Industrial flexibility and competitiveness in a low carbon world

June 2018

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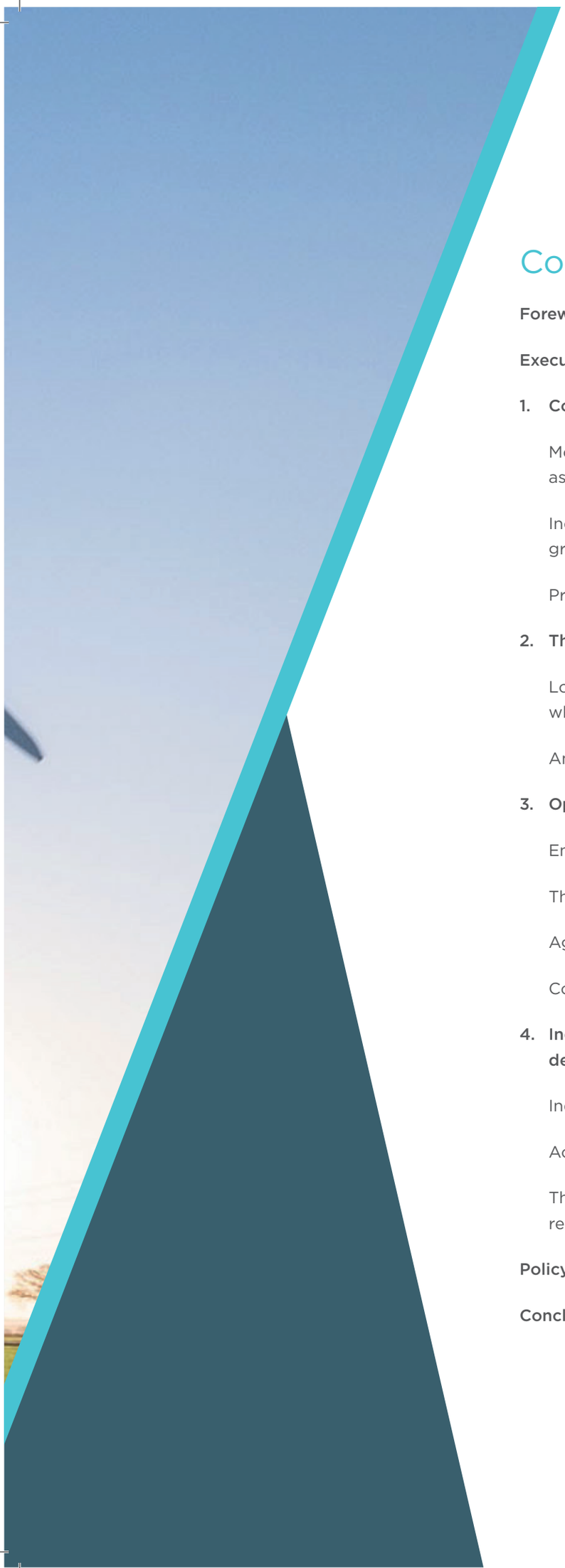

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Foreword

Greenhouse gas emissions have fallen by 43% since 1990 and the UK's economy has grown by more than two-thirds. The transformation of the energy system sector is gathering pace with the carbon intensity of the power system having almost halved since 2012; a reduction driven by the move away from coal and the roll out of renewable and distributed generation. The industrial sector has made significant progress in decarbonising, decreasing energy usage per unit of production by more than 30% between 2000 and 2016.

It is clear, despite often being presented as being in conflict, that there is clear alignment between decarbonisation and business competitiveness.

This alignment is nowhere more apparent than in the need to create a more flexible power system; a system that is adaptable to our changing energy mix and one where flexible business energy use is key in managing energy costs and enabling greater renewable uptake.

The Association for Decentralised Energy and RenewableUK represent more than 450 companies which are leading the transformation of the UK's energy system to a modern, low carbon grid. Our organisations have collaborated to explore the synergies between renewable generation and the ability for business energy users to provide flexibility. We also examine how business energy users are able to improve their competitiveness and play a valuable role in achieving our decarbonisation targets by providing this flexibility.

The vision we set out is for a new model of industrial energy use in which companies are actively participating in the energy market to improve the competitiveness and productivity of UK industry.

Tim Rotheray
Director, The Association for Decentralised Energy

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Executive summary

Britain's electricity system is undergoing profound changes in the move to a low carbon economy. In 2016, UK greenhouse gases emissions were 42% below 1990 levels, with significant progress in the power sector[1]. In particular, the UK has been more successful than any other G7 country[2] at decoupling emissions from economic growth over the past 25 years – a period in which the economy grew by 62%[3].

The energy mix is shifting towards lower carbon sources, driven by technological advances and growing commitments to tackle climate change. Industries, businesses and public sector organisations which are able to flex their power demand are helping drive this transition, and in doing so are reducing their energy bills by selling these services to the power System Operator (National Grid). Providing this flexibility is known as demand response.

Demand response is where energy users change their electricity consumption patterns in response to a signal or incentive; to match supply with demand when fluctuations occur; and to shift demand, including reducing peak demand. Within this report, demand response is defined as the provision of flexibility services from electricity consumption, onsite power generation and battery energy storage systems. Demand response is not defined in the *Electricity Act 1989* as the rules were written to reflect the system at the time – a system of broadly passive energy customers and load-following thermal generation fleets.

On the continent, where demand response is more prevalent, large consumers can reduce their annual energy bills by up to 10% by participating in demand response programmes[4].

There has always been a need for flexibility to ensure power supply and demand are matched but this need is increasing as more renewable power generation capacity is installed in Great Britain (GB). Traditional thermal generation plants (i.e. coal, oil gas and nuclear), which have historically provided this flexibility, are closing due to a combination of carbon taxes and the retirement of ageing power stations. In total, circa 23 gigawatts (GWs) of thermal capacity has been closed or mothballed since 2010, and a further 24GWs of coal and nuclear capacity are expected to close between now and 2025[5].

The closure of these thermal generation plants is driving the System Operator to find alternative flexibility sources and those able to provide the flexibility required are being paid by the power system and reducing their energy bills.

Previous reports have shown that there are significant consumer and environmental benefits from increasing the amount of flexibility in the power system, including through the use of demand response. The National Infrastructure Commission suggested that flexibility could lead to consumer savings worth £2.9-8.1 billion per year by 2030, equivalent to a reduction in the average household energy bill of £30-90 annually[6].

The System Operator estimates that up to 2.7GW of demand response participated in balancing and ancillary services between 1 April 2016 and 31 March 2017[7]. There is also significant interest in the new commercial and business opportunities from offering flexibility services in the power market, with changes being progressed through System Operator industry forums. This greater business flexibility, in turn, has the potential to enable increasing renewable power penetration, supporting the decarbonisation of GB's grid and the whole economy.

1 The Committee on Climate Change (CCC) on 'How the UK is progressing'
2 The Group of Seven (G7) is an informal bloc of industrialised democracies—Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States—that meets annually to discuss issues such as global economic governance, international security, and energy policy.
3 Conscious Decoupling Energy and Climate Intelligence Unit (ECIU) report, April 2017
4 'La bataille de l'effacement fait rage', L'Usine de l'Energie, April 2014
5 Building a smarter, greener, cheaper electricity system, Richard Howard and Zoe Bengherbi, Policy Exchange, 2016
6 Smart Power, Energy report by National Infrastructure Commission, March 2016
7 Non-BM BalancingServicesVolumes and Expenditure 2016-2017 Full Year, National Grid

There is a major opportunity for the Government, Regulator and System Operator to harness the synergies offered by demand response from businesses and renewable generation deployment. Combined, these can play a key role in meeting the UK's climate ambition, while managing costs for all energy customers.

This report presents a number of case studies illustrating what is already happening throughout the UK, and sets out recommendations about how to harness the largely untapped potential of flexible demand and cost-effective low carbon generation.

The key recommendations of the report are for the Government, Regulator and System Operator to:

1. Create a level playing field to encourage greater competition between supply and demand response options in the balancing services, ancillary services and the Capacity Market. This should be built on the principles of open and competitive access, transparency and non-discrimination between technologies at both transmission and distribution levels;
2. Ensure new policy enables customers to benefit from the deployment of the most cost-effective mature renewable generation; and,
3. Improve the transparency on products and services offered by the System Operator. In particular, the use of industry forums will enable greater communication on current changes and reforms concerning the whole energy system.

The case studies included in the report are:

- Cornwall Local Energy Market (Centrica)
- Sharp Focus on Intelligent Planning (Ørsted and Kodak Alaris)
- Blue Lab's Low Carbon Technologies and Energy Solutions (EDF)
- The Renewable Balancing Reserve (Ørsted)
- Storing energy to cope with spikes in demand in Gateshead (Centrica)
- Thameswey Central Milton Keynes (Flexitricity)
- The Changing Face of Roosecote (Centrica)
- Aberdeen Heat and Power (Flexitricity)

THERE HAS ALWAYS BEEN A NEED FOR FLEXIBILITY TO ENSURE POWER SUPPLY AND DEMAND ARE MATCHED BUT THIS NEED IS INCREASING AS MORE RENEWABLE POWER GENERATION CAPACITY IS INSTALLED IN GREAT BRITAIN

1. Context: power system trends

Britain's power system is undergoing profound change. Historically, the system was designed for centralised thermal generators delivering electricity to end-users. Today, however, we are seeing increasing renewable generation, and reducing generation from thermal power plants. This is a trend set to continue, as old nuclear and coal power stations are shut down in the 2020s. New forms of generation will be needed to ensure power supply meets demand at all times and to manage the peaks and troughs in non-load following generation.

