UtilityWeek

in association with

CGI

Experience the commitment®

ENERGY *FLEXIBILITY*

TRANSFORMING THE POWER SYSTEM BY 2030

1. WELCOME

> The UK needs a more flexible power system. This view is fast becoming the prevailing orthodoxy, with the recent National Infrastructure Commission report, *Smart Power*, suggesting that enhanced flexibility could save consumers as much as £8 billion a year by 2030.

> What is clear from the survey is the recognition across all sectors of the degree by which flexibility in the system will need to increase by 2030 and how it will grow in strategic significance, particularly for DNOs.

2. EXECUTIVE SUMMARY

The UK needs a more flexible power system. This view is fast becoming the prevailing orthodoxy, with the recent National Infrastructure Commission report, *Smart Power*, suggesting that enhanced flexibility could save consumers as much as £8 billion a year by 2030.

The three key means of achieving flexibility in the power system are:

- demand-side flexibility,
- energy storage, and
- interconnection.

This exclusive high-level survey from *Utility Week* in association with CGI highlights how, despite broad industry support for these measures, a step change in delivery is required.

Industry respondents are clear on the strategic significance flexibility will play to the power system by 2030, but they highlight a range of ongoing practical and policy-based barriers to its achievement.

With the greatest barriers to flexibility in the power system tending to arise from the policy and regulatory status quo, the onus is on government and stakeholders such as Ofgem to create a more supportive framework. The means to do so have been clearly spelt out by industry in a number of reports, and the government is due to consult shortly on a range of measures to encourage demand-side response and storage.

With a more supportive framework in place, greater uptake of solutions that deliver flexibility should in turn help overcome barriers arising from the current limited use and investment – for example, the relatively high cost of some technologies.

> **“With the greatest barriers to flexibility in the power system tending to arise from the policy and regulatory status quo, the onus is on government and stakeholders such as Ofgem to create a more supportive framework... the means to do so have been clearly spelt out by industry in a number of reports.**

KEY FINDINGS

- **Respondents believe the flexibility in the power system must more than double in the next 14 years, from a current level of four out of a possible ten to 8.4 by 2030**
- **There is little doubt of the strategic significance of flexibility by 2030, rated 9.1 out of a possible 10**
- **The key drivers for greater flexibility in the power system are:**
  - constraints management
  - new business opportunities,
  - balancing the system, and
  - demand-side flexibility, which is seen as the most important aspect of flexibility.
- **The greatest opportunities arising from flexibility in the power system are:**

  Demand-side flexibility
  - Demand-side flexibility sharing between DNOs and the system operator
  - Selling industrial and commercial demand-side flexibility
  - The creation of a central market platform for trading demand-side flexibility

  Storage
  - The ability to manage intermittent generation patterns and demand variability
  - Grid stability services
  - The ability to provide an alternative to traditional network performance
- **The greatest barriers to flexibility in the power system are:**

  Demand-side flexibility
  - Lack of a commercial/market framework to optimise demand-side flexibility
  - Commercial and regulatory barriers in the existing market arrangements for demand-side flexibility
  - Policy framework

  Storage
  - The cost of storage solutions
  - The structure of balancing services
  - The classification of storage as a generation activity
  - There is a strong belief that interconnection will play a significant role in energy security by 2030 – 82 per cent of respondents agreed

3. BACKGROUND

"The UK is uniquely placed to lead the world in a smart power revolution. Failing to take advantage of that would be a costly mistake." So says the National Infrastructure Commission's *Smart Power* report, released this spring. As the power system transitions from old, linear models of supply and demand to new patterns of intermittent, two-way generation and changing consumption, the influential Treasury-commissioned report calculates that a more flexible power system could save consumers £8 billion a year by 2030. Such an impressive figure will put significant political impetus behind the move already in train towards a flexible, or smart, power system.

DEFINITION

Flexible power (or smart power in the context of the NIC report), means a power system that can respond to fluctuations in supply and demand created by renewable generation and new, low-carbon, demand-side technologies such as electric vehicles.

Such a power system will be created in three main ways:

- **Demand-side flexibility** Consumers, whether business or domestic, cut their discretionary power use in times of peak demand, or increase their demand at times of excess supply, to balance the system (and are rewarded, financially or otherwise, for doing so).
- **Storage** Excess energy (for example, that generated through intermittent renewable sources) is stored and used at times of peak demand when there is less energy going into the grid than coming out.
- **Interconnection** Power is purchased from or sold to neighbouring markets at times of excess or shortage, and transmitted through interconnectors.

It is worth noting that the Ofgem definition of flexibility in the power system is "modifying generation and/or consumption patterns in reaction to an external signal (such as a change in price) to provide a service within the energy system".

FLEXIBILITY: GATHERING MOMENTUM

The National Infrastructure Commission's *Smart Power* report is the latest in a series of thought-leadership papers highlighting the importance of creating greater flexibility in the power system. This is the central theme of a number of recent publications, including:

- *Future Power System Architecture* project report from the Institution of Engineering and Technology and the Energy Systems Catapult, which defines the technical functions of a flexible power system. Published in May 2016.
- *A Sustainable Europe: Green Gas, Green Grids, Green Future*, from the Energy Networks Association and Goede, examining the forms of flexibility needed by the gas networks. Published in April 2016.
- A series of essays in development with Carbon Connect focusing on power system resilience and low-carbon gas. Publication date to be confirmed.

The NIC report is the latest of a series of policy papers that highlight the potential of a more flexible power system (see box above). In October 2015, the Committee on Climate Change's fifth carbon budget report concluded: "It will be important to improve the flexibility of the power sector. That will require investment in flexible gas-fired generating capacity alongside expansion of international interconnection, flexible demand response and potentially electricity storage."

While the direction of travel is clear, there remain a number of practical and legislative barriers to the widespread adoption of a flexible power system. The government is expected to launch a consultation on removing barriers to demand-side response and storage shortly.

Utility Week, in association with CGI, conducted a survey of senior representatives from energy companies, distribution networks operators (DNOs), and aggregators in March-April 2016. The aim of the survey was to capture the industry's perceptions of the current level of flexibility in the power system, and of where it needs to be.

Another purpose of the survey was to identify the challenges and opportunities arising from the three pillars of flexibility – demand-side flexibility, energy storage and interconnection.

"The National Infrastructure Commission's *Smart Power* report, released this spring, calculates that a more flexible power system could save consumers £8 billion a year by 2030. Such an impressive figure will put significant political impetus behind the move already in train towards a flexible, or smart, power system.

METHODOLOGY AND NUMBERS

This survey was carried out by an independent, accredited market research agency on behalf of *Utility Week* and CGI. Senior individuals at the UK's major energy companies and new entrants, distribution networks operators (DNOs) and aggregators were asked to complete an online survey between March and April 2016. There were 42 confidential responses that were viewed by only the market research agency, with the resulting data presented in this report in an aggregated and anonymised form.

