind

turbine factories in Saint-Nazaire, laying the foundations of a French industrial cluster that will create close to 7000 jobs. The factories are expected to be commissioned in 2014.

The Saint-Nazaire plants will be devoted to assembling nacelles and manufacturing generators for the 6 MW Haliade 150 offshore wind turbine.

They will be scaled for a production capacity of 100 machines per year. In 2014, those plants will take over from the temporary workshop in Saint-Nazaire where Alstom is producing early series of the Haliade 150, the first of which has just begun final testing prior to certification. By 2015, two other plants in Cherbourg intended for the

production of blades and towers will complete this industrial scheme.

Alstom will deliver the 240 Haliade 150 units to be deployed at the Cour-sulles-sur-Mer, Fécamp and Saint-Nazaire wind farms starting in 2016. After a 30-year period without inaugurating a factory inside France, the Group is committed to creating about 1000 direct jobs in the country in the marine renewable energy sector. Alstom's industrial plan should also generate about 4000 indirect jobs among its suppliers and sub-contractors. The consortium's business operations alone will provide 2000 additional jobs, mainly working on wind farm maintenance.

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# Gas price rise will reverse coal's decline

- EIA forecasts rise in coal and renewables consumption
- PTC extended

Siân Crampsie

Natural gas consumption in the US electric power generation industry is set to decline in 2013 and 2014 as natural gas prices rise, according to the US Energy Information Administration (EIA).

The EIA's *Short-term Energy Outlook* indicates that natural gas prices will see a slight rise through to 2014, leaving the possibility of a rise in coal fired generation.

A rise in natural gas prices would also be good news for the US wind industry, which at the end of 2012 welcomed a one-year extension of the production tax credit (PTC).

According to the EIA, Henry Hub natural gas spot prices will average \$3.74/MMBtu in 2013 and \$3.90/MMBtu in 2014, compared with \$4.00/MMBtu in 2011 and \$2.75/MMBtu in 2012.

If these forecasts are realised, EIA expects coal's share in total electricity generation to rise from 37.6 per cent in 2012 to 39 per cent in 2013 and 39.6

per cent in 2014.

Coal consumption in the US electric power sector last year fell to its lowest level since 1992, says the EIA, reflecting a structural shift in the electric power sector to greater reliance on natural gas.

EIA expects total generation of electricity to remain largely unchanged in 2013 and to grow by 0.8 per cent in 2014. An expected 32 per cent increase in the price of natural gas delivered to power generators drives a 264 GWh/day reduction in the use of natural gas in 2013, resulting in a fuel share of 27.9 per cent of total generation compared with a share of 30.3 per cent in 2012.

The decline in natural gas use will be offset by a rise in coal, renewable and nuclear generation.

Generation from wind energy plants grew by 17 per cent, according to the EIA, although future investment in the wind sector is uncertain in spite of the PTC extension.

The PTC was granted a one-year extension to the end of 2013 by Congress but uncertainty over its future caused

investment levels to decline in late 2012.

The industry is confident that orders will once again pick up, but says it is unlikely that development will reach 2012's record level of 12 000 MW installed. The American Wind Energy Association (AWEA) criticised "uncertain federal policies" that have caused frequent boom-bust cycles in the wind energy sector for over a decade.

The PTC is worth \$22 per MWh of energy generated, typically saving 20-30 per cent from the cost of a project. Research firm IHS estimates that without the PTC extension, installation of new wind capacity in the USA was likely to have fallen to just 2000 MW in 2013, according to the *Financial Times*.

With the extension of the PTC, installation of new wind capacity is likely to be in the region of 5000-6000 MW. This year the PTC will be made available to all wind energy projects that break ground in 2013, rather than only to those that start producing energy.

## Ontario plan ahead of schedule

Ontario is to shut the last of its coal-fired power plants in the south of the province by the end of 2013, marking a major milestone in its long-term energy plan.

The Canadian province pledged around ten years ago to phase out coal fired electricity generation completely by the end of 2014. It says that by the end of 2013 it will have shut down 17 of its 19 coal fired units and that by the end of 2014 the province will be one of the first places in the world to eliminate coal as a source of power production.

Premier Dalton McGuinty said that the early closure of Ontario's two largest coal fired electricity plants,

Nanticoke and Lambton, is a result of the province's improved, smarter electricity grid, increased efficiency, strong conservation efforts and diversified supply of clean energy.

Ontario expects its use of coal to be less than one per cent of total electricity generation in 2014, down from 25 per cent in 2003 and 2.5 per cent in 2012. It derives just over half of its electricity from nuclear power plants, 22 per cent from hydropower, 15 per cent from natural gas, and wind energy three per cent.

It is investing heavily in wind, natural gas and other renewables as well as energy conservation in order to achieve its clean energy goals.



Ontario is rapidly closing the door on coal

## Bolivia nationalises Iberdrola units

The Bolivian government has continued its programme of nationalising key economic sectors by taking control of power companies owned by Spain's Iberdrola.

President Evo Morales issued in late December a decree to nationalise Electricidad de La Paz and Luz y Fuerza de Oruro SA, electricity companies controlled by Iberdrola with minority shareholders based in the USA and Argentina.

Morales said that the expropriation of the assets would give Bolivian consumers more competitive electricity rates and better service quality. He pledged to compensate Iberdrola within six months.

The move by Morales follows the expropriation of an electricity distribution company owned by Red Electric de Espana last year. In 2009 Bolivia took control of other power generating companies, including a 50 per cent stake in Empresa Guara-cachi that was owned by Rurelec.

Spain's government issued a statement saying that it "regrets" Bolivia's decision and called for fair compensation for investors. The Spanish ministry of foreign affairs said it hopes that Bolivia will conduct an "objective valuation process" of the assets. "Spain reminds [Bolivia] of the need for legal certainty on foreign investments," the ministry said.

Iberdrola has operated in Bolivia

since the late 1990s. Electricidad de La Paz supplies around 470 000 customers in the cities of La Paz and El Alto, while Luz y Fuerza de Oruro supplies 80 000 customers in the city of Oruro.

The nationalisation also included two small suppliers owned by Iberdrola, which provide services to the distributors.

Since coming to power in January 2006, Morales has nationalised the country's oil sector as well as mines, smelters, telecoms and electric power companies.

**Taking control: Bolivia's President, Evo Morales**



## Brazil awaits new thermal capacity

New thermal power capacity will offset the shortages left by a season of low rainfall.

The imminent commissioning of new thermal power plants in Brazil will help reduce the risk of energy rationing, according to one power plant developer in the country.

MPX Energia says that two power plants with a total capacity of 680 MW will be connected to the grid by the end of February, while several other power plants in its development pipeline will also come on line in 2013.

Brazilian energy regulator Aneel said last month that a total of 13 new thermal power plants would start operating by the end of May.

The new thermal capacity will help Brazil to overcome a looming energy shortage caused by low rainfall levels.

Reservoir levels are reported to be critically low and rainfall in January

has done little to relieve the situation, according to local reports.

Water levels at hydropower plants in Brazil are at around one-third of their capacity – just above levels seen in 2001 during the country's last electricity crisis.

Since then the government has made a concerted effort to boost thermal power generating capacity and reduce the country's reliance on hydropower.

According to Aneel, new power plants scheduled to come on-line by May include the 360 MW Porto de Itaqui and the 176 MW Nova Venécia facilities. MPX Energia's Maranhão IV and V power plants will enter operation by the end of February, adding 680 MW to the grid.

MPX Energia is also developing the

360 MW Pecem II power plant and an extension to the 360 MW Pecem I power plant and will bring these on-line in 2013.

President Dilma Rousseff rejected in January rumours that electricity rationing would have to be imposed in Brazil because the system is better equipped to cope with shortages than it was in 2001.

Nevertheless analysts believe that the system will remain stretched if the rainfall situation does not improve before the onset of the dry season in April.

Consumers are also concerned that greater reliance on fossil fuels will lead to an increase in electricity prices in Brazil, which already has high prices relative to other countries in the region.



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# Power shortages put spotlight on sector reform

South Korea's new government is discussing plans to restructure its power sector and alleviate power shortages.

| Syed Ali

South Korea is discussing ways to restructure its electricity market—a move that could help solve the country's chronic power deficit.

According to local news reports the new government is likely to break up state-run Korea Electric Power Corp.'s (Kepeco) monopoly in the electricity sales market.

A presidential transition committee is considering the separation of Kepeco's two business sectors of electricity transmission and distribution and electricity sales, and will allow third parties access to the electricity sales market.

The reform of the electricity market,

which Kepeco has dominated from power generation to distribution to sales, has emerged as a major national agenda as Korea, the world's 11th-largest energy consumer, has faced electricity shortages for the past few years.

Stock market observers projected a positive outlook for Kepeco shares, saying the reform plan in sales of electricity will help Kepeco solve the chronic deficit issue, which was caused by the government's limit on the price of electricity.

Kepeco's labour union, however, has hit out at the reform plan, saying that competition in the sales of electricity could further increase electricity prices

and worsen the imbalance between electricity supply and demand.

Last month the government raised power tariffs for the second time in less than six months. Following a 4.9 per cent hike in August last year, tariffs were increased by an average 4 per cent on January 14. Low electricity tariffs have seen Kepeco struggle to fully cover its costs, a situation that has been exacerbated by increased power demand resulting from record highs for power demand during a very cold winter.

Embattled by daily threats of a possible power shortage, the government recently said it is seeking to increase the country's overall electricity generation capacity by nearly 40 per cent over

the next 15 years, government and industry sources said in January.

The government outlines a 15-year plan every two years for the country's power supply. Under its current plan, the country's generation capacity will increase from about 70 GW in 2010 to 95 GW by 2024.

According to reports, the sixth 15-Year Plan, which was due to be finalised at the end of January, includes measures to increase the country's maximum generation capacity to 110 GW by 2027, up 37.5 per cent from the current 80 GW. The revised plan will see the construction of six gas fired power plants by the end of 2017. It is also said to be considering six coal fired

projects that would come on line between June 2018 and the end of 2020.

The move to significantly increase the country's generation capacity follows a series of power shortage warnings caused by unprecedentedly low temperatures.

■ The world's first underground thermal power plant will be built in Seoul, according to Korea Midland Power (KMP), an affiliate of Kepeco. The plant with a capacity of 800 MW will be built under the site of a current thermal power plant in Mapo, western Seoul, by December 2016. Some residents living near to the plant, however, are poised to take legal action to prevent its construction.

## Thailand plans \$10 billion spending spree

- Baht 200 billion for transmission upgrades
- MoU to invest in Laos power sector

| Syed Ali

The Electricity Generating Authority of Thailand (Egat) is to spend Baht300 billion (\$10 billion) over the next five years, mainly to upgrade power facilities nationwide.

Two-thirds of the total will go to upgrading 40-year-old transmission lines, with the remaining Baht100 billion slated for new capacity such as the Wang Noi and Chana power plants, said governor Sutat Patmasiriwat.

Egat can seek financing for the massive spending because its debt-to-equity ratio is less than 0.5, said Mr Sutat.

He said Egat can subsidise electricity prices until the end of this year in line with the Energy Regulatory Commission's policy of capping power prices and fuel tariffs at 52 satang/kWh.

"Energy prices this year are unlikely to fluctuate like last year, as the economies of Europe and the US are expected to remain weak," said Mr Sutat.

The budget excludes foreign investment, especially for power plants in Laos and Myanmar, from which Egat plans to import a combined 20 GW of electricity over the next 20 years.

Last month Egat International Co. signed a memorandum of understanding (MoU) with Electricite du Laos (EDL) to work with the Laotian state enterprise to invest in power and related sectors in Laos.

The main areas of cooperation are high-voltage transmission lines, power generation, power plant maintenance and fibre optic telecommunications.

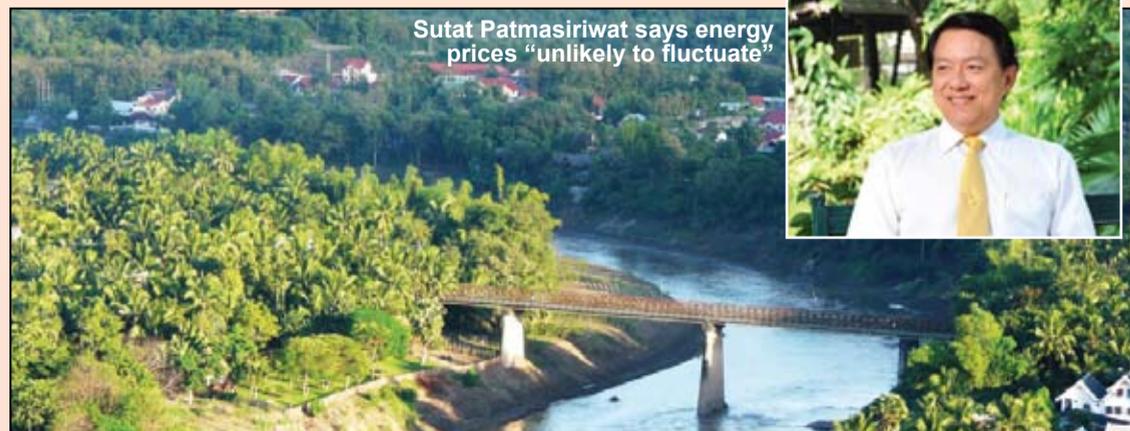
Several years ago, Laos announced an ambitious plan to become Asean's

"battery", given its great potential in hydroelectric power generation.

As of December 31, 2012, Thailand had bought 2000 MW of electricity from Laos.

Ongoing projects such as Hongsa Lignite, with a capacity of 1653 MW, will begin to supply electricity to Thailand in 2017, followed by the Xe Pian Xe Namnoy and Nam Ngiep projects in 2018 with a combined power output of 660 MW.

Strong protests in Thailand against power plant construction have prompted the country to double electricity purchase from Laos to 7000 MW between now and 2030.



## Meralco returns to boost Philippines

Meralco's return to generation after a 40-year hiatus could help meet a significant portion of electricity demand of the main island of Luzon.

Meralco President Oscar Reyes said the Philippines electricity retail company will build 2700 MW of coal- and gas-fired plants in Luzon in seven years, to supply as much as 30 per cent of the island's demand.

Meralco currently sells electricity to the capital and nearby provinces, which together account for half of the Philippines' \$225 billion economy. Producing its own power will reduce Meralco's dependence on generators and secure electricity supply in a nation where sales rose 7.1 per cent last year.

