

Energy

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The 'age of abundance' poses fresh dilemmas

Oil and gas output is rising but resource constraints will re-emerge in the longer term, reports *Ed Crooks*

The defining image of the global energy industry in 2014 has been a tanker loading up with an ultralight form of crude oil known as condensate in Galveston, Texas, bound for South Korea.

The delivery was significant because US exports of crude oil have been tightly restricted under regulations dating back to the 1970s. For most of that period, the restrictions have been an irrelevance: the US was a large and growing importer of both oil and natural gas up until the 2000s.

Now, however, that has changed: US

oil and gas output has risen so strongly in recent years that companies are pushing for whatever routes they can find to sell their output overseas.

It is a phenomenon that has been described by some in the energy industry as "the age of abundance", the prospect of long-lasting supplies of affordable fossil fuels unlocked by the shale revolution. Advances in the techniques of horizontal drilling and hydraulic fracturing, made commercially viable by relatively high oil and gas prices, have set off a wave of production from areas such as the Eagle Ford and Bakken oilfields of Texas and North Dakota

respectively, and the Marcellus Shale gasfield of Pennsylvania.

These techniques have not yet been exported very successfully beyond the US: hopeful shale developers have been hitting obstacles in countries such as China and Poland, although many have faith in their longer-term potential.

Even with shale production largely confined to the US, though, the global consequences have been momentous, driving down the cost of both oil and gas.

Ideas about "peak oil" - the view that oil production was at or near the highest level that could ever be reached - seem to have been decisively refuted. All the

talk among energy companies and their investors is about how to manage in a world in which prices could be lower for some time. Already we are seeing corporate moves in response, such as the decision by Baker Hughes, the oil services group, to accept a takeover bid from its rival Halliburton in the biggest corporate deal in global energy since the megamergers of 1998-2000.

At times like these, it is worth remembering the one iron law of commodity markets: this too shall pass. While abundance is undeniably the theme of the moment, there are longer-term trends that suggest resource constraints will

re-emerge as an issue in the foreseeable future. The simplistic idea that the world is "running out of oil" is indeed hard to maintain. Global total recoverable oil, including proved reserves and unproved resources, adds up to about 3.3tn barrels, according to the US government's Energy Information Administration: about 100 years of consumption at present rates. For natural gas, the equivalent figure is about 22,900tn cubic feet, equivalent to about 200 years of current consumption. For coal, the world has 112 years of consumption in proven reserves alone, according to

Continued on page 5



Exploration underground: the Marcellus Shale gasfield of Waynesburg, Pennsylvania, in the US -Mladen Antonov/Getty Images

Inside

Shale jubilation fades as prices begin to fall

US producers face their most severe test since the boom began

Page 2

Renewable battle lines

The Magritte Group's hostility to green power subsidies has not proved popular

Page 3

Smart engineering offers an alternative

Floating wind turbines for offshore use could revolutionise the industry

Page 4

Technology

Remote control of devices means the web is moving from the virtual to the physical

Page 5



Nuclear decline

Public scepticism could turn off the reactors

Page 6



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Energy

Shale jubilation fades as price falls undercut model

Oil prices US producers face their most severe test since the boom began, says *Ed Crooks*

The revolution devours its children. That observation, made by French journalist Jacques Mallet du Pan in 1793, has become a commonplace of political upheavals, but it is often true of revolutions in business, too. Companies that create a new market or disrupt an existing one do not always benefit in the long run.

Many of the pioneers of the US shale revolution are still thriving, although they have experienced some hard times along the way. With the fall in oil prices since the summer, they face their most serious challenge, largely as a consequence of their own success.

Eric Otto, an analyst at CLSA, says the industry appears to be in "a multi-quarter period of lower oil prices", and that the US shale industry will have to adjust to that new reality.

The first crisis in shale came with the collapse of natural gas prices in the summer of 2008. For the first five years of

the industry's life, beginning with the successful combination of horizontal drilling with hydraulic fracturing to extract gas from the Barnett Shale of Texas in 2003, gas prices rose steadily. In 2008, Henry Hub, the US natural gas pricing benchmark, peaked above \$13 per million British thermal units.

As the financial crisis deepened and the US plunged into recession, natural gas prices fell and hit a 10-year low below \$2 in April 2012. Peak to trough, it was a fall of more than 85 per cent.

Industry analysts kept wondering when low prices would make so much production uneconomic that supplies would fall and prices recover. That point was lower than many expected. It is possible for the best operators in the best areas of the Marcellus Shale of Pennsylvania to produce gas more cheaply than almost anyone realised.

Cabot Oil & Gas, for example, reports a cash cost in the Marcellus of just 75 cents per mBTU. That is somewhat misleading, because it excludes expenses needed for long-run production, but even including other costs, the estimate that its wells can earn an 80 per cent internal rate of return while selling gas at \$2.80 per mBTU is still remarkable.

From 2010, many shale companies that found it impossible to compete in gas production at the prevailing prices began to shift their rigs to oil produc-



Market forces: drilling for oil in the Bakken shale formation — Andrew Burton/Getty Images

tion, taking advantage of the discovery that techniques that worked for gas could be applied to liquids.

The economics were irresistible. With US benchmark crude at about \$100 a barrel, and gas at about \$4 per mBTU, oil was worth four times as much as gas for an equivalent energy content. US oil production boomed: crude output rose from 5m barrels a day in 2008 to about 9m barrels per day currently.

Even though the US has strict controls on its crude oil exports, its production affects world markets, as it imports less. Yet as the US added millions of barrels a day to the market, its impact was offset by disruptions elsewhere: sanctions against Iran and the turmoil in Libya. With demand in emerging economies growing, global oil prices stayed above \$100 a barrel, making most US shale oil production commercially viable.

This year, however, the balance in the market has changed. Gary Ross, head of the consultancy Pira Energy Group, says oil producers' "luck ran out". Demand growth slowed sharply, particularly in China, and some supply disruptions eased, with a rise in exports from Libya. US prices have fallen by about 30 per cent since June. Other high-cost sources of oil, including offshore production and the Canadian oil sands, will be hit. Transocean, the offshore contractor, has warned of a "cyclical downturn". But US

shale producers are in the line of fire as well. Estimates of the costs of shale production vary widely. Half of North American shale developments would still be profitable with US crude at \$57 a barrel, according to IHS, the research group, while Abdalla El-Badri, secretary-general of Opec, has suggested half of US shale production would be knocked out by oil at \$85. The decisive factor is likely to be whether US shale companies can keep raising the cash to finance their drilling programmes.

Matt Portillo, an analyst at Tudor Pickering Holt, says he expects the US shale industry to slow down, rather than go into reverse, but says the effect depends on how long the oil price remains at these levels, especially for financially weaker companies.

"Most are believers in the commodity long-term, so they don't want to cut [their drilling budgets]. But the longer we stay in this commodity price environment, the more pressure they are under," he says. "If they are outspending their cash flows, eventually, the numbers won't work out."

