



UtilityWeek™

EMBRACING
FLEXIBILITY

TRANSFORMING THE POWER SYSTEM BY 2030

2018 EXCLUSIVE RESEARCH REPORT



IN ASSOCIATION WITH

CGI

FOREWORD



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There is no doubt that establishing alternative sources of flexibility is the key to the power system of the future. Now in its third year, this programme of exclusive market insight, by Utility Week in association with CGI, shows that energy players of all shapes and sizes are convinced that storage, demand side flexibility and interconnection are the answer to many of the challenges facing UK power. But implementing the solution won't be easy – despite major advances in the policy and regulatory landscape, such as the publication of BEIS and Ofgem's Smart Systems and Flexibility plan in July 2017, the market still lacks a proper framework to unlock the full value of flexibility.

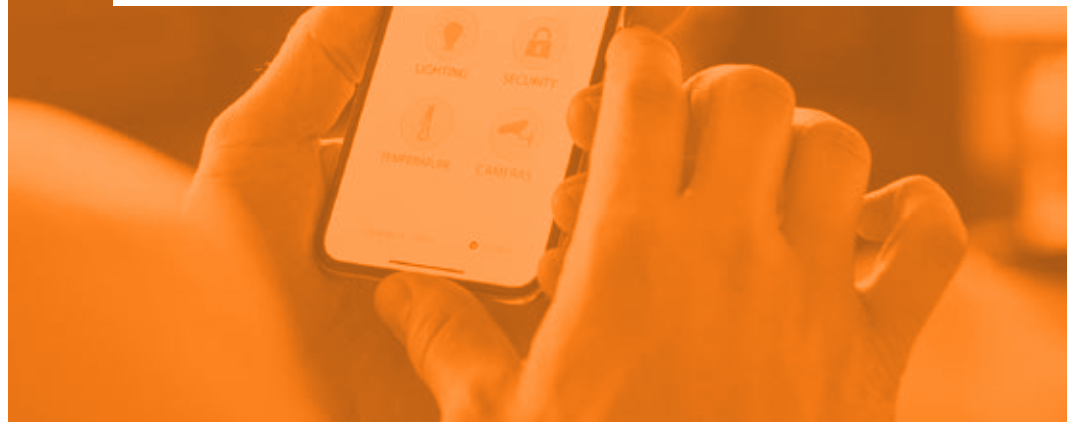
Our research shows that this lack of formal frameworks is far more of a barrier than technology maturity or even costs. Our respondents are confident that the enabling technologies for a flexible power system, such as electric vehicles and demand side storage, are nearly at the point of economic viability. Yet the infrastructure to underpin them, such as charging infrastructure for electric vehicles, is further away – requiring, perhaps, some policy intervention.

Our respondents still highlight numerous barriers to flexibility – but compared to previous years, their views of the nature and scale of those barriers is diverging. This suggests that businesses are moving from seeing flexibility as an amorphous mass on the horizon, and they are starting to see in practical terms what it means for their businesses. While many remain sceptical that they will ever see a return on investment for flexibility, others are busy creating their own business cases.

With many respondents seeing 2023 as a major tipping point for their business's ability to realise opportunity from flexibility, it's clear the market is moving. The onus now is on policymakers and regulators to keep up.

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EXECUTIVE SUMMARY

The need for alternative and increased sources of flexibility in the power system is now widely accepted. Industry, policymakers and regulators alike recognise that the provision of flexibility – through grid scale storage, demand side response, and interconnection – is critical if the power system is to cope with changed patterns of generation on one hand, and of consumption on the other.

As renewable and distributed sources of generation take over from traditional power sources, the grid will have to cope with a huge increase in intermittency of generation. Unlike with traditional coal or gas fired power plants, renewable generators can't control when the wind blows or the sun shines, meaning that sometimes more energy than is needed will be generated, and sometimes less. Thus, the ability to store excess energy; to manage demand according to the availability of power; and to connect to neighbouring power systems must be built into the system.

Added to the changes in supply driven by the changing nature of generation are the consumer driven changes in demand. Already, many consumers are becoming more active, putting any surplus electricity from their solar panels or other forms of small scale generation back into the grid. However, many believe the biggest change will come with the mass take up of electric vehicles. This has the potential to create a huge rise in power demand, but also provides an opportunity as an alternative source of flexibility. If this opportunity is to become reality, then the need for charging infrastructure, both at homes and offices and 'on the go' in public places, is clear. The cost of putting in place the necessary infrastructure to cope with this increased demand for power will be prohibitive unless it can be mitigated by flexibility in the grid – for example, with charging being done at off peak times. A flexible power system will also create opportunities for consumers as they move to electric vehicles – for example, through vehicle to grid (V2G) storage, whereby EVs can act as mobile batteries, enabling their owners to store power and use it to satisfy their own energy needs or even sell it back to the grid at times of peak demand (or have an agent do it for them).

Against the backdrop of these seismic changes, Utility Week, in association with CGI, has been exploring the challenges and opportunities of flexibility in the power system for the energy industry for three years. In a series of high-level events and targeted market research, we have charted opinion year-on-year from the different players in the energy value chain: system operators, distribution network operators (DNOs), energy suppliers, energy traders, and aggregators and providers of flexibility.

Their answers reveal the huge potential that flexibility has to transform both the power system, and the experience of the customers that use it. They show beyond a doubt that participants across the energy value chain recognise the value of flexibility, and believe that value will grow exponentially over the next decade and beyond. However, they also reveal the myriad challenges that flexibility faces – economic, regulatory and customer focused.

This year's insight is particularly interesting in how it differs from previous years. Greater variation is coming into respondents' answers and, while they still see a number of barriers to flexibility, those barriers are beginning to vary more by audience type. We suspect this is because flexibility projects are becoming more 'real', and as different players engage in them, they become more focused on 'on the ground' problems associated with delivery, than with obstacles to the overall implementation of a flexible power system.

Meanwhile, the policy framework for flexibility is emerging. Three years ago, when this series of insight began, flexibility was a relatively new concept among policymakers and regulators. There have been huge strides since then, beginning with the publication of the National Infrastructure Commission's Smart Power report, in March 2016, which highlighted potential annual savings of £3-3.5 billion at the 2030 target level of 100gCO₂e/kWh. In the past year, the long awaited Smart Systems and Flexibility plan has been published jointly by BEIS and Ofgem, setting out their expectations on the shape of the new markets. While this paper undoubtedly leaves numerous questions still to be answered, it sets the roadmap for achieving the vision of a flexible power system.

KEY FINDINGS



Significance of flexibility

Respondents rate the strategic significance of flexibility to their business at 6.6 out of a possible 10 presently, and expect it to grow one-third to 8.7 by 2030, which is consistent with the results of the 2017 survey.

Respondents believe flexibility in the system requires a massive increase in contribution from grid scale storage and demand side flexibility, rising 72 per cent from a current level of 4.6 out of a possible 10, to a required 7.9 out of 10 by 2030.

Policy and regulatory context

Of the policy and regulatory initiatives in the 12 months since the previous survey, respondents were most positive about Ofgem's review of network charging, rating its impact on investment, confidence and pace of change at 7.2 out of a possible 10; and the Smart Systems and Flexibility plan, with respondents rating its impact on investment, confidence and pace of change at an average of 6.8 out of a possible 10.

Suppliers and traders were the most positive group about the Smart Systems and Flexibility plan, rating its impact on investment, confidence and pace of change 7.5 out of 10.

Drivers and opportunities

While drivers for flexibility vary by business type, the capacity market is not generally considered to be a major driver. Operating the distribution system comes out as the top driver, heavily influenced by the 9.1 out of 10 and 8.7 out of 10 scores from DNOs and SO respondents respectively. Unsurprisingly, suppliers and traders see customer experience (8.7) and customer propositions (8.6) as primary drivers for their businesses.

The main current opportunities for businesses arising from flexibility are: providing industrial and commercial demand side flexibility; utilising flexibility to avoid the need for new infrastructure; and utilising storage and demand side flexibility to balance the network.

Businesses anticipate a tipping point in the availability of opportunities arising from flexibility around 2023, with 80 per cent of respondents seeing the sharing of demand side flexibility between the DNO and SO being significant by 2023.

Seventy-eight per cent of respondents predict opportunity arising from the creation of a market platform for trading demand side flexibility by 2023.

Enablers

Respondents expect electric vehicles to reach economic viability within just 3.2 years. However, the charging infrastructure for electric vehicles is expected to take longer to reach economic viability, at 4.5 years, suggesting some policy intervention and/or investment support may be required.

Pessimism from SO respondents (9.7 years) and DNOs (5 years) is driving the longer score for the charging infrastructure being in place, in contrast with their optimism about the economic viability of EVs (2.7 and 2.6 years respectively).

The smart meter rollout is not widely anticipated to unlock value from flexibility, with respondents rating its potential to do so at just 5.2 out of a possible 10. Suppliers and traders are the most positive at 5.8.