"The expansion into power generation will significantly boost profitability," said George Ching, a Manila-based analyst at COL Financial Group Inc. "A power plant's profitability can be higher than power distribution because there is a cap on returns from distribution. The power plant won't have merchant risk because the electricity will be sold to its own franchise

area."

Meralco buys most of its electricity from producers such as First Gen Corp., Aboitiz Power Corp. and San Miguel Corp.

"Rather than being a pure price taker, without any leverage, we felt it was necessary to re-enter the generation business," Reyes said.

The power retailer is building a \$1.2 billion, 600 MW, coal fired plant in Zambales, a province north of Manila, with Aboitiz Power and Taiwan Cogeneration Corp. that will start in 2016, Reyes said. A feasibility study is being conducted for a 1500 MW to 1700 MW gas plant in southern Luzon. An additional 600 MW coal plant in the island is also planned, he said.

A government law prohibits a single company from supplying more than 30 per cent of installed generating capacity in each of the country's three grids. Meralco is therefore also planning a 300 MW coal fired plant in Mindanao, the nation's second largest island that suffers from daily outages, Reyes said.

## Malaysia likely to miss nuclear target following Fukushima

- Doubtful reactors will be built by 2021
- Japan still keen to build new reactors

Malaysia Nuclear Power Corp. says its first nuclear power plant is unlikely to be built by the targeted date of 2021 due to public concerns following the accident at the Fukushima Daiichi nuclear power plant in Japan in March 2011.

Speaking at a regional nuclear conference in Kuala Lumpur, Mohamad Zamzam Jaafar, chief executive officer of Malaysia Nuclear Power Corp., said the March 2011 accident at Japan's Fukushima nuclear power plant has "put a damper" on the project. "In my personal opinion, it may be later than 2021," he said.

Malaysia plans to build a twin-unit nuclear power plant with a total capacity of 2 GW. The first unit is targeted to be in operation by 2021 and the

second one a year later. The project, expected to cost Ringgit21.3 billion (about \$6.95 billion) is being sold as a more cost-competitive and cleaner energy alternative to coal and gas.

Despite concerns following Fukushima, Japan's newly elected Prime Minister Shinzo Abe has expressed willingness to build new nuclear reactors in Japan, abandoning the goal set by the previous Democratic Party of Japan-led government to terminate nuclear power plants in the 2030s.

In late December he said: "New reactors will be totally different from those at Tepco's Fukushima Daiichi plant that caused the crisis," adding, "We will be building them with consent obtained from the Japanese people."

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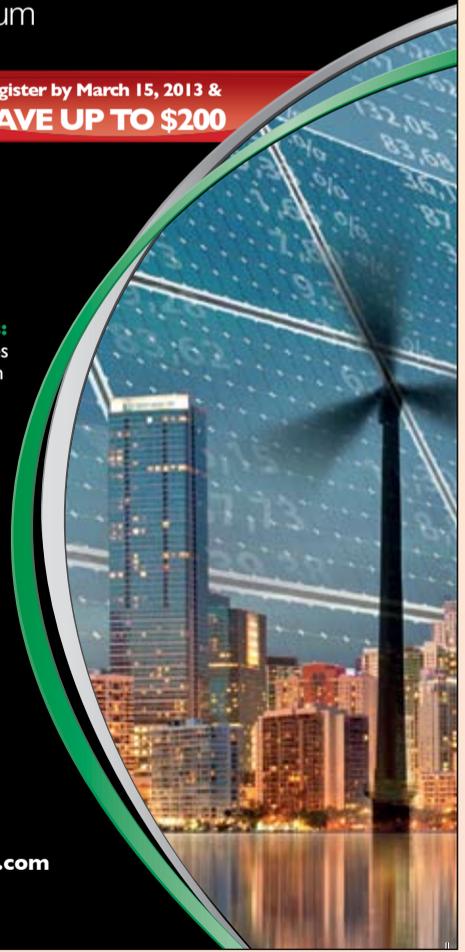
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# UK shifts to coal

The outlook for renewable energy in the UK looks uncertain in spite of political commitment to building a green future.

Siân Crampsie

Rising natural gas prices and a fall in carbon allowances are favouring an increase in the use of coal in the UK's power generation sector.

Official figures from the UK's Department of Energy and Climate Change (DECC) indicate that gas burn fell throughout 2012 due to a decline in the spark spread – the difference between the price of natural gas and the wholesale electricity price.

The clean dark spread – the difference between the cost of coal and carbon emission allowances and the price of electricity – have risen, in part due to a decline in the value of emission allowances.

Rising natural gas prices have also

enabled a rise in generation from the renewables sector. In the year July 2011 to June 2012, total electricity generation from renewables increased by 27 per cent, reaching 37.9 TWh, says DECC.

Renewables now account for more than ten per cent of electricity generation in the UK.

The UK government recently published an update of its Renewable Energy Roadmap, which indicates that the country is on track to meet its target of deriving 15 per cent of all its energy needs from renewable sources by 2020. The roadmap reiterates the government's commitment that renewable energy has "a pivotal role to play in the UK energy mix".

The roadmap was welcomed by the

renewable energy industry. "The update... highlights the sector's dynamic growth and the healthy pipeline of wind, wave and tidal projects to come," said Maf Smith, Deputy CEO of trade body RenewableUK. "It's right to note that costs are falling steadily, so renewables will continue to offer even better value for money for all of us. This will help to stabilise the price of energy, providing a secure alternative to importing expensive fossil fuels."

But the UK government has been criticised for not providing enough clarity on policy beyond 2020 and its own official forecasts indicate a sharp slowdown in renewable energy investment after 2020.

Recent DECC forecasts show that

cumulative new installations of renewable power capacity will rise from 35 GW in 2020 to 42 GW in 2030. "We are at risk of throwing away the great progress the UK has made in becoming a world leader in renewables," Keith MacLean, policy director at SSE told the *Financial Times*.

Official figures show that the share of renewable energy in the generating mix will remain unchanged between 2020 and 2030 at 34 per cent. The share of gas will rise from 29 per cent to 35 per cent over the same decade and nuclear will increase from 20 per cent to 24 per cent.

Coal fired electricity generation will fall from 12 per cent to three per cent, reflecting the government's position on the construction of new coal fired

capacity.

The pro-renewable energy lobby believes that the government's reluctance to commit to clean energy targets beyond 2020 will also threaten the government's goal of making the country a global centre of renewable energy technology.

The government has already identified the offshore wind sector as a major engine of economic growth in its Industrial Strategy, which shows that by 2012 more than 47 000 people will be working in the offshore wind sector.

RenewableUK said that the strategy was a "clear prioritisation of the offshore wind sector" by the government and would "help secure billions of pounds of investment" in the UK.

# Germany urged to reform energy market

■ Concerns over cost of renewables ■ Mitsubishi partners TenneT

The German government has been urged to reform the energy market in order to enable the country's planned transition to a nuclear-free, green energy economy.

Energy giant RWE said last month that the government should prioritise energy policy this year and in particular reform the renewable energies law in order to provide the right support mechanisms for clean technologies.

However Hans Bunting, managing director of RWE Innogy, told reporters

that he is concerned that little progress would be made this year because of planned elections, including general elections in the autumn.

The renewable energies law is the centrepiece of Germany's green energy policy, which now calls for 35 per cent of electricity to be sourced from renewables by 2020 and 80 per cent by 2050. It aims to subsidise renewables by adding a levy to consumers' bills, but there is concern among consumer groups and the industry itself

about the costs associated with a massive expansion in renewable energy capacity.

There is also concern in the industry that new regulations aimed at speeding up investment in the country's electricity grid – including transmission links for offshore wind farms – are inadequate.

RWE is one of several offshore wind farm developers in Germany whose projects have been delayed due to technical difficulties encountered by

grid operator TenneT with the construction of offshore wind grid connections.

TenneT received a boost in January, however, when Japanese engineering firm Mitsubishi agreed to invest €576 million in four offshore wind farm connections.

Under the deal, Mitsubishi will take a 49 per cent stake in four offshore high voltage projects: BorWin 1, BorWin 2, HelWin 2 and DolWin2. The combined capacity of the four connec-

tions will be 2.8 GW, equivalent to 30 per cent of Germany's overall target for North Sea offshore wind farms.

Crucially for TenneT, Mitsubishi's investment will enable it to fulfil its obligations to the offshore wind energy sector without compromising its financial position. It has completed two offshore wind connections so far and is constructing or planning a further eight.

The total cost of the ten connections will be €6 billion, says TenneT.

## Ireland explores shale gas



Ireland is to carry out a comprehensive study into the potential impacts of shale gas extraction as it prepares to develop regulations for the emerging industry.

The country has awarded three onshore license options for shale gas extraction and wants to investigate in detail the environmental impacts of hydraulic fracturing – or 'fracking' – the method used to extract shale gas.

No exploratory shale gas drilling

has yet been undertaken in Ireland and the three license options awarded give the licensees the option to apply for an exploration license.

The country's Environmental Protection Agency (EPA) has launched a consultation on the proposed study.

The two-year study aims to examine the impacts of exploration and extraction activity on groundwater, surface water and associated ecosystems, as well as investigate potential seismic

impacts. It will also look at mitigation measures and identify regulatory measures that should be taken.

The programme of research is expected to be commissioned around the middle of 2013 and a number of interim reports will be published before a final report at the end of the study, says EPA.

Last year the EPA published a preliminary report into the impacts of fracking.

## Belgium plans "energy atoll"

Belgium is planning to build a ring-shaped island in the North Sea to help it boost the uptake of renewable energy and wean itself off nuclear power.

The proposed island would store excess energy produced by wind power plants, releasing it at times of peak electricity demand.

Dubbed an "energy atoll", the island would feature a large, central water reservoir and would be equipped with pumped storage hydro turbines. Water would be pumped into the 30 m-deep reservoir using electricity generated by offshore wind turbines, and released through the turbines again to generate energy.

The total generating capacity of the project would be around 300 MW, according to the country's government.

"We have a lot of energy from the windmills and sometimes it just gets lost because there isn't enough demand for the electricity," a spokes-

person for Deputy Prime Minister Johan Vande Lanotte told *Reuters*. "This is a great solution."

Belgian grid operator, Elia, said the project is still undergoing feasibility studies, but could be completed within seven years if approved.

Wind energy capacity is growing in Belgium and in 2011 stood at just over 1 GW. The country has set a target of 2300 MW of offshore wind capacity but due to the intermittent nature of wind generation, needs to improve its energy storage capacity.

The country is also planning to close its nuclear power plants.

The proposed island would be built 3 km off the Belgian coast near the town of Wenduine and would also serve as an offshore substation for North Sea wind farms. Elia said that one of the key elements of the project would be the reinforcement of the onshore grid.

**Special Project:** Samcheok Green Power Project

# Samcheok leads the way in supercritical CFB

Civil works are underway at a massive green energy project in South Korea. In addition to implementing wind, solar, wave and hydropower, the plant will notably use the largest and most advanced supercritical circulating fluidised bed boilers in the world, capable of co-firing a wide range of coals with biomass. **Junior Isles**



Artist's impression of the Samcheok Green Power Project

Just 40 km outside the city of Samcheok, in Gangwon-do province on the east coast of South Korea, state-owned power company Korea Southern Power Company (KOSPO) is hard at work on a revolutionary power generation project aimed at providing cheap, green energy to the country.

The Samcheok Green Power Project, which is being built on a 2.6 million m<sup>2</sup> site of reclaimed coastal land, will not only generate electricity from various renewable energy sources but will notably also see the country's first use of advanced ultra-supercritical circulating fluidised bed (CFB) technology enabling it to burn a combination of biomass and coal of varying quality, including low rank coals.

The plant will be equipped with four boilers in tandem with two steam turbine generators for a total generating capacity of 2000 MW. An additional 1000 MW will come from a mixture

of combined thermal power and renewable generation. There are also plans to generate electricity from a fuel cell plant at a nearby facility owned by Korea Gas Corporation.

The South Korean story is one of strong economic growth, which in turn is driving power demand. Like Japan, Korea has no significant natural energy resources and is heavily dependent on fuel imports. It is also in a region of very high oil and gas prices. Compared to the \$2-3 per million Btu in the US, the price of imported natural gas is in the range of \$12-15 per million Btu. Meanwhile, plans for new nuclear plants have slowed in the aftermath of Fukushima and, with its long lead-time, is not an option for meeting urgent demand.

Apart from renewables, one of the few remaining options to meet demand, while keeping a lid on energy prices, is coal. However, although coal prices are around five times

lower than gas, they have also been rising in the region. At the same time, the availability of good quality coal is declining.

Ho-Ki Nam, Chairman and CEO of Korea Power Exchange (KPX) and head of KOSPO at the time, said: "To support our growing industrial sector, Korea imports about 100 million tonnes of coal. When the price of coal was low, there was no problem but as the price began to rise, it had a negative impact on the economy and exports. This is when I began thinking about using low calorie coal."

After a comprehensive study of boiler technologies KOSPO found that CFB technology could reliably fire low quality coals and resolve the problem. "This was a key factor behind my recommendation to the government to select CFB technology for the Samcheok Green Power Project," said Mr Nam.

This decision resulted in a contract

being awarded to Foster Wheeler in 2011 for the design and supply of four 550 MWe (gross) ultra-supercritical boilers for the first phase of the project – making it the largest CFB plant in the world. This first phase (Units 1 and 2) will be configured as two blocks with each block having two boilers feeding into an 1100 MW steam turbine.

Commenting on Korea's decision to opt for CFB technology, Robert Giglio, Vice President of Strategic Business Development and Strategy for Foster Wheeler's Global Power Group, said: "CFB technology has the flexibility to burn the lower quality coals that they saw becoming more abundant, namely from Indonesia. The CFB was their first major step into opening the fuel window – it would enable them to burn this low quality coal, which trades at a discount, and not be locked in to buying high quality coal."

## Special Project: Samcheok Green Power Project



Cutaway of a single boiler

He added: "If you use a pulverised coal boiler, it has to be designed for a narrow fuel range. The coal has to be finely ground before being fed to the boiler and you could only burn a limited amount of biomass."

The plant will fire imported and domestic coals with heating values from 4000-5000 kcal/kg. The current thinking, however, is that coal will be bought from the international market with the plan that most of it will come from Indonesia. This is the type of coal that is increasingly being exported from Indonesian.