The shale oil boom proved an escape route for gas producers that were under financial strain. It does not look as if there is anything that can provide a refuge for oil producers in the same way. The coming year is set to test how durable the US shale revolution really is.

Stand-off threatens to stymie development Countries pool resources for hydro power project

Australia

The country could lose its crown as the world's biggest exporter of liquefied natural gas just after it achieves this goal, writes *Jamie Smyth*

For more than a decade, China's rapacious demand for natural resources boosted Australia's economy. But with the prices of its two biggest exports - iron ore and coal - in free fall and mining investment slowing, Canberra is hoping a \$200bn investment in liquefied natural gas (LNG) can diversify the country's exports and support its economy. "Australia is currently the fourth-largest exporter of LNG in the world and by 2018 is set to be the largest, exceeding Qatar," says Phil Craig, general manager of Origin Energy.

Origin is one of a host of companies aiming to cash in on the fast-rising demand in Asia for cleaner energy sources to complement coal and oil.

It has joined with ConocoPhillips and Sinopec to build a \$25bn LNG plant on Curtis Island in Queensland. It is scheduled to begin production next year. Two other LNG plants on the island are run by rival consortiums led by operators

BG Group and Santos, and are due to start exporting gas this year or next.

On the west coast of Australia, the \$54bn Gorgon LNG project, a joint venture between Chevron, Royal Dutch Shell, ExxonMobil and Osaka Gas, is due to begin production in mid-2015. And on the north coast the Ichthys LNG plant, operated by Inpex of Japan, will begin exporting gas in 2017.

Appea, Australia's oil and gas lobby group, forecasts that LNG production will more than triple to 85m tonnes by 2018 and that by 2020, the industry will contribute A\$13bn in annual taxes to the exchequer. The ramp-up in LNG production is already under way, with it becoming the country's third-biggest export this year, Appea reports.

Gertjan Leideman, managing director of Accenture's energy strategy practice, says: "Australia has significant growth potential because of natural resources, its proximity to the fastest-growing markets in Asia and a well understood tax and regulatory system."

But he warns that a slowdown in global demand for LNG and lower commodity prices is threatening to undermine investment in exploration and development.

Last month, Goldman Sachs cut its projection for growth in global LNG demand to 5 per cent by 2020 on an annual compound basis, down from

6 per cent. It cited weaker European demand and increased pipeline gas to China displacing LNG.

It also flagged delays in Australian, African and Canadian projects because of competition from the US, which is building a LNG export sector. A shale gas revolution in the US, which is forecast to see LNG production treble by 2035, is prompting buyers in Japan and elsewhere to delay agreeing prices with energy companies. In the absence of long-term pricing contracts, investors

Australia is set to be the largest LNG exporter in the world by 2018
Phil Craig
Origin Energy



are balking at making decisions on new multi-billion-dollar projects.

The higher cost of building LNG plants in Australia and a series of cost blowouts on existing projects has led investors to put more than A\$100bn of Australian LNG projects on hold.

"LNG developments in Australia are going to be difficult to get off the ground because of the high costs," says Neil Beveridge, analyst with Bernstein Research. "The recent decline in oil prices also makes things more difficult."

Another factor that could impede

growth of Australian LNG is the recent decision by Japan to restart two nuclear reactors. If this goes smoothly and further nuclear plants come online, demand could weaken further.

Woodside, an energy company that is seeking customers for a proposed multi-billion dollar floating LNG project in Western Australia, is more optimistic that gas demand will outstrip supply.

Peter Coleman, Woodside chief executive, told a conference in Japan in November: "In the current climate of rising costs, oil price uncertainty and capital constraints, we are seeing super majors pull out of LNG projects."

He said supplies of LNG from the US were unlikely to meet global demand and warned that the stand-off between buyers and sellers risked creating a supply crunch in the early 2020s. "We need to make final investment decisions on new LNG projects now," he said.

The LNG industry is calling on government to reform employment law and streamline regulations for foreign workers, warning that Australia could lose its crown as the world's biggest LNG exporter just after it achieves this goal.

Mr Leideman says: "The stakes for Australia are high. A lack of investment in LNG projects could lead to unrealised resource potential. More importantly, Australia would lose tax revenue and job creation opportunities."

Africa

A new dam financed by international investors typifies a continent-wide trend towards co-operation, reports *Rose Jacobs*

The Ruzizi river forms part of the border between the Democratic Republic of Congo and both Rwanda and Burundi. It thus runs through a region that can hardly be described as a paragon of political harmony or a magnet for business investment.

And yet the Ruzizi is set to play host to a project - a hydro-electric dam - that represents what experts believe are two key elements to bringing stable sources of electricity to more people in sub-Saharan Africa: regional co-operation and public-private partnerships.

Whereas two previous dams were government-funded, this project - which will include a 147MW hydropower plant - depends on private investors who will be responsible for financing, designing, and building the plant, as well as running it for 25 years.

Lining up those investors has not been easy: "Regional projects definitely add complexity," says Thierno Bah at the African Development Bank, which has helped secure funding. "But the fact that countries can pool their resources adds reliability."

The project is typical of a continent-wide trend, says David Humphrey, global head of power at South Africa's Standard Bank. "It's hard to generalise about the continent, but... there's now a general acceptance that the private sector has a role to play."

The need for investment is clear. Demand for energy in sub-Saharan Africa consistently outpaces supply: countries boast average annual GDP growth of about 5 per cent, whereas power access is growing by only about 1 per cent a year, according to the World Bank. The bank estimates that if trends continue, fewer than six in 10 Africans will have electricity at home by 2030 - a serious miss, given the UN's goal of universal access by then.

Fortunately, there is "a wall of money" ready to invest, with interest growing strongly among institutional investors, says Mr Humphrey. But moving from interest to cash injections requires "legal, commercial contracts and government policy that is consistent".

Mr Bah and Mr Humphrey both point to the telecoms sector as a model, reaching near-universal access thanks to light-touch regulation.

Makhtar Diop, vice-president for Africa at the World Bank, hopes private sector guarantees by his own and other organisations will help reduce political risk enough that the market becomes competitive.

He sees interest from around the globe, with companies eager to apply technologies that have worked in their countries. "The technologies Africa needs are available; the question is how



The Ruzizi, where a hydroelectricity plant will offer stable energy supply

we create the conditions that will persuade the private sector to invest."

A willingness by governments to allow prices to rise is certainly one of those conditions. "Politicians need to stand back and see that tariff increases that might affect their popularity can still be a good thing in the long term," says Mr Humphrey. Given that these could lead to a more stable network, the long-term benefits are clear.

Moreover, individuals might find that even higher tariffs for on-grid power are more economical than their off-grid solutions. The World Bank found that South African households with access to modern energy spent 5-5 per cent of their household income on power, compared with households without access, which spent 14-16 per cent of their income on energy.

