cerre Centre on Regulation in Europe

REPORT

April 2021

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OPTIMAL REGULATION FOR EUROPEAN DSOs TO 2025 AND BEYOND

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ACKNOWLEDGEMENTS

The authors would like to thank the sponsors and the members of the steering committee of the project for comments during the survey design process and for their feedback on previous drafts of the report. We would like to thank E.ON, GEODE and CEER for helping us with the distribution of the survey to national regulatory authorities (NRAs) and distribution system operators (DSOs).

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Acronyms

ANM	Active network management
BSP	Balancing service provider
CAPEX	Capital expenses
CBA	Cost benefit analysis
CEER	Council of European energy regulators
CEP	Clean energy package
DER	Distributed energy resources
DFES	Distribution Future Electricity Scenarios
DSO	Distribution system operator
ENTSO-E	The European Network of Transmission System Operators for Electricity
EV	Electric vehicle
NRA	National regulatory authority
OPEX	Operational expenses
P2P	Peer-to-peer
RIIO	Revenue=incentive + innovation + outputs
ROR	Rate of return
TOTEX	Total expenses
TSO	Transmission system operator
WACC	Weighted average cost of capital

Glossary of terms

Active network management Smart solutions that manage efficiently the integration of DER, monitoring network constraints continuously and avoiding any network violations.

Ancillary service **(Art. 2 of Directive (EU) 2019/944, point 48)** "A service necessary for the operation of a transmission or distribution system, including balancing and non-frequency ancillary services, but not including congestion management."

Balancing **(Art. 2 of Regulation (EU) 2019/943, point 10)** "All actions and processes, in all timelines, through which transmission system operators ensure, in an ongoing manner, maintenance of the system frequency within a predefined stability range and compliance with the amount of reserves needed with respect to the required quality."

Balancing service provider **(Art. 2 of Regulation (EU) 2019/943, point 12)** "A market participant providing either or both balancing energy and balancing capacity to transmission system operators."

Congestion management **(E.DSO, 2019 p. 44)** "Activating a remedial action to respect operational security limits."

Distributed energy resources **(E.DSO, 2019, p. 44)** "Refer to small, geographically dispersed generation resources, such as solar, wind or combined heat and power, installed and operated on the distribution system at voltage levels below the typical bulk power system."

Distribution system operator **(Art. 2 of Directive (EU) 2019/944, point 29)** "A natural or legal person who is responsible for operating, ensuring the maintenance of and, if necessary, developing the distribution system in a given area and, where applicable, its interconnections with other systems, and for ensuring the long-term ability of the system to meet reasonable demands for the distribution of electricity."

Distributed generation **(Art. 2 of Directive (EU) 2019/944, point 32)** "Generating installations connected to the distribution system."

Flexible connections (ANM) **(ENA, 2020b, p. 4)** "Connection options where in return for a faster, cheaper connection, the participant accepts a contractual, mandated requirement for their usual power flows to be changed by the DNO (DSO) remotely, in real-time, through automation. The amount of change, or curtailment, varies as per the connection agreement."

Flexibility **(Eurelectric, 2014, p. 5)** "The modification of generation injection and/or consumption patterns in reaction to an external signal (price signal or activation) in order to provide a service within the energy system."

Flexibility service **(ENA, 2020b, p. 4)** "Is a commercial mechanism which requires participants to deliver a change in their usual power flows in real time or at times requested by the DSO. It is a market-led initiative that, through procurement exercises, finds customers' assets located within constrained networks that are able to deliver flexibility to help manage constraints. Customers can choose not to respond to the dispatch signal (albeit with commercial consequences in some areas)."

Flexibility (service) provider **(E.DSO, 2019, 45)** "A market participant providing flexibility services to either the wholesale market or to system operators."

Grid code Contains the technical specifications and requirements to connect and have access to the electricity grid.

Non-frequency ancillary service **(Art. 2 of Directive (EU) 2019/944, point 49)** "A service used by a transmission system operator or distribution system operator for steady state voltage control, fast reactive current injections, inertia for local grid stability, short-circuit current, black start capability and island operation capability."

Pareto optimality A state of affairs is Pareto-optimal (or Pareto-efficient) if and only if there is no alternative state that would make some people better off without making anyone worse off.

Platform **(E.DSO, 2019, p. 45)** "A (distributed) software functionality, needed by actors to perform their tasks, corresponding to their roles and responsibilities, which as part of an ecosystem interacts with other relevant actors in the energy system."

