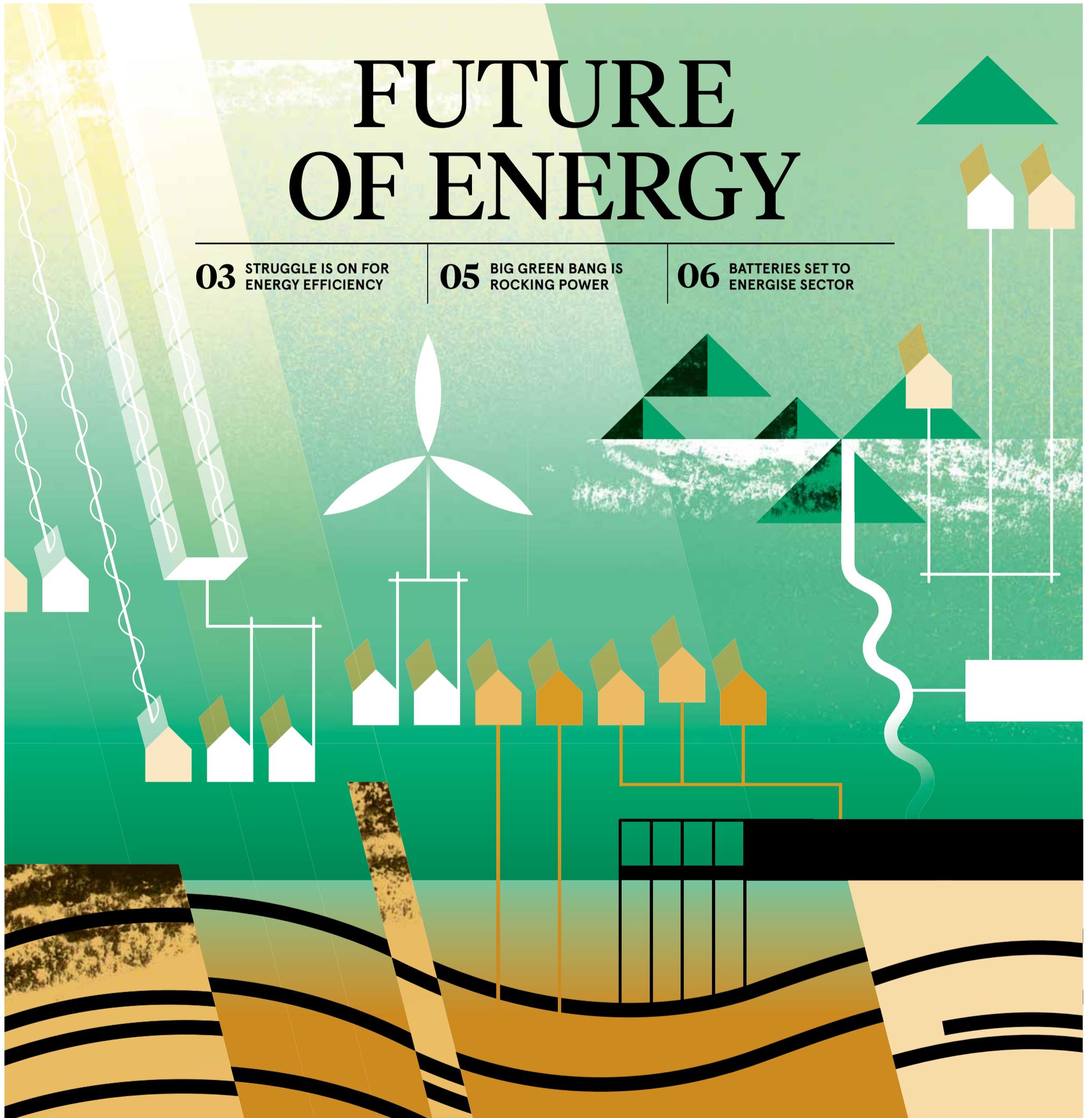


# FUTURE OF ENERGY

**03** STRUGGLE IS ON FOR ENERGY EFFICIENCY

**05** BIG GREEN BANG IS ROCKING POWER

**06** BATTERIES SET TO ENERGISE SECTOR



Regardless of its age, make your building fit for the future by reducing your energy use and cutting carbon emissions.

Find out how on page 4



Cooling | Heating | Ventilation | Controls



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# FUTURE OF ENERGY

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# Life-and-death struggle for energy efficiency

In the tangled relationship with water resources and food production, energy efficiency is saving livelihoods and lives

## JIM McCLELLAND

If we really are what we eat, then we are mostly water and energy – and we are running dangerously low on both. According to the United Nations, agriculture is the largest consumer of freshwater resources on the planet, accounting for roughly 70 per cent. More than a quarter of global energy use also goes on food production and supply, with the UN Food and Agriculture Organization forecasting 70 per cent additional output needed to feed a 2050 population of nine billion.

For the future of energy, water is essential at the level of large-scale power generation, not just literally in terms of hydro, wave and tidal, but indirectly, facilitating extraction and processing of fuels, as well as, importantly, providing cooling.

Cooling is critical. Research from the World Resources Institute found 40 per cent of India's thermal power plants located in areas of water stress. As a consequence, 18 faced shutdowns caused by water shortages during 2016. The total loss to the country has been calculated at roughly 14 terawatt-hours of thermal electricity generation, enough to power Sri Lanka.

In turn, water as a resource is uniquely susceptible to climate risk, says Mark Fletcher, global water leader at Arup. "Whether we're experiencing too little or too much water, climate change is felt most through its impact on the water cycle," says Mr Fletcher.

Agriculture suffers both immediately and incrementally. He adds: "Climate change can impact through shocks and stresses. It can disrupt food production in the short term by ruining single crops and also on a longer-term seasonal basis."

Research from the World Bank has estimated that since 2001 rainfall shocks have caused a loss of food production sufficient to feed about 81 million people, the equivalent of the population of Germany, every day for an entire year.

Talk of human-made climate change inevitably brings us back to energy, acknowledges Mr Fletcher. "Impacts of climate change are mitigated by use of low-carbon renewable energy rather than carbon-intensive fossil-fuel sources," he says. "Energy efficiency helps reduce overall demand."

For sustainability, this is the trilemma of the water-energy-food nexus, a tangled web of circular relationships and infinite reciprocity,



where everything depends on everything else.

According to Pedro Faria, strategic adviser at CDP, there are at least two ways of framing this challenge. "Firstly, it's as an issue of competition for resources," he says. "Energy competes with other uses of water for the water itself and it also competes with food as another use of land for biomass.

"Secondly, it's related to resilience. How does a population find the balance of resource supply and demand that provides the highest level of resilience to shocks for the three variables essential for human lives?"

Solving this riddle of resilience is nowhere more important than in Africa, says Dr Richard Munang, Africa regional climate change co-ordinator at the United Nations Environment Programme. "This nexus presents opportunities to create income in a manner that accelerates realisation of multiple [UN] sustainable development goals (SDGs), those responsible for poverty, food security, climate action and ecosystems," he says.

With escalating climate change, the second *Africa Adaptation Gap Report* warns that total water available for agriculture will decline by more than 10 per cent. The implication is that Africa's agriculture and food systems, currently 98 per cent fed by rain, will increasingly rely on irrigation to achieve productivity. This calls for energy-efficient systems.

In Kenya, estimates from small-scale initiatives show that using solar-powered, efficient micro-irrigation is saving farmers more than \$10,000 annually in operating costs. The system conserves up to 1.9 billion litres of water a year, while offsetting carbon with 64,499 kilowatt-hours of clean energy.

Furthermore, with Africa in dire need of income and employment prospects for its booming youthful population, an industrialised agriculture sector could harvest \$1 trillion in opportunities. Energy stands as a critical enabler to this end.

However, unlocking achievement of multiple SDGs calls for game-changing thinking as joined

up as the nexus itself, says Dr Munang. "The urgent need is for policy coherence across multiple ministries towards establishing energy efficiency, specifically for powering sustainable agro-industrialisation to accelerate much-needed socio-economic transformation and climate resilience," he says.

On a more domestic scale, energy efficiency is also core to a pioneering four-year programme to promote resource management and sustainable livelihoods, currently being undertaken in Afghanistan by People in Need, a Czech NGO working to implement humanitarian relief and long-term development projects worldwide.

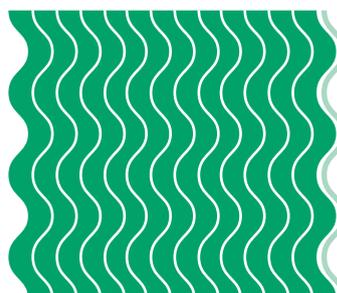
Seeking to boost prospects and build resilience, the project directly supports around 6,500 households, comprised of 45,500 people, in 75 villages throughout the province of Samangan. It provides for training in agricultural resource conservation and water management, establishment of commercial fruit plantations and nurseries, plus introduction of energy-saving stoves and home insulation.

Targeting a 20 per cent rise in agricultural yields, the initiative aims to get 40 per cent of selected households using energy-efficient technologies, so needing 20 per cent less firewood. The energy-efficiency measures are hugely important to the project. Accounting for at least one in every €10 of investment, they reduce wood-burning in homes, leading to less deforestation, which improves rainwater management, soil quality and crop yields.

The water-energy-food resilience gains are vital, concludes Wail Khazal, country director for Afghanistan at People in Need. "Especially in rain-fed areas, considering the unpredictable weather in recent years, the nexus is crucial to planning not just the projects, but more importantly, the farming season," he says.

"While the connection between all three aspects is important worldwide, in the case of most of Afghanistan and the very limited resources of water available here, associated good planning and preparedness can prove a life-saving approach."

This is the inescapable truth of the water-energy-food nexus, experienced firsthand in the fields of Africa and Afghanistan. Saving energy is saving livelihoods and saves lives. ♦



# 98%

of global electricity supply critically depends on the availability of water

World Energy Council 2016

# Buildings are an opportunity not to be wasted

How to achieve sustainability when refurbishing building stock by cutting energy and carbon

When it comes to the future of energy, buildings are both a bad news headline and a good news story. They are responsible for 40 per cent of EU energy consumption and 36 per cent of CO<sub>2</sub> emissions. According to the European Commission, though, energy efficiency could cut both impacts by at least 5 per cent.

On average, older properties consume five times more energy, with about 35 per cent of EU buildings now over 50. This ageing and evolving building stock brings with it a multiplicity of design, specification and installation challenges.

Availability of proven energy-saving and carbon-cutting tech, however, makes rising to those challenges an everyday reality, says Martin Fahey, head of sustainability at Mitsubishi Electric's UK Living Environment Systems. "Addressing climate-resilience concerns by adopting sustainable solutions and adapting our built environment is actually not that difficult, in principle," he says. "It is an opportunity waiting to be seized."

For the UK to achieve an 80 per cent cut in emissions by 2050, making buildings a better fit for the future is a must. Moreover, with 18 per cent

of UK commercial stock falling into bands F and G for Energy Performance Certificates, almost one in five properties risk becoming illegal to rent on the arrival of the Minimum Energy Efficiency Standard (MEES) in 2018.

The business imperative is, therefore, clear and Mitsubishi Electric has been busy helping developers and owners seize opportunities in buildings, new and old, big and small, from a refurbished hotel and charity HQ, to County Hall on London's South Bank.

## FROM DERELICT SHELL TO PRESTIGIOUS VENUE

Once the historic headquarters of the Greater London Council, County Hall is a listed London landmark on the River Thames, sat across from Big Ben and the Houses of Parliament.

Fast-forward to 2017 and the majority of its third and entire fourth floor were transformed to provide 68,000 square feet of 21st-century conference and meeting spaces for etc.venues.

In a building dating back to 1922, the new areas boast all the advantages of modern heating, ventilation and air-conditioning system, designed, installed and commissioned by Cool Systems Holdings, manufactured and supplied by Mitsubishi Electric.

Sympathetic restoration meant working around listed elements and energy-efficient comfort has been guaranteed through the use of seven outdoor condensing units on the roof, delivering simultaneous heating and cooling to 72 fan-coil units. Air handling and mechanical ventilation with heat recovery also provides fresh air to the conference suites, while recovering up to 80 per cent of otherwise wasted energy.

