

Renewables will widen investor enthusiasm

Guy Chazan reports that, despite many obstacles, the rise of green power is slowly transforming the energy landscape

Subsidies cut, bank lending down, shale gas booming – it seems the cause of renewable energy has never faced so many headwinds. But the reality is not quite so gloomy.

“When it comes to onshore wind and solar, there’s never been a better time to invest,” says Ian Simm, chief executive of Impax Asset Management, which specialises in the environmental sector.

He is not alone. The global investment community is more at ease with green energy, despite pessimism about funding crises and policy flip-flops. A sector that was once heavily reliant on venture capital and private equity is now attracting big pension funds and other institutional investors looking for an alternative to unstable stock and bond markets.

Helping the improved outlook is a stunning drop in costs that has transformed the industry’s economics. Technological progress and increased capacity have driven prices for solar photovoltaic (PV) modules down 75 per cent over the past three

years. Wind turbines have seen similar falls, while the cost of fossil fuels has risen.

Michael Liebreich, head of Bloomberg New Energy Finance, says: “Big wind farms in breezy locations such as the Great Plains in the US are now completely competitive with new coal-fired power stations.” He says that, by 2016, “the average wind farm in the US won’t need a subsidy at all”.

The rise of green power is transforming the landscape of modern energy. The share of wind, solar and other renewable sources in power generation is expected to rise from 3 per cent in 2009 to 15 per cent by 2035, according to the International Energy Agency, while the global supply of biofuels should triple over the same period.

But those numbers mask the stark truth that, despite the inroads of low or no-carbon alternatives, fossil fuels will dominate energy use for decades to come. The old industrialised nations may be reducing their dependence on hydrocarbons, as they strive to cut their emissions and imports from unstable regions such as the Middle East.

But in developing countries, where millions of people are moving to cities in search of a better life, the thirst for crude is only intensifying.

With the number of passenger cars worldwide set to double by 2035, energy demand in the poorest nations is growing



Sunshine state: the mechanical harvesting of energy grass for a BP biofuels project in Florida. See ‘US policy pushes biofuels’ on Page 3

relentlessly, and the kind of energy most in demand is that provided by fossil fuels. By 2035, according to the IEA, oil, gas and coal will still make up three-quarters of global energy consumption.

Meanwhile, reserves of oil and gas that have long been considered too difficult and expensive to develop, such as shale gas in North America, are gradually being opened up thanks to techniques such as hydraulic fracturing, or “fracking”.

From the oil sands of Canada to the coal seams of Australia, the unstoppable march of “unconventional” oil and gas has reinvigorated the western oil majors and presaged a new

golden age of hydrocarbons. That has huge implications for global warming. Without new policies, the world is on track for “alarming” increases in the global average temperature – of as much as 6C under a business-as-usual scenario, the IEA says. Yet experts believe that only by limiting the increase to 2C can dangerous climate change be avoided.

Clean energy has a huge role to play in global efforts to stick to within the 2C target. But there are fears the sector is still not growing fast enough to tip the balance away from conventional sources of energy.

“If you want to see emissions peak and fall, you need a dou-

bling of investment in renewables, from \$250bn at present to \$500bn,” says Bloomberg’s Mr Liebreich. “We’re a half to a third of where we need to be from a climate perspective.”

Yet the overall environment for such investments has deteriorated in some cases. Governments are under pressure to cut subsidies for green energy. Germany, the UK, Spain, Italy and other European countries have been trimming support for solar power. Even China has slowed down its dash into renewables.

The UK government published an energy bill in May designed to incentivise the £110bn in investments needed over the next decade. The reforms hold-

out the promise of long-term contracts at fixed prices for low-carbon generation, including nuclear. Renewables investors welcomed the changes but they could provoke a backlash if household energy bills rise as a result.

In the US, all eyes are on the production tax credit (PTC) for onshore wind power, a subsidy that has been one of the main factors behind the fourfold expansion of US wind generation since 2006. The PTC is due to expire this year and many in the industry predict dire consequences if it is not renewed.

The subsidies issue has been

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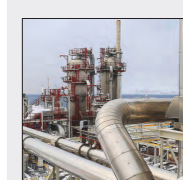
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Fukushima has cooling effect on western zeal

Nuclear power

Many of the world's next reactors are going to be built in developing countries, writes **Leslie Hook**

The neon models of nuclear reactors glittering and blinking across the convention floor at a nuclear conference in Beijing in April testified to an often overlooked fact. In spite of the aftermath of the Fukushima nuclear crisis last year, the global nuclear industry is alive and growing fast, particularly in emerging economies.

Through several European countries shifted away from nuclear energy after Fukushima, overall global nuclear growth has continued to be strong, with 61 reactors under construction today, according to the World Nuclear Association.

Many of the world's next nuclear reactors will be built in developing countries where power demand is surging.

These include China, which accounts for 41 per cent of glo-

bal reactors under construction, and India, which accounts for 11 per cent of the total being built.

