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Reactive power market design – DER, blockers and routes to market

Report to National Grid ESO

MARCH 2022

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Agenda

Agenda

SUMMARY

Key messages

There is **additional reactive capability** embedded in the distribution networks that could help to resolve **transmission level** voltage issues

DSOs must manage their **own system voltages** and keep them **within safe limits**, but DSOs have **fewer tools** to manage voltages than the ESO

Voltages at the distribution network level are primarily managed through **tap changing** and distribution networks tend to run at the higher end of the voltage range to minimise losses which can have **adverse effects on the transmission network**

Potential providers at the distribution level can be exposed to **increased costs** due to their behaviour with respect to reactive power, at best **disincentivising service provision** and at worst creating a **value passthrough** from ESO to DSO for services

Due to legacy behaviour and rules around reactive power for providers in the distribution network, it is unclear how much reactive can be **transferred to the transmission network effectively**

SUMMARY

Key recommendations

Additional capability from the distribution network **should be facilitated** if **practical/cost effective** to do so

Where there are issues of **conflict** between the distribution network and transmission network, **DSO instructions** should take **primacy** due to there being **fewer tools** available to DSOs to manage local system issues than available for ESO

Historically, losses were a **financial incentive** under the DSO RIIO framework, but this is now moving to a reputational incentive – DSO network outcomes should be **monitored** to ensure that behaviour is not causing **net-adverse effects on consumers** due to offloading reactive issues to the transmission network

Distribution charging arrangements for reactive should be **reviewed**, and where appropriate, providers' **exposure** to these costs when providing reactive services **should be revised/removed**

DSOs will need to **re-run network studies** to understand **limitations**, and potentially **modify connection agreements** to allow providers on the distribution network to provide reactive power services

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CONTEXT

System security and uncertain future economics are driving the case for change in the provision of reactive power services

Tools obliged to provide reactive power are disappearing	*Retiral of old plant providing services under the ORPS arrangements, in particular coal and in the future gas and nuclear*
Shifting economics of different technologies means new generators are not replacing 'like-for-like'	*Rapid increases in embedded generation and a shift towards intermittent technologies with complex characteristics and commercial arrangements potentially not bound by traditional arrangements and/or located far from system needs*
Demand for reactive power services to manage voltage is increasing	*Changes to network topology, offtake at GSP to DSO networks (due to embedded generation) and consumer behaviour are changing the need for reactive power to manage voltages*
Spend on reactive power is increasing	*Accessing providers is becoming increasingly expensive as traditional ORPS providers are being driven 'out of merit' by new technologies, which require synchronisation to provide access to capabilities*
No enduring arrangements to drive technical innovation	*No route to market for some solutions or insufficient economic incentives to stimulate innovation*

System security could be threatened without action

New reactive power providers will need to emerge to ensure voltage performance in the future.

In practice ESO and TO arrangements are relatively robust, current arrangements can theoretically facilitate the transition (e.g. building grid assets) but there is potential to increase efficiency in service provision.

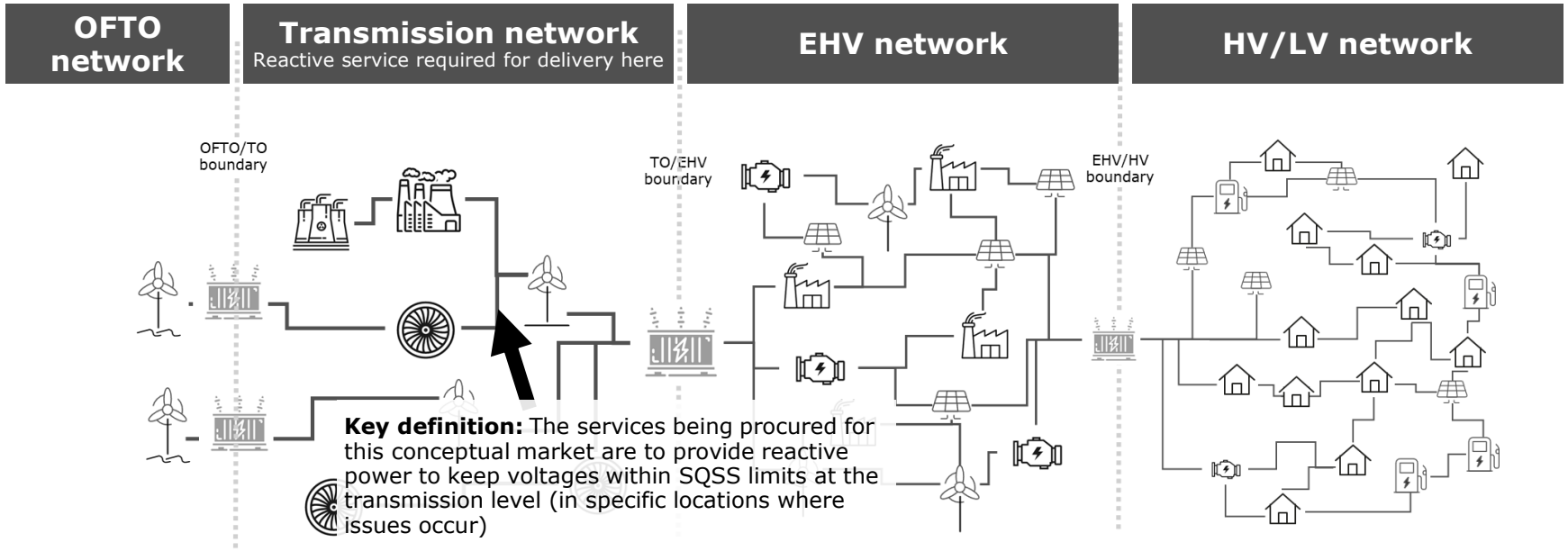
CONTEXT

Reactive power markets are being considered as routes to support the system voltage at the transmission level

1. NGESO is seeking to procure reactive power services to ensure **voltage security** at the **transmission level**

2. Current arrangements mean that there is **no explicit price signal for voltage support** (beyond pathfinders and ERPS which is not currently used)

3. **Effective** solutions will be located (electrically) **close to** where the voltage conditions are changeable or unstable