## ENHANCING THE BRAND

Another recent refurbishment that has delivered high-value energy efficiency, combined with first-class comfort, is the upgrade to the Fox & Goose Hotel, near Hanger Lane in Ealing.



01



02

**01** Refurbishment of parts of County Hall has transformed it into a 21st-century conference centre

**02** The upgrade of Locality's Shoreditch offices shows how any sized building can benefit from energy efficiency

The 73-bedroom hotel, run by Fuller, Smith & Turner plc, was built in 1997 and extended in 2000. With the existing air conditioning reaching the end of its useful working life, Fuller's approached Mitsubishi Electric to ask for a recommended contractor.

"We spoke to Turn Key Air Conditioning and they came up with a proposal that allowed us to upgrade to new, energy-efficient heat recovery air conditioning without the loss of any bedrooms throughout the works," says Tony Hogan, senior property surveyor for Fuller's.

"For a working hotel this was an essential requirement, which allowed our management team to continue providing the very best comfort

for our guests, while enabling us to future-proof the building and gain even better control of energy use."

Turn Key offered a full design, supply, installation and maintenance solution to provide Fuller's with complete assurance throughout the refurbishment work as sales manager Mitch Swirles explains: "As a Diamond Quality Partner (DQP), we have reached the highest level of partnership with Mitsubishi Electric which allows us to offer longer warranties."

"This DQP status is also a proven demonstration that our work matches the high quality of manufacturing so Fuller's know they are going to get the best out of the system throughout its working life."

This long-term assurance is vital to businesses such as Fuller's that need surety the investment in modern, energy-efficient equipment will increase guest comfort, while enabling increased centralised control and energy reporting.

"At Fuller's we take our responsibilities to our clients, our staff and our brand very seriously," says Mr Hogan. "Working closely with both the manufacturer and one of their most trusted suppliers enables us to tick all the right boxes."

## SIZE IS NOT AN ISSUE

Catering principally for the needs of staff, rather than guests, refurbishment of the London offices of Locality also gave the network of community-led organisations opportunity to provide a more comfortable, energy-efficient environment.

The upgrade to its Shoreditch building necessitated use by installation contractor 361 Degrees of different air-conditioning and ventilation solutions on all three floors. Diverse layouts and requirements ranged from high ceilings and exposed ductwork, through a separate meeting pod and suspended ceilings, to new designs for retention of natural light. Thanks to the versatility of the Mitsubishi Electric offering, Locality

now has a light, airy and comfortable office facility that delivers energy, carbon and cost-savings for the charity.

A 2016 exemplar project at the London home of the UK Green Building Council (UK-GBC) also saw Mitsubishi Electric contribute to the achievement of the lowest embodied carbon footprint ever recorded for an office refurbishment in the UK. Such ambition, not just on the part of clients, but the construction industry as a whole, is driving forward the green agenda, says Cat Hirst, director of learning and innovation at UK-GBC.

"There is a real business case for sustainability, which is increasingly getting proven, at both organisation and building-project level," she says. "We are seeing amazing examples of leadership."

As a member of UK-GBC, Mitsubishi Electric is working hard to help "sell" sustainability into mainstream built-environment markets. It is important to get the message out there that deliverability is not an issue. Mr Fahey concludes: "We need to demystify and derisk the idea of sustainability to convince clients that cutting energy and carbon is not only doable, but is actually being done – the solutions and skills already exist."



**Martin Fahey**  
Head of sustainability  
Mitsubishi Electric's UK Living  
Environment Systems

**We need to demystify and derisk the idea of sustainability to convince clients that cutting energy and carbon is not only doable, but is actually being done – the solutions and skills already exist**

**Mitsubishi Electric UK Living Environment Systems regularly appears in the SustMeme Top 500 Built Environment ranking, published by Jim McClelland every Monday @SustMeme. The company can be followed on Twitter @meuk\_les and publishes useful articles on legislation such as MEES on its blogsite <http://thehub.mitsubishielectric.co.uk>**



Cooling | Heating | Ventilation | Controls

RENEWABLES

# Big green bang is rocking energy sector

Once relegated to an environmental alternative, renewables are becoming the most economic energy choice

FELICIA JACKSON

Investment in renewables must triple to reach 2050 targets, warns Adnan Amin, director general of the International Renewable Energy Agency (IRENA). But, for the first time, as the costs of renewable power continues to fall, due to lower equipment costs, improvement in performance and tenders putting pressure on prices, it seems there is a real possibility of achieving that goal.

Mr Amin says: "The ecosystem of energy is changing, and we're seeing the impact of renewable energy in economic and social terms. We've passed the tipping point for power generation for the developed and developing world, and I see a decade-long cost reduction process ahead of us."

There has been a fundamental change in perception of renewables. Renewable energy is rapidly becoming the economic alternative for energy provision all over the world. According to the findings of an IRENA report, the average cost of onshore wind power is now competitive with the cheapest fossil fuels, marking a significant turning point.

In fact, global weighted average costs over the last 12 months for onshore wind and solar PV (photovoltaic) now stand at 6 cents and 10 cents per kilowatt-hour respectively. European offshore wind is seeing subsidy-free bids at auction, while the price of solar electricity has fallen 73 per cent since 2010 and, according to Mr Amin, is expected to at least halve in price by 2020.

A constant question is what new forms of renewable technology will increase economies of scale and become attractive propositions for the private sector. The IRENA chief says: "I'm not a gambling man. Given the dynamism we've seen in the innovation process there'll be a series of hybrid options emerging in different markets. Decentralisation, for example, has become a big phenomenon."

He does, however, see three particular areas of significant potential growth. The first is floating wind. The Japanese are trialling it while the world's first floating turbines are providing electricity to the grid through Scotland's Hywind project. Fixed-bottom solutions become



Popov/Jullstein bild via Getty Images

IRENA director general Adnan Amin

unviable beyond around 50 metres because the cost becomes prohibitive in deeper waters. According to Statoil, Hywind can operate at depths of 800 metres, opening many new regions for development.

Storage continues to develop and Mr Amin says: "If the innovation and R&D we've seen in battery storage continues it'll be a game-changer." Grid management remains a key driver, but with grids in China, Spain and Germany able to predict solar and wind accurately 24 to 48 hours ahead, this begins to overcome system congestion issues.

Mr Amin adds that system operators can manage a significant load of renewables and, if the growth in decentralisation continues, the growing focus on home storage systems will also contribute to the changing nature of the grid.

Another exciting area is perovskite solar cells, which can be in solid form or sprayed on to materials, transforming the potential use of the technology. While there have been challenges in taking the technology out of the lab, Moscow State University has reported success with stabilisation and 22 per cent efficiency rates. Mr Amin

comments: "If it works, it could dramatically cut the cost of solar in the future."

When it comes to accelerating investment, one thing most financiers agree upon is there is no lack of capital, but rather a lack of bankable projects and that means risk profile. While risk-mitigation tools or credit enhancements exist, they can raise the total cost of projects. What is changing is the nature of risk.

Projections of a market tipping point are crucial to an assessment of risk; when does the balance shift between investing in the status quo and investing in the future? Kingsmill Bond of Carbon Tracker argues that markets shift as opportunities shift. The issue is demand; as demand grows will electrification replace power generation and what will fuel transportation?

Mr Bond points out that small falls in market share can have a profoundly disruptive impact and argues that major tipping points occur when a disruptive technology takes only 2 to 3 per cent of the market. Electric vehicles (EVs), for example, already constitute 1 per cent of sales and this is set to grow rapidly.

Peak oil demand is critical to this. The International Energy Agency projects peak oil consumption in 2040, but BP's 2018 *Energy Outlook* has shifted its projections from mid-2040s to mid-2030s, moving a decade within one year. BP forecast a 100-fold growth in EVs by 2040. While travel demand will double, higher oil demand is expected to be offset by increased engine efficiency standards as well as the larger number of EVs and shared travelling.

Even Shell has said that if the most optimistic EV forecasts are correct, then peak oil could hit in the 2020s. Mr Bond believes it could be as soon as 2021.

Mr Amin says: "E-mobility is a driver for renewable energy; it's the next step-change. If the EV market follows the pattern of renewable energy technology over the next four years, it will have a dramatic impact on oil demand and therefore the global energy industry."

**Developments during the past few years exceeded the expectations of even the most optimistic supporters**

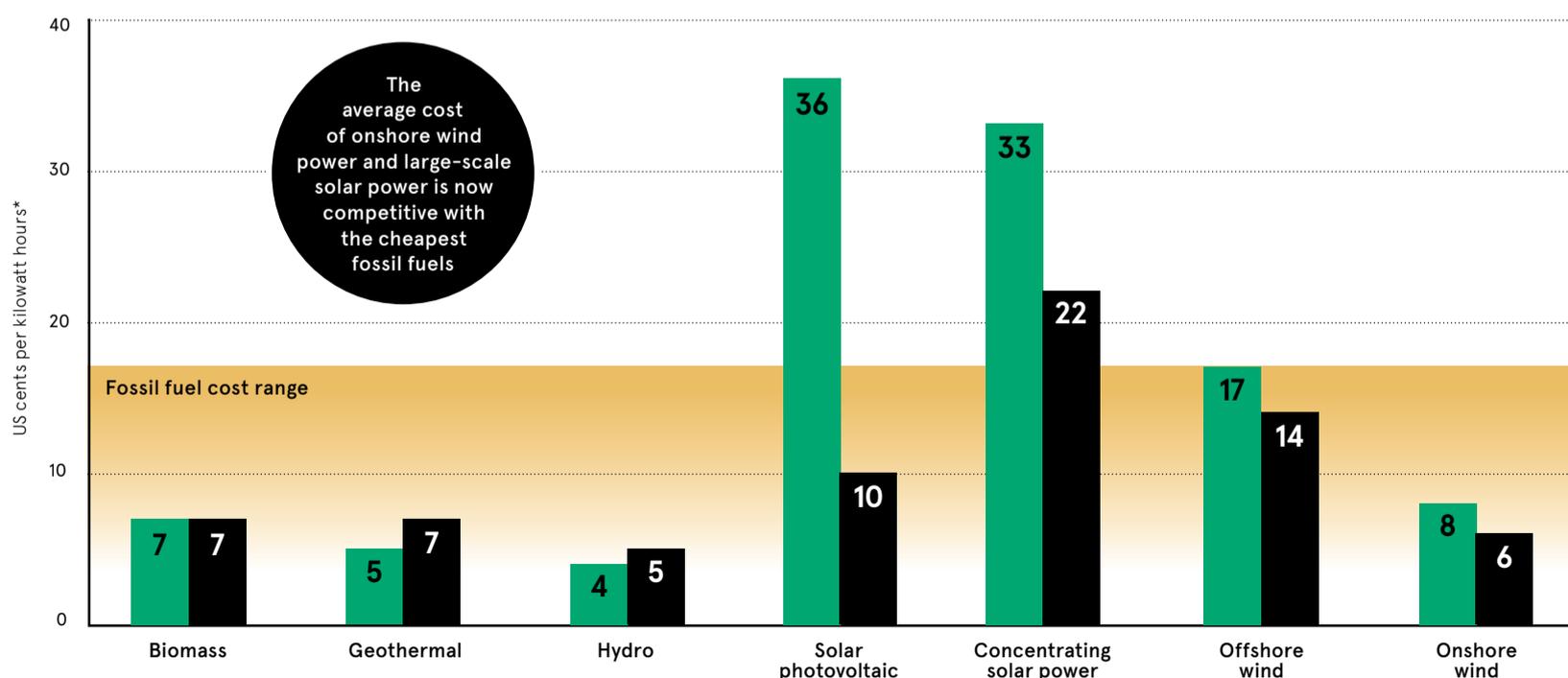
"The shift from one energy system to another is not simple and, undoubtedly, it will take many years before the current system is transformed. But the transformation of the current energy system is gaining pace and is unstoppable. Developments during the past few years exceeded the expectations of even the most optimistic supporters."

It seems the fossil fuel industry and policymakers have underestimated renewable energy in almost every historical projection, and this may well continue. The reality, however, is the future is bright and green. ♦

## Cost of electricity from renewable power generation

Levelised costs from utility-scale renewable energy

◆ 2010 ◆ 2017



\*The levelised cost is the average cost over a generating asset's lifetime

# Solving the energy crisis

Power supply is falling, leaving the UK in an energy crisis, with increased electrification of domestic lives and a growing population prompting a seismic escalation in electricity demand. The dilemma, sustained by the decline of fossil fuel-based power plants and the rise of renewables, is being resolved by the latest technologies

**T**he UK and Irish electric grids are at the forefront in terms of the volume of integrated renewables. However, because renewable energy sources, such as wind and solar, are intermittent and can change rapidly, their integration into the grid may not provide sufficient power during peak demand," says Michael Phelan, chief executive and co-founder of GridBeyond, formerly Endeco Technologies.