KEY FINDINGS

Demand side flexibility

The most significant barrier to demand side flexibility is the lack of a commercial or market framework to realise its value, rated at 7.1 out of a possible 10, closely followed by the related inability to stack value at 6.9 out of 10.

While half of respondents (50 per cent) have experienced economic barriers to demand side flexibility projects, less than one third (31.3 per cent) have experienced technical barriers, suggesting that the technology is more advanced than the business case.

Nearly half - 46.9 per cent - of respondents have experienced customer side barriers, second only to economic barriers at 50 per cent. This is consistent with the 86.7 per cent of respondents that identify low levels of customer awareness as a barrier from their experience of demand side flexibility projects.

The number of respondents who say they have not seen any barriers to demand side flexibility projects - 9.4 per cent - is almost half the 18% reported in the 2017 survey, suggesting that understanding of the challenges is growing with experience.

Return on investment

Opinion is divided as to when respondents will see ROI for their businesses from flexibility in the power system, with 31.3 per cent already seeing ROI, and a further 25 per cent predicting ROI by 2023. However, 34.4 per cent of respondents predict never seeing ROI for their business.

More than a third (37.5 per cent) of aggregators and flexibility providers say they will never see ROI for flexibility, begging the question of what value they see in operating in the market. However nearly two thirds (62.5 per cent) say they already see ROI.

DNOs are sceptical about the business case for flexibility, with just 23.1 per cent currently seeing ROI, rising to 46.2 per cent by 2023. 46.2 per cent anticipate never seeing ROI on flexibility.



Methodology

Our survey was conducted on behalf of Utility Week and CGI by Insight Advantage, an independent market research consultancy, in March and April 2018. Answers were confidential, and are reported only in their aggregated form. Our online survey was completed by 41 individuals from across the power sector, who spent more than 26 minutes on the survey on average; significantly longer than the previous years' surveys. Nearly three quarters (73 per cent) of respondents were board director, director or head of department level.

The research was informed by discussions at a working group held in London in March 2018, and attended by 20 senior leaders from DNOs, suppliers, traders, aggregators and providers of flexibility.



OVERVIEW

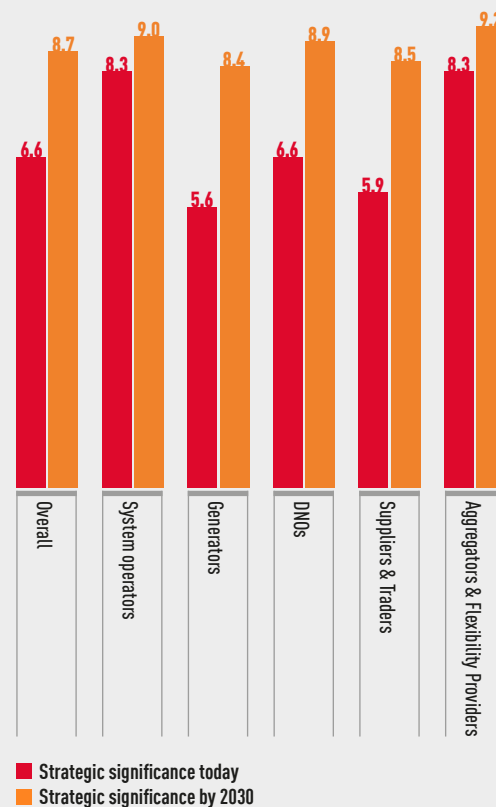
Over the three years that Utility Week and CGI have been looking at the strategic significance of flexibility to the power system, expectations have been high – and this year was no different. Respondents to this year’s survey (2018) rated the strategic significance of flexibility to their business at 6.6 presently, expecting it to grow nearly one-third to 8.7 by 2030. While this is very slightly lower than the expectation of significance by 2030 recorded in the 2016 survey (9.1), it is exactly the same as the 2017 survey and shows in both cases similar expectations of growth.

Breaking down responses by audience group, it is little surprise that aggregators and flexibility providers give the highest rating to the strategic significance of flexibility to their business, now and in 2030 (8.3 and 9.2 respectively). It is interesting to note that system operators are the next highest (8.3 and 9) and DNOs the third highest (6.6 and 8.9), while all respondents come in at 8.4 or higher by 2030.

Q On a scale from 1 to 10, how would you rate the strategic significance of flexibility to your organisation today?

Q On a scale from 1 to 10, where do you expect the strategic significance of flexibility to your organisation to be by 2030?

Average score (out of 10)



KEY FINDINGS

SIGNIFICANCE OF FLEXIBILITY

Respondents rate the strategic significance of flexibility to their business at 6.6 out of a possible 10 presently, and expect it to grow one-third to 8.7 by 2030, which is consistent with the results of the 2017 survey.

Respondents believe flexibility in the system requires a massive increase in contribution from grid scale storage and demand side flexibility, rising 72 per cent from a current level of 4.6 out of a possible 10, to a required 7.9 out of 10 by 2030.

POLICY AND REGULATORY CONTEXT

Of the policy and regulatory initiatives in the 12 months since the previous survey, respondents were most positive about Ofgem’s review of network charging, rating its impact on investment, confidence and pace of change at 7.2 out of a possible 10; and the Smart Systems and Flexibility plan, with respondents rating its impact on investment, confidence and pace of change at an average of 6.8 out of a possible 10.

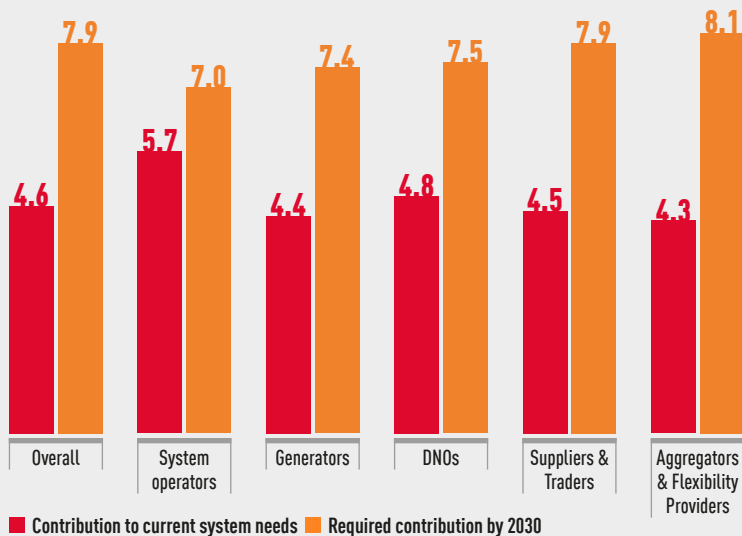
Suppliers and traders were the most positive group about the Smart Systems and Flexibility plan, rating its impact on investment, confidence and pace of change 7.5 out of 10.

But where will this flexibility come from? Respondents overwhelmingly felt that the contribution of grid scale storage and demand side flexibility to overall flexibility in the power system needed to rise massively by 2030. On average, respondents rated the current contribution of the two solutions at 4.6, and said it needed to rise by a huge 72 per cent, to 7.9, by 2030. Breaking down the responses by audience type, aggregators and flexibility providers had the lowest current view of the contribution of grid scale storage and demand side flexibility, at 4.3, and the highest view of its required future contribution, at 8.1.

Q On a scale from 1 to 10, how would you rate the contribution of grid scale storage and demand side flexibility to current system needs?

Q On a scale from 1 to 10, how would you rate where you think the level of contribution from grid connected storage and demand side flexibility towards meeting system needs will need to be by 2030?

Average score (out of 10)



The policy landscape

Since our last research in 2017, there have been a number of policy developments relating to flexibility in the power system. The importance of such flexibility is now clearly recognised at ministerial level, and government is attempting to clear a number of the barriers that our earlier research identified.

In July 2017, the long awaited Smart Systems and Flexibility Plan was published jointly by the Department for Business, Energy and Industrial Strategy (BEIS) and Ofgem. This was expected to clarify what the new markets for flexibility would look like, and set out a roadmap for establishing them.

Government is attempting to clear a number of the barriers that our earlier research identified

MARKET VIEWS

Regulators and policymakers are behind the curve with flexibility, according to attendees at the Utility Week/CGI working group on flexibility. As a result, regulation is often based on assumption and not fact – and this creates problems. “We’re in danger of creating imaginary regulations that bear no relevance to the market, as they were conceived theoretically and too far in advance,” said Dr Alastair Martin, chief strategy officer of Flexitricity.

Attendees also questioned whether Ofgem has enough resources to move quickly on flexibility, and noted that Brexit is an ongoing distraction for BEIS and the rest of Whitehall.

They asked whether instead of regulators defining a market structure for everyone to work within, they could let the industry advance and catch up with appropriate measures as and when required?

Aggregators at the event agreed there are three institutions that have the potential to create frequent barriers to aggregator participation in a flexible energy system (and in some cases do) – these being Ofgem, National Grid as system operator and BEIS. Their conduct is crucial to achieving an industry working at its optimum capability. Those three aside, it was discussed that emerging barriers often occur at the grid edge – but centralization is not seen as the answer.