China temporarily suspended approvals for nuclear reactors in the aftermath of Fukushima, while it designed a new set of atomic energy regulations, but the approval process is expected to restart in the next two to three months.

The fundamental goal of boosting nuclear energy has not changed.

That determination was on full display at the recent nuclear conference, where China's state-owned nuclear companies trotted out some of the most detailed reactor models they have ever made public, in a dual attempt to address safety concerns and to promote their products for export.

As Chinese officials toured the exposition, representatives from companies such as China Guangdong Nuclear Power Group described the safety features of their reactors with the assistance of glossy pamphlets bearing subject headings such as "earthquakes and nuclear security".

China is the biggest reactor builder in the world today, but

several other countries remain committed to nuclear power.

They are the nations that will drive reactor construction in the coming decade. Aside from the top three current nuclear builders – China, India and Russia – reactors are also expected in Saudi Arabia, Korea, Turkey, and the United Arab Emirates, among others.

Chris Gadomski, head of nuclear research for Bloomberg New Energy Finance, says: "The leadership in the nuclear power industry is moving away from western Europe and going primarily eastward. The Russians, are very aggressive in exporting their technology, and there are the Chinese and Indian markets."

Mr Gadomski adds that: "The Koreans are going to be the world leaders, as far as exporting nuclear technology worldwide is concerned."

China is also stepping up efforts to export its nuclear technology, recently making a bid for a reactor project in Turkey that was very attractive because China offered to supply its own financing and it did not require Turkish government guarantees.

However, analysts say that it will still be several years before China's nuclear technology matures enough to make the country truly competitive with the likes of Russia's Atomstroyexport.

Fukushima has undeniably had a cooling effect on global nuclear ambitions, but much of this has been centred in

'The need to fuel the economy and provide light to the general population is taking governments toward nuclear energy'

Europe and developed markets.

Overall, 24 reactor projects representing more than \$135bn in new build have been postponed or cancelled in the wake of the Fukushima crisis, according to estimates by Bloomberg New Energy Finance.

Countries including Germany, Italy, Belgium, Kuwait, Switzerland and Mexico have scaled back their nuclear power programmes and cancelled or post-

poned projects. With the recent presidential victory of François Hollande, who wants to reduce French dependence on nuclear power, France, too, could join the list.

But outside Europe, many of the countries where energy use is growing the fastest remain committed to expanding their nuclear programs, often with design adjustments to incorporate the lessons learnt from Fukushima.

The process has not been seamless and some countries, including China, face growing public opposition to nuclear energy after having watched the crisis in Japan unfold on their television screens.

However, more than a dozen countries intend to expand their nuclear programmes over the next decade.

They include South Korea, which brought two new nuclear reactors into service this year and has three more under construction. Saudi Arabia also plans a 16-reactor nuclear programme to be completed by 2030.

The United Arab Emirates has signed a \$20bn contract with Korea's Kepco to build four

reactors. And Vietnam intends to build two reactors.

"People need it there and it's not such a political issue," says Lady Barbara Judge, former chairman of the UK Atomic Energy Authority. "The need to fuel the economy and provide light to the general population is taking these governments toward the path of nuclear energy."

Lady Judge says the high price tag of most reactors could be reduced "There will be a real competition in emerging markets for reactor parts, which ought to drive prices down," she explains.

In the Beijing nuclear expo hall, such companies as China National Nuclear Corporation had hoped that they could help make that happen. In CNNC's display centre, giant posters on safety precautions were meant to assuage fears that may still linger after Fukushima.

Eager visitors and government officials perused the models curiously. Here, at least, the nuclear renaissance is set to continue.

Additional reporting by *Gwen Chen*.

Renewables are likely to widen investor enthusiasm

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compounded by the advent of cheap, abundant shale gas.

As US utilities retire their old coal-fired power plants, they are now more likely to switch to natural gas than to wind or solar, attracted by a price of about \$2.50 per million British thermal units, about a quarter of its peak four years ago. "The long-term case for renewables has been undermined by shale gas," says Mr Simm.

Other alternatives to fossil fuels have also lost ground. The 2011 Fukushima disaster in Japan delivered a massive blow to the credibility of nuclear power, which until then was set for a global renaissance. Germany pledged to close its nuclear plants and other countries shelved plans to build new ones.

But perhaps the largest challenge to renewables is the lack of capital, as a weakened banking sector pulls back from long-term lending for infrastructure projects. Clean energy is particularly vulnerable because the upfront costs are so high. By contrast, however, its operating costs are low – the wind that drives turbines is free.

This situation could get worse. The Basel III rules for banks, designed to bolster their balance sheets, could limit their ability to provide project finance loans for roads, power plants and big energy developments such as wind farms.

Yet, with the banks pulling back, others are there to take up some of the financial slack. Infinis, the renewable energy business of Guy Hands' private equity group Terra Firma, has been buying wind farms in the UK over the past couple of years. Meanwhile, HgCapital, a private equity firm, has a renewable energy fund investing in onshore wind, solar and hydro power.