It is a typical sub-bituminous coal with high moisture, low ash, and low sulphur with a heating value of around 4250 kcal/kg. High quality coals typically have a calorific value of around 6000 kcal/kg.

This coal is 20-30 per cent cheaper than premium quality coal, i.e. a saving of around \$20-30 per tonne based on the average price of coal delivered to Korea. For a plant as large as Samcheok's Phase I, this fuel discount works out to be a considerable amount in plant operating cost savings, considering that the fuel cost is around 70 per cent of a power plant's total running cost.

Another area of saving is the elimination of the need for flue gas desulphurisation (FGD) systems to remove SO<sub>x</sub> emissions – CFB boilers have a built-in FGD.

Emissions from the plant are very low. Samcheok is designed to be an example of green power generation in Korea. NO<sub>x</sub> and SO<sub>x</sub> emissions are each guaranteed at 50 ppm (at 6 per cent O<sub>2</sub>). Dust emissions will be

controlled by an electrostatic precipitator so that particulates do not exceed 20 mg/Nm<sup>3</sup>. Carbon dioxide emissions are estimated at around 800 g/kWh which is about 25 per cent below a typical operating coal plant in Korea today.

The plant's green credentials are further enhanced by the use of biomass. The boilers are expected to burn about 5 per cent biomass in terms of heat input, depending on availability. Korea has extensive forest and there are options of sourcing recycled wood



Giglio: CFB technology has the flexibility to burn lower quality coals

waste from the local lumber industry or importing wood pellets from overseas markets.

The biomass will be delivered to a different dock than the one used for coal. A dedicated offloading dock is located at the side of the plant to receive biomass shipped to the plant via barge. Little to no preparation of the biomass is needed before it is burned in the CFB boilers. "CFB boilers are very flexible," said Giglio, "the biomass is only chipped to about a two-inch size but no drying is required."

The biomass will be sucked from the barge with a vacuum system onto a pneumatic transport system and then stored in silos before it is fed to the boilers.

Coal will be delivered to an unloading port located at the front of the plant. A coal unloading facility typically uses parallel mooring, in which only one side of the pier is used. However, the Samcheok Green Power plant will adopt the bilateral mooring method, where two coal barges can dock on both sides of the pier in order to maximise usable space, while reducing construction costs of the seawall.

Notably, there will be no visible coal at the site. Coal will be stored in indoor coal bunkers whose roofs are covered with solar photovoltaic panels, which will also generate electricity. Coal will be conveyed underground to the boilers, so there will be no coal dust blown into the surroundings as is typical at

plants where coal is stored in open piles above ground.

The coal and biomass are to be burned in the CFB boilers, which Foster Wheeler says are the largest and most advanced in the world. The once-through ultra-supercritical (OTUSC) CFB boilers utilise advanced vertical tube low mass flux Benson evaporator technology, which is more efficient and easier to build and maintain than conventional spiral-wound supercritical boiler technology.

Supercritical steam conditions represent a physical point just above the triple point of water. When the boiler pressure reaches above the critical pressure of 221.2 bar and temperature of 374°C, two-phase mixtures of water and steam cease to exist, and are replaced by a single supercritical fluid. These high steam temperature and pressure conditions result in greatly increased efficiency.

Giglio explained the difference between subcritical and supercritical technology in simple terms. "The traditional subcritical boiler has been around for over 100 years. It's simple. It's like a pot of boiling water – no matter how much heat you put into the pot, as long as there is a liquid component, the pot will always stay the same temperature until all the water boils away. Then the pot will start to rise in temperature very quickly.

Like the boiling pot, the walls of a subcritical boiler have that same mixture of steam and water. No matter how much heat you put into the walls, the temperature of the water/vapour mixture and the metal tubes of the walls will remain unchanged. If a section of the wall gets more heat than another, because of the natural equilibrium of the system, the higher heated area will naturally have a higher circulation of the water/steam mixture to maintain the same temperature as all other sections.

"With a supercritical boiler, essentially you put a lid on the pot and pressurise it. If you bring the pressure to a high enough point, you no longer

Foster Wheeler uses the same simple vertical tube hanging design common in subcritical drum boilers, but instead uses much smaller tubes. This reduces the weight of the steam/water mixture in each tube allowing buoyancy forces to become strong enough so that even at supercritical conditions, tubes that receive more heat will naturally flow more steam and water.

This provides additional cooling to limit temperature differences between different wall tubes. Foster Wheeler says that out of the hundreds of boilers sold in the market, only a few use this new technology.

Giglio summarised: "Our boilers have a simpler design, are easier to maintain, have a lower steam pressure drop and self-cooling protection you don't get with the spiral design."

The material used for Foster Wheeler's subcritical boilers is much the same as for its supercritical boilers, except in the final superheater section, which is subjected to very high temperatures.

With pulverised coal boilers, superheating takes place at the top of the boiler. In Foster Wheeler's CFB boilers, final superheating is not done here since the boiler flue gas in this area can be very corrosive. Instead the final superheating is done in a high efficiency fluidised bed heat exchanger called an INTREX. This is an integrated heat exchanger at the bottom of the boiler that extracts heat from the hot circulating bed material. As the hot solids return from the solid separators, they are collected and returned to the furnace through the INTREX.

The INTREX is a chamber containing bubbling hot solids that are fluidised by fresh combustion air. The coils that perform the final superheating are immersed in the hot solids and protected from the corrosive flue gases. This means the same supercritical temperatures can be reached using a lower grade coil material than would be needed in a PC boiler or that a lower quality fuel can be used without sacrificing steam temperature or unit reliability.

### Foster Wheeler's CFB technology has been proven at increasing sizes for a number of years, achieving the 200 MW utility size in the 1990s.

have a constant temperature. The more heat you put in, the higher the temperature of the liquid in the pot. And the more heat the liquid can absorb, the more efficient the process becomes."

The boiler produces main steam at a temperature of 603°C and reheat steam at 603°C. Superheat steam pressure is 237 bar [g].

The vertical tube design has several advantages over a spiral tube design. It has a lower pressure drop across the boiler, resulting in higher efficiency. The plant has an estimated net electrical efficiency of 42.4 per cent (LHV) compared to the 38-39 per cent typically achieved with traditional boilers.

Foster Wheeler says its vertical tube supercritical CFB design also makes it easier to build and maintain. Giglio explained: "Structurally, it avoids the complicated support system needed for a spiral tube boiler.

"Spiral wrapping the tubes around the furnace helps even-out the temperature differences between boiler tube to boiler tube but the spiral winding has a natural tendency to structurally unwind, putting a twisting force on the boiler since it is hung from the top. To counter the twisting forces, an elaborate bracing and lateral support system is required adding cost to the boiler and making it more difficult to build and then maintain."

Ash produced by the combustion process will be recycled to produce lightweight aggregate for the construction industry and help reclaim land destroyed by coal mining in the Gangwon-do region.

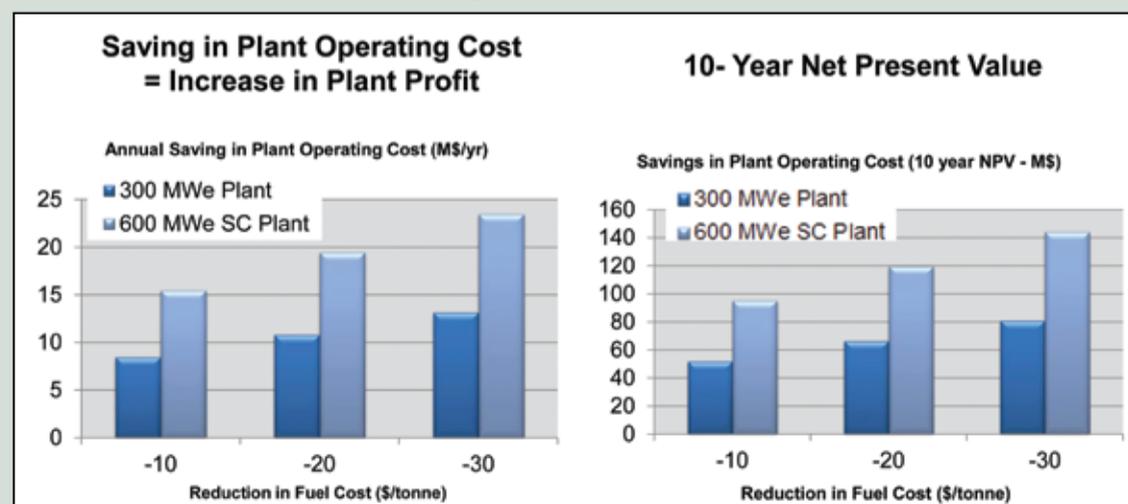
Foster Wheeler's CFB technology has been proven at increasing sizes for a number of years, achieving the 200 MW utility size in the 1990s. Today, there are around 20 CFB units of over 200 MWe scale in operation or under construction capable of burning a wide range of fuels.

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

The Samcheok units represent the next evolutionary step in the design and scale-up of Foster Wheeler's CFB boilers.

In order to satisfy the desire for local content, Foster Wheeler worked with

CFB technology can deliver fuel cost arbitrage value to power generators



## Special Project: Samcheok Green Power Project

Civil works at the Samcheok Green Power Project are well under way



KOSPO to maximise the scope from Korean suppliers.

“Our scope is most of what we call the ‘hot loop’, where the solids circulate,” noted Giglio.

Foster Wheeler’s contract scope therefore covers the design and supply of the most critical pressure parts of the boilers. These included the furnace, the solid separators, INTREX and specially designed loop seals used in the boiler. Some of the more traditional parts such as the economiser and some of the back-pass components, which are not proprietary technology, are being handled by Korean suppliers.

Following the award of the contract in May 2011, Foster Wheeler was given the Notice to Proceed (NTP) for the project in July 2011.

The Samcheok Green Power Plant site is located along a 3 km stretch of coastline between Hosan Port and Jakjin Port. Using the excavated rock from the mountain, the site will have an innovative tier design to save on construction costs.

As of this year the foundations for the boilers were almost complete. Structural steel should be shipped to the site around the middle of this year so that boiler erection can begin shortly after.

Boiler construction, and construction of the rest of the plant, is expected to take another year after Foster Wheeler completes its pressure part deliveries. According to the schedule, start-up of the Unit 1 boilers is planned for June 2015, six months prior to starting commercial operation in December 2015. The planned start-up of the boilers in Unit 2 is July 2015, with commercial operation scheduled for June 2016.

Samcheok Green Power Plant is a key strategic project for Foster Wheeler. As Giglio said: “This is really the next step in taking the CFB from a small industrial technology to a large mainstream supercritical utility power technology. The plant in Poland was the first step into the utility sector. This project is a huge next step for us. It will show at a huge scale what CFBs can really do.”

With the scaling up of CFB technology, Giglio believes other opportunities could materialise in the region. “Indonesia is looking at CFB technology as a way of burning low quality coal, leaving them free to export high quality coal. We could also see opportunities in Japan. Although some of the drivers are the same as Korea, following Fukushima Japan has to make some tough decisions in a short period of time. Like Korea it also faces high energy costs. Korea is meeting its challenge by methodically following an energy strategy that encompasses long term fuel sustainability and energy security.”

The Samcheok project will certainly do a great deal in helping Korea demonstrate its green credentials. When the first two units are complete in 2016 Samcheok will be at the forefront of the energy field and globally recognised as a model power plant.

### A renewable showcase

In addition to using the biggest and most advanced ultra-supercritical CFB boilers, the Samcheok Green Power Project will be a showcase for renewable technologies.

KOSPO aims to use a range of renewable energy sources at the plant, and plans to install: wind turbines on the seawall; solar photovoltaic panels on the roofs of buildings and slopes of the site; a small hydropower generation at the drainage canal and wave power generation units at the seawall.

A fuel cell facility will use gas from Korea Gas Corporation and bog gas to generate power.

There will be a comprehensive research centre set up within the power plant to research and develop technologies aimed at reducing CO<sub>2</sub> emissions. For example, some of the gas from the stack will be diverted to the research centre to investigate the absorption capabilities of algae and other plant life.

KOSPO also plans to conduct research into gasification through a gasification facility that will gasify some of the coal to produce syngas.

Samcheok Green Power will also showcase what is possible in terms of complete energy efficiency and sustainability. The coal units’ stacks are integrated with the office buildings in an architectural design that will see excess heat from the power plant chimneys used to heat the office buildings and other buildings on the site.

The plant will feature an energy saving electricity system, with an artificial intelligent lighting control system using natural and LED lighting.

There is also a focus on water conservation and recycling. According to KOSPO, specific emphasis was placed on water supply and disposal methods. Water for the power plant will be secured by: the bank filtrated water method; collected rainfall purification systems; and seawater desalination systems. It will also recycle all outflow by establishing an integrated water and wastewater treatment system that will minimise the plant’s water usage.

Environment friendly bio-paints will also be applied to pipes buried under the ground and sea to prevent corrosion.