The Smart Systems and Flexibility Plan was seen as the second most significant initiative, with respondents rating its impact on investment, confidence and pace of change at 6.8 out of a possible 10. Within this, suppliers and traders were the most positive, giving it 7.5 out of 10, and generators the least positive at just 6 out of 10.

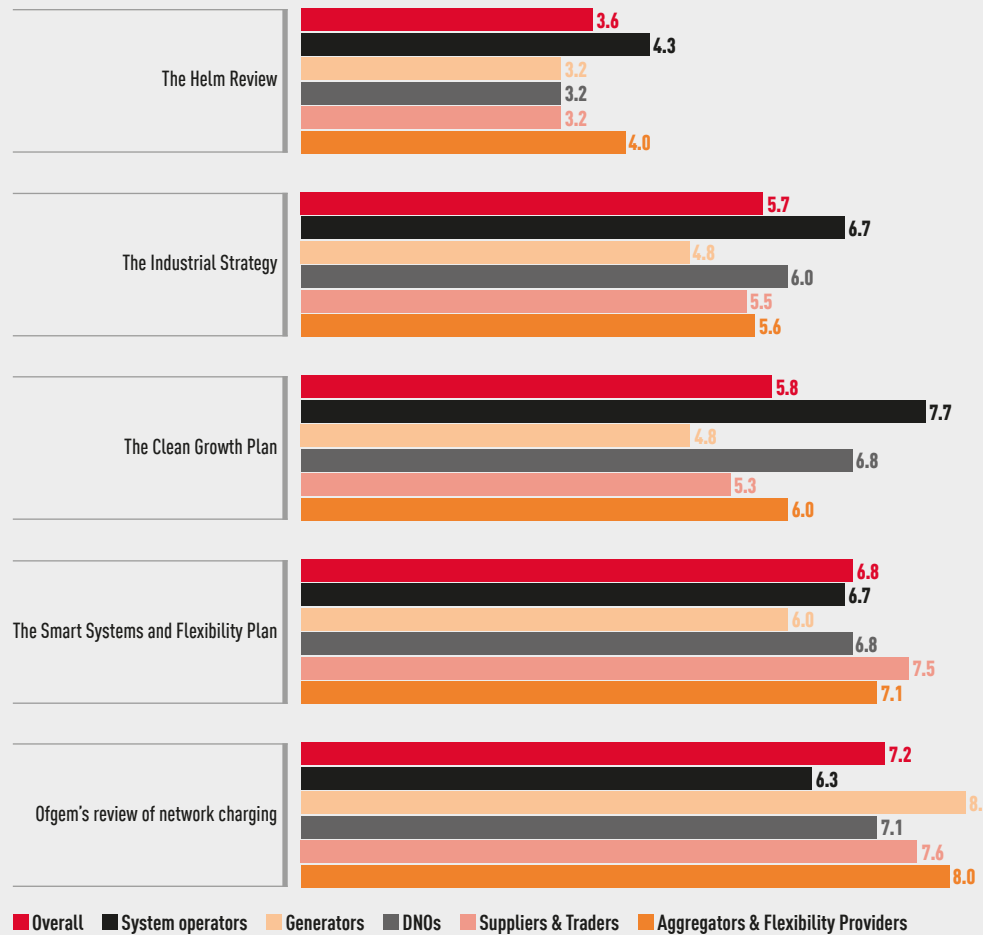
Of the policy and regulatory developments we asked our respondents about, the most impactful was seen to be Ofgem's review of network charging

Of the policy and regulatory developments we asked our respondents about, the most impactful was seen to be Ofgem's review of network charging. This was rated at 7.2 out of 10 for its impact on investment, confidence and the pace of change, with generators and aggregators markedly enthusiastic as 8.2 and 8 respectively. The review began in late 2017, with a final consultation expected later this year.

There was little enthusiasm, however, for Professor Dieter Helm's government-commissioned review of the energy system, which set out a vision of wide ranging reform in 2017. This was rated at just 3.6 on average, with no single rating higher than 4.3.

Q To what extent are each of the following initiatives having an impact on investment in alternative sources of flexibility; confidence and the pace of change?

Average score (out of 10)





DRIVERS FOR FLEXIBILITY

Of course, the drivers for flexibility vary considerably by audience segment. For system operators, the greatest driver for flexibility is balancing the transmission system, at 9 out of a possible 10, closely followed by operating, including balancing, the distribution system, at 8.7 out of 10; and interestingly, by household and business customer experience and retention at 8 out of 10. In similar vein, DNOs rate operating, including balancing, the distribution system as the biggest driver for flexibility, at 9.1 out of 10, followed by constraints management at 8.7.

On the retail side of the business, customers are the major driver,

with suppliers and traders rating household and business customer experience and retention at 8.7 out of 10, closely followed by household and business customer proposition at 8.6. Likewise, aggregators and flexibility providers rate household and business customer proposition at 8.5 out of 10 and new business opportunities, plus efficient management of the energy portfolio, at 8 out of 10.

The capacity market, which offers financial support to providers of flexible or traditional capacity to provide back up power, is not considered a significant driver of flexibility, with an average score of just 6 out of 10 across all audience segments.

Q How important are each of the following drivers for flexibility to your organisation?

Please indicate the importance on the scale from 1 to 10

AVERAGE SCORE (OUT OF 10)	OVERALL	SYSTEM OPERATORS	GENERATORS	DNOs	SUPPLIERS & TRADERS	AGGREGATORS & FLEXIBILITY PROVIDERS
The capacity market	6.0	6.0	6.4	4.9	6.9	6.8
Balancing the transmission system	6.7	9.0	7.0	6.0	6.7	7.5
Efficient management of energy portfolio	6.8	6.0	8.4	5.6	8.0	8.0
Household and business customer experience and retention	7.1	8.0	5.6	6.5	8.7	7.8
Household and business customer proposition	7.1	6.7	5.8	6.1	8.6	8.5
Constraints management	7.2	7.7	6.2	7.8	6.5	6.6
New business opportunities	7.3	7.7	6.2	6.7	7.8	8.0
Operating, including balancing, the distribution system	7.7	8.7	4.6	9.1	6.8	6.7



OPPORTUNITIES

Asked when the opportunities that energy flexibility offers their business would be realised, respondents were clear in their view. The main opportunities at present were: providing industrial and commercial demand side flexibility; utilising flexibility to avoid the need for new infrastructure; and utilising storage and demand side flexibility to balance the network. These three opportunities, all of which are available in varying degrees under the current regulatory and market frameworks, were rated significant today, and even more so by 2023.

It is interesting to note that a significant majority (78 per cent) of respondents believed the creation of

a market platform for trading demand side flexibility would offer their business opportunity by 2023. This shows considerable optimism that such a market platform will materialise – some might say surprising optimism given that today, five years out from that date, the clarity on market frameworks is still identified as the most significant barrier at 7.1 out of 10, closely followed by the related inability to stack value at 6.9 out of 10.

Indeed, 2023 was seen across the board as a tipping point for the opportunities arising from flexibility, with significant expectations of growth in opportunity by that date across the board. This reflects similar findings in our earlier research.

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KEY FINDINGS

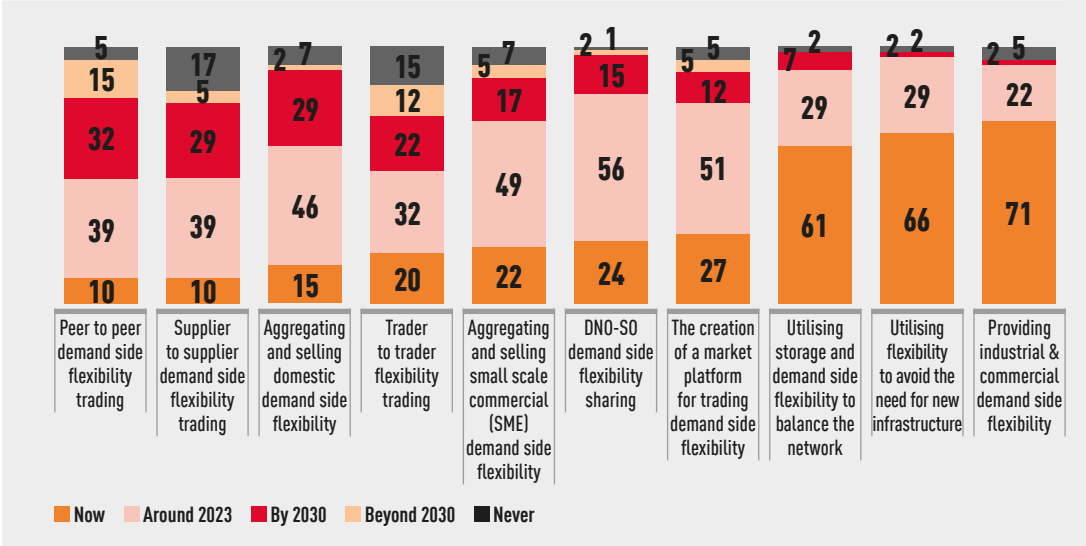
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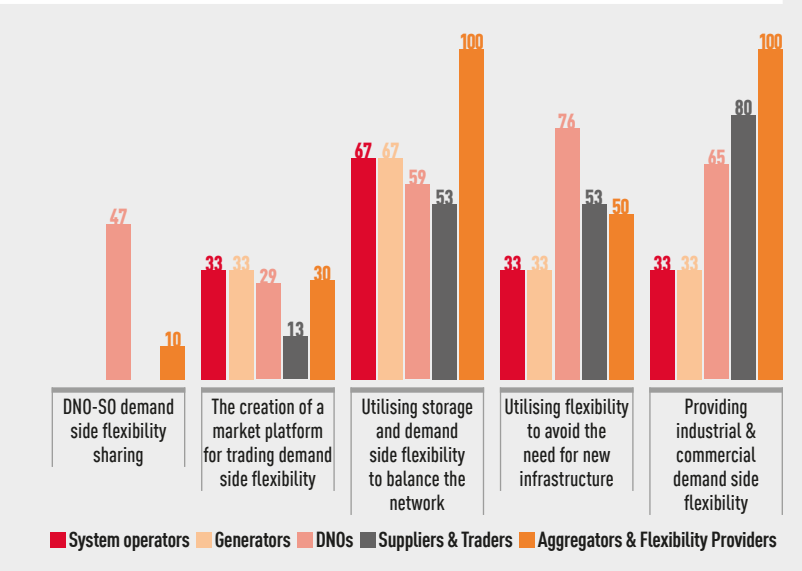
Businesses anticipate a tipping point in the availability of opportunities arising from flexibility around 2023.