Institutional investors and wealthy individuals are also increasingly attracted to the sector, especially since the sovereign debt crisis has reduced the attraction of bonds.

Denmark's Dong Energy, for example, has sold stakes in its offshore wind farms to pension funds PensionDanmark and PKA of Denmark and PGGM of the Netherlands. Part of the appeal of one of the wind farms, Anholt, was an agreement that Dong had with the Danish Energy Agency to sell power at a fixed price during the first 12 years of its operation, promising a stable return to investors.

"All investors are looking at new investment opportunities, new asset classes," says Andreas Quint, head of Europe, the Middle East and Africa corporate finance at property services group Jones Lang LaSalle. "If you have a wind farm, it generates a stable cash flow for decades. That can replace a bond-type investment."

That kind of investment is helped by the knowledge that advanced countries, especially in Europe, are moving inexorably to low-carbon energy and away from polluting coal, despite zigzags on the way.

"If you have a power generation asset supplying a market that's going to be structurally short of power for the next few decades, and your fuel costs nothing, it can provide an annuity income stream," says Mr Simm. "These are great investments."

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Financing woes pose a threat to 2020 target date

Offshore wind

Pilita Clark says that changes to subsidies are encouraging potential backers to play the waiting game

Who would want to be an offshore wind developer in Britain? Not long ago, this would have seemed an odd question to ask about the world's leading offshore wind market.

It is just over a decade since the UK government launched financial and regulatory incentives to exploit the renewable energy riches of the British Isles' fierce winds and relatively shallow waters.

The result is that, unknown to many Britons, their country has become the Saudi Arabia of offshore wind, with as much generating capacity in the sea as in the rest of the world combined.

At the end of last year, the UK had 636 turbines in 18 wind farms, accounting for more than 2 gigawatts of installed capacity, according to industry figures.

That gave it a 55 per cent share of the market in the offshore wind superpower of

'In 2007 prices, £80bn was invested in developing North Sea oil and gas'

Europe – more than double its nearest rivals in Denmark and far more than the Netherlands, Germany, Belgium and Sweden combined.

But homegrown pressure to cut costs, coupled with regulatory uncertainty and international financial woes, are combining to make 2012 a difficult year for the sector.

Of the three, the UK government's insistence on the need to rein in costs is the most predictable. Ten years ago, when the first big wind farms were built, they were relatively small and capital expenditure costs were less than £1.5m per megawatt.

Since then the industry has started to build bigger farms further out in deeper water. And, as their size has grown, so has the cost of materials. The upshot is costs soared to £3m and more per MW by 2010.

That means the 16GW of offshore wind farms in the pipeline up to 2020 could cost as much as £48.6bn and even the 10GW that some analysts think is the more likely amount to be installed over the next eight years could cost £30bn.

This amount needs to be put in the context of how much was paid to get other industries off the ground, says Andrew Mack, energy specialist at the Boston Consulting Group (BCG).

"In 2007 prices, £80bn was invested in developing North Sea oil and gas between 1974 and 1984," he says. "By comparison, installing an additional 10GW of offshore wind by 2020 would cost the UK some £30bn over eight years."

Still, the UK is in recession and offshore wind is supposed to be playing a big role in helping the country reach its target of obtaining 15 per cent of

energy from renewable sources by 2020. Last year, the coalition government announced an offshore wind "cost reduction task force", the results of which are likely to be announced this month.

"I think it's quite realistic to expect costs to be lower by 2020," says Nick Medic of RenewableUK, the wind industry lobby group.

Many hope so, not least because of the financing pressures the industry faces. Until now, utilities led by Denmark's Dong and Sweden's Vattenfall have been the biggest investors in offshore wind.

"About 80 per cent of investment is coming from utilities," says Gunar Hering, a renewables expert with BCG who is based in Berlin.

"In the future, this will no longer work, because the size of the investment needed is too big. Our expectation is that the utilities will only be able to carry about 25 per cent of the investment needed up to 2020."

That means finding other investors, such as pension funds and private equity groups, and depending more on banks for project financing. This is not always so easy in an immature industry where the risks are often deemed complex and big.

"The hope is offshore wind gains enough experience that risk levels come down and overall risk levels will be acceptable to investors," says Mr Hering. "That's the challenge we see."

Some pension funds have shown an appetite for offshore wind, but finding acceptable bank financing terms is not as easy as it was. "Project finance is tight," says John Wood, a partner at the Norton Rose law firm. "Traditionally, on project finance you would get a 15-year repayment schedule for your debt," he says. This has fallen to six or seven years, which adds pressure when it is time to refinance.

The UK's offshore wind developers still have to deal with a regulatory environment many find worrying. Under sweeping electricity market reforms the government is putting before parliament, the existing renewable energy incentive framework is to be replaced with a set of price supports to encourage investment in renewables and other low-carbon sources.