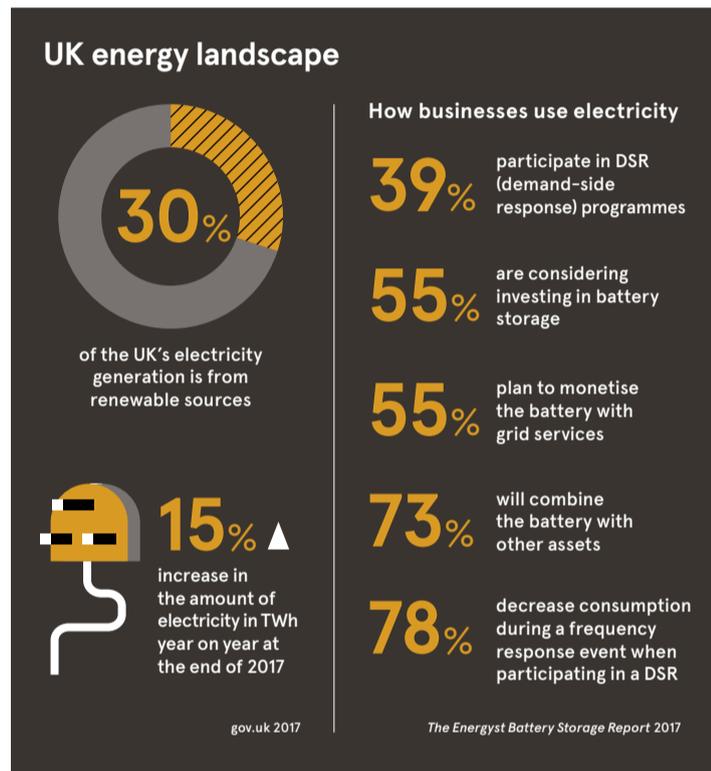
Maintaining the balance between energy generation and demand is crucial to ensuring the grid remains at a safe frequency of 50Hz. Technology is progressively providing the solutions needed to manage the fluctuations in grid frequency, and with accessibility comes incentives for large energy consumers in the industrial and commercial space to vary their energy consumption. For short periods, they can help to keep the lights on when grid frequency starts to look dangerously high or low, known as frequency response events.

Seen as the way forward by system operators and energy industry authorities, frequency response programmes are enabling energy to be generated or removed from the grid within seconds, when needed.

Mr Phelan says: "We've been managing and rewarding industrial and commercial clients' participation into National Grid programmes, including frequency response, for more than five years. Over time we've seen an increase in the number of events, indicating that the National Grid is finding it evermore challenging to stabilise effectively as renewable generation increases and that system inertia is reducing too."

GridBeyond leads the UK and Irish markets in providing pioneering internet of things demand-side response (DSR) solutions, and has developed a smart grid optimisation technology platform that enables system operators like National Grid to balance network frequency rapidly and maintain inertia, making greater use of renewable technologies and mitigate against blackouts.

At the same time, industrial and commercial participants benefit from significant financial rewards for fluctuating their energy consumption, and automated energy savings through the avoidance of demand peaks. In addition, consumption, predictive maintenance and OEE (overall equipment



effectiveness) analytics can be automated and monitored via a cloud-based portal.

Another key technology for renewable integration will continue to be battery storage. Renewable energy may be

## The key lies in energy flexibility and ultimately in technology

harnessed at times of wind and sun, but any excesses go to waste. To reduce this, energy companies can use batteries to collect and store excess electricity. However, with marginal returns on investment and relatively short-term revenue streams, Mr Phelan points to a hybrid approach.

He says: "By connecting a battery to an industrial or commercial site, electricity can be stored when it is most abundant, and cheap, and used when demand on the grid exceeds generation. Combining this resilience with an advanced DSR platform geared to optimise savings and revenue allows

businesses to eliminate the financial risk associated with a standalone battery. We have put the world's first hybrids into the market and we are adding to that all the time."

The UK is moving from a centralised system, with very large power stations generating the majority of power, to a decentralised one, where generation is more widely dispersed, from solar panels on roofs to offshore and inland wind farms. The pace of change driven by technology has created some confusion for customers in terms of where the opportunities for future energy flexibility lie.

Mr Phelan concludes: "Many of the new technologies have only become available in the last few years. It's about pushing boundaries and looking at the next phase of problems to solve with the grid and large energy consumers, such as frequency balancing, capacity fulfilment, voltage issues and tracing problems. The key lies in energy flexibility and ultimately in technology, and facilitated in a way that is palatable to all involved, from the grid to industrial, commercial and eventually residential consumers."



**GridBeyond**  
formerly Endeco Technologies

# Batteries set to energise power storage

Affordable battery technology is key to development of electric vehicles as well as renewable energy generation and storage, but how reliable is the supply of the raw materials used?

ROHAN BOYLE

**B**atteries are revolutionising the way we use energy, primarily in transport and storage of renewable power. About 1.1 million battery and plug-in hybrid passenger cars were sold worldwide in 2017, an increase of 57 per cent on the previous year, according to Bloomberg New Energy Finance. This year, sales are forecast to increase by a further 40 per cent. Although impressive, this is just a hint of the change about to sweep through the transport industry.

Volkswagen, Toyota and Nissan, among others, have announced ambitious plans, while all new Volvo models will be either partially or completely battery powered from 2019. Jaguar Land Rover will follow suit in 2020. Such is the drive to electrify in China, the world's biggest electric vehicle market, that two major manufacturers will drop internal combustion engines altogether after 2025. The electric bus market will grow by 33.5 per cent

a year to 2025, according to P&S Market Research.

Batteries are also central to overcoming the problem of renewable energy intermittency. Policymakers in several countries are encouraging their use in conjunction with the growing number of solar panels on homes, schools and businesses. This so-called behind-the-meter deployment of batteries amounted to 466 megawatts in 2017, an increase of almost 80 per cent compared with the previous year, according to Bloomberg.

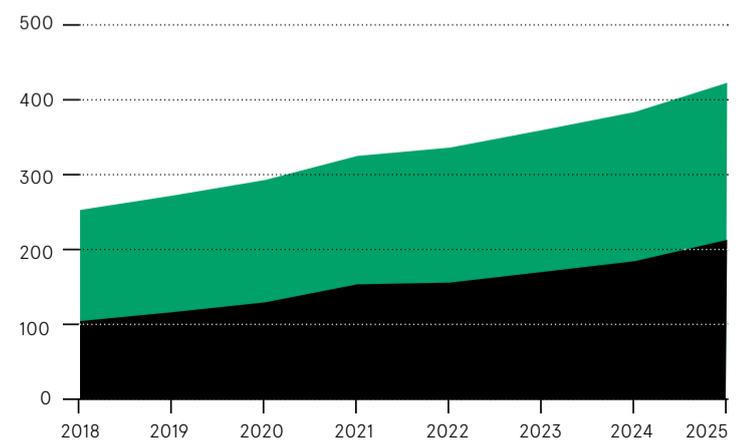
There are many technologies in use, but lithium-ion is predominant because it is energy dense, more than 80 per cent efficient and can be used in high-power and high-energy capacity applications. The batteries contain a large number of raw materials and, despite the name, contain comparatively little lithium. The other key elements are graphite, nickel, manganese and cobalt.

A central assumption in both the transport and home energy storage sectors is that sufficient quantities of cheap, high-performance

## Projected demand for global lithium

Thousand metric tonnes of lithium carbonate equivalent

◆ Demand ◆ Lithium demand for rechargeable batteries



Stormcrow 2017



AIZAR RALDES/AFP/Getty Images

Operations at the Uyuni Salt Flats in Potosi, Bolivia

lithium-ion batteries will be available to meet forecast demand. Given that the booming consumer electronics industry is also dependent on lithium-ion technology, the stress on the supply chain is bound to increase dramatically. A crucial question will be can the battery industry keep up?

Analysis by researchers at the Massachusetts Institute of Technology (MIT) indicates that for the near future there will be no absolute limitations on battery manufacturing due to shortages of the critical metals they require. "But without proper planning, there could be short-term bottlenecks in the supplies of some metals, particularly lithium and cobalt, that could cause temporary slowdowns in production," says Elsa Olivetti, assistant professor of energy studies at MIT.

Increased demand for lithium has pushed prices up from around \$7,000 a metric tonne in 2015 to more than \$15,000 in 2017. Similarly, cobalt has gone from \$25,000 a metric tonne in mid-2016 to more than \$80,000. The supply of graphite is not thought to be an issue, at least not in the short term. Nickel and manganese are used much more widely in other industries, so a jump in battery production is unlikely to have much of an impact.

Lithium is either mined or extracted from brine deposits in South America. The latter can be ramped up relatively rapidly, within as little as six months, compared with bringing a new underground mine into production, says Professor

**“To secure long-term supplies of raw materials, some automakers have started investing in materials production**

Olivetti. Although there might still be disruptions in the supply of lithium, she says, these are unlikely to disrupt battery production seriously. New mining capacity, due to come on line in the early-2020s, will also help to meet demand.

To secure long-term supplies of raw materials, some automakers have started investing in materials production. Great Wall Motors, for instance, has invested in the supply chain and Toyota Group's trading unit recently acquired a 15 per cent stake in Orocobre, an Australian lithium miner. More upstream investments are expected later in the year.

Both lithium mining and brine processing have imperfect environmental credentials. The former is energy intensive and currently heavily carbon emitting, although many miners say they plan to use more renewable energy. "In the short term, the CO<sub>2</sub> footprint from [lithium] 'hard rocks' will be less than ideal," according to David Deak of Lithium Americas. Meanwhile, the chemicals used in brine processing

can harm communities, ecosystems and food production, warns Friends of the Earth.

The supply of cobalt is also a concern, although partly because hedge funds have stockpiled the equivalent of 17 per cent of 2016 global production. Once normalised there should be sufficient supply until 2021, when new capacity will be needed to meet demand, say industry analysts. Of great concern are the environmental and humanitarian impacts of small unregulated mining operations in the Democratic Republic of Congo (DRC), home to more than half of the world's supplies of the metal.

"Our initial investigations found that cobalt mined by children and adults in horrendous conditions in the DRC is entering the supply chains of some of the world's biggest brands," says Seema Joshi, head of business and human rights at Amnesty International. Apple, HP and Samsung, among others, are engaged in an effort to shed more light on the cobalt supply chain, but it is fiendishly complex and opaque.

Nickel mining also has a poor environmental record. Epidemiological studies of workers employed in the production show an association between exposure to nickel compounds and lung and nasal cancer.