In addition, there has been rapid growth in digitalisation of industrial processes and facility management, leading to new patterns of end-user demand. The power System Operator is now managing much more complex flows of electricity and a growing number of market players interacting with the grid on both the transmission and distribution networks. The market for electric vehicles and batteries is expected to grow significantly over the next 10 years, changing the way domestic and business consumers connect and interact with the grid.

Industry, Government, the Regulator and the System Operator need to ensure that our upgraded energy system is prepared and can harness new sources of flexibility to capture the benefits for both domestic and industrial consumers.

Centrica case study:
Cornwall Local Energy Market

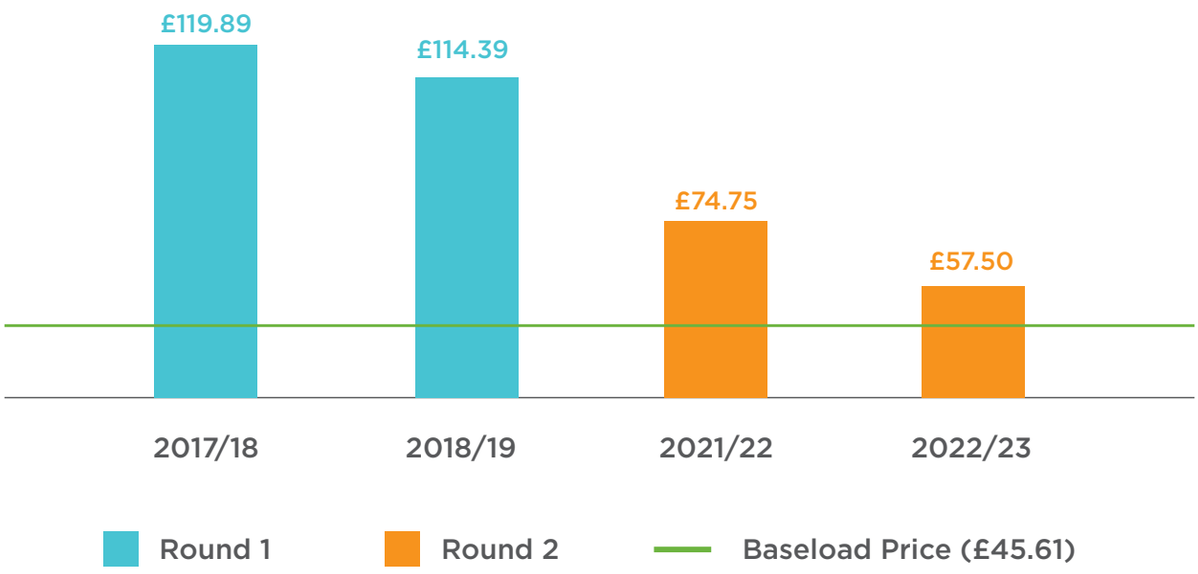
Centrica is leading a £19m programme in Cornwall to explore flexible, smart energy solutions for the UK. This pioneering trial in Cornwall will test the use of flexible demand, generation and storage across both the domestic and business sectors.

It is developing a virtual marketplace that will provide participants with a platform to buy and sell energy and flexibility both to the grid and amongst themselves. As a result, this trial market will help to enable more renewable generation (for domestic and business customers) as well as reduce constraints through the use of flexibility from Cornish businesses.

More decentralised and variable generation as the market grows

As a consequence of a supportive policy framework and of technology innovation, clean energy costs have decreased rapidly over the past few years, increasing interest in the adoption of renewable generation for consumers and governments. The Contracts for Difference (CfD) have been effective at driving down prices through competition: the recent auctions for less established technologies revealed the major cost reduction undergone by the offshore wind industry in just five years. The last 'Pot 2' CfD auction in September 2017 procured new offshore wind at close to half the price of an auction two years previously (Figure 1). At the same time, new onshore wind is projected to be the cheapest form of new build generation available[8].

Figure 1 - Decreasing UK Contract for Difference offshore wind strike prices (£/MWh)



Source: UK industrial electricity prices: competitiveness in a low carbon world, UCL 2018

As a result of this deployment, generation from renewable power plants is becoming one of the largest contributors to the GB power generation mix. In the first quarter of 2018, for the first time, generation from renewables accounted for 29% of the UK's total generation, greater than that of coal and nuclear power plants combined. This greater deployment has led to rapid decarbonisation of electricity generation. Emissions in the power sector reduced by more than 50% between 1997 and 2017[9] to approximately 250-300gCO_2/kWh. The 2030 target is even lower, and should be considered alongside the decarbonisation progresses in other key sectors such as heat and transport.

8 Baringa report An analysis of the potential outcome of a further 'Pot 1' CfD auction in GB, Baringa for Scottish Renewables, April 2017

9 Source: 2018 BEIS Updated Energy and Emissions Projection data, RenewableUK calculations

Increased flexibility, smarter systems, greater market access and more actors

The Government, Regulator and System Operator all agree on the need to invest in a smarter and more flexible power system to ensure the low carbon transition is efficient and benefits consumers, including industrial consumers. Moreover, technology innovation means more flexibility in our current system is possible.

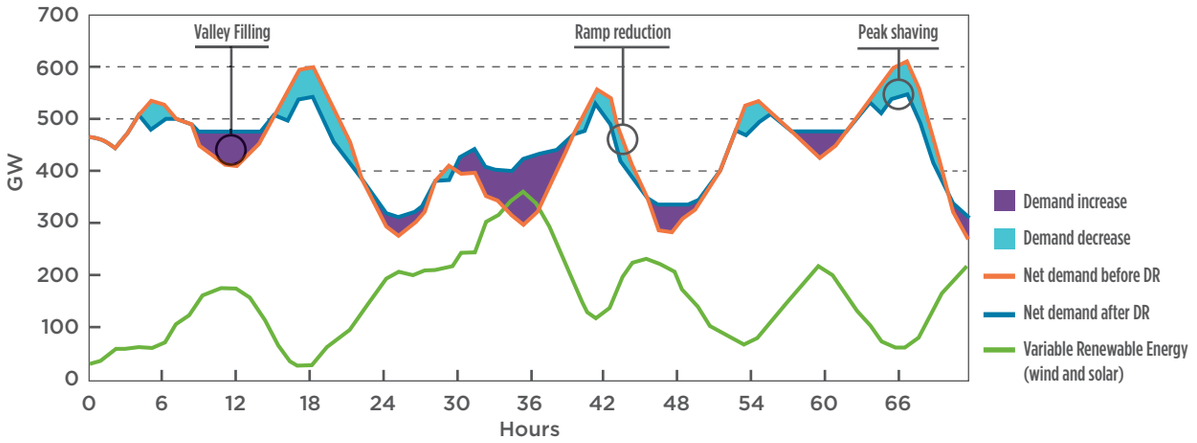
A smart system enables both power supply and demand to be flexed in the most efficient way possible, rather than simply changing generation to meet demand as in the past. The ability to tap into flexibility sources ensures power supply and demand are matched, that the grid is not overloaded and that supplies are at the correct voltage and frequency across the network. In GB, a smart system could save up to £40 billion by 2050[10] in avoided network upgrade, peak generation build and curtailment costs.

The 2017 *Smart Systems and Flexibility Plan* aims for demand response providers to have easier access to a range of different markets, including the balancing market, Capacity Market and ancillary services, so they can compete fairly with large generators. The *Smart Systems and Flexibility Plan* also sets out Ofgem's intention to open up the wholesale power market to demand response providers[11]. Innovative industry initiatives, such as the Power Potential project, aim to create new local power markets enabling the provision of demand response from distributed energy sources[12].

In today's markets, demand response takes the form of a modulation, upward or downward, of electricity flows to support the grid at times of system stress or storage to make the whole system more efficient. Demand response can be used for different objectives as per Figure 2 below:

- **Peak shaving:** reducing peak consumption during constrained system conditions so as to release pressure on generation and grid capacity. This also reduces the need for investment in peak generation assets and additional power lines;
- **Valley filling:** increasing or shifting consumption to hours of ample wind and/or solar generation; and,
- **Ramp reduction:** reducing the steep increase in power demand (known as ramping) which occurs towards peak demand time. This is achieved by shifting load away from times when the system is under constraint.

Figure 2 - The different roles of demand response in a power system with high shares of renewables



Source: Re-powering markets, International Energy Agency, 2016

10 An analysis of electricity system flexibility for Great Britain, Imperial College London and Carbon Trust, November 2016

11 https://www.ofgem.gov.uk/publications-and-updates/independent-aggregators-and-access-energy-market-ofgem-s-view

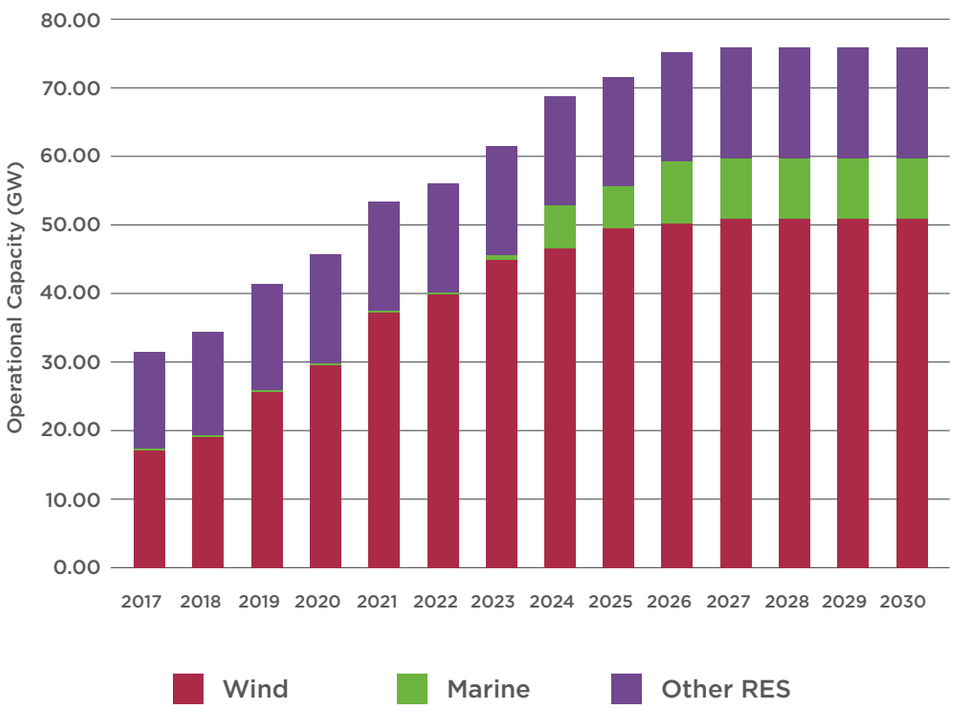
12 https://www.nationalgrid.com/uk/investment-and-innovation/innovation/system-operator-innovation/power-potential