Ninety-four per cent of respondents were managers or more senior; 36 per cent were chief or head of department; and 33 per cent were directors or board directors. Respondents were from companies including: Scottish Power, SP Energy Networks, SSE, SSE PD, Electricity North West, UK Power Networks, Northern Power Grid, Centrica (group level), British Gas, Eon EDF, Flexitricity and KiwiPower.

4. OVERVIEW

The scale of the challenge facing the power industry was laid bare by the responses to the survey.

Respondents believe that flexibility in the power system must more than double to an average of 8.4 on a scale of one to ten by 2030. The current level of flexibility is just four, suggesting the industry has a significant mountain to climb in the 14 years ahead.

The perceived disparity was broadly similar across the three respondent groups – energy companies, DNOs and aggregators – though it was marginally higher for aggregators.

Respondents were also asked to rate the strategic significance of flexibility in the power system to their own businesses and to the overall power system – today and in 2030. There was little doubt of the strategic significance of flexibility by 2030, with an average rating of 9.1. The average rating for the strategic significance of flexibility to the power system today was considerably lower, at 7 overall. Interestingly, DNOs rated the strategic significance of flexibility to their business at present considerably lower than aggregators and energy companies, perhaps reflecting their more traditional role in the power system.

Breaking down the three key elements of flexibility, demand-side flexibility was seen as the most important, and interconnection as the least important overall. A breakdown of the results by respondent groups reflects stakeholders' differing interests: aggregators and energy companies place a higher value on demand-side flexibility, and DNOs are the only group to rank interconnection as more important than energy storage, though only by a small margin. This may be a reflection of the current market rules that preclude DNOs from owning or operating storage.

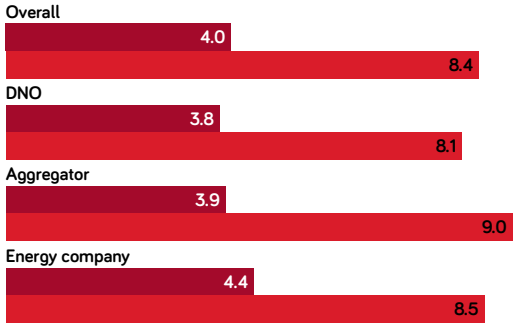
KEY FINDINGS

- **Flexibility in the power system must more than double in the next 14 years, from a current level of four out of a possible ten to 8.4 by 2030**
- **There is little doubt of the strategic significance of flexibility by 2030, at 9.1 out of a possible 10**
- **Demand-side flexibility is seen as the most important aspect of flexibility**

35%

of respondents said they were already seeing a return on their investment in power system flexibility

HOW WOULD YOU RATE THE **CURRENT LEVEL OF FLEXIBILITY** IN THE SYSTEM AND WHERE DOES IT **NEED TO BE BY 2030**?

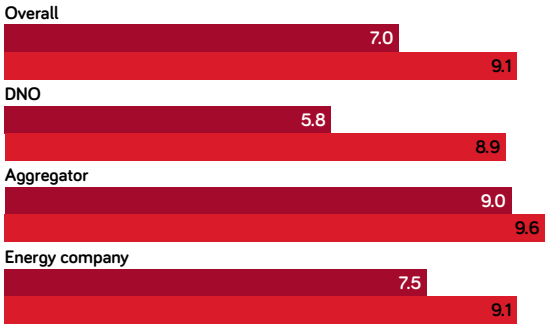


Average rating out of 10 • 10 = extremely flexible

■ Current level of flexibility ■ Required level of flexibility by 2030

> **"DNOs are the only group to rank interconnection as more important than energy storage. This may be a reflection of the current market rules that preclude DNOs from owning or operating storage.**

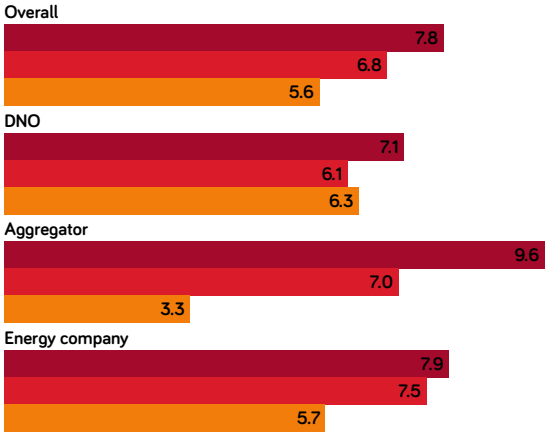
HOW WOULD YOU RATE THE **STRATEGIC SIGNIFICANCE OF FLEXIBILITY** IN THE POWER SYSTEM TO YOUR BUSINESS TODAY AND WHAT YOU EXPECT THE **SIGNIFICANCE TO BE BY 2030**?



Average rating out of 10 • 10 = extremely significant

■ Strategic significance of flexibility today ■ Strategic significance by 2030

HOW WOULD YOU RATE THE RELATIVE IMPORTANCE TO YOUR BUSINESS OF THE FOLLOWING **ASPECTS OF FLEXIBILITY**?



Average rating out of 10 • 10 = extremely important

■ Demand-side flexibility (inc DS storage) ■ Energy storage ■ Interconnection

RETURN ON INVESTMENT

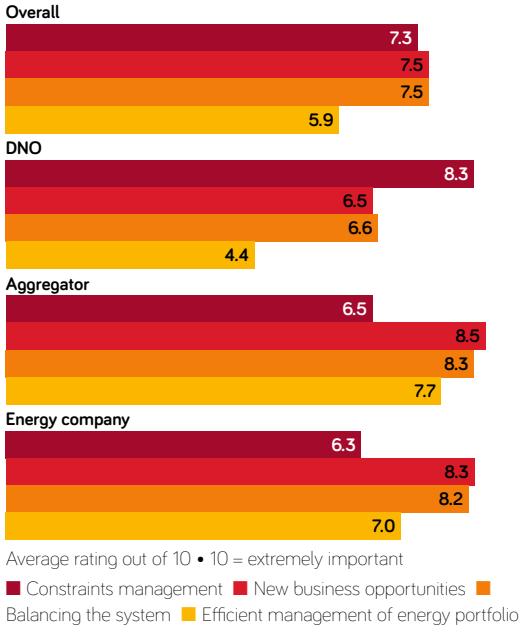
Respondents were asked when they expect a return on investment for flexibility in the power system – for their organisation and for the industry as a whole.