"Tariff increases that might affect politicians' popularity can still be a good thing in the long term"

Interconnections between countries also need to be a focus, with energy-exporting nations working closely with their neighbours rather than simply selling to the wholesale market.

Regional power pools already exist in east Africa, southern Africa and west Africa, but they have limited capacity and require development.

Nor is power generation the only challenge. Unless transmission and distribution receive similar attention, there is a risk of bottlenecks, such as the one Nigeria faces. Capacity is set to rise significantly in the next few years, but transmission lags behind - in terms of both its extension and the development of the network.

Mr Diop points out that off-grid projects can provide some relief to an overburdened network - and make particular sense for remote areas.

But Mr Humphrey believes this is best left to philanthropic organisations for now. For private investment, off-grid "has its place, but you have to attack the low-hanging fruit first".

Urbanisation, moreover, means that low-hanging fruit will be abundant in Africa over the coming decades.

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Energy

Lobbyist's take on renewables loses it friends

Battle lines

The Magritte Group's hostility to green power subsidies has not proved popular, writes *David Crouch*

One of Europe's biggest utilities has broken ranks with EU counterparts over the issue of incentives to maintain conventional power generating capability.

Sabine Froning, head of European affairs at Vattenfall, the Swedish utility, says it left the Magritte Group of big European energy companies after the Group continued to push for "capacity mechanisms" - payments for maintaining the ability to generate power when needed, rather than for the amounts of energy produced.

"The perception of the Magritte Group being positive to capacity markets made it easier for us to leave," Ms Froning said. "We do not think they are the correct solution."

Vattenfall quit the Magritte Group in February 2014, but has been guarded about its reasons for doing so. Perceptions of the Group as "locked in the past" helped persuade Vattenfall to pull out, Ms Froning said, as the main purpose of its membership was to launch a debate over Europe's energy future, not to become a "permanent platform".

"It is not a problem to be outside the Magritte Group - there are sufficient platforms in Brussels where we are discussing the challenges with our peers and with other stakeholders, not only inside the utilities industry," she says.

The Magritte Group, established by Gérard Mestrallet of GDF Suez in May 2013, has pushed to stop or reduce radically subsidies for renewable energy, while seeking support for conventional power generation. EU leaders' rejection of binding renewables targets at their climate summit last month met another of the Group's demands.

Named after the venue of its inaugural meeting in the Brussels museum of René Magritte, the surrealist artist, the



Group says Europe may suffer blackouts if its energy markets are not reformed.

"Energy companies are facing an unprecedented financial meltdown and competitiveness crisis," it warned in a recent internal document.

Large investments in oil and gas-fuelled power stations in the first decade of the century backfired as prices for coal fell and energy demand shrank as a result of the financial crisis, leaving many utilities companies with "stranded assets" as plants were mothballed or closed.

Subsidy schemes have been useful in kick-starting investment in renewable energy, the Group says, but have resulted in "higher than expected costs

for society and distortions in the electricity market". The situation is leading to "premature decommissioning of efficient power plants, even though they are needed".

Conventional back-up generating capacity is indispensable to meet peak power demand on windless or cloudy days, hence the Group's push for capacity mechanisms to help stem its losses on gas-fuelled power plants.

The Magritte Group initially brought together France's GDF Suez, EON and RWE from Germany, Iberdrola and Gas Natural Fenosa from Spain, ENEL and ENI of Italy, GasTerra of the Netherlands, Sweden's Vattenfall, Czech utility CEZ, Austria's OMV and Finland's

Keeping the lights on: power bosses suggest that renewables may cause blackouts across Europe

Dreamstime

'Energy companies are facing an unprecedented financial meltdown'

Fortum. Its members account for more than half Europe's power generation, although it does not include one of the largest companies, EDF of France.

The Group stresses that its members invest substantially in renewables and merely seek their "integration" into energy markets in a less disruptive manner.

EON, for example, has invested close to €10bn in renewables since 2007 and is "greener day by day", a representative says. The company plans to shut 13 megawatts of conventional power generation between 2011 and 2015.

But climate campaigners are angered by the "sensational and alarmist claims" of the Magritte Group and portray it as a

powerful lobby working to lock Europe into dependency on "dirty fuel imports". The Group has ignored the hard-headed business case for expanding renewables portfolios, they say.

Kaisa Kosonen, climate policy adviser at Greenpeace, says: "Energy companies are stuck in their old business model and have not sensed the way things are moving, or they have seen it but are refusing to accept it."

"Renewables are becoming increasingly attractive. A tipping point is approaching quite fast. It is interesting to observe utilities when they are discussing these issues - a big chunk do realise that change is essential."

Greenpeace says the growing conviction that business models must change in response to political realities and the increasing economic appeal of renewables, together with investor pressure, are pulling the companies in different directions.

"These pressures will pull apart the Magritte Group," says György Dallos, senior adviser on global climate and energy at Greenpeace International. "We have been intensively in contact with them and we heard the whole thing is cracking; they have open differences."

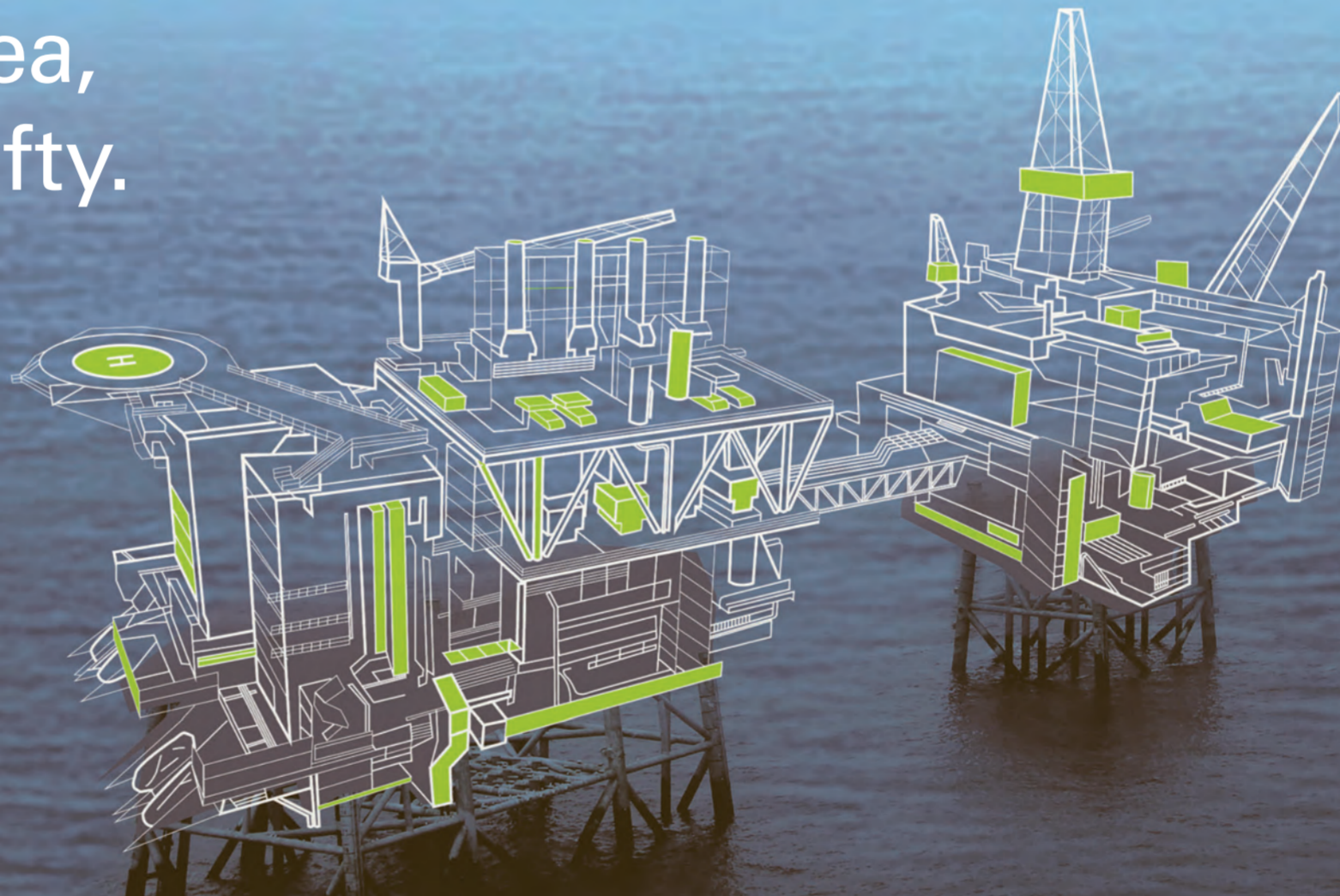
With the EU's 2030 climate targets now decided, differences in the strategies of big energy companies will come to the fore, says Mr Dallos. He says some Magritte Group members have told Greenpeace they agree with its critique of energy investment priorities. "It is becoming weaker, more companies are thinking about leaving," he says.