Pressure from decarbonisation targets

Under the *Climate Change Act (2008)*, the UK has set a target to reduce its annual greenhouse gas emissions by 80% by 2050 (compared to a 1990 baseline), with five yearly carbon budgets. These targets have triggered a rapid and growing deployment of renewable energy capacity in the country. Between 2000 and today, the installed renewable capacity in the UK increased more than ten-fold, reaching nearly 40GW at the end of 2017[13].

As the deployment of renewables continues to increase, there will need to be still more integration of renewable energy into the system to meet our emissions reduction targets. The Committee on Climate Change (CCC) calculates that to meet the 5th Carbon Budget (2028-32), the UK has to reach a 50-100gCO_2/MWh level of emissions in the power sector[14]. The Department for Business, Energy and Industrial Strategy (BEIS)'s reference scenario in its Updated Energy and Emissions projection exceeds this threshold by more than 60%.

Figure 3 – High renewable deployment scenario in 2030 based on current pipeline of projects in the UK



Source: RenewableUK scenarios based on RenewableUK project intelligence Database and BEIS RES Public Database

This chart shows a possible high scenario, based on current and upcoming projects, where a large deployment of renewables would be compliant with carbon targets (below 50gCO_2/kWh).

13 2018 BEIS Updated Energy and Emission projection data

14 https://www.theccc.org.uk/wp-content/uploads/2015/11/Committee-on-Climate-Change-Fifth-Carbon-Budget-Report.pdf

Ørsted case study: Site Optimisation cuts energy costs at Kodak Alaris by 11%

Kodak Alaris has cut its energy costs by 11% by using Ørsted's Site Optimisation. Site Optimisation is a cloud based program that uses sophisticated algorithms to calculate the optimal run schedule for an operating plant.

The program analyses market signals, such as wholesale energy prices, in relation to operating constraints and asset availability. It then creates bespoke, daily run schedules which detail the commercially optimal way to operate equipment, schedule production, and generate electricity on-site or export to the grid.

Before Site Optimisation 'went live', Ørsted assessed Kodak Alaris' operational and technical requirements, focusing on the consumption of gas and electricity, export potential, and the variable need for steam. Site visits also allowed Ørsted's consultants to determine any operational constraints around particular assets, such as start-up periods and running times.

Once operational, Site Optimisation calculated the optimal daily run schedules for Kodak Alaris against changing market prices, therefore reducing the time required to plan operations. Run schedules are accessed via Kodak Alaris' online account, where plant information can be entered or updated, and the result can be viewed and printed ready for use at the site.

Through Site Optimisation, Kodak Alaris has been able to take full advantage of the site's flexibility capabilities and has followed Site Optimisation's run schedules to within 3%. As well as boosting resource savings through a reduction in daily planning time, Kodak Alaris has optimised operational performance resulting in an 11% saving in energy costs.

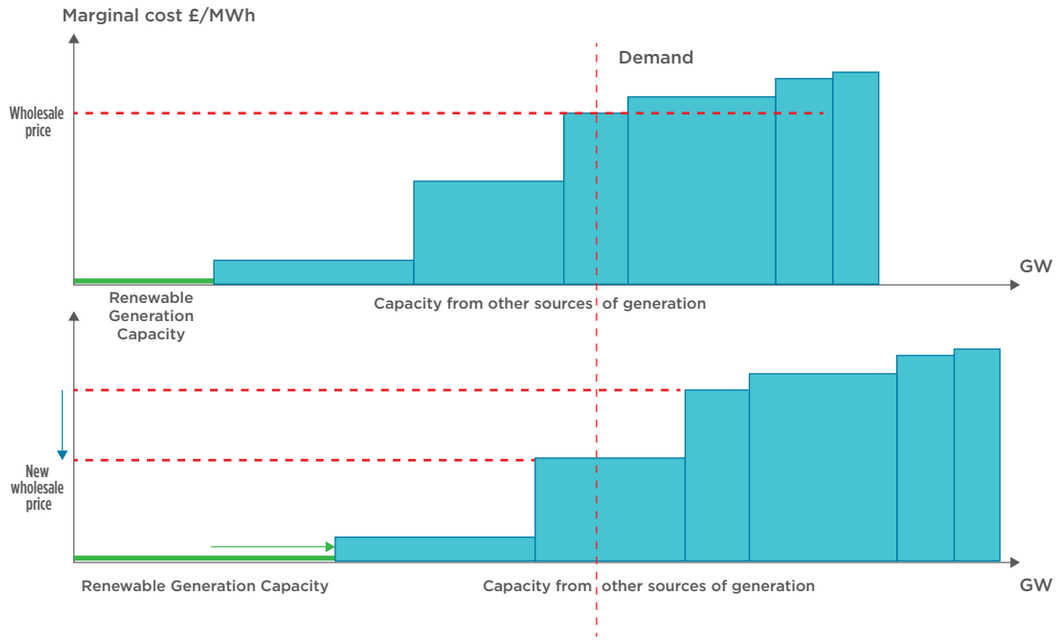
2. The impacts of changes on the system

Low marginal cost renewable energy is decreasing wholesale electricity prices

The cost of running renewable generation is low, as their fuels – the wind, sun and sea - are free. Increased generation from renewable sources is pushing down wholesale prices, driving more expensive generation out of the mix (Figure 3).

Therefore the forecast increase in deployment of renewable energy sources will ultimately push highly efficient gas plants to become the main wholesale price setter. This is reducing the average price at which generators and suppliers trade on the wholesale market, which has fallen from over £53/MWh in 2013 to below £40/MWh in 2016[15].

Figure 4 – Illustration of the merit order effect on prices



Source: Illustration from RenewableUK

With near zero marginal cost, renewable energy pushes anything more expensive out of the merit order. This has had the greatest effect on coal generation, where the load factor for coal fired power stations decreased from 39.3% in 2015 to 16.5% in 2016[16]. This, in addition to reducing overall prices, is leading to greater short-term price volatility due to the mismatch between generation and demand. This price volatility is creating new revenue opportunities for those energy users and generators which can provide flexibility services to the system.

IT MAKES ECONOMIC SENSE TO ENSURE THAT RENEWABLES DEPLOYMENT CONTINUES TO DISPLACE THERMAL GENERATION WHERE COST-EFFECTIVE FOR THE BENEFIT OF END USERS, IN A MORE FLEXIBLE POWER SYSTEM.

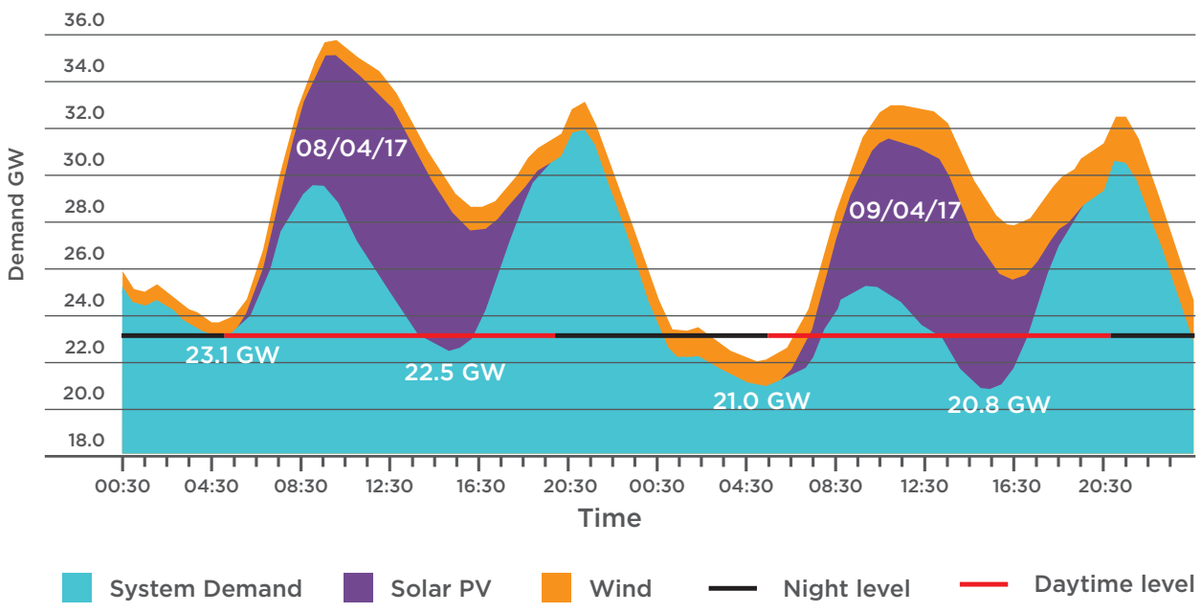
15 BEIS 2017 Updated Energy & Emissions Projections, Annexe M, reference scenario

16 BEIS DUKES 2017, Ch.5

An immediate need for system flexibility

In spring 2017, the day time minimum demand fell lower than the overnight minimum demand on the GB's transmission system for the first time (Figure 5). This was caused by very high distribution connected generation (both renewable and other generation sources)[17].