More than half of respondents predict opportunity arising from the creation of a market platform for trading demand side flexibility by 2023.

Q When will your organisation see each of the following as opportunities arising from energy flexibility? Please select a time period for each
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Q When will your organisation see each of the following as opportunities arising from energy flexibility? Please select a time period for each
Percentage that see opportunity "now" (top 5)



As you would expect, views of the current opportunities afforded by flexibility vary considerably by sector. Aggregators and providers of flexibility were overwhelmingly the most positive about the current level of opportunities, with 100 per cent seeing current opportunity from providing industrial and commercial demand side flexibility and from utilising storage and demand side flexibility to balance the network.

One interesting anomaly in the findings is the discrepancy between the system operators' and DNOs' views of the opportunity afforded at present by DNO-SO demand side flexibility sharing. While 47 per cent of DNOs saw this as a current opportunity, no system operator respondents did. It is difficult to see how it could exist for one group and not the other, suggesting that DNOs' optimism is either misplaced – or the perceived benefit may be all on one side.

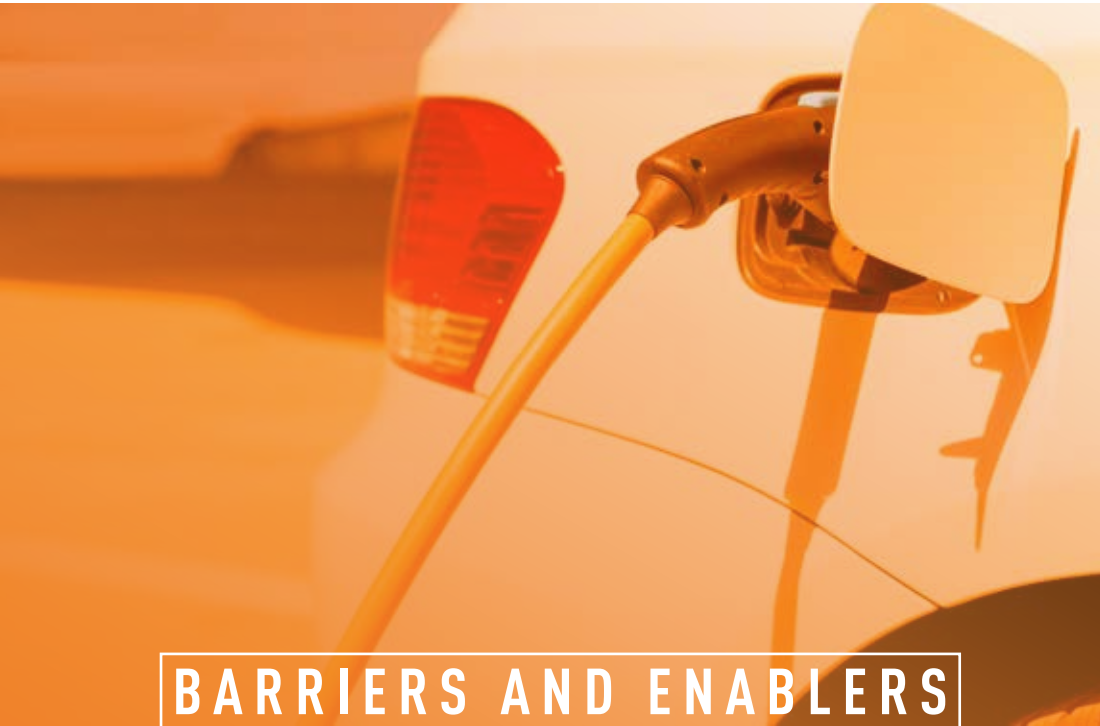
DNOs rate their current ability to realise the benefits of providing industrial and commercial demand side flexibility at just 5.8 out of a possible 10

In addition to asking respondents about the opportunities they see for their business from flexibility now and in the future, we asked them to rate their business's ability to realise those benefits. The numbers here tell some interesting stories: for example, DNOs rate their current ability to realise the benefits of providing industrial and commercial demand side flexibility at just 5.8 out of a possible 10, and system operators at just 5. This suggests that while aggregators and flexibility providers may be well on their way to realising the benefits, at 7.7 out of 10, the actual operators of the grid acknowledge they are further behind. They would likely argue that they are hamstrung by regulation and the lack of market frameworks – and may also suggest that the contrasting views of aggregators may be overly optimistic.

Q To what extent would you rate your organisation's current ability to realise the benefit of each of the following opportunities arising from energy flexibility?

Please indicate the level of current ability on the scale from 1 to 10

AVERAGE SCORE (OUT OF 10)	SYSTEM OPERATORS	GENERATORS	DNOs	SUPPLIERS & TRADERS	AGGREGATORS & FLEXIBILITY PROVIDERS
DNO-SO demand side flexibility sharing	–	7.0	6.5	–	6.0
The creation of a market platform for trading demand side flexibility	7.0	–	5.4	6.5	6.7
Utilising storage and demand side flexibility to balance the network	7.5	7.6	6.1	7.0	7.7
Utilising flexibility to avoid the need for new infrastructure	7.0	6.5	6.4	4.4	5.2
Providing industrial & commercial demand side flexibility	5.0	7.0	5.8	7.1	7.7



BARRIERS AND ENABLERS

ENABLING TECHNOLOGIES

We asked our respondents over what timescale they saw the most important enabling technologies for flexibility becoming economically viable. The answers revealed considerable optimism, with respondents expecting most technologies to become economically viable within the next five years.

Overall, electric vehicles were considered to be the closest technology to economic viability, with respondents putting it at an average of just 3.2 years away. It is interesting to note that DNOs were the most optimistic audience group, expecting EVs to be economically viable in 2.6 years, with system operators just behind at 2.7 years. Generators, who may be said to be further from the



technology in their daily dealings, lagged at six years. Electric vehicle charging infrastructure, however, is a different story. The charging infrastructure, which is vital to the mass takeup of EVs, is problematic because it is difficult to see who should invest in the infrastructure, particularly public 'on the go' infrastructure, and whether infrastructure provision should come ahead of demand. Thus, EV charging infrastructure was predicted to reach economic viability in 4.5 years, significantly later than EVs themselves, with system operator respondents by far the most pessimistic by audience type, putting it at 9.7 years. This gap between the economic viability of EVs and of their charging infrastructure suggests that some form of policy intervention may be required to bring forward the rollout of charging infrastructure, particularly public infrastructure, in line with the takeup of EVs.

It is worth looking at the views of the different respondent groups here, with SO respondents (9.7 years) and DNOs (5 years) driving the pessimism about the charging infrastructure being in place, in contrast with their optimism about the economic viability of EVs (2.7 and 2.6 years respectively).

KEY FINDINGS

Respondents expect electric vehicles to reach economic viability within just 3.2 years. However, the charging infrastructure for electric vehicles is expected to take longer to reach economic viability, at 4.5 years, suggesting some policy intervention and/or investment support may be required.

Pessimism from SO respondents (9.7 years) and DNOs (5 years) is driving the longer score for the charging infrastructure being in place, in contrast with their optimism about the economic viability of EVs (2.7 and 2.6 years respectively).

The smart meter rollout is not widely anticipated to unlock value from flexibility, with respondents rating its potential to do so at just 5.2 out of a possible 10. Suppliers and traders are the most positive at 5.8.