A slim majority said they were already seeing a return on investment for their own business – 35 per cent responded in this way. A further 27 per cent expect to see ROI by the end of 2020, but a significant minority (11 per cent) are not sure they will ever see ROI.

A similar number (30 per cent) believe the UK power industry as a whole is already seeing a return on investment for flexibility in the power system. A further 24 per cent expect the UK to see ROI by the end of 2020. Fourteen per cent are not sure the UK will ever see ROI.

Of those that have not yet achieved a return on investment, many are working on or around a five-year timeline. DNOs

HOW WOULD YOU RATE THE IMPORTANCE OF THE FOLLOWING **DRIVERS FOR FLEXIBILITY** TO YOUR ORGANISATION?



anticipate a ROI for their business within 5.2 years, and for the UK as a whole within 8.1 years. Aggregators anticipate five years for their own businesses, and 4.3 years for the UK as a whole; and energy companies 4.2 years for their own businesses and 5.1 for the UK as a whole.

DRIVERS

Respondents were asked to rate the importance of a number of drivers for flexibility for their organisation. Although responses varied by business type, the sector overall views three drivers of equal importance: constraints management, new business opportunities and balancing the system. In these three drivers, the various stakeholder groups gave responses that reflected their own priorities – DNOs, for example, gave particular weight to constraints management, scoring it at 8.3.

Constraints management

A constraint on the network is a pinch point at either transmission or distribution level, where the system is unable to deliver power generated to the place required at the time it is needed because of a lack of physical capacity – the network may be overloaded, or the voltage too low. Such constraints are increased by new types of connections and changing behaviour patterns on the demand side.

A flexible power system can mitigate this problem by flexing demand, shifting load away from peak times or by allowing power generated at times of lower demand to be distributed and stored. In consequence, a more flexible power system can obviate the need to reinforce the current network by bringing down peak demand to a manageable level.

New business opportunities

A flexible power system does not just solve problems – it also creates opportunities. There is potential commercial benefit arising from flexibility for a number of stakeholders in the power system. Aggregators and energy companies, for example, can aggregate customer demand, agreeing with the network operator at distribution level – or the system operator at transmission level – to turn down demand at peak times, and receive financial incentives for doing so.

Other business opportunities include the potential for DNOs to store and sell power – though this is not allowed under the current licensing regime.

Balancing the system

Today, balancing the power system is generally achieved by fulfilling the requirement that demand is always matched by supply in real time, keeping the system frequency in a narrow range of around 50 hertz – or risking a system shutdown. Demand-side flexibility, under which customers can turn off demand at peak times; and storage, where power can be taken off or put into the system depending on need, create numerous new ways to balance the system.

Commenting on the findings, consultant John Scott of Chiltern Power observed that balancing the system "could look quite different in the future" if DNOs mature into distribution system operators and take on parts of the balancing role currently reserved for the system operator, National Grid. "The DSO could balance local parts of the network. That would really add to the call for flexibility," he says.

OPTIMISTS
Respondents who believe the UK power industry is seeing a return on investment in flexibility

30%

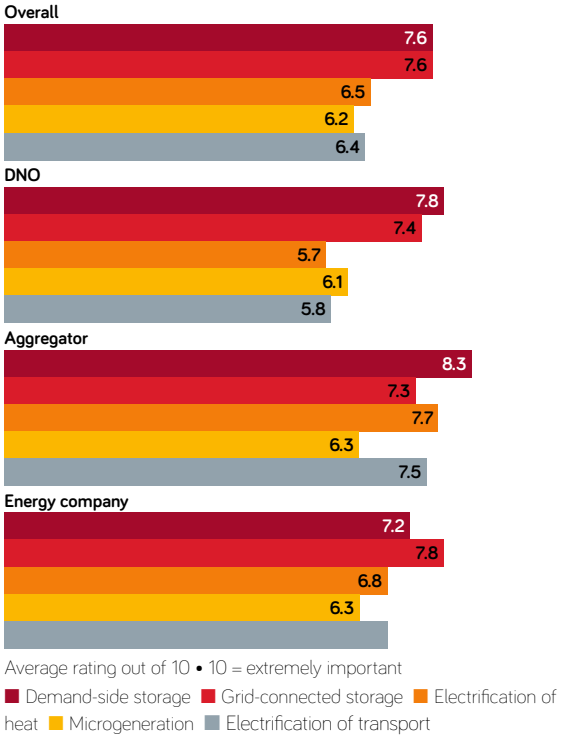
14%

PESSIMISTS
Respondents who are not sure the UK will ever see a return on its investment in flexibility

7.6
Importance of demand-side storage and grid-connected storage technology – overall score out of 10

> "Although responses varied by business type, the sector overall views three drivers of equal importance: constraints management, new business opportunities and balancing the system.

HOW WOULD YOU RATE THE IMPORTANCE OF THE FOLLOWING **TECHNOLOGIES IN FACILITATING FLEXIBILITY** IN THE ENERGY SYSTEM?



FACILITATING TECHNOLOGIES

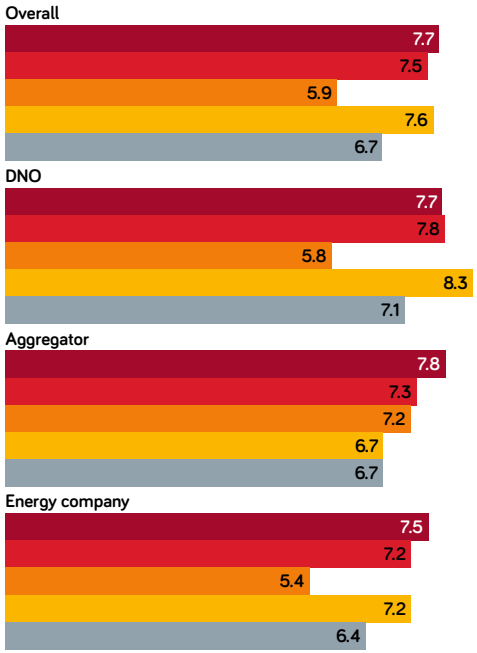
Respondents were asked to rate the importance of five key technologies for facilitating flexibility in the power system. Views here were more varied. Overall, respondents rated demand-side storage, grid-connected storage and the electrification of heat as the most significant. With grid-connected storage and demand-side storage both receiving scores of 7.6, they were the standout leaders.

However, results varied significantly according to respondent group, with energy companies placing greater emphasis on grid connected storage and aggregators on

the electrification of transport. It is interesting to note that microgeneration scored relatively low, with an average of 6.2. DNOs tend to rate demand-side technologies lower than aggregators and suppliers, with the notable exception of demand-side storage – a reflection, perhaps, of their arm's-length relationship with customers.