Figure 5: Daytime minimum demand vs. overnight demand



Source: Summer Outlook 2018, National Grid

The increasing integration of renewable generation onto the grid requires flexibility in the power system to ensure reliability of power supply at times when renewable generation is not matched to demand.

This mismatch between generation and demand is leading to greater short-term price volatility. Countries with high shares of renewable generation, such as Germany, have identified a new trend in intraday wholesale prices due to the rise of solar power. Prices tend to decrease in the middle of the day as decentralised solar feeds more power to the grid, and then increase in the evening, leaving a distinctive price pattern referred to as 'the duck curve' (Figure 6).

17 Because distributed energy sources refer to generation connected to the distribution system, they are therefore not directly visible to National Grid and act to reduce demand on the transmission system.

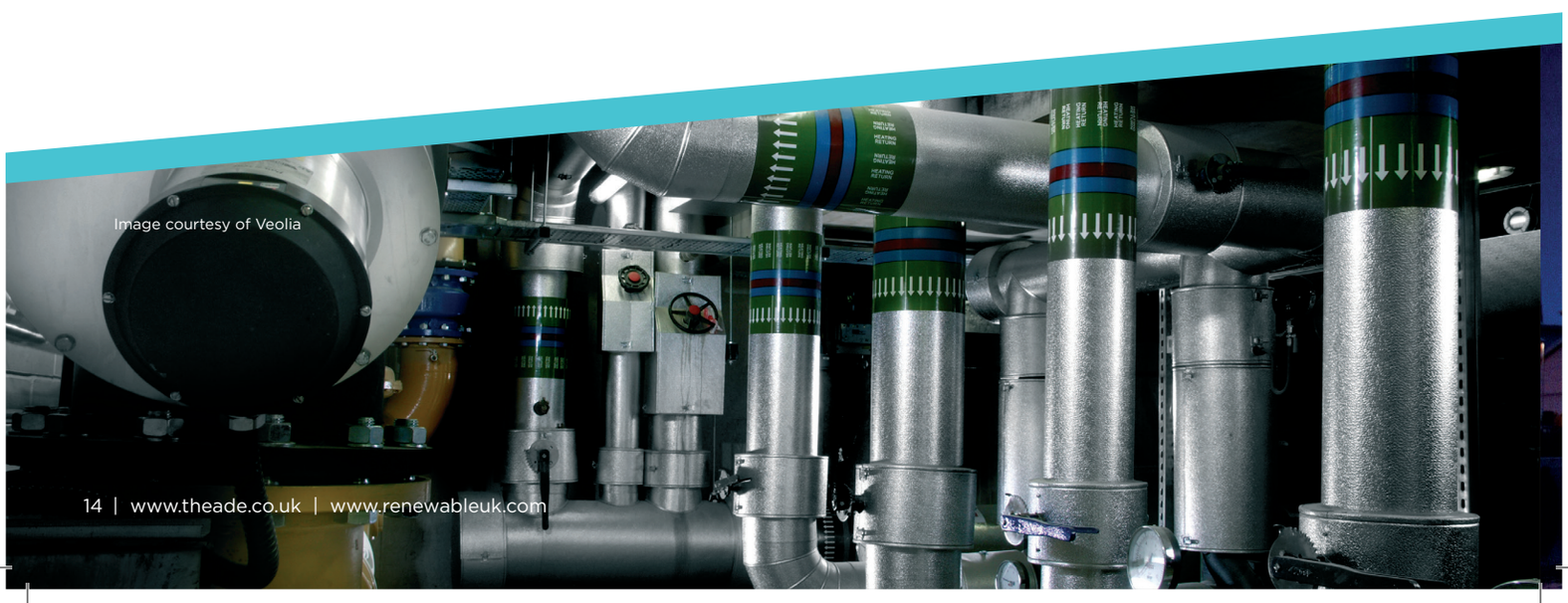
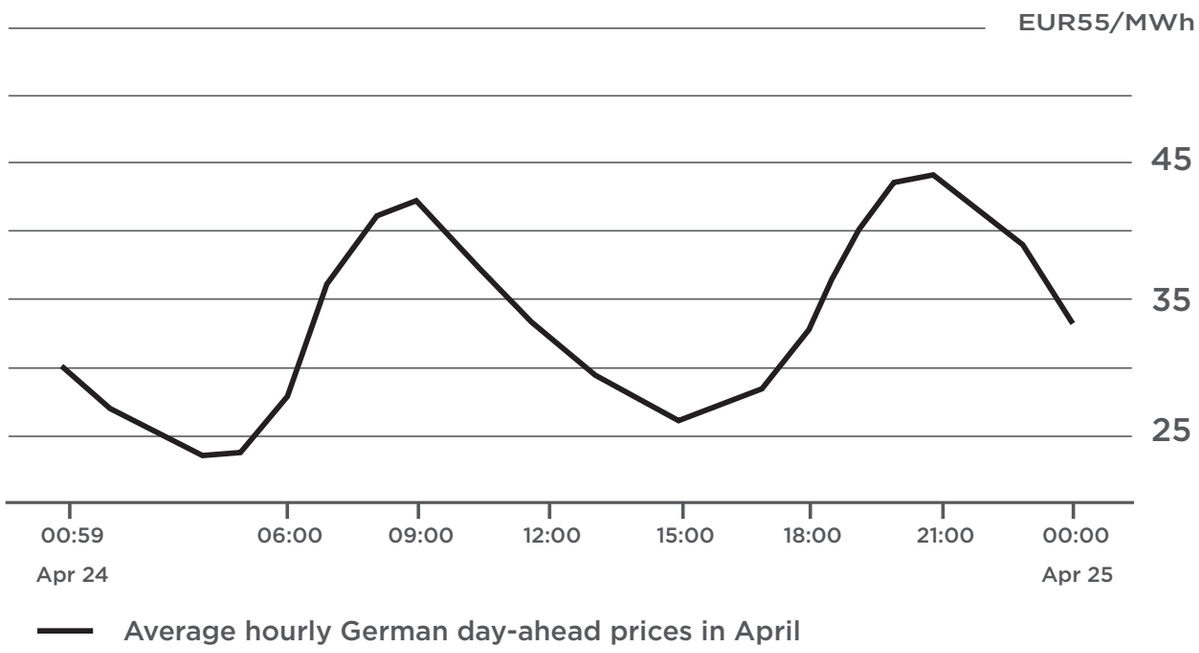


Image courtesy of Veolia

Figure 6: **Price volatility driven by solar generation in Germany**



Source: **'The Electricity Industry Is Giving Europe's Power Traders a Headache', Rachel Morison, Jesper Starn and Brian Parkin, Bloomberg, April 2018**

This price volatility and demand for flexibility offers value and revenue opportunities for industrial and business consumers who are able to offer flexible services. Traditionally, only large thermal power plants were contracted by the System Operator to provide these flexible services and much less the smaller and more efficient generators. Closing thermal generation is creating an opportunity for these services to be offered by industrial and business energy users, who are perfectly placed to offer the flexibility needed.

EDF Energy case study: innovative energy solutions for customers - from Blue Lab at EDF Energy

EDF Energy is working on numerous projects to assist sites in increasing flexibility and utilising demand response capability.

Selective Catalytic Reduction (SCR) technology is being deployed at a customer service centre in Exeter to enable demand response capabilities. This will allow for participation in the various demand response markets, including Triad, Short Term Operating Reserve (STOR), Firm Frequency Response (FFR) and the Capacity Market. The installation of the technology will lower emissions from the 0.7MW back-up diesel generator, meaning the site will meet regulatory diesel emission requirements. Additional benefit will include real time engine performance monitoring, Medium Combustion Plant Directive (MCPD) compliant emissions reporting and the unlocking of revenue streams. The return on investment is expected to be within two years.

Battery storage solutions are also a vital part of the future energy mix in helping to lower carbon emissions, smoothing the daily demand shape – by shifting consumption from high to low demand periods – and complementing renewable energy projects. EDF Energy has installed a Panasonic 50kW/65kWh system at a national training facility in Cannington. This asset is expected to generate attractive revenues over the lifetime of the battery, using PowerShift to access grid ancillary services, demand shifting, and wholesale markets optimisation. The Cannington battery will provide vital frequency response and Capacity Market services to the National Grid.

Ørsted case study: Renewable Balancing Reserve increases P3Ps export revenue by an average of 4%

P3P Energy Management AE Ltd is a leading supplier of Combined Heat and Power (CHP) energy solutions to the industrial and commercial sector. The company operates a 3MW CHP plant for GB's largest commercial tomato grower. Electricity is produced by the plant as a by-product of the growing process, which is then exported to the grid, generating revenue for P3P.

P3P recognised that by accessing the imbalance market, further revenue could be made from the CHP plant, but needed a way to access this without additional resource or investment.

Ørsted's Renewable Balancing Reserve (RBR) provided a solution to P3P's challenge and has increased P3Ps export revenue by an average of 4%.

Ørsted monitors system imbalance and alerts P3P when there is an opportunity to help balance the system. Responding to the alert, P3P then changes on-site generation by activating the CHP plant remotely at the times needed.

Each month, P3P sets its strike prices per MWh of flexibility delivered across each day. This is the minimum price it would accept to provide volume. When P3P responds to an alert, Ørsted guarantees the strike price P3P has set. If the imbalance market closes at a higher price, P3P also takes a share of this.