Though the outline of the reforms is known,

investors want to know more about price support and how this will apply to each form of power, which will be revealed next year.

For some, this all raises issues about how easily the UK will meet its 2020 renewable energy targets.

"Is the 2020 target achievable?" asks Norton Rose's Stephen Rigby.

"I think it is, but it isn't obvious how we're going to do it."



Surf's up: The Oyster, built by Aquamarine Power, being tested in Pentland Firth, which is dubbed the 'Saudi Arabia of marine power'

Marine sector starts to make waves in industry

Technology

The challenge is driving the cost down and reliability up, reports **Guy Chazan**

Limpet, Oyster, Pelamis (or yellow sea snake) are the evocatively named machines that are leading a revolution in wave and tidal energy.

Oyster is one of the newest wave energy converters. Rather like an oyster shell that opens and closes, it has a hinged flap attached to the seabed that is dragged back and forth by the current. This drives two pistons that push high-pressure water into an onshore turbine. Hey presto, loads of clean electricity.

The Oyster, built by Aquamarine Power, is being tested at the European Marine Energy Centre (EMEC) in Scotland's Pentland Firth, one of the world's key testing sites for wave and tidal devices.

The Firth, which separates the Orkney Islands from the Scottish mainland, has some of the fastest tides in the world. Its windswept waters are home to a clutch of leading utilities and technology companies – from Eon and Rolls-Royce to Kawasaki Heavy Industries of Japan – that are exploring ways to harvest the sea's energy.

"The power you can get from the Pentland Firth's tidal stream is enormous, so it's a great place to test equipment," says Tom Lamb, head of energy, trade and investment at Scottish Development International, which promotes inward investment into Scotland.

With its 14 full-scale test sites, EMEC is an unrivalled centre for experimentation and innovation in a sector that is in its infancy but expected to grow fast in the next decade, as countries such as the UK seek to reduce carbon emissions and wean themselves off fossil fuels.

The UK government has set a target of 300 megawatts of power generated by wave and tidal energy by 2020, up from 7.67MW now – a jump that will require an investment of £1.5bn.

RenewableUK, the wind, wave and tidal trade association, says the marine energy industry could ultimately generate up to 20 per cent of the UK's energy needs. And, though it is lagging far behind wind energy, marine is beginning to make progress.

In 2010 the Crown Estate, which owns the seabed off the UK, held the world's first commercial leasing round for marine power, approving six wave and five tidal schemes for the Pentland Firth and Orkney Water that should together generate 1.6 gigawatts by 2020, enough to supply 70,000 homes.

Part of tidal power's attraction is its one huge advantage over wind energy – the predictability of the world's tides. "You're getting power at exactly the times when you expect to get it," says Angus McCrone, an analyst at Bloomberg New Energy Finance. "It's intermittent, but predictable."

Outside the UK, however, wave and tidal are expected to remain a niche interest for many years to come. Few countries boast the long coastline, strong tides and rough seas that Britain has.

However, even in the UK the industry has almost no history: very few devices have been in the water long and it will be a challenge to prove any of them can work for a period of several

years, let alone across decades. "Durability is crucial to making marine power commercially acceptable," said Steve Carden, an energy innovation expert at PA Consulting. And, he says, this is just the start: "Designing a marine power system to withstand harsh environments is hard, but designing one that is easy to install and maintain in an ocean environment is even harder."

One company is ahead of the pack. Bristol-based Marine Current Turbines (MCT) has had a device called SeaGen, one of the world's first commercial tidal-stream generators, producing electricity in Strangford Lough, Northern Ireland, since 2008. It is now moving ahead with two much bigger projects, one

a Norwegian developer, was bought by Andritz, an Austrian technology group.

In the UK, there is a big push to get big projects in place quickly. This is partly to do with government policy – the current system of support for clean energy, based on renewables obligation certificates will expire in 2017, and there is much uncertainty about what will replace it.

Also, projects hoping to apply for a new £20m government fund for the first marine energy arrays – clusters of machines grouped together, such as wind turbines in a wind farm – must be full functional by 2016 to qualify.

"There's a lot of pressure to put projects in the water by 2017 at the latest," says Mr Krohn. Already plans are advancing for the first big developments. Last year, the Scottish government approved a 10MW array for the Sound of Islay between the Scottish islands of Islay and Jura, based on a device currently being tested at EMEC – a giant underwater propeller built by Hammerfest Strom.

The first commercial tidal project to be built in Scottish waters, it will provide enough electricity for Islay's 3,000 inhabitants.

All who watch the industry agree that great progress has been made in getting such products to the testing stage. However, there will inevitably be difficulties on the path towards commercial deployment.

"The challenge is getting the cost down and reliability up," says Ian Simm, chief executive of Impax Asset Management, an environmental and clean technology investor. "But," he adds, "it's only a question of time before this technology becomes economic."