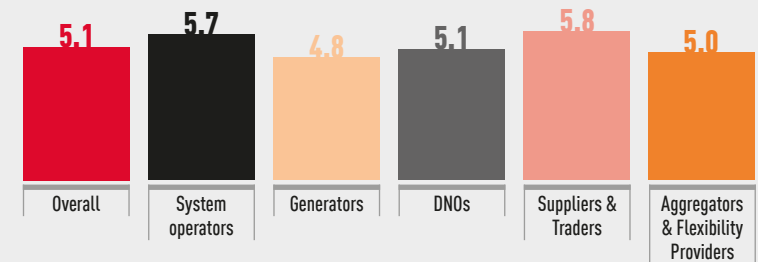
The next technology to reach economic viability was predicted to be demand side storage, at a combined average of 3.7 years. There are some interesting anomalies in the breakdown of this average – system operator respondents, for example, were markedly pessimistic, rating this at 9 years, compared to 1.9 years from the most optimistic market participants, aggregators and flexibility providers. DNOs came in the middle of the pack, at 4.3 years.

Electrification of heat was the outlier in terms of expected time to reach economic viability, coming in at a combined average of 6.6 years. System operators and DNO respondents were the most pessimistic, at 10.7 and 7.6 years respectively. This finding reflects a major shift in the narrative around heat. It was just a few years ago that the full electrification of heat was confidently expected in the near future, with some market observers even questioning whether gas networks would have a role beyond 2021. That view has now changed across the board, with policymakers and regulators predicting a more blended approach to the UK's future heat needs, combining electrified heat with existing gas infrastructure and the greening of the gas supply.

Smart meters

The current rollout of smart meters has been touted as the number one enabler for a flexible power system, allowing as it will for half hourly settlement and other more granular monitoring and management of the power system. Our respondents were unconvinced that it would unlock the value of flexibility. Overall, they rated their expectation that the smart meter rollout would unlock value at just 5.2 out of a possible 10, with little range by audience segment.

Q On a scale from 1 to 10, to what extent do you expect the mass rollout of smart meters and the associated ability to move consumers to elective half-hourly settlement to unlock the value of flexibility for market participants?
Average score (out of 10)



Q Over what timescale do you see each of the following becoming economically viable?

AVERAGE - NUMBER OF YEARS	OVERALL	SYSTEM OPERATORS	GENERATORS	DNOs	SUPPLIERS & TRADERS	AGGREGATORS & FLEXIBILITY PROVIDERS
Electric vehicles	3.2	2.7	6.0	2.6	3.8	3.7
Demand side storage	3.7	9.0	5.4	4.3	3.6	1.8
Grid connected storage	4.3	5.7	2.5	4.9	4.4	1.4
Micro-generation	4.4	10.0	5.4	4.9	4.3	3.6
Charging infrastructure for electric vehicles	4.5	9.7	6.0	5.0	4.0	3.3
Connected home technologies	5.5	10.3	5.0	6.4	4.1	4.3
Electrification of heat	6.6	10.7	6.0	7.6	6.0	4.6

MARKET VIEWS

The race for a flexible power system is no longer about technology, according to the DNOs which attended Utility Week and CGI's working group. They said the enabling technologies have now reached maturity, and the main challenge they face in this regard is knitting them all together to form an integrated system.

However, attendees highlighted the critical importance of telecoms technology. As the smart grid emerges, with its dependence upon sensors and other telecommunications, its reliability will be determined by that of the telecoms underpinning it. A sensor that fails to send a critical message at a critical moment could create a power outage – and DNOs predicted there would be little public patience with such errors.

The network operators said overcoming these barriers and others will require clarity, certainty and decisiveness in terms of regulations and policy. They welcomed the strong support from government and Ofgem for the Energy Networks Association's Open Networks Project.

BARRIERS

We asked our respondents to provide detailed commentary on the current barriers to enabling technologies, and to give their views on what will accelerate the development and uptake of those technologies. Their answers showed a continued focus on the cost of technology as a barrier in many cases, combined again with the lack of market frameworks and, in some instances, a lack of awareness or interest among customers.

Electrification of heat

The major barrier to the electrification of heat was overwhelmingly identified as cost. The widespread use of gas boilers and the challenge of retrofitting the existing housing stock were also identified, though arguably these barriers relate back to cost.

Here's a selection of our respondents' answers to the question: **“What are the barriers to the electrification of heat, and how can adoption be facilitated and accelerated?”**

“Cost of deep retrofit, current housing stock. Cost of network reinforcement.”

“Old building stock and the labour costs associated with renovation.”

“Cost and awareness - make cheaper and promote.”

“Barrier is cost compared to gas. Not on a level playing field due to where policy costs arise.”

“Customer choice, costs, carbon benefit.”

“Technology/ability to provide the electrical capacity. We need to provide some stability for existing infrastructure providers to do their job and provide capacity. Regulator needs to provide appropriate mechanisms to allow more speculative investments to facilitate this.”

“Seasonality.”

“Very difficult given need for retrofit in areas will not be possible. Also cost versus benefit since existing systems are cheaper to continue with.”

“Equipment and installer supply chain in GB. Low cost of gas. Fixed by investment and carbon storage.”

“Barriers - willingness to adopt new approach & provision of micro-generation to support.”

Connected homes

Asked to identify the barriers to connected home technologies, our respondents focused on customers and the complexity of the market. Some questioned whether customers had the necessary interest in connected home products, or whether they were too complex - as one respondent noted, “customers will drive the market.” This is reflected elsewhere in our survey where 46.9 per cent of respondents cited customer-side barriers to demand side flexibility projects.

Respondents scored connected homes as the second furthest technology away from economic maturity, at an average of 5.5 years, second only to the electrification of heat at 6.6 years. It is interesting to note that suppliers and traders were the most optimistic group, putting economic viability at 4.1 years away. This reflects the significance of customer propositions as a driver for flexibility for these organisations, which scored customer proposition and customer experience at 8.6 and 8.7 out of 10 respectively.

Here's a selection of our respondents' answers to the question: **“What are the barriers to connected home technologies, and how can adoption be facilitated and accelerated?”**

“Centralised structure of the energy system; regulatory barriers; institutional barriers. A complete redesign of the energy system and the roles within it is required; an open-source blockchain with regulatory rules designed in is required to make this happen and have a truly bottom-up democratised energy market working for the UK.”

“Capital cost / marginal return.”

“Fragmentation, the fight for control of the house, and unwillingness of suppliers to create open APIs.”

“Automated energy markets that allow intelligent devices and home owners to benefit from markets which currently exclude them.”

“Barrier is putting together a useful proposition for the customer.”

“There are no barriers here. Customer will drive the market.”

“Barrier: size of the prize. significant effort required for minimal returns. Also limited by lack of HH settlement.”

“Complexity for consumers.”

“Energy system belief that they can provide reliable flexibility services. Support large scale demonstrators.”

“Inability to monetise all forms of flexibility without supplier involvement.”

“Regulatory barriers on use of data.”

Micro-generation

Asked to identify the barriers to the adoption of micro-generation technologies, responses focused heavily on cost. There was a general sense that, at the moment, the numbers just don't add up, with the upfront costs making the payback period unviable. Consumer apathy was also identified as a barrier, as was physical capacity in the distribution network.

Here's a selection of our respondents' answers to the question: **"What are the barriers to micro-generation, and how can adoption be facilitated and accelerated?"**



"PV cost / longer term payback."

"Pure economics while the technology improves. Will be more economical when flexibility markets working. For domestic, need long term cheap finance to push adoption."

"Barrier is the cost and payback. For intermittent renewables (PV), batteries will help make the case more attractive."

"Incentives and pricing structure."

"Cost and therefore payback, as well as realising wider benefits from additional markets."

"Support for community programmes with the right fundamentals."

"Up front costs and value back."

"Unknown to people, education."

"Dependence on gas."

"Move from subsidy to market based remuneration."

"Distribution network capacity. CapEx."



Grid connected storage

Asked to identify barriers to the adoption of grid connected storage, our respondents did not give one stand-out barrier. Answers focused on a range of issues including market access and design; cost and the needed for technology developments, for example longer-life battery storage and vehicle to grid charging.

Here's a selection of our respondents' answers to the question: **"What are the barriers to grid connected storage, and how can adoption be facilitated and accelerated?"**

"Policy barriers / stacking of services."

"Realising the benefits through services and markets to justify the cost, it's not a simple single source revenue stream."

"Cost of batteries. Lack of curtailment to make profitable. Storage will be used in short term to shift from night time to day peak."

"Access to more markets required. Industry is already addressing this (DNO to DSO transition, BM lite etc)."

"Customer choice."

"Barrier is Risk v Reward. Allowing infrastructure companies the option of owning storage to get this moving would be sensible as they can balance risk."

"Uncertainty on future economics means difficult to justify significant investment now."

"V2G will challenge the business model."