Although RBR is available 24/7/365, P3P can choose when to take part. If the company is unable to participate, the alert can be ignored without penalty.

Over a year, P3P was available to take part in just over half of the 48 settlement periods in a day (due to the tomato growers' requirements for heat and CO_2). During the times P3P was able to take part, it was able to increase export revenue by an average of 4%, creating an average of £273 of additional revenue per hour. With no additional impact to on-site operations or running costs, P3P has been able to access this revenue without extra investment.

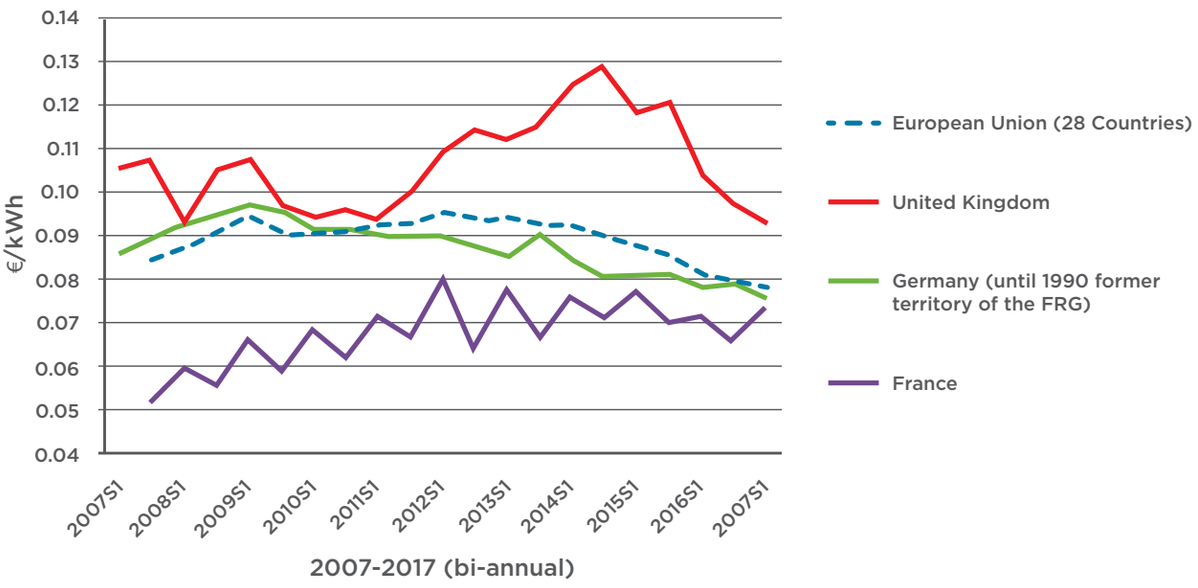
3. Opportunities for industry and business energy users

Intensive users need to take control of their energy costs

Energy users want predictable and stable energy costs

Energy consumers want to benefit from affordable, low carbon and secure energy. However, the average electricity price of large UK consumers was approximately 20% higher than the price paid by large consumers in other European countries (28 countries) in the first semester of 2017[18]. Higher electricity costs are one of the main drivers to rising UK industrial production costs.

Figure 7: **Electricity prices for non-household consumers**



Source: Eurostat

Recent research suggests that industrial electricity prices have increased in the UK due to a combination of three main factors[19]:

- The long lasting effect of exceptionally high gas prices that peaked in 2013 increased **energy and supply costs**;
- New investment to maintain and expand the network increased **network costs;** and,
- The UK's carbon price support, which accounted for part of the increase in **taxes and levy costs**.

In the *2017 Industrial Strategy*[20], the Government recognised the need to drive down energy costs for businesses, in particular electricity, and raise resource productivity.

18 http://ec.europa.eu/eurostat/en/web/products-datasets/-/NRG_PC_205

19 UK industrial electricity prices: Competitiveness in a low carbon world, UCL research report, February 2018

20 https://www.gov.uk/government/publications/industrial-strategy-building-a-britain-fit-for-the-future , pages 160-161

Centrica case study: storing energy to cope with spikes in demand in Gateshead

The Gateshead District Energy Centre is a ground-breaking scheme designed to deliver energy to the local area. It aims to bring together multiple energy sources to generate cost savings and strengthen energy resilience.

The centre includes a pair of 2MW CHP units, which generate enough electricity to power 3,000 homes. Gateshead Council, which owns the site, wanted to supplement CHP with battery storage to provide more flexibility.

Centrica Business Solutions installed a battery storage scheme with a total capacity of 3MW. The scheme comprises six units which hold the equivalent of one million AA battery cells, with a minimum response time of 140ms.

Centrica will manage the project under a 10 year contract, providing various flexibility services for the grid which help keep the national electricity network in balance. In time, it will also be used to help meet peaks in local demand, providing electricity through a private wire to council-owned buildings and well-known Tyneside buildings, including Gateshead College and the Sage Gateshead concert venue.

The Centrica solution is capable of storing enough energy to meet the needs of 3,000 homes for one hour. Combined with the two CHP units, it is the final piece in the puzzle for Gateshead Council, helping to meet the needs of both the existing network and future-proofing the system for further commercial and residential development.

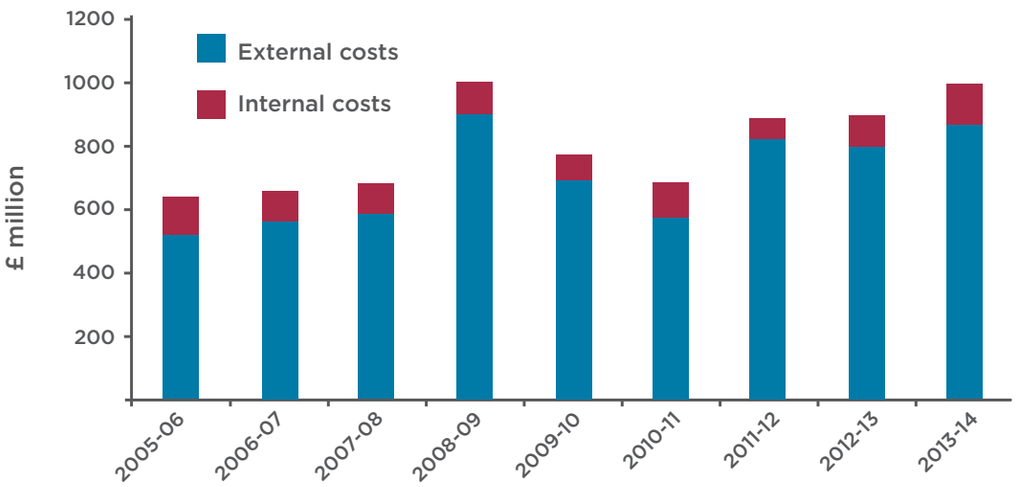
There is a business case for industrial flexibility

Flexibility is a win-win for energy users, energy system players and the System Operator.

Industrial users receive payment for their dynamic interactions with the grid and ultimately benefit from reduced network and policy costs. For the System Operator, the participation of energy users in the electricity system can reduce the whole system cost, which in turn reduces costs for all energy users.

The System Operator has set an aspiration to meet 30–50% of balancing capability from demand response by 2020 to help keep generation, demand and network capacity in balance at the least cost for consumers[21]. In the context of rising overall costs of balancing services, as illustrated in Figure 8, it is becoming increasingly important to procure much needed flexibility from the most cost-effective sources.

Figure 8: Total costs of balancing services



Source: Electricity Balancing Services, National Audit Office briefing for the House of Commons Energy and Climate Change Select Committee, May 2014

Flexibility can allow higher shares of renewable generation to be consumed when it is available, thereby increasing the efficiency of the GB power system and lowering energy costs for all users.

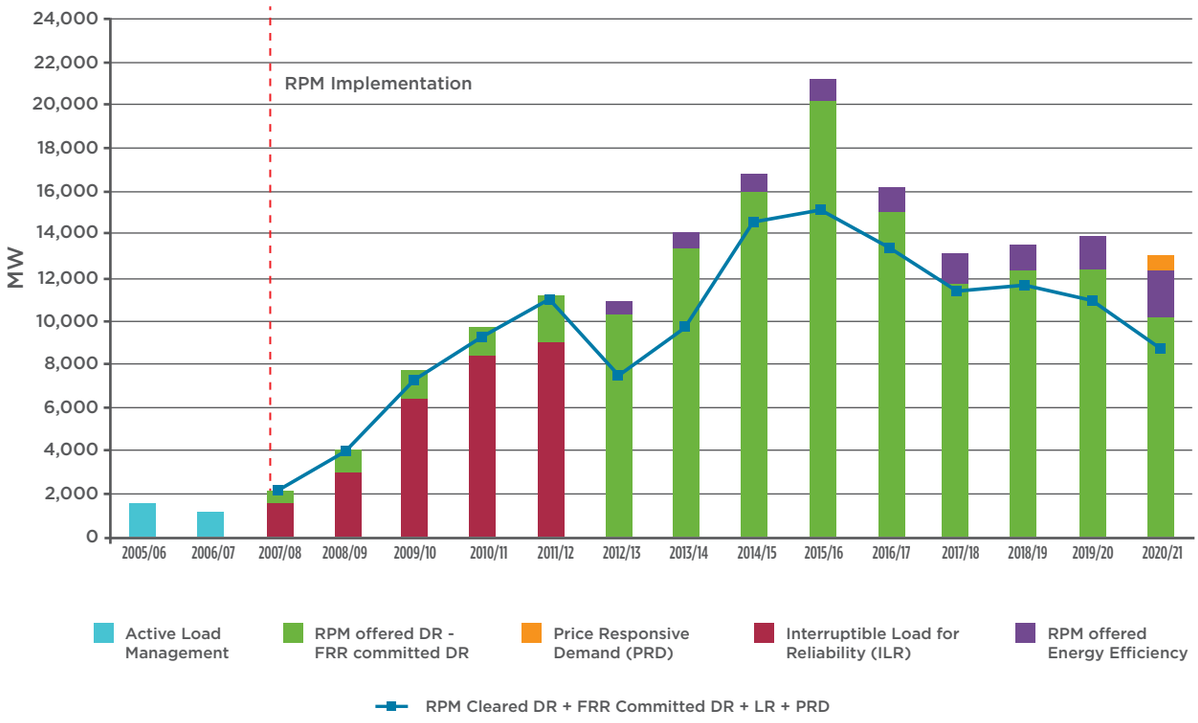
21 Demand side flexibility, Power Responsive Annual Report 2016 - page 3

Aggregation of demand response flexibility

Even though a customer might only be able to flex a small share of its demand, by joining with other users providing flexibility services, the total reduction in demand can reach sufficient scale to make a significant contribution to flexibility markets. To manage the mix of users providing services, demand response services are often brought together by an aggregator who develops the technology to optimise different assets. Aggregators source flexibility from business energy users in batch production processes, electric intensive processes, refrigeration processes, onsite generation in hospitals and universities, battery storage and hot water systems.