Stranded assets **(CEER, 2020c, p.1)** 'regulated gas or electricity assets can be considered to be stranded when it is expected that regulated companies, as owners of those assets, cannot recover their efficient investment costs under the conditions for allowed revenues given the changes between the current and expected environment.'

Transmission system operator **(Art. 2 of Directive (EU) 2019/944, point 29)** "A natural or legal person who is responsible for operating, ensuring the maintenance of and, if necessary, developing the transmission system in a given area and, where applicable, its interconnections with other systems, and for ensuring the long-term ability of the system to meet reasonable demands for the transmission of electricity."

EXECUTIVE SUMMARY

Executive summary

a. What we do in this report

This report seeks to shed light on the nature of optimal regulation of the electricity distribution system operator (DSO) over the period to 2025 and beyond, following the implementation of the EU Clean Energy for all Europeans Package (Clean Energy Package or CEP) and its constituent parts: Regulation (EU) 2019/943 and Directive (EU) 2019/944.

We conducted two parallel surveys of DSOs and their national regulatory authorities (NRAs). The surveys were sent to DSOs and NRAs from 39 European countries. This produced 39 responses from DSOs and 12 responses from NRAs covering, respectively, 40% and 78% of customers in those countries.

We asked both DSOs and NRAs three sets of questions, under the following headings:

These were, first, **how can and should the system operator (SO) function of the DSO be defined and regulated?**

Second, **what can regulators and EU policymakers learn from transmission system operator (TSO) regulation that can be translated down to the DSO?**

Third, **how can regulators support the capacity of the DSO to operate and coordinate the system?**

Based on the surveys, we provide a more detailed comparison of six European countries to explore how they are supporting the transition to a more active DSO. We then discuss the nature of five example projects looking at the future of the DSO. These concern the role of the DSO in: the promotion of electric vehicle (EV) charging infrastructure; local gas and electricity decarbonisation (sector coupling); promotion of flexibility markets/assets (e.g. for constraint management and reactive power); information provision to facilitate longer-term planning; and smart energy system integration at a local/regional level.

Next, we outline a number of scenarios where we discuss the extent to which existing European legislation and its national manifestation is facilitating a more active role for the DSO. In each scenario we offer a perspective from the literature and from the types of issues raised by our surveys.

b. Our survey findings

Our survey findings are consistent with the observation that the move towards a more active role for the DSO remains a work in progress for both DSOs and their NRAs, given the fact that the CEP has only passed into European Law relatively recently and some Member States are still implementing its provisions.

While many DSOs and NRAs are doing things that are in line with the commitment of the EU to an expanded role for DSOs there is little evidence that this has progressed very far in terms of the quantities of congestion management (MWs) or reactive power (MVars) being procured, apart from in the UK.

Most DSOs have no competitive procurement of congestion management or reactive power. Much research activity is focused on trials which are themselves often at early stages and/or small.

DSOs and NRAs are not fully aligned on how the movement towards a more active DSO should be supported. This is hardly surprising since DSOs are – legitimately – interested in sufficient returns on their investments and NRAs are – legitimately – concerned with protecting consumers from unnecessary expenditure.

Many of our surveyed DSOs want more regulatory support in terms of higher rates of return or specific revenue allowances in return for higher technical and regulatory risks, while NRAs remain more uncertain about the potential of more active DSOs, and some are reluctant to provide financial or indeed technical support in the form of a regulatory sandbox or regulatory derogations.

Some DSOs and NRAs express concern about the prospects for the new EU DSO Entity. While it can learn from its transmission-level equivalent (ENTSO-E), enhance the role of the DSO across the EU and promote flexibility solutions, there is a worry that it will struggle to reconcile the very different situations faced by DSOs across Europe. There is an identified tension between it providing a unified voice and promoting a nuanced set of policies.

There are many trial projects underway at the local, national and EU level examining the future of the DSO. Many of these are intellectually exciting, but few are well known outside their own jurisdiction.

NRAs and smaller DSOs seem to be less willing or able to name projects whose results may be worthwhile. This raises the question of how the extensive learning arising from individual experiments related to the future of the DSO will be defused across Europe.

Strikingly, only 1 out of 12 NRAs and 1 out of 39 DSOs mentioned developments outside Europe as being of interest, in spite of the fact that there are many other DSOs (particularly in the US and Australia) who are among the leaders in elements of smart grid development.