"No major barriers, although not necessarily the first-choice solution to most issues."

"Cost. Lack of locational price signals."

Electric vehicles

Costs and the availability of charging infrastructure – particularly ‘on the go’ infrastructure – were front of mind when we asked our respondents about the barriers to the widespread adoption of electric vehicles. This reflects other findings noted above, whereby electric vehicles themselves were expected to reach economic maturity before electric vehicle charging infrastructure, at 3.2 and 4.5 years respectively.

Here’s a selection of responses to the question: **“What are the barriers to electric vehicles, and how can adoption be facilitated and accelerated?”**

“Current capital costs. Charging infrastructure inadequate. High cost of petrol / diesel will shift people to EVs.”

“Interoperable charging infrastructure, safe public space charging.”

“Only perception and expectations - easy to say public charging infrastructure but is expected to grow, and if it grows with EV uptake then there is no problem there.”

“No charging infrastructure creating lack of consumer confidence.”

“Costs higher than ICE cars, but costs are decreasing. Charging infrastructure needs to be in place to give customers confidence.”

“Technology maturing. needs larger scale to make viable. also lack of V2G infrastructure (no domestic V2G charger available).”

“Legacy tail and lack of charging locations - education and EV charging proposition.”

“Infrastructure capability. Ultimately it will be cheaper for a coordinated approach to developing infrastructure to make this happen quickly. Regulator needs to provide an incentive for infrastructure providers to invest and get a fair return.”

“Cost of batteries. Ongoing research to drive down prices. Development of additional revenue streams from flexibility services and second life batteries.”

“Vehicle cost.”

“Costs and charging infrastructure. Fixed by time and investment.”

“Cost. Availability of infrastructure.”



Electric vehicle charging infrastructure

Asked to name the barriers to electric vehicles charging infrastructure, our respondents highlighted a range of obstacles, many of which centred on uncertainty – for example, uncertainty about smart charging rules; about consumer habits; and about the potential for return on investment. This suggests, again, that some centralised approach to the rollout of charging infrastructure, providing that certainty, may be required.

Here’s a selection of responses to the question: **“What are the barriers to electric vehicle charging infrastructure and how can adoption be facilitated and accelerated?”**

“Utilisation, return on investment.”

“More ultra fast chargers are needed at competitive prices at service stations etc.”

“Smart charging markets need to develop to minimise impact on networks.”

“Uncertainty over demand - de risk investment.”

“More ultra fast chargers are needed at competitive prices at service stations etc.”

“Technology maturing. Needs larger scale to make viable. Also lack of V2G infrastructure (no domestic V2G charger available).”

“Uncertainty on where and how people will charge cars.”

“Stable mechanism for infrastructure and an incentive to invest. The ‘market’ is the right solution for some areas but not wider infrastructure which needs co-ordination.”

“Number of EVs. Distribution network capacity. Uncertainty of CapEx recovery.”

“Smart charging rules (they don’t exist yet).”

“Supplier-centric model. Move away from supplier-centric model [to facilitate and accelerate adoption].”

“Widespread adoption of EVs.”



DEEP DIVE: DEMAND SIDE FLEXIBILITY

KEY FINDINGS

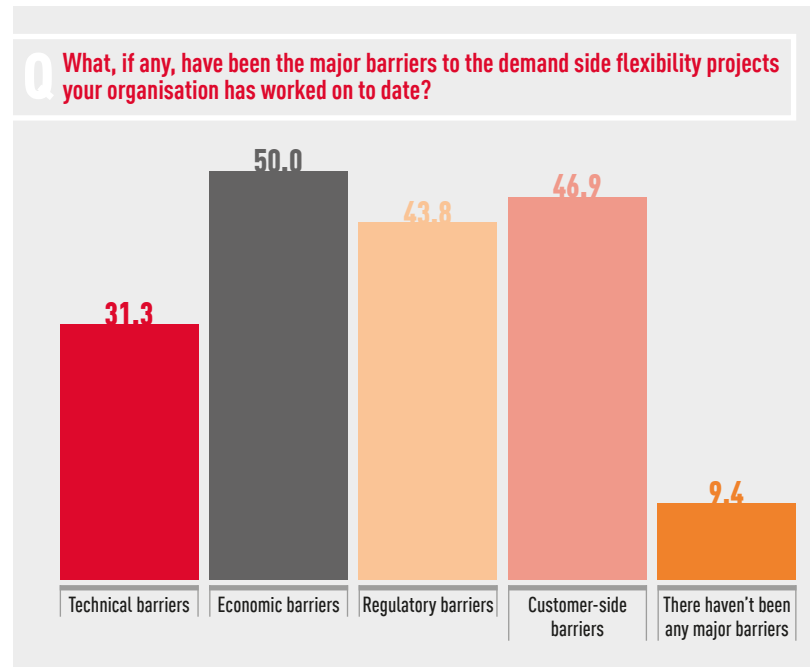
The most significant barrier to demand side flexibility is the lack of a commercial or market framework to realise its value, rated at 7.1 out of a possible 10.

While half of respondents (51 per cent) have experienced economic barriers to demand side flexibility projects, less than one third (31.3 per cent) have experienced technical barriers, suggesting that the technology is more advanced than the business case.

We asked our respondents to take a deep dive into demand side flexibility, widely seen as the most immediate of the three key planks of flexibility (demand side flexibility, grid scale storage, and interconnection). This built on our 2017 study, which focused exclusively on demand side flexibility, finding that while expectations of the market were high, numerous barriers still existed.

This year's study found that to still be the case. Only one in ten respondents had not seen any major barriers to the demand side flexibility projects their businesses have engaged in to date, almost half the level for 2017, suggesting that understanding of the challenges is growing with experience. Economic barriers were

the most common, with 50 per cent of respondents experiencing them, closely followed by customer-side barriers (46.9 per cent) and regulatory barriers (43.8 per cent). It is interesting to note that technical barriers came in significantly lower, cited by just 31.3 per cent of respondents. This suggests that the technology exists for widespread demand side flexibility – it is the business case that needs to be proven. However, it is worth noting that technical barriers were markedly higher this year than last year, when just 24 per cent of respondents had experienced them. This may be indicative of the market being further along in the implementation of demand side flexibility, and thus encountering more granular challenges on the ground.



This is supported by the answers to the next question, which asked respondents to rank the major barriers to demand side flexibility. The most significant was felt to be the lack of a commercial or market framework to realise the value of demand side flexibility, rated at 7.1 out of a possible 10. It is perhaps little surprise that aggregators and the providers of flexibility felt most strongly about this barrier, rating it at 7.4, closely followed by suppliers and traders at 7.1.

The second biggest barrier was the current inability to stack value for demand side flexibility, by combining several value streams for one activity, at 6.9 out of a possible 10. This was identified as a particular challenge by DNOs, which rated it at 7.2.

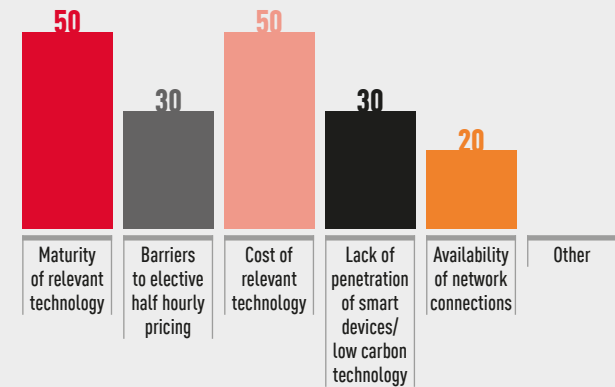
It is worth noting that while the market continues to identify a number of barriers to demand side flexibility, they are mostly scored around six out of ten, with the highest at just 7.1. The lack of a stand out barrier may suggest that while the market continues to face obstacles, none seem insurmountable.



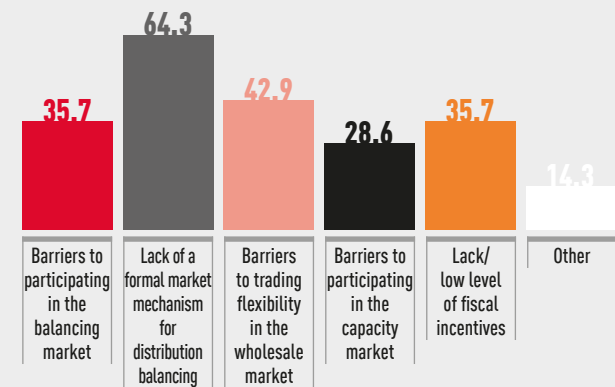
Asked to detail the type of technical and regulatory barriers they have encountered to demand side flexibility projects, half (50 per cent) of our respondents cited the maturity of relevant technology, and the cost of relevant technology. Also significant, though less so, were barriers to elective half hourly pricing, named by 30 per cent of respondents as a barrier they had encountered, and the lack of penetration of smart devices and/or low carbon technology, also named by 30 per cent.

