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Enabling the DSO transition - a consultation on the ESO's approach to Distribution System Operation - a response by The Institution of Engineering and Technology

About the IET

We are the Institution of Engineering and Technology (IET), and one of the world's largest engineering institutions with over 168,000 members in 150 countries. Our aim is to inspire, inform and influence the global engineering community to engineer a better world. 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 Institution of Engineering and Technology (IET) provides independent, impartial, and expert advice, spanning multiple sectors including Energy, the Built Environment, Transport, Manufacturing and Digital.

On behalf of the profession, the IET strives to inform and influence government on a wide range of engineering and technological issues. The organisation's membership spans a broad range of professional knowledge, and regularly offers unbiased, independent, evidence-based advice to policymakers via several channels. We believe that professional guidance, especially in highly technological areas, is critical to good policymaking.

The IET welcomes the opportunity to comment on the Energy System Operator (ESO) consultation and to provide feedback on the ESO's principles and vision in enabling the Distribution System Operator (DSO) transition.

Enabling the DSO transition - a consultation on the ESO's approach to Distribution System Operation

This is an opportunity for a more coordinated approach to the development of the whole electricity system through joined-up thinking and application of systems engineering principles. The IET Energy Policy Panel has been a longstanding advocate of the need for a whole energy system approach, including through its work in collaboration with the Energy Systems Catapult on the Future Power Systems Architecture (FPSA) programme, and in its communications with Ofgem and Government (BEIS) generally. We believe that promoting understanding of the critical interdependencies between systems, technologies, stakeholders, and customers is essential to the DSO transition and the ultimate transition to a whole energy system approach that will enable Net Zero.

We have studied the consultation and considered the specific questions raised i.e.

1. The ESO's principles to enable the DSO transition.

- Do you support our proposed principles and approach to the DSO transition?

2. Our proposed 2025 vision

- Do you agree with our proposed high-level vision?
- Do you have any comments on our proposed high-level vision?
- Do you believe that there are any further co-ordinating functions between ESO and DSO that we should be considering?
- Do you have any comments on the draft vision for each of the 10 co-ordinating functions as described in Annex 1?
- What additional activities do you believe the ESO needs to undertake to facilitate our 2025 vision?

3. Proposed next steps

- Do you support our proposed next steps?
- Is there anything more you believe we should be doing to facilitate the DSO transition?

In general, we support ESO's principles, vision, and next steps, but with some degree of qualification. Rather than address the above questions individually, we have set out a range of challenges and opportunities which we feel ESO should take into consideration in order to maximise the effectiveness of the DSO transition and ongoing ESO-DSO coordination. ***In particular, we feel that a truly 'whole (electricity) system' approach requires a broader perspective than is promoted in the consultation***, i.e. recognising the wider role of different parties accessing DERs, behind the (boundary) meter assets, and flexibility services in optimising the end-to-end electricity system across the timescales of investment planning, operational planning and real-time.

In addition to conventional parties and market players (including generators, energy storage operators, wholesalers, retailers, aggregators, VPPs, ESO and DSOs) ***it should be expected that parties such as community energy enterprises (physical or virtual), energy hubs and individual customers (enabled by technology) will have an increasing influence on physical energy flows across distribution, and ultimately transmission networks***. In the medium to longer term, electrification of transport and heat decarbonisation will require inter-vector coordination in the form of both supply and demand-side arbitrage to achieve efficient management of the wider energy system. It follows that 'next steps' should support arrangements that are future-proofed insofar as they allow for further evolution and transition (considering for example the possible emergence of a future energy system operator).

Relevant Inputs and Considerations

Each of Britain's DNOs have set out their strategies and/or development plans for DNO-DSO transition in the form of reports and/or consultation documents[1]. They have also each published their Distribution Future Energy Scenarios (DFES) – some as interactive documents facilitating stakeholder engagement and interaction. FESs enable stakeholders to identify the network impacts of additional generation and demand; where capacity headroom or constraints are anticipated; and where opportunities might exist to provide flexibility services.

