The Institution of Engineering and Technology

The Future of Distributed Flexibility (Ofgem call for evidence)

About the Institution of Engineering and Technology (IET)

The IET is one of the world's largest engineering institutions with over 158,000 members in 150 countries. We are a diverse home across engineering and technology and share knowledge to engineer solutions to global challenges like climate change. With our roots in electrical engineering, we have been championing engineering solutions and the people who deliver them for 150 years. The IET provides independent, impartial, and expert advice, spanning multiple sectors including Energy, the Built Environment, Transport, Manufacturing and Digital.

The following represents The IET's submission from the IET Energy Panel and Future Power systems Architecture (FPSA) committee.

Summary

The benefits of power system flexibility are significant and well documented and have the potential to reduce the levels of generation, transmission and distribution infrastructure needed for net-zero. Provision of these flexibility arrangements exemplifies the associated requirements for a robust digital infrastructure, and the mutual inter-dependency of power and data services. Clear ownership of the design and delivery of these systems and services is vital.

Whilst flexibility services can support transition and usefully help the timing of infrastructure installation, they should be positioned as a valuable component of the developing energy system. Advancement should not divert focus away from or compress the delivery timescales of the extensive power system infrastructure required for 2050.

Q1. What do you think distributed flexibility could contribute to the energy system?

The potential value of flexibility in responding to both the national supply demand balance and local constraints on network capacity is well studied and documented. Benefits are measured in terms of a reduction or deferral of generation investment and network infrastructure reinforcement across all voltages, along with the creation of new value propositions for businesses and customers. Flexibility measures could also be used to temporarily increase demand at times of excess renewable power production or to relieve transmission boundary constraints, and to reduce the need to curtail surplus generation or construct storage to absorb it. When distributed and therefore largely located towards the ends of the distribution network, these facilities have the potential to simultaneously, or separately respond to national, regional, or local constraints.

As well as helping with capacity constraints, flexibility measures could provide effective system services such as operating reserve, especially at times where supply margins are tight, and also frequency support in a system potentially operating with reduced dynamic inertia.

Additionally, flexibility could potentially help to reduce the despatch of higher marginal cost generation, or possibly minimise the deployment of higher carbon generation options if marginal merit took account of emissions intensity.

Whilst this flexibility will support decarbonisation its role should be appraised as just one part of a well-designed energy system. In this context it can provide some valuable intra-day supply-demand imbalance resolution and help ameliorate many widespread system constraints. Its contribution during the sustained anticyclonic periods of negligible wind and solar output experienced at UK latitudes is inevitably limited. The benefits electricity is expected to deliver to a zero-carbon world will require development of multiples of today's power generation capacity. Sufficient generation and network infrastructure therefore needs to be provided within the system, in advance, to meet the most onerous climatic and demand conditions.

Flexibility and operational services will become an enduring feature of an energy system with extensive intermittent renewable power input, and variable demand. In some situations, these can provide valuable temporary support that is subsequently overtaken by system reinforcement that needs to be identified, planned, and implemented in accordance with national and local strategic 2050 system-wide design architectures.

Regarding sources of demand flexibility, the growth in electric vehicle usage and deployment of heat pumps for space heating seem to offer the greatest widespread CER opportunities. Electric vehicle charging, and potentially 'vehicle to grid' services can provide beneficial system support, including ancillary services such as operating reserve, Demand Flexibility Services, and frequency response. These services are likely to be less deliverable by fast chargers where time is generally critical, or shared chargers with parking time restrictions. Heat pumps will also be an important CER source in a future, energy efficient system, ideally associated with enhanced building efficiency measures allowing greater heat retention. Their potential contribution to demand flexibility must be judged against the essential design requirement for the system to meet the worst planned winter climatic conditions when curtailment of heat output, or even the notion of curtailment is undesirable.

Another perspective on the contribution that flexibility can make to the energy system is that it can enable new service offerings from new sector participants, thereby creating economic opportunity and benefits. This effect may be supportive of accelerating progress in system transition if the right market and regulatory environment is present.

The impact of CER flexibility rather depends on consumers responding in an economically rational way to a market structure. This is not universally the case with existing consumer behaviour, and it is far from clear how the balance of service delivery and the response to energy flexibility would play in the long term. Smart appliances, and home energy management systems help to manage household flexibility delivery, though the costs and complexities may be beyond the reach of some vulnerable or low-income households. Indeed, in the worst situation curtailment arrangements could encourage the most vulnerable to be incentivised to manage without essential heat and hot food.