Asked to name the regulatory barriers, more than 64 per cent of respondents cited the lack of a formal market mechanism for distribution balancing, followed by barriers to trading flexibility in the wholesale market (42.9 per cent).

Q What technical barriers to demand side flexibility projects has your organisation experienced to date?



Q What regulatory barriers to demand side flexibility projects has your organisation experienced to date?



Q To what extent are each of the following barriers to demand side flexibility in the current system?

Please indicate the extent on the scale from 1 to 10

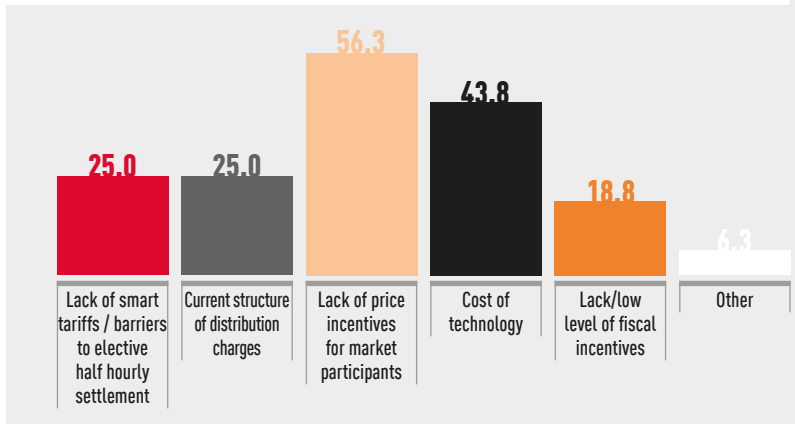
AVERAGE SCORE (OUT OF 10)	OVERALL	SYSTEM OPERATORS	GENERATORS	DNOS	SUPPLIERS & TRADERS	AGGREGATORS & FLEXIBILITY PROVIDERS
Lack of visibility of other market participants' demand side flexibility arrangements	5.8	5.7	5.4	5.8	6.4	5.8
Lack of smart metering infrastructure	6.1	4.0	6.8	5.8	7.8	5.8
Regulatory barriers in the existing market arrangements	6.3	5.0	6.0	4.8	7.0	7.4
Potential for conflicts between market participants, and lack of clarity on market rules	6.5	5.7	6.6	6.4	6.4	6.9
Policy framework	6.6	5.7	4.6	6.3	6.3	6.3
Commercial barriers in the existing market arrangements	6.6	5.7	5.6	6.2	6.5	7.3
Inability to stack value	6.9	6.7	5.2	7.2	6.4	6.9
Lack of a commercial/market framework to realise value	7.1	6.7	6.8	6.8	7.1	7.4

The most significant economic barrier to demand side flexibility was the lack of price incentives for market participants, highlighted by 56.3 per cent of respondents, and the costs of technology, highlighted by 43.8 per cent. It's interesting to note that the lack of fiscal incentives seemed less worrisome than in 2017, cited this time by 18.8 per cent of respondents, compared to 46 per cent a year earlier. This may suggest that as demand side flexibility inches towards maturity, the lack of an incentive regime is becoming less of a blocker in the eyes of the market.

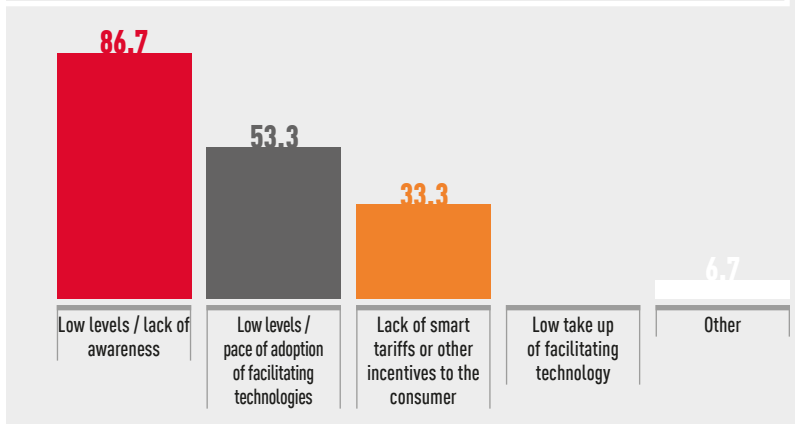
The most significant economic barrier to demand side flexibility was the lack of price incentives for market participants

The standout barrier this time round was the low level, or total lack, of customer awareness of demand side flexibility. This was cited by 86.7 per cent of respondents who had experienced customer-side barriers – an overwhelming majority. With more than half (53.3 per cent) of these respondents also citing low levels/pace of adoption of facilitating technologies as a barrier, it seems clear that educating customers and gaining their support for demand side flexibility is now the market's most pressing task.

Q What economic barriers to demand side flexibility projects has your organisation experienced to date?



Q What customer-side barriers to demand side flexibility projects has your organisation experienced to date?



RETURN ON INVESTMENT

We asked our respondents when they expected to see a return on investment (ROI) on flexibility in the power system – both for their businesses and for the UK as whole. The answers make interesting reading.

While a little under a third of respondents (31.3 per cent) already see a return on investment for their business from flexibility, and a quarter (25 per cent) expect to see ROI by 2023, more than a third say they do not expect to ever see ROI. Breaking this down by audience group, it is curious to see that more than a third (37.5 per cent) of aggregators and flexibility providers say they will never see ROI – which may lead to one question: why are they operating in the market in the first place? That being said, aggregators and providers of flexibility remain the most positive group on balance when it comes to ROI, with nearly two-thirds (62.5 per cent) already seeing an ROI.

Interestingly, DNOs are sceptical about the business case for flexibility, with just 23.1 per cent currently seeing an ROI, rising to 46.2 in total by 2023. However, the same proportion anticipate never seeing an ROI on flexibility – a result that may speak to a lack of clarity about the business case for the DSO model, or perhaps lobbying for a more generous settlement in the upcoming RII02 price control, depending on your perspective.

Indeed, pessimism about ROI seems to have grown since our first survey in 2016. At that time, 35 per cent of respondents said they were already seeing ROI on flexibility, compared to 31.3 per cent this time. Just 11 per cent said they were not sure they would ever see ROI, compared to 34.4 per cent this time. This may suggest that as businesses become more advanced with flexibility projects, the challenges of developing a viable business model are becoming clearer.

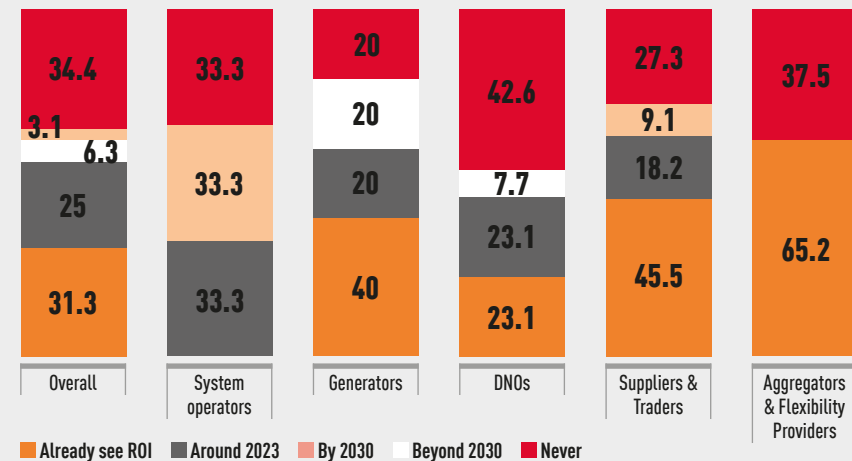
KEY FINDINGS

Opinion is divided as to when respondents will see ROI for their businesses from flexibility in the power system, with 31.3 per cent already seeing ROI, and a further 25 per cent predicting ROI by 2023. However, 34.4 per cent of respondents predict never seeing ROI for their business.

More than a third (37.5 per cent) of aggregators and flexibility providers say they will never see ROI for flexibility, begging the question of what value they see in operating in the market. However, nearly two thirds (62.5 per cent) say they already see ROI.

DNOs are sceptical about the business case for flexibility, with just 23.1 per cent currently seeing ROI, rising to 46.2 per cent by 2023. 46.2 per cent anticipate never seeing ROI on flexibility.