At the end of 2011, the UK had 636 turbines in 18 wind farms

US policy aids second generation biofuel push

Clean technology

The sector appears to have come of age and is growing rapidly, reports **Guy Chazan**

In the world of biofuels, all eyes are on the tiny northern Italian town of Crescentino, site of the world's first commercial-scale cellulosic ethanol plant, which will start production this year.

The venture might be small, with output of just 60,000 tonnes of fuel a year. But it is a harbinger of a new movement in clean technology.

Producing petrol substitutes from sources such as sugar cane, corn and wheat has had a bad press. Critics say biofuels production takes up vast tracts of farmland that could better be used for growing food.

It was blamed for a surge in food prices in 2008 that triggered a backlash against the industry.

But a solution is emerging: second-generation biofuels that, unlike ethanol, are not made from food crops but use feedstocks including agricultural waste, energy grasses and algae.

The Crescentino plant, part of Beta Renewables, a €250m joint venture between Italian engineering and chemicals group Mossi & Ghisolfi and TPG, the Texas private investment firm, is an example of this trend.

It will produce bioethanol from a giant reed, arundo donax, as well as rice husks, the parts of corn left after harvesting, and wheat stalks.

Crescentino is the first of a number of commercial-scale

plants due to open this year, as companies move up from pilot and demonstration projects to industrial-sized facilities. About 20 such plants should begin operating in the next 18-24 months, according to Bloomberg New Energy Finance research.

"The sense of progress is very real," says Phil New, head of biofuels at BP, the oil group.

But there is also uncertainty. Much of the early promise was dashed on the rocks of the financial crisis and, with banks cutting lending to big infrastructure projects, analysts expect the pace of commercialisation to be slow.

"Quite a lot of the early stage companies have discovered it's more capital intensive to build a new molecule than to create a new piece of software," says Harry Boyle, analyst at Bloomberg New Energy Finance.

Still, there is momentum, much of it driven by government policy. In the US, biofuels are seen as a crucial way to reduce dependence on foreign oil and bolster energy security.

The Renewable Fuel Standard (RFS) mandates an expanding share of clean fuels in the transport fuel mix with a target of 21bn gallons a year of advanced biofuels by 2022, on top of 15bn gallons of corn-based ethanol.

Mr New at BP says: "The RFS is the cornerstone, the key piece of legislation that pushed everyone in the direction of second-generation biofuels. It was important in providing the certainty there will be a market for these products. It's the reason the US has the global lead."

Most of the plants scheduled to come on stream in the coming months are in the US. They include KIOR's \$222m facility in



Going green: algae is being cultivated to create feed stocks that can be used to fuel power plants **Bloomberg**

Columbus, Mississippi, to produce fuel from wood, principally southern yellow pine trees.

KIOR's plant will heat wood chips till they turn into a slurry-like material similar to crude oil, which can be run through existing oil refineries to make standard gasoline or diesel fuel. With a capacity of 11m tonnes a year, it will be the largest of its kind in the US.

Gevo of the US last month started up the world's first commercial isobutanol plant in Luverne, Minnesota. Its low vapour pressure and high energy content mean isobutanol can be added to gasoline at higher blend concentrations than ethanol, without requiring specially adapted vehicles.

BP is in a joint venture with Dupont to produce biobutanol, and will use some of it during the London Olympics. BP is one of a number of oil companies investing heavily in a sector long dominated by venture capital. Others are Royal Dutch Shell, Chevron and Total.

"A lot of people have struggled to deal with the reality of integrating engineering and technology at scale," says Mr New. "BP is used to large-scale engineering projects, which is a big advantage."

After buying the cellulosic ethanol business of biofuels company Verenium in 2010, BP is planning a big plant to use energy cane and napier grass as feedstocks for renewable fuels. It is planting 2,000 acres of the crops in Florida, in what will become a 20,000-acre facility.

The majors are not the only investors. Poet, a US biofuel producer, has a joint venture with chemical company Royal DSM of the Netherlands to build a commercial-scale cellulosic ethanol plant in Emmetsburg, Iowa. The tie-up is an example of how advanced biofuels plants can be rolled out relatively quickly when they evolve from existing first generation facilities – what the industry calls "add-ons".

Susan Hansen, a credit analyst at Rabobank, says: "If

you've got an ethanol refinery, you can add on an extra unit to make second-generation fuel from the byproducts of your ethanol production."

Start-ups that are not building add-ons or lack the support of a strategic investor such as BP can find the going can be tough. Banks are wary of lending to standalone next-generation plants given the uncertainties, and prefer to invest in proven technologies with reliable cash flows, such as onshore wind farms.

The sector can be confusing for potential investors. There are an estimated 300 companies engaged in second-generation biofuels research, working with dozens of feedstocks and processes. Each will require its own supply chain, since none of the building blocks yet on offer are global commodities.

"We still don't have a winning technology and we don't have a winning feedstock," says Ms Hansen. "That's why it's so challenging."