OMV of Austria says it recently followed Vattenfall and pulled out of the Magritte Group, though it declined to give an explanation.

Asked to respond to Greenpeace's criticisms, GDF Suez and Eni said they supported the Group's agreed position of backing renewable energy sources, investing in new technologies and defending the transition to a low carbon economy.

Ms Froning said: "It is clear that [Vattenfall] needs to embrace change, which is driven by climate concern, by public opinion and also by technological advancements. Trying to slow down developments would not be a good strategy for us."

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Energy

Aspiring superpower looks to private sector for \$250bn injection

India

Power is vital to growth but raising funds to overhaul the system is proving difficult, writes *Amy Kazmin*

In late July 2012, more than 600m people across northern and eastern India abruptly found themselves without fans, air conditioners or light in sweltering, humid heat, as the national power grid suffered a series of catastrophic late night failures.

The outage started at 2.30am, triggered by northern states drawing more than their allocated electricity quota, as drought-hit farmers ran water pumps to irrigate parched fields and Muslims rose before dawn to prepare food for the Ramadan festival.

The blackout, which also hit the national capital, New Delhi, lasted more than 12 hours in many areas, crippling trains and disrupting traffic. A second major grid collapse followed just

36 hours later. It was a painful reminder to an aspiring superpower of the fragility of its basic power infrastructure.

Two years on, Indian officials and industry executives say aggressive steps have been taken to prevent a repeat of such a widespread failure. But with Indian power demand surging – and both generating capacity and transmission and distribution infrastructure struggling to keep up, the situation remains precarious.

“Unless more is built, we are going to remain vulnerable,” says Anish De, a partner and infrastructure expert at KPMG, the consultancy.

“We are seeing better controls, so we should expect fewer failures. But since network augmentation is not enough, better controls can only work to a point, leaving us vulnerable.”

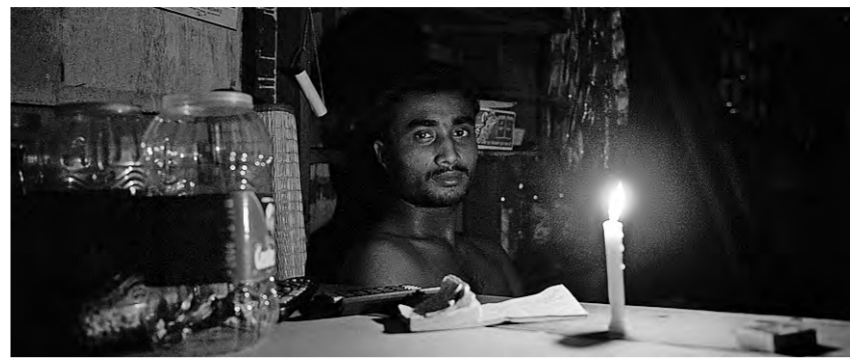
Nearly 25 years after it began liberalising its state-controlled economy, India still suffers an acute shortage of power. Nearly 53m Indian households are not connected to the grid, but even areas that are electrified suffer routine, protracted power cuts.

Per capita, electricity use in India is a quarter of the global average, but demand grew 6 per cent last year, as rising incomes fuelled growing use of power-consuming appliances such as fans, TVs and air conditioners.

Demand for electricity is expected to rise even higher as the economy recovers from its present slowdown, with a new administration focused on reviving growth.

In this climate of relative power scarcity, Indian states all have quotas for how much power they can draw from the national grid. But in the past, states faced few penalties for overdrawing, as the northern state of Uttar Pradesh was believed to be doing when the grid collapsed. Since that calamitous blackout, however, the government-controlled Power Grid Corporation of India has got tougher with states that breach “grid discipline”.

“The controls are getting better and better,” says Mr De. “They are equipping substations so that, if there is indiscipline, they can cut users off much faster.”



Work ethic: keeping the shop open during a blackout – Chandan Khanna/Getty Images

The policy of getting tough with states has been aided by significant investments in high-tech sensors to monitor power flows to predict requirements more accurately.

But while such policies and technologies are helping alleviate pressure on the grid in difficult circumstances, India still faces fundamental challenges that leave the grid vulnerable.

The power distribution system was traditionally organised in regional grids, creating large demand-and-supply imbalances. Generating capacity is

concentrated in coal-rich eastern India, while demand was strong in the heavily industrialised areas of the south and west, but links between the regions were limited.

The country is now trying to integrate its regional grids to create a robust national network, but it remains a work in progress.

Piyush Goyal, minister for power, coal and new and renewable energy, says: “There are states such as Chhattisgarh with power they are desperate to sell, and then states like Delhi that are

desperate for power but don't have enough lines to bring it in.”

Under prime minister Narendra Modi, India's new government has also pledged to ensure all Indians have access to power 24 hours a day, seven days a week by the next parliamentary election in 2019, a pledge that implies a significant expansion of both power generation, and transmission and distribution.