Confidence that these technologies will have reached maturity and mass market penetration by 2030 was relatively high; demand-side storage and grid-connected storage were the two technologies respondents were most confident about. There was less confidence in the electrification of heat, however, at just 5.9 – a reflection of the growing uncertainty over the extent to which electric heat will replace gas-fired heat, and over what timescale.

HOW WOULD YOU RATE YOUR CONFIDENCE THAT THESE **TECHNOLOGIES WILL HAVE REACHED MATURITY** AND MASS PENETRATION BY 2030?



Average rating out of 10 • 10 = extremely important

■ Demand-side storage ■ Grid-connected storage ■ Electrification of heat ■ Microgeneration ■ Electrification of transport

SMART METERS AND TIME-OF-USE TARIFFS

The widespread adoption of time-of-use tariffs is a key part of the government's business case for the smart meter rollout that officially begins this year. Smart meters will facilitate the wider rollout of time-of-use tariffs by providing the technical capacity to offer such tariffs as:

- Static time-of-use, under which customers are charged different rates for power use at two or more different times of day. An early example of this is the Economy 7 tariff.
- Dynamic time-of-use, under which customers pay a different rate at different times of day. The rates and times may vary according to a number of factors – for example, the availability of power generated from renewable sources.
- Dynamic load control, under which customers give operators or aggregators the ability to control certain functions in their home. For example, the operator or aggregator could pay the consumer for allowing them to turn off their electric heating at times of high demand, within pre-agreed parameters.

However, John Scott of Chiltern Power warns that the necessary back-end systems must also be in place to facilitate time-of-use tariffs: "[Smart meters] won't be able to facilitate time of use tariffs until the right settlement systems are sitting behind them," he says.

Cross-referencing respondents' views on the various technologies with their confidence that they will reach maturity throws up some interesting contrasts. For example, DNOs take a relatively low view of the importance of microgeneration (6.1), but are quite confident it will reach maturity by 2030 (8.3). And although energy companies give the lowest importance to demand-side storage of all three stakeholder groups, at 7.2, they are nevertheless more confident that it will reach maturity by 2030 than any of the other technologies cited.

Respondents were asked how these technologies will be controlled, from a system perspective, by 2030. The most commonly occurring answer was price signals, whereby consumers will be encouraged to use technologies, and/or to participate in demand shifting, through tariffs that are set to encourage certain behaviours – for example, time-of-use tariffs (see box above).

Answers included:

- Aggregation.
- Price signals.
- Technology specific – most larger points of flexibility will be accessed through constraints signals specifically agreed with the provider. Large populations of smaller assets are more likely to be accessed through pricing signals.

MATURE
Respondents' score for the likelihood that demand-side storage will be mature by 2030

7.7

5.9

IMMATURE
Equivalent score for electrification of heat

- Price and system frequency signals transmitted through smart meters.
- Ancillary services, capacity payments, constraint/network charging, energy price, hedging for suppliers or generators.
- Price and frequency.
- Time-of-use tariffs, direct control through aggregators.
- Sharper price signals including constraint signals, wholesale market reform, half-hourly settlement.
- Locational marginal pricing similar to the Midwest ISO.
- Constraint signals from DNO or TSO.
- Distribution system operators and community schemes.
- Multiple methodologies – is that not what flexibility is?

Respondents were also asked if they could name any other technologies that they thought would facilitate flexibility in the power system.

Responses included:

- hot water storage;
- home-scale storage;
- dynamic line rating;
- typical flexible load such as HVAC, electric storage heaters, refrigeration and freezers;
- energy vectors such as hydrogen, synthetic fuel; and
- efficient aggregation and verification of services delivered.

5. DEMAND-SIDE FLEXIBILITY

Demand-side flexibility is arguably the easiest means to achieve greater flexibility in the power system, and the least reliant on technological advances. Attitudes to the strategic significance of demand-side flexibility are changing – National Grid last year told *Utility Week* that it expected to rely on demand-side measures to balance the grid for "well over 50 per cent of the time" by 2030. The NIC's *Smart Power* report says that £200 million a year could be shaved off the UK's grid-operating costs if 5 per cent of the current peak demand were met through the use of demand-side solutions.

In a recent interview with *Utility Week*, Philip Graham, chief executive of the National Infrastructure Commission, acknowledged that demand-side solutions are the element of flexibility that "gets talked about least", but said they can make "a huge difference to how we operate our homes and live our lives – as well as to businesses that are already using [them]".

Graham predicted that, "by the 2020s we will think it is very odd to just run your dishwasher at the point at which you've filled it up. It will become second nature to be taking decisions on how you use electricity depending on how it is priced" – whether directly or with the help of an automated service based on algorithms.

Respondents to our survey were mixed in their views on the opportunities arising for their organisations from demand-side flexibility in the system. Overall, demand-side flexibility sharing between DNOs and the system operator was seen as the greatest opportunity, with selling industrial and commercial demand-side flexibility close behind, and the creation of a central market platform for trading demand-side flexibility in third place.

> **"By the 2020s we will think it is very odd to just run your dishwasher at the point at which you've filled it up. It will become second nature to be taking decisions on how you use electricity depending on how it is priced.**
> Philip Graham, CEO, NIC

CASE STUDY: LIVING GRID

Large-scale energy users are waking up to the potential of demand-side response (DSR). In one major DSR scheme, water company United Utilities has teamed up with supermarket chain Sainsbury's and construction and building materials manufacturer Aggregate Industries to be founding partners in a scheme that aims to create 200MW of flexible power by 2020. The three companies, which can between them create 39MW of flexible power by 2030, are working with technology partner Open Energi, which is providing kit that connects their energy-intensive equipment to smart technology, creating a network of smart equipment that smooths out peaks and troughs in energy demand.