To help reduce these and other environmental and human costs, initiatives such as battery recycling will need to become an integral part of the industry. It is clear that further regulation and better battery technology will be needed to rid this clean technology of its dirty side. ♦

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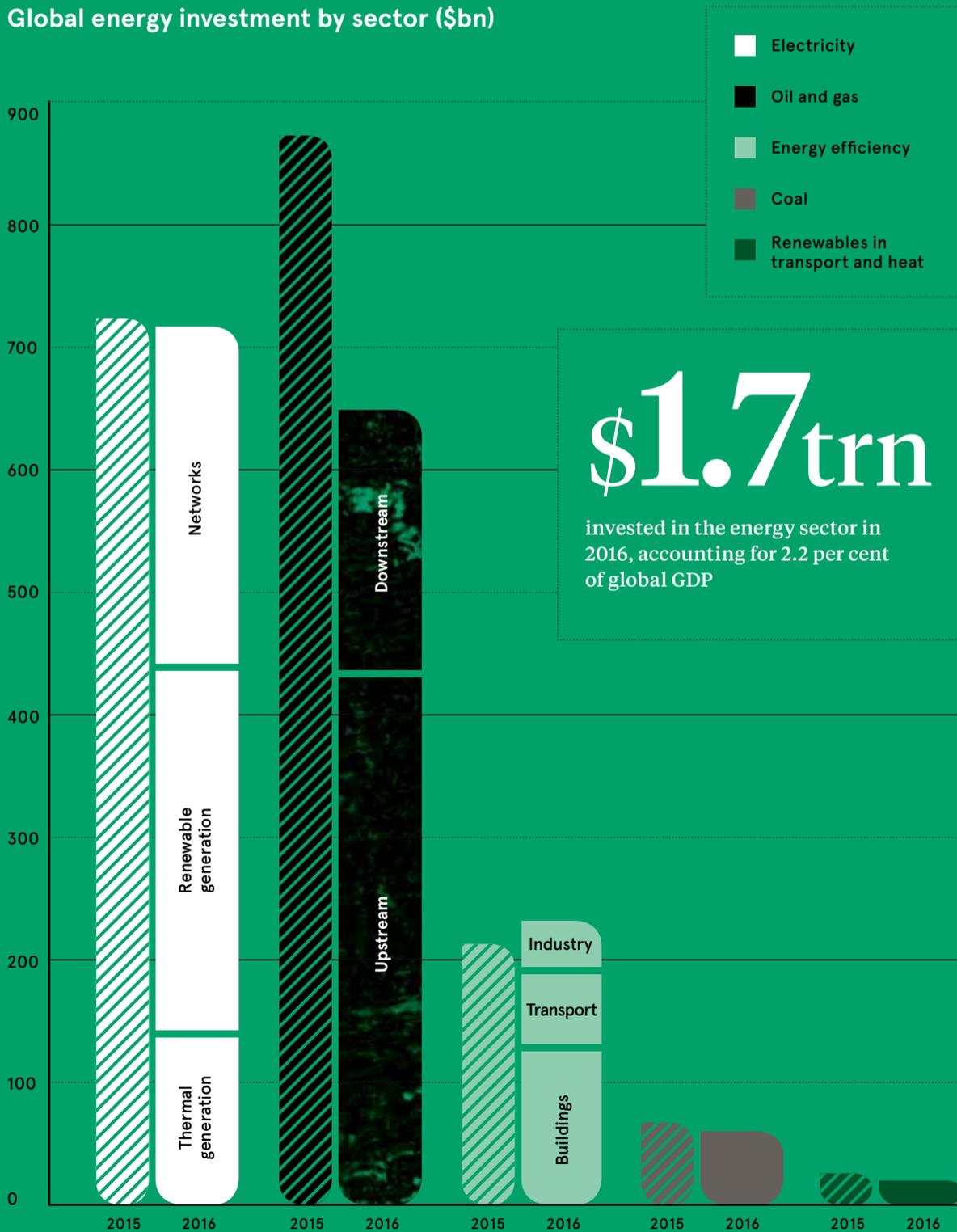
ENERGY. DATA. CONNECTED



# INVESTING FOR THE FUTURE

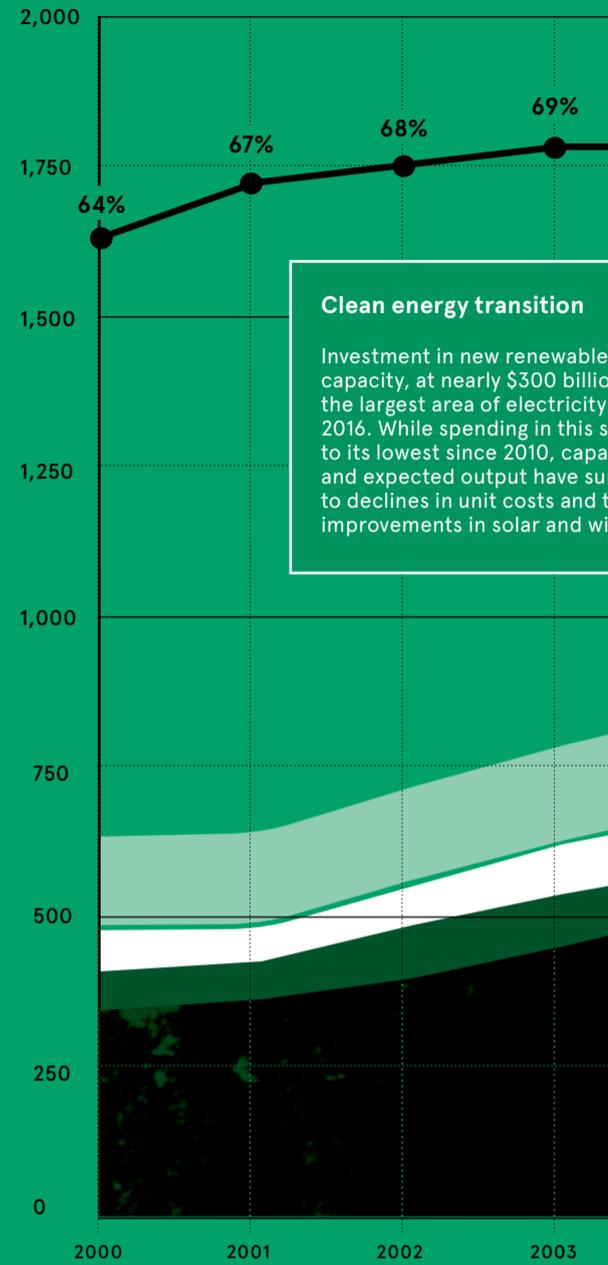
The future of energy undoubtedly lies with renewables. Yet, while investment continues to flow towards a cleaner future, demand for conventional resources remains, with fossil fuels accounting for more than half of energy supplies worldwide. We are still a long way from a full transition to renewables, but for now the global energy landscape is very much dependent on old ways

Global energy investment by sector (\$bn)

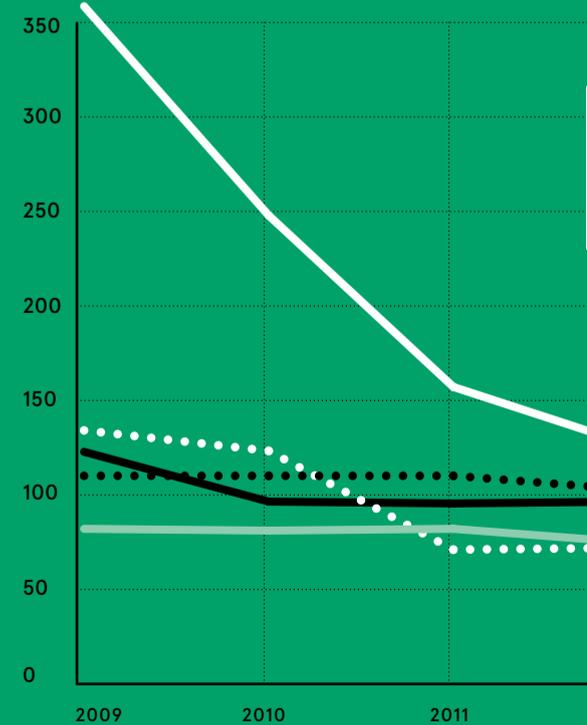


International Energy Agency 2017

Global investment in energy supply



Mean levelised cost of energy (\$ per MWh)

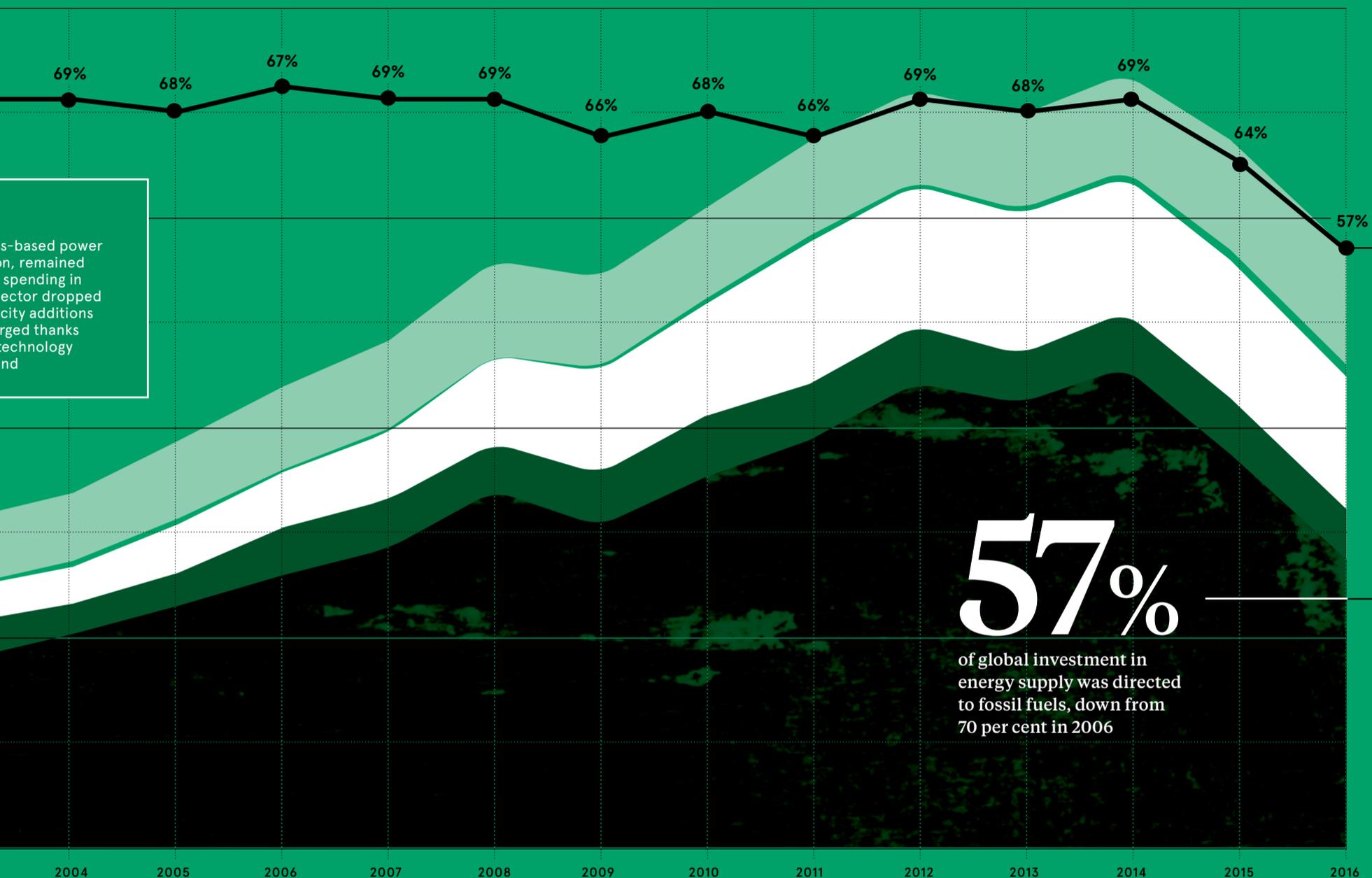


\*Average costs over a generating asset's lifetime

Investment (\$bn)

- Fossil fuel percentage of supply investment
- Fossil fuel supply
- Fossil fuel power generation
- Renewables
- Nuclear
- Electricity networks

International Energy Agency 2017



Renewables-based power generation, remained spending in the sector dropped. Capacity additions increased thanks to technology and...