Such access and use of demand as a flexibility tool is common in other markets such as the US and the EU. Figure 9 shows the increase in demand side participation in the PJM Capacity Market, and for the first time 'Price Responsive Demand' participation in the 2020/21 auction (558MW committed)[22].

Figure 9: Demand side participation in the PJM Capacity Market[23]



Source: PJM's Capacity Market 2020/2021 Base Residual Auction Report

A 2017 briefing paper from E3G suggests that demand resources have helped reduce peak demand between 10-12% in North-eastern and Midwestern regions in North America[24]. The System Operator of the GB grid system is increasingly sourcing flexibility from demand response but more can be done.

22 http://www.pjm.com/-/media/markets-ops/rpm/rpm-auction-info/2020-2021-base-residual-auction-report.ashx?la=en. PRD is provided by a PJM Member that represents retail customers having the ability to predictably reduce consumption in response to changing wholesale prices. In the PJM Capacity Market, a PRD Provider may voluntarily make a firm commitment of the quantity of PRD that will reduce its consumption in response to real time energy price during a Delivery Year.

23 PJM Interconnection is a regional transmission organization (RTO) that coordinates the movement of wholesale electricity in all or parts of Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia and the District of Columbia.

24 Developing Demand Side Flexibility through the "clean energy for all Europeans" package, Briefing Paper, April 2017, E3G, Simon Skillings, Manon Dufour

Cost-effective demand response services

In the GB power system, all energy consumers can participate in demand response, with large industry consumers offering some of the most cost-effective potential solutions:

- Industrial consumers have the flexibility to adjust production processes or use efficient combined heat and power and energy storage to manage their energy costs;
- Commercial consumers can typically use automated solutions to manage air conditioning/lighting loads or use efficient cogeneration and battery storage to decrease their energy costs;
- Residential consumers can participate through innovative commercial services offering energy savings with minimal impacts on daily life, for example via smart appliances; and,
- The deployment of smart vehicles is opening the transport sector to demand response markets.

The GB demand response market is currently small but growing. A total 1,206MW carbon-free demand response received Capacity Market contracts in the 2017 T-4 auction, up from 174MW in the first 2014 T-4 auction.

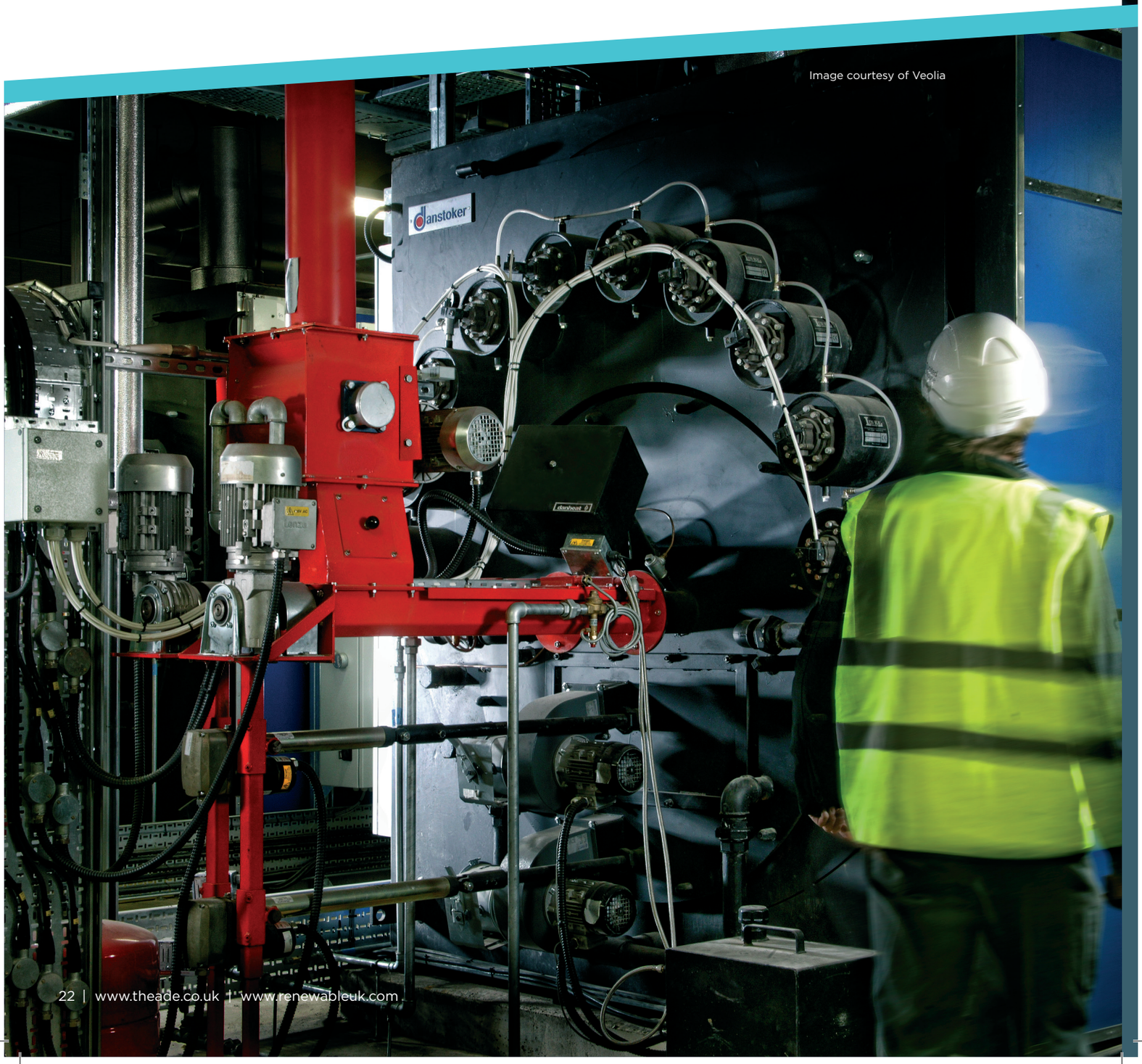


Image courtesy of Veolia

Flexitricity case study: Thameswey provides 6MW of generating capacity to help support National Grid

Thameswey Central Milton Keynes was set up in 2005 to build and operate a low carbon CHP energy station. Thameswey supplies nearly 20,000MWh of low carbon electricity per year to local homes and businesses. Thameswey has been reliably providing reserve energy to National Grid through aggregator Flexitricity since 2011.

Using two gas CHP engines which can be made available to Flexitricity when not required for local generation, Thameswey is able to provide 6MW of generating capacity to help support National Grid during times of system stress and to support the transmission system during winter peaks.

Reserve energy is delivered to National Grid through a fully automated control and monitoring system. The two gas CHP units are remotely operated in response to a national or local requirement. The fully managed service optimises revenue through tight management controls and intelligent arbitraging between services.

Triad management at Thameswey is complementary to its STOR participation, one of National Grid's most important tools for securing the national electricity system in real time. Fast-acting generators are held in readiness so that Flexitricity can start them when called on, for example when demand is unexpectedly high.

During the November to February triad season, Flexitricity remotely starts generation during likely triad periods. This lowers site consumption and reduces the triad charges on the site's electricity bills.

Thameswey is set to implement Flexitricity's new negative reserve service, Footroom. This service provision helps National Grid balance the system and make use of excess wind energy during times of low system demand.

Thameswey has also committed to participation within the Capacity Market and will earn revenue estimated at more than £100,000 a year from 2018 onwards, with no disruption to core processes.