CONTEXT

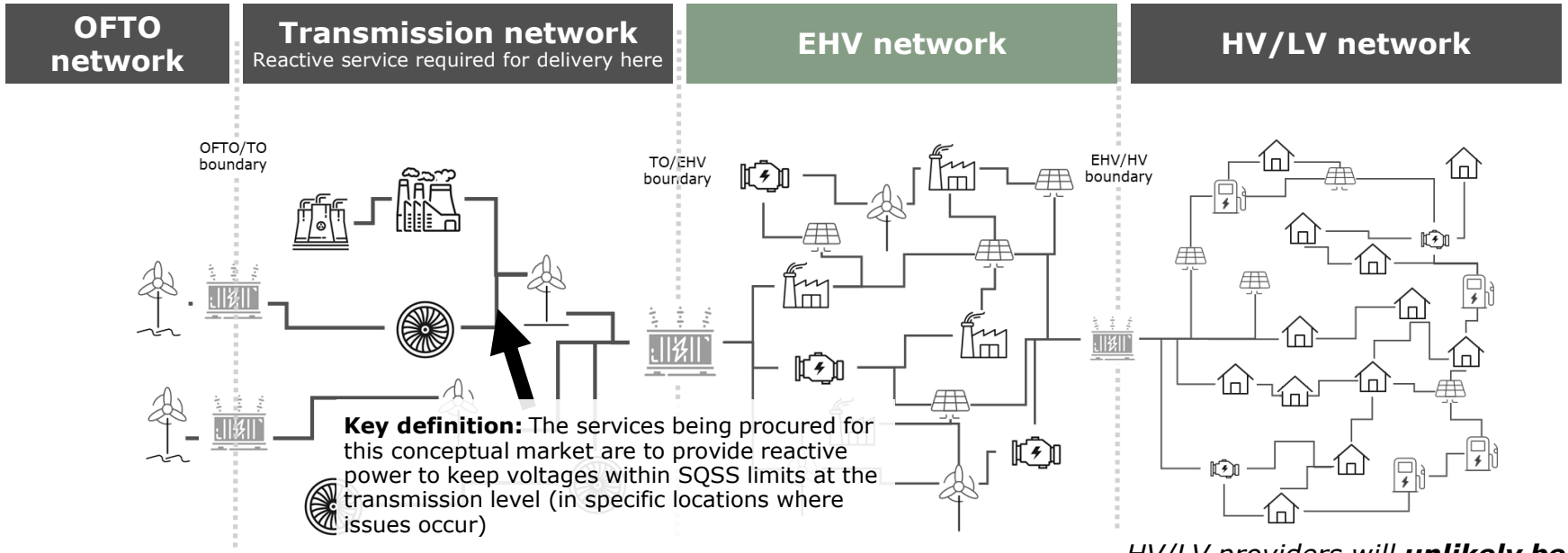
Distribution level assets at EHV may be able to provide services to support the transmission system

1. NGESO is seeking to procure reactive power services to ensure **voltage security** at the **transmission level**

2. Current arrangements mean that there is **no explicit price signal for voltage support** (beyond pathfinders and ERPS which is not currently used)

3. **Effective** solutions will be located (electrically) **close to** where the voltage conditions are changeable or unstable

4. What role can EHV level **distribution connected solutions** take?



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*HV/LV providers will **unlikely be able/economic to provide** as they would be ineffective at transferring reactive power across the DSO networks. This is due to the localised nature of reactive power, which means that ability to provide useful services to ESO diminishes the further a site is from the transmission network.*

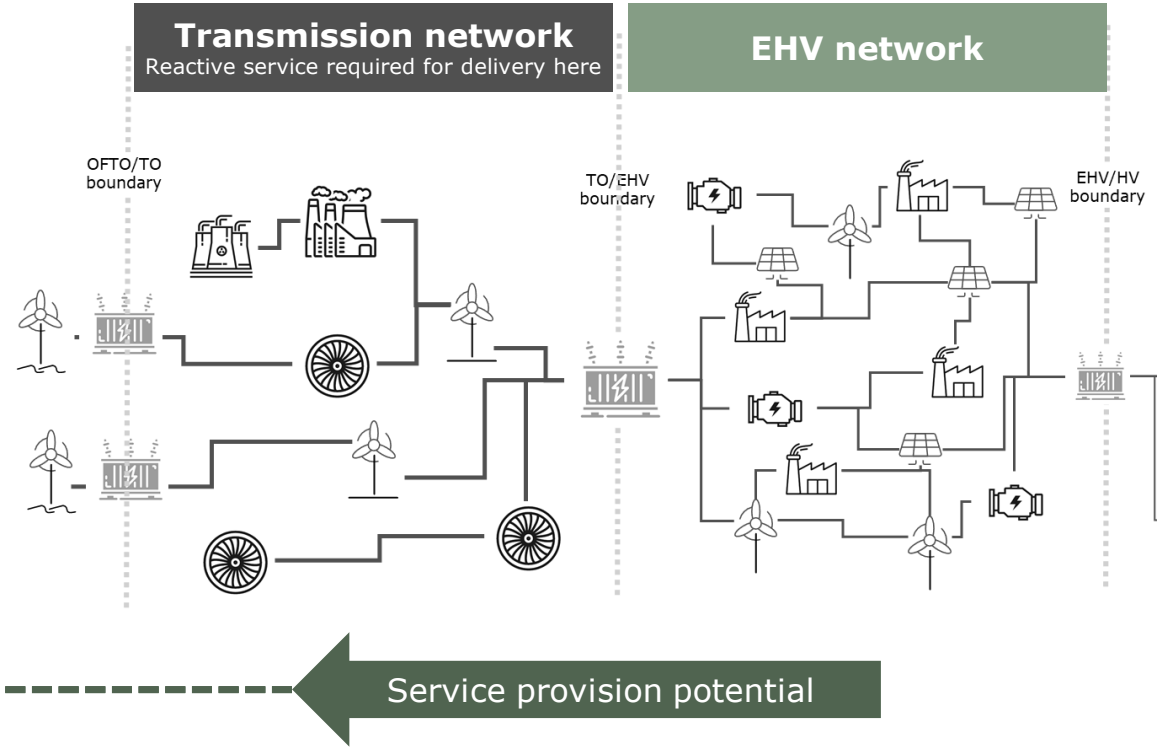
CONTEXT

Focus on understanding blockers for EHV asset provision to ESO, options to overcome them and potential routes to market for DER

1. What are the **blockers** for EHV asset service provision?

2. How may **blockers be overcome**?

3. What **routes to market** exist for distributed resource?



CONTEXT

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2. How may **blockers be overcome**?

3. What **routes to market** exist for distributed resource?

Scope

Provision from EHV level only

Provision by DSO assets and by DER assets

Inputs

Feedback from DSOs and DER

Desk research

Qualitative appraisal

Agenda

CONTEXT

Limited reactive power service provision to ESO from distribution connected assets

Network assets	Network assets are one of the primary tools for managing system voltage, the three most widespread technologies are capacitors, reactors, and SVCs. These assets are typically instructed/used first (before ORPS providers) and costs are recovered by providers through system losses and RAB (of the Transmission Owner).
ORPS	This is the primary route to procure services from large generators connected to the transmission network where participants are obliged to provide reactive power services within a fixed range and paid a regulated price. Importantly whilst not dispatching they are not obliged to provide the service and so may be instructed through the Balancing Mechanism or Schedule 7a trades.
Voltage contracts	These are a derivative of ORPS where providers are paid the ORPS rate but guarantee availability to provide the service (by contracting with a provider at a pre-agreed price to be operating at their SEL) where providers are paid ORPS rates for their reactive power and a separate payment (usually market index based) for their availability.
Pathfinder contracts	NGESO has procured some short and long term contracts for reactive power provision in Merseyside and is running a further tender in the Pennines region. Long term contracts give access to high availability solutions for reactive power that are paid an availability fee.