The ESO consultation references Ofgem's RIIO-ED2 Sector Specific Methodology documentation which (in the context of Ofgem's baseline expectations) identifies three broad roles for a DSO: Planning and Network Development; Network Operation; and Market Development. However, in August 2019, following extensive industry involvement, Ofgem more helpfully set out a position paper identifying 19 high-level functions which characterise DSO functionality across three broad categories: Long Term Planning; Operations, Real Time Process and Planning; and Markets & Settlement[2].

[1] UKPN - https://smartgrid.ukpowernetworks.co.uk/wp-content/uploads/2019/11/FutureSmart-Consultation-Report.pdf

WPD - file:///C:/Users/David/Downloads/Western%20Power%20Distribution%20-%202020%20version%20(1).pdf

ENWL - https://www.enwl.co.uk/globalassets/go-net-zero/dso/dso-consultation-documents/dso-strategy-2021.pdf

SPEN - https://www.spenergynetworks.co.uk/userfiles/file/SPEN_ED2_DSO_Strategy_Report_June_2020.pdf

NPG - https://www.northernpowergrid.com/asset/0/document/5139.pdf

SSEN - https://ssen-transition.com/dso/ssen-dso-strategy/

[2] Ofgem Position Paper on Distribution System Operation
https://www.ofgem.gov.uk/system/files/docs/2019/08/position_paper_on_distribution_system_operation.pdf

These 'DSO' Functions have similarities to the 35 (whole electricity system) Functions identified by the Future System Architecture Programme FPSA2 report in 2016[3].
Ofgem's position paper also sets out four strategic outcomes from their proposed DSO reforms:

- Clear boundaries and effective conflict mitigation between monopolies and markets.
- Effective competition for balancing and ancillary services, and other markets.
- Neutral tendering of network management and reinforcement requirements, with a level playing field between traditional and alternative solutions.
- Strongly embedded whole electricity system outcomes.

Whilst each DSO strategy provides an appropriate emphasis to regional challenges, a number of generally common themes emerge including:

- IT Architecture - Data and Digitalisation
- Decarbonisation and LCT Enablement (in particular electrification of transport)
- Neutral Market Facilitation
- DER and Management Systems (DERMS)
- Management of New Connections
- Demand (and Generation) Flexibility
- Enhanced Network Visibility
- Active Network Management and Advanced Distribution Management Systems (ADMS)
- Customer Service and Unlocking Customer Value
- Whole (Electricity) System Optimisation
- Enabling Net Zero

Taken together, these reports, consultations and position papers provide a rich backdrop to inform strategies aimed at preparing for what will necessarily be an evolving landscape for DSO transition.

Whole System

Frequent reference is made in the consultation to 'whole system(s)'. However, the focus appears primarily constrained to Transmission and Distribution system planning and operation. In particular, whilst there is extensive reference to 'flexibility' and distributed energy resources (DER) including 'beyond the boundary meter' assets, ***there is little consideration in the consultation as to the important role that flexibility from DERs will play in terms of the wider electricity (and ultimately whole energy) system.***

Whilst DSOs will naturally look to DERs and flexibility to help relieve distribution network constraints (through the now standardised ENA flexibility services agreement) National Grid ESO will recognise the role that DERs (including assets beyond the boundary meter) are expected to increasingly play in system balancing[4], the capacity market, and in providing ancillary services – including STOR, frequency response, generation constraint relief[5], reactive power, and black start services.

[3] FPSA 2 Report - https://esc-non-prod.s3.eu-west-2.amazonaws.com/2018/10/FPSA-Main-Report.pdf

[4] Including balancing mechanism wider access provisions and BSC P375 modification https://www.ofgem.gov.uk/system/files/docs/2021/02/p375_final_authority_decision.pdf

[5] Including for example through shifting demand supplied by distribution networks to relieve transmission boundary constraints – ref. 4D Heat project https://www.theade.co.uk/news/policy-and-regulation/4d-heat-project-could-provide-substantial-savings-to-electricity-consumers

Meanwhile, Suppliers and Aggregators are now recognising the role of flexibility in reducing commercial imbalance risk and in mitigating the impact of (increasing) wholesale price volatility. This will become increasingly important as conventional dispatchable generation is displaced by weather-dependent renewables, even allowing for the mitigating effect of energy storage.