The coal units’ stacks are integrated with the office buildings in an architectural design

### Plant design specifications

#### Fuel specifications

##### Bituminous coal

	Design fuel	Range
LHV (a.r.) (MJ/kg)	16.3	14.2 – 24.9
Moisture (%)	33.5	20 – 43
Ash (a.r.) (%)	3.76	1.1 – 15.3
Sulphur (a.r.) (%)	0.1	0.1-1
Chlorine (dry.) (%)	< 0.03	< 0.03

##### Wood pellets

LHV (a.r.) (MJ/kg)	17	15.8-18
Moisture (%)	10	5 – 15
Ash (a.r.) (%)	1	0.7 – 5
Sulphur (a.r.) (%)	0.03	0-0.16
Chlorine (dry.) %	< 0.01	< 0.05

#### Design steam parameters at 100 % load

SH steam flow (kg/s)	437.7
SH steam pressure (bar[g])	257
SH steam temperature (°C)	603
RH steam flow (kg/s)	356.4
RH steam pressure (bar[g])	53
RH steam temperature (°C)	603
Feed water temperature (°C)	297



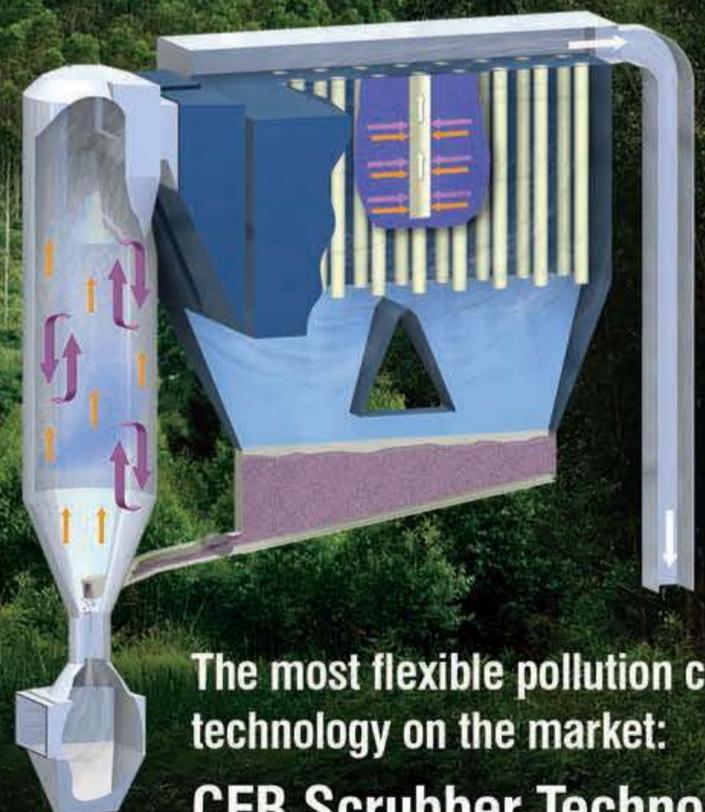
## Industrial Emission Directive ... Best Available Technology ... What's Next?

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by Foster Wheeler

# Emerging economies boost renewable finance

New markets are becoming the target of clean energy finance as established countries in Europe and North America waver on green policy.

Siân Crampsie

South Africa and Japan led the charge of the "new markets" in 2012 in the renewable energy sector as global investment in clean energy fell, according to Bloomberg New Energy Finance (BNEF).

The market intelligence firm says that clean energy investment declined by 11 per cent last year over 2011 levels to \$268.7 billion, with key markets such as the USA, Italy, Spain and India recording falls.

Emerging renewable energy markets such as South Africa and Japan were among the few countries to show large increases in investment, while China also experienced a 20 per cent year-on-year increase on 2011 investment levels. The data illustrates a shift in investment from established renewable energy markets to new ones in Africa, Asia, the Middle East and Latin America.

The overall decline in investment globally was largely due to regulatory

uncertainty and policy changes in key markets, although the deterioration in the market was not as large as had been expected.

"We warned at the start of last year that investment in 2012 was likely to fall below 2011 levels, but rumours of the death of clean energy investment have been greatly exaggerated," said Michael Liebreich, CEO of BNEF. "Indeed, the most striking aspect of these figures is that the decline was not bigger – given the fierce headwinds the clean energy sector faced in 2012 as a result of policy uncertainty, the ongoing European fiscal crisis, and continuing sharp falls in technology costs."

According to BNEF, the sharply lower prices of renewable energy technologies such as solar modules and wind turbines also exerted a downward pressure on investment volumes. "Solar photovoltaic (PV) module prices, for instance, fell another 24 per cent over the course of last year," said Liebreich.

South Africa saw investment in clean energy leap to \$5.5 billion, from just a few tens of millions in 2011, as it embarked on its renewable energy tender programme.

Japan's fresh emphasis on renewable energy following the Fukushima nuclear disaster in 2011 and the start of a new renewable energy subsidy programme helped investment in the country to soar by 75 per cent to \$16.3 billion.

In China, a surge in the solar energy sector led to investment levels of \$67.7 billion, more than 50 per cent higher than the USA, where investment levels declined by 32 per cent to \$44.2 billion.

Declining investment levels were also witnessed in Italy, where policy changes curbed the solar PV boom and led to a 51 per cent plunge in investment, and in Spain, where fiscal austerity led to major policy changes and a 68 per cent decrease in investment.

"Another message from the 2012 data is that investment is broadening

rapidly, from established markets such as Europe, the US and China, to new ones in Africa, the Middle East, Latin America and Asia-Oceania," said Liebreich. "Australia, South Africa, Morocco, the Ukraine, Mexico, Kenya, Brazil, Ethiopia, Chile and South Korea were among the countries seeing at least one project of more than \$250 million financed during the year."

The International Renewable Energy Agency (IRENA) and the Global Wind Energy Council (GWEC) have compiled a report showing a set of conditions that must be fulfilled to harness wind energy and attract investment. The report identifies and reviews the history of significant policy and regulatory measures that have contributed to the successful development of wind energy with a focus on 12 leading markets – Brazil, China, Denmark, Germany, Greece, India, Ireland, Italy, Portugal, Spain, the UK and the US – providing the most comprehensive analysis of wind energy policy yet produced.

## Zambia coal plant on track

Zambia's first coal fired power plant is to be commissioned in 2014, according to the plant's owner.

Maamba Collieries Limited (MCL) says that work on the 2 x 150 MW project is progressing well and that the first unit will be brought on line in September next year.

The plant's second unit will be commissioned in December 2014, said MCL head of corporate affairs Janardhan Lavu. It will be located at MCL's Maamba coal mine located approximately 350 km from Lusaka in Zambia's Southern Province.

MCL says that the new power plant will not only reduce Zambia's dependence on hydropower, but will also make use of the low-grade coal that MCL would otherwise dump as a by-product of its mining activities.

MCL contracted China's SECO Electric Power Construction Corp to build the power plant.



Zambia's first coal fired power plant is to be commissioned in 2014

## TAQA, Masdar seek overseas projects

UAE-based energy companies are seeking international agreements to boost investment and extend their global reach.

Abu Dhabi-based Masdar has signed a framework agreement with Morocco focusing on cooperation in the renewable energy field, while Abu Dhabi National Energy Co. (TAQA) has signed an inter-governmental agreement with Turkey for the development

of power plants and coal mines in the Turkish region of Afsin-Elbistan.

Moroccan Minister for Energy, Mines, Water and the Environment Fouad Douiri said that the agreement with Masdar would help his country develop its renewable energy sector.

Morocco is planning to invest \$20 billion in its renewable energy sector by 2020.

TAQA, meanwhile, could develop 7000 MW of generating capacity in Turkey in conjunction with Turkey's Electricity Generation Co. (EUAS). Turkish Energy Minister Taner Yildiz was quoted in the local press as saying that the investment may total \$12 billion.

TAQA and EUAS will form a project company that will initially acquire, upgrade and expand an existing 1400 MW plant and develop several new power plants and associated mines in sectors C, D, E and G of the Afsin-Elbistan region.

Preparatory work on the existing plant and the feasibility study for a planned 1440 MW plant and associated mine development will start immediately.

## Qatar mulls smart grids for energy conservation

The Qatar General Water and Electricity Corporation (Kahramaa) is to launch a pilot smart electricity grid project as part of plans to conserve electricity and the environment.

"We are going to start a pilot project soon to introduce a smart power grid system in Qatar. The project, to be built in Duhail, will be implemented in cooperation with Iberdrola," Saleh Hamad Al Marri said in Doha last month.

Al Marri, who heads Kahramaa's Renewable Energy Technology and Technical Affairs Department, added: "We also have the cooperation of Qatar Environment and Energy Research Institute (QEERI) and Qatar Science and Technology Park (QSTP) for the pilot project."

Qatar is hoping to implement 200 MW of renewable energy capacity by 2020. Overall the country needs to add around 8200 MW of electricity generating capacity by 2019 to cope with rising energy demand, according to data from MEED Insight.

The smart grid project will be implemented in two phases, with the first stage spanning one year and comprising a study of Qatar's strategic energy objectives and infrastructure.

The second phase will involve the implementation of a pilot project and making preparations for smart grid technology deployment in the country.

Qatar, with one of the highest per capita water and electricity consumption coupled with the world's highest

carbon footprint, is working to conserve the scarce resources.

"On the demand side management, we have created in Kahramaa a new department for energy conservation and energy efficiency. We are also auditing a lot of other measures to put in place aiming to conserve water and electricity resources in Qatar," said Yousef Janahi, Manager, Corporate Planning and Business Development at Kahramaa.

He added: "We have a target to conserve about 35 per cent of electricity and water in the next five years by reducing demand. And on the supply side, we are introducing efficient and environment friendly technology to produce about 200 MW of electricity by using renewable resources."



Yildiz: investment may total \$12 billion

## Iberdrola reconsiders position

Iberdrola is likely to hang on to its Scottish Power division after selling non-core assets worth over \$1 billion in 2012.

The Spanish energy giant was considering the sale of its UK regulated business as part of a plan to cut debt but press reports now indicate that it no longer deems the Scottish Power disposal necessary.

In December Iberdrola sealed a deal to sell 32 wind farms in France to EDF Energies Nouvelles, MEAG and GE Energy Financial Services for €350 million. It will receive a further €50 million from the transaction if wind resources at the wind farms prove adequate.

It has also sold seven wind farms in Germany to MVV Energie and its 20 per cent share in Medgaz to Fluxys.

Overall Iberdrola is aiming to sell €2 billion of non-core assets by 2014 in order to reinforce its financial strength and maintain its credit rating. Like other European utilities, Iberdrola's business has been affected by reduced energy demand and regulatory uncertainty.

Other sales made by Iberdrola last year include the sale of US-based companies The Energy Network to Energetix and NYSEG Solutions to Direct Energy; all of its gas distribution assets in Spain; its 13.25 per cent stake in Gas Natural Mexico; most of its shares in telecommunications operator Euskatel and the sale of GH Electrotermia.

# Toshiba looks to reduce nuclear exposure

Siân Crampsie

Toshiba has confirmed that it is seeking strategic partners to participate in its nuclear energy business.

The Japanese technology giant is reported to be in talks with three parties interested in buying a minority stake in Westinghouse Electric Co., the US-based atomic power company that Toshiba majority owns.

The move is thought to be in response to the current uncertainties in the global nuclear energy market following the Fukushima accident in Japan in 2011.

Toshiba has also sealed a deal with GE that could see the two companies jointly develop gas fired power plants around the world, a further sign of Toshiba's strategy to find growth outside of the nuclear business.

Toshiba owns 87 per cent of Westinghouse following a decision last year by Shaw Group to exercise an option to sell its 20 per cent stake in Westing-

house to the Japanese firm.

Toshiba says that it wants to retain a majority stake in Westinghouse but is looking for a long term partner that will help it to gain a firmer footing in markets such as China, Brazil, India, the USA and UK.

Westinghouse is building four new AP1000 reactors in the USA and a further four in China.

Since the Fukushima nuclear power plant accident two years ago, the pace of nuclear power plant development has slowed and the trend has been exacerbated by the global economic slowdown. Toshiba President Norio Sasaki told the *Wall Street Journal* in December 2012 that demand for nuclear power plants would "materialise two to three years later" than previously anticipated.

Toshiba paid \$4.16 billion for 77 per cent of Westinghouse in 2006. It sold a ten per cent stake in the company to Kazakhstan's Kazatomprom in 2007.

The Japanese firm is expected to

- Seeks long term partner for Westinghouse
- MOU with GE on CCGT development

raise the Yen125 billion (\$1.37 billion) needed to buy Shaw's 20 per cent stake in Westinghouse through a syndicated loan, putting pressure on its balance sheet.

It is expected to sell up to 16 per cent of the nuclear company in order to help reduce debt.

In January Toshiba signed a memorandum of understanding with GE to form a global strategic alliance for the construction of combined cycle power plants.

The deal also calls for the two companies to explore the formation of a strategic joint venture for the development of advanced, next-generation combined cycle power plants.

The alliance with GE would allow Toshiba to take advantage of the growing market for gas fired power plants that has been underpinned by the availability of cheap natural gas in North America and the growth in LNG.

The two companies have cooperated in gas turbine combined cycle power

generation systems since 1982 and have existing agreements to pursue 50 Hz and 60 Hz projects together in Japan and in key regions in Asia.

GE and Toshiba won a contract in 2012 to supply GE's new FlexEfficiency technology to Chubu Electric Power's Nishi Nagoya plant in Japan. This system is being configured to achieve the world's highest thermal efficiency of 62 per cent.

"Toshiba's sophisticated engineering, procurement and construction solutions have been well recognised by customers all over the world. Such capability, together with GE's FlexEfficiency portfolio, will enable the most efficient combined cycle power plant," said Sasaki. "Our 30-year relationship with GE has been mainly focused on Japan in the past, and we are excited to work toward collaborating with GE in select projects around the world, while also developing technologies together for even more fuel-efficient power plants in the future."

Lechêne: evaluating manufacturing footprint



## Tower deal revives Vestas

- Third party deal uses manufacturing footprint
- Company adapting to uncertain market

Vestas is gearing up to recruit staff once more in the USA following a deal to manufacture wind turbine towers for third parties in North America.

The wind turbine company has been reducing its workforce in response to the difficult trading environment in the wind energy sector but said in January that it would hire more than 100 workers to help it fulfil a new contract.

Vestas has signed an agreement to supply towers for a number of non-Vestas wind energy projects in North America over a two-year period. It said it would ramp up production at its

tower factory in Pueblo, Colorado and create more than 100 jobs by the end of the first quarter of 2013.

The deal will help Vestas to fulfil its strategy to make its business more flexible and scalable "to adapt the company to the uncertain market situation in the wind industry". The new contracts could use up to 25 per cent of its production capacity at the Pueblo facility.

"Vestas is continuously evaluating its manufacturing footprint and opportunities to utilise the current production capacity better. Producing components for third parties is part of this strategy,

and although we have had other smaller orders, this new agreement is the first major step in realising this plan," said Jean-Marc Lechêne, Executive Vice President & COO for Vestas Wind Systems A/S.

In late 2012 Vestas said that it would increase the amount of job cuts that it planned to make globally in order to hit its financial targets. It also said that it expected 2013 to be "a tough year for the wind industry".

Vestas reduced its Colorado workforce from 1800 workers to 1100 in 2012.

## French state compensates EDF

The government of France has agreed to compensate electricity company Electricité de France (EDF) for the costs that the company incurs for purchasing electricity generated from renewable sources and selling electricity at social tariff rates.

EDF will receive €4.9 billion by the end of 2018 to eliminate the burden of the Contribution to Electricity Public Services (CSPE) mechanism on its balance sheet.