Overall, Mr Goyal estimates that more than \$250bn in investment will be needed in the next few years to meet these goals, including about \$50bn in transmission and distribution.

It remains unclear whether the funds are to come from the cash-strapped government or private companies, which have shown little interest in investing in transmission infrastructure.

Even if financial constraints are overcome, India will face a tough time securing land on which to erect transmission pylons, unless the new administration is willing to tweak a recent law that lays down onerous procedures for acquiring farmland for infrastructure.

Floating wind turbines for offshore use could revolutionise the industry

Engineering

The technology circumvents unsuitable seabeds and may cost less too, says *Michael Kavanagh*

The stresses and strains on large wind turbines demand costly investment in strong foundations to ensure their safe and effective operation on land and at sea.

In the UK – which leads the world in wind farm installation – disputes over the falling subsidies available to wind power operators have commonly been blamed for the cancellation or curtailment of projects this year.

But the constraints of poor seabed conditions, which could critically compromise the pile-driving of turbine foundations, have also been cited as a reason for abandoning plans for fixed-foundation offshore turbine arrays.

In July, plans for the Celtic Array – which would have been Europe's largest wind farm, off the north coast of Wales – were scrapped. Project backers blamed challenging ground conditions, although the cancellation also coincided with the announcement of a less generous subsidy regime.

Such geological excuses, however, could soon be a thing of the past. Last month, DCNS, a French industrial group specialising in naval defence and energy, confirmed that it was joining forces with engineering group Alstom to develop floating wind turbines that avoid the need to install fixed foundations for offshore wind farms. The company also announced an agreement with Brittany's regional authorities to back the development of a floating offshore wind test site at Groix by 2018.

According to Frédéric Le Lidec, director for marine energy at DCNS: “The Groix site offers conditions representative of the Atlantic market and provides a unique opportunity to set up an initial pilot floating wind turbine farm.”

Though Brittany is keen to establish itself as a centre for floating wind farm testing and installation, plans are also afoot to trial a floating wind turbine prototype on the other side of the Channel, off Cornwall's north coast at the Wave Hub marine power centre.

Here, in a project backed by the UK's Energy Technologies Institute (ETI) and US naval architects Glosten, engineers are seeking to test a prototype that would also employ an Alstom turbine capable of generating 6 megawatts.

The aim is to test the theory that large-scale floating turbines could emerge as a cheaper alternative to farms built on solid foundations, as well as allowing installation where subsea conditions do not allow for conventional arrays of offshore turbines.

Andrew Scott, programme director of offshore renewables at the ETI, says such pilots aim to release wind farm developments from restrictions created by the demands of installing turbines on sea floors capable of bearing the full weight of blades, motors and their supportive casings.

Instead, engineers hope to show that suitably anchored semi-submersible platforms, using water as ballast to hold turbines steady, or tension-leg platforms exploiting the natural buoyancy of turbine gases to maintain them in place, offer a low-cost alternative in



Wind instruments: semi-submersible platforms have been trialled off Norway and Portugal – Marc Preel / AFP / Getty Images

both shallow and deep waters. Such engineering is already used in the oil and gas industry to limit the costs of steel, concrete and upfront installation of fixed foundations in shallower waters, and also to push platforms out into deeper seas where fixed foundations are not practicable.

The prototype proposed by Glosten and ETI involves installing a proven Alstom turbine on a specially designed tension-legged platform attached by ties to the sea bed. “The water pulling back creates an extremely stable platform,” says Mr Scott. “Our work indicated that floating will be cost effective in water depths from 50m up.”

He argues that floating wind turbines based on current costings should be capable of delivering power at a cost of £85 a megawatt hour, making them economically competitive with fixed-foundation offshore arrays.

One potential attraction of floating turbines is the possibility of anchoring them close to shore lines, where sea depths increase rapidly at short distances from land.

While the UK is awash (so to speak)

with good offshore sites for conventional wind farm arrays, parts of Europe and much of the west coast of the US lack suitable seabed conditions, according to Mr Scott.

So too does Japan, which following the Fukushima nuclear disaster is desperate to develop wind farms in waters that drop to rapidly challenging depths off most of its coast.

Two smaller-scale pilots have already been launched, delivering more modest output than those planned by CNCS and Glosten, but in testing waters.

Hywind, a floating platform featuring a 2.3 megawatt Siemens turbine and backed by Statoil, was deployed in a Norwegian fiord in 2009. It has since produced 32.5GWh of energy.

That pilot was followed by WindFloat, which used a 2MW Vestas turbine and was installed 5km off Portugal by a consortium including EDP, Repsol and US designers Principle Power. It has reportedly held up well in challenging sea conditions.

But small increases in the size of wind turbines can have a disproportionately large effect on power ratings and eco-

nomics viability as a green energy source; hence the drive to prove that bigger units can be successfully deployed without fixed foundations.

Nick Medic, director of offshore renewables at lobby group RenewableUK, says the UK already has 4GW of offshore wind turbines deployed – more than the rest of the world put together – with plans to increase that to 10GW by the end of this decade.

These plans are based on fixed foundation units. But Mr Medic agrees that the success of floating pilots capable of using more powerful turbines could establish the concept as an important part of the renewable energy mix.

He says there are areas that are more suited to floating technology, where there are difficulties with the sea shelf.

“Mass production of these could deliver cheaper and quicker instalment when you don't need to monopolise foundations – you just need to tag them out.”

“Circumventing the need for a lengthy and costly offshore installation process could be a selling point.”

Alliances with importers will give competitive edge

GUEST COLUMN

Nick Butler

The oil sector is just beginning to come to terms with the fall in prices that has occurred over the past four months. A drop of 30 per cent in the price of Brent crude since June is a jolt but not as negative for the companies as it is for the governments of oil exporting countries.

Most of the price of a barrel of oil is taxes and duties and many governments had come to rely on \$100 a barrel or more to balance their budgets. Profit margins account for only a small part of the total and, although the fall in prices will hit profits, the costs of production for most fields are relatively low. Dividends are secure, with some companies still bravely increasing them.

In the strategic reviews that are now being undertaken, the questions are whether prices will stabilise and what will happen to projects that need oil at \$100 a barrel or more to generate a competitive return. With total revenue down, the companies have to prioritise. They are likely to be cautious, putting dividends first and postponing the most expensive new ventures. This applies to gas as well as oil, making the next wave of planned liquefied natural gas projects particularly vulnerable.

Many companies will think the oil price fall is temporary and will soon bounce back, as the impact of the lack of investment in new supplies – especially in areas such as Iraq – begins to work through. By contrast, natural gas prices look set for a steady downward trajectory, which will be reinforced by the return of nuclear power to Japan next year.

Gas supplies to Japan grew rapidly after the Fukushima nuclear disaster, pushing prices – particularly in Asia – to unprecedented levels. The coming fall in demand as the nuclear stations resume operation is already reducing price expectations for next year and beyond.