Moreover, in the near future (certainly within the RIIO-ED2 period) it can be expected that the conclusion of the smart meter rollout programme and the introduction of mandatory half-hourly settlement will result in suppliers offering a range of Time of use (ToU) and dynamic (e.g. day-ahead pricing) tariffs, encouraging domestic and SME customers to take advantage of demand flexibility by avoiding high-price periods – noting that under half-hourly settlement, both use of system and energy prices will be more cost-reflective, encouraging customers to avoid distribution 'red-band' periods, and aligning demand more closely with periods of relatively high output from intermittent renewable energy sources.

This will significantly impact inter-day and intraday demand profiles and will be particularly pertinent to the manner in which customers in the future manage the charging regimes for their electric vehicles and, potentially, electric home space and water heating.

Aside from the above, there is increasing interest in the concept of community energy enterprises (both physical and virtual) which in the future can be expected to look to optimise community import and export profiles (including through embedded energy storage and peer-to-peer trading), to minimise overall community energy costs and maximise revenues from provided services. EV charging hubs will also look to optimise their energy costs through smart charging, and in some cases through co-located electrical energy storage (which might also reduce their network connection costs by mitigating their peak demand intake).

It follows from all the above that DERs and flexibility services need to be considered, not simply from a transmission and distribution perspective, but from a truly whole electricity system perspective. System parties will increasingly deploy DERs and flexibility to: protect their commercial positions and exposure to wholesale price spikes; reduce overall energy import costs and/or maximise export revenues; and exploit opportunities for revenue stacking from providing balancing and ancillary services. ***Fully exploiting DERs and flexibility in this way will give rise to potential synergies, which need to be recognised in order to avoid unnecessary duplication of procurement and also avoid potential conflicts.***

Conflicts can arise where the management of export or import profiles to optimise one part of the system, gives rise to higher costs of managing a different part of the system. An example might be an action to reduce a generation constraint by forward-shifting demand which in turn results in a local network constraint that incurs mitigation costs. With reference to the ESO's principles to enable the DSO transition (slide 05 of the consultation), and the 2025 vision (slide 06-09) it follows that in order to fully enable enhanced outcomes for consumers, ***actions to improve coordination across markets will need to extend beyond ESO-DSO system operations and network development processes***.

In the medium to longer term, particularly in the context of heat decarbonisation, the focus will increasingly shift towards the whole energy system – i.e. a multi-vector energy system, including transport and telecommunications as interdependent vectors. A multi-energy vector approach will offer opportunities for both supply and demand side arbitrage. Examples include cogeneration (especially if a heat store is available); electrolysers powered by surplus wind generation output; and hybrid electric/gas heating systems.

Current regulatory and licence boundaries preclude a multi-vector DSO function (i.e. planning and operating both electricity and gas - and possibly heat - networks). ***However, the delivery of whole energy network efficiencies and the achievement of Net Zero objectives, will ultimately require a whole energy system approach***. It follows that in developing a longer-term DNO-DSO transition strategy, ***consideration needs to be given to future-proofing arrangements,*** to facilitate further progression towards a whole-energy system planning and operating regime, including attention to regulatory and licence remits.

Innovation

It is surprising to see only two references to innovation in the consultation (under ESO Principles - slide 05, and under System Development - slide 15). The DNO-DSO transition is highly dependent on both technological and commercial innovation. Innovation (largely funded through regulatory and other innovation funding) has delivered a wide range of proven solutions to emerging network challenges. These include management of voltage rise and harmonic distortion (due to rooftop solar PV penetration) on LV networks, correction of LV network phase load imbalance, and soft-meshing of LV networks to release capacity headroom.

