ADDLESHAW GODDARD

ENERGY

Disruption in Great Britain's Energy Market

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ABOUT ADDLESHAW GODDARD

At Addleshaw Goddard, our business is about strong client relationships built on successful delivery across national and international markets. A real meeting of minds.

We are a premium business law firm offering an exceptional breadth of services. Our approach combines a deep understanding of our clients' businesses, markets and sectors with high-calibre expertise, straight talking advice and a collaborative team culture. By delivering what clients want wherever they need it, from high-value strategic advice to the everyday, we pride ourselves on a service which is high quality, focused, relevant and consistently excellent.

Addleshaw Goddard - Energy & Utilities Sector

Wherever innovation is happening in the global energy market, Addleshaw Goddard is at the forefront, helping our clients anticipate and respond to change and to identify and capitalise on opportunities. Many businesses are actively looking at ways to be involved in the energy supply chain (either alone or with partners) whether to reduce costs, improve energy security, exploit commercial opportunities or enhance their green credentials.

However, making sound investment decisions in an uncertain market is risky. You need advisors who understand the uncertainties and can provide pragmatic, incisive advice that helps to minimise those risks.

Our International Energy and Utilities Group has extensive experience around power generation and renewable energies; from nuclear and gas to solar, biomass, wind and offshore marine. We act for clients all over the world on a diverse portfolio of matters across the sector. This broad coverage means we bring not only real know-how and experience but also new ideas and innovative ways of working.

AREAS OF EXPERTISE:

- **Anaerobic Digestion**
- **Battery Storage**
- **Biofuels**
- **Biomass**
- **CHP**
- **Decommissioning**
- **District Heating**
- **Downstream Energy**
- **Electric Vehicles**
- **Energy Market Regulation**
- **Mining and Minerals**
- **Networks**
- **Nuclear**
- **Oil and Gas**
- **Solar**
- **Waste**
- **Water**
- **Wind**

INTRODUCTION

Technology and decentralisation are the two major themes of the energy market today. To understand the full impact of these themes, just consider the role both have had in two other sectors in the last 10 years. In the retail sector, the role of Amazon and online shopping alone has utterly changed the character of what being a retailer means. Each of our personal experiences of retail will show how much retail now comes to us and not us to it.

In financial services, online apps, comparison websites, blockchain, Apple Pay and other advances again show what can happen. Where are the local branches? On our phones is where. When did you last have to physically go into a bank?

Turn that knowledge towards energy and you realise what we are on the cusp of. We can see it already in so many ways but it feels like it is the start: electric vehicle charging, battery storage, solar panels becoming so much cheaper, innovation in RIIO, connected homes, smart meters and on it goes. Yet has our behaviour really changed? All we know is we are at the start of something interesting and we are all at our best when we share insights, hence our report and planned follow ups.

We are looking forward to it and hopefully you are, too.

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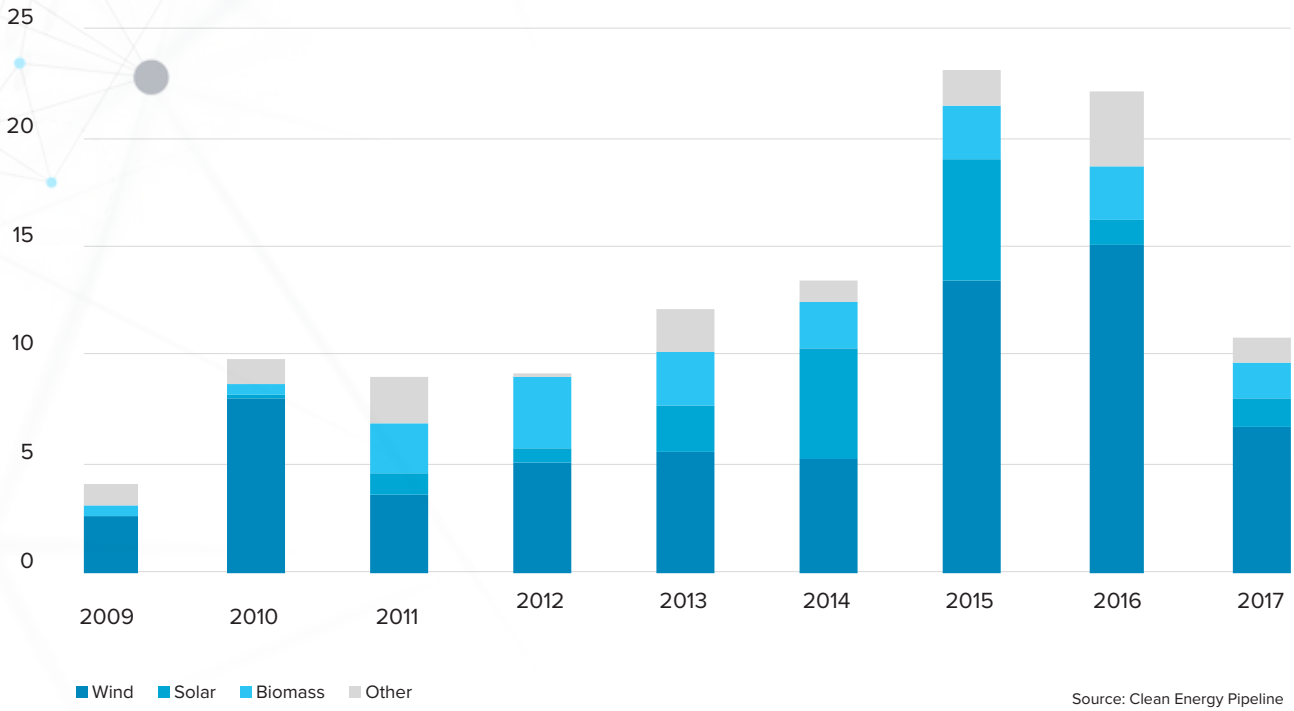
ADDLESHAW GODDARD

DISRUPTION IN BRITAIN'S CHANGING ENERGY MARKET

Technological innovation is shaping our power mix

The UK's energy sector has experienced significant changes over the past few decades thanks to the integration of clean energy generation – including wind, solar, biomass and other clean technologies such as wave, tidal and small hydro – into the power mix.

UK CLEAN ENERGY PROJECT FINANCE, 2009-2017



Source: Clean Energy Pipeline

Nearly £82billion was invested into UK renewable generation assets between 2013 and 2017, according to figures compiled by Clean Energy Pipeline. Offshore wind and solar PV played a key role, attracting £33bn and £15.2bn respectively.

Renewables, as a result, currently holds the second highest share of electricity generation, only behind gas-fired power. Renewable energy accounts for 29.4 per cent of the UK's electricity mix, generating a record 98.9 TWh of electric power in 2017[1] .

However, whilst increased renewable energy generation helps us to reduce our carbon footprint, such rapid growth is not without issue.

Renewable energy generation is, on the whole, more expensive than conventional generation – certainly until the technology is well-established. Also since much renewable energy generation is, by its nature, intermittent this does not provide the secure baseload we need – and we will often hear Government talk of their priority to 'keep the lights on' which means renewable energy generation alone is not the answer.

For some time now, Government, Ofgem and energy companies have been focused on addressing this "energy trilemma" – of balancing the three needs for affordable, secure and sustainable energy generation.

This is often seen as a give-and-take situation where one or more of the three pillars have to be sacrificed in favour of another. The big question has always been and always will be:

[1] UK Energy Statistics, 2017 & Q4 2017

to what extent will there be a trade-off in safeguarding security of supply, keeping energy costs down, while at the same time keeping the UK in line with its decarbonisation mandates?

Rapid increases in renewable generation is another challenge for our electricity grids which were designed around a centralised system fed by a small number of large generators where power flowed one way, through the transmission and then the lower-voltage distribution network to the consumer.

What we have now, however, is a mix of generation including a significant number of small decentralised and intermittent loads, connected to and exporting power on to the distribution network. This means that power is flowing back up the grid, from the distribution to the transmission network, which the network was never designed for. That power is unpredictable, surging when it is windy or sunny and not necessarily at times of high demand.

Parts of the Grid that were never designed to carry large capacity have had to be reinforced to accommodate the large loads delivered from wind and solar farms in particular, which are often found where the Grid capacity was previously at its smallest.

Renewable generators were the early disruptors but now we are seeing a range of additional disruptive technologies that are again changing the way the energy system is being used and exerting different stresses. Energy storage, smart metering, demand response software, electric vehicles and blockchain to name but a few are all examples of disruptive technologies because of their ability to fundamentally transform how power traditionally has been generated and consumed.

This is why creating an energy system that is fit for purpose, not only today but in the coming decades, is underlined as a key priority for the UK government, as set out in its Industrial Strategy white paper, the Clean Growth Strategy[2], the National Infrastructure Assessment[3] and other key policy documents.