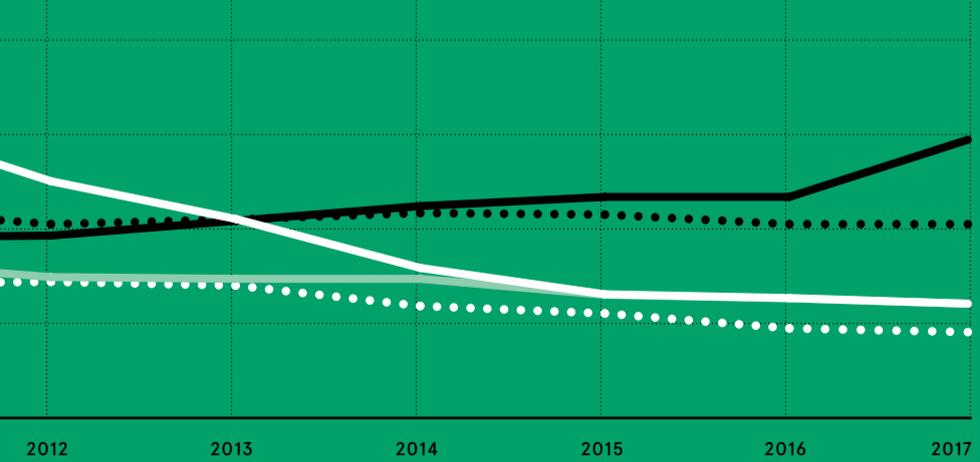
**57%**

of global investment in energy supply was directed to fossil fuels, down from 70 per cent in 2006

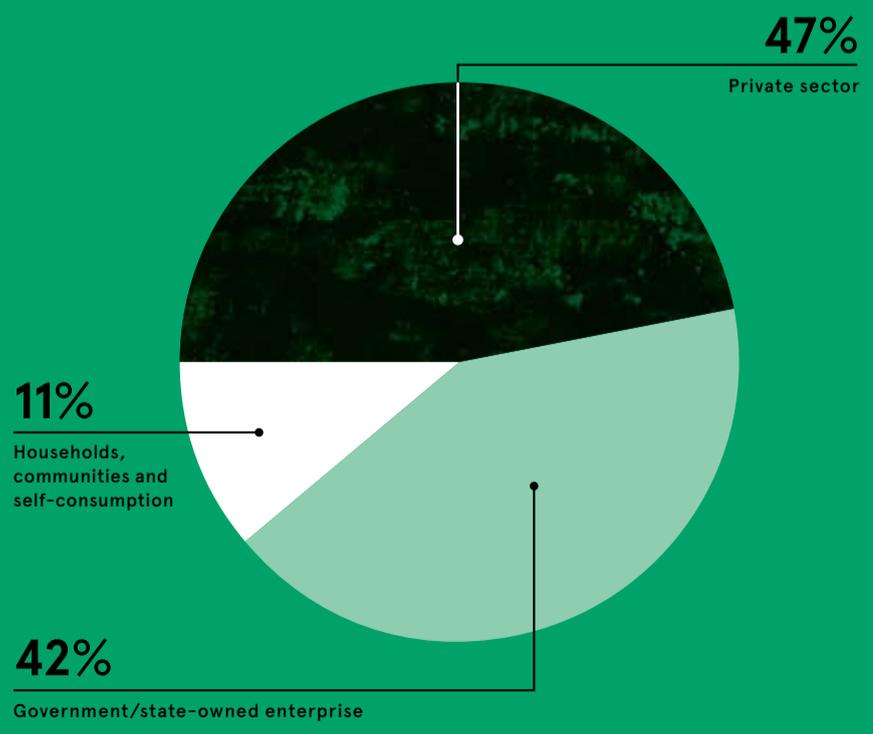
Cost per megawatt hours)\*

- Solar (utility scale)
- ..... Wind
- Nuclear
- ..... Coal
- Gas (combined cycle)

Some renewable prices have sunk to the same levels as conventional energy, with solar and wind now both cheaper to produce than coal and the same price as gas



Sources of finance for \$1.7 trillion of energy investments



Lazard 2017

International Energy Agency 2017

# Global energy mix set to ebb and flow

Demand and supply of oil and gas are set to change, but it is likely consumption will continue to rise for some time, despite environmental pressures

FELICIA JACKSON

The price of oil is back around \$60 a barrel and natural gas is projected to provide 45 per cent of power generation by 2040. Rebounding market fundamentals, quests for production independence and protection of market share, as well as geopolitical tensions, continue to drive both optimism and scepticism within the industry. With renewable energy projected to account for the majority of new generation capacity to 2050, what does the future hold for oil and gas?

The current critical importance of oil and gas to the energy mix is undeniable, but as the markets continue to evolve, it's important to understand what's driving changes in both demand and supply. Energy demand can be effectively split into three areas: electricity, where the biggest source remains coal; transport, still predominantly oil based; and heating, which is currently dominated by gas. As the demand patterns change for these sectors, so does the industry overall.

Guy Doyle, chief energy economist at Mott MacDonald, points out: "Unconventional hydrocarbons have already changed the global dynamics for oil and gas markets, led by developments in exploration and production technologies applied in the US." Supply no longer seems to be a concern.

According to the International Energy Agency (IEA) *World Energy Outlook 2017*, overall energy demand is set to expand by 30 per cent between now and 2040, at around 1 per cent a year, with the global economy growing at an average rate of 3.4 per cent. Over the longer term, the IEA foresees that under the existing and announced policies, oil demand growth will continue into the 2040s.

As Laszlo Varro, IEA chief economist, says: "When you tell a story about the future, unavoidably you

make assumptions. Over the longer term, political and technological questions multiply." Under its *Sustainable Development Scenario*, where regulation is imposed to achieve deep emission cuts, the IEA expects to see oil demand peak in the 2020s and be in decline by more than a million barrels per day by the 2030s.

Mr Varro says the energy mix will undergo a significant shift, with the lead taken by natural gas, by the rapid rise of renewables and energy efficiency. Continuing decline in energy intensity, due to the changing structure of the global economy, is likely to have a major impact on energy demand, he adds.

**A fall in oil demand is expected to be driven by growth in transport electrification and efficiency improvements in internal combustion**

A fall in oil demand is expected to be driven by growth in transport electrification and efficiency improvements in internal combustion engines, predominantly in personal vehicles rather than logistics, shipping and air. With today's 800 million personal vehicles projected to hit two billion by 2040, the speed of electrification will make a huge difference.

Predictions of peak demand are dependent on many variables, including investment interests, market size and government policy. Stephen George, chief economist at KBC, says: "Everybody uses

different scenarios, and these strategies need to be resilient and robust. KBC predicts no peak for oil, only a plateau at around 2040 of around 110 or 111 million barrels per day. It doesn't show a peak and drop by 2050, which is the furthest most projections go."

While he accepts that electrification will have an impact on oil demand, Mr George doesn't believe that electric vehicles will be the solution everywhere. In the United States there will be cultural issues to overcome, in India there will be infrastructure challenges. He adds: "Our view is a slowing down of oil demand, retreat from coal and massive growth in natural gas. Petrochemicals will grow as fast as oil demand for power drops."

Natural gas use is expected to increase by 45 per cent to 2040 in the power sector. At the same time natural gas has a more diversified set of applications than renewables, particularly for high-temperature industrial use and transportation. Mr Varro points out that around half of industrial heat use is high temperature and natural gas also has an important role in household energy consumption. In China, for example, natural gas is benefiting from air pollution regulations and its liquefied natural gas imports were up 42 per cent last year.

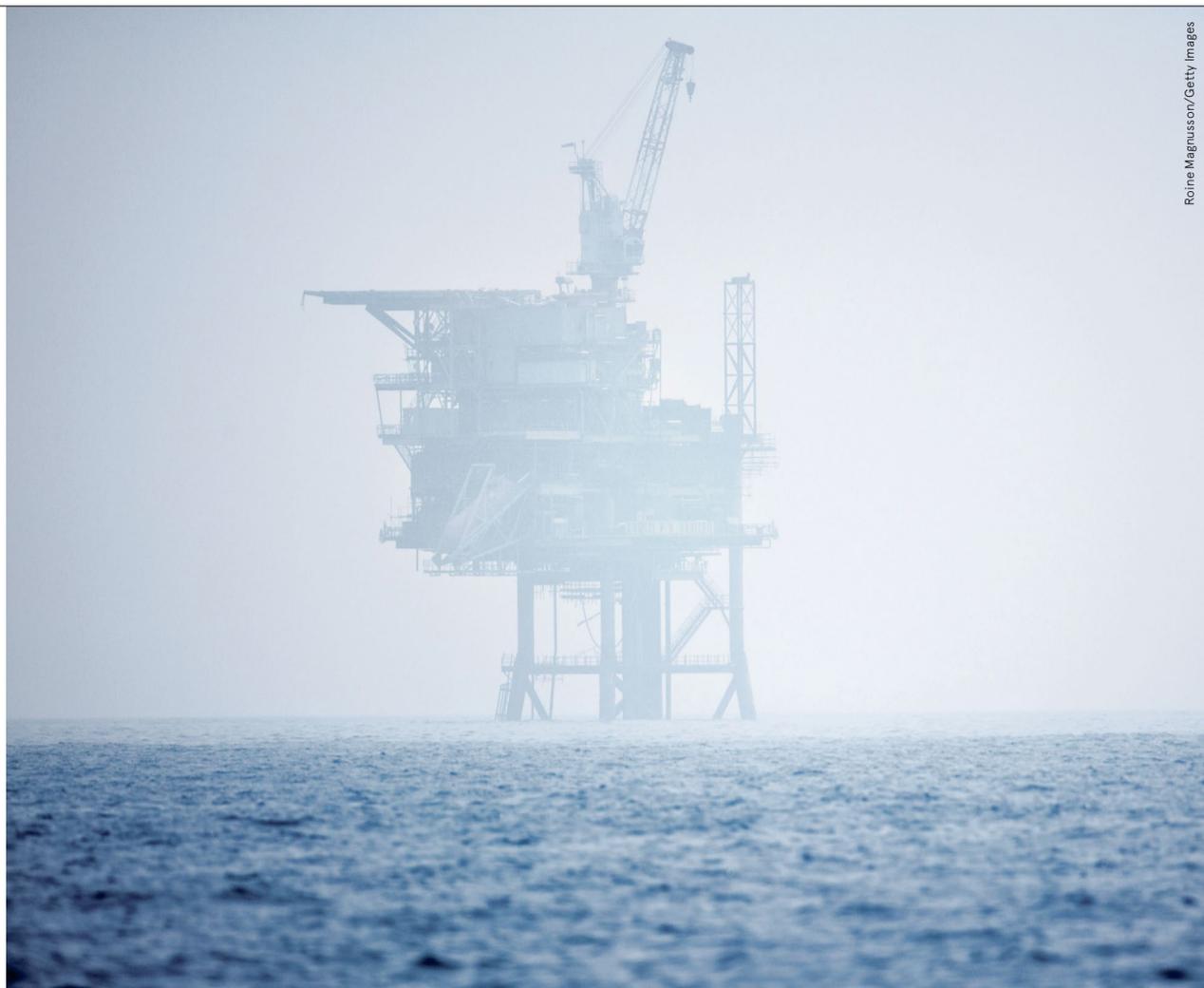
One concern of increasing importance is stranded assets. Mr Doyle says: "On a pure energy cost basis, renewables will be cheaper than new gas or coal generating plant." Mr Varro points out that a few years ago, when capital investment in the oil and gas industry was around \$800 billion a year, this might have been a fair criticism, but the investment cycle has changed.

2015-2016 saw a 25 per cent cut in upstream capital investment two years in a row and it has remained low. Companies have been focusing on short-cycle projects with average lead times down at around three years. Mr Varro also points out we are already seeing repurposing of plant; in Italy and France refineries are now working on biodiesel.

He says: "It's not that some investors won't make mistakes, but overall what we see is a remarkable

change in the industry's investment strategy." What we're seeing is recognition that oil and gas will remain important energy sources, but not necessarily in the way analysts predict.

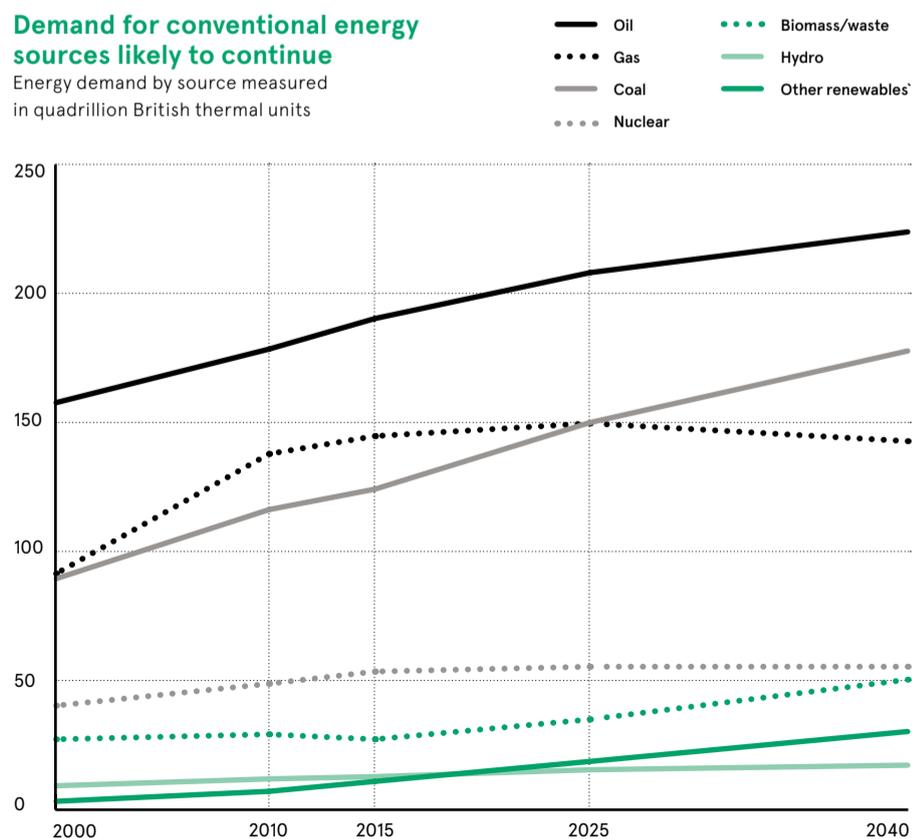
No matter what, population growth, combined with the demands of the emerging global middle classes, is expected to keep consumption of oil and gas increasing for some time to come. Flexible dynamic thinking and responsiveness will be crucial to strategic success in the sector.