At higher voltages, innovations include dynamic plant ratings, soft power bridges and power electronics quadrature boosters to improve circuit load sharing, fault current limiters to address the impact of embedded synchronous and induction generators on prospective short circuit currents, and active generator curtailment to reduce connection costs and queues for onshore wind and solar PV farms.

These issues have increasing importance as challenges such as system resilience, thermal constraints, voltage regulation and protection stability (e.g. due to reverse power flows extending to higher voltage systems) are becoming more prevalent, requiring real-time (automated and/or autonomous) interventions through Advanced Distribution Management Systems (ADMS) and Distributed Energy Resource Management Systems (DERMS).

Examples can be noted of innovation that looks across the transmission and distribution boundary, e.g.

- The Power Potential project (ESO and UKPN) in SE England is a good example of this, where high levels of weather-dependent generation and a concentration of interconnectors require data exchanges across investment and operational planning timescales and in real-time, to ensure robust contingency planning and enable constraints on generation export to be minimised by managing reactive and real power flows
- CLASS (ENWL) which uses conventional distribution assets (primary substation transformers and tap-changers) to provide a range of ESO ancillary services including frequency response, demand reduction (or boost), and reactive power absorption to address high overnight transmission system voltages
- 4D Heat (SSEN) which has investigated the potential for relieving a transmission boundary constraint to generation export by shifting demand on the distribution system to align demand import and wind generation export profiles more closely, and
- Distributed ReStart (ESO and SPEN) which is exploring the potential for a black-start to be initiated from the distribution system (i.e. bottom-up rather than top-down).

These are just a few examples of innovative approaches which are fundamental both to the DNO-DSO transition and to ESO/DSO coordination. There is already a high level of collaboration and information sharing between DNOs and with the ESO, largely as a consequence of the innovation funding mechanisms. ***In terms of next steps, what is now needed to ensure a timely DNO-DSO transition is a commitment to fast-tracking many of the proven innovations to establish them as BAU solutions.***

Long-term Energy Scenarios

The consultation (slide 13) anticipates that ESO's Future Energy Scenarios (FES) will remain a separate activity to DFES with its own documents - albeit there would be a clearer process for information exchange with (and logically between) DSOs to inform both (ESO) FES and DFESs.

We agree that DFESs should provide more detailed insights about regional needs than might reasonably be provided by a single national publication. We note that the ESO team would account for DSO insights and utilise them in the development of future (ESO) FES, as well as providing further valued industry insights. Whilst we agree this would result in the development of more 'joined-up' scenarios, ***it is concerning that the consultation stops short of suggesting full reconciliation between DFES and ESO (FES) outputs.***

We acknowledge that this wouldn't always be a straightforward exercise, but it nevertheless creates a risk that any unresolved inconsistencies would compromise the integrity of one or other of the FES documents leading to suboptimal coordination. Unresolved differences or inconsistencies between the ESO and DSOs regarding (national and regional) future energy scenarios would also inevitably lead to compromises in terms of the quality of coordination of regional development programmes.

We would urge that the ESO and DSOs continue to evolve systems and processes that minimise inconsistencies, including applying sensitivity analyses to better understand the potential impact of any unresolved differences.

System Development

We note the proposal for processes for Network Options Assessment (NOA) and distribution equivalents (DNOA) with co-ordination mechanisms and increased data sharing (slides 14 and 15). We agree the need for coordinated transmission and distribution system development, identifying the most cost-effective solutions for resolving both transmission and distribution needs. The increased penetration of distributed generation at all distribution voltage levels, combined with the increasing contribution from transmission connected self-dispatching generation, is blurring the distinction between transmission and distribution systems. Two-way distribution system power flows, extending in some cases to reverse power (and reactive) flows from distribution to transmission networks, increases the need for coordinated system design and development.