The government faces a significant task in creating a dynamic energy market that can successfully move the country away from a top down, centralised system and fully accommodate the spectrum of green disruptive technologies as part of the generation mix.

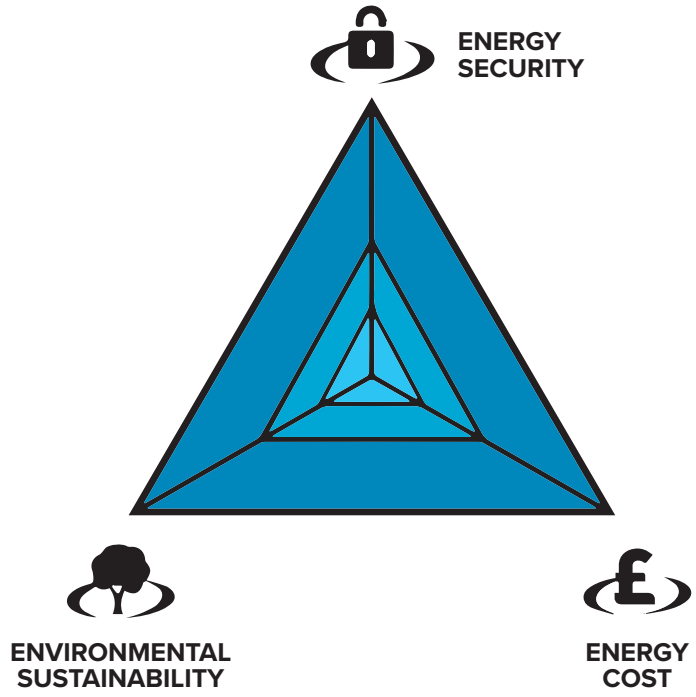
“The energy system is transforming so quickly that it is difficult to predict which technologies will come to the fore,” explained Andrew Burgess, Deputy Director of Charging & Access at industry regulator Ofgem.

“Smart meters and technology that makes automation easier or offers demand-side response have great potential to help people engage more in the energy market. Blockchain also opens up exciting opportunities for customers and communities to trade energy between themselves. Our job is not to back any particular technology. Instead we make sure regulation is fit for purpose, and does not hold back any new developments which could benefit consumers. Regulation must also continue to protect the interests of future consumers as well as today’s.

“Around a quarter of the UK’s electricity now comes from renewables compared with just five per cent 10 years ago. A lot has been done to accommodate this but now we need more fundamental change to capture the estimated £17bn -£40bn benefits of a smart, flexible energy system.

“Besides helping smarter technology we need to reform the way grid access is allocated. Parts of the networks are already full, so scarce capacity needs to be used more efficiently. Options include pricing capacity so that it can be offered to those who value it most, while ensuring households have the electricity they need.”

THE ENERGY TRILEMMA



[2]refer to AG report supplement – “The clean growth strategy has finally been published, but was it worth the wait”
[3]refer to AG report supplement – “National Infrastructure Assessment – energy implications”

IS THE GRID FIT FOR PURPOSE?

The UK's renewable energy sector experienced a boom period for new projects between 2010 and 2016 thanks to attractive incentives in the form of Feed-in Tariffs (FiTs) and Renewables Obligation Certificates (ROCs) and other revenue streams such as frequency response and balancing services.

The intermittent nature of renewables, however, is the main issue that threatens the security of energy supply in the UK.

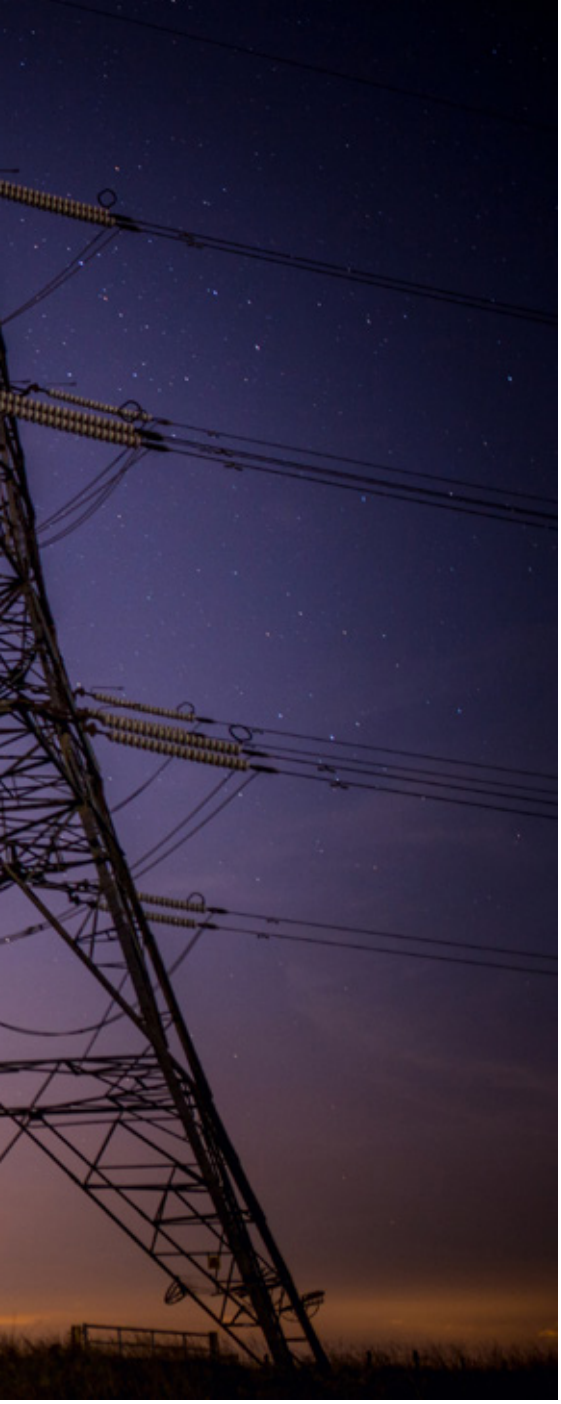
With the UK set to decommission its remaining coal-fired power plant fleet by 2025, questions remain over the reliability and flexibility of the grid and whether or not grid operators can respond adequately to the changing nature of supply and demand.

Where the privatisation of the UK's energy system signalled the first landmark change in the country's power market, the second wave came through the deployment of renewable generation.

The next step in the evolution of the country's energy sector will be the successful assimilation of disruptive technologies to solve the energy trilemma.

"Together with the government, we are revamping 20-year-old energy regulation so that it doesn't hamper progress towards a smarter, more flexible market," said Andrew Burgess. "There are more and more ways to make better use of our energy system and to save money for consumers.

"We need competitive markets in electricity storage and other flexibility services. We're working to introduce rules so storage can compete fairly in different markets. We also want to



> **“THERE ARE MORE AND MORE WAYS TO MAKE BETTER USE OF OUR ENERGY SYSTEMS TO SAVE MONEY”**

licence storage as a specific type of generator so it can compete more easily against traditional generators.

“Lower carbon, distributed generation is replacing large fossil fuelled power stations. More of this generation, and new technologies such as storage, electric vehicles and heat pumps, are connecting to the local networks. At different times and in different locations, the grid becomes constrained.

“Technology and regulatory reform will play an important role in helping to solve this. Storage can take on excess renewable electricity generated during the day and release it on to the grid at peak times. Smart meters pave the way for more ‘time of use’ tariffs where appliances can be programmed to run when electricity prices are cheaper.

“We also plan to reform how grid capacity is allocated and used to make better use of the system and to keep down costs for consumers.”

GETTING THE MOST OUT OF THE GRID

Ofgem are now consulting on the reforms that Burgess mentions. They recognise that the GB energy system is undergoing a radical transformation due to the increasing decentralisation of energy, the rise in intermittent renewable generation and the expected increase in demand from electrification of transport and heat. The current processes for accessing the electricity networks and the charges for using them do not encourage users to use the network at times or places where there is more spare capacity. Ofgem see three top priorities:

1. Enabling growth in demand while managing constraints on the networks

More electric vehicles and heat pumps could lead to network capacity being constrained at peak times. We need a solution to ensure that this growth is not prevented because there is just not enough capacity on the system.

Part of the solution could include, for example, an incentive on electric vehicle users to charge their car at off-peak times which would help smooth out the demand profile and exert less pressure on the system when it can least cope with it. Electric vehicles are just one obvious example where the timing of charging the vehicle is – by and large – irrelevant as it isn’t necessarily linked to the time of use.

2. Managing constraints on the distribution network as a result of more generation connecting there

There is now 28GW of generation connected to the distribution network (compared to 75GW on the transmission network) and according to National Grid’s latest Future Energy Scenarios (2018) this could rise to between 37 and 71GW by 2030. The grid was not built to cope with this but changing the access and charging regime could encourage generators to connect to the grid in areas where there is spare capacity.