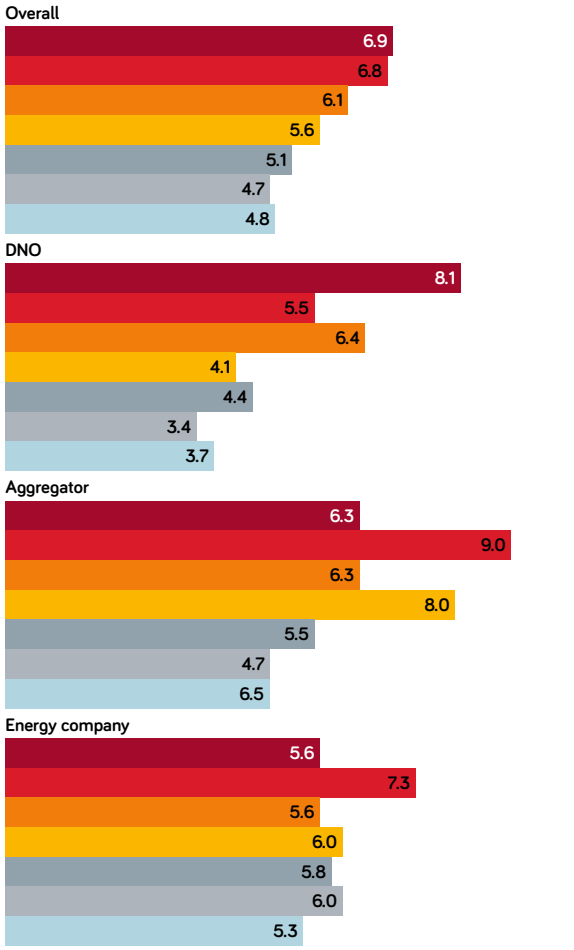
Demand-side flexibility sharing between DNOs and the system operator will be possible because there is likely to be spare capacity in any DSR contract between a DNO and an end customer – or pool of end customers. This spare capacity can be sold on as a service to the system operator, either by the DNO directly or by a third party aggregator. Alternatively the sharing could operate the other way, with the system operator making spare capacity available to the DNO. Elexon estimates £75 million of benefits available to DNOs and the system operator in such models, over and above the wider values available from DSR.

Unsurprisingly, views on which was the greatest opportunity varied significantly by respondent group, reflecting their role, or potential role, in the transactions arising from demand-side flexibility. DNOs saw significant opportunity in sharing demand-side flexibility with the system operator, but aggregators and energy companies were most enthusiastic about the potential for selling demand-side flexibility.

50%

National Grid expects to rely on demand-side management to balance the grid more than half of the time by 2030

HOW WOULD YOU RATE THE FOLLOWING **OPPORTUNITIES** FOR YOUR ORGANISATION ARISING FROM **DEMAND-SIDE FLEXIBILITY** IN THE SYSTEM?



Average rating out of 10 • 10 = huge opportunity

■ DNO-SO demand-side flexibility sharing ■ Selling industrial and commercial demand-side flexibility ■ The creation of a central market platform trading demand-side flexibility ■ Aggregating and selling small scale commercial (SME) demand-side flexibility ■ Peer-to-peer demand-side flexibility trading ■ Aggregating and selling domestic demand-side flexibility ■ Supplier to supplier demand-side flexibility trading

5. DEMAND-SIDE FLEXIBILITY (CONTINUED)

Enthusiasm for the potential of aggregating and selling demand-side flexibility was more marked among aggregators and energy companies.

It is interesting to note that aggregators, which operate at the industrial and commercial end of the market, rated the domestic opportunity lower than energy companies (4.7 compared with 6.6), which may suggest that some energy companies are already developing plans to use their wider customer base in new ways.

BARRIERS TO DEMAND-SIDE FLEXIBILITY

Respondents were asked to rank a number of barriers to demand-side flexibility in order of importance. The barriers given were:

A Lack of a commercial/market framework to optimise.
B Potential for conflicts between market participants, for example where several participants are competing for one supplier of demand-side flexibility.
C Lack of visibility of other market participants' demand-side flexibility arrangements.
D Inefficiencies in the system – for example, the potential for aggregators to be paid multiple times.
E Metering infrastructure.
F Policy framework.
G Commercial or regulatory barriers in the existing market arrangements.

Overall, the three main barriers were:

- Lack of a commercial/market framework to optimise demand-side flexibility.
- Commercial and regulatory barriers in the existing market arrangements for demand-side flexibility.
- Policy framework.

When these barriers are broken down by respondent group, they were:

DNO

1 Lack of visibility of other market participants' demand-side flexibility arrangements.
2 Lack of a commercial/market framework to optimise.
3 Potential for conflicts between market participants – for example, where several participants are competing for one supplier of demand-side flexibility.

The DNOs' responses here are particularly interesting, because they suggest a lack of visibility and poor communication between stakeholders are the biggest barriers to DNOs making full use of demand-side flexibility.

Commenting on the findings, Jamie McWilliams, head of futures at the Energy Network Association (ENA) says: "There's certainly a lack of clarity right now between different parties in the flexibility market. This is something we're keenly aware of and we're discussing ways to make it more clear – that's around establishing information exchange."

McWilliams adds that ENA's shared services group is pulling together a timeframe of issues that must be addressed, and it is due for publication this year. The issue is also being discussed at the transmission and distribution working group that has DECC and Ofgem membership, as well as system operator, transmission operator and DNO participants.

Responses from aggregators and energy companies cited the same three barriers, albeit in a different order:

Aggregator

1 Policy framework.
2 Lack of a commercial/market framework to optimise.
3 Commercial or regulatory barriers in the existing market arrangements.

Energy company

1 Lack of a commercial/market framework to optimise.
2 Policy framework.
3 Commercial or regulatory barriers in the existing market arrangements.

It is interesting that energy companies rate commercial and regulatory barriers third, perhaps suggesting a confidence that they can find a way around them. Such barriers include the structure of contracts with National Grid and the entry rules for the capacity market.

Asked whether there were any other barriers to demand-side flexibility in the current system, responses included:

- Supplier hub, vertical integration, lack of access for DSR to balancing mechanism and energy markets.
- Lack of financial incentives to invest.
- Lack of business case.
- Customer awareness/willingness/confidence.
- Storage technology.
- Lack of half-hourly settlement.
- Limited long-term visibility/ confidence in the market.
- Lack of level playing field for transmission-connected generation as embedded generation secures multiple hidden subsidies beyond its economic contribution.
- Existing information communication systems and the efficient use of network data from various locations.
- Cost of infrastructure to effectively balance demand and supply.
- The success of existing demand-side flexibility shows there are no significant barriers and in some circumstances current commercial incentives, such as avoided TNUoS charges, lead to over-reward. Smart metering will enable customers to respond to price signals.