Roine Magnusson/Getty Images

## Demand for conventional energy sources likely to continue

Energy demand by source measured in quadrillion British thermal units



# Digitalisation of the power industry is real and it's happening now

If your organisation does not begin to adopt plant digitalisation then will your competitors leave you behind? Will adopting new digital processes increase revenues in your organisation? Or do you think that digitalisation is just a buzzword and is not here to stay as part of a long-term revolution?

Four hundred senior decision-makers in five process plant sectors, including power generation, in 21 countries worldwide answered these questions posed by Vanson Bourne, the independent market research specialist. The wide-ranging survey was commissioned by AVEVA, a leading engineering software provider to the plant, power and marine industries. The results, published this month, reveal that almost nine out of ten power generation companies agreed with the first two questions. Surprisingly, more than half concurred with the third statement.

The digital revolution is affecting the power industry. If the last decade was about developing hardware capable of generating cheap, plentiful renewable energy, the next one will be about making energy generation systems smarter. Exponential growth in low-cost processing power, advances in big data management and growing cloud capabilities, coupled with the acceleration in analytics and machine-learning, have the potential to transform the way we produce, buy and sell electricity.

The World Economic Forum estimates that \$1.3 trillion could be generated by digitalising electricity generation worldwide between 2016 and 2025. It lists five initiatives in particular – better management of asset performance, real-time platforms data, integration of energy storage and customer-centric solutions – that it believes will individually unlock at least \$100 billion of value over the ten-year period.

Transformation of the industry is already underway, according to a majority of survey respondents. Twenty eight per cent believe it is happening now, while a further 46 per cent say plant digitalisation is a rapidly growing focus across the industry with most organisations working on their strategy and initiatives. The remainder think it is only slowly gaining traction or in the early stages of development.

**Digitalisation comes with up-front costs, but technology's ability to improve productivity can pay dividends**

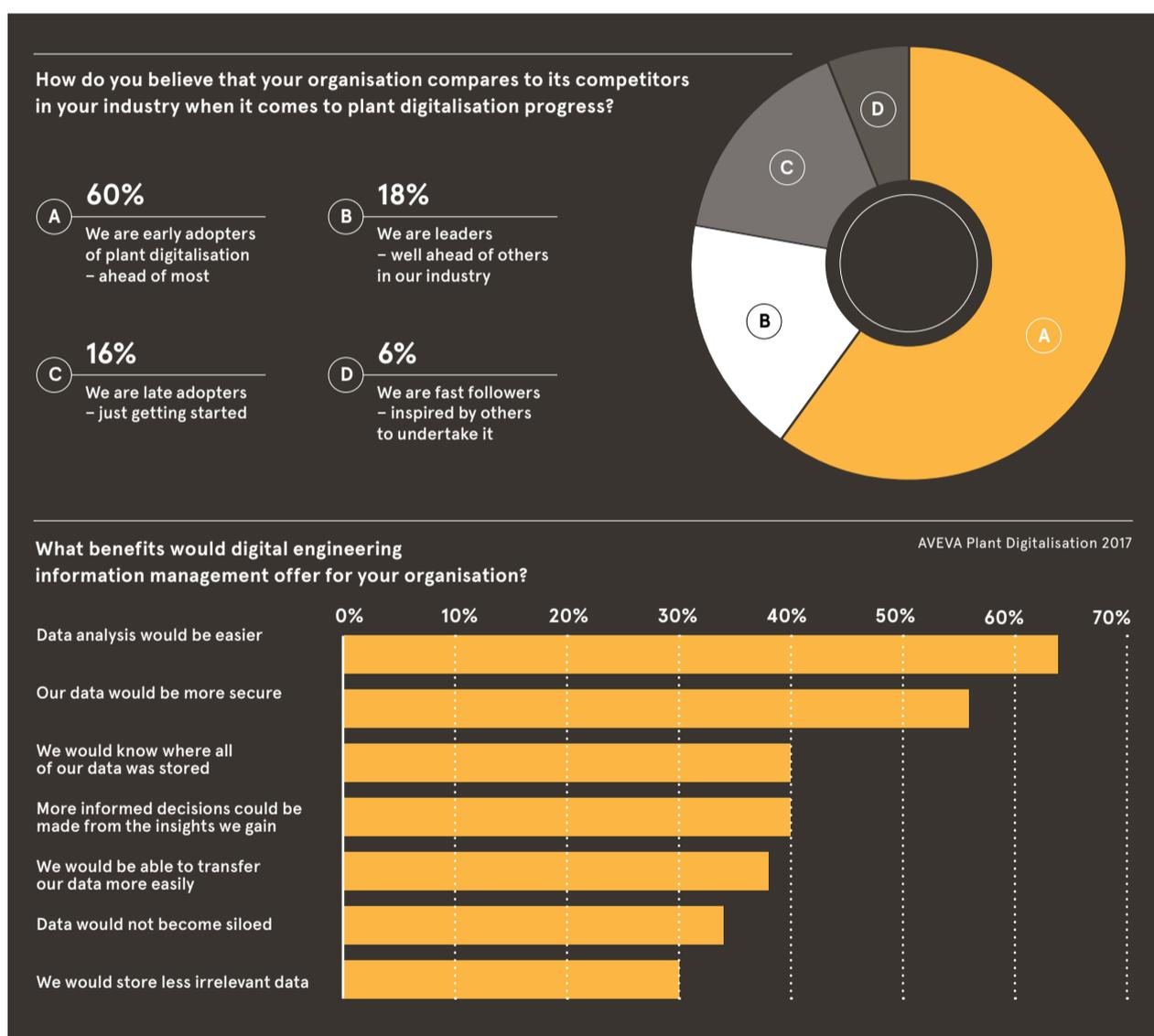
An overhaul of the power industry is long overdue. Power generation networks have become much more complex in recent years, thanks mainly to the rise in renewable energy power generation and the growing number of small, distributed power producers. Demand for power is also increasing in many countries, yet grid infrastructure is often old and creaking. Equipment is both difficult and costly to maintain, but tighter regulations are driving the industry to be more efficient and cleaner than ever.

Digital technology can help to solve some of these challenges. For instance, intelligent data systems are enabling network operators to handle large volumes of intermittent wind, solar and other renewable power, and to accommodate more distributed power producers. For plant operators, building a database that forms a digital twin version of the physical plant can lead to the development of analytics that can trigger service and maintenance actions, even before problems occur.

We know that companies are embracing digital technologies because they fear being left behind, but we also know that a sizable majority – four out of five respondents – think they are ahead of the curve. Some 78 per cent classify themselves as early adopters of plant digitalisation, while some 18 per cent believe they are leaders in the field and well ahead of the majority. Just 16 per cent confess to being late adopters, while 6 per cent say they are followers, waiting to be inspired by others.

So how exactly do power companies see digital technology helping them? Most think it will support the core fundamentals of their businesses. More specifically, over half cited cost management as a major focus, while 50 per cent viewed it as a means of optimising processes. A slightly smaller percentage picked out operations and maintenance, alongside improvements in production capacity, safety and information management.

Homing in on production performance, every respondent agreed that digitalisation has the potential to boost the production capacity of their facility by at least 10 per cent. The average hoped for was 29 per cent, but one-third said they thought it would raise production by 30 to 40 per cent, with a smaller number hoping for up to a 50 per cent increase. The survey also found that companies think digitalisation will reduce operating costs by anywhere



from 10 per cent to 50 per cent, with an average of just over 27 per cent.

Economics and technical advantages will drive digitalisation in the energy system, but major challenges remain. Power companies are awash with data – a modern gas-fired power plant is equipped with more than 10,000 sensors – but most have a long way to go before they can use this effectively to trim costs, increase sales, and boost efficiency and reliability. Among the 400 companies surveyed, not one uses more than half the data they collect. The average is 27 per cent.

More than 90 per cent of respondents concede they have difficulties embracing digital engineering information management. Incomplete and inaccurate data are a problem for nearly 50 per cent, while 40 per cent cite a lack of real-time data as an issue. Establishing

an intelligent engineering master data management system can be key to helping organisations improve on these numbers. More than 60 per cent say data analysis would be easier with digital information management and 40 per cent say it would enable them to make more informed decisions.

Digitalisation comes with up-front costs, but technology's ability to improve productivity can pay dividends. "The case for investing in plant digitalisation is a strong one," says Tim Miser, associate editor of Power Engineering. "Indeed, it is because of the enormous capital expenditures required by the industry that it becomes so important to wring every last drop of productivity from power assets, and software is indispensable in this effort."

And digitalisation will bring great rewards. But it will also bring change

and uncertainty to what is a relatively conservative, risk-averse industry. This timely study of digitalisation lifts the lid on what organisations are currently doing to join the digital revolution. It reveals just how big a priority digital is, what factors are driving digital agendas, the challenges holding companies back and which technologies companies are investing in.

<sup>1</sup>Digital Transformation of Industries: Electricity, World Economic Forum/Accenture 2016

<sup>2</sup>Ones & Zeros: How Digital Power Plants Are Leveraging Big Data and Analytics for Greater Reliability and Profit, Power Engineering 2016

To download the full report **Digitalisation in Power Generation** please visit: [aveva.com/digitalisation](http://aveva.com/digitalisation)

**AVEVA**

# How to outsmart the future

Understand energy opportunities today to create an energy-resilient tomorrow

The way energy is generated and consumed around the world has changed, and will continue to change for the rest of our lives. While there are many worst-case scenarios in business crisis management, an energy-related failure ranks among the most frequent and most damaging, yet it remains one of the least well prepared for.

The energy landscape is being reshaped by the shift away from traditional, centralised power generation towards a decentralised model that brings renewable energy sources such as solar, wind and tidal into the energy mix. Organisations that rely on constant, uninterrupted energy from a single source provider are in danger of being left behind by the broadening energy landscape and vulnerable to energy-related pitfalls that lie ahead.

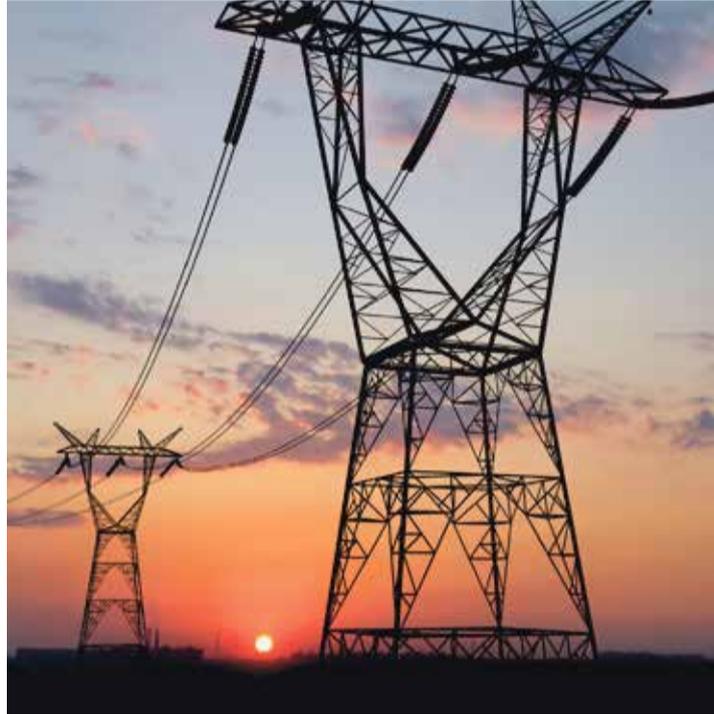
And therein lies the problem: reliance. Organisations need to become less energy reliant and more energy resilient by investing in their own energy-producing capabilities as well as making the energy they use go even further.