Our detailed comparison of six European countries seeks to highlight how some countries making more progress with the active DSO are supporting this. This comparison reveals the positive impact of a more supportive environment – such as the provision of innovation funding and regulatory sandboxes – and the fact that there is not just one set of factors favouring the future of the DSO.

c. Future of the DSO projects and the state of knowledge

We then discussed the nature of five example projects looking at the future of the DSO. These were in the promotion of EV charging infrastructure, local gas and electricity decarbonisation (sector coupling), promotion of flexibility markets/assets (e.g. for constraint management and reactive power), DSO information provision to facilitate longer-term planning, and smart energy system integration at a local/regional level.

Next, we outline a number of scenarios where we discuss the extent to which existing European legislation and its national manifestation is facilitating a more active role for the DSO. In each scenario, we offer a perspective from the published literature and from the types of issues raised by our surveys. The scenarios allow us to highlight gaps in the Clean Energy Package.

d. Recommendations for the way forward

We suggest that **a major role for the new EU DSO Entity should be in evaluating, collating and spreading useful lessons from the DSO-related projects**, and using these to inform grid code development and its other areas of responsibility.

We find that there is significant disagreement on the answers to our questions about the future of the DSO between and within our sample of NRAs and DSOs in different countries. This suggests that **there is work for NRAs and DSOs to do in clarifying the best way forward for the DSO.**

The CEP **does not put any requirement on electricity DSOs to coordinate across gas and electricity networks, or offer any guidance on innovation funding arrangements** related to the future of DSOs. There is work to do in this area, in the light of European policy towards the future of gas and sector coupling.

Directive (EU) 2019/944 is **potentially open to wide interpretation on the role of the DSO in storage and in EV charging**, when the optimal role for the DSO in different circumstances remains unclear. There remain circumstances where the DSO should have a leading role in the development and provision of storage and EV charging facilities.

Both Directive (EU) 2019/944 and Regulation (EU) 2019/943 **promote the widespread use of competitive arrangements to procure flexibility services by DSOs, in spite of a lack of evidence of clear electricity consumer benefit.** NRAs need to prioritise the evaluation of evidence on the value of various competitive mechanisms handling procurement for such services.

We conclude that while the Clean Energy Package certainly aims to promote a more active role for the DSO, further regulatory clarification is required in order to interpret and implement the CEP.

01

INTRODUCTION

1. Introduction

As part of the Clean Energy for All Europeans Package, the EU recognised the rising importance of the electricity distribution system operator in the energy transition. This is because of the DSO's key role in managing the connection of increasingly distributed generation and flexibility resources (such as controllable demand and batteries), as required by the net zero by 2050 objective. The DSO would have to change from its traditional role as a passive one-way network – distributing electricity from bulk transmission grid supply points to final customers – to an active two-way network, increasingly involved in active procurement of flexibility resources within its network area. With the further electrification of transport and heating, this active role would increase even further. In addition, the DSO is likely to be involved in the local and regional integration of the energy sector, such as electricity, gas (including renewable and low-carbon gas) and heat. Thus, in fulfilling the Electricity Regulation 2019/943 requirement, the EU has created a legal entity to boost cooperation among electricity DSOs, mirroring ENTSO-E at the transmission level.[1]

The Electricity Directive (EU) 2019/944 sets out guidelines for the key tasks (outlined in Art. 31) that DSOs are expected to undertake in support of the common EU goal of decarbonising the energy system. DSOs have a duty to "*ensure the long-term ability of the system to meet reasonable demands for the distribution of electricity, for operating, maintaining and developing under economic conditions a secure, reliable and efficient system*". However, Art. 31 envisages the possibility that Member States allow the DSOs to perform other activities outside those indicated in the Directive if these are "*necessary for the fulfilment or their obligations*", provided that NRAs have assessed the necessity of such derogation. The Article also identifies the need for close consultation with relevant TSOs on a clear definition of products and services to be procured, as well as the need for DSOs to provide information so system users can easily access and use the distribution system.