But oil and gas prices are not the only issue of strategic concern. There is Russia. With the Middle East and Iraq in particular looking too dangerous to justify major investments and north Africa in continuing chaos, Russia is one of the few places in the world where private sector investment in large-scale resource plays is possible.

But the country is under a tightening sanctions regime and projects are going to be very hard to fund through any financial institution based in Europe or the US. After the BNP Paribas case, which ended in a fine of \$8.9bn for a violation of US sanctions against Iran, Sudan and Cuba, banks' risk committees are unlikely to take chances on Russia.

Some companies have a significant presence in Russia, others have aspirations. The tricky strategic challenge is that, as things stand, investors can

neither move forward nor back. To go in further could be deemed a breaking of sanctions. To pull out would alienate Russia for a very long time. The companies are left powerless, hoping the conflict will resolve itself and that the sanctions in place do not provoke a Russian response targeted at their existing assets and dividend flows.

Another strategic issue is not new, but has become more urgent: big growth in energy demand will come in Asia, and perhaps Latin America, not in the US or Europe.

But, despite years of trying, none of the majors have broken into China or India on any significant scale. Local companies, often with government backing, control the downstream. That leaves the majors competing to sell oil and gas in a process that threatens to cut margins to the minimum, especially if trade becomes dominated by state to state deals between producer and consumer governments.

The Russians have signed a 30-year deal to supply 58bn cubic metres of gas to China, and Vladimir Putin, Russia's president, arrives in Delhi on December 10, no doubt with another offer in hand.

If the centre of gravity of the energy business is moving east, the majors and most of the rest of the sector look to be behind the game. If any one of them can break through and build a strategic alliance with one of the importing countries, it will have won the first important competitive contest of the 21st century.

Nick Butler is a visiting professor at Kings College London, and editor of the FT's Energy and Power blog

Floating turbines could be a cheaper alternative to farms built on solid foundations

If the centre of gravity of the energy business is moving east, the majors and most of the rest of the sector look to be behind the game

Energy



Mobile services: Nest produces smart thermostats that can connect products with devices from washing machines to cars, allowing customers to adjust the temperature at home before they arrive - Nest

Long heralded internet of things comes of age

Technology

Remote control of devices means the web is moving from the virtual to the physical, writes *Jeevan Vasagar*

Encouraging customers to buy less from you sounds like an odd way to run a business. But, as the traditional model of suppliers undergoes changes, that is one way that utilities hope to boost their earnings.

Power generators can save the expense of using their peak-load power plants by persuading householders to reduce their consumption when demand is high.

The tricky part is that - in contrast to supplying to businesses, where

consumption is monitored closely - tracking the costs of usage in households has traditionally had a time lag.

There is a risk of the supplier being out of pocket if incentives to cut demand are too generous and too widely taken up by consumers. Household bills are generally settled in arrears, but with a business, special offers can be adjusted in real time.

"A large factory is usually read on a half hourly meter," says Neil Pennington, director of smart innovation at RWE Npower, the UK company.

"The risk of sending a price signal to an industrial client is a lot lower than shifting a lot of domestic load that only gets settled a year later."

However, the rise of smart meters and smart thermostats is ushering in an era when household use can be measured and controlled with greater accuracy.

For many, Google's \$3.2bn purchase of Nest Labs - a maker of smart thermostats and smoke alarms - was the

moment when the long-heralded internet of things came of age for household electrical devices.

Hardware can be used by companies to map overall use, instead of installing smart plugs on every appliance.

By looking at usage data, the weather and profiles of consumption, accurate predictions can be made. Customers can be offered time-sensitive predictions of costs, enabling them to shift usage. Suppliers can then manage demand across the vast numbers of domestic users.

In the US, deployment of smart meters and thermostats outstrips the rest of the world, so potential benefits for power suppliers are increasingly significant.

Manufacturers of the technology have struck deals with utilities to offer their products to consumers. Once installed, the thermostats and meters are able to adjust consumption with programmes such as Nest's "Rush Hour Rewards".

Lauren Callaway, an analyst at Navigant Research, says: "The technology is at a point where [households] can provide a substantial resource in a small amount of time."

Ms Callaway says that a leading US grid operator is pushing for household demand response to be included in a reserve market that trades in electricity needed at short notice. This creates an incentive for suppliers to promote more effective management of household consumption.

The technology of smart thermostats also has the potential to transform the relationship between customers and suppliers of heating systems.

Tado, a Munich-based smart thermostat developer, has launched a service that helps customers detect malfunctions and maintenance needs before their boiler breaks down. The data being gathered could also be used to offer tips about which heating system to buy.

Co-founder Christian Deilmann says:

"There is basically nobody out there who knows as much about heating system performance as we do. We know which systems are efficient and which ones are not, and we know which ones break down often."

From the fitness sector to the car industry, the internet is shifting from the virtual to the physical. Makers of smart thermostats are trying to make control of home energy frictionless by linking devices. Nest, for example, has agreements to connect its products with devices from washing machines to cars.

Lionel Paillet, general manager for Europe with Nest Labs, says: "We're not going to create a fridge. We're not going to create a washing machine."

"We know those products are very important in the house. If they are connected to the internet, there's a great way to connect and exchange [data]."

Thanks to an agreement Nest has with Mercedes-Benz, the GPS in a customer's car can be used to adjust the tempera-

ture at home for the time of arrival. However, opportunities created by smart devices can seem intrusive. Energate, an Ottawa-based energy management company, says one of its executives worked out a customer's air conditioning had a blocked filter by studying the data.

"We told the utility, there's a customer that needs to replace a filter," explains Louis Szablya, executive vice-president of sales and marketing at Energate. "They decided not to tell the customer, because of the implication that somebody was watching him."

Energy is a humdrum commodity. Consumers expect a reliable supply and only notice when there is a failure, or prices seem excessive. This is an opportunity to exploit the appetite for a home that ticks over without intervention.

As Mr Paillet of Nest puts it: "You don't have to tell [the devices] what to do or how to do it - it's a conscious home."

The 'age of abundance' poses fresh dilemmas for companies

Continued from page 1

the World Coal Association. These numbers are estimates, and subject to large revisions, but the lesson of the US shale boom is that human creativity, if provided with the right economic incentives, can achieve remarkable feats.

If the resources are there, someone, given enough time will find a way to use them profitably.

What cannot be relied on, however, is that favourable conditions in economics, politics, finance and engineering will always be there to mobilise resources when they are needed, particularly in the context of a world in which the total demand for energy is expected to grow by more than a third by 2040.

The abundance of US oil and gas is having an impact on prices by adding to global supplies. Although US crude oil exports are tightly restricted, there are no such constraints on overseas sales of products such as diesel, which have been soaring.

Booming domestic production is also taking the US out of the market as an energy importer. Imports are expected to provide just 21 per cent of US liquid fuel consumption next year, down from 60 per cent in 2005. As the new US liquefied natural gas (LNG) export plants come on stream, with Cheniere Energy's Sabine Pass expected to start up late in 2015 or early in 2016, the country will also shift from being a net importer of gas to being a net exporter.