Key question: What role can EHV level distribution connected solutions take?

Distribution arrangements	The distribution network has not been a traditional source of reactive power (although transfers across the interface between DSO region and TO assets affect the voltages on the system to some degree). Limited service provision from distribution connected assets via innovation projects such as Power Potential, as well as SPEN's tenders through the Piclo Flex platform to procure reactive power.

Note: Some other 'one-off' arrangements exist, ORPS = 'Obligatory Reactive Power Service', SEL = 'Stable Export Limit', ERPS excluded as not used by market participants today

CONTEXT

DSO current practice for reactive power management results in problems at the transmission network – however innovative solutions are emerging

1. DSOs are obligated to keep voltages within limits governed by their licence conditions.

2. Changing utilisation of network assets across both the distribution and transmission networks has resulted in additional reactive compensation needs, partially due to the way volts are managed on the distribution network.

3. The primary method for DSOs to manage voltages on their system is through tap changing.

4. Tap changing reduces/increases number of windings in a transformer, which affects the voltages at either side of the transformer (compared to if a fixed ratio was always employed).

5. The problem of 'high volts' (voltages towards to upper limit of equipment rating, the most prevalent issue) is passed to the transmission network as tap changing configurations and a lack of other reactive compensation equipment in the distribution network mean DSOs have limited routes to keep voltages within limits.

6. To help overcome these challenges, DSOs have been exploring innovative solutions to help support the overall system, such as procurement of reactive power to manage their own networks, and the Power Potential project aimed at providing reactive power to support transmission network issues.

CONTEXT

Power Potential has established a potential framework for enabling reactive power provision from distributed energy resources through cooperation between ESO and UKPN

Key characteristics of Power Potential	
Product	Dynamic reactive power (core product)
Operational limits	An acceptable PQ[1] envelope which ensured compliance with DSO system voltage requirements was determined by UKPN, allowing safe operation without undermining existing obligations.
Effectiveness of solutions	A single static effectiveness factor was assigned to each plant, allowing economic assessment of bids adjusting for provision at the point of service delivery (rather than solution location).
Dispatch route	Dedicated platform (DERMS) for instruction, integrated with DSO and ESO existing platforms. Services instructed from ESO to DSO (commercial signal), then DSO to generator (technical signal).
Commercial arrangements	Availability by settlement period (day-ahead), submitted offer for availability price and utilisation price
Next steps	UKPN intends to work alongside ESO to develop BAU solution by 2028

Roles and responsibilities

ESO – service buyer

- Determines high level needs for transmission network and assesses effectiveness of service delivered at GSP to meet system needs
- Provides needs to DSO at the GSP
- Evaluates and accepts offers

Future costs could be recovered through existing arrangements

DSO – service facilitator

- Defines PQ envelopes to ensure voltage levels in distribution network do not exceed limits
- Defines effectiveness factors for DER delivery at GSP
- Relays availability information and offers from DER to ESO
- Relays instructions to DER

No clear route to recovering costs in the future (charge provider, charge ESO, shared, passthrough in EDCM/CDCM, or other?)

DER – service provider

- Relays availability and offer prices to DSO
- Acts on instructions as received from DSO

Future costs should be recovered through market mechanism if solution is economic

Notes: [1]PQ envelope refers to the space governing the allowable reactive & active power operating region for a provider

Agenda

Focus on technical, commercial and regulatory blockers to reactive power service provision to ESO by DER and distribution network assets

1. What are the **blockers** for EHV asset service provision?

2. How may **blockers be overcome**?

3. What **routes to market** exist for distributed resource?

Blocker type

Technical

Not possible / difficult to technically provide service

Commercial

Not possible / viable to commercially provide service

Regulatory

Not feasible / compatibility issues with regulatory framework

DER BLOCKERS

A range of technical, commercial and regulatory blockers affecting service provision have been identified

			Tech	Comm	Reg
1	Distribution system stability	– Power quality on distribution systems needs to be maintained to defined standards to maintain their stability, potentially limiting capability	☑		☑
2	Distribution system losses	– Provision of reactive power affects levels of distribution system losses, which creates a disincentive to service provision		☑	☑
3	Distribution charging	– Reactive power charges within distribution charging arrangements may discourage service provision		☑	☑
4	Connection agreement power factors	– Connection arrangements specify requirements to maintain power factors to defined standards, potentially limiting capability	☑		☑
5	Non-firm connection limitations	– Sites with non-firm/flexible connections may not be able to provide reactive services reliably at all times	☑	☑	
6	System studies	– Assessing feasibility and impacts of potential service provision requires system studies, with associated cost and resourcing overheads to recover		☑	☑
7	ESO / DSO conflict potential	– Scope for service provision to both ESO and DSO creates the potential for conflicts	☑	☑	☑

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Power quality on distribution systems needs to be maintained to defined standards to maintain their stability, potentially limiting capability

Identified issue / blocker

- Need to maintain distribution system security and performance standards alongside potential provision of reactive power services from a distribution network to the transmission network.
- Operation at lower power factors to provide reactive services may compromise stability of network assets and their ability to operate correctly.

Supporting information / comment

- Statutory voltage limits specified in the Electricity Safety, Quality and Continuity Regulations 2002 (ESQCR) must be observed. Permitted variations within the Regulation in relation to voltage are:
  - for low voltage supply: +10% > permitted variation <-6% declared voltage (at frequency of 50Hz)
  - for high voltage supply below 132kV: +6% > permitted variation <-6% declared voltage (at frequency of 50Hz)
  - for high voltage supply above 132kV: +10% > permitted variation <-10% declared voltage (at frequency of 50Hz)
- Standards of supply are specified in the Distribution Code (DPC4.2), which links back to the details of ESQCR. It also states the need to take into account requirements from Standard EN 50160 'Voltage Characteristics of Public Distribution Systems', which sets European standards for supply quality including voltage. Reference is also made to the need to adhere to voltage limits defined in Engineering Recommendation P28, 'Planning limits for voltage fluctuations caused by industrial, commercial and domestic equipment in the United Kingdom' in the case of voltage disturbances.

Summary

Technical	☑
Commercial	
Regulatory	☑

- Potential provision of reactive power services from distribution level assets can not compromise adherence to stated security and quality standards from technical performance perspective. Deviation could lead to breach of regulatory requirements, with associated consequences for the distribution business.
- Technical capability for distribution level assets to provide services may be restricted by the need to ensure distribution system stability.

Provision of reactive power affects levels of distribution system losses, which creates a disincentive to service provision

Identified issue / blocker

- Higher reactive power flows on distribution systems and for longer periods of time leads to increased levels of distribution losses.
- Distribution businesses are incentivized in respect of distribution losses, potentially creating a distortion in the incentive to provide reactive power services that have an adverse impact on losses outcomes.