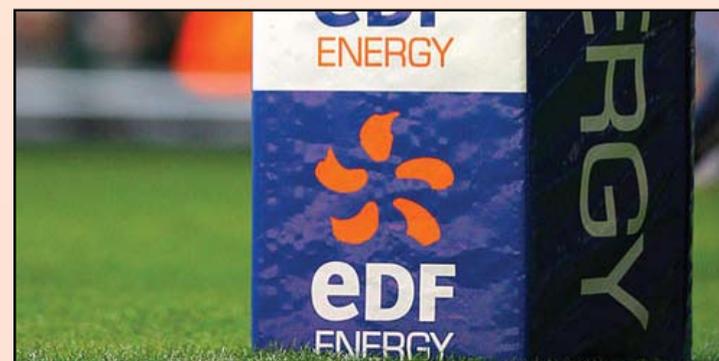
The CSPE is a tax levied on electricity end-consumers in France and enables EDF to recover the extra costs of buying renewable energy and performing other public service obligations such as subsidising electricity

sold to the poor.

The level of the CSPE is set by the government but since 2007 has been too low to adequately cover costs, says EDF. This resulted in the accumulation of a CSPE deficit on EDF's balance sheet.

The government has agreed to reimburse the cumulated deficits EDF has incurred, which are estimated to total around €4.3 billion. EDF estimates the cost of financing the deficits will be €600 million.

EDF says that the final receivable amount will be confirmed later this year after French energy regulator CRE validated the actual CSPE deficit for 2012.



## Tenders, Bids & Contracts

### Americas

#### Landmark project selects Bechtel, Alstom

The developer of the first proposed offshore electricity transmission system in the USA has chosen Bechtel and Alstom to fulfil two key contracts for the project.

Atlantic Wind Connection (AWC) is developing the New Jersey Energy Link and has signed an engineering, procurement and construction (EPC) contract with Bechtel. Alstom will be its HVDC technical advisor.

The New Jersey Energy Link will be an offshore electrical transmission cable, buried under the ocean, linking energy resources and users in northern, central and southern New Jersey. The cable will span the length of New Jersey and when complete could carry 3000 MW of electricity.

The link will be built in three phases over a decade. Alstom's and Bechtel's contracts are for the first phase of the project, which is expected to be in service in 2019.

#### Ovation win for CSP plant

Emerson Process Management has been awarded a contract to supply its Ovation control system to the USA's first commercial-scale concentrating solar power (CSP) plant equipped with molten salt storage technology.

The 100 MW Crescent Dunes project near Tonopah, Nevada is being developed by Tonopah Solar Energy, an affiliate of SolarReserve, and will be equipped with energy storage technology developed by Pratt & Whitney Rocketdyne.

Emerson's Ovation system will control the plant's water/steam cycle and the circuit and heating process of the molten salt system. It will also control auxiliary systems and supervisory control of the mirrors.

#### Voith secures Brazil upgrades

Voith is to upgrade three hydropower plants in Brazil after sealing deals with Tractebel Energia and Duke Energy.

The Heidenheim-based firm is to modernise the 1420 MW Salto Santiago and the 226 MW Passo Fundo power plants on behalf of Tractebel, and has signed a contract with Duke to upgrade the 414 MW Chavantes hydro plant.

At Salto Santiago, Voith will refurbish the plant's four turbines and generators as well as the electro-mechanical equipment and the automation system while at Passo Fundo it will modernise the two generating units, the automation systems as well as the governors for the turbines.

The Chavantes project covers the renewal of three generating units, including turbines and generators, and the associated electro-mechanical systems.

### Asia-Pacific

#### Alstom wins Dong Nai contract

Alstom and its consortium partner Hydrochina Huadong Engineering Corporation have been awarded a contract worth around €20 million by Vinacom Power Holding Corporation to supply electro-mechanical equipment for Dong Nai 5 hydropower project.

Alstom's scope of contract includes the design, manufacturing, delivery to site and supervision of installation of two 77 MW turbine-generator sets as well as electrical and mechanical auxiliaries.

Located on the Dong Nai river, Dak Nong and Lam Dong provinces, the Dong Nai 5 hydropower plant is part of the Vietnamese government's

Power Development Master Plan VII. The project is due to be commissioned in 2015.

#### Sri U Thing orders Alstom GIS

Alstom Grid has been awarded a contract worth over €4 million to install seven gas insulation substation (GIS) bays in southern Thailand.

The order was placed by Sri U Thong Ltd., which is building the Vibhavadi extension project on behalf of Thailand's Metropolitan Electricity Authority (MEA). Alstom will supply and supervise the installation of five 230 kV, one 115 kV and one 69 kV GIS bays.

The bays will be commissioned in April 2014 and will help MEA to meet the increasingly high electricity demand in the Vibhavadi area and surrounding Bangkok metropolitan region.

The contract is Alstom's second in the last year for Thailand's MEA.

#### Phu My 3 LTSA extended

Siemens Energy Service says it has signed an extension to its long term service agreement (LTSA) for the Phu My 3 combined cycle power plant in Vietnam.

The 740 MW power plant in Ba Ria-Vung Tau province began commercial operation in 2004. Under the contract extension, Siemens will service the plant's major equipment for a period of approximately eight more years once the gas turbines have reached 100 000 equivalent operating hours.

Phu My 3 was built on a build-operate-transfer basis by the Phu My 3 BOT Power Company, which is owned jointly by BP, SembCorp Utilities, Kyuden International Corp. and Sojitz Corp.

#### Metso wins NSW upgrade contract

Marubeni Power Development Australia Pty Ltd. has chosen Metso to upgrade the automation system at its Smithfield Energy Facility in Smithfield, New South Wales, Australia.

Under the contract, Metso will refurbish the 162 MW cogeneration plant's existing control system, with commissioning scheduled for June-August 2013.

The plant is operated by Marubeni Australia Power Services and produces energy for the national grid as well as process steam for an adjacent cardboard recycling plant. Metso supplied the plant's existing control system in 1996-97.

#### Jenbacher chosen for data centre

China National Petroleum Corporation (CNPC) has ordered five Jenbacher cogeneration systems for installation at a new data centre in the Beijing district of Changping.

The five 3.34 MW J620 cogeneration units will form the heart of a combined cooling and heating power plant and will meet the site's energy needs as well as supporting the regional grid.

The plant will serve as a model for other data centre projects in China and also supports the country's National Energy Administration's goal to build more distributed energy facilities.

#### MHI, Marubeni rehabilitate India plant

Mitsubishi Heavy Industries (MHI) and Marubeni have jointly signed a contract to rehabilitate a combined-cycle power plant in Auraiya, Uttar Pradesh state, India.

The two companies will rehabilitate the gas turbines and control systems at

the 663 MW power plant, which has been in operation since 1990 and which is owned by NTPC Limited.

The rehabilitation work is expected to boost the power station's installed capacity by 55 MW and extend its service life by more than 10 years.

### Europe

#### Mitsubishi, Eneco seal wind farm deal

Mitsubishi Corp. and Eneco have signed a deal to jointly build and run a wind power project off the coast of the Netherlands.

The 130 MW Luchterduinen wind-farm will be located offshore 23 km from the city of Noordwijk and will be equipped with over 40 wind turbines.

Mitsubishi will acquire a 50 per cent stake in the facility and the two companies have also signed a long-term partnership agreement that signals their intention to undertake further activities in the offshore wind energy sector.

The construction of the Luchterduinen wind farm will start in July 2014 and will be completed after the summer of 2015. Other partners in the project are Vestas, Van Oord, Joulz and TenneT.

As part of the partnership agreement, Mitsubishi has agreed to become a partner in Eneco's Prinses Amalia Wind Farm that was put into operation in 2008. The two companies say they will also discuss the potential for Mitsubishi's involvement in Eneco's wind projects in Belgium and the UK.

#### Fred Olsen orders wind turbines

Fred Olsen Renewables has placed an order with Siemens Energy for the supply of 25 wind turbines for the Mid Hill wind farm in Scotland.

The wind farm will be equipped with Siemens' SWT-2.3-93 turbines, which are due for installation in August 2013.

#### SVO orders biomass plant

Metso has signed a deal with Savon Voima Oyj to supply and construct a biomass-fired heating plant in Leppävirta, Finland.

Metso's turnkey delivery contract includes process equipment and buildings as well as installation and construction work. Metso will also supply a flue gas scrubber for the project.

The 8 MW plant will enter service in 2013 and will reduce SVO's consumption of oil. It will be fired by wood-based biomass sourced locally, such as forest residue and peat, and will produce hot water for the district heating network of the Leppävirta municipality.

#### 61 MW PV park on line

A 61 MW solar photovoltaic (PV) park in a former military field in Germany has started commercial operation, according to Trina Solar.

The PV module manufacturing firm supplied over 252 000 multi-crystalline solar modules to the Green Tower project in the German state of Brandenburg and says that the plant is now considered to be one of the most efficient PV parks in the world.

The Preschen airfield underwent a land conversion process before the modules, each with an average output of more than 240 Wp, were installed in rows extending for more than 1 km.

### International

#### ACWA-led group to build Rabigh power plant

ACWA Power International and its partners have won the bidding to build a \$2.6 billion power plant on Saudi Arabia's Red Sea coast, according to

local reports.

Saudi Electricity Co. (SECO) awarded the contract to the ACWA-led group, which includes Samsung C&T Corp., to build and operate the Rabigh II IPP. The facility will have a capacity of 1813 MW and is to start operating in the summer of 2016.

Financing arrangements for the deal are to be complete by the end of March 2013.

#### Alstom signs Libya parts deal

Alstom has signed an accord with General Electricity Company of Libya (GECOL) to supply spare parts for gas turbines operating at power plants in the North African country.

The deal includes parts for 11 gas turbines located at five power plants as well as a package of strategic spares for use across GECOL's installed base. Delivery of the parts is scheduled for 2013 and 2014.

Alstom gas turbines account for more than 50 per cent of GECOL's installed based, according to the French engineering firm.

#### ABB supplies Saudi switchgear

ABB has won an order to design and deliver 420 kV gas insulated switchgear (GIS) that will facilitate the supply of power to a new desalination facility and support the grid integration of a new 2.5 GW power generation plant in Saudi Arabia.

The order was placed by Al Fanar Group and will help Saudi Arabia address its increasing need for water and electricity.

#### Wärtsilä signs LTSA

Wärtsilä says that it will provide service support and parts to the world's largest tri-fuel power plant after signing two long term service agreements (LTSA) with KEPCO Plant Service & Engineering Co.

The 573 MW Al Manakher power plant in Jordan is owned by Amman Asia Electric Power and is expected to start operating in February 2014. Wärtsilä has signed a 15-year parts supply agreement as well as a five year technical service agreement.

A Wärtsilä-led consortium is building the power plant, which will comprise 38 Wärtsilä 50DF engines capable of using heavy fuel oil, natural gas and light fuel oil.

#### Alstom equips Ethiopia dam

Alstom has signed a contract with Metals & Engineering Corporation (METEC) to supply turbines and generators for the Grand Renaissance dam in Ethiopia.

Located on the Blue Nile River, the 6000 MW hydro plant will be operated by Ethiopian utility EEPSCO and will be the largest hydropower project in Africa.

It will quadruple Ethiopia's current electricity production capacity and help the country to become a key regional player in power generation.

Alstom will supply and supervise the installation of all electromechanical equipment for the plant, including eight 375 MW turbines and eight generators for the first phase.

The contract also includes engineering and power plant commissioning. Jérôme Péresse, President of Alstom Renewable Power commented: "Alstom... is willing to play a major role in developing Ethiopia's energy sector, enabling the country to drastically increase its power production capacity and develop local skills."



## Oil

# Crude market starts new year on healthy note

- Saudi Arabia cuts production
- Swings expected in China's demand

David Gregory

The US government's fiscal cliff dilemma during the last days of December, a cut in Saudi Arabia's crude production and the attack on Algeria's In Amenas gas facility in the Sahara Desert in mid-January pushed crude oil prices into a higher range as markets moved into the new year.

West Texas Intermediate (WTI) crude was around \$95/b in mid-January, up by nearly \$10/b from mid-December. Brent has moved between \$107/b and \$111/b during the mid-December/mid-January period.

Crude prices increased towards the end of 2012 due to strong winter demand and geopolitical concerns, the Paris-based IEA said in the January edition of its *Oil Market Report*. Meanwhile, the price of the Opec reference basket averaged \$109.45/b in

2012, up by \$1.99/b over the 2011 average of \$107.46/b. Opec stated in its latest *Monthly Oil Market Report*.

The IEA said global oil markets tightened in December as China's demand for crude rose and Saudi Arabia cut production. The agency said the drop in Saudi output is nothing for world markets to worry about, as it was essentially a fall in domestic electricity demand and refinery maintenance.

Some analysts saw the cut in Saudi output – to 9.025 million b/d in December – as a move to adjust market supply and keep prices in the \$100/b range in the face of rising Iraqi output and growing volumes of US shale oil. Saudi production averaged 9.49 million b/d in November.

But the Saudi Ministry of Petroleum issued a statement saying that Riyadh did not cut production in order to influence prices. "Recent media reports wrongly interpret Saudi Arabia's

production data for December, accusing the country of a deliberate attempt to push the oil price higher," the statement said. "These reports are categorically wrong. Saudi production fluctuates month to month, and depends on a range of domestic, regional and international factors. At this point in time, production is primarily driven by customer requirements, not by price levels. It is the market which sets the price of oil."

On China, the IEA said swings in demand – in both directions – could be expected because of elevated debt levels and economic uncertainties.

World demand is forecast by the IEA to reach 90.8 million b/d in 2013, while non-Opec supply is projected to average 54.3 million b/d this year. Demand for Opec crude in 2013 is expected to average 30 million b/d.