As oil supply disruptions in other countries such as Libya ease, and global demand slows sharply this year, the growth in US production has started to weigh heavily on prices, driving down crude by about 30 per cent since June.

Because natural gas prices are often linked to oil on long-term contracts in Europe and particularly in Asia, that is



Exploration in the Marcellus Shale

having the effect of driving down prices for gas consuming countries' LNG imports and other gas supplies as well.

The question of how well the US shale oil industry can survive with these lower prices is yet to be decided. The industry only really took off about four years ago, and has benefited from US benchmark crude above \$90 for most of that time. It is now having to adjust to a price of about \$75.

Pearce Hammond, an analyst at Simmons & Co, an investment bank specialising in the energy industry, argued in a recent note that the smaller and mid-sized US companies that have led the shale revolution have been achieving higher output from their wells as a result of adjustments to their production techniques.

He added that "the resource abundance of US tight oil could make US oil production more resilient than many

currently surmise, even at a lower price". If US production remains strong for longer, it could drive oil prices down more. Yet whatever happens in the next two years, the long-term picture shows there is still enormous unmet demand for energy worldwide.

In its latest World Energy Outlook the International Energy Agency (IEA), the watchdog backed by developed countries, predicted global consumption would rise from the equivalent of 13.4bn tonnes of oil in 2012 to 15.3bn tonnes equivalent in 2020 and 20bn tonnes in 2040, if current policies were maintained. If new policies to improve efficiency and curb consumption succeed, those numbers are cut to 15bn tonnes in 2020 and 18.3bn tonnes in 2040, but that is still significant growth, all from emerging economies.

Energy demand in the developed world seems to have peaked and is likely to be roughly flat from now on. China's demand is rising slowly, but a combination of demographics and the end of rapid industrialisation is expected to cap its consumption by 2030.

For the rest of the world, however, the IEA thinks demand will keep growing. Unless there is a concerted effort to tackle the threat of climate change, most of that additional energy demand will be for fossil fuels. For oil in particular, that has important implications. In terms of geology, the world's most accessible reserves are in the Middle East, but the tensions in the region suggest oil supplies could easily face disruption.

US shale drillers responded with impressive ingenuity and entrepreneurship the last time supplies were constrained and oil and gas prices soared in the mid-2000s. The energy industry is likely to demand similar creative leaps in the decades to come.

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LET'S GO



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Energy

Public scepticism could turn off the reactors

Nuclear Industry at risk despite climate benefits, reports *Ed Crooks*

In the past year, two competing visions of nuclear power have hit cinema screens. One was *Pandora's Promise*, a thoughtful documentary about the risks and benefits of nuclear generation. The other was the spectacular big-budget remake of *Godzilla*, the Japanese allegory about the perils of nuclear energy run amok, with allusions to the Fukushima disaster of 2011.

In cinemas worldwide, *Godzilla* has grossed \$525m, while *Pandora's Promise* has made about \$67,000.

This contrast is indicative of the state of the global debate over nuclear power: whatever the benefits might be, there is a weight of public scepticism that needs to be overcome.

Nuclear energy is the world's second-largest form of generation that is low in greenhouse gas emissions after hydro power. But it has been in relative decline, dropping from 18 per cent of global electricity supply in 1996 to 11 per cent in 2013. The International Energy Agency (IEA) has warned it may decline further in coming decades.

The scale of nuclear plants, their longevity, the problems of waste disposal, decommissioning and risk management mean that nuclear investment is inevitably a highly politicised business.

From China to the state of Georgia in the US, new plants are mostly being built in heavily regulated markets. Where there is new investment in nuclear energy in competitive electricity markets, as in the UK, it has required generous government guarantees.

This means that to grow, the nuclear industry needs support from politicians and - in democracies - the public.

In some countries, opinion has taken a decisive shift away from nuclear power since the Fukushima disaster. Germany undertook to shut down all its nuclear plants by 2022, while increasing its reliance on renewables, including wind and solar power. This move has raised concerns about electricity costs and reliability, and prompted a new round of investment in coal-fired plants.

Italy's government had a plan to increase its reliance on nuclear power, in part to reduce its exposure to imports of Russian gas, but that was rejected by voters in a referendum in June 2011,



Protesting against nuclear power

three months after the Fukushima crisis.

In other countries, there was no such shift in attitudes. In Britain, public support for nuclear power has dropped slightly since Fukushima, but has nevertheless risen over the past decade.

However, even where there has not been a decisive shift away from nuclear power, public opinion is generally equivocal. A poll for the UK Energy Research Centre last year found 32 per cent of people supportive of nuclear power but 29 per cent opposed. Solar power, by contrast, was supported by 77 per cent of respondents.

As a result, political support is often hesitant. President Obama's administration has supported nuclear power, this year, agreeing \$6.5bn in loan guarantees for two reactors being built by Southern Company in Georgia, but he talks more often about renewable energy.

The Republicans, who made sweeping gains in this year's midterm elections, are focused on support for fossil fuels, prioritising cases such as the Keystone XL oil pipeline from Canada and blocking environmental regulations that would restrict coal-fired generation.

Some traditionally pro-nuclear countries have become more sceptical. In France, for example, the chief executive of EDF, the state-controlled electricity group, used to brag that public support

for nuclear energy was the country's great natural resource. Last month, however, the lower house of parliament backed a bill mandating a cut in nuclear power from 75 per cent to 50 per cent of the country's electricity by 2025.

In Japan, prime minister Shinzo Abe is keen to see nuclear plants that were shut down after Fukushima restarted, as imports of expensive liquefied natural gas are driving up electricity costs and increasing the trade deficit. However, polls show only about a third of the public supports that plan.

These attitudes matter, because developed democracies operate most of the world's nuclear power plants: about 80 per cent, according to the IEA.

Many emerging economies would like to develop nuclear power programmes, and 45 are "actively considering" it, according to the industry group World Nuclear Association. China dominates the global outlook for the industry, accounting for 40 per cent of all nuclear capacity under construction worldwide, according to the WNA, and 35 per cent of all the capacity that is planned.

Over the coming decades, however, the growth of nuclear generation in emerging countries will be offset by retirement of ageing plants in the developed world.

The IEA calculates that by 2040, about 200 of the 434 reactors operating at the end of 2013 will have been shut down, the vast majority of those in the EU, US, Japan and Russia.

Those trends make it possible to envisage a future described by the IEA as the "low nuclear case", in which the share of nuclear generation drops to 7 per cent by 2040.

Other outcomes are possible, and an industry that is better at delivering plants on time and on budget, and wins more political support, could increase nuclear power's market share to 14 per cent.