The Directive also states that DSOs should be enabled and incentivised to use services from distributed energy resources (DER), based on market procedures in order to operate their networks efficiently and avoid costly network expansions. Art. 32 identifies the incentives for applying flexibility and the need for a transparent network development plan by the DSOs, while Art. 33 covers the integration of electromobility into the system. The tasks of DSOs in data management are covered in Art. 34 and ownership of energy storage facilities in Art. 36. Across the different areas of activity of the DSOs, some derogation to the Directive's requirements would be allowed in circumstances where services have to be procured from other parties, such as for energy storage (Art. 36) if, following appropriate tendering procedures, other parties have not been granted the right to own, develop, manage and operate such facilities, or could not provide the service *at reasonable cost and in a timely manner*. This situation would require an assessment by NRAs on the necessity of such derogation and might lead to more direct involvement by DSOs in these activities. With respect to EV charging points, derogations to Art. 33 of Directive 2019/944 are meant to support the installation of publicly accessible EV charging points in the event that a market-based approach fails to do this.

The Electricity Regulation (EU) 2019/943 updates the provisions of Regulation (EC) No714/2009 in order to promote the achievement of decarbonisation goals, in light of recent technological developments giving consumers a more active role in the electricity market. Among other objectives, the Regulation aims to promote increased efficiency in the Union's distribution networks, and to facilitate full participation of consumers in the market, on equal footing with other market participants. Several chapters of Regulation 2019/943 are relevant to the future of DSOs.

[1] See https://www.eudsoentity.eu/

Chapter III (Art. 18 and 19) covers network charges and congestion income. Art 18(2) covers methodologies with explicit reference to the objective *"to facilitate innovation in [the] interest of consumers in areas such as digitalisation, flexibility services and interconnection".* Chapter IV provides guidance on distribution system operation and sets governance rules and tasks for the newly established EU DSO Entity in Art. 52-55, while Art. 56 covers consultations in the network code development process. Guidelines for cooperation between DSOs and TSOs are provided in Art. 57. The provisions in Chapter VII on network codes and guidelines and on smart metering rules are also relevant to the future of DSOs.

While Member States are still in the process of transposing the CEP's guidelines into national legislation, since the CEP was originally drafted in 2015-16 the level of ambition on environmental and sustainability goals has increased significantly at the EU and national levels. Consideration is now being given to the possibility that some energy-related legislation, such as the Renewables Energy Directive[2] (2018), might require revisions and amendments. The heightened level of ambition in the European Commission is well illustrated by the recently developed strategies on sector coupling[3] and hydrogen[4]. This suggests that, while the CEP was a significant step forward, it is already in need of review thanks to significant developments since 2016.

In this context, this report sets out to address three research questions:

1) How can and should the system operator function of the DSO be defined and regulated?
2) What can regulators and EU policymakers learn from transmission system operator regulation that can be translated down to the DSO?
3) How can regulators support the capacity of the DSO to operate and coordinate the system?

We address these questions through two parallel surveys conducted with DSOs and national regulatory authorities across Europe, with the aim of looking at the long- to medium-term future of DSOs, going beyond the implementation of current legislation.

Drawing on the responses to our surveys, we identify a number of case studies in which DSOs are developing innovative or notable approaches to a more active role for the DSO in an electricity system consistent with the EU's net-zero emissions target.

The aim of the paper is to suggest how regulation of the DSO, in light of the CEP, can be improved in the period to 2025 and beyond. We take 'optimal regulation' to be a situation where no obvious improvements can be made based on the starting position. Now is a good time to look at this because even though the CEP has recently clarified the starting position, it has initiated a period of implementation, interpretation and experimentation across Europe. Furthermore, we interpret the concept of regulation as the set of incentives that regulators can put in place to reward the regulated companies for their performance, and to promote changes in their behaviour which will contribute to achieving national and EU-level objectives.

In our analysis of current and future regulation, we also rely on the concept of social welfare as commonly used in economic theory, which is the total social benefit from consuming a good minus the total social cost of producing it. Social welfare is maximised when the conditions of 'Pareto optimality' (or social efficiency) are satisfied, i.e. no individual can be made better off without someone else being made worse off (see Sloman et al. 2012).

[2] https://ec.europa.eu/energy/topics/renewable-energy/renewable-energy-directive/overview_en
[3] https://op.europa.eu/en/publication-detail/-/publication/60fadfee-216c-11ea-95ab-01aa75ed71a1/language-en
[4] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0301&from=EN

Following this introductory chapter, Section 2 provides a general description of the survey participants. Section 3 discusses the general survey questions about the future of DSOs. Section 4 covers the survey questions relating to lessons for changes to DSO regulation that can be learnt from transmission (and other) regulation. Section 5 reports the results from the survey questions on the role of the regulator and DSO itself in facilitating the move towards a more active role for the electricity DSO. Section 6 provides a detailed comparison of the regulatory environment in six countries based on the survey results. Section 7 summarises the main findings from the surveys. Section 8 presents a selection of case studies – as put forward by survey participants – which showcase a more active role for the DSO. Section 9 presents a number of scenarios exploring the extent to which existing European legislation, and its national manifestation, is facilitating a more active role for the DSO. Section 10 draws the final conclusions of the report.