Demand for Opec crude during 2012 averaged 30.1 million b/d the organi-

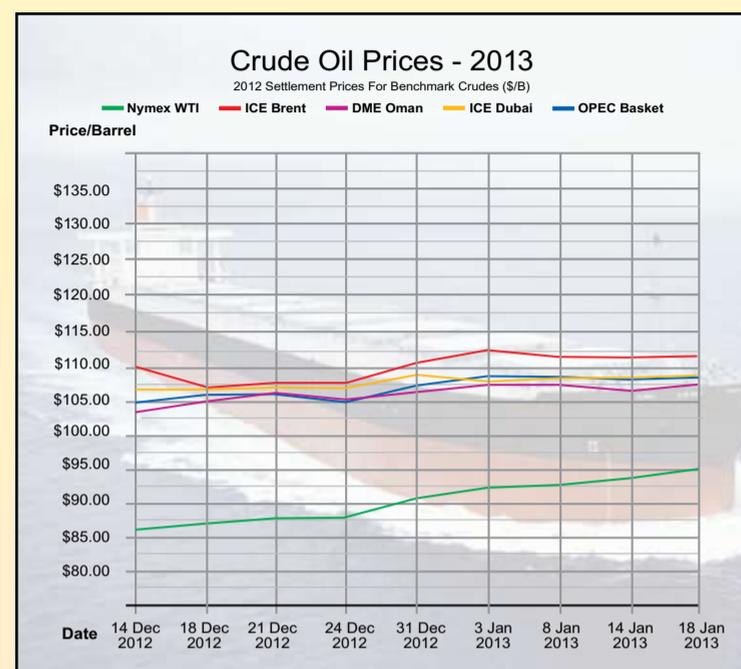
sation said in the latest report. Opec forecast crude demand for 2013 to average 29.6 million b/d. It said that world oil demand in 2012 averaged 88.80 million b/d in 2012 compared with 88.04 million b/d in 2011. And it reported that 2012 crude demand in the OECD countries averaged 46.11 million b/d compared to 46.50 million b/d in 2011. OECD demand in 2013 is forecast to average 45.90 million b/d, while global demand this year will average 89.55 million b/d, according to Opec's estimations.

Amongst Opec members, total production averaged 29.785 million b/d in 2011 compared to 30.365 million b/d in 2012. Most of this increase was due to Libyan production coming back on-stream after the civil war that removed Qadhafi from power. Iraq, Kuwait and the UAE saw significant increases in output during last year, but the biggest loser was Iran, which saw

output fall from 3.628 million b/d in 2011 to 2.656 million b/d last year as a result of international sanctions leveled against it because of its nuclear power programme.

In its monthly *Short-Term Energy Outlook* (STEO), the US Energy Information Administration (EIA) reported an improving energy situation for the US. It said total crude oil production averaged 6.4 million b/d in 2012, a rise of 0.8 million b/d over 2011. It forecast that US crude production would rise to 7.3 million b/d in 2013 and to 7.9 million b/d in 2014, "which would make the highest annual average level of production since 1988," it said.

Demand for crude oil and liquids increased by 0.9 million b/d in 2012 to 89.2 million b/d, the EIA said. The EIA forecast that global demand would reach 90.1 million b/d in 2013 and 91.5 million b/d in 2014.



## Gas

# Support grows in US for LNG exports

The US has yet to decide on whether to export LNG but there is a growing argument that says gas exports would help create jobs and reduce the country's debt.

Mark Goetz

Support is growing in the US among businesses and economic think-tanks in support of exporting natural gas in the form of LNG. The administration of President Barack Obama has yet to decide on dozens of applications to export LNG to non-free trade agreement (FTA) countries, but an argument is rising in the US that says gas exports would work wonders in creating jobs and reducing the country's debt.

In mid-January the US Chamber of Commerce issued a statement quoting Chairman Thomas Donohue urging the US government to take advantage of the "historic opportunity" that now presents itself in order to "swiftly and responsibly" develop American energy.

The US is now in a position to export LNG and coal, Donohue said, noting that this would reduce the country's trade deficit and bring billions of dollars to the US. "The abundance of affordable natural gas is attracting good manufacturing jobs back to America, particularly in the chemical and steel

industries," Donohue said. "All of this adds up to a lot of jobs, growth, improved national security, and more revenues for government."

Other top officials at the Chamber expressed their support for LNG exports. Bruce Josten, Executive Vice President for Government Affairs argued that there should be no restrictions, as some major US companies are wanting. "We clearly should be establishing mechanisms to export natural gas," Josten said in the statement, noting that the US is a member of the WTO and that it prohibits restrictions on exporting raw materials. "We can't go around the world lecturing and encouraging other countries to open up their markets and then turn around and close ours on raw material that we have boatloads of," he said.

And the head of the Chamber's energy institute Karen Harbert said: "Natural gas is an emerging global market and it doesn't make sense to remove ourselves from it."

But several large American companies have formed an interest group that opposes unrestricted natural gas

exports, arguing that exporting large volumes will cause the price of natural gas in the US to rise to an extent that it will erase any economic benefits to US manufacturing.

The newly-formed American Energy Advantage (AEA) group includes heavyweight companies such as Dow Chemical, Alcoa, Eastman Chemical, Celanese, Nucor, Huntsman and the American Public Gas Association among those firms that want to see American gas retained for domestic use, arguing that its position will best serve the US economy. The AEA's position is that unlimited shipments of LNG to foreign businesses will create a stronger demand within the US for natural gas and thus raise domestic prices and therefore threaten investment in US manufacturing.

Support for LNG exports by the National Association of Manufacturers and the American Chemistry Council have prompted some AEA members to threaten to end their own memberships in those organisations.

Gas producers have meanwhile formed their own lobby group, hiring

former secretaries of energy Bill Richardson and Spencer Abraham to promote gas exports.

A report recently released by the Department of Energy on the impact of natural gas exports on the US economy said that LNG exports would have a positive effect on the US economy and that it would not cause a big increase in the domestic price.

There are now about 20 proposals for LNG export facilities in the US. So far, the US Federal Energy Regulatory Commission (FERC) has approved only one export plant – for Cheniere Energy at Sabine Pass in Louisiana. Several export plants have also been proposed in Canada.

The chief economist at the American Petroleum Institute (API) John Felmy said during a press conference last month that LNG exports are "indisputably" in US national interest.

"The US DOE should approve pending authorisations for exports of gas without delay," he said, adding that LNG exports would boost US economic growth and create jobs.

Furthermore, a study carried out by

Deloitte MarketPoint said that US LNG exports would accelerate a transition away from oil-linked gas delivery contracts in the global LNG markets, putting downward pressure on LNG prices.

The study said that prices of LNG would likely decrease in regions that import US LNG while in the US domestic prices would increase only marginally. It said that gas prices in the US would rise only by \$0.15/million BTU between 2016 and 2030 because of the country's large reserves and its ability to increase production to meet demand.

Should the US wind up exporting as much as 45 million tons per year by 2020, it would not only impact prices in the gas market but would also have political ramifications that would benefit US allies, especially in the OECD, according to US political analysts. US LNG exports would provide many gas importers with a new source of supply and thus make them less dependent on countries that have used their hydrocarbon resources in political ways, they say.

# Closing the energy gap

A lack of investor confidence is at the heart of meagre generating capacity. But plenty can be done to reduce risk in the region, and creating robust and fair regulatory regimes is a good place to start.

**Prem Mahi**

**W**ith its coal deposits, abundant sunshine and wind, and vast lakes and rivers, sub-Saharan Africa could be the world's power plant. Its natural resources could provide enough energy to create booming economies and fully electrified populations in all of its 48 countries.

The unkind reality, however, is that despite being an enormous region with a population of almost 900 million, sub-Saharan Africa's total installed generation capacity is smaller than South Korea's, at only 68 GW. If South Africa is discounted, installed capacity shrinks to a meagre 28 GW, and problems including lack of maintenance mean that as little as 75 per cent of that figure is thought to be currently available for generation.

These figures are dismal when one considers the International Renewable Energy Agency's estimate that Africa as a whole could potentially generate 19 672 TWh annually from renewable technologies alone – more than 54 times the annual consumption of the UK – with a great deal more potential available in coal, oil and gas. Undeniably, a profound chasm exists between sub-Saharan Africa's installed capacity on one side, and its potential on the other.

A lack of investor confidence is at the heart of the problem – for many financiers, sub-Saharan African projects carry unacceptable risk. The World Bank reports that utilities are struggling with system losses, poor collection rates, opaque cash flows, sub-economic tariffs and subsidies, unclear regulation, political pressure from governments and inadequate human resources – all of which tend to leave investors unconvinced of utilities' commercial viability. Political instability in the region further exacerbates financial risk and discord between individual countries can inhibit sustained cooperation on infrastructure projects.

Power purchase agreements (PPAs) – which typically commit a utility to buy power from an independent power producer (IPP) over a long term contract period, thereby guaranteeing future revenue from the project – should reassure investors. However, payments are not always affordable and many utilities have poor credit ratings, meaning the presence of a PPA does not

necessarily mollify investors.

With many large hydro projects and long distance transmission lines costing intimidating sums, financiers are easily dissuaded. But creating investor confidence by reducing risk is fundamental to attracting private finance on the scale necessary to close the region's energy gap.

Plenty can be done to reduce risk in this region, and creating robust and fair regulatory regimes is a great place to start. Although many countries have now established regulatory bodies for power they vary in their capacity, transparency and independence from government. Forming and empowering appropriately mandated regulators will require a great deal of time, funding, expertise and political will. Happily, there is help at hand in the shape of funding, training and twinning schemes from institutions such as the African Development Bank which are keen to get sub-Saharan African regulatory bodies up to standard. Consultants like Mott MacDonald can also play a part as advisors and facilitators.

However, maintaining regulators' integrity for future years is perhaps the bigger challenge, in the face of daunting issues such as making tariffs more sustainable. This politically sensitive challenge is further complicated by the question of how many consumers could actually afford cost-reflective energy prices. The World Bank has proposed that many utilities provide subsidies to customers that do not strictly need them, and so a reallocation of subsidies could enable the setting of more economic tariffs.

But the path is thorny. Successful reform could pay off in the form of improved financial stability and increased investor attention, but a misstep could quickly put both utilities and the public in a worse position than they are now. Complex tasks like this mean that good intentions for regulation can be weakened or compromised following the initial regulatory cycle – and so government commitment and resourcing must be firmly sustained for decades.

Experts agree that regulatory reform will require careful tailoring of regulation to each country's particular circumstances, achieved over many years of unhurried work. But this does not mean that positive results cannot be achieved in the shorter term.

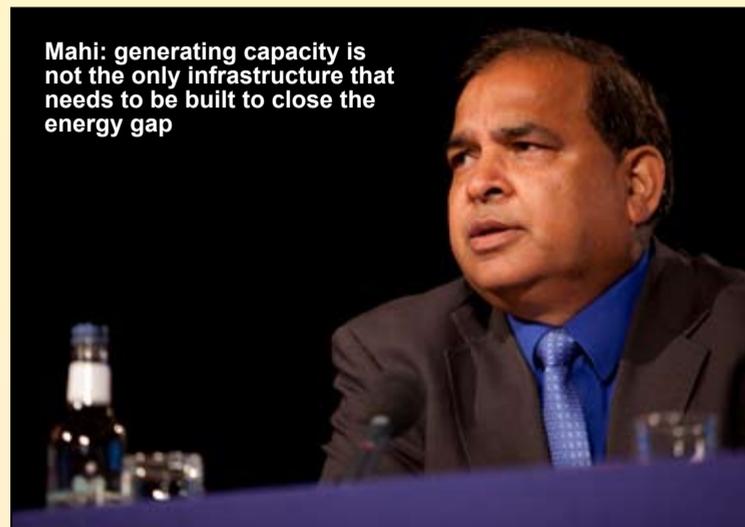
Uganda's Bujagali Hydroelectric Project is a good example of how investor confidence can be nurtured in the current climate – and indeed it is one of the only examples of a major private sector hydropower project being successfully completed in Africa in the past 20 years. The Ugandan government and the World Bank managed to create sufficient confidence for the project to reach financial close with a syndicate of development banks.

The measures employed included devising the concession agreement and PPA so that many cost risks were passed to the government with support from the World Bank, and using World Bank partial risk guarantees to underwrite the purchase and payment obligations of the electricity offtaker. The project was successfully completed in 2012.

South Africa's Renewable Energy Independent Power Producer Procurement (REIPP) programme is another example of a government helping things along. The REIPP facilitates the development of 3725 MW of renewable generation capacity by asking developers to bid against each other in Rounds.

Each Round requires preferred financial

**Mahi: generating capacity is not the only infrastructure that needs to be built to close the energy gap**



commitments by signing an implementation agreement with the South African Department of Energy, making a PPA and connection agreement with utility Eskom, and achieving financial close.

By proving its commitment to renewables, the government is creating confidence among investors that they will be welcomed in the market, and the bidding process ensures projects are as price competitive as possible.

The successful financial close of Round 1 in November 2012 and the subsequent start of construction have further boosted investor confidence for future Rounds.

There is also evidence of investor confidence to be found in activity to develop thermal projects such as Jorf Lasfar in Morocco, the Tema project in Ghana and the Mmamabula plant in Botswana, with the added benefit of finance coming from commercial banks who subscribe to the Equator Principles – a risk management framework that ensures projects are socially and environmentally responsible.

And emerging economies such as China are providing a steady influx of investment in generation projects – particularly large hydropower – using 'Angola mode' deals in which infrastructure loans are repaid with natural resources such as oil. Such deals typically require that the financing country's manufacturers and contractors are used on the project.

This model allows for higher investor confidence because the investment generates lucrative opportunities for the investing country's industries, brings natural resources into that country, and means that African countries without strong financial guarantees to back their borrowing are more able to make repayments. In fact, China has such confidence in this model that in 2006-07 the World Bank estimated Chinese financial commitments to African infrastructure at a hefty \$6 billion per year.

Critics have questioned the quality of Chinese-built infrastructure and the liberal environmental conditions attached to Chinese loans, and only time will tell whether this type of financing will still be available, or desirable, in decades to come. But for now this funding model is prevalent in African countries, gets projects to completion, and shows no imminent sign of drying up, and so it has a part to play in meeting Africa's infrastructure financing needs.

Generating capacity is not the only infrastructure that needs to be built in order to close the energy gap in sub-Saharan Africa. Power transmission and distribution infrastructure is weak in capacity, reliability and geographical

reach, putting physical limits on the region's ability to access markets domestically, continentally and overseas.

The business case for expanding and upgrading this infrastructure needs to be examined, and in some cases it may not be economic to do so – but it is easy to imagine the dramatic difference that better networks could make to the region.