KEY FINDINGS

The greatest opportunities arising from demand-side flexibility in the power system are:

- Demand-side flexibility sharing between DNOs and the system operator
- Selling industrial and commercial demand-side flexibility close behind
- The creation of a central market platform for trading demand-side flexibility

The greatest barriers to demand side flexibility in the power system are:

- Lack of a commercial/market framework to optimise demand side flexibility
- Commercial and regulatory barriers in the existing market arrangements for demand side flexibility
- Policy framework

HOME SWEET HOME
Energy companies' rating for the domestic opportunity from demand-side flexibility

6.6

4.7

HOME ALONE
Equivalent rating from aggregators

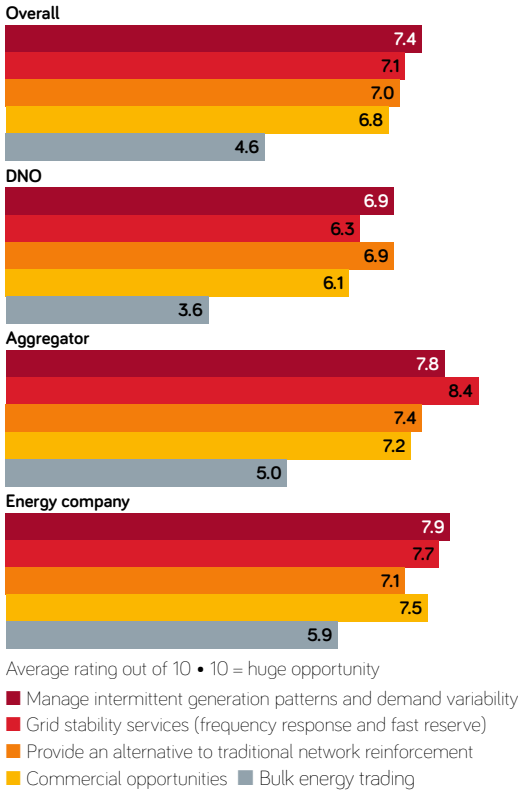
> **"There's certainly a lack of clarity right now between different parties in the flexibility market. This is something we're keenly aware of and we're discussing ways to make it more clear.**
> Jamie McWilliams, head of futures, ENA

6. STORAGE

The second major pillar of a more flexible power system is energy storage – both on the demand side, whereby users store energy, and at grid scale. The National Infrastructure Commission is optimistic about the prospects for increased deployment of energy storage, noting that costs are falling across the board for the most common storage technology – lithium ion – reducing from around $3,000/kWh in 1990 to less than $200kWh today. If costs continue to fall at this rate, the NIC says up to 15,000MW of storage could be in use by 2030.

The sector agrees there are a number of significant opportunities arising from storage. Overall, the greatest opportunities were perceived to be the ability to manage intermittent generation patterns and demand variability, and grid stability services.

HOW WOULD YOU RATE THE FOLLOWING **OPPORTUNITIES** FOR YOUR ORGANISATION ARISING FROM **STORAGE**?



KEY FINDINGS

The greatest opportunities arising from storage:

- The ability to manage intermittent generation patterns and demand variability
- Grid stability services
- The ability to provide an alternative to traditional network performance

The greatest barriers to widespread deployment of storage are:

- Cost of storage solutions
- Structure of balancing services
- Classification of storage as a generation activity

The three most significant storage technologies are:

- Battery storage
- Pumped hydro
- Fuel cells

BARRIERS TO STORAGE SOLUTIONS

There remain a number of significant barriers to energy storage in the current system. Respondents were asked to rank the following barriers in order of importance:

A Cost of storage solutions.
B Classification of storage as a generation activity.
C Classification of storage as an end user.
D Balancing charges.
E Structure of balancing services.
F Trading and settlement arrangements.
G Treatment under the current capacity market rules.
H Exclusion from CfDs.
I DNOs currently precluded from participating in the market.

The cost of storage solutions was by far the main barrier, with each respondent group putting it top. Overall, the main barriers were:

1 Cost of storage solutions.
2 Structure of balancing services.
3 Classification of storage as a generation activity.

Commenting on the findings, John Scott warns that current uncertainty about the regulation of storage was deterring the very investment that could bring costs down. "While we have regulatory uncertainty, we are not going to have investment at scale. Uncertainty kills investment," he says.

8.4

An indication, as a score out of ten, of aggregators' enthusiasm for using storage to stabilise the grid

FLEXIBILITY AND TRADING

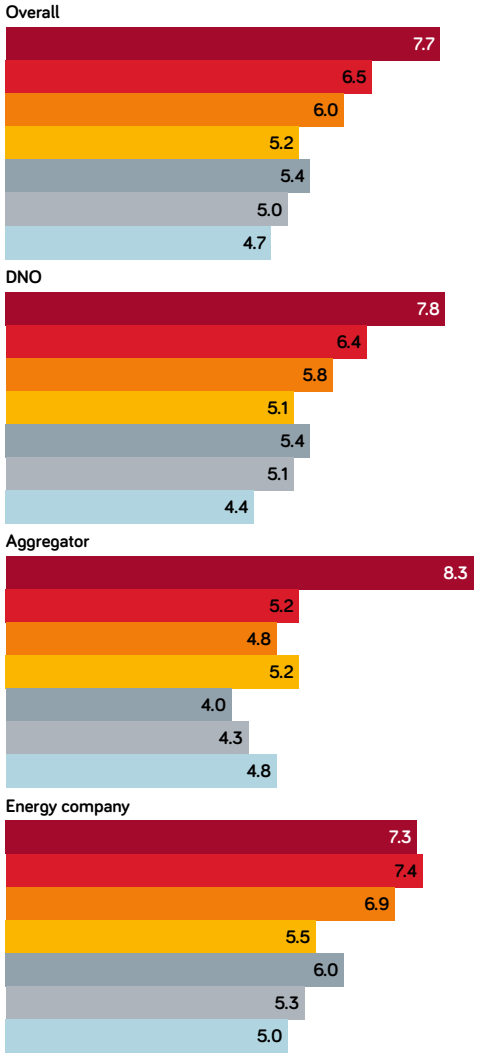
As relatively new technologies, demand-side response and storage face a number of barriers in an electricity market that was designed for more traditional solutions. These include contracts that are structured in a way that disadvantages or precludes them from playing, and the rules of the capacity market, for example.

Elexon, which sits at the heart of the electricity market and is responsible for imbalance settlement, acknowledges the challenges facing flexible solutions. Elexon's senior market adviser John Lucas says: "It's very complex and there are lots of different routes to market. People have to put together a lot of different types of contracts. There's value for different stakeholders – suppliers, National Grid, DNOs – and it's not really co-ordinated."

One solution that has been mooted by a number of parties is the creation of a central market for demand-side response, bringing together the wholesale market (supplier-to-supplier DSR trading) and the balancing services market (DNO–SO sharing). Lucas says: "A central market is an ambitious aim in the short term. In the longer term, out to the 2030s, there would be many benefits to that type of arrangement."

In the short term, Elexon and other stakeholders such as National Grid are attempting to find quick wins. Ofgem, for example, is looking at ways to open up the balancing mechanism to independent aggregators, and National Grid is introducing new types of balancing service contract (such as enhanced frequency response) designed with new technologies in mind.

HOW WOULD YOU RATE THE **POTENTIAL** OF THE FOLLOWING **STORAGE TECHNOLOGIES**?