We note and agree with the observation that this should lead to the development of co-ordinated markets for flexibility services (slide 13). We also note the observation that DER service providers would use ESO and DSO publications like the NOA and NDPs, to identify commercial opportunities for solutions to transmission system needs, whether using their existing or new assets connected to the distribution network (slide 14).

No mention is made of DSO's published constraint managed zones (CMZs) which identify DNOs' priorities for flexibility services, or the now standardised ENA flexibility services agreement which should simplify the tendering process for prospective flexibility providers.

We are aware that the ENA Open Networks project has considered options for coordination of ESO and DSO requests for flexibility services.

Service Procurement and Dispatch

We agree with the observation (slide 20) that by 2025 local DSO markets for voltage control, thermal rating management and restoration may exist in all Grid Supply Point (GSP) groups. Indeed, DNOs are currently procuring up to four distinct flexibility services: Secure, Sustain, Dynamic and Restore[6] and for 2021 have issued tenders for 2.9GW of flexible capacity, of which 1.3GW had been contracted to date (as at February 2021).

However, we again note that the perspective offered by the consultation is limited to ESO and DSO requirements and opportunities for flexibility; with apparently little consideration of how other parties might be looking to exploit flexibility and in some cases may place a higher market value on flexibility services.

It follows that the availability of flexibility services to ESO and DSOs might be limited. Indeed, it is not clear at this stage whether DNOs will succeed in securing their total 2021 flexibility requirements. We also observe in this context that, at the current time, the ESO's requirements for Dynamic Containment (post event frequency response) have not yet been fulfilled.

This raises a further question as to the ultimate scope for ancillary services provision from DERs. Moreover, a significant contribution to DNO flexibility services is currently diesel standby generation, ***and the question must be raised as to whether this source of flexibility is sustainable in the longer term from a Net Zero perspective***; particularly when used for pre-fault services such as Secure and Sustain (where inevitably utilisation levels compared with post-fault services are relatively high).

In terms of coordinated dispatch, we agree that co-ordination between DSOs and ESO will be essential (slide 24) but we would reiterate our comment under '***whole system***' that fully exploiting DERs and flexibility (including by parties other than ESO and DSOs), will give rise to potential synergies (which need to be recognised in order to avoid unnecessary duplication of procurement). There are also potential conflicts whereby manipulating export or import profiles to optimise one part of the system gives rise to higher costs of managing a different part of the system.

We note the suggestion that automated systems may be in place to manage these conflicts (between ESO and DSO requirements) but unless, and until all markets for flexibility are coordinated (or have some form of hierarchical structure), there will remain a risk of conflicting dispatch actions leading to the possibility of one service negating another, and/or over-procurement through multiple parties contracting for services which are likely to overlap in terms of dispatch periods.

Customer Connections and Network Access Planning

Slide 22 notes that a review may have commenced to consider how the signals from network charges and electricity markets (wholesale, ancillary services, capacity market and balancing mechanism) can complement one another.

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[6] Secure and Sustain are pre-fault services and will generally require availability only over specified weekday evening peak demand periods (though for industrial and/or summer peaking networks the period might include working day hours). Dynamic is a 'post-fault' service and will generally apply only during summer-time maintenance periods. 'Restore' is also a post-fault service but applicable all year round to deal with unusual fault conditions such as (unplanned) second-circuit outages.

This review could inform further work to potentially align network charging methodologies (DUoS and TNUoS). The consultation suggests that revenues associated with DSO costs could have grown significantly, and that the review may also consider the need for more mature mechanisms for charging of these costs.

We agree that more mature mechanisms are required, and we would observe that the potential for a proposed new connection to provide useful flexibility services should be considered as part of the evaluation of access charges (Connection, DUoS, TNUoS and BSUoS as appropriate), so that opportunities are identified from the outset.