A multi-vector strategic planning process is essential to reduce duplication of cost and effort, and maximise the chances of coordinated policy, regulation, incentives, market design, local planning, standards, resources, and skills. The development and timely commissioning of the essential assets and system services including flexibility, along with linkages to related digital, water, transport, food, and industry activities must be directed by an effective strategic system architect function.

Multi-vector considerations include potential arbitrage opportunities where a wind or solar power generator may choose between supplying the grid, storing output, or producing green hydrogen. Similarly, cogeneration might be configured to prioritise electricity, heat or cooling output depending on immediate needs and market conditions.

The primary challenge is the delivery of efficient and resilient, zero-carbon consumer services by an electricity system of at least twice today's capacity. Whilst clearly important, the pursuit of flexibility must support, but not divert attention away from or compress the delivery timescales of the vital infrastructure required by 2050.

Q2. Will a focus on CER flexibility also help enable other forms of flexibility, especially distributed flexibility?

The consultation document makes clear the fundamental differences between CER and DER. Whereas DER is built and operated to provide the services the system needs, CER is only a secondary consideration applied to the primary role of home heating, industrial production, commercial service delivery or family transport, and therefore offers less dependable functionality. This will be reflected in how they each engage with flexibility. Investors in DER need some certainty that their assets will not be stranded, and it is therefore possible that the often-anticipated levels of CER response could compete with and therefore deter DER investment.

A non-technical, but important benefit of CER is its potential to encourage wider consumer engagement in future energy system developments. The level of media coverage and extent of consumer interest in demand reduction trials for example suggests that CER could help to win hearts and minds in a way that pure policy measures may not.

It is also important to consider the level of certainty of availability a system operator can rely upon to ensure that it can always fully and safely deliver power and meet its licence operating obligations without recourse to asset reinforcement. A level of automation removing the need for CER customers to actively engage whilst allowing smart systems to act on their behalf would likely prevail, but the differing drivers of CER and DER flexibility provision make the question of reliance quite challenging to answer.

It could be that the earlier introduction of DER (i.e., industrial and customers as providers of flexibility) would allow mechanisms to be put in place that would provide learning, risk mitigation, and reduce risks being placed on domestic customers. The subsequent extension of a DER implementation to include CER is then a matter of scale and not more risky complexity.

Q3. Is there a 'case for change' and a need for a common vision for distributed flexibility?

It is likely that a 'case for change' and shared vision would be helpful drivers if the pace of required change is seen to be important. Such a vision would need to encompass the many forms of distributed flexibility, which is a requirement some believe to be unrealistic. An approach that overcomes currently reported inconsistencies between network operator performance requirements would seem to be an important contributor to the 'case for change'.

The fundamental common vision requirement is the development of a clear market structure and incentives for operators, be they owners of CER or DER, to drive the delivery of flexibility services and be remunerated accordingly. These would also be supportive of the development of innovation in service offerings and lower barriers for participants, both existing and new. This could include cross-sector opportunities for service innovation.

Related to this vision, a common framework would make it easier to assess whether the flexibility infrastructure was sufficiently reliable to be used without undermining the security of supply provided to customers.

Q4. What is your vision for how to accelerate the delivery of accessible, coordinated, and trusted markets for distributed flexibility?

The principal driver of an accelerated outcome would be the establishment of an entity with the mandate to act and the accountability for delivery. It seems likely that the FSO could undertake this role, in association with the DSOs, though this may present a conflict of interest given the FSO's role in flexible services procurement, so requiring care in the definition and implementation of the various functions to be delivered.

Within the vision of trusted markets, it is essential that the buyers of flexibility have clarity about the extent to which they can rely on its availability in discharging their licence obligations to run a safe, efficient system. Liabilities and related regulatory performance penalties need to be clear if for example a shortfall in availability perhaps during severe weather conditions, causes power outages or equipment overload. A similar concern is raised in relation to the risk of communications failure.

Q5. Will certainty of an end vision help accelerate enabling work and make it cohesive?

The development of a coherent strategic energy system architecture for 2050 is essential for all aspects of transition, along with a methodology for the incorporation of ongoing innovation and understanding as transition progresses. Such a plan provides a foundation for local planning, regulation, incentives, skills development, standards and the anticipated role and scale of flexibility measures, along with appropriate market structures.

Care though needs to be taken in referring to "certainty of an end vision" for flexibility services, and the implication that a precise solution can be defined in an area where the energy system is changing. It seems then appropriate to plan an architecture for realisation of the aims, providing structure and coherence whilst allowing for ongoing evolution.

An action plan related to the vision objectives should include delivery targets and accountability, with a strong structure and suitable resource to ensure delivery at the pace needed.

Q6. When should a common digital energy infrastructure be in place? And therefore, when should development begin?