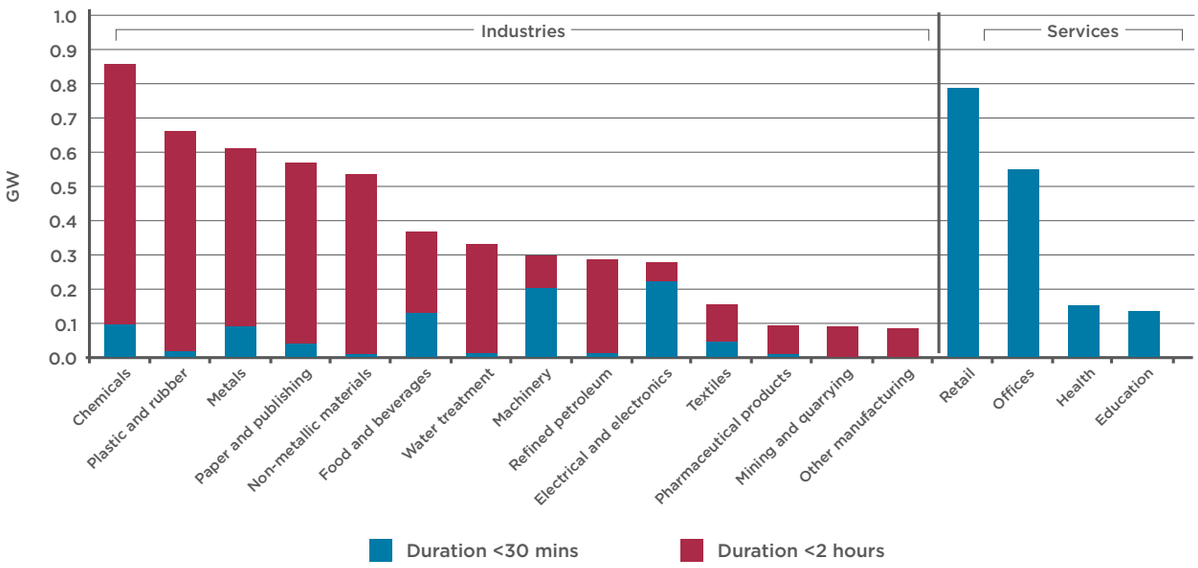
4. Industrial flexibility allows for a cost-effective decarbonisation of the grid

Industrial flexibility has untapped potential

The industrial, commercial and public sectors account for more than half the UK power demand. Of this, the industrial sector represents 26% of the UK power demand and the commercial and public sectors account for a further 27%[25]. As demand flexibility services are proportional to the scale of electricity consumption, there is significant demand flexibility potential for industry.

This potential is still to be fully realised and changes in electricity demand, due to electric vehicles, will create new opportunities for demand response. Indeed, demand response technologies have the potential to become a game changer for electricity markets, as in Figure 10.

Figure 10: **Potential for demand response in the UK from industries, businesses and the public sector**



Source: The ADE calculations peer reviewed by Professor Torriti (University of Reading)

In addition, demand response is also evolving as electricity generation becomes more decentralised. In manufacturing sites and offices, energy management systems can optimise site electricity demand depending on wholesale power prices, network charges, local storage and the fuel cost of back-up generators. There is scope from all this commercial behavioural change to tap into more flexibility services, and for businesses to manage their energy costs.

COMBINED, THE INDUSTRIAL COMMERCIAL AND PUBLIC SECTOR ACCOUNT FOR OVER HALF OF THE UK POWER DEMAND

25 Digest of United Kingdom Energy Statistics, BEIS, 2017

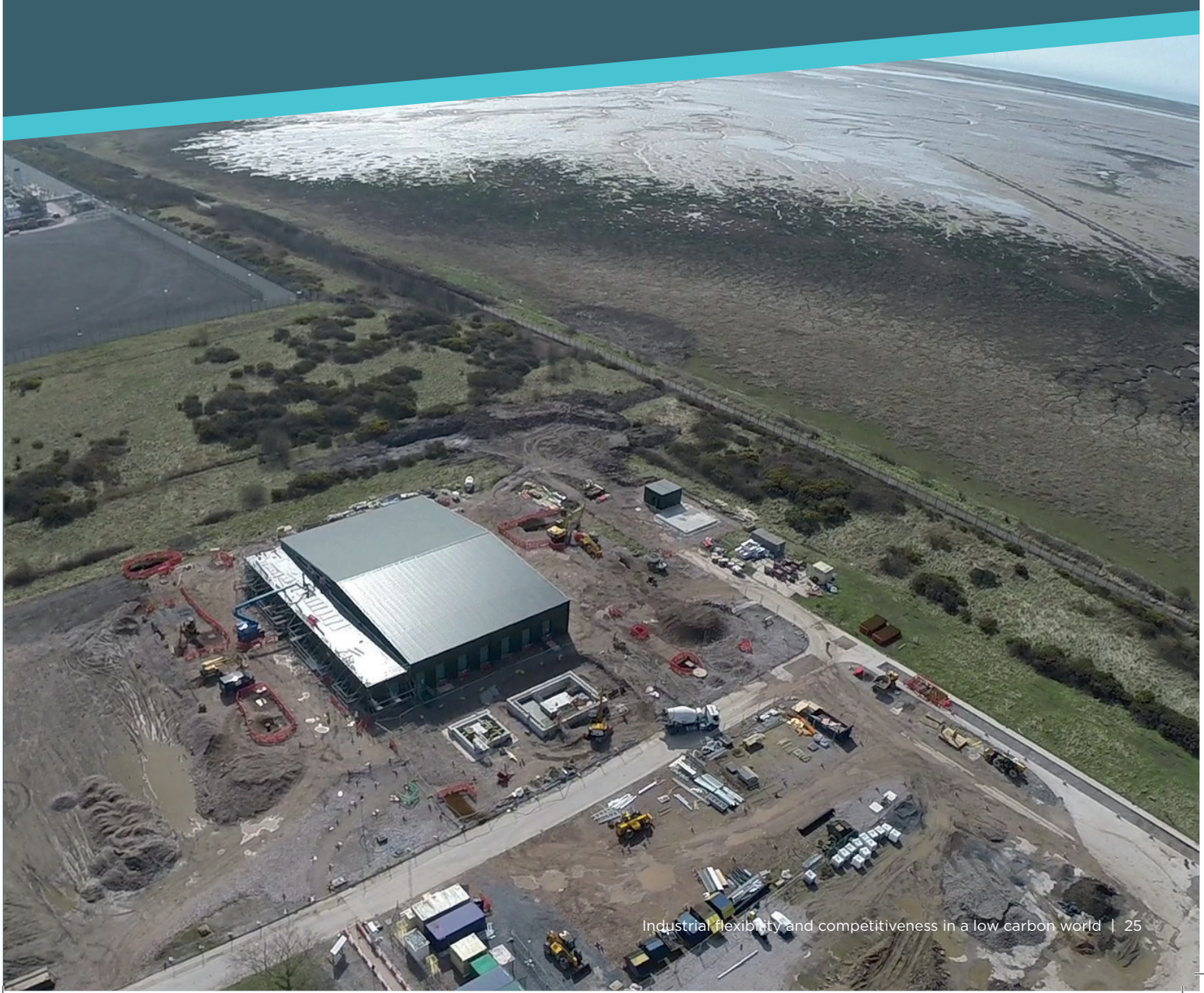
Centrica case study:
the changing face of Roosecote

One of the world's largest battery storage facilities is being built at the site of the former Roosecote power station in Barrow, Cumbria. When operational, the facility will be capable of responding to fluctuations in demand in under a second and will hold enough power to meet the needs of around 50,000 homes – more than all the homes in Barrow combined.

Construction of the 49MW facility was confirmed in December 2016 as part of a £180m investment programme being made by Centrica into new flexible power plants across the country. The facility is expected to be operational in late 2018.

The site of Roosecote has a history in power generation starting back in 1954. It originally accommodated a 120MW coal-fired plant, which was then transformed in 1991 into a 225MW gas-fired power station housed within the old turbine hall. Fuelled by gas from Morecambe Bay, Roosecote was the first power station in the country to use combined cycle gas turbine technology.

The Roosecote site has played an important part in the North-West's energy landscape for more than 70 years and its most recent transformation to a flexible power facility reflects a new era for energy at the site, bringing the very best in terms of state-of-the-art battery technology to help ensure stability of supply for local homes and businesses.



Access to markets

The regulation of the electricity market is not fully adapted to the fast-paced decentralised energy transition, which in turn is limiting energy intensive industries from deriving real value from these markets. For example, GB energy-intensive industries cannot sell their demand side response capacity in the wholesale market under the current regulatory arrangements.

Enabling energy intensive users to sell their flexibility is essential to unlocking the value of the renewable energy on the system and reducing their energy costs. The following demand response services have been key in propping up business opportunities from flexibility:

- **Short Term Operating Reserve (STOR)** – the System Operator procures tertiary reserve or additional sources of power in order to deal with unforeseen increases in demand or a lack of generation, which aggregators and other demand response providers can access;
- **Demand turn-up** is a reserve service for consumers who are able to turn up their demand during periods of oversupply on the grid;
- **The Capacity Market** provides a steady, forward payment stream that aggregators and other demand response providers can use to pre-pay programme participants; and,
- **Triad** - the three half-hourly settlement periods with highest system demand used to determine the annual network costs. The charging methodology is currently under review so this reward for flexibility may change substantially.

Flexitricity case study: Aberdeen Heat & Power Ltd

Aberdeen Heat & Power Ltd (AH&P) was formed as an independent not-for-profit company in 2002 to develop and operate heat network systems, with a primary aim of alleviating fuel poverty and reducing carbon footprint. Progress through the years has resulted in more than 3,000 homes and public buildings being supplied with affordable and controllable heat.

AH&P partnered with aggregator Flexitricity in 2016 and has been earning Capacity Market revenue from October 2017. Flexitricity's Capacity Market team worked closely with AH&P throughout the CM process – from ensuring their sites were ready and connected, entering the Early Auctions and T-4 auction, to metering and delivery.

AH&P has 3.4MW CHP generation capacity and participation in the Capacity Market is forecast to raise an additional £200,000 revenue in the first three years alone.