02

INFORMATION ABOUT THE SURVEYS AND RESPONDENTS

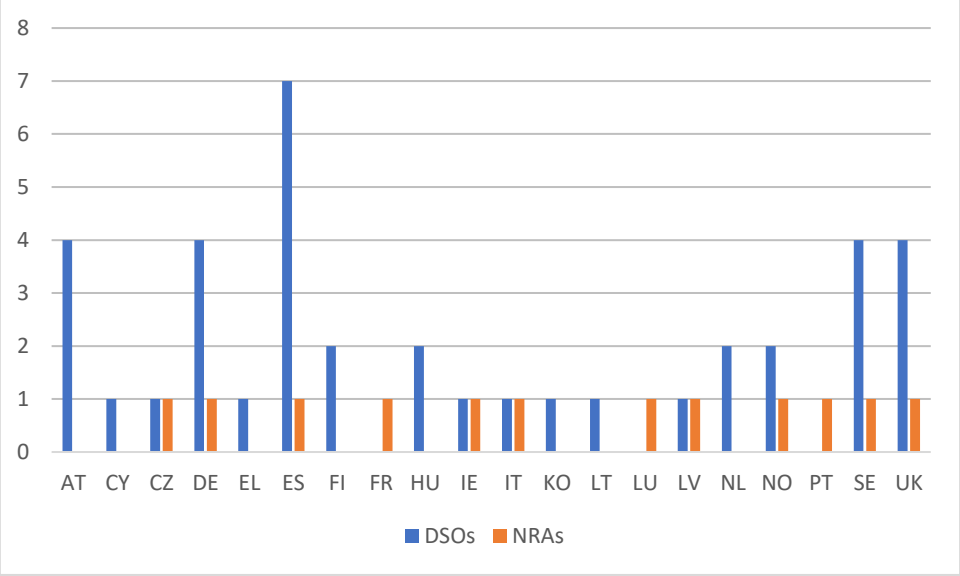
2. Information about the surveys and respondents

Two similar surveys were designed, one for DSOs (including energy network associations) and another for national regulatory authorities. The survey aimed to capture their views regarding: (1) the future of the electricity DSO including new roles, coordination with other parties and potential lessons from TSOs; (2) how regulators and EU institutions can support the move to the DSO; and (3) best practices that reflect the future DSO. Many of the DSO and NRA survey questions were the same or similar. Those that differed related to what DSOs think of their NRAs, and vice versa. The DSO and NRA survey templates can be found in Appendix 1 and 2, respectively.

We received a total of 51 responses from DSOs, energy associations and NRAs, covering 20 European countries, over the period August to December 2020.

The overall number of responses from individual DSOs was 37, while 2 responses were from energy networks associations (from the UK and Sweden[5]). For 5 countries, we have only 1 response from the largest DSO in the country[6]. We also had responses from representatives of 12 NRAs. For 9 countries we have received responses from both DSOs and NRAs[7]. The Spanish regulator oversees the activities of 7 DSOs in our survey, the German regulator oversees the activities of 4 DSOs, 3 are overseen by the Swedish and UK regulators (if we exclude the Swedish and British associations who took part in the survey) and 2 by the Norwegian regulator. The Czech, Irish, Italian, and Latvian regulators oversee the activities of a single DSO each in our survey.

Figure 1 – Number of respondents by country



In our analysis, we have separated the DSOs by size into 3 categories: those with more than 1 million customers (labelled as large), those with less than 1 million but more than 100,000

[5] We include these in our count of DSO responses, as in both cases they represented at least one non-responding DSO and hence we were not double counting responses.
[6] According to CEER (2019b), in 2018 there were around 2500 DSOs operating in the EU and Norway, of which around 2200 have fewer 100,000 customers.
[7] Out of the 883 DSOs in Germany only 182 are regulated by the Federal Network Agency BNetzA, with around 700 being subject to regulation at the State level (Bundesnetzagentur, 2019).

(labelled as medium) and those with 100,000 or fewer customers (labelled as small)[8]. We count the electricity association responses as large DSOs. Among our respondents, 17 were large DSOs, 15 were medium ones and 7 have 100,000 or fewer customers, as illustrated in Figure 2. Of the 37 DSOs included in our analysis, 15 operate both gas and electricity networks.