Supporting information / comment

- Historically, an explicit financial incentive has operated in relation to distribution losses. RIIO-ED1 included a Losses Discretionary Reward component. However, this is expected to be removed in RIIO-ED2.
- RIIO-ED2 instead includes consideration of losses within arrangements to foster delivery of an environmentally sustainable network. The framework includes:
  - Environmental Action Plan (EAP) submitted as part of business plan, outlining activities to be undertaken to support realisation of an environmentally sustainable network, with activities relating to distribution losses contributing towards decarbonisation of the networks.
  - Baseline expectations including implementation of a strategy to efficiently manage losses and contribution to the evidence base on proportion of losses that network companies can influence/control. This will be assessed through reporting on progress made in implementing losses strategy.
  - Publication of Annual Environmental Reports to present performance relative to baseline expectations and EAP.
- Losses will no longer have an explicit financial incentive, but reputational incentives remain based on business performance in respect of losses management.

Summary

Technical	
Commercial	☑
Regulatory	☑

- While an explicit losses-related financial incentive is not expected under RIIO-ED2, outturn losses and performance relative to baseline expectations/losses strategy will have reputational incentives for distribution businesses. The losses strategy may cater for losses impacts from reactive service provision, however, this may be complex to couch and/or too subtle to reflect in performance assessment. Therefore, the potential for disincentive may remain under RIIO-ED2, albeit less overtly than with the existing explicit financial incentive.

Reactive power charges within distribution charging arrangements may discourage service provision

Identified issue / blocker

- Standard charging methodologies impose additional charges for operating outside normal power factor parameters.
- This introduces an additional cost for distribution connected resource who have to operate outside standard power factor parameters in order to provide reactive power services, creating a potential disincentive for service provision.

Supporting information / comment

- Distribution charging methodologies can include reactive power charges, with provision for standard and excess charges:
  - standard charges are calculated with reference to a power factor within the range 0.95 leading and 0.95 lagging
  - excess charges can be applied to power factors outside this range
- The basis for this differentiation is to cover the extra costs of providing the additional capacity needed to deliver requirements within the broader power factor range.
- The DCUSA indicates that, as part of the Common Distribution Charging Methodology, these charges can be included in site specific demand charges and site specific generation charges. There is scope, however, for excess reactive power charges to not apply if a generator is operating at a power factor of less than 0.95 at the request of a DSO.
- The DCUSA indicates that the EHV Distribution Charging Methodology (EDCM) does not include a separate charge component for reactive power flows. However, a demand connectee's power factor is reflected in other elements of the charges. For example, unit charges can increase if a site's power factor is poor (below 0.95).

Summary

Technical	
Commercial	☑
Regulatory	☑

- The reactive power charging arrangements within charging methodologies, and the higher charge potential if power factors are lower than 0.95, add cost to service provision and so disincentivize participation from distribution connected resource.

Connection arrangements specify requirements to maintain power factors to defined standards, potentially limiting capability

Identified issue / blocker

- Standard connection terms require distribution connectees to maintain power factors under tight control, with firm consequences for non-adherence.
- This restricts technical ability and commercial appetite to engage in provision of reactive services.

Supporting information / comment

- The National Terms of Connection state that, unless otherwise agreed, distribution customers must ensure that the power factor of imports from or exports to the distribution system through there connection point is maintained. Failure to adhere to these requirements can lead to de-energisation.
- For example, for connections with C/T metering[1] the requirement is that power factor is maintained:
  - so that there is never a leading power factor, unless otherwise agreed with the distribution business for operational reasons; and
  - at or as near to unity as practicable, but in any case no less than 0.95 lagging.
- Building on this, individual connection agreements also stipulate permitted power factor performance standards. The potential to operate outside these standards would require amendment to connection agreements and supporting system studies to evaluate the impacts of any changes to standards.

Summary

Technical	☑
Commercial	
Regulatory	☑

- Connection terms require adherence to specified power factor ranges, limiting technical ability to provide reactive power services. Altering these ranges to allow for greater potential reactive power service provision will need system studies and then connection agreement amendment.

1: Connection is metered indirectly by using current transformers to induce a reference current which is then put through the meter.

Sites with non-firm/flexible connections may not be able to provide reactive services reliably at all times

Identified issue / blocker

- Non-firm connection agreements flex the system access available to a user to provide a tool for network operators to manage constraints. However, in the context of reactive power service provision, non-firm connections may limit availability/reliability of potential providers.

Supporting information / comment

- Non-firm or flexible (constrained) connections are being used to facilitate new generation and demand onto the distribution networks in areas where the time and cost to reinforce the network can be a significant deterrent to connections. These types of connection arrangements can either limit times in which a generator/demand customer can export/import, or the capacity that can be exported/imported.
- The frequency of potential curtailment depends on the extent of coincidence between the site's profile and the times constraints are likely to appear on the system. However, the availability of a site with a non-firm connection to provide reactive power services will likely be restricted at times when there are constraints on the system. This may:
  - reduce the feasibility of participation from such sites
  - increase the level of holdings needed to provide the required level of 'firmness' overall for reactive power provision, with potential cost implications

Summary

Technical	☑
Commercial	☑
Regulatory	

- Provision of services from sites with non-firm connection may be restricted given uncertainty regarding availability when there are distribution system constraints.

Assessing feasibility and impacts of potential service provision requires system studies, with associated cost and resourcing overheads to recover

Identified issue / blocker

- Potential provision of reactive power services by distribution connected sites will require system studies to assess the possible effects on distribution system operability. Such studies are costly to carry out and need dedicated resources, however, no allowance is given for either at present in the context of reactive power service provision by distributed resources.

Supporting information / comment

- Factors that have the potential to influence costs of system studies include:
  - number of sites in question and the degree of interaction between them
  - availability of data
- The case for conducting studies should be accompanied by clear allocation of responsibility with associated provision for securing and covering costs of specialist personnel, data acquisition and IT needed to undertake the assessment.

Summary

Technical	
Commercial	☑
Regulatory	☑

- Conducting required system studies to assess the potential effects of reactive power provision by different sites will require allowance for associated costs.

Scope for service provision to both ESO and DSO creates the potential for conflicts

Identified issue / blocker

- A distributed resource may have separate arrangements to provide services to each of the ESO and its DSO. This presents the potential for conflict to arise, absent measures for coordination in respect of usage.

Supporting information / comment

- A single distributed resource may be able to provide system support to its connected DSO and to the ESO. However, use of the resource by either ESO or DSO has the potential to affect the other. For example, use by one party can:
  - preclude use by the other party at or around the same time, without consideration of the respective value ESO and DSO each place on the provider's service or alternative options available for meeting requirements
  - have adverse effects for system conditions on the other party's system (e.g. if automatically responding voltage services procured by ESO offset use of tools that exist today in the distribution network such as voltage control for demand reduction – the magnitude of the demand reduction may be reduced relative to activation if ESO services are absent)
- Therefore, conflicts can arise if the distributed resource has multiple system service counterparts. Absent some form of framework to coordinate use of 'shared' assets, this may lead to reduced opportunity for distributed resource to contract to provide system support services (if there is a risk that they will not reliably be available for the contracting party) or increased potential for adverse system outcomes (if there is narrow focus use decisions).