The way forward: combining business' flexibility and renewable deployment

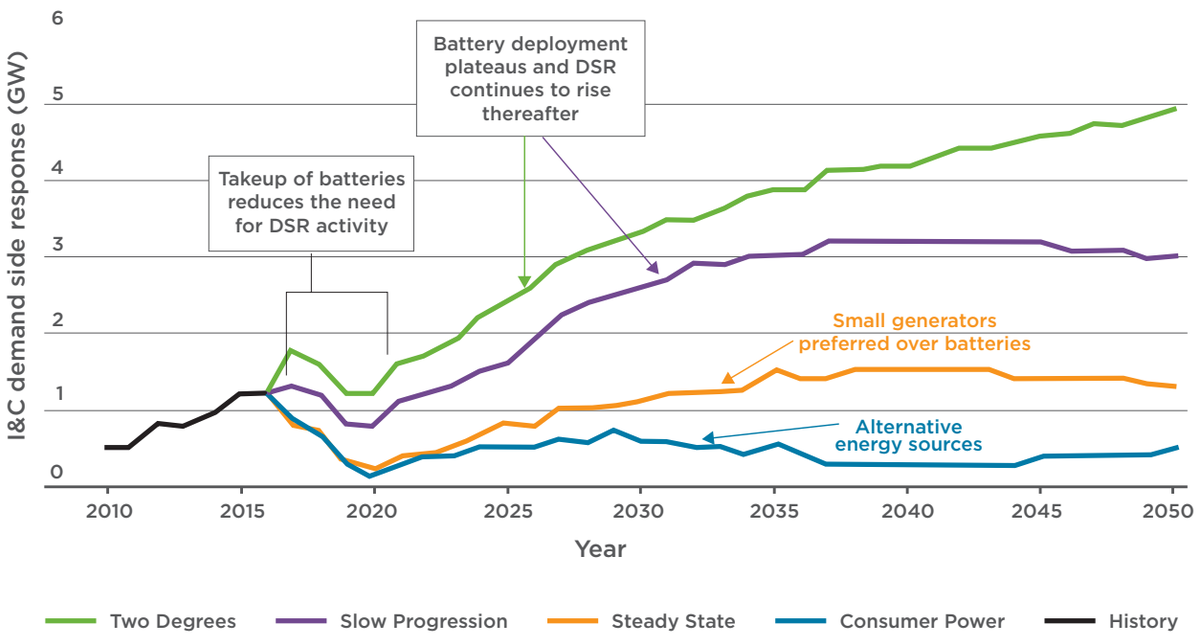
Both renewable generators and industrial customers are key players in decarbonising the UK economy. To maintain competitiveness in an increasingly decarbonising global economy, businesses and industries will need to cut their carbon emissions. As such, demand response from industrial and commercial sites offers a chance for real innovation in a system led by renewable energy sources.

Increased competition in such markets is crucial in achieving the levels of flexibility needed for the UK low carbon energy transition. There is greater demand response flexibility potential that could be untapped by removing the existing regulatory barriers.

Businesses are major energy users with a largely unexplored potential to flex their electricity demand and onsite generation. This demand response flexibility can facilitate the integration of renewable energy sources on the grid in a cost-effective way to support the low carbon transition.

According to National Grid Future Energy Scenarios, demand response could provide a ready-to-go solution with a constant rise over the years. In reality, only one scenario from National Grid, 'Two Degrees', enables the UK to meet its carbon targets, and this scenario is the most flexible one, characterised by a continuous growth in the size of the demand response market up to 5GW (Figure 11).

Figure 11 – Demand response provision by industrial and commercial consumers



Source: National Grid, Future Energy Scenario, 2017

THERE IS GREATER DEMAND RESPONSE FLEXIBILITY POTENTIAL THAT COULD BE UNTAPPED BY REMOVING THE EXISTING REGULATORY BARRIERS.

The ability to intelligently manage demand and coordinate the actions of many decentralised assets in real-time, each with bespoke and dynamic operational constraints, is a significant step towards a grid that can integrate renewable generation efficiently at scale. Continued Government support to enable users to provide these services will ensure businesses do not miss revenue saving opportunities by operating assets in isolation.

Policy recommendations

Achieving the UK's carbon targets in a cost-effective manner will only be possible with a more flexible grid. Further potential for flexibility exists, both on the supply side and on the demand response side. The Association for Decentralised Energy and RenewableUK recommend that the Government, Regulator and System Operator:

1. Create a level playing field to encourage greater competition between supply and demand response options in the balancing services, ancillary services and the Capacity Market. This should be built on the principles of open and competitive access, transparency and non-discrimination between technologies at both transmission and distribution levels;

2. Ensure new policy enables customers to benefit from the deployment of the most cost-effective mature renewable generation; and,

3. Improve the transparency on products and services offered by the System Operator. In particular, the use of industry forums will enable greater communication on current changes and reforms concerning the whole energy system.

Conclusion

Renewable generation and decentralised energy capacity is increasing significantly in the UK. In addition, industry, businesses and public sector organisations are more aware than ever of changes in the power market and how this impacts the costs of doing business and providing public services. Industrial energy users and new generators are taking up the opportunity to develop new business models and benefit from a smart, flexible and decentralised system where abundant renewable energy and dynamic industrial consumers boost competitiveness.

The *2017 Helm Review*, *Clean Growth Strategy* and *Industrial Strategy* all emphasise the centrality of continued deployment of low carbon generation and growth of industrial flexibility in delivering the Government's energy policy objectives. The untapped potential in existing assets can be leveraged to avoid or delay network reinforcement and accelerate the transition to a smart, flexible grid.

Industry and renewable generators have a shared opportunity to participate in a flexible market that is open, transparent, and operates on a level playing field at both transmission and distribution levels. The low carbon transition offers the opportunity for British businesses, Government, the Regulator and the System Operator to come together and use energy flexibility to deliver a low carbon economy while giving UK businesses a competitive edge in the global marketplace.

The Association for Decentralised Energy and RenewableUK would like to thank the following organisations for their support in producing this report:

centrica

EDF ENERGY

Flexitricity

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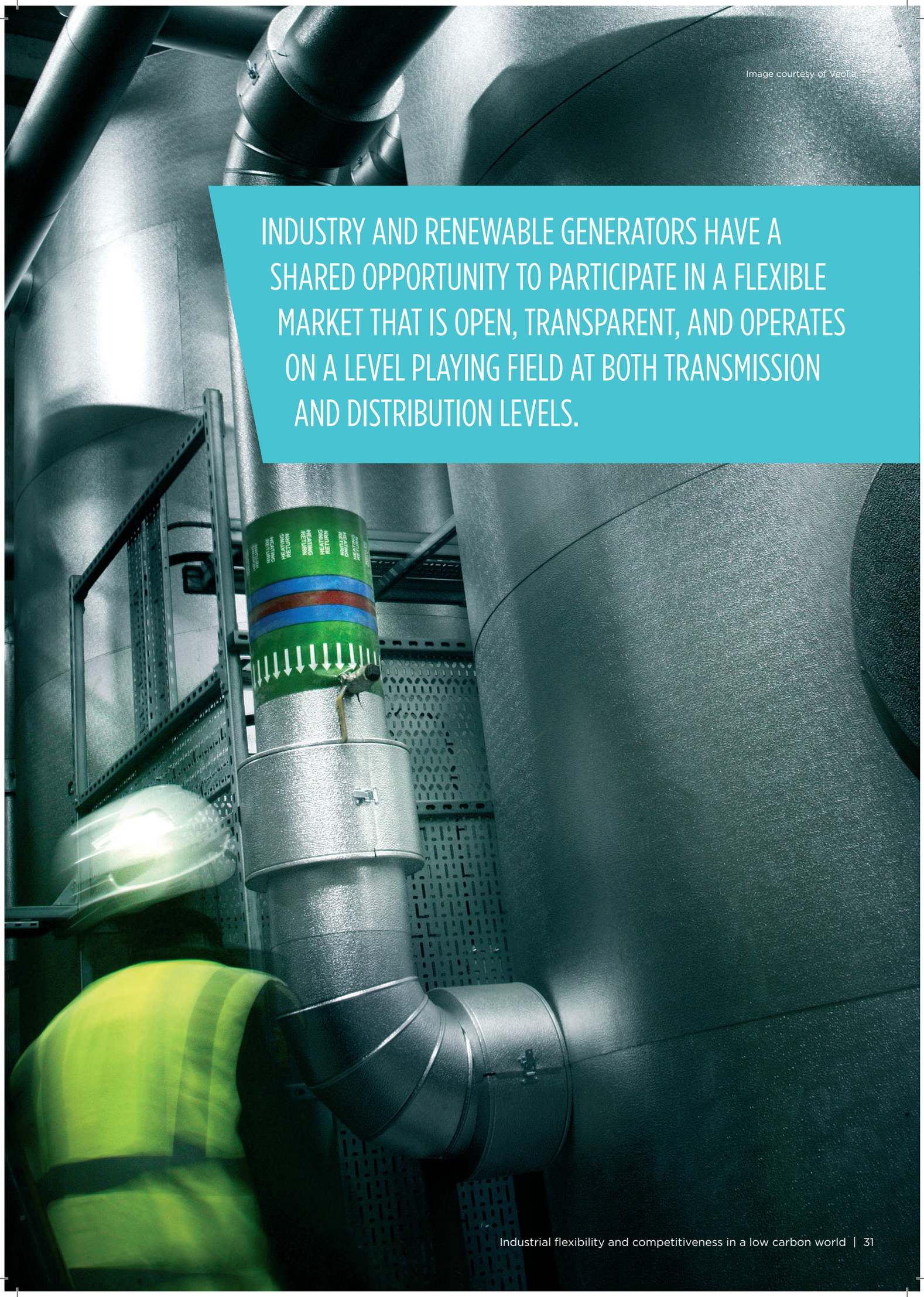

Image courtesy of Veolia

INDUSTRY AND RENEWABLE GENERATORS HAVE A SHARED OPPORTUNITY TO PARTICIPATE IN A FLEXIBLE MARKET THAT IS OPEN, TRANSPARENT, AND OPERATES ON A LEVEL PLAYING FIELD AT BOTH TRANSMISSION AND DISTRIBUTION LEVELS.


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