What makes an energy-related failure so hard to protect against, and therefore so damaging to business, is that it's almost impossible to know when one is going to happen. But when we start to look at their various causes, we begin to see there are in fact ways that businesses can be better protected.

**Organisations need to become less energy reliant and more energy resilient**

Ageing and poorly maintained equipment are among the commonest causes of energy-related failures, but maintaining every piece of equipment and machinery so that it remains in peak working order is an absurdly expensive way for any large organisation to prevent breakdowns. Fortunately, there are more elegant and cost-effective solutions that are now available to help businesses become more energy resilient.

Panoramic Power, for example, uses self-powering sensors that attach to energy-using equipment and wirelessly transmit real-time



data to PowerRadar, a cloud-based analytics platform, to track energy consumption across the organisation and to identify potential equipment failures before they happen.

Organisations that have already introduced Panoramic Power to their systems have benefited from reduced maintenance costs, prevented unscheduled downtime and seen savings upwards of 50 per cent.

For organisations that want to take greater control of their energy usage by being able to produce their own, combined heat and power (CHP) offers an effective two for one.

Gas remains far cheaper than electricity, so with gas-powered CHP generators on-site, organisations have a cost-efficient alternative energy source that protects them from local grid failure, as well protecting against future rises in energy prices, in particular non-commodity costs which currently make up over half of their bill.

CHP units are also able to capture the additional heat they generate so, instead of wasting it, this can be used as a cost-efficient heat supply – less external reliance, more internal resilience.

Centrica Business Solutions has surveyed energy decision-makers across multiple industries to assess the challenges posed by a lack of energy continuity. The results from this survey, along with Centrica's recommendations on how to reduce exposure to energy-related failures and unstable energy markets, can be found in *The Resilience Report*.

**81%**

of UK businesses experienced an energy-related failure in the past 12 months

**67%**

suffered power supply problems due to poor maintenance of equipment

**39%**

experienced unscheduled downtime as the result of an energy-related failure

**52%**

agree that the cost of building an energy resilience strategy is far less than the cost of an energy-related failure

*The Resilience Report*

Please visit [www.centricabusinesssolutions.com/resilience](http://www.centricabusinesssolutions.com/resilience) to download *The Resilience Report* and learn more about how energy resilience can help you and your organisation to outsmart the future

**centrica**  
Business Solutions

## 'There's a whole world of export opportunities out there, so make sure your company is first in line come Brexit'

This March sees the Energy Industries Council (EIC) turn 75, making it one of the oldest trade associations in the world. March 2018 also marks a year since the UK formally triggered Article 50.

With the UK officially leaving the European Union on March 29, 2019 the countdown to Brexit is starting to feel very real. The next 12 months will be of vital importance for UK businesses to take the right actions to ensure they are as prepared as possible.

The last few years have been among some of the toughest in the energy industry and, even with improving oil prices, the uncertainty around Brexit means it may get even harder in the short term. So, what can companies do to grow during these challenging times?

Well, during my time as EIC chief executive, I've had the opportunity to speak to and learn from hundreds of UK suppliers of all sizes, and covering all energy sectors, from tier-1 EPC (engineering, procurement and construction) oil and gas contractors through to small family-run technology firms in renewables.

Many have put incredible strategies in place which have enabled them to flourish even during the downturn. However, one strategy is notable by its relative lack of uptake, of particular significance given the new horizons we'll be facing post-Brexit, that of export.

According to government statistics, only 11 per cent of companies across all sectors export and the energy industry appears to be no different. Indeed, *EIC Survive & Thrive 2017* analysis found that only 8 per cent of companies surveyed focused on new export markets as their primary growth strategy. Given the phenomenal results that exporting can achieve, and with Brexit looming, this is surprising and worrying.

There are brilliant exceptions of course. One example of a company choosing export as its growth strategy in the downturn is the winner of the 2017 EIC Export Award, PJ Valves.

Headquartered in Hertford, PJ Valves manufactures valves primarily for the oil and gas sector. In 2011 it took the decision to expand into new markets, setting up offices in Houston, Texas and then Singapore. Today export sales account for more than 70 per cent of its revenues, compared to 20 per cent in 2011. To put a figure on it, that's about \$30 million over three years.

It's clear that finding new markets for your products can pay off. So the obvious question is why aren't more businesses doing it?

A key reason is that developing new energy sector export markets takes, on average, three years to yield profits; too long for many companies to wait when cash strapped. Companies have typically chosen faster routes to cash generation, focusing on core customer retention through product and service innovation; a good strategy, but often providing lower growth rates than exports.

Frustratingly, there are many government agencies that are available to help companies to accelerate their export campaigns and build trading links around the world, but our studies show that only about 20 per cent of businesses are aware of, or utilise, this support.

We work closely with the Department for International Trade (DIT), UK Export Finance (UKEF) and Scottish Development International (SDI) to support their export strategies, products and services, including organising round tables with ministers.

UKEF has the potential to create step-change export growth. We support UKEF export showcases, procurement portals for energy projects being financed by UKEF. In return for funding, these projects must include a minimum of 20 per cent UK content; it's a fantastic initiative, shortcutting international growth for experienced and first-time exporters in some of the biggest energy projects around the world.

DIT and SDI have trading experts located around the world who are specifically there to help UK companies make connections, establish local partnerships and grow business globally. Business owners and sales leaders normally are not afraid to take free help, so why not here as well? Funding is also often available to subsidise attendance at overseas exhibitions and delegations.

There's a whole world of opportunities out there. Make sure your company is first in line come March 2019.



**Stuart Broadley**  
Chief executive  
Energy Industries Council

# Combating hackers who threaten power

In an age of digital connectivity, energy networks are increasingly vulnerable to crippling cyberattacks by criminals, rogue hackers or hostile states

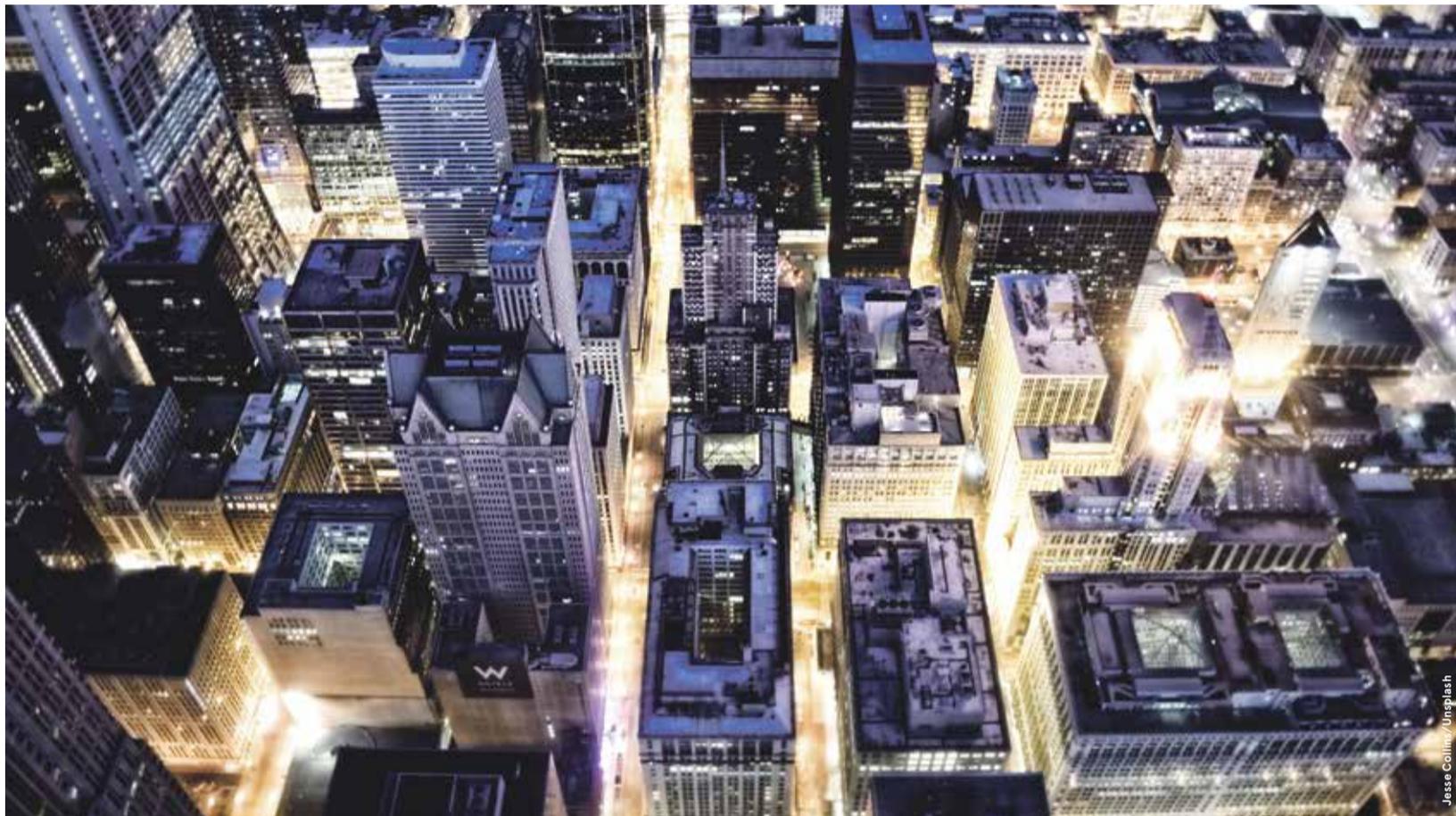
OLIVIA GAGAN

For most of us, cybersecurity might call to mind one-off irritating computer bugs, struggling to remember online passwords or a teen hacker operating out of a suburban bedroom. For governments and corporations, however, understanding how to prevent and counter attacks on computer systems and data is now key to national, and international, security.

Attacks are becoming more frequent and more costly on both an economic and human scale. The May 2017 WannaCry attack infected computer systems in 150 countries, exposing the online security weaknesses of major institutions around the globe. In the UK, the health service was hit, with an estimated 19,494 appointments cancelled and ambulances diverted, according to NHS England.

The energy industry did not escape harm either. Indian power utility West Bengal State Electricity Distribution Company, which has 17.8 million energy customers, found the malicious software had spread across its computers, leaving employees unable to access company data unless a ransom was paid.

Leo Simonovich, global head of cybersecurity at Europe's biggest electronics business Siemens, says the effect of WannaCry on the global energy industry has been profound. "It brought cybersecurity to the boardroom level," he says. "Now it's the top security issue for most energy companies,



together with the economy and national disasters."

Mr Simonovich adds that in 2018 energy looks set to be the most attacked infrastructure sector. But what makes the industry a particular focus for hackers? He posits that in both developed and developing countries, it is an industry with ageing, yet still essential, power plants, pipelines, substations, storage units and transmission cables. Many of these are "assets that have not been maintained, patched and hardened" to protect against digital threats.

Cyberattacks on energy assets can also be used as an act of warfare. Power is needed by everyone, and so attacks and subsequent energy outages can bring entire cities to their knees. In Ukraine, for example, a December 2016 cyberattack on the power grid saw parts of the capital Kiev experience a blackout.

Mr Simonovich says the scale and complexity of cybersecurity threats make it hard for energy companies

to get to grips with the issue. "Many of them want to address it; they just don't know where to start," he says. "We also have a global shortage of skills to address the new internet of things (IoT) environment."

The IoT is of great significance to the energy sector, and a key reason why energy companies and citizens alike must take cybersecurity seriously. Simply put, the IoT refers to the vast web of physical objects with built-in internet and electronic connectivity, which can send and receive data.