3. An effective interface between transmission and distribution arrangements

The access and charging arrangements for connecting to and using the transmission network and the distribution network differ. This means, in some cases, generators might choose to connect to the distribution network whereas, from a capacity viewpoint, it would be better to connect to the transmission network. Ofgem want developers to respond to signals that reflect the economic reality and not the peculiarities of the regulations.

The upshot of these reforms should be that renewable generation is incentivised to use the network in the most efficient way, avoiding the need for costly reinforcement work where possible and instead connecting to and using the networks in a way that maximises existing capacity. But first we need a model that offers those incentives[4].

[4] refer to AG report supplement – "Getting more out of our Electricity Networks"

FLEXIBLE SOLUTIONS

As well as the reforms coming from the regulator, the energy industry itself has developed its own solutions to the problem of intermittent generation and the need to continuously balance supply and demand.

Different users have different energy requirements and, whilst some have fairly rigid requirements, others are much more flexible in their demand. Using that flexibility, where possible, to alleviate system stresses is another part of the solution. Demand side response is all about tailoring the amount of electricity the customer uses to match the available supply at any given time: for example, turning down a refrigeration unit during peak demand or carrying out an energy-intensive manufacturing process at night when more power is available.

Given the increased penetration of renewables, utilities and energy companies are targeting energy intensive businesses that can provide demand curtailment during times of intermittent clean energy production.

"The future electricity systems will be built around its customers, not the big energy generators –that is a fact," said Alastair Martin, Chief Strategy Officer at demand-response company Flexitricity.

"FUTURE ELECTRICITY SYSTEMS WILL BE BUILT AROUND ITS CUSTOMERS NOT BIG GENERATORS."

"Utilities are changing their corporate structures to deal with this, things like separating their customers and renewables in one pot and big power stations in another. But it doesn't get them past the customer engagement problem at street level."

Large industrial and commercial customers will also have the capability to participate in providing flexibility as more and more intelligent management systems are rolled-out.

"We do demand response with a variety of clients and operate this from a 24-hour control room. Our Flexitricity+ programme enables us to take flexible electricity consumers,

generators and battery developers right into the heart of energy balancing," Martin added.

"This is aimed at more sophisticated customers for which energy is a major part of their business. They tend to be industrial sectors where the product they sell is largely composed of electricity when it comes to evaluating the costs."

Britvic, one of the world's largest soft drinks manufacturers, is one such example of an industrial company with very specific energy and heating requirements for several of its production plants and distribution centres in the UK and Ireland which has been undertaking a top-down review of how it can optimise its consumption.

Richard Herring, Category Manager (Utilities), at Britvic, said the British company would be investing approximately £250m – £300m to explore and deploy operational efficiency solutions at three of its manufacturing facilities.

Much of this investment is going towards updating its supply chain infrastructure – cutting down the amount of packaging materials used – but the reduction and optimisation of its use of heat and power is intrinsic to this.

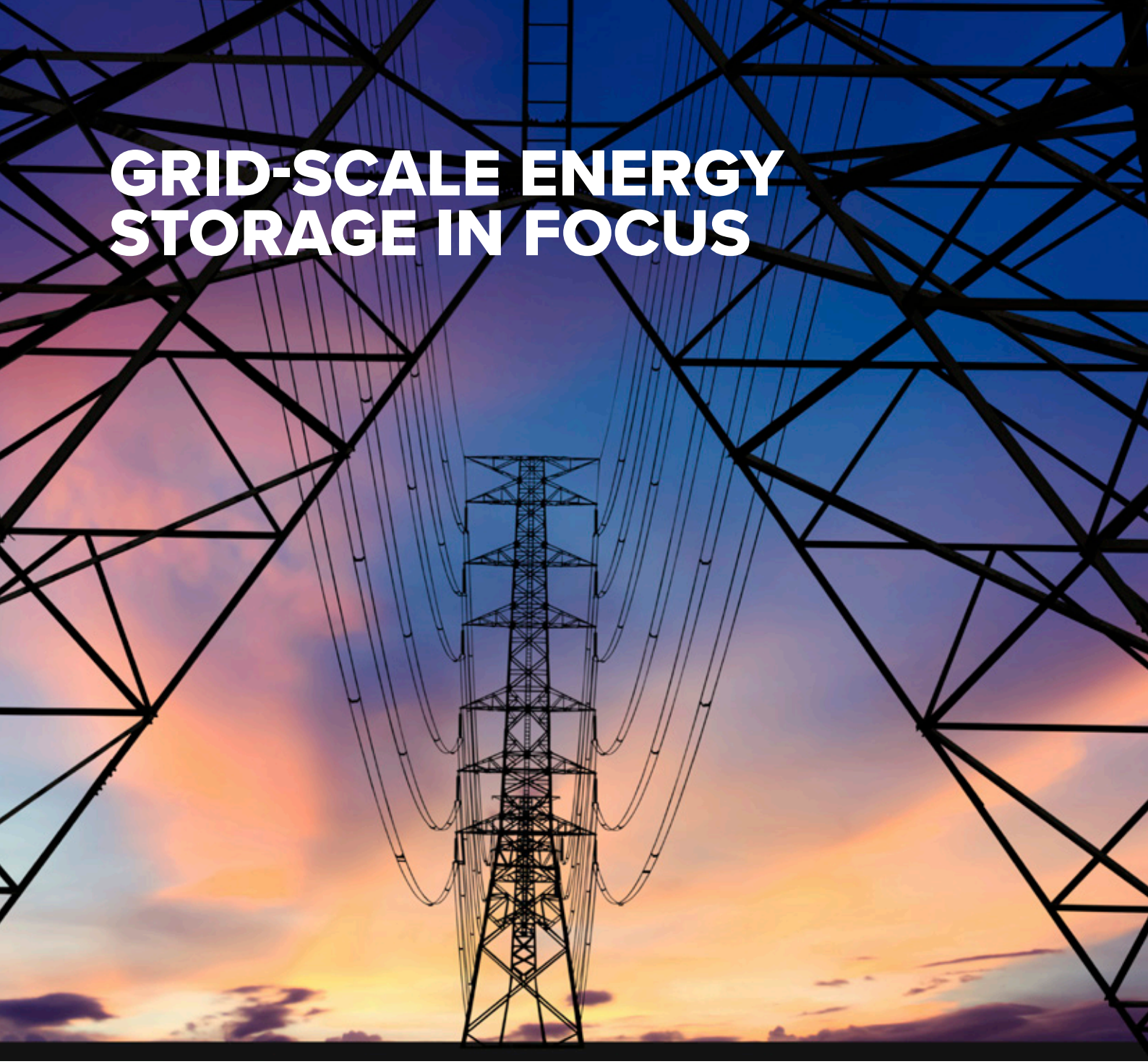
Herring said: "The challenges for Britvic as we go through the investment programme and start to vet those options down is: how do we get smarter and how do we optimise our production processes and infrastructure to reduce the amount of electricity we use?

"We are working on the answers. Some of the answers might include supplanting our sites with solar photovoltaic and wind resources.

"It might be additional Combined Heat and Power facilities. And there's also demand management; how we time production to optimise cost from our manufacturing facilities.

"There's a lot of work going on at the moment as we start to break down infrastructure to really understand how we align customer demand, our manufacturing capabilities with what the input costs are and what the benefits might be in changing our patterns."

GRID-SCALE ENERGY STORAGE IN FOCUS



Across the spectrum of disruptive technologies, energy storage could have the broadest applicability to a range of industries and sectors. The flexibility services alone that energy storage can deliver makes it a crucial piece of infrastructure to help relieve the constraints of the grid network.

No wonder then that network operators, energy companies and investors now view storage as one of the most immediate and viable disruptive technologies in the energy sector. But there are definite hurdles related to cost, regulation and financing risks preventing the full potential of storage being realised[5].

Within the energy storage sector itself there are several different technologies: pumped hydro, compressed air, liquid nitrogen, hydrogen fuel cells and lithium ion. Across this spectrum, lithium ion storage has attracted the most investment among corporates and financial investors because it is more cost-effective to deploy than its counterparts and benefits from the abundance of technology providers in the supply chain. Technologies such as compressed air storage show some promising future but are relatively unproven, with there being only two facilities of this kind in the world (in Germany and the US). Moreover, the cost curve for hydrogen and hydrogen fuel cells is yet to come down to the point where it is a viable form of storage.