Summary

Technical	☑
Commercial	☑
Regulatory	☑

- If distributed resource can be contracted to provide system services to both ESO and DSO, the potential for conflicting use arises. This may constrain service provision by distributed resource of lead to adverse system outcomes.

Agenda

High-level consideration of enablers which may help to address identified blockers

1. What are the **blockers** for EHV asset service provision?

2. How may **blockers be overcome**?

3. What **routes to market** exist for distributed resource?

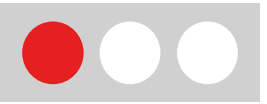
Areas of focus for further attention

Options

What can be done to progress?

POTENTIAL ENABLERS

Possible ways forward exist to allow for routes for overcoming barriers to be considered, although many are complex

			Relative ease (provisional)
1	**Distribution system stability**	– Technical review of standards specified in ESQCR and Distribution Code to identify scope for amendment. Given importance of ensuring security, risk aversion may mean that the prospect for change is limited.	
2	**Distribution system losses**	– Issue may be expected to diminish under RIIO-ED2 given the proposed removal of financial incentive around losses. However, reputational focus still expected. As part of losses strategy, DSOs can make case for the value of trading-off increased losses and provision of reactive services, but this may be complex.	
3	**Distribution charging**	– Review of charging methodologies to identify potential alternative approaches or parameters to apply in respect of treatment of power factor to support efficient provision of reactive power services within cost-reflective charges. Could be effort intensive and complex, with scope for distributional impacts on users.	
4	**Connection agreement power factors**	– Technical review of standards specified in connection terms to identify scope for amendment to support efficiency while maintaining stability/security. If potential benefits available, need cost-benefit analysis to assess merits of rollout. Could be effort intensive and complex, with scope for distributional impacts on users.	
5	**Non-firm connection limitations**	– Non-firm connections provide valuable flexibility for system management and so are expected to remain. Inclusion of a non-firm reactive power product in ESO design may allow for provision by parties with non-firm connections.	
6	**System studies**	– Scope for specific provisions to cover system study costs/resources under RIIO-ED2 (although final business plans now submitted, so if not covered already, it will be difficult to achieve for RIIO-ED2).	
7	**ESO / DSO conflict potential**	– Requires ongoing consideration of appropriate frameworks for coordination. This is a long-standing issue and difficult to resolve. Models such as Power Potential offer a possible solution, but it requires broad consensus and effort to rollout.	

Agenda

Focus on role of DSO within provision of services by DER to ESO

1. What are the **blockers** for EHV asset service provision?

2. How may blockers be overcome?

3. What **routes to market** exist for distributed resource?

DSO roles

Passive

Relatively detached from provision by DER

Active

More direct role in provision by DER

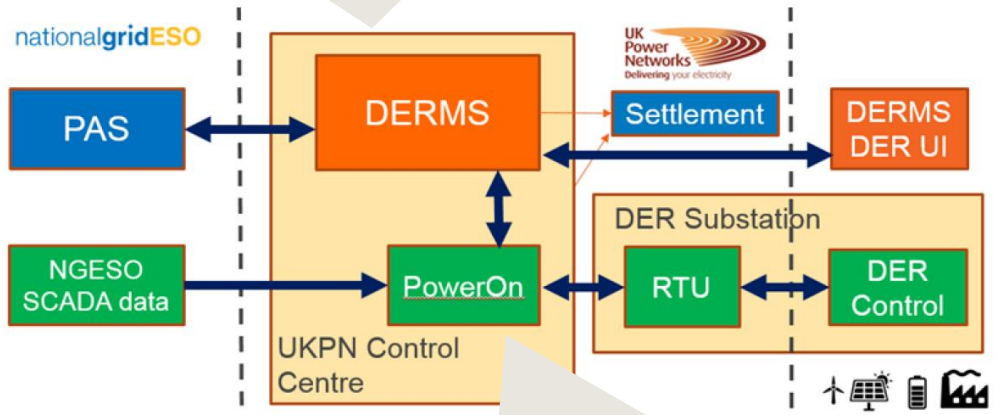
Power Potential developed a technical solution to allow automated delivery of dynamic voltage control by DER

DERMS:

Distributed Energy Resources Management System allowed for day-ahead offer of services by DER and ESO procurement of those services

PAS:

DERMS integrated with ESO's Platform for Ancillary Services (PAS) to provide visibility to ESO control room

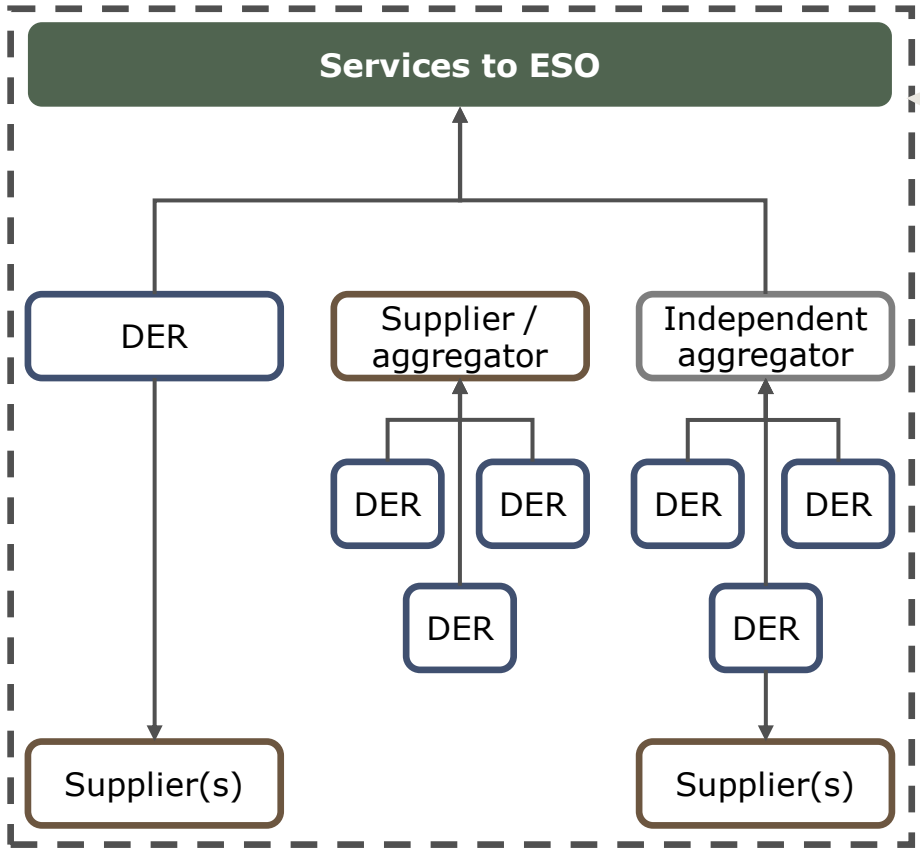


PowerOn:

DERMS also integrated with UKPN's PowerOn network management system to provided visibility to its control engineers

Source: Power Potential documentation (UKPN and National Grid ESO)

Increased use of DER for ESO service provision necessitates a more active role for the DSO to mitigate distribution system issues and potential conflicts

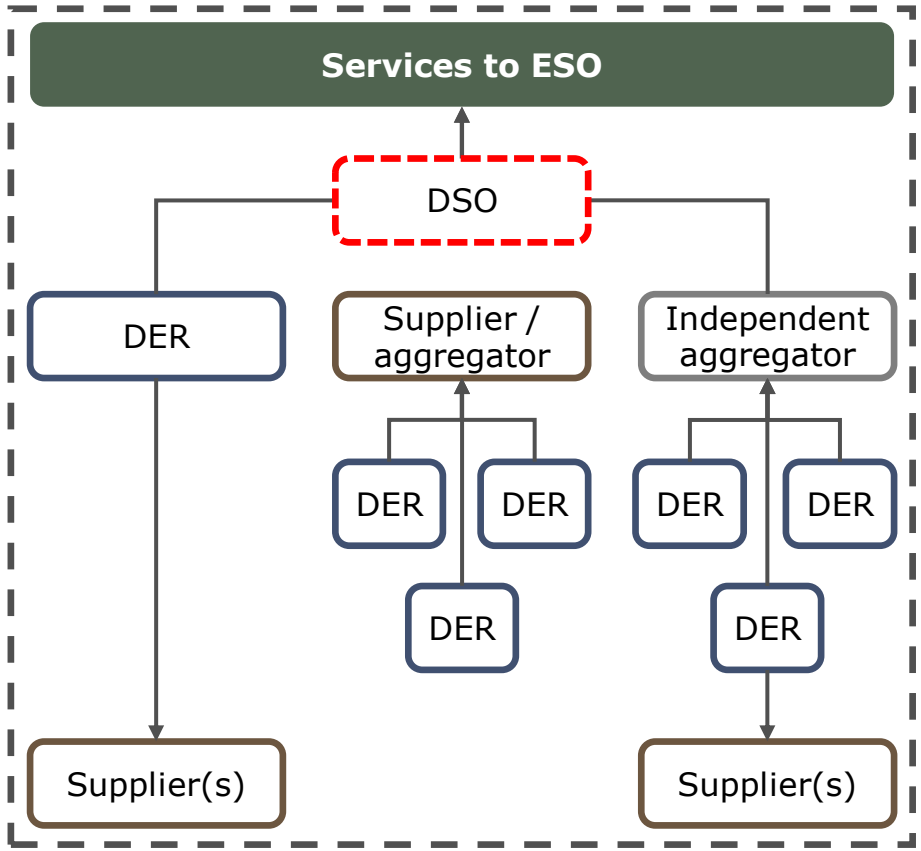


FROM:

To date, contracting approach for service provision from DER has not allowed for or included much coordination between ESO and DSO

TO:

As DER and its usefulness to ESO increases, the DSO is expected to need a greater role. What type of role will DSO have?



Source: Adapted from Energy Networks Association

Several studies have highlighted a preference for DSOs to take an active leading role in the utilisation of DER

1	**Imperial College / Power Potential**	– 'Incremental coordination', in which DSO takes first call on DER use with ESO then having access to remaining DER capacity, identified as best solution
2	**Imperial College / Power Potential**	– Recommendation for central role for DSO in providing interface in service provision, with sequential process reflecting local distribution conditions
3	**AFRY / Energy Systems Catapult**	– In the absence of perfect information, DSO led solution provides largest potential system cost savings relative to business as usual
4	**AFRY / Low Carbon London**	– Framework in which the DSO can overrule or change an ESO decision if needed, given more significant impact of DSR use conflicts for DSOs

‘Incremental coordination’, in which DSO takes first call on DER use with ESO then having access to remaining DER capacity, identified as best solution

Study

- As part of their input into the Power Potential project, Imperial College studied the effects of different methods of DER coordination, involving different roles for the DSO.
- Focus included how to best allocate DER resource to avoid triggering conflicts between ESO and DSO and, instead, to maximize synergies between ESO and DSO in terms of DER utilization.

Key points

- Three commercial models were assessed:
  - not coordinated – involves no coordination
  - incremental coordination (as applied in Power Potential) – coordination opportunity, with DSO having first access to DER
  - fully integrated, whole system approach – perfect coordination which is expected to result in least-cost system to the system

▶

- **Incremental coordination**: DSO takes first decision on how to use DER to solve the distribution network problems, followed by ESO decision to use remaining DER to solve the transmission problem.

Outcome

Incremental	Whole-system
Practical as problems solved incrementally	Complex and computationally intensive
May be suboptimal for system (although active management helps), but DSO then ESO order expected to perform better than ESO then DSO, given greater sensitivity of distribution networks to DER	Optimal from system perspective, but not necessarily from ESO or DSO perspective
Can cause/frustrate constraints in other system and restrict ESO access to DER	Maximises synergy and access to DER collectively

▶

- **Conclusion**: DSO-ESO incremental coordination is most appropriate solution.
- Solution is close to optimal, as DERs have higher locational impact on local distribution compared to transmission, so solving distribution issues first is pragmatic.

Source: Evaluating Synergies and Conflicts of DER Services for Distribution and Transmission Systems and Market Power Assessment, May 2019

Recommendation for central role for DSO in providing interface in service provision, with sequential process reflecting local distribution conditions

Study

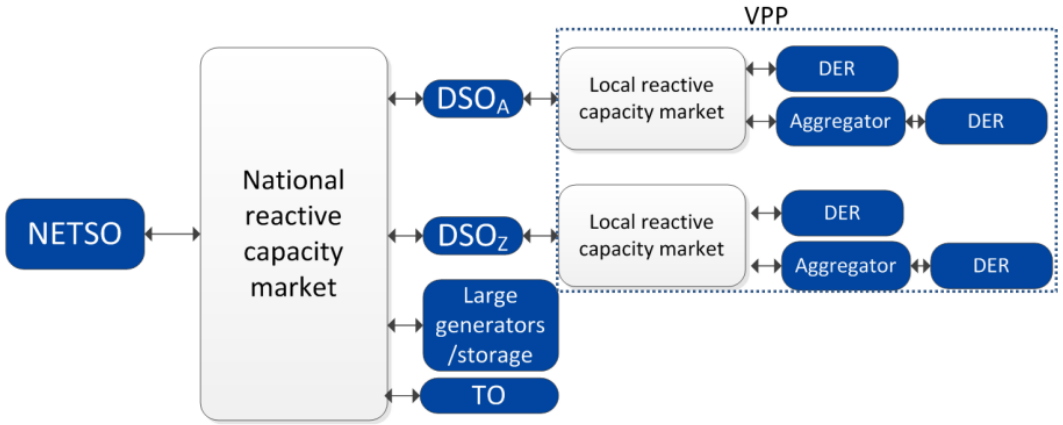
- Also as part of their input into the Power Potential project, Imperial College considered market framework options for DER provision of network services.
- Focus is on informing the development of market arrangements and the commercial framework for selecting the most cost-effective portfolio of contracts for the provision of reactive power support based on offers from different service providers (range of DER and conventional sources).