Average rating out of 10 • 10 = huge potential

■ Battery storage ■ Pumped hydro ■ Fuel cells ■ Compressed air storage ■ Hydrogen storage ■ Other forms of kinetic storage ■ Flywheels

FIVE WAYS TO BOOST ENERGY STORAGE DEPLOYMENT

Utility Week recently highlighted five key ways the government could boost storage deployment:

1 Remove balancing charges

Removing the need for storage to contribute twice to the £1 billion system charge payment that larger loads and generators pay National Grid every year for balancing the system would remove a significant barrier. Storage is caught twice by the payment, once for charging and again for discharging.

2 Make it a separate licensed activity

The current classification of storage as generation is simply an "accident of history" from how the market was split during privatisation, but prevents distribution network operators (DNOs) from owning and operating storage. DNOs are arguably best placed to fully optimise storage assets, but a network company is not allowed to simultaneously hold a generation licence.

Ofgem dashed industry hopes that an imminent change could be on the horizon when partner Andy Burgess, associate partner, energy systems, told MPs: "Our principle is network companies shouldn't own or operate storage… If you want competitive markets to develop, you need to keep regulated monopolies out of them."

3 Allow it to secure a CfD

Partnering with renewable energy is a good approach for energy storage business models, but storage is unable to secure a contract for difference (CfD), and neither is a developer able to secure one for a whole site, just the renewable generation element of it.

4 Remove end user classification

In another apparent accident, storage has been defined as an "end user". Energy storage operators are hit with a charge for the climate change levy as it goes into the device, meaning the charge is collected twice because the actual final end user also ends up paying out.

5 Remove artificial licensing limits

Pumped hydro, such as at Dinorwig, in North Wales is a form of energy storage already at technical maturity and the only one capable of delivering high-capacity storage. However, it is unlikely that the UK will see any more pumped hydro built at the scale of Dinorwig because of the "very long investment timeframe" and difficulty securing planning, on top of the obvious geographical restrictions that apply to a project of this nature. There is potential for more pumped storage in the UK, particularly in the conversion of hydro-electric to pumped hydro, but companies developing such projects are sticking below 100MW because of the generation licence criteria.

DECC is soon to publish a call for evidence on smart systems that will cover the barriers to energy storage deployment.

> **"Battery storage was seen to have the greatest potential, with pumped hydro and fuel cells in second and third place.**

Broken down by respondent group, the barriers were:

DNO
1 Cost of storage solutions.
2 DNOs currently precluded from participating in the market.
3 Classification of storage as a generation activity.

Aggregator
1 Cost of storage solutions.
2 Trading and settlement arrangements.
3 Classification of storage as a generation activity.

Energy company
1 Cost of storage solutions.
2 Treatment under the current capacity market rules.
3 Structure of balancing services.

Other barriers to storage in the current system were:

- Klondyke approach to enhanced frequency response likely to damage market.
- Electricity price (remuneration).
- Economics not good enough for mass deployment yet.
- Lack of measures to mitigate policy risk to develop regarding likelihood of sufficient out-turn price arbitrage.
- Technology and environment barrier. A whole life assessment should be carried out through battery material mining to recycling.
- Market structure makes it impossible to stack value streams.
- The main barrier to large scale storage is the lack of an appropriate risk mitigation scheme to encourage a relatively capital intensive investment with a long lead time.

STORAGE TECHNOLOGIES

Respondents were asked to rate the potential of the major storage technologies. Overall, battery storage was seen to have the greatest potential, with pumped hydro and fuel cells in second and third place respectively. These views were reflected when the responses were broken down by type of organisation.

7. INTERCONNECTION

Interconnection is the third pillar of a more flexible power system. The NIC thinks increased interconnection is essential to the UK's future energy security and the country's ability to manage seasonal shifts in demand without having to build many more power stations simply to meet peak demand – power stations that won't required most of the time – and the consequential implications for energy affordability. National Grid is also enthusiastic about the potential of interconnection, having conducted research that indicates the net benefits of 8-9GW of interconnection could be as much as £3 million per day in reduced wholesale prices (thanks to the increased supply).

These publications have seemingly influenced government thinking. In its response to the *Smart Power* report this spring, the government said it supports a 9GW increase in the UK's interconnector capacity, adding it may even back further capacity "as more potential projects are assessed later this year". It had previously backed a 5GW increase in interconnector capacity.

Respondents were in no doubt that interconnection will play a significant role in energy security, – 82 per cent of respondents agreed. Enthusiasm was less marked among energy companies, where 25 per cent of respondents disagreed; and aggregators, where 20 per cent disagreed.

Asked to explain their belief that interconnection will play a significant role, responses included:

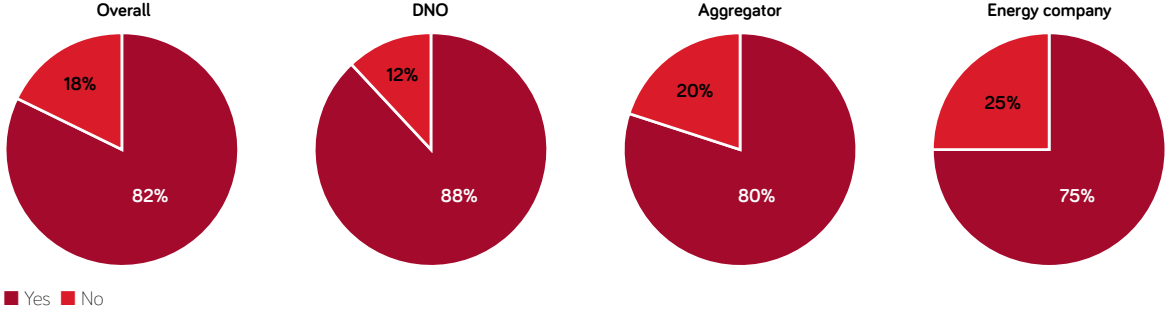
- "Already does. EU target model, increase in capacity."
- "Interconnector capacity will increase significantly – it will either add to or reduce energy security significantly."
- "Increases time difference peak management."
- "Drive to more integrated markets across Europe, rise of capacity markets in Europe."

KEY FINDINGS

- 82% of respondents believe interconnection will play a significant role in energy security in the UK by 2030
- Enthusiasm for interconnection was less marked among energy companies and aggregators than DNOs

- "Competing source of wholesale power that arbitrages prices between adjacent markets but it enjoys advantages of an uneven playing field with domestic generation whereby it escapes costs and taxes but receives support from capacity market."
- "Growth in capacity."
- "Greater security of electricity supply and opportunities to import and export excess renewable electricity generation, therefore increasing the ROI for wind and solar projects."
- "Objectively, its is the most powerful technology by far."
- "It would reduce risk and, potentially, price."
- "Smart grids."
- "It will be a good source of flexibility services."
- "Provides a relatively good degree of diversity for the cost."
- "Provide energy in a more efficient manner."
- "Import/export of electricity from European and island markets will help create further balance."
- "Secure frequency-response services with the reduction in coal generation."
- "Intermittence of renewables."