Fire ice Gas source is little understood

As unconventional sources of energy go, methane hydrate is one of the strangest. Known as "fire ice" for its resemblance to a burning lump of ice when ignited, it is a widespread but, until recently, little understood potential fuel source.

Methane hydrate comprises a lattice of water-ice, enclosing molecules of methane, the primary component of natural gas. It forms under pressure in the polar regions in sediments under the permafrost and under the seabed on the edge of the continental shelf.

When exposed to surface temperatures, the ice melts and the gas expands, with one cubic foot of solid methane hydrate releasing 164 cubic feet of gas.

Its concentrated nature helps to explain its appeal, but recovering it threatens to speed up climate change. Burnt as a fuel, methane is a clean source of energy but, if it escapes into the atmosphere during drilling or as a result of natural causes, it is a powerful greenhouse gas.

Releases of gas from methane hydrate deposits have been suggested as a factor in mass extinctions in the past and there are concerns drilling could destabilise undersea deposits, endangering drilling rigs and even triggering landslides that may cause tsunamis.

A 2006 UK government review of the threat of climate change warned that a possible release of gas from methane hydrates represented one of the "largest uncertainties" facing climate change researchers.

But the large volumes of hydrates in the earth's crust and the rising prices of existing fuels have spurred a growing interest in exploiting this potential source of energy. A frequently quoted estimate of global methane hydrates, cited in a 2011 report by the US National Energy Technology

Laboratory, is about 700,000 trillion cubic feet (Tcf), although "only a small portion of this enormous resource is likely to be harvested as an energy fuel", the report warns.

Methane hydrates in the northern Gulf of Mexico alone have been estimated at more than 21,000Tcf, of which 6,700 Tcf was in high concentrations in sandy sediments – the sort of reservoir that could be most easily tapped. If only a third of these hydrates could be recovered the US would double its total natural gas resource, currently estimated at 2,074Tcf, the laboratory suggested.

Alaska's North Slope, one of the other main focuses of research in the US, is estimated to contain about 85Tcf of recoverable gas and successful field trials have been completed, US energy secretary Steven Chu announced last month.

The US energy department is making \$6.5m available this year for research and seeking an additional \$5m for 2013. The goal is to make sustained production economically viable, the department says.

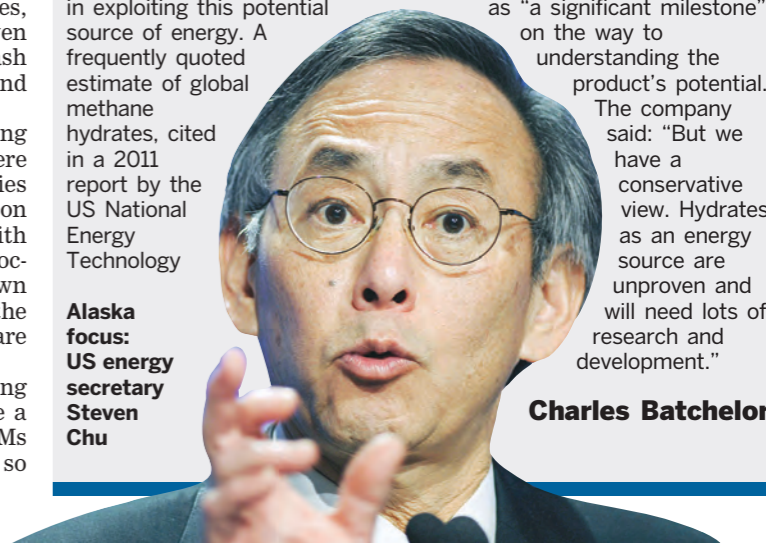
The Japan Agency for Marine-Earth Science and Technology began preparatory drilling in waters 1,000m deep off Aichi prefecture in February. Methane hydrate deposits off south-central Japan are estimated at 10 years' worth of domestic consumption of natural gas.

But there is still some way to go before methane hydrate becomes a commercial proposition.

BP, another early participant in test drilling in Alaska, says it is not actively pursuing hydrates research. It described the tests

as "a significant milestone" on the way to understanding the product's potential. The company said: "But we have a conservative view. Hydrates as an energy source are unproven and will need lots of research and development."

Charles Batchelor



3DEXPERIENCE

IF WE think a little deeper, could ocean currents be the key to sustainable energy?

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Modern Energy

Developing markets are a ray of sunshine

Renewable power

Enthusiasm is growing in poor nations but it has to be cost-effective, reports Ed Crooks

If the dominant global theme of the 21st century has been the shift in dynamism and capability towards emerging economies, then 2012 has been the year in which that trend has hit the renewable energy industry.

While many developed economies that led the way in renewable energy are faltering, the enthusiasm from countries such as India, Brazil, South Africa and Saudi Arabia has been growing.

However, China, the world leader in terms of investment in clean energy from 2009-10, applied the brakes last year and ceded top position to the US.