Key points

- Considered a two step approach for accessing DER:
  1. Aggregate technical and economic characteristics of DER, taking into consideration distribution network constraints while optimising network assets and control settings, into a VPP.
  2. Security constrained optimal power flow algorithm used to identify optimal portfolio of commercial contracts.

- Provision of services to the transmission system by the VPP is possible so long as it does not violate local distribution network constraints.

Outcome



- **Conclusion**: Central role for DSO in providing the interface between ESO and aggregators / DER.
- Sequential reactive power market framework using the VPP approach to aggregate DER capacity and local distribution network characteristics is technically sound

Source: Market Framework for Distributed Energy Resources-based Network Services, June 2018

In the absence of perfect information, DSO led solution provides largest potential system cost savings relative to business as usual

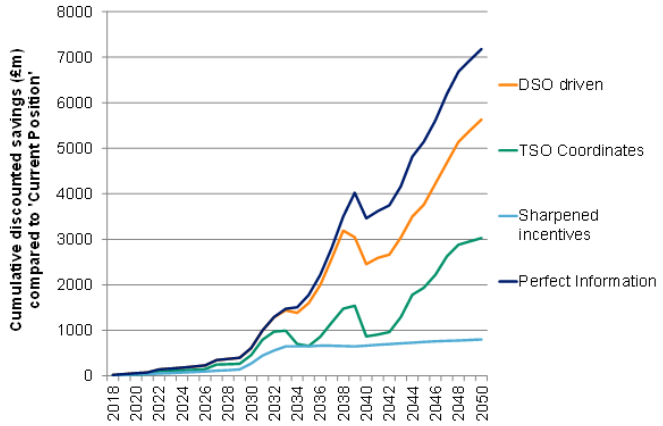
Study

- Assessment conducted by AFRY (then Pöyry) for Energy Systems Catapult considers alternative frameworks for DSO participation, each of which represents a potential future architecture for DSO and TSO interaction.
- The aim is to contribute to the debate on the future market architecture through analysing the extent to which different approaches impact on the potential value of flexibility to the electricity system and the role of DSOs.

Key points

- Five frameworks were assessed:
  - Current position, reflecting status quo
  - Sharpened incentives, in which charging arrangements are expected to have some impact on locational decisions, but the DSO remains largely passive
  - TSO coordinates, with the TSO leading system optimisation but coordinating with the DSO to take account of local and national requirements
  - DSO driven, with the DSO taking an active role and having first access to resources
  - Perfect information, in which local and national needs are optimally resolved

Outcome



- **Conclusion**: there is a higher value from using local flexibility resources to address local network issues (due to lack of alternative options) and frameworks that do not acknowledge this, or ensure this higher value can be signalled, will lead to higher costs.

Source: Assessing the potential value from DSOs, April 2019

Framework in which the DSO can overrule or change an ESO decision if needed, given more significant impact of DSR use conflicts for DSOs

Study

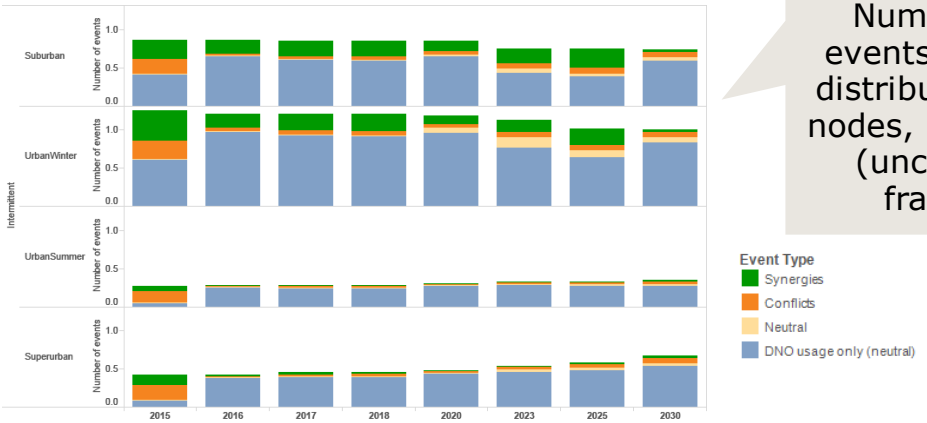
- Assessment conducted by AFRY (then Pöyry) for UK Power Networks as part of Low Carbon London project examines the "synergies and conflicts" of I&C DSR use locally (by a DSO, UKPN within central London in this case) and nationally (the System Operator (SO) and suppliers).
- This built on results from trials involving contracting, through commercial aggregators, for DSR from large commercial consumers to provide constraint relief services for UKPN.

Key points

- The analysis shows that there are a number of potential conflicts and synergies in the use of DSR at both national and local levels. In particular, two important insights were generated:
  - there is a greater proportion of conflicts when information/dispatch is not shared between parties (information/dispatch sharing leads to a 60% to 85% decrease in conflicts depending on scenario and modelled year); and
  - the conflicts are much more significant in volume from the DSO's perspective (20% of the time) compared to the TSO's perspective (1% of the time).

- Important for commercial and regulatory frameworks to take these conflicts into account.

Outcome



Number of DSR events on different distribution network nodes, by event type (uncoordinated framework)

- **Conclusion**: Shared information or dispatch could take the form of a co-optimisation approach where the DSO could overrule or change the decision of the SO if needed.

Source: Low Carbon London Project – Synergies and conflicts in the use of DSR for national and local issues, August 2014

DSO activities must adhere to regulatory expectations, which include DSO ownership of framework for DER dispatch and no role in aggregation of DER

DSO roles		Ofgem high level expectations for ED2 for role 2.2		Ofgem baseline expectations for ED2 for role 2.2 (selection only)
1: Planning and network development	1.1: Plan efficiently in the context of uncertainty, taking account of whole system outcomes, and promote planning data availability	**Decision-making framework**	In the near term, the **DSO is the right entity to own the decision-making framework** for what should be dispatched in real-time on their networks and for **sending the dispatch instructions** for distribution flexibility services. This will ensure the DSOs maintain the distribution network within operability limits.	– DSOs to have decision-making framework for DER dispatch decisions. Framework to include rules for coordinating dispatch instructions for DSO and ESO flexibility services, which could be through primacy rules of more comprehensive optimisation processes. – DSOs shall facilitate secondary trading of distribution flexibility services.
2: Network operation	2.1: Promote operational network visibility and data availability **2.2: Facilitate efficient dispatch of distribution flexibility services**	**Ancillary services**	In RIIO-ED2, **DSOs shall not procure ancillary services from flexibility providers on behalf of the ESO** or otherwise act as the commercial route to ESO markets for flexibility providers. Need for DSOs to **set parameters for what the ESO can procure** from the distribution network to maintain safe operation of the network is recognized.	
3: Market development	3.1: Provide accurate, user-friendly, and comprehensive market information 3.2: Embed simple, fair, and transparent rules and processes for procuring distribution flexibility services			

Source: 'RIIO-ED2 Methodology Decision: Overview', Ofgem, 17 December 2020.