Higher capacity transmission lines could support major plants with large, 800 MW machines across sub-Saharan Africa – in contrast to the current situation, where only South Africa can support machines of this size while other countries are limited to machines of around 150 MW. With larger machines would come greater cost efficiency for utilities, more reliable supply for industrial consumers, and reduced carbon emissions.

Like the canals and railroads of the Industrial Revolution, an upgraded transmission network could therefore enable more industrial activity in more places – with economic benefits for local communities.

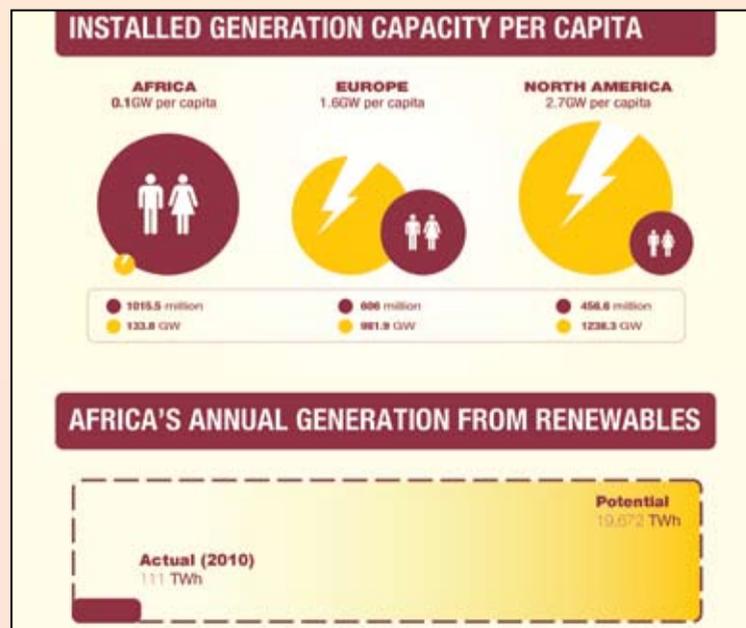
Likewise, a focus on building gas capture infrastructure could create access to new fuel sources and thus new generation opportunities. For example, in Rwanda Mott MacDonald is overseeing the development of innovative technologies to extract useful methane from the biological and geological gases trapped in Lake Kivu. The project would prevent dangerous gas releases from the lake-bed while potentially increasing Rwanda's generating capacity from 100 MW to 350 MW.

Meanwhile, in Nigeria Mott MacDonald has provided detailed engineering design on one of Shell Petroleum Development Company's numerous projects to eliminate waste from gas flaring. New infrastructure is allowing Shell to recover 200 million standard cubic feet of gas from three oil fields each day, alleviating environmental damage and creating a new income source worth more than \$200 million annually.

If investor confidence can be cultivated in sub-Saharan Africa, all types of infrastructure projects will become eminently more attainable than they are now. Whether a generation, gas capture or transmission project, each positive investment experience that a financier has in Africa will augment investor confidence a little more – and allow the current green shoots of activity to grow faster and stronger towards minimising the energy gap.

*Prem Mahi is Divisional Director of Energy at global management, engineering and development consultancy, Mott MacDonald Group Limited.*

**Despite having a population of almost 900 million, sub-Saharan Africa's total installed generation capacity is a meagre 28 GW. Africa as a whole could potentially generate 19 672 TWh annually from renewable technologies alone**



# Solar export from North Africa to Europe: no longer a mirage

The TuNur project in Tunisia is shaping up to become the first gigawatt-scale solar export project between Tunisia and Europe.

Dr. Till Stenzel and Kevin Sara

The European power mix is radically changing. Several countries have decided to phase out nuclear power (or not to introduce it), while tough European environmental legislation, coupled with local NIMBY (not in my backyard) protests makes it ever harder to build new conventional power plants.

At the same time, more and more intermittent renewable energy technologies such as photovoltaic (PV) and wind are added to the electricity mix, increasing the need for flexibility in the power system and making new interconnections ever more important.

The summer of 2012 showed that even the traditional periods of peak power demand no longer coincide with peak power pricing. In Germany on sunny days, about 20 GW of PV injected electricity into the network during the peak periods mid-day, depressing wholesale market pricing. Similar trends can now be witnessed in Italy and Spain.

Against this backdrop, electric utility companies and governments alike have increasingly evaluated the opportunity to introduce concentrating solar thermal power (CSP) supply into the European power mix.

What makes CSP technology so attractive is the fact that they can deliver dispatchable power, a feature that intermittent PV and wind cannot offer in the

absence of economic large-scale electricity storage systems. CSP plants can either store heat captured during the day for release "on-demand" for additional power production when the sun is not shining or they can be co-fired with bio-fuels or fossil fuels to extend operating hours and smoothen the production profile during cloudy days.

However, there are few sites for large-scale installations of CSP in Europe due to the limited solar radiation potential and the lack of large-scale sites for >100 MW plants. Yet, ever since the development of the Desertec concept, it has become increasingly clear that the abundance of high solar radiation coupled with the availability of vast areas of desert land makes CSP a viable option on the southern side of the Mediterranean in North Africa.

The potential is enormous, not just for regional electricity supply in the Maghreb region, but also for exports from North Africa to Europe. The numbers are simple: Just 0.3 per cent of the North African desert surface area could serve the entire Europe-Middle East-North Africa (EU-MENA) electricity demand. HVDC electricity transmission technology is mature and makes long-distance electricity transmission feasible at low losses (around 5 per cent over 1000 km).

First utility-scale projects are being realised. A 160 MW concentrating solar power (CSP) project, including three hours of thermal storage, has been fully approved and financed at the Ouazazarte site in southwestern Morocco. The project leaders are ACWA Power of Saudi Arabia together with two Spanish engineering partners. A financing package from leading multilateral banks, including the European Investment Bank (EIB), the World Bank and the African Development Bank, has been secured alongside a 25-year PPA.

However, while Ouazazarte aims at the domestic Moroccan market, the TuNur project in Tunisia is shaping up to become the first gigawatt-scale solar export project between Tunisia and Europe. TuNur takes advantage of several factors – rapidly falling costs of CSP technologies, a solar resource-rich site in the Tunisian desert, and a close link to the import-dependent Italian power market.

TuNur has already achieved several milestones. Technical planning began in 2009, and by 2010 a target site was identified and a solar-radiation measurement station installed to verify data from satellite-based solar resource data providers. Environmental impact studies and geotechnical studies were completed later that year and after the political change of the Arab spring, a full project proposal was submitted to the new Tunisian government in 2011. The Desertec Foundation has officially endorsed the project.

At the same time, a dedicated cable route between the project site and the Italian coast was identified with support by marine engineering specialists Intertek Metoc, and based on work by expert engineering consultants CESI in Italy, an interconnection point on the Tyrrhenian coast in Italy was chosen, and later approved by Terna S.p.A, the Italian grid operator. Hence, TuNur already has a grid connection solution provided by Terna, which can accept up to 2000 MW on the Italian



TuNur overview of solar energy production and electricity export link to Italy

network without the need for lengthy grid reinforcements or upgrades.

TuNur is currently in detailed discussions with the Tunisian government over an investment framework agreement for the TuNur project in Tunisia. This will establish the legal, fiscal and environmental framework for the project implementation, thus providing the investment certainty required to realise the project.

Under the current timetable, project engineering and the project consortium will be ready in the second half of 2014, with project financial close scheduled for the first half of 2015. Multilateral banks will be a cornerstone investor to the project, with the African Development Bank and the World Bank Group already actively engaged in the project's evaluation. Discussions have begun with commercial banks and selected strategic equity investors.

What are the benefits and costs of the electricity delivered to the Italian network?

CSP systems are now being built in the USA for power purchase agreements (PPAs) in the \$0.15/kWh (about €0.11/kWh) range, and are expected to fall further once the first power plants have started operations and next generation designs are under way. NREL/Sandia Laboratories estimates that solar tower CSP technology can reach \$0.078/kWh (including a 10 per cent tax credit) in the USA by 2020. Translated to the solar conditions of North Africa, and excluding the tax credit, this still leads to cost levels of around €0.08/kWh.

Furthermore, the flexibility of CSP technology means that for the same energy collected, CSP can produce electricity under various configurations to match different types of load. Thermal storage design of the plants is optimised so that the energy stored is released when it is the most economic and profitable to dispatch the power plant. Hence, CSP design is closely developed with future clients of the electricity output. This flexibility has a value, which has been estimated in a range between \$16-\$40/MWh (approximately €13-€32/MWh) in California.

Furthermore, a detailed study with Imperial College, London, and DNV Kema, the consultants, has shown that the advantageous production profile of CSP with storage, coupled with the strong interconnection point in Italy, delivers significant grid integration benefits from a system perspective.

The capacity value of TuNur is calculated at 95 per cent – close to conventional power plants. Adding to that a strongly interconnected grid with >11 GW of capacity between Northern Italy and its neighbours, and it has been demonstrated that solar exports into Northern European countries can deliver savings in terms of reduced grid extension requirements due to offshore wind, and lower system operating costs.

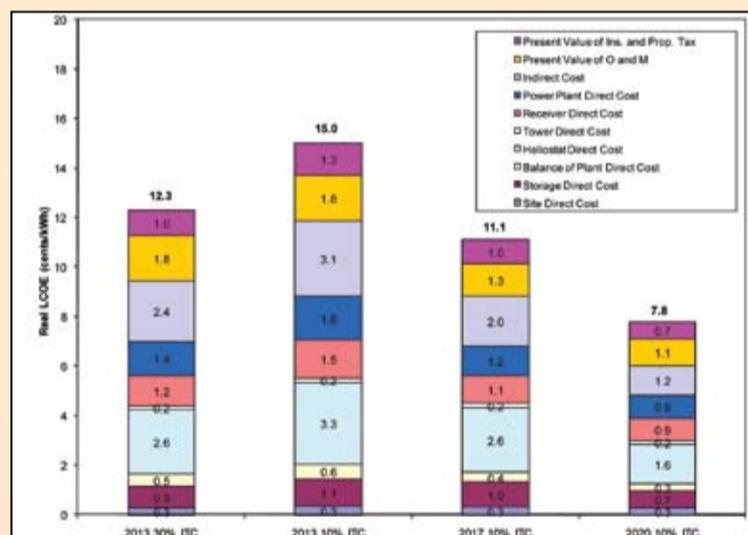
One scenario, showing a displacement of 3.4 GW of offshore wind in the UK and Germany by TuNur, yields savings from over 2.5 GW in reduced transmission extension requirements, as well as from lower system operating costs due to less demand for balancing and ancillary services on the grid.

Several EU governments are evaluating the option to strategically expand their renewable energy portfolios with imports. The EU's Renewable Energy Directive 2009/28/EC has already provided the framework for such imports, but it is down to individual member states to transpose these provisions into national law.

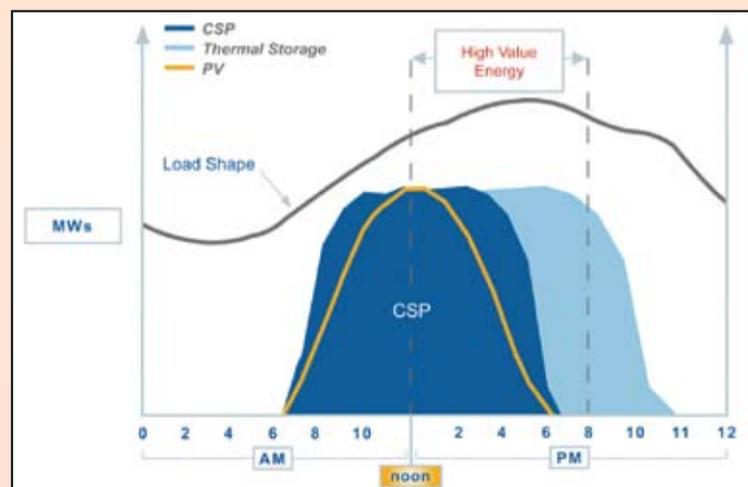
Already, the Secretary of State in Germany's Federal Ministry for Economics and Technology, Stefan Kapferer recently declared that Germany would support first solar export projects in order to demonstrate the feasibility of this approach and to act in partnership with other EU member states and the EU commission. And while Germany has already plenty of intermittent wind and PV installed at home, CSP is simply not an option in this Northern part of the hemisphere. While a first intergovernmental declaration for solar exports from Morocco was slowed down by the economic crisis in Spain, discussions, also including France and Italy, continue.

Although some regulatory and commercial issues remain, progress is rapidly being made on all fronts, and TuNur could represent the very first large-scale utility-scale solar export project. With the first tranche of 1000 MW of capacity targeted to go into construction in 2015, the Desertec vision is finally moving "from power point to power plant".

Dr. Till Stenzel and Kevin Sara are CEO and Chairman, respectively, of TuNur Ltd., a South-North partnership between a group of Tunisian investors led by TOP Group and Glory Clean Energy (50%) and UK-based Nur Energy (50%).



Expected LCOE of solar tower systems 2013-2020 (including investment tax credits (ITCs) of 30 per cent and 10 per cent respectively). Source: Sandia Laboratories, 2011



Matching CSP electricity production to peak pricing periods, due to the use of thermal storage

## Technology

# Breaking the current approach

It has been 100 years in the making but the development of a circuit breaker that is able to break high voltage direct current could offer new possibilities for utilities building the grids of the future.

## Junior Isles

**T**he war of currents: alternating current (AC) versus direct current (DC) goes back 100 years. It was a battle that AC eventually won.

In November last year, however, ABB made a breakthrough that could change the existing electrical transmission system. Following years of research, ABB has developed the world's first low loss hybrid circuit breaker for high voltage direct current (HVDC).

This breakthrough removes one of the major technical barriers to the development of a DC grid and paves the way for the efficient integration of renewable energy and improving the reliability and capability of existing AC grids.

Commenting on the breakthrough, Claes Ryttoft, Chief Technology Officer, for ABB's Power Systems division, said: "There were two main reasons why AC conquered the world: firstly, the availability of an AC transformer, which allowed voltage levels to be changed, and secondly, the circuit breaker, which made it possible to protect the lines and build grids. There was no breaker for DC, and the equivalent of a transformer basically does not exist."

The reason it is so hard to break DC compared to AC comes back to the fundamentals. As AC oscillates between positive and negative, the current passes through zero twice during a complete cycle. AC breakers are based on the ability to switch or break when the current passes through the zero point. This means it is possible to break the circuit when the energy level is at zero or at a minimum, thus avoiding a large arc.