According to Reza Shaybani, Vice President (Strategic Projects) at Leclanché & board member at

[5] refer to AG report supplement – "Battery Storage – a SWOT analysis"

Quercus Investments, the number of obstacles preventing utility-scale battery storage from becoming a mainstay feature in the UK is coming down layer by layer. He says: "The first layer coming down is cost. The cost of battery storage has come down dramatically although it is stabilising now and the economics of battery storage is becoming more and more compelling and more attractive for asset owners and for investors.

"The next layer which is coming down, and needs to come down faster in my view, is legislation and policy which would allow asset owners to integrate battery storage within their renewable assets."

ATTRACTING PROJECT DEBT FINANCE

The predictability over the future revenue streams of energy storage assets seems to be a significant challenge for infrastructure investors.

"This space is quite challenging for infra investors," comments Ed Simpson, Partner at investment manager Downing. "When people ask me what the revenue stack looks like in 24 months or five years the answer is that I have no idea.

"Fundamentally, with the increased penetration of renewables, which will continue, there will be a greater need for smart solutions to help manage the frequency and current on the grid, so there will be a need for frequency response, demand management etc.

"I don't know how the National Grid will pay for it and they are consulting.

"THE COST OF BATTERY STORAGE HAS COME DOWN DRAMATICALLY ALTHOUGH IT IS STABILISING NOW."

It will have to be paid for by someone, so providing you have a solution that works there will be the opportunity for returns.

"We are not tying ourselves down and have looked at compressed air, flywheels etc and there will be space for all of them. We are looking at investing across the lifecycle and will invest in ventures to project finance. One strategy de-risks the other."

Prior to 2010, solar photovoltaic and onshore wind were highlighted as the choice of generation technology to back for the future but the investor community remained doubtful over their long-term economic viability.

It was not until a stable government-backed remuneration system was introduced that clean energy investment truly began to hit its stride.

From the introduction of the Renewables Obligation and then the Feed in Tariff and the additional income stream from the sale of ROCs and receipt of fixed tariff payments, lenders then had the confidence to provide non-recourse senior debt financing to renewable energy projects, transforming wind and solar into long-term income growth assets.

The energy storage sector today is at a similar juncture to where wind and solar were about a decade ago, with lenders reticent to provide project financing without an established and stable path for revenue.

A fundamental shift in the legislative landscape is needed to create new revenue streams and markets outside of existing mechanisms such as the capacity market and the wholesale market.

Government-led mechanisms such as the National Grid's Enhanced Frequency Response (EFR) auction in 2016 helped spread a certain amount of investor confidence in the technology.

Peter Kavanagh, Director of Harmony Energy Storage, commented: "There is a question as to what regulators are going to do with this as energy arbitrage is all merchant revenue at the moment. The problem is that the investor mind-set has gone from solar and wind, which has nice long-term guaranteed revenue streams, to this more merchant model and lots of investors just won't go there.

"Investors were keen when there was a decent EFR contract and the capacity market had potential but the capacity market is almost an irrelevance now."

These types of initiatives have been few and far between and the EFR process itself has come under fire for the relatively short contracts being offered to winners, a criticism that has also been levied at Firm Frequency Response (FFR) contracts.

Shaybani commented: "The whole Enhanced Frequency Response and Firm Frequency Response scenario is quite complicated and costly. We are hoping that legislation will be simplified so that investors will be encouraged to integrate battery storage in their renewable assets."

National Grid currently have a Future of Balancing Services project to rationalise, standardise and improve the 21 existing balancing services products into a more coherent and easily-accessible product suite, to encourage the industry to provide more balancing services[6].

Paul Dight, Energy Partner at Addleshaw Goddard thinks this is good news for storage at a time when embedded benefits are being cut, as National Grid has identified that a number of its current balancing services are not available to smaller generators (including storage) and that this needs rectifying.

"What's more, the simplification and rationalization of balancing services

[6] refer to AG report supplement – "National Grid SNAPS into action on electricity balancing services"

products shouldn't just encourage industry uptake, it should also make these types of projects more investible if those products are simpler and better understood by the funding community"

But Simon Daniel, CEO of smart battery company Moixa, highlights the UK's capacity market doesn't favour short-term energy storage.

"The de-rating factors applied to the capacity market contracts penalise short-duration storage," he said. "This means that short-duration storage now represents less than 5 per cent of the original number of contracts available."

It's true that the change to the de-rating factors was bad news for those with short duration storage. The change also knocked confidence in the sector just as it was gaining momentum[7]. The de-rating change means that battery storage projects that apply for a capacity market contract will receive a reduced capacity payment, reflecting the fact that they can generally only discharge electricity for a short time.

This has led to such storage projects not being able to rely on the capacity market as a guaranteed source of income unless they can get classed as DSR (which has a higher de-rating factor), which at least one battery storage project has done. The current Capacity Market Review being undertaken may result in this loophole being closed and DSR being de-rated in the same way as storage.

WHERE DOES STORAGE FIT IN A POST-SUBSIDY ERA?

Given the lack of new generation projects in the UK, energy storage projects in the pipeline are instead being considered as a co-located, complementary feature to support existing solar PV, onshore wind power plants and now offshore wind projects.

Solar PV is making the biggest impact in the UK's post-subsidy landscape as the cost of the technology is falling at a faster rate than many of the other clean energy technologies. And importantly, these subsidy-free solar projects are being realised with a battery storage component. That's because co-locating energy storage with solar power plants, solar asset owners can create additional value to the sites and enhance the economics of their projects.

Peter Kavanagh, Director of Harmony Energy Storage, calls storage the missing link to making renewables work at a higher level. He explained: "The most attractive market for front-of-meter generators such as ourselves is energy arbitrage.

"It is a much larger market than frequency response but it will take a few years to get there because you need more volatility in the energy market to make it work.

"The numbers you can make from a traditional trading strategy right now aren't that attractive for an investor to invest just on a standard trading basis.

"If you get the decline in battery prices that people are predicting and you get more volatility in markets we see the energy arbitrage market being the main revenue stream after frequency response."

Head of Energy & Utilities at Addleshaw Goddard Richard Goodfellow comments: "We are proud to have been the advisors on several of the known storage deals in the market. Whether selling UKPR to Sembcorp or advising on a battery/solar combination nationwide we understand the challenges around storage. Those who do well are those who understand the huge opportunity storage gives – at times of peak demand the money saved can be eye catching. Batteries are relatively easy to install and move.

"The way contracts are set up with Grid involves merchant risk and you need to understand the complex regulation around metering, how use of systems work and so on but perhaps fortune favours the brave?"

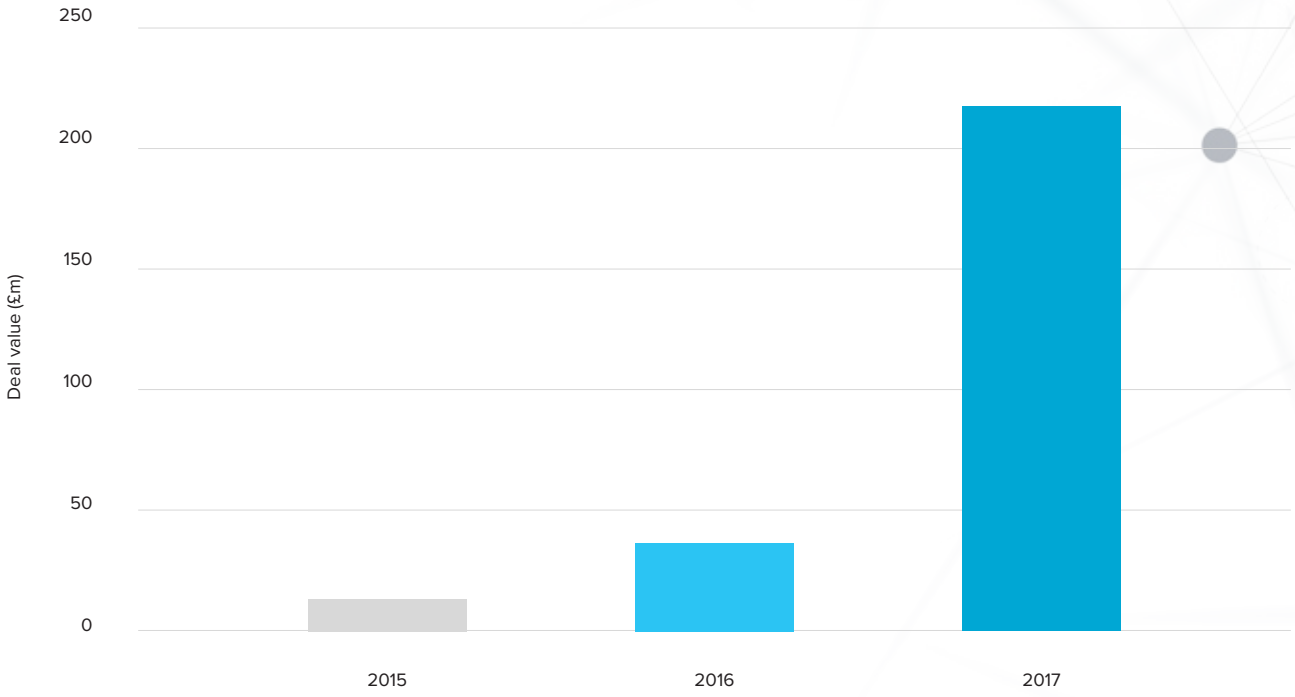
"THOSE WHO DO WELL ARE THOSE WHO UNDERSTAND THE CHALLENGES AROUND STORAGE."