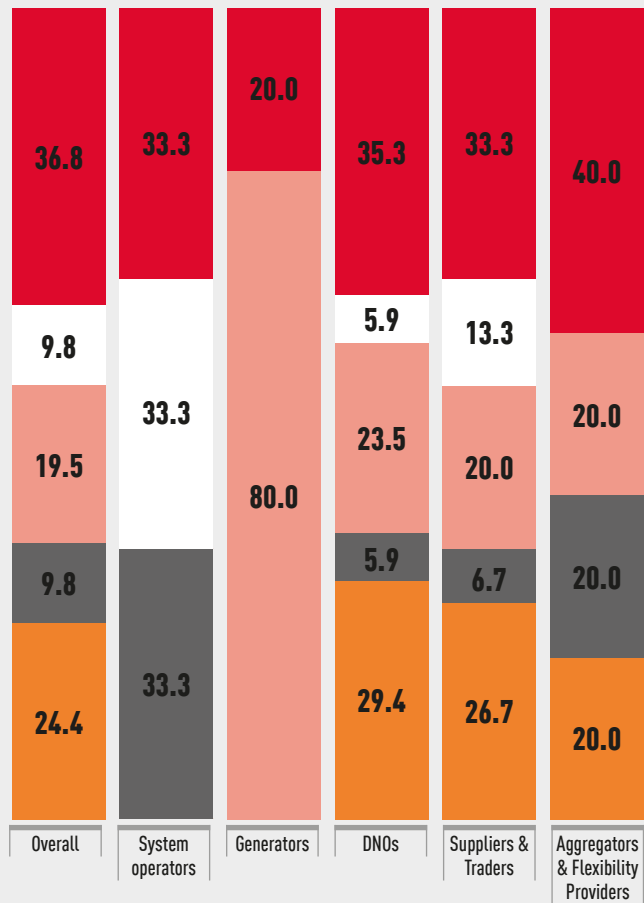
Q By when do you anticipate a return on investment for flexibility in the power system, for your organisation?



RETURN ON INVESTMENT (ROI)

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8

Q By when do you anticipate a return on investment for flexibility in the power system, for Britain as a whole?



Legend: ■ Already see ROI ■ Around 2023 ■ By 2030 ■ Beyond 2030 ■ Never

MARKET VIEWS

The current market framework is not fit for purpose. That was the clear view of energy suppliers and traders who attended Utility Week and CGI's working group.

The discussions revealed considerable frustration with the lack of a formalized market for flexibility, and with the consequent inefficiency of products operating in the existing market. As attendees noted, the current market framework was designed with two key drivers in mind – price and capacity – at a time when flexibility in the power system was not a concern.

“We know we will need to produce and consume energy more flexibly and doing this economically and efficiently will allow consumers to make significant cost savings,” said Fiona Navesey, director of wholesale electricity markets at Centrica.

“Technology is allowing consumers to use energy in new ways: managing demand intelligently and interacting with the electricity grid and flexibility markets to unlock new sources of value.

“We have to get flexibility markets operating at a local level where people can buy and sell their ability to flex their demand. We need to move on from pilots, implement the lessons learned and make flexibility markets a reality.”

According to Chris Harris, head of regulation at Npower, “currently, the array of market products available to prosumers do not fit together well and can be prone to high price volatility and sudden regulatory change.”

Network operators, too, agreed that the main barrier to the transition to

a flexible energy system is the difficulty in establishing local markets.

Although they can unlock a huge amount of value for others, the network themselves said they can access only a limited portion of this value. Whilst flexible solutions can save large amounts of money when compared to traditional reinforcements over their 40-year lifespans, the savings in any given year are relatively small.

The revenues they can offer are therefore insufficient on their own to entice potential participants to enter local flexibility markets.

Providers will need to stack these revenues on top of those from the capacity market and balancing and ancillary services, which will instead form the foundation of their business models.

CONCLUSION



Rich Hampshire
Vice President Utilities
CGI UK

This year's research is perhaps the most challenging so far. When we set out this programme with Utility Week in 2015, it was about producing some quantitative data to inform the debate about what has come to be referred to as the 'smart, flexible energy system' – oh, and of course, identify the perceived barriers to achieving that goal.

But back in 2015, this thinking was nascent. Our first piece of research was commissioned before the National Infrastructure Commission published its 'Smart Power' report and just after the Committee on Climate Change's 5th Carbon Budget identified the need to improve flexibility in the power sector.

Whilst previous years' research provided insights and helped to put some quantitative data behind what people were talking about, the results weren't surprising. However, this year's research has begun to show some contradictions, they have started to diverge from previous years and identify greater differences between the perspectives of different parts of the sector.

The most significant barriers to demand side flexibility are identified as the lack of a commercial or market framework (identified by 7.1 / 10),

closely followed by the inability to stack value (at 6.9 / 10). I might argue that the ability, or lack thereof, to stack value is an economic barrier – and economic barriers remain the highest category of barriers at 50%, of which 56.3% of respondents identified lack of price incentive as the major economic barrier. The identification of the need for a market framework is really the market identifying how to enable value stacking. Although, of course, an effective market framework has other benefits, including the ability to secure investment.

But perhaps the most telling statistic is that the number of respondents reporting not seeing barriers to their demand side flexibility projects has almost halved from 18% in 2017 to 9.4% in this year's research. This is undoubtedly reflective of the growing experience in the market. Whilst economic and



regulatory barriers remain high, they have fallen since 2017. The fact that technical and customer-side barriers have increased this year arguably supports the growing practical experience across the sector.

Customer side barriers (identified by 46.9%) are seen as a significant barrier to demand side flexibility projects, only just behind the economic barriers (50%). These customer side barriers are predominated by lack and low levels of customer awareness (identified by 86.7%).

The second rated customer-side barrier is the pace of adoption of the technologies that will deliver demand side flexibility. Even the most optimistic group, the suppliers and traders, identify connected home technologies taking a further 4.1 years to reach economic viability. It's not surprising that they are the most optimistic. They are eyeing the opportunities that flexibility provides as means of improving customer experience and retention (8.7), the basis of customer propositions (8.6), efficient management of their energy portfolio (8.0) and new business opportunities (7.8).

Just 28.6% of respondents identified participating in the capacity market as a regulatory barrier to demand side flexibility. Taken in

Perhaps the most telling statistic is that the number of respondents reporting not seeing barriers to their demand side flexibility projects has almost halved from 18% in 2017 to 9.4% in this year's research

isolation, the regulator may be patting itself on the back given all the lobbying for demand side flexibility to be treated equally within the Capacity Market. However, this needs to be considered in the context of the Capacity Market being regarded as the lowest overall driver of flexibility (scoring just 6 out of 10). This may be indicative of flexibility's value being seen as a day ahead or an intra-day measure rather than over medium term or investment timescales.

When it comes to electric vehicles, a comparison of the views of the System Operator and the DNOs with those of the suppliers and traders highlights the growing differences in opinion. Suppliers and traders foresee the economic viability of EVs and charging infrastructure being

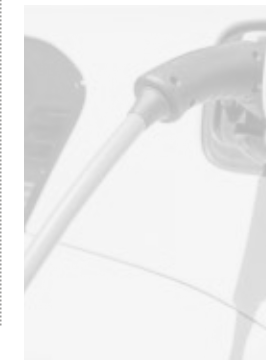
closely aligned at 3.8 and 4 years respectively. The DNOs are somewhat more pessimistic about the viability of charging infrastructure (taking 5 years), which is in contrast with their optimism about how quickly EVs will become viable at 2.6 years, and raises questions about whether a lack of charging infrastructure could slow the adoption of EVs.

So what does this tell us about the areas of focus to accelerate our transition a smart, flexible energy system?

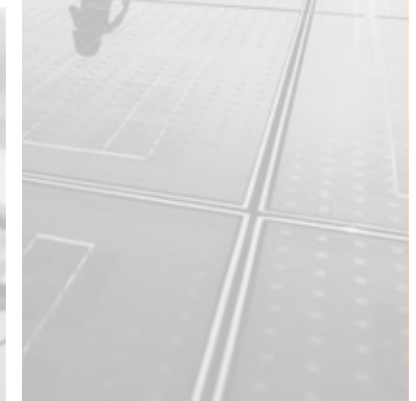
- **Raise consumers' awareness of the opportunities for them in selecting low carbon and connected home tech when choosing their next home or refurbishing their existing one.**

- **Identify the technical challenges that are emerging for the projects and address them, including getting the EV charging infrastructure in place in time to support EVs becoming mainstream.**
- **Deliver a market framework that enables value to be stacked and a market infrastructure that underpins that framework, enabling the cash to flow.**

From this year's research it remains clear that there is a tipping point around 2023 when there is a step change in the level of opportunities from flexibility. I will therefore close with the same thought as last year. If we are to get the market framework and enabling capabilities into place by 2023, then time is short.



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A person's hands are shown holding a smartphone. The screen displays a user interface for 'SMART HOME SYSTEMS' with several icons and text elements. The background is a blurred indoor setting.

CGI

Founded in 1976, CGI is one of the world's largest IT and business process services providers, helping clients transform their businesses into digital enterprises. In the Utilities sector, CGI has over 6,000 members 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. CGI leads the market in the provision of the technology that enable utility markets to operate effectively. In the UK, we designed, built and continue to operate the BSC Settlement systems for ELEXON; the data systems on behalf of the Data Communication Company (DCC) at the heart of Britain's smart metering implementation programme; and the central market system for Market Operator Services Ltd (MOSL) to support the operation of the non-household English water market. CGI is enabling network operators to make Smart Grids a reality - creating a reliable, economic, sustainable low-carbon energy infrastructure.

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