This followed concerns in Beijing that the headlong rush into renewables was causing strains on the economy and electricity system. Analysts questioned the effectiveness of the heavy investment in wind power, given that a substantial minority of turbines were not connected to the grid.

Nevertheless, China has also been raising the level of its ambitions for wind and solar power, including a push into the more challenging offshore wind starting in the next decade.

The "sustainable energy for all" initiative begun at the start of the year by Ban Ki-moon, the UN secretary-general, encapsulates the idea that renewables can be a viable source of energy for poor and middle-income countries as well as rich ones.

The initiative is open to the usual criticisms of well-meaning UN projects. However, by mobilising political and business support around its targets, which include doubling the share of renewables in the world's energy mix by 2030 from its present 15 per cent, Mr Ban could play an important role in accelerating the industry's development. A commitment to increased use of renewable



Hot prospect: pipes for cooling salt that has been heated by an array of mirrors being installed at SolarReserve's power generation project at Crescent Dunes, Nevada

Power Storage Solution to a perennial problem may be to take it with large doses of molten salt

One of the abiding problems of the renewable energy business is power storage. The leading generation technologies, wind and solar, both suffer from intermittency.

If the wind does not blow or the sun does not shine, you need back-up, typically fossil fuels. Anyone who can deliver an answer to the problem of how to store power cheaply on a big scale will make a huge contribution to the global renewables industry – and a fortune. The owners of California-based

SolarReserve believe they have at least part of the solution. Its technology uses mirrors to focus the sun's energy to heat molten salt to about 540C, at which point it can be stored and released slowly to heat water to drive a steam turbine. This generates electricity at a steady rate for 10 to 16 hours a day, compared with a traditional photovoltaic cell that operates only during daylight.

The technology, was tested with support of the US government in the 1990s, and is licensed by SolarReserve from

Rocketdyne, now a subsidiary of United Technologies, the aerospace and engineering group. Of its first three projects, two are in the US. However, the most promising markets are generally abroad. SolarReserve has a presence in about 20 countries, and is working on projects in South Africa. It sees potential elsewhere, from Mexico to Saudi Arabia.

By taking a \$737m loan guarantee from the US federal government for its Crescent Dunes project in Nevada, SolarReserve has exposed itself to attack

over the use of taxpayers' money for speculative projects using new technology.

Kevin Smith, SolarReserve's chief executive, rejects such criticism, and describes the energy department's loan guarantees, begun under George W. Bush and made easier to obtain under Barack Obama, as "great". He says: "The rest of the world is expanding, while unfortunately the US is still arguing. But there is still a lot that is up for grabs outside the US."

Ed Crooks

energy is likely to emerge as one of the "sustainable development goals" set as international targets at the UN's Rio+20 Earth Summit conference, in June.

Among developed countries, that objective will meet a mixed reaction. Some are pushing hard for renewable energy, and a few have increased their efforts. Japan's Fukushima disaster last year has encouraged several, in particular Japan itself, to scale

back their expectations for future nuclear generation, and to aim for more renewables.

The European Union is still sticking to its target of deriving 20 per cent of its energy from renewable sources by 2020.

However, many countries including Greece, Italy, Spain and France have been reducing some of their renewable energy subsidies, particularly for solar power. In Germany, Angela Mer-

kel's government is trying to push through a round of solar subsidy cuts in the face of opposition from state representatives in the upper house of parliament.

In the US, the issue has become ferociously partisan. President Barack Obama's rhetorical and financial support for renewable energy has spurred his opponents to use it as a weapon against him. The tax

credits and regulations that support renewable energy are under heavy attack from Republicans.

But, with the shale revolution depressing the price of natural gas, which hit a 10-year low this year, it has become harder for renewable energy to compete without those supports.

Emerging economies often take a more "strategic approach to energy", says Ben Warren,

head of environmental finance at Ernst & Young, the professional services firm. E&Y's latest ranking of countries' attractiveness for investment in renewable energy include three emerging economies – China, India and Brazil – in its top 10.

Other countries with ambitious schemes include Saudi Arabia, which plans a big expansion of solar power, and South Africa, which has a

detailed renewables development plan.

"These countries have an insatiable demand for energy as part of their development, so investment in renewables is easily justified," Mr Warren says.

If a country's installed fossil fuel-based system is inadequate, the case for renewables can sometimes be made more easily, particularly for distributed local generation that is not handicapped by the lack of a comprehensive power grid and where the resources at hand, sunshine in particular, are often plentiful.

However, the pressure to be cost-competitive with fossil fuels is, if anything, even greater in poorer countries.

First Solar, the US solar panel manufacturer and project developer, said in May it had appointed a chief executive who would target new markets, but has stressed it is looking for "sustainable" markets not dependent on big subsidies.

General Electric of the US, Alstom of France, Siemens of Germany and Vestas of Denmark, among others, have been pushing aggressively into Brazil, where the wind power market is growing fast, but where it is also keenly competitive.