[7] refer to AG report supplement – "Capacity Market Update – March 2018"

FUTURE OF ENERGY STORAGE PROJECT FINANCE

According to Clean Energy Pipeline figures, investments in energy storage projects in the UK totalled just £14 million in 2015 before rising to £37 million in 2016. Energy storage investment then surged to £218 million in 2017 thanks to a number of pioneering deals reaching financial close.

ENERGY STORAGE PROJECT FINANCE IN THE UK



Source: Clean Energy Pipeline

But the volume of energy storage project financing deals available will have to continue increasing if it is to become a serious consideration for infrastructure investors.

"PV was relatively well known and everyone saw the cost curve coming down," Simpson surmised. "But with the price of batteries coming down so fast and uncertain future revenues, why would people invest now when you could wait a few years for batteries to be cheaper and there are strong enough revenues?

"With the technology changing and the lack of visibility on revenues, there is a good investment case to say it is better to sit on your hands and do nothing rather than invest now.

"Instead, more active asset management is required for storage and we are working very hard to make sure we understand it. We work with the development partner that will operate it for us but we will jointly agree the trading strategy and this is then reviewed on a regular basis."

Paul Dight adds: "We've certainly not seen any slow-down in the number of battery projects coming across our desks in recent months and clients continue to speak to us about developing new and innovative products and models.

"But we've also seen attitudes changing over the last 12 months with some investors choosing to sit back or slow down the rate of investment. Understanding the revenue streams and the risk involved can be quite complicated and stakeholders aren't always keen to take those on – it is a far cry from PV, which is comparatively straightforward in terms of income and risks and which you can largely just plug in and forget about."

ELECTRIC VEHICLES AND CHARGING INFRASTRUCTURE

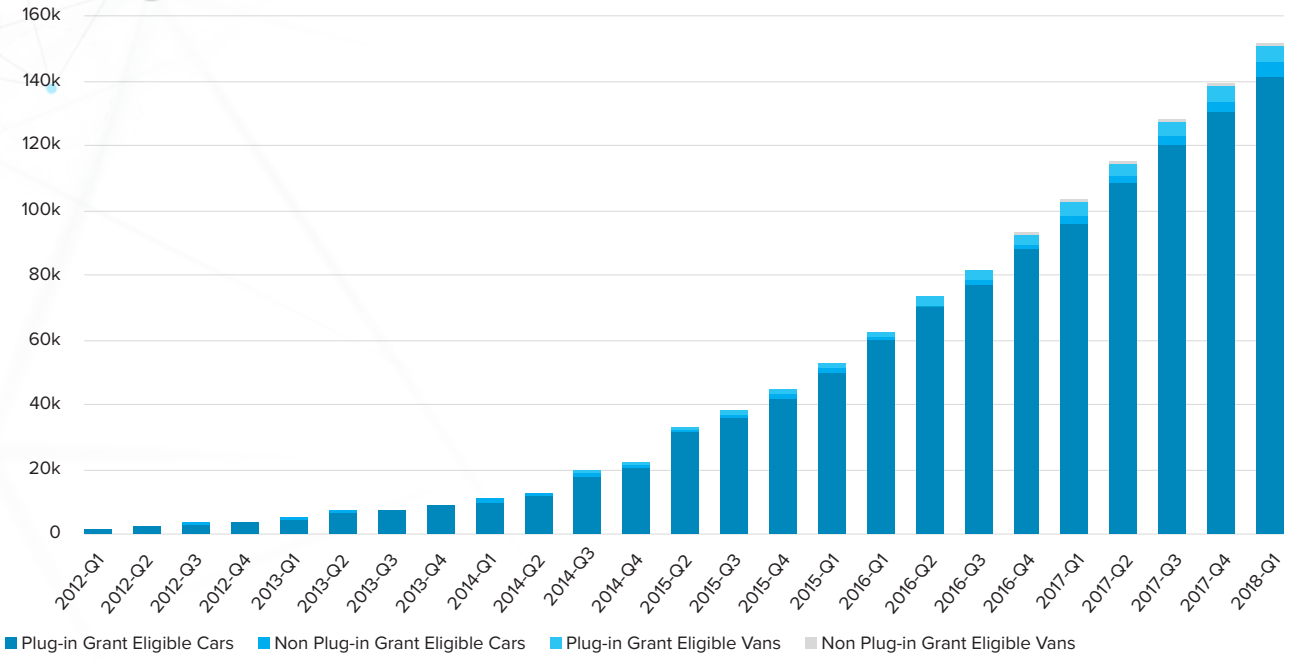
Opportunities in sight

The UK Government in July 2018 published its Road to Zero Strategy[8] which outlines plans to ensure at least half of new cars are ultra-low emission by 2030.

The Strategy identifies electric and automated vehicles as the transport choice of the future and reiterates the Government's pledge to ban the sale of petrol and diesel cars by 2040.

Sales of EVs have also been increasing year-on-year. The number of fully-electric and plug-in hybrid cars in the UK reached over 130,000 in 2017 after a record 46,500 new ultra-low emission vehicles were registered last year.

CUMMULATIVE YEAR-ON-YEAR ELECTRIC VEHICLE REGISTRATIONS IN THE UK (2012-2018)



Source: Society of Motor Manufacturers and Traders, Department of Transport and Office for Low Emission Vehicles

DEALING WITH THE CHALLENGES

Driving the mass adoption of EVs is not without its difficulties. According to the Department for Transport, the three main obstacles to EVs being more widely adopted are:

- **The availability of charging stations**
- **The distance that an EV can travel on a single charge**
- **The overall costs involved in buying an EV**

In the Road to Zero Strategy, the proposal points to the "massive expansion of green infrastructure" across the country as being an enabler for making the UK the "best place in the world to build and own an electric vehicle".

But we are seeing the landscape change quickly as large companies are recognising EVs' place in the future transport landscape and embracing the potential that the sector has to offer, among them, oil companies BP which recently acquired Chargemaster, the UK's largest operator of EV charging points, and Shell which acquired NewMotion, the Dutch EV charge point company.

AG M&A Energy Partner, Angus Rollo says: "This is just one of the spaces where we see activity from the large oil and gas companies. They have been making big investments in the renewables space recently

[8] refer to AG report supplement – "The road to EVs"

as well – including BP, whom we advised on their investment in leading global solar developer Lightsource (now Lightsource BP). This is a clear statement of intent from them and another clear indicator of the disruptive forces at play in the energy sector right now."

UK energy company SSE plc, through its SSE Enterprise division, is now also making bold strides in the sector, building and operating EV charging infrastructure.

"Most venture capital-backed companies focus on public charging infrastructure; the kind of infrastructure that's in the street for anyone to use on a pay-as-you-go basis," explained Saraansh Dave, former Head of New Markets at SSE Enterprise, who recently joined as Asia Pacific-focused power investor CLP as Head of New Business Development.

"We struggle with that business model because there is risk associated in that it's really dependent on buying the cars and then using the charge point."

Another big challenge is undoubtedly going to be consumer acceptance and uptake and it is widely recognised that there will need to be a significant behavioural shift to help make this transition a success. Government is looking at ways to help drive those behaviours and whilst it can only make so much headway in incentivising the general public and the private sector, it can have much greater influence on the public sector. Public sector tenders are now emerging for public transport projects and there are encouraging signs the uptake is gathering pace.

Public transport is therefore expected to become fully-electrified long before consumer transport wholly adopts EVs. "We think it's best to focus on specific segments: one is the electrification of buses and public transport and the second is the electrification of corporate fleet," Dave added.

CHARGING INFRASTRUCTURE INVESTMENT FUND

One of the ways the UK has sought to insulate the automotive industry from the uncertainties of Brexit is by introducing measures to encourage car makers with large manufacturing plants in the UK such as Nissan, JLR and BMW to build their fleet of next-generation electric vehicles (EV) in the country including funding the UK's Centre for Connected and Autonomous Vehicles, and establishing the £400m Charging Infrastructure Investment Fund. The fund is aimed at accelerating the deployment of charging infrastructure by providing funding to new and existing companies that produce and install charge points, and includes £100 million for plug-in car grants and £40 million for research and development.