However, it also follows that the value of flexibility services is likely to be influenced by these charges and hence this might impact the availability and/or price of services for DSOs. Ofgem's current SCR into Network Access and Forward-Looking Charges will be relevant here, as will the extent to which moving to a 'shallower' connection charging regime, with the possibility of locational DUoS charging, might impact customer attitudes towards siting of DERs and agreement to flexible connection arrangements.

Codes and Frameworks

The consultation makes valid observations on the need for consolidated and standardised ways of working between the ESO and DSOs. We note the suggestion that combining the Grid Code and Distribution Code into a 'whole system' technical network code could help clarify arrangements, ensure standardisation, aid visibility and 'control' of DER, and provide clearer rules for relevant parties.

Reference is made to the Energy Codes Review and the need to align with its conclusions. ***Whilst we see some logic to these proposals, we believe a more fundamental review of industry code governance is called for***. In particular the creation of a more inclusive and agile framework which is able to take a truly 'whole system' perspective in both preparing for, and responding quickly to, emerging challenges and opportunities. The Future Power System Architecture programme has considered this requirement and a summary of its conclusions can be found in its phase 3 report – 'Fast Track to Britain's Future Power System'[7]

Operational Liaison – Incident Planning and Management

We agree (slide 26) that improved operational liaison will be necessary in both investment planning and operational timescales, and also in real time, and not only following system events. By way of an example, UKPN's KASM (Kent Active System Management) project delivered enhanced visibility and analysis capabilities to control room operators, and outage planners regarding power flows on the 400kV and associated 132kV networks in the Kent area.

This part of the system (which is operated as an interconnected 400-132kV system) is characterised by very high levels of weather-dependent distributed generation and a concentration of interconnectors, resulting in inter and intraday variations in power flows on both the transmission and distribution system. One of the key deliverables of the project was an ICCP link[8] which provides real-time measuring data between NG's and UKPN's control centres.

[7] https://es.catapult.org.uk/news/fast-track-to-britains-future-power-system-2/

[8] ICCP is a real-time data exchange inter-control centre protocol.

Data provided through the ICCP link limits the need for generation constraints and informs contingency planning in respect of potential unplanned outages. The ICCP link is now being used in the Power Potential project (referred to above under 'innovation'). It is reasonable to expect that the enhanced operational liaison capability established through the KASM project will provide a sound basis for future implementation across all DSO control centres.

In terms of ESO-DSO liaison following and during system events, whilst this is an established discipline, events such as on 9 August 2019 (and the 'near miss' event on 11 March 2021) suggest that post-event operational liaison will become increasingly important, as will coordination of actions to mitigate reduced levels of inertia and system stability.

Recent volatility in day-ahead auction prices and more frequent issues of Electricity Margin Notices (EMNs) can be considered leading indicators of future operational challenges, as synchronous generation continues to be displaced by inverter-coupled weather-dependent generation (and/or DFIGs on distribution networks). Provision of frequency response services (including Frequency Regulation, Moderation and Dynamic Containment) will become a priority for DER based services, and in particular services derived from electrical energy storage.

It follows that liaison over procurement and dispatch of services from battery energy storage must be carefully coordinated in order to avoid batteries becoming depleted at critical times. Meanwhile, whilst DNOs are proactively promoting the 'accelerated loss of mains change (protection modification) programme' to relevant embedded generators, progress has been slower than had been hoped for despite financial inducements. ***There may therefore be some delay before the programme is completed; perpetuating the risk of Fault Ride Through (FRT) failure, resulting in DG tripping in the event of frequency and voltage disturbances.***

In the (still unlikely) event that a total or wide-area system shutdown should occur, then operational liaison capability will be severely tested. ***The current ESO/SPEN Distributed ReStart project must therefore be considered a high priority, and it will be important that any identified uncertainties, in terms of a distributed restart capability, are rigorously pursued***.

It should also be anticipated that the project will deliver valuable learning in terms of day-to-day coordination in the operation of both the transmission and distribution systems. It will be important to take full advantage of this opportunity.

The IET *Net Zero Energy Systems group* would be delighted to engage further on this consultation, and the broader energy system transition;

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