Some contracts were signed there last year to provide wind power at prices that were lower than for gas-fired generation.

Emerging economies may want more renewable energy, but they do not want it at any price and political support has its limits. Mr Ban has said that the "green economy" – environmentally-friendly investment and technology – was still up for debate at Rio.

"People understand that this is an important and very effective tool," he says.

"But some developing countries [including the Alba group of Latin American countries such as Venezuela and Cuba] are suspicious that it is a tool to restrict their sustainable development."

If renewable energy companies cannot demonstrate that their services are cost-effective, then they will not have a long-term future in emerging economies any more than in the developed world.

Technological advance fuels voyage to bottom of the sea

Subsurface

Extraction of oil and gas is moving under water, writes Guy Chazan

The classic image of the offshore oil industry is a big, clunky drilling platform, looming above the restless waters of the North Sea. It is an image which is increasingly out-of-date.

These days, much of the world's oil and gas production is hidden from view, deep below the waves, on the seafloor.

And more and more production processes are moving away from platforms to the subsurface.

For companies such as Norway's Statoil, the aim is to dispense with offshore installations altogether.

"I will not retire until we've realised our first subsea factory," says Margareth Øvrum, Statoil's head of technology, projects and drilling. "In the company they call it Margareth's retirement plan."

Subsea oil production is not new: the first subsea wells were drilled in the 1940s. But underwater production systems are growing in complexity, as the oil majors venture into riskier areas. New energy frontiers such as the Arctic seas off the shores of Alaska and Russia's far north, and the vast pre-salt fields deep in rocks under the South Atlantic off Brazil, present technological challenges of unprecedented complexity.

"We want to get into ever deeper waters, colder waters, and further offshore," says Ms Øvrum, "so we'll be even more dependent on subsea technology."

Part of the motivation is the need to reduce costs. Dispensing with platforms and operating subsea wells remotely from the shore means less expenditure on steel and fewer offshore workers – some of the oil industry's most generously rewarded employees.

Putting oil production out of sight also has social benefits, since it interferes less



Pipe work: Statoil's gas processing plant near Hammerfest

with sea traffic and fishing trawlers – a key consideration in Norway.

Over its history, Statoil has gained a reputation for its subsea knowhow.

It was one of the first oil companies to put equipment on the seafloor to separate oil from the water it is mixed with as it emerges from the reservoir: to tie its subsea wells to floating production units on the surface; and to use seawater injection pumps that stand directly on the seabed.

But perhaps Statoil's finest achievement is Snøhvit, a huge natural gasfield in the Barents Sea, deep inside the Arctic Circle, and the first in the world to have no accompanying offshore installation.

Snøhvit was discovered in 1984 off the town of Hammerfest in Norway's far north. But with the gas 2km beneath the seabed and 350m below the waves, extracting it was considered

uneconomical. Freezing temperatures and stormy seas would have made it next to impossible to use a fixed drilling platform.

Only in the 2000s did Statoil begin to see it as an opportunity to showcase its subsea expertise.

The company decided to

"We want to get into ever deeper waters, even colder waters, and even further offshore"

pump Snøhvit's gas from remote-controlled wells on the seabed. That entailed building a 143km, multi-phase pipeline – the longest in the world – to carry the volatile mixture of unprocessed gas, oil and water to the shore.

The mixture is processed on Melkøya, a small island near Hammerfest, and the

gas chilled to -162C to create liquefied natural gas (LNG). Carbon dioxide stripped from the gas is sent back offshore and reinjected into the seabed.

But now Statoil is aiming for a new innovation – a subsea gas compressor.

"To have this on the seafloor is a paradigm shift," says Ms Øvrum. "It's like a step-up from an aircraft to a spacecraft."

Compressors are a common piece of equipment in the oil industry. Pressure declines in a reservoir: the more oil or gas is produced: compressors are used to keep the pressure up, improve recovery ratios and extend a field's life. Without them, production would come to a standstill.

Normally, they are located on the platform above the field. But their efficiency improves the closer they are to the wellhead: so Statoil is now planning to put one on the seabed, at its Åsgard development, 200km off Norway.

Seventy metres long, and weighting in at 1,500 tonnes, it is a huge piece of kit, a massive complex of compressors, pumps, scrubbers and coolers powered by submarine cables attached to the Åsgard platform.

The hope is that it will help extend the field's life out to 2050, and deliver 278 million barrels of oil equivalent in increased volumes.

Similar moves are planned for two other Statoil fields on the Norwegian continental shelf – Gullfaks and Ormen Lange.

Other challenges remain. Ms Øvrum sees all surface facilities migrating to the seafloor one day. She envisages better equipment to improve the quality of subsea oil, water and gas separation, and improved power distribution.

At the moment, she says, AC/DC current can be provided only up to 200km away from the shore.

She sees technology improvements pushing that to 250km and beyond.

"There's a still a long way to go," she says. For Ms Øvrum, retirement could be some way off.

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