Figure 2 – DSO by size (number of customers)

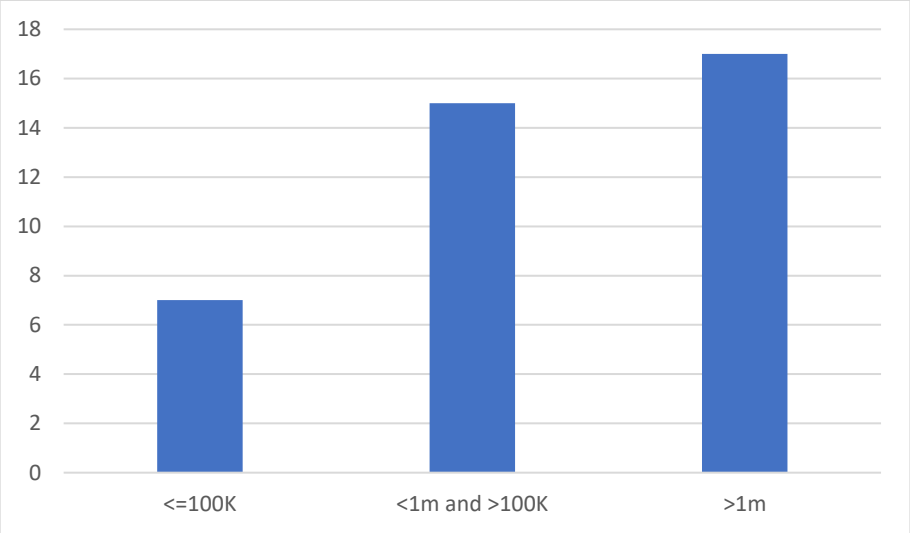
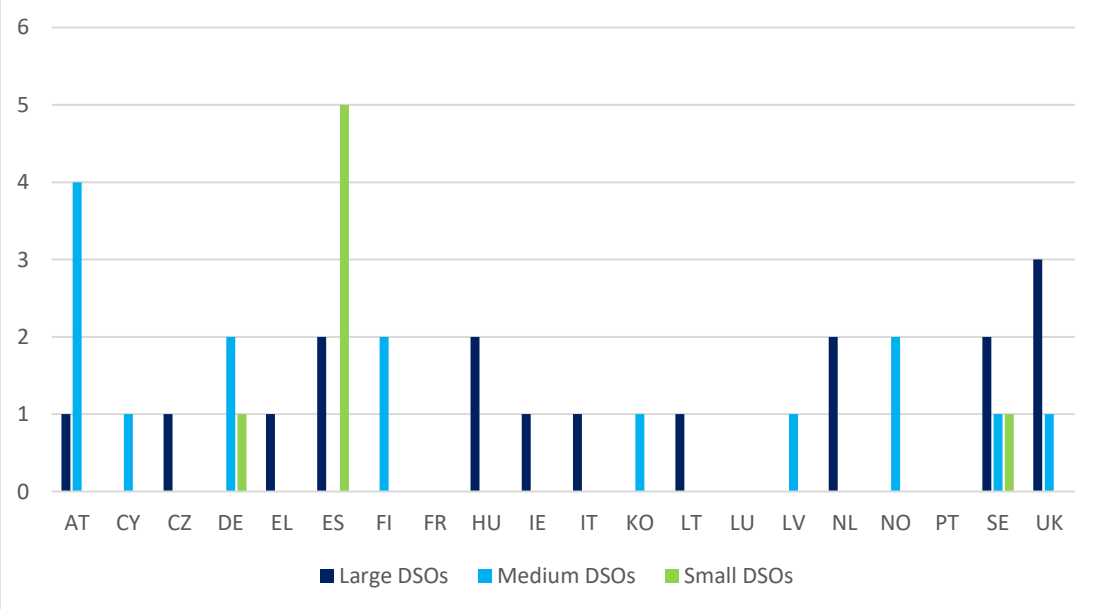


Figure 3 shows the number of DSOs who responded to our survey by country and size.