> **"ELECTRIFICATION OF PUBLIC SECTOR TRANSPORT IS THE MOST ATTAINABLE STEP CHANGE."**

Given that today's battery packs have energy densities capable of getting a full day's use without recharging in the interim, it makes economic sense for the UK's bus fleet to be electrified, especially as current fleet management is being handled with little to no power constraints.

"The electrification of the public sector transport fleet is perhaps the most attainable step-change for the industry," says Simon Courie, Energy Partner at Addleshaw Goddard, "and that is one indirect way Government can help to change public perception and consumer acceptance. We are already seeing examples from other parts of the world where public transport is helping to lead the way on electrification."

Large corporates (in particular delivery companies) are also placing far greater emphasis on sustainability and customers are demanding that their on-line orders are delivered using a low carbon transport solution. Simon Courie says: "Roll forward a few years and we will see a massive step change in the way corporate fleet operators and bus operators will be using EVs alongside other emerging technologies such as robotic battery swapping, already being trialled in India by Sunmobility."

CAN THE GRID HANDLE MORE EVS ON THE ROAD?

The electric transport revolution will naturally be fuelled by electricity. Delivering that power to the road network in the quantities, at the locations and at the time it is needed presents a new set of challenges and business opportunities.

As things stand the grid network does not have the capacity to handle a mass take-up of electric vehicles unless there is significant smart charging – in other words, not everyone plugs in their EVs at the same time but staggers the charging over times of lower electricity demand.

“I would say EVs are the most disruptive technology that we will probably see in the near future,” Reza Shaybani said of the future outlook for the industry.

“At the moment we have approximately 130,000-140,000 EVs on the road. When that number gets to 2m-5m and if our infrastructure in energy generation and energy management is not adequate, we will have a difficulty. Not only the lights will go off but the wheels will come off as well. We need to be ready to strengthen the grid when all these vehicles are on the road and they all want to charge at the same time."

“And we have seen a shift in this case that almost all of the oil and gas companies have started investing in renewables and because of EVs this time they are here to stay. They are not just doing this for money reasons they are here because they are losing significant market share if they don’t.”

This is opening new business opportunities for UK technology companies. For example, Pivot Power has recently announced plans to roll out utility-scale batteries to electricity substations that connect directly to the extra-high-voltage transmission system before feeding directly into strategically located rapid PV charging stations.

Colin Corbally, Partner at Downing and investor in Pivot Power, identified charging stations as an “infrastructure that the country needs”.

Matt Allen, CEO of Pivot Power, further explained: “We see battery storage as an enabler and therefore that technology is facilitating the power requirements and the power challenges that EV charging – especially on the rapid vehicle charging infrastructure side – is facing.

“Through our business model we have the ability to have access to that abundant amount of power and to be very flexible to where we roll that out. Especially right now in the rapid EV charging space you have a limited number of locations throughout the UK and really on a worldwide basis.

“But as this industry really starts to take off we’ll see these cost curves start to take over and see those costs come down quite substantially. We see that as a great opportunity and we see a big role for us to play within that.”

> **“AS THIS INDUSTRY REALLY STARTS TO TAKE OFF WE’LL SEE THOSE COSTS COME DOWN SUBSTANTIALLY.”**

LEGAL FRAMEWORK

The Automated and Electric Vehicles Act[9], passed in July 2018, gives the Government powers to set standards for the reliability and availability of chargepoints, standardise how customers can pay to use them and make sure they are compatible with all EV types.

The Government can also regulate the provision of chargepoints at motorway service stations and large fuel retailers.

These powers will only be used if the industry does not step up. In reality the powers may not be needed but they give confidence to investors that there is government support for the roll-out of EV infrastructure.

The arrival of Clean Air Zones in our cities will mean demand for low-emission transport will increase. UK local government is now faced with creating transport strategies that improve air quality and embrace the technological advances on the horizon.[10]

EV networks are shaping up to be a new infrastructure asset class that satisfies those objectives, and is already attracting interest from early investors. As always the Government treads a fine line between providing regulatory certainty while not stifling market initiatives.

According to Paul Minto, Energy Partner at Addleshaw Goddard “We are entering a period of significant change across the transport and energy sector.

"The supply of electricity to battery operated vehicles is a new route to market for electricity companies.

“Also, the advances in digital technology means that the arrival of driverless vehicles powered by low carbon fuels appears destined to follow quickly behind EVs.”

[9]refer to AG report supplement – "Automated and Electric Vehicles bill published""
[10]refer to AG report supplement – "Leeds leads the way on clean air"

THE ROLE OF DATA

Data collection and analysis in the power sector plays a central role in the smart energy generation and consumption era. Digitised power networks, smart meters and Internet of Things (IoT) appliances are creating vast amounts of data points surrounding the way energy is generated and/or consumed. Utilities, energy companies and even households are using this information in a variety of different ways to better improve their energy efficiency.

SMART METER STRATEGY

Smart meters are one of the best examples of how data is being used to influence and affect energy usage.

With close to 70 different electricity and gas suppliers in the domestic energy retail market in the UK, users are more willing than ever to switch energy suppliers in search of a better deal. Retaining customers is therefore proving to be a sizeable task for even the biggest suppliers.

In 2016, the UK government launched the ambitious task of deploying smart meters across all homes and businesses by the end of 2020. This would involve about 50 million devices being installed in residential homes and a further 30 million for non-domestic sites[11].

"The reason for smart metering is because a lot of what happens in energy is on estimated billing or the homeowner reading something and this is not always accurate," explained Thom Thorp, CEO of Foresight Metering. "The reality is that we all overpay for energy. Consumers can get a better service by having a smart meter. The government wants people to better understand their usage and then reduce it if possible and also make sure they are on the most appropriate tariff.

"We provide the backbone for this and it is the energy supplier that has access to the data. There is a lot of money that will be invested in this smart metering programme and a key question is whether it will deliver."

As a smart meter asset provider to energy suppliers, Foresight Metering has deployed more than 230,000 devices for suppliers ranging from small independent companies to the Big Six. Even with companies like Foresight Metering helping with the smart meter agenda, Thorp said that the government would likely fall short of its target due to the sheer size of the task, though this would still result in about 40-45 million devices being put into operation.

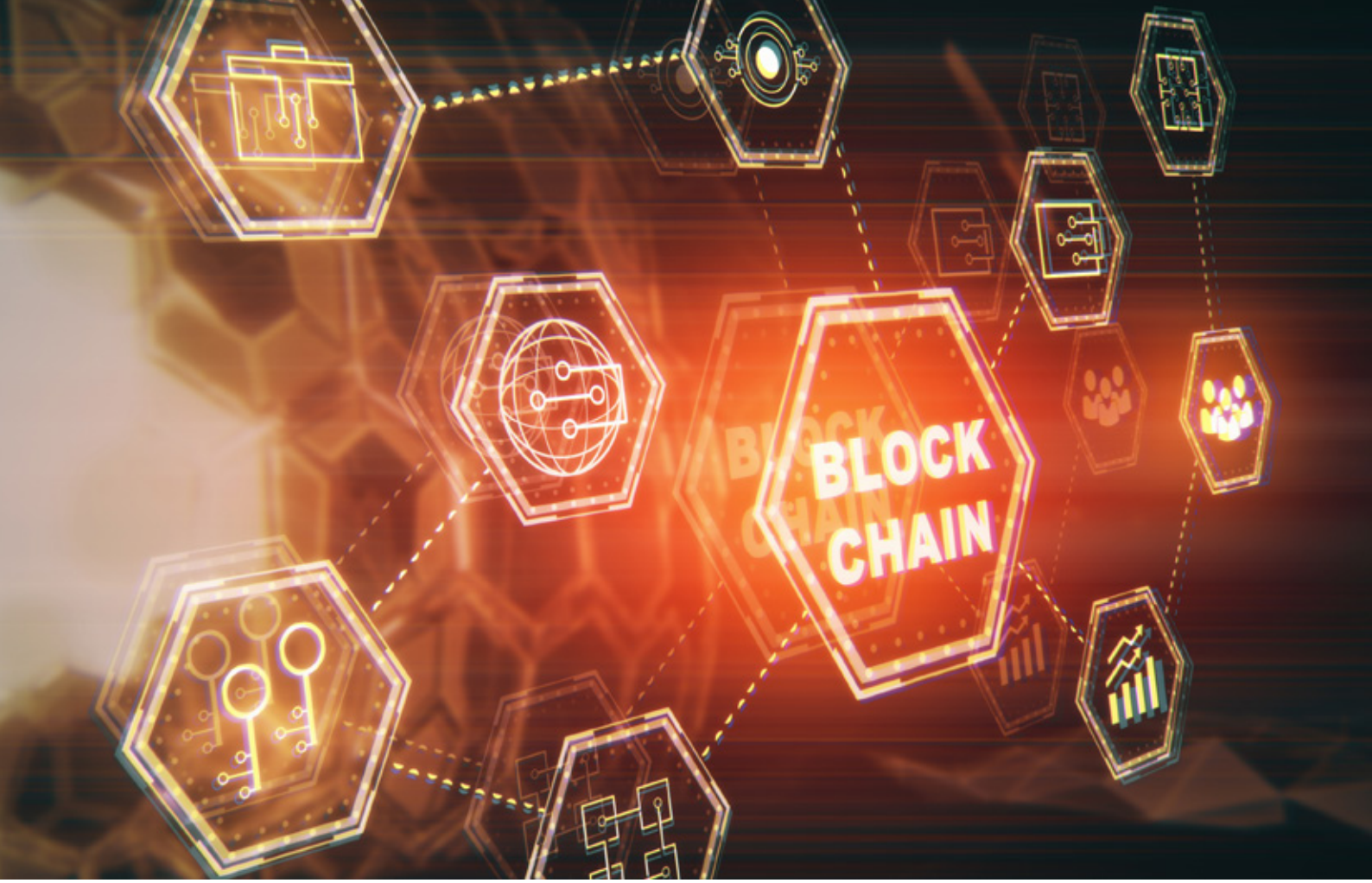
> **"IN TERMS OF MONETISING DATA IT WOULD BE A FANTASTIC THING TO DO BUT HOW DO YOU DO IT?"**