DO YOU THINK **INTERCONNECTION** WILL PLAY A SIGNIFICANT ROLE IN **ENERGY SECURITY** IN 2030?



INTERCONNECTED
DNOs were the most enthusiastic about the role of interconnection in 2030

88%

25%

DISCONNECTED
Many in energy companies predicted a smaller role

INTERCONNECTION PRESENT AND PLANNED

There are four interconnectors between the UK and the rest of Europe, providing around 4GW of capacity:

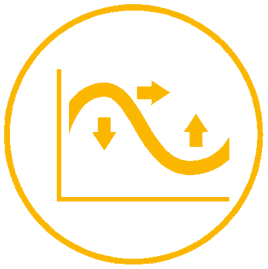
- 2GW to France (IFA)
- 1GW to the Netherlands (BritNed)
- 500MW to Northern Ireland (Moyle)
- 500MW to the Republic of Ireland (East West).

In March Ofgem launched a consultation to gauge opinion on three potential new interconnectors: the 1.4GW FAB link running between Exeter and Menuel in France; the 1GW IFA 2 between Chilling in Hampshire and Tourbe, also in France; and the 1GW Viking Link connecting Revsing in Denmark and Bicker Fen in Lincolnshire.

Asked to explain their belief that interconnection will not play a significant role, respondents answered:

- "There is no significant need for it, it is overrated."
- "Simultaneous stress events."
- "There needs to be a balance between generation investment in the UK and reliance on interconnection. As things stand, we seem to have too much reliance on interconnection."
- "It's there already and not a geopolitical risk."

8. CONCLUSION



Our survey clearly shows that the push towards a more flexible power system from bodies such as the National Infrastructure Commission and the Committee on Climate Change is reflected in industry at a senior level. Our respondents were in no doubt about the strategic significance of flexibility in the power system, and clear that a step change in delivery is required to achieve the necessary level of flexibility by 2030.

It is no surprise that the perception of the major barriers and opportunities arising from flexibility in the power system varies according to stakeholder group. The complexity arising from the numerous stakeholders and their different motivations is one of the reasons flexibility has been so difficult to achieve.

Given the different, and sometime competing, priorities of different industry interest groups, it seems clear that the drive for flexibility must be led by government. The forthcoming consultation on smart power is a key part of this, and the extent to which government responds to calls to remove barriers to demand-side response and storage will determine the speed and scale at which flexibility can be achieved in the next decade and a half.

FLEXIBILITY IS KEY IN A TRANSFORMED ENERGY SYSTEM

Rich Hampshire, Smart Utilities Director, CGI UK

The so-called energy "trilemma" of security, affordability and sustainability has long been at the heart of Britain's energy policy. However, the use of the word trilemma may have underpinned the view that there are trade-offs between these three pillars of policy.

With the dialogue moving towards a "whole system approach" and growing recognition of the significance of flexibility, in all its forms, we are starting to see the "trilemma" give way to a virtuous circle where the progressive adoption of low-carbon, demand-side technologies to de-carbonise heat and transport and provide energy storage delivers the increased flexibility required to deal with the intermittency associated with low-carbon generation on the supply side.

This report provides the perspective of the sector on flexibility – its significance today and the clarity of understanding of how and where its significance is expected to grow by 2030. The sector's leaders also identify some of the barriers that will need to be addressed if the full value of flexibility is to be realised and create that virtuous circle from the three policy pillars.

What is clear from the survey is the recognition across all sectors of the degree by which flexibility in the system will need to increase by 2030 and how it will grow in strategic significance, particularly for distribution network operators (DNOs). Where there is greater degree of difference between the market roles of Energy Company, DNO and Aggregator, is the relative importance of the different sources of flexibility. The level of importance, at 9.5/10, attached to demand-side flexibility by Aggregators is unsurprising. Perhaps what is surprising is the relative importance placed on interconnection and the lack of importance placed on grid-connected storage by the DNOs.

All the market roles identified the significance of the role of storage – both grid-connected and on the demand side – in realising the level of flexibility the energy system will require. What is perhaps more striking is the optimism across all roles that storage will have reached maturity by 2030.

This study also identifies where the value lies between the different market roles, with the DNOs focused on constraints management and the Energy Companies and Aggregators eyeing new business opportunities and balancing.

There are also useful insights provided about the perceived barriers to the value of flexibility being realised.

When it comes to demand-side flexibility, for Energy Companies and Aggregators it comes down to clarity about policy, regulatory and market frameworks, whereas the DNOs are more concerned with understanding how the other parties will be using flexibility on the DNOs' networks and the conflicts that might arise.

When it comes to storage, it is apparent that the cost is front-of-mind for all market roles, which is perhaps surprising given the importance attached to storage and the optimism about its maturity by 2030. Evidently, the policy, regulatory and market frameworks, as they apply to the different market roles, also need to be addressed for storage in order to fulfil its perceived full potential.

We hope that you will find the insights provided by this report useful in your businesses and that they complement the work on Energy Flexibility by the National Infrastructure Commission and the Committee on Climate Change, and that these insights will help inform the discussion about how flexibility should become an integral part of Britain's energy system.

> **"With the dialogue moving towards a 'whole system approach' and growing recognition of the significance of flexibility, in all its forms, we are starting to see the 'trilemma' give way to a virtuous circle.**

ENERGY FLEXIBILITY

TRANSFORMING THE POWER SYSTEM BY 2030

About CGI

CGI is a global business with 68,000 professionals in 40 countries across the Americas, Asia-Pacific and Europe who provide end-to-end IT and business process services that facilitate the ongoing evolution of our clients' businesses. In the Utilities sector, CGI has over 3,000 staff worldwide who specialise in providing innovative solutions to our clients' most complex business challenges.

CGI has been at the heart of every major change in the UK energy market since privatisation: enabling network operators to make Smart Grids a reality in creating a reliable, economic, sustainable low-carbon energy infrastructure and supporting the Data Communications Company by delivering the systems at the heart of Britain's smart metering implementation programme. CGI leads the market in the provision of the technology that supports utility markets, having designed, built and currently operating 12 of the 18 utilities market systems in the world today, including the UK BSC Settlement for ELEXON; the data systems at the heart of the DCC and the central market system for Market Operator Services Ltd (MOSL) to support the operation of the English water market when competition is introduced to non-household customers in April 2017. Find out more: www.cgi-group.co.uk/utilities

About Utility Week

Utility Week is the leading source of market information for business professionals wanting to gain insight into the electricity, gas and water sectors in the UK. Its subscription services include a weekly print magazine, website and the premium service Utility Week Intelligence. Find out more: www.utilityweek.co.uk