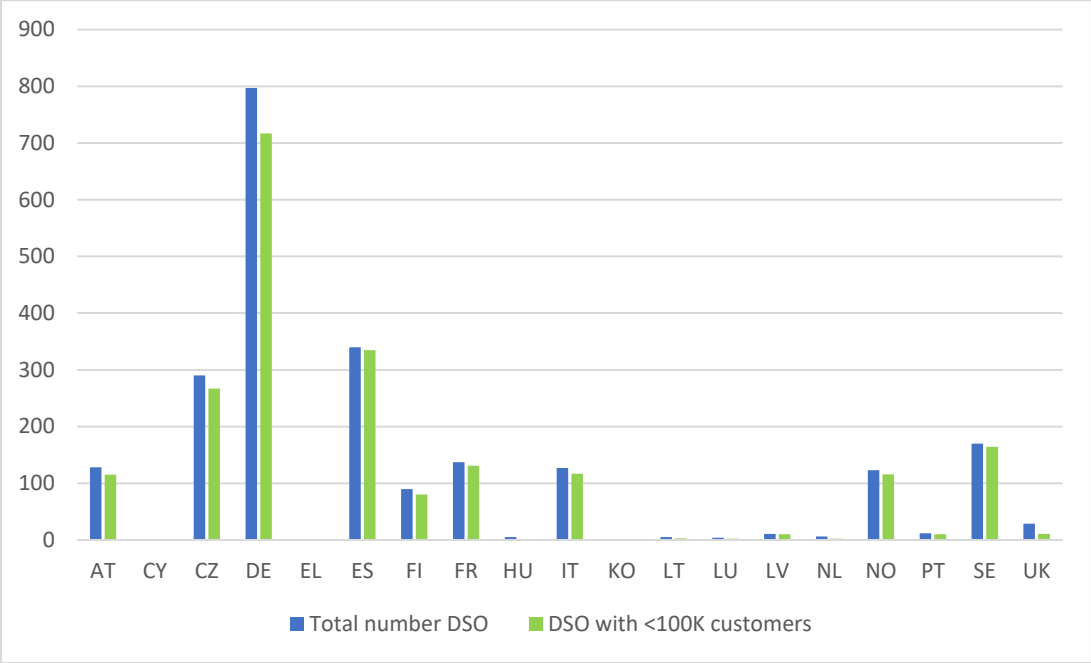
Figure 3 – Number of DSO respondents by country and size



[8] This is an arbitrary choice of threshold which puts the size of some of our respondents on the borderline between two of the categories.

For the countries of the respondents, we report below the total number of (electricity) DSOs in blue and the number of DSOs serving fewer than 100,000 customers in green. The graph shows that the distribution of DSOs in European states is characterised by the presence of a large number of DSOs in some of the countries, with many DSOs having fewer than 100,000 customers.[9]