Stephen Preece, Business Development Director at arbnco, a UK-based software company that works to improve energy performance in the commercial real estate sector, explained that the reason the government would likely miss its smart metering target was because of the fragmented nature of the technologies' deployment.

"We are all getting smart meters but they are all being installed by different companies with different data communication protocols. This should ideally be standardised and, with permission, it would be possible to derive benefit from interpreting this data across a standard platform. Data is really important but the danger with data is that you can drown in it. A half-hour reading from a single meter is 17,500 data points.

"This by itself wouldn't tell you anything so you need to turn data into intelligence that you can do something about, such as looking at your switch-off protocols and then seeing if you have moved the readings in the right direction."

[11] Department for Business, Energy & Industrial Strategy



Even with such an abundance of data being created from smart meters, the avenues for which this data can be monetised are not clear to the market as of yet.

“Ultimately, the consumer owns their own data but as part of their servicing conditions they do sign it over to the energy supplier. This data has also been collected by third party data providers.

“In terms of monetising data it would be a fantastic thing to be able to do but the question is how do you do it?” commented Preece.

What we can say is that smart meters will enable Ofgem to introduce half hourly settlement for all electricity users, so that suppliers can start to offer more intelligent tariffs including introducing ‘time of use’ charging. This will mean customers are charged more to use electricity at peak times and so are incentivised to use it at cheaper, off-peak times – helping to balance the grid.

TRADING ENERGY DATA WITH BLOCKCHAIN

The role of data in the energy sector goes much broader than analysing consumer or commercial usage.

In fact, blockchain, or distributed ledger technology, is being highlighted as one avenue to give the ever-growing number of interconnected decentralised generation assets access to a coordinated trading marketplace.

In its purest form, a blockchain is a decentralised, distributed ledger that offers a community of independent users a means to securely record and verify information and transactions without the need for a central entity that administers and controls the process.

The cryptographic methods used to process and verify transactions, and the fact that this is done on a transparent and decentralised basis, are the reasons why these transactions are perceived to be secure.

BLOCKCHAIN CHARACTERISTICS

TRANSPARENT: Every user in the community has a copy of the ledger and all information and transactions are open and available for all to see. Information is easier to audit and users build trust in the process.

IMMUTABLE: Once information or a transaction is added to the blockchain it is virtually impossible to reverse the transaction or remove the information.

DISTRIBUTED: At the very core of the technology is that the ledger operates and runs on multiple nodes. The data in the ledger is replicated across all nodes in the network. No single organisation has control over the network therefore facilitating secure peer-to-peer transactions and interaction without the need of intermediary organisations.

SECURE: Digital signatures and cryptography are used to ensure the security of each transaction and, because of the distributed nature of

the ledger, there is no single point of failure.

In fact no blockchain has perfect immutability. Much depends on the consensus mechanism used and the rules that underpin the operation of the relevant blockchain.

Joanna Hubbard, Co-Founder and Chief Operations Officer at blockchain-based energy system provider Electron, describes blockchain as a "shared data architecture similar to running a programme on multiple computers at the same time that are using the same set of rules."

"When we say blockchain what we mean is a particular protocol or a particular set of rules," explained Hubbard.

"By running that programme, users can cooperate and coordinate with one another without violating the rules of the system. Blockchain is particularly interesting for energy because it's coming into the market in a time when we just have so many assets and so much noise down at the edge of the grid.

"Getting one central energy controller to know and optimise all of those assets is an extremely inefficient, impractical, and maybe an even impossible approach." The UK's flexibility markets are where blockchain technology could cause the most disruption to the energy sector, especially with regards to distributed storage and generation or heating and cooling systems.

"The flexibility market is really suited to all of these new assets coming into the system that are much smaller and harder to coordinate centrally and there's a really special set of attributes to each distributed energy resource," Hubbard explained.

"WHEN WE SAY BLOCKCHAIN WE MEAN A PARTICULAR PROTOCOL OR SET OF RULES."

Benefits of Blockchain Explained

Joanna Hubbard, Co-Founder and Chief Operations Officer, Electron

"On the blockchain asset registry you can track and verify those assets and essentially get a whole coordinated picture of all the assets in the system, without everyone necessarily revealing or handing over ownership of their data to anyone else.

"And then on the basis of that blockchain identity the assets can access the traded market and it can trade on those attributes that are associated with it.

"These assets do not have to just trade on a bilateral basis. Today, if you are big enough, you can trade with National Grid or with a Distribution Network Operator (DNO) directly, but on a blockchain system you can really trade with the whole market.

"You can sell your location to a DNO at the same time as you can sell your energy to the National Grid and we call that trilateral or collaborative trading, which is completely impossible in today's exchanges.

"We are essentially like an exchange and we monetise through membership fees and transaction fees and data brokerage."

DATA SECURITY

Safeguarding the country's utilities networks against the risk of system hacking is now a reality because of the ever growing amount of digitisation and automation.

The Network and Information Systems Regulations 2018 came into force on 10 May 2018 and impose duties on operators of essential energy services to manage the risks posed to the security of network and information systems on which their essential service relies; and to prevent and minimise the impact of security incidents. They apply to electricity and gas transmission and distribution networks, large electricity and gas suppliers and operators of electricity generators of 2GW and over.

There is a duty to report any incidents within 72 hours and penalties of up to £17million for breach of the NIS Regulations.

One of global safety consulting company UL's new lines of business in the energy sector is to ensure generation plants, industrial facilities and grid assets are more resilient to the potential exposure of hacking and data manipulation.

"Energy security is a real key growth area for UL," said Adam Terry, Director of Due Diligence for Europe, Middle East and Africa, Renewables at UL.

"What's driving this is an increased global awareness of data manipulation. A client today is now more aware of the potential risks of people with bad intentions interacting with their project in a way they never previously considered."

Part of UL's safety testing mechanisms involves looking at the data provided by a generation or grid infrastructure asset and analysing the most efficient method to provide a backup system in a worst case scenario.

"A CLIENT TODAY IS NOW MORE AWARE OF THE POTENTIAL RISKS."

"We look at how easy it is for outside parties to get into these systems," Terry explained. "We're going in and testing the system, looking at what the fall-back measures are, what the supporting infrastructure is and how quickly could you recover from an event should the worse-case happen.

"And part of that is analysing how you look at the data provided by these systems, how you back that data up and where, so should you have asset issues, how quickly and safely could you get it back up.

"Strengthening the security of a network is not purely software driven, it also involves looking at backups and actual equipment security because, if you think of the data that is available, what you can do from the control computer on-site is massive."

RENEWABLE HEAT AND GAS

Heating, alongside demand-side response, energy storage, decentralised energy generation and electric vehicles is widely viewed as the final piece of the "whole system approach" to the low carbon economy.

Heating from homes and businesses currently accounts for 32 per cent of UK emissions and 70 per cent of the heat energy supplied comes from burning natural gas.[12]

There is an understanding from central government that further work is needed to reduce these two figures if the country is to meet its legally binding fourth and fifth carbon budgets.

Heat is the slowest and most challenging sector to decarbonise. Assets are not changed as regularly as in other sectors: consumers typically only replace their boiler every 10 to 15 years. As stated above, heat is still heavily reliant on natural gas which, although cleaner than coal, is still a fossil fuel.