The energy industry is a major element of the IoT ecosystem. Globally, utilities are expected to spend \$73 billion on the IoT in 2018, according to the International Data Corporation, with spending focused on smart grids for electricity, gas and water, which use digital data to react to fluctuations in usage and demand. Within homes, smart devices and apps, which allow a user to control their home's energy consumption via the internet, are also expected to multiply.

**Now cybersecurity is the top security issue for most energy companies, together with the economy and national disasters**

So how do we prevent attacks on such energy infrastructure, both large and small? Governments and industry need to work together to create some basic international cybersecurity standards, says Eva Schulz-Kamm, Siemens' head of global government affairs. Some countries, such as Canada, are already drafting fresh legislation and, as of May 2018, the UK government will fine organisations up to £17 million if they

do not have effective cybersecurity measures in place.

Ms Schulz-Kamm wants governments to go further, and is lobbying for the European Commission to work with the United States and other superpowers to create global cybersecurity standards. "If we set out basic international rules, companies will begin to innovate in cybersecurity to meet them," she says. "These businesses will start to compete with each other, creating a whole industry and jobs. It will help build trust in the internet of things, too."

Cybersecurity must evolve and adapt as quickly as the malicious software it is supposed to prevent. But when it comes to securing the data and online operations of government, businesses and citizens, it seems there is still plenty of work to do in 2018. "If there are still vulnerabilities in cybersecurity where a 12 year old could feasibly disrupt a power plant, there's something wrong," Ms Schulz-Kamm concludes. ♦

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Matthew Hirst  
CEO, Utiligroup

Contact:

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## DECENTRALISED ENERGY

# Switching on the billion

Power supply through clean micro and minigrids is empowering disadvantaged people in remote areas of the world

MAGDA IBRAHIM

**A**round 1.1 billion people globally have no access to electricity, with 95 per cent in rural locations in sub-Saharan Africa and developing countries in Asia. However, the United Nations has set an ambitious sustainable development goal to ensure universal access to affordable, reliable and modern energy services by 2030.

And there’s a decentralised solution that could play a significant role in promoting greater democracy of power supply and bringing people out of poverty. Mini grids, or smaller capacity microgrids, are among a burgeoning supply of off-grid electrification solutions, alongside standalone home systems.

Global microgrid capacity is expected to grow from 1.4 gigawatts (GW) in 2015 to 7.6GW in 2024, according to Navigant Research, while decentralised renewables are the source of 6 per cent of new electricity access, the International Energy Agency reports.

“Microgrids democratise electricity delivery,” says Harish Hande, chief executive at the India-based not-for-profit SELCO Foundation, which has been replicating successful models of decentralised energy since launching in 2010 and reached more than half a million end-users to date. “A shift from waiting for energy to flow, to active generation and consumption of energy is important. A microgrid will not remove poverty, but is a powerful tool.”

Collaboration of financial institutions, innovative technology and communities is critical for scalability, he says, ultimately impacting on markers such as health, education and gender equality. “There is a perception the poor will not pay, so are high risk, but when we go to a new location, we take bankers from an existing successful area to do training,” Mr Hande explains. “Bankers listen to other bankers.”

The Indian government has recognised the microgrid market can spur socio-economic development in rural areas where the national grid has not extended. Its draft national policy promoting decentralised energy aims to establish at least 10,000 renewable-based micro and minigrid projects across the country.

Those ambitions are echoed at entrepreneur level by Oorja



Development Solutions co-founders Clementine Chambon and Amit Saraogi, who launched their first minigrid in the northern state of Uttar Pradesh last summer.

Powering up to 100 households and providing irrigation to farmers in Sarvantara village, Ms Chambon says the socio-economic impact is evident, with solar-powered lighting displacing kerosene lamps and businesses able to earn around 50 per cent more from increased efficiency. “There is a realisation that decentralised energy is part of the solution, but the challenge is how to implement that at ground level,” she adds.

**No one yet has stumbled across the jackpot to roll it out**

The pair plan to develop 250 minigrids over the next five years, although Mr Saraogi concedes that “navigating the policy environment can be a challenge”.

For Dr Philip Sandwell, researcher at the Grantham Institute – Climate Change and the Environment at Imperial College London, while government policy can be a catalyst in stimulating the sector, business buy-in is essential to innovation and scalability. “In general, the industry is driven by people who want to do good, but there is the business side of ensuring it is sustainable,” he points out. “In the past, we have been stuck in an aid-based model, but now it is about getting a sustainable return.”

In Nepal, challenges of geography and isolated communities, compounded by an energy crisis caused by floods and drought, have left a

gap. While hydropower has typically been the energy source of choice, notably for the national grid, solar microgrids are an exciting prospect, says Gham Power general manager Anjal Niraula.

Energy cuts of up to 18 hours a day meant urban businesses incurred high costs of using back-up diesel generators, he says, creating a microgrid opportunity. “We realised we could do the same in rural areas where extension of the transmission line is not feasible or very expensive,” says Mr Niraula.

Gham Power is focusing on creating multiple clusters of three or four microgrids; its Khotang cluster, north east of Kathmandu, reaches 102 households and 87 businesses. It has proved most successful for productive uses, with local entrepreneurs increasing revenue, leading to wider economic benefits.

“Microgrids are misunderstood because there can be a focus on comparing cost on a kilowatt/hour basis and asking why the poorest are being supplied with expensive energy,” says Mr Niraula. “But they are displacing dirty energy and increasing revenue for local people, and no one has yet quantified that.”

The economic need for reliable energy was brought into sharp focus in Nigeria in 2016, when thousands of shops in Kano State’s Sabon Gari market, powered by diesel generators after disconnection from the national grid, were damaged by fire.

In the last month, Nigeria’s Rural Electrification Agency (REA)

**14.7%**

of people function without electricity, equal to 1.06 billion worldwide

United Nations

# left without electricity



01



02

launched a project to switch four major markets and economic centres on to solar-powered minigrids. The first phase of 500 shops in Sabon Gari market was unveiled on February 7 and REA managing director Damilola Ogunbiyi says once completed it will be the “largest virtual power plant in Africa”.

“Our aim is to have 30 per cent of power supply from renewables by 2030, of which minigrids will play a significant role,” she adds.

Mobile payments and smart meters are among technologies improving scalability as microgrid developers look to Africa.

In Rwanda, MeshPower director Lukas Lukoschek employs 25 local women entrepreneurs as mobile money vendors working across 70 villages, selling top-up cards to add pay-as-you-go energy. “Our mantra is that it must be a cookie-cutter system for us to scale it up,” he says.

Meanwhile, after a minigrad pilot in Tanzania in 2016, multinational utility ENGIE replicated the model in three more locations and has another four in construction. It now has ambitions to develop thousands more minigrads and branch into up to five new countries this year.

While the opportunities are clear, the pathway to full global scalability is less well lit, warns Chris Tattersall, who leads the energy and resources sector at Deloitte in Switzerland.

“In terms of scalability and success, there are four things that need to be worked on: continued cost reduction of photovoltaic production; cheaper storage; a cost-effective, low-voltage smart grid with demand response and real-time management of electricity flows; and [who is] the orchestrator,” says Mr Tattersall. “Everyone in the industry is thinking about what business models will make decentralised energy successful in the future. No one yet has stumbled across the jackpot to roll it out.” ♦

## Case study

### Solar home systems

A standalone solar home system (SHS) can be the first rung on the ladder of energy access for many people in remote areas of developing countries.

Fenix International is among renewable energy companies in this market and its ReadyPay Power product provides lighting, phone-charging, and power for TVs and radios on a lease-to-own basis financed through micro-instalments over mobile money.

An entry level SHS costs \$160 (£114) and includes a 10-watt solar panel, 22-watt-hour battery, two LED lights and a phone-charging cable.

Customers pay a \$14 (£10) deposit and take home their self-install system for seven days of free power before the unit locks.

When the customer makes a payment through their mobile, Fenix’s database generates an unlock code sent by SMS for the

customer to enter using a remote.

Once a customer has paid off the full loan over 24 to 30 months, the system unlocks permanently.

“The majority of customers are self-employed with irregular income and could not afford this kit without financing,” explains Lyndsay Handler, chief executive of Fenix International.

Founded in 2009, and headquartered in Uganda, Fenix has already sold 180,000 of its ReadyPay Power units and plans to reach 1.5 million people by 2020.

Fenix uses the financing element to build a credit score for each customer that can be used to finance other products and services, such as additional solar panels, lights or even cooking stoves as well as school fees.

“Our mission is not only to empower our customers with life-changing energy technology, but also to open up inclusive financial services,” says Ms Handler.



Fenix International's self-intall ReadyPay Power System includes solar panels, energy storage and appliances



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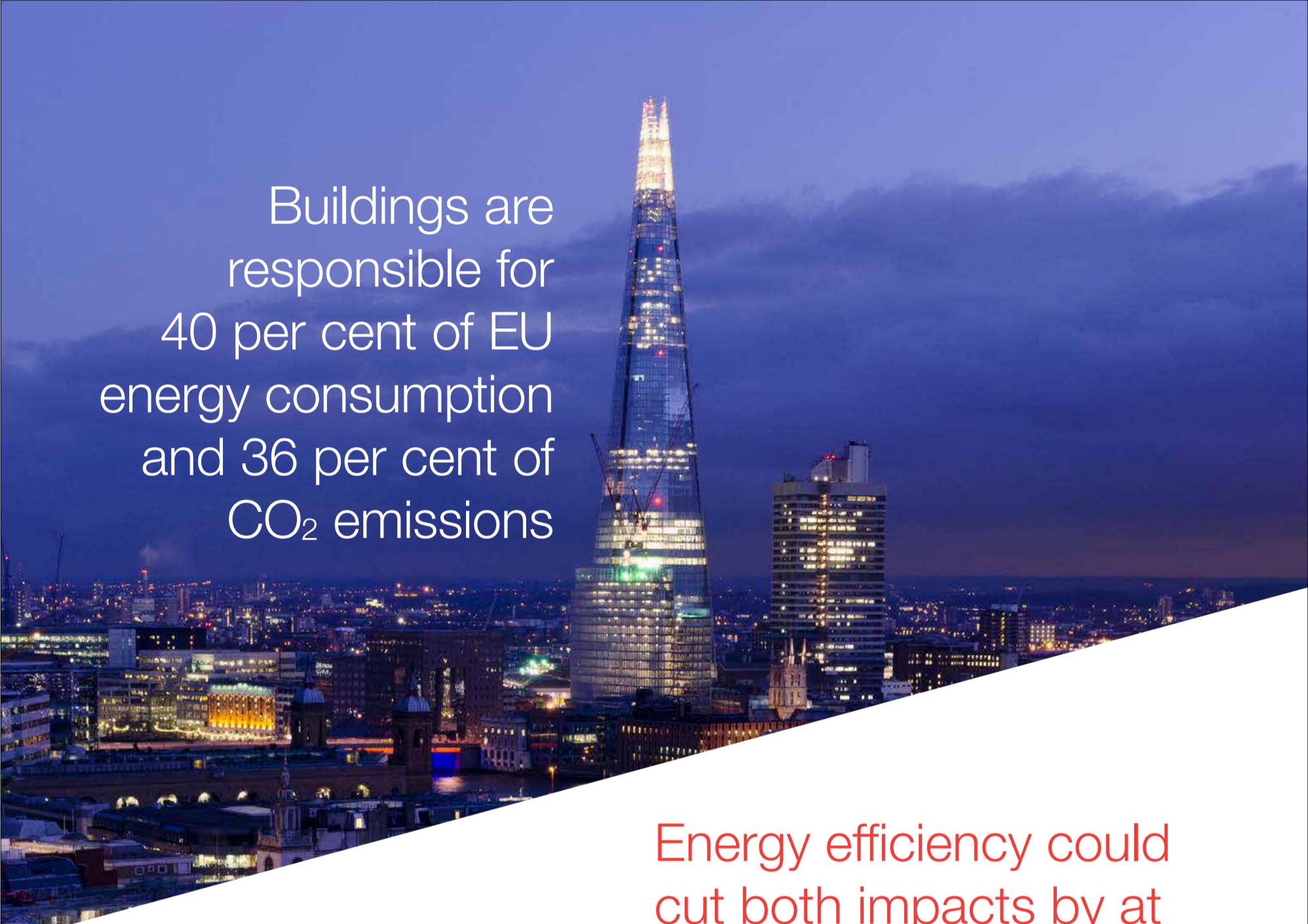
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