Ongoing initiatives under ENA's Open Networks processes, which are helping to improve coordination in procurement of flexibility services, have relevance

ENA activities under 'flexibility services' element of Open Networks programme

1: Common Evaluation Methodology	Making enhancements to the Common Evaluation Methodology (CEM) and tool used to evaluate flexibility and traditional intervention options
2: Standard agreement	Improvement to existing Standard agreement for procuring Flexibility services across DSO and ESO
3: Procurement process alignment	Increasing alignment of flexibility services procurement processes across DSOs and ESO and reviewing the approach to settlement across DSO services
4: Inter-operability	Reviewing interoperability of systems across DSO and ESO systems
5. 'Primacy Rules'	Defining and implementing 'Primacy Rules' for the ESO and DSOs to manage service conflicts
6. Product review	Reviewing existing (and new if applicable) Flexibility products and analysing stackability to address barriers
7. Carbon monitoring	Supporting Ofgem and BEIS' initiative to achieve common methodologies for carbon reporting and monitoring across DSOs
8. Curtailment information	Improving provision and accessibility of curtailment information for Active Network Management enabled Flexible Connections
9. Coherent framework	Integrating the various aspects of flexibility into a coherent framework and setting out a clear strategic view of further development required in key aspects of flexibility

- Ongoing work regarding liabilities, settlement and primacy under items #2, #3 and #5 in particular are of relevance for DER provision of services

Price controls and incentive arrangements need to reflect any change in DSO role and allow for appropriate cost recovery, with incentives

- Power Potential considered two possible incentive arrangements for different DSO roles.

Cost pass-through with DSO performance incentive

- Operating model:
  - DER dispatched via DERMS based on day-ahead nominations and instructions from ESO
  - No corrective or optimization actions taken by DSO
- Operating costs:
  - Linked to operation and maintenance of DERMS
- Incentives:
  - Ex-ante allowance to operate and maintain DERMS and coordinate service provision
  - Performance incentives relating to DERMS availability and performance

Enabling whole system solutions with DSO performance incentive

- Operating model:
  - DSO optimises DER dispatch to enhance service delivery in a cost-effective way, while ensuring that NGESO has access to the maximum volume that can be provided by the available DER and while keeping the distribution network secure
  - DSO can also reconfigure the network by optimising distribution network assets (e.g. transformer taps) and through active network management measures, to further reduce costs
  - DSO coordinates the dispatch of DSO ancillary services to resolve distribution and transmission constraints simultaneously
- Operating costs:
  - DSO incurs additional operating costs in service optimization and data exchanges
  - DSO may also operate its assets in more complicated operating profiles, which requires development of active management processes
- Incentives:
  - Costs could be compensated under RIIO-ED2 allowances
  - Could form part of outputs under Output Delivery Incentive

Source: Power Potential

CLASS is the best known example of defined regulatory treatment for DSO provision of balancing services

- CLASS, as developed by ENW, involves DSOs providing network voltage control and network management services, via the remote management of deployed network assets, to the ESO for its balancing services activity.
- Taking CLASS as an example, potential provision of services by the DSO will **require specific regulatory approvals** and decisions in terms of treatment.

Treatment to date

- In 2016, following completion of the LCNF project that created CLASS, Ofgem published a Direction for the regulatory treatment of CLASS as a balancing service to be included in the directly remunerated services category 8 (DRS8) under the distribution licence.
- DRS8 treatment means this arrangements are outside the price control, with the DSO selling CLASS to ESO and charging directly for it.
- The net revenue is shared with consumers.
- This treatment allows DSOs to offer CLASS to the ESO creating the potential to promotion of efficient procurement of balancing services and consumer benefits by sharing any profits that the DSO makes.

Future treatment

- Ofgem is consulting on the treatment of CLASS for RIIO-ED2. Options include:
  - **1**. continuing to allow DSOs to sell CLASS to the ESO, maintaining the regulatory treatment of RIIO-ED1 or with alternative revenue arrangements.
  - **2**. requiring DSOs to provide it to the ESO outside of market mechanisms and thereby cover the costs in the DSO price control.
  - **3**. prohibiting CLASS's use as a balancing service completely
- Ofgem's minded to view is to retain the existing treatment for RIIO-ED2, with a final decision pending.

Agenda

NEXT STEPS

A number of blockers and potential high-level initiatives to start the process to overcome them have been identified

			Relative ease (provisional)
1	**Distribution system stability**	– Technical review of standards specified in ESQCR and Distribution Code to identify scope for amendment. Given importance of ensuring security, risk aversion may mean that the prospect for change is limited.	
2	**Distribution system losses**	– Issue may be expected to diminish under RIIO-ED2 given the proposed removal of financial incentive around losses. However, reputational focus still expected. As part of losses strategy, DSOs can make case for the value of trading-off increased losses and provision of reactive services, but this may be complex.	
3	**Distribution charging**	– Review of charging methodologies to identify potential alternative approaches or parameters to apply in respect of treatment of power factor to support efficient provision of reactive power services within cost-reflective charges. Could be effort intensive and complex, with scope for distributional impacts on users.	
4	**Connection agreement power factors**	– Technical review of standards specified in connection terms to identify scope for amendment to support efficiency while maintaining stability/security. If potential benefits available, need cost-benefit analysis to assess merits of rollout. Could be effort intensive and complex, with scope for distributional impacts on users.	
5	**Non-firm connection limitations**	– Non-firm connections provide valuable flexibility for system management and so are expected to remain. Inclusion of a non-firm reactive power product in ESO design may allow for provision by parties with non-firm connections.	
6	**System studies**	– Scope for specific provisions to cover system study costs/resources under RIIO-ED2 (although final business plans now submitted, so if not covered already, it will be difficult to achieve for RIIO-ED2).	
7	**ESO / DSO conflict potential**	– Requires ongoing consideration of appropriate frameworks for coordination. This is a long-standing issue and difficult to resolve. Models such as Power Potential offer a possible solution, but it requires broad consensus and effort to rollout.	

NEXT STEPS

Several studies have highlighted a preference for DSOs to take an active leading role in the utilisation of DER

1	**Imperial College / Power Potential**	– 'Incremental coordination', in which DSO takes first call on DER use with ESO then having access to remaining DER capacity, identified as best solution
2	**Imperial College / Power Potential**	– Recommendation for central role for DSO in providing interface in service provision, with sequential process reflecting local distribution conditions
3	**AFRY / Energy Systems Catapult**	– In the absence of perfect information, DSO led solution provides largest potential system cost savings relative to business as usual
4	**AFRY / Low Carbon London**	– Framework in which the DSO can overrule or change an ESO decision if needed, given more significant impact of DSR use conflicts for DSOs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