There are various actions the government could take to decarbonise heat. At the moment it is exploring the options with a view to making a decision by the mid 2020s. It is likely to be a mix of energy efficiency measures in buildings, heat pumps, injecting hydrogen into the gas grid, and district heating schemes.

Gideon Richards, CEO of UK renewables development consultancy Consulting With Purpose champions the development of a circular economy in the heating sector.

"There needs to be a cultural and societal shift in the way we all think about energy." he said. "Obviously, resource reduction and efficient use of heat at all scales is vitally important."

"Government needs to reconsider how it provides incentives and other economic support mechanisms for energy intensive industries, nudging them into a faster transformation to cleaner and more effective utilisation of energy, with emphasis on utilising their surplus heat. We should not consider heat as waste but as a resource."

"Industries need to futureproof their energy mix and utilisation, but clear direction is lacking (i.e. what energy carriers will dominate). Connecting the dots in a holistic way is crucial."

"For example, district heat, especially from localised Energy from Waste plants (after recycling) should be high on the agenda albeit waste recycling reduces the potential calorific value of the energy feedstock. Also, district heating as part of a smart cities' strategy is predicated on an economic model based on heat load, which if reduced becomes less sustainable."

DECENTRALIZED HEAT NETWORKS AND THE ROLE OF LOCAL AUTHORITIES

Decentralized energy networks are not particularly new but they are becoming a much more prominent consideration for developers in the UK[13]. The schemes come in all shapes and sizes involving; combined heat and power (CHP), district heating and cooling, waste to energy and/or renewables and serving one large single commercial entity, entire communities, multiple residential customers or any combination in between. However, they all have one common theme; the energy is generated entirely or partially off the main grid.

Local authorities have altered the way they use their planning powers with many now expecting developments to contain some renewable or sustainable generation.

The London Plan, for example, has an expectation that 25 per cent of the heat and power used in London will be generated through the use of localised decentralised energy systems by 2025 and so it requires boroughs to develop proposals to establish decentralised energy networks and developers to prioritise connection to existing or planned decentralised energy networks where feasible.

Local authorities can take a leading role in encouraging the development of district energy schemes, including by proactively bringing forward city-wide schemes in partnership with district energy scheme developers, operators and other stakeholders.

The government's £320million Heat Networks Investment Programme (HNIP) scheme, to be launched this autumn, will offer grants and loans to both the public and private sectors in England and Wales, for networks serving two or more buildings.

According to government figures, heat networks could meet up to 17 per cent of heat demand in homes and up to 24 per cent of heat demand in industrial and public sector buildings by 2050.

Whilst there are challenges in delivering these types of schemes, businesses are seeing the benefits[14] they can bring in achieving environmental standards such as the Code for Sustainable Homes, BREEAM and LEED, plus more energy efficiency and lower carbon emissions. Some are going further and setting up their own Energy Services Company (ESCos) to run the schemes, thereby providing an additional revenue stream. Whether these measures are enough on their own to achieve our decarbonisation targets is doubtful but it makes sense to implement them as, in the long term, they offer cost savings to businesses.

[12] www.ofgem.gov.uk/system/files/docs/2016/11/ofgem_future_insights_programme_-_the_decarbonisation_of_heat.pdf
[13] refer to AG report supplement – "Decentralised energy schemes – what's all the fuss about?"
[14] refer to AG report supplement – "Renewable energy solutions on your property: opportunities and legal issues"

THE FUTURE OF GREEN HEATING IN THE UK

Unlike power and transport, a clear pathway into the 2020s and 2030s has yet to be put in place for “green heating” in homes and businesses. The government needs to decide on an approach by the mid 2020s at the latest if the UK is to meet its binding carbon reduction targets.

There are two main options for large-scale solutions and a range of smaller solutions (such as energy efficiency and district heat networks) that will complement them. The two main options are:

- **Electrification (using electric heat pumps in place of gas boilers)**
- **Hydrogen[15] (using hydrogen generated by electrolysis, or by steam methane reforming plus carbon capture and storage).**

Each of these will mean a lot of disruption and increased costs, although by 2050 the cost of heating as a proportion of GDP should reduce. Both these options could take 20–30 years to deploy at scale, which is why the government needs to decide sooner rather than later.

Each option has its problems. Electrification of heat would place more demand on the grid: the peak heat demand in the UK is roughly six times that of peak electricity and the grid could not cope with that increase. However, better energy efficiency measures in buildings and use of smart heating controls (like Hive and Nest) should help smooth peaks in demand.

Converting the gas grid to hydrogen would be a major undertaking and would mean replacing or adapting the boilers and cookers in every home and business, not to mention the iron gas pipes with plastic ones (although this has to a large extent already been done). There is also the issue of persuading people that hydrogen is safe and there will need to be extensive trials.

The other issue with hydrogen is that the cheapest way of producing it in bulk is by steam methane reforming but this is only a low-carbon option if the carbon produced from this process can be captured and stored. The UK CCUS industry is not in a position to roll-out this technology at scale as yet and so more funding and government support is needed.

[15]refer to AG report supplement – "Hydrogen: more than just hot air?"

CONCLUSION

The power sector as we know it is changing. The generation mix has been gradually evolving over the last 10 or so years as more and more renewables in particular are being put on to the system. There is a noticeable step-change in the sector with the confluence of smart technologies, additional flexibility, an increasing appetite for decentralised energy generation and the decarbonisation of heat, not to mention the seismic effect that the electrification of transport will have.

It is clear though that this is not just about the technology – the technology is without doubt a key enabler – but attitudes are changing too. Our understanding of power markets and energy use is changing from the biggest consumers down to the individual and that is driving important changes in behaviours.

“DISRUPTION IN THE SECTOR INEVITABLY MEANS THERE WILL BE HURDLES TO OVERCOME.”

For the bigger users, that could be a case of taking energy generation into your own hands and installing decentralised generation equipment or adapting working patterns to generate additional revenues from balancing services. For the individual that could mean using a comparison app to switch energy suppliers, changing the time you put your dishwasher on or choosing to embrace the electric vehicle revolution. All of this is transforming the way the energy sector operates.

The disruption in the sector inevitably means that there will be hurdles to overcome. The regulatory and legal landscape will need to be made fit for purpose with Ofgem already promising changes in the way it regulates to help it be more responsive to the emergence of new technologies. Structural change will be needed; with more intelligent management of the transmission and distribution systems and simpler and more investible products to encourage the development of additional reliable capacity and more efficient use of energy.

Energy companies will need to adapt so they can continue to thrive alongside the raft of more nimble and tech-savvy new entrants. They will need to reorganise their structures so they are aligned with the markets and the consumer of tomorrow and able to maximise the opportunities that present themselves in this brave new data-rich world.

It’s fair to say that we don’t have all the answers. In National Grid’s own words, it’s impossible to accurately forecast a single energy future over the long term. One look at their four possible Future Energy Scenarios makes this all too clear. That means making long-term plans around the development of the energy system extremely challenging – particularly when the timing and investment consequences of getting it wrong are so high.

As ever, only time will tell but any energy business will need to face these challenges head on if it is to continue to prosper.

ABOUT THE RESEARCH

This report from Addleshaw Goddard was written in collaboration with Clean Energy Pipeline, a specialist provider of clean energy news, data and research.

The findings in this report have been supplemented by interviews conducted with the following individuals from among Addleshaw Goddard's extensive client base and industry contacts:

- **Adam Terry, Director of Due Diligence for Europe, Middle East and Africa, Renewables, UL**
- **Alastair Martin, Chief Strategy Officer, Flexitricity**
- **Andrew Burgess, Deputy Director of Charging & Access, Ofgem**
- **Colin Corbally, Partner, Downing LLP**
- **Ed Simpson, Partner, Downing LLP**
- **Gideon Richards, CEO, Consulting With Purpose**
- **Joanna Hubbard, Co-Founder and Chief Operations Officer, Electron**
- **Matt Allen, CEO, Pivot Power**
- **Peter Kavanagh, Director, Harmony Energy Storage**
- **Reza Shaybani, Vice President (Strategic Projects) at Leclanché & Board Member at Quercus Investments**
- **Richard Herring, Category Manager (Utilities), Britvic**
- **Saraansh Dave, Head of New Business Development at CLP (former Head of New Markets at SSE Enterprise)**
- **Simon Daniel, CEO, Moixa**
- **Stephen Preece, Business Development Director, arbnco**
- **Tom Thorp, CEO, Foresight Metering**

The views and opinions expressed in these quotes are those of the individuals quoted and do not necessarily represent or reflect the official policy or position of the companies they work for or any of their affiliates. These quotes do not constitute financial advice, investment advice, trading advice, or any other advice.

A number of Addleshaw Goddard energy partners were also interviewed for this report. These include:

- **Paul Dight**
- **Richard Goodfellow**
- **Paul Minto**
- **Simon Courie**
- **Angus Rollo**

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