Figure 4a – Number of DSOs by country and size

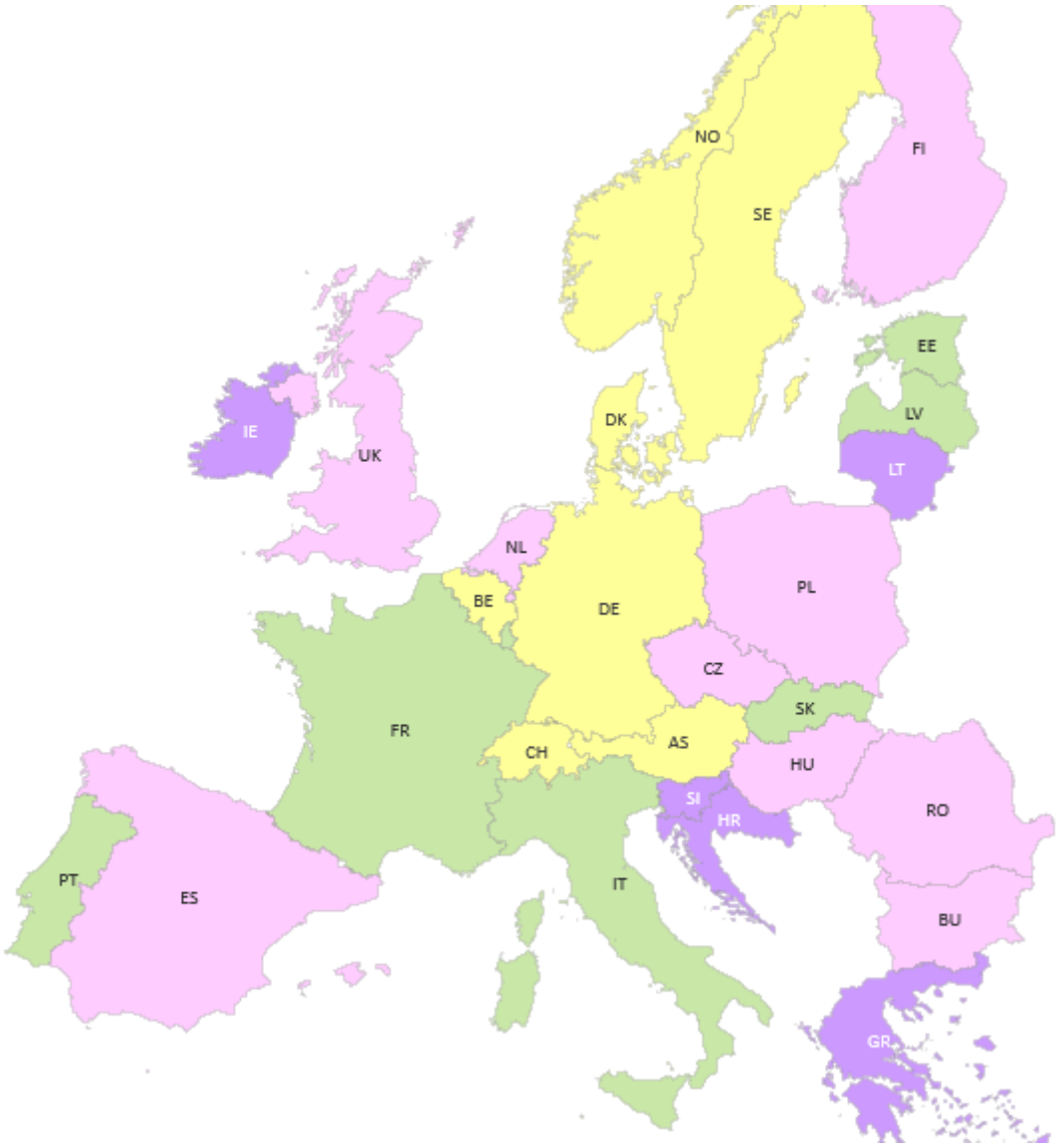


Source: CEER (2019b) and ARERA (2019)

Figure 4b illustrates the levels of DSO concentration in different European countries (on the basis of the proportion of distribution power delivered).

[9] The comparison of Figure 2 and 3 reveals that in some of the countries the number of DSOs is larger than the number of respondents, so their responses might not be representative of all DSOs in the country.

Figure 4b – Level of DSO concentration in Europe



Low concentration	Medium concentration	High concentration	Very high concentration
Small and local DSOs. The three largest DSOs usually deliver less than 50% of distributed power	A mix of DSOs, with the three largest accounting for more than 60% of distributed power	One dominant DSO (more than 80% of distributed power) and several local DSOs	one DSO company

Source: Eurelectric (2020), slide number 4 (adapted)

The table below indicates that the total number of customers served by the DSOs in our survey is about 125 million, with the large majority (about 93%) served by the large DSOs.

Table 1 – DSO responses to the survey[10]

DSOS	LARGE DSO	MEDIUM DSO	SMALL DSO	TOTAL
Number of DSOs	17	15	7	39
Number of customers (mi)	116.2	8.0	0.2	124.6

More than 2000 DSOs operate across the 12 countries from which we had NRA respondents, serving more than 220 million customers[11]. Thus, the DSO sample covers 40% of customers and our NRA sample covers 78% of customers, across the 39 countries which are either members or observers of CEER[12].

Table 2 – NRA responses to the survey

NRAS	
Number of NRAs	12
Total number of regulated DSOs[13]	2030[14]
Total number of customers involved (mi)	225

[10] We include electricity associations in the large DSOs and count their additional national customer numbers (over and above any of their constituent firms in the sample) in the large company customer numbers.
[11] Based on the ACER (2020) report on retail markets, it is estimated that there are around 290 million electricity customers in the CEER area, by which we mean CEER member countries and countries with observer status. The membership of CEER includes the 27 EU Member States plus UK, Norway and Iceland. The 9 countries with observer status are Albania, Bosnia Herzegovina, Georgia, Kosovo, Moldova, Montenegro, Republic of North Macedonia, Republic of Serbia and the Swiss Confederation.
[12] Answers to the survey were obtained from 20 of the 39 countries surveyed.
[13] As revealed by Figures 1 and 4a regulators in different Member States regulate a different number of DSOs.
[14] This figure has been calculated on the