If an early role of flexibility is to stall to enable other system developments like network reinforcement, then the infrastructure should be in place as soon as possible. This should not imply that the infrastructure is approached as a monolithic implementation, but that early capability could be established and progressively developed. This implies the need for prompt decisions about ownership, governance, resources etc.

Q7. What should a common digital energy infrastructure look like, and why? Please consider the archetypes or develop your own proposition.

The archetypes helpfully describe realistic approaches to addressing the question of digitally enabled flexibility. They may not be discrete. It is possible to imagine a pathway that, in order to make important early progress could begin with the BAU case enhanced by the definition of good practice and process. This then expands to the 'Thin' case, so providing visibility, continuing over time to the

'Medium' case and the opportunity to allow the exchange of flexibility services should they not be required on specific occasions and able to be released for application elsewhere. This could help a prompt start and provide learning through evolution and evaluation as experience is acquired.

Whilst all the enablers are important, communications connectivity must be highlighted as central to the delivery of this functionality. The reciprocal dependency between electricity supply and digital infrastructure means that if one fails the other fails. The resilience of the platform is of paramount importance where system operation depends on the application of flexibility services.

It is not clear how any of the archetypes accommodate circumstances in which flexibility does not operate, or more specifically, what reserve mechanisms would be in place to assure system operational integrity in the event of a failure of the operating environment.

Q8. What is your view on the desirability and feasibility of the archetypes or your own alternative proposition?

As noted in the response to Question 7 above, it is possible to envisage a pathway that migrates albeit with many challenges, from BAU to enhanced BAU to the 'Thin' case, and then on to the 'Medium' case. It is too early to consider a migration pathway to a potential 'Thick' case. This should be deferred until experience is gained with the 'Medium' case and the opportunities for extensive optimisation, perhaps incorporating aspects of artificial intelligence can be safely implemented.

The response to this question is influenced by the current difficulties experienced whilst managing megawatt levels of DER and extrapolating to a system operating with kilowatt levels of CER. The deliverability ambition needs to be tempered by consideration of the real-life challenges posed by the complex and legacy systems employed and an understanding of the trade-offs between scale and simplicity. CER will require greater scale (measured in terms of numbers of parties) and greater simplicity (on the basis that the parties involved may not be as sophisticated or familiar in their operations as those for DER).

Q9. Should a common digital energy infrastructure be new-build, or should it build-out from existing infrastructure?

Whilst theoretically this could be a new build, it is not a greenfield application, so in practical terms a total reliance on a new build is likely to be impossible when dealing with a live 24x7 market environment needing continuous support, certainty, and stability.

It is though reasonable to anticipate the inclusion of both existing and new build components installed as part of the desired architecture framework. The architecture acts as a reference for the subsequent iteration and integration of new modules, and the retirement of existing elements.

In theory, whilst the architecture needs to be owned and governed by the central body, it may be possible for the associated central infrastructure to be separately owned. The complexities and inefficiencies of separate ownership may introduce additional risks requiring management.

Q10. What are the important areas for consideration when designing institutional delivery models for a common digital energy infrastructure?

The delivery model needs to allow the current systems to continue in operation with services delivered in a prompt and user-friendly way. It should not be seen as a technical solution, but respond to operations, processes, and user needs. Robustness and simplicity should be more important than complexity, allowing future users to engage.

The infrastructure must be also able to rapidly adapt as the market changes - a challenge not to be simplified as being 'future proof'. To enable this the development process should adopt a "product management" approach with an architecture framework to guide its evolution and to support a disciplined response to changing needs, requirements, and priorities. This needs to be assisted by

engagement with stakeholders to ensure that the direction of travel is aligned with need, and that the best advantage is being taken of new technologies, methods etc.

The architecture needs to be centrally owned and governed. Contributions from others, including modules, tools etc. could be possible, but with rigorous integration methods maintained. Quality assurance and accountability should rest with those charged with delivery. Due account should be taken of developments in other areas of critical national infrastructure digitalisation to ensure the incorporation of best practice with regard to resilience and cyber security.

The governance model needs to be, and acknowledged as open, transparent and fair. It should be technically, operationally, and commercially strong and empowered to make decisions in a robust and timely way. Vested interests and 'digital gaming' effects must be avoided.

Q11.What are the important areas for consideration when designing financial delivery models for a common digital energy infrastructure?

A fit-for-purpose system is required, at an affordable cost potentially paid for by the market players, as the systems are now, and delivered by or for the FSO.

It may be possible for third parties to offer enhancement modules or functionality, but the guiding principles must be transparency and system development for the common good.