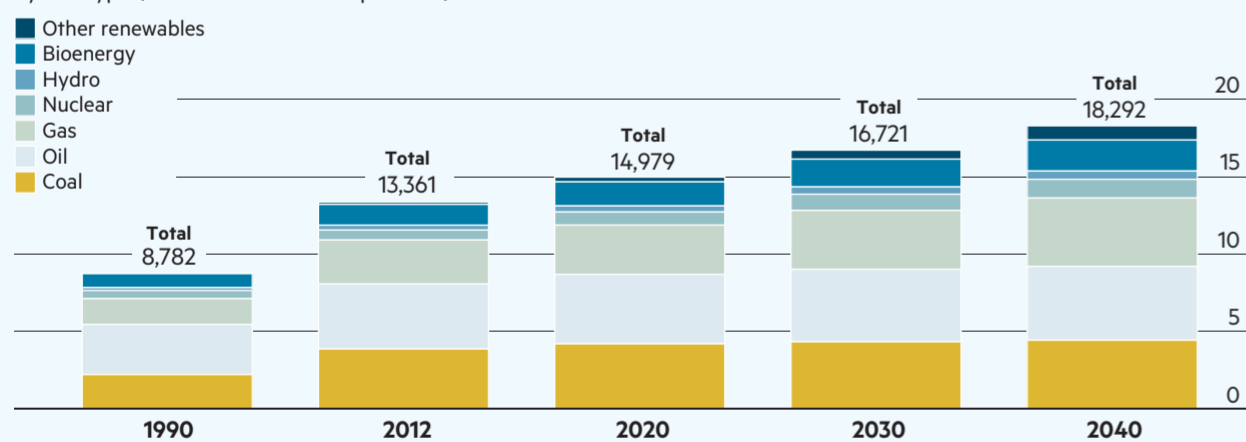
A future in which greenhouse gas emissions are curbed to an extent that gives the world a good chance of avoiding damaging climate change, however, could require an even greater commitment to new nuclear power, according to the IEA.

It says an important factor for that would be "broad public consent".

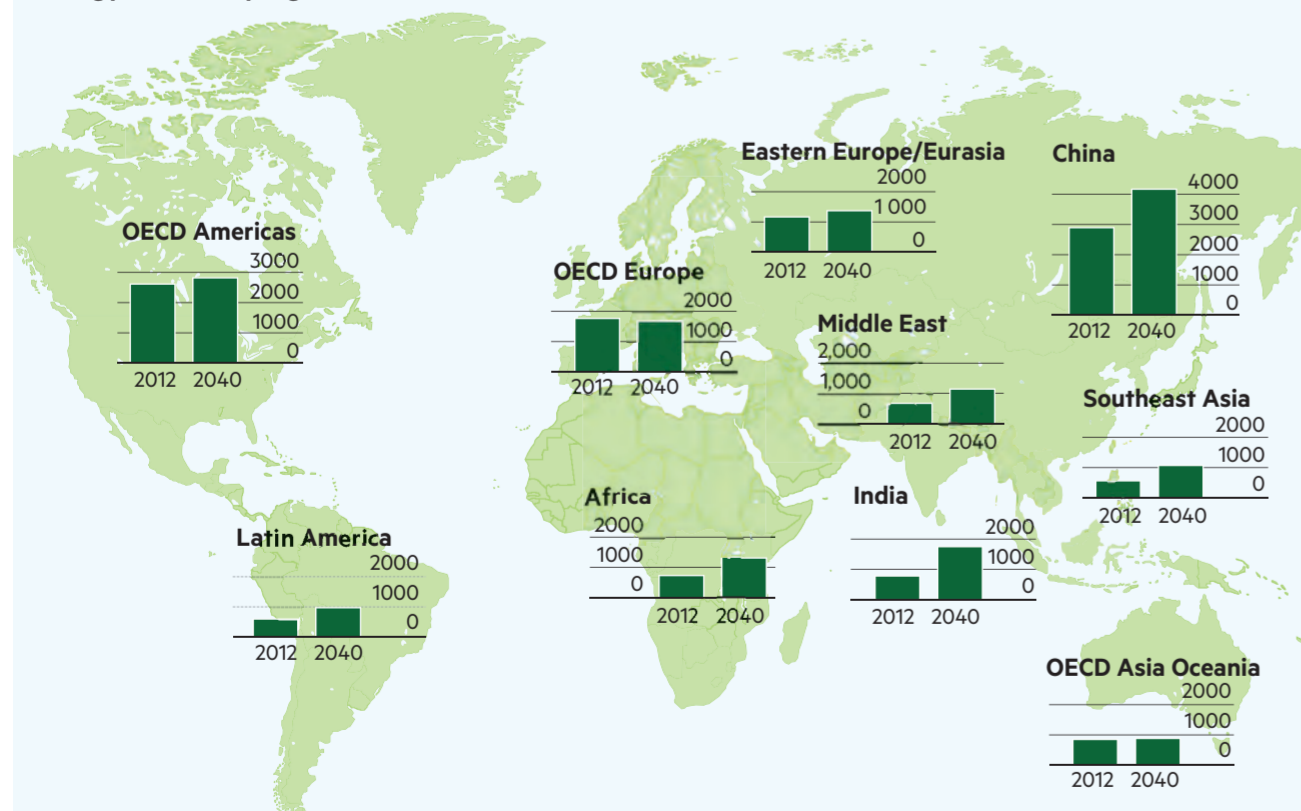
A growing demand for energy

Forecast world consumption

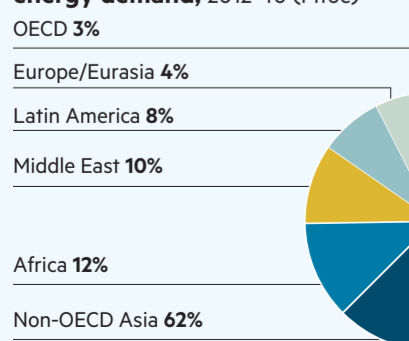
By fuel type (million tonnes of oil equivalent)



Energy demand by region (Mtoe)

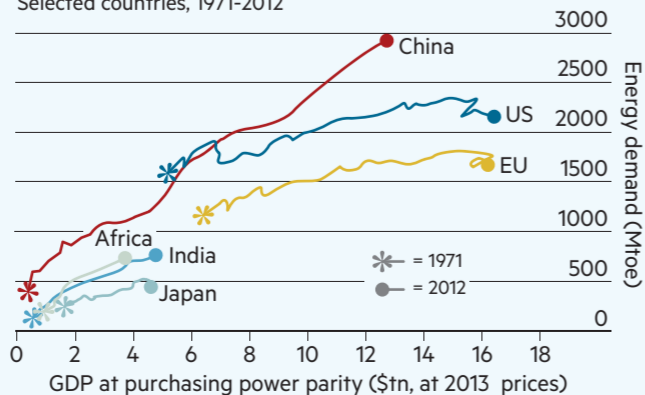


Forecast shares of growth in total energy demand, 2012-40 (Mtoe)



Energy demand and GDP

Selected countries, 1971-2012



Sources: IEA; FT research

Forecasts are IEA central scenario, assuming changed government policies



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