With DC, there is no zero crossing. This means any breaking has to be done at full load, resulting in arcing. There have been many attempts to build DC breakers over the last 100 years, and although there are commercial DC breakers that can break at full current, 3 kV seems to be the upper limit.

"Even if you compare AC and DC breakers at 50 V, the design is different because you have to find a way of extinguishing the arc," noted Ryttoft. "We have developed a breaker that is

initially designed to break direct currents of up to 320 kV, clearing a major technology hurdle in building a DC grid."

Through the use of power electronics, it has been possible to break currents at high voltages for a number of years. However, the solution has not been commercially viable due to the high losses.

ABB says its hybrid breaker combines the low losses of a mechanical breaker with the breaking capabilities of a power electronics breaker in a single device.

As with many breakthroughs, development of the breaker started with a perceived market need.

HVDC, which has been around since the 1950s, has several advantages over AC. In addition to higher power transmission capability over long distances with minimum losses, it has a smaller footprint and cables can be run underground or underwater. But with no way of transforming voltage levels or breaking the circuit, almost all of the installations have been point-to-point connections. Therefore, although there has been a DC grid vision around for a while, technical feasibility has been one of the stumbling blocks.

However, the massive addition of wind and solar in recent years, especially in Europe, has seen an increased need for grid reinforcement as utilities try to transfer electricity from renewable installations to major load centres. In the face of huge permitting challenges to build new overhead lines, utilities have looked at the possibility of converting AC lines to DC to enable greater throughput. But it is a solution that has its challenges.

Ryttoft explained: "In AC, there are three phases, so you need four wires (including neutral or zero). You only need two for DC. Also, the constant current in DC versus the oscillating current in AC means that the throughput of DC can be some 20-30 per cent higher for the same cable. However, DC links are point-to-point, so if the link goes down all power is lost. This has prompted the need for a breaker that is fast, efficient and reliable."

ABB began patent work on the new

## Laboratory tests have been successfully performed at currents of several thousand amps

technology around 2007-2008, which was then followed by a specific development project. This started with an overall design, which was followed by a programme to develop the components needed for mechanical switching and the power electronics. These components were verified individually before being put together as a complete hybrid breaker system.

Ryttoft compares the challenge of breaking an HVDC circuit to stopping a high speed truck in a very short time – 30 times faster than the blink of an eye – and taking care of the resulting dissipated energy. The hybrid breaker essentially consists of three key elements: two power electronics breakers – one large and one small; and a mechanical breaker.

The large electronic breaker sits in the lower current path while the smaller electronic breaker and the mechanical breaker are in the upper current path. Under normal operating conditions, both paths are in operation and current attempts to flow through the path of least resistance i.e. the upper path.

When the hybrid breaker is switched, the breaking process is carried out in three stages. In the first stage the small electronic breaker in the upper current path is opened for a very short period of time. This forces current through the large power electronics breaker in the lower path. Then during the few milliseconds when there is low or zero current in the upper path, the mechanical breaker is opened in the second stage to completely block the upper path. In the last stage, the large power electronics breaker opens to cut off the alternative current pathway as well.

Ryttoft added: "We have a very short time period because the small electronic breaker can only withstand the voltage for a few milliseconds. This breaker, which is small so losses are low, works with a very fast acting mechanical breaker capable of switching before the small power electronics breaker is destroyed. So a key element was to make a very fast mechanical breaker. Once the mechanical breaker is open, we can then open the large power electronics breaker, which does the actual breaking. The full sequence takes just 5 ms."

A prototype has been built successfully and its functionality was successfully verified in the laboratory in October last year. "This," says Ryttoft, "means we know we can build one. There have been many attempts in the past to break DC but this time I feel we have a solution

that will work."

ABB says the laboratory tests have been successfully performed at currents of several thousand amps with a breaking sequence of around 5 ms.

Ryttoft noted: "The challenge has been to get down to these millisecond levels, or the concept would not work. This is important not just to protect the semiconductors, but from a system point of view as well. If there is a ground fault in a DC line, the current rises extremely fast. So to protect the equipment, the breaker has to have a very short reaction time."

Ryttoft stressed that the complete development programme is much bigger than just the DC breaker. "The breaker is just one component, although an essential one. Control, for instance, is another key element."

He says, however, that DC grids would not replace AC grids but would be "embedded" in the existing grid. "In Europe, much of the discussion has been about the next level of overlay grid and this could well be a DC grid. We have therefore been spending a lot of effort and money to try to understand the interaction between AC and DC," said Ryttoft.

The company has built a special purpose simulation centre in Sweden, which it says allows it to simulate AC and DC grids in real-time and the interaction between them. "The idea is to develop control strategies for a future HVDC grid. This is something that utilities will need," he added.

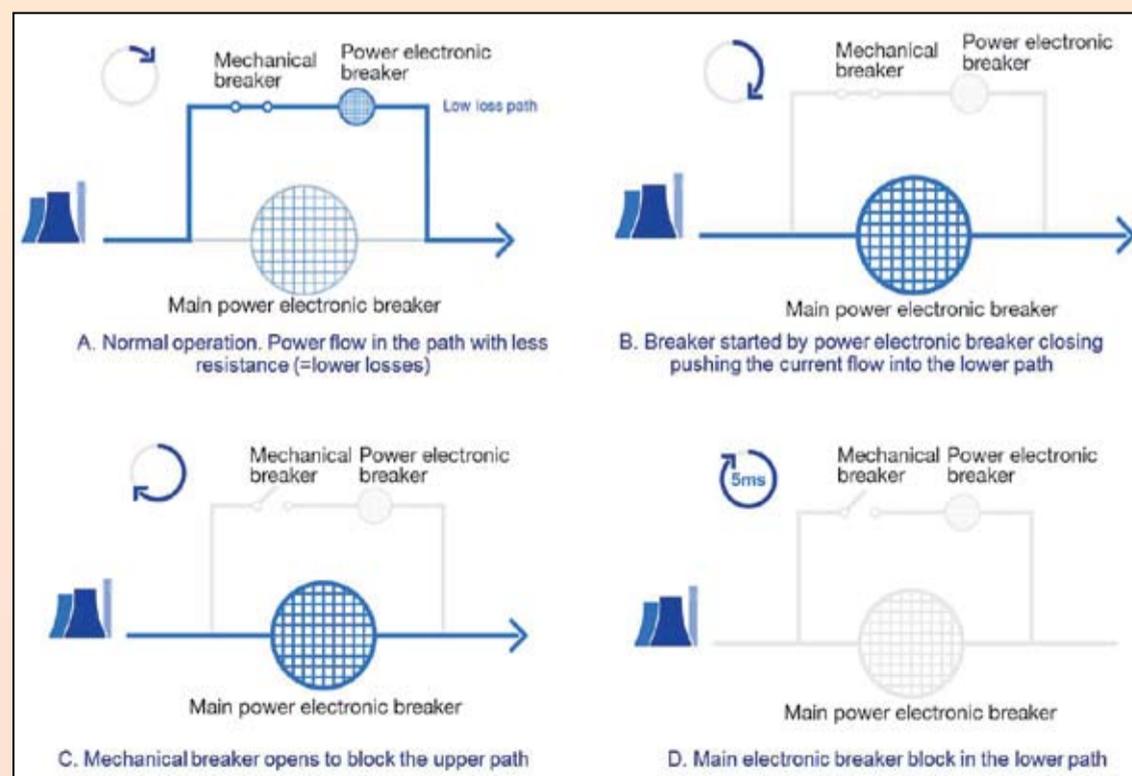
With the new hybrid breaker concept verified, the next step is to implement a pilot to see it operate under real conditions. ABB says it is currently in discussions with a few utilities for such a pilot.

"We are discussing with utilities in several locations. Having an existing HVDC line will shorten the timespan. We expect to have a pilot in 12-18 months from now, which will provide operational experience. And then we should hopefully see the first commercial hybrid breaker in operation in around five years," said Ryttoft.

The cost of a commercial hybrid breaker is expected to be more than a corresponding AC breaker but ABB says it should present a commercially viable solution when considering the overall scheme.

It may be some decades before the full value of the hybrid breaker and a DC grid are realised but as Ryttoft summarised, "now that utilities know it is possible to make a DC breaker, they can start planning for the future".

## Operation of the hybrid HVDC breaker





Junior Isles

# Harder than you think

Following the use of their hard-hitting track, *'Harder Than You Think'* during the UK's television coverage of last year's Paralympics, legendary rap music group Public Enemy seems to be once again experiencing a taste of the popularity it enjoyed some 25 years ago – no doubt finding new fans in unexpected quarters.

It is unlikely that the International Energy Agency's chief economist Fatih Birol is part of that new fan-base – and I doubt he has ever been a follower of militant hip-hop culture – but in a different time and place, who knows? Like Public Enemy, Birol is never afraid to go against the grain – comfortable to call it as he sees it, regardless of the audience.

Speaking at last month's *World Future Energy Summit* in Abu Dhabi, Birol was one of the few brave enough not to give the same sugar-coated message that was so often regurgitated by many of his peers.

"I followed the discussions yesterday

of the ministers and companies and take great pleasure in the achievements of governments and success stories of the renewable companies... but I can tell you, my message will be very different," he said. "I do not currently see an enthusiastic context for renewables. I cannot even say that I am very optimistic when I look at the global energy picture and renewables in general. I have question marks in my mind."

Global investment in renewables fell last year as a result of the global downturn but the problem is more than just a tough economic climate. As Birol pointed out, "renewables is not an island" in the energy mix. According to the IEA, in the last five years renewables accounted for 15 per cent of the global energy use. This compares to 47 per cent for coal and nearly 30 per cent for natural gas.

Birol described a global energy system whose "foundations are shifting rapidly and in a significant manner". He described three major shifts, one of

which has been in oil and gas.

Like Public Enemy, the oil and gas industry has made a comeback. In the last 18 months it has made a resurgence in some unexpected countries like the US, Canada and Iraq. "Oil and gas production in the US is very impressive," Birol told delegates.

According to the IEA, the US will be the world's largest oil producer by 2017, overtaking Saudi Arabia, and

impact of subsidies and government promises to reduce them, there was still a substantial level of renewables subsidies in 2011. The IEA also noted that while renewables subsidies amount to some \$80 billion a year, fossil fuel subsidies are around six times higher – in the region of \$0.5 trillion a year.

"Fossil fuel subsidies are public enemy number one in the fight against climate change," said Birol, arguing

**"Fossil fuel subsidies are public enemy number one in the fight against climate change... renewables are being strangled by fossil fuel subsidies"**

will overtake Russia as the world's largest gas producer in 2015.

The rebirth of the gas industry in the US has predominantly hit coal fired generation there, but there has also been a slowdown in renewable investment. Citing the Ernst & Young *Renewables Attractiveness Index 2012*, Gil Forer, Ernst & Young's Global Cleantech Leader, said: "Compared to 2011, renewables investment has declined. The fundamentals [for investment] are still the same but recovery will be slow... the country has bigger things to worry about."

Certainly the downturn in global clean energy investment, which according to Bloomberg New Energy Finance fell by 11 per cent in 2012 compared to 2012, is not restricted to this sector alone. However, when considering climate change, the potential long term impacts are far more damaging than any decline in other industries.

Jeffrey Sachs, United Nations Secretary-General's Special Adviser on the Millennium Development Goals and Director of the Earth Institute at Columbia University, USA, said that with the exception of Europe, none of the major economies have a strategy in place for getting on to a low carbon trajectory.

"In the US we conveniently tell ourselves that gas is clean, but it's only low carbon compared to coal," he said.

"My strong recommendation is that we do the arithmetic together over the next year; that we look at the actual numbers instead of consoling ourselves with how many gigawatts of one kind of energy or another have been put in place. What counts is not what we're doing but what we are failing to do; and what we are failing to do is slow the growth of emissions of greenhouse gas."

This second point is one that ministers, overly keen to point out their countries' success, often overlook. As Birol put it: "For renewables, which is the most important policy option we have to address climate change, I am not in a position to tell you that I have very good news – unlike some of my colleagues. Renewables is at a crossroads."

Birol noted that renewables are growing but the growth is not sufficient to address climate change.

Possibly the biggest part of the problem is the continuing prevalence of subsidies across the board. Despite the widespread concerns on the negative

that when something is cheap it leads to overuse. He also claimed that renewables "are being strangled by fossil fuel subsidies".

Birol may be no hip-hop fan but I have my suspicions about Dr. Eddie O'Connor. Sporting a pair of dark glasses on stage, the Founder and CEO of Mainstream Renewable Power could have been an older Eminem. In a later panel discussion, O'Connor also spoke out on fossil fuel subsidies "making for an uneven playing field".

In response to a comment from a fellow panellist from Shell, he said: "I find it very self serving of Shell to say that renewables don't compete. The average price of gas in the world today is around \$9 per million BTUs. Let me assure you that we make a really good profit at \$7 per million BTUs for wind and solar. You can put in a wind resource that gives you an approximately 35 per cent capacity factor – you get a lot more than that offshore, and more with new technology. On PV we are getting a capacity factor of 34 per cent. When you put in these numbers, you are actually competitive."

"Fossil fuels are subsidised to the tune of \$560 billion a year. So there is no level playing field where we compete against the likes of Shell and BP. Fossil fuels have been around for 100 years or more but are still subsidised..."

O'Connor believes these subsidies are institutional and coupled with barriers that are preventing the growth of renewables.

Unless governments can phase out fossil fuel subsidies and provide greater certainty on energy policy, renewables will not be in for an easy ride, and the fight against climate change will be even harder.

Birol said: "If governments give a predictable and reliable framework, in the year 2015 renewables will be the second fuel in the global energy mix. But this 'if' is very critical. If governments [take a] go and stop [approach], they will discourage investors. I am sceptical whether governments can provide this reliable framework to the renewable industry. We definitely need renewables to address climate change, energy security etc., but me saying this and showing nice charts doesn't change anything. Politicians making prepared statements doesn't change anything. What will change the picture is a framework that provides the lifelong market conditions that make renewables profitable, including the elimination of fossil fuel subsidies that provide an artificial hurdle to renewable energy investment."

Birol is right; painting a pretty picture and delivering sugar-coated messages of where renewables will be in the next 10, 20 or 30 years is easy but in reality, getting there will be harder than they think. And winning the battle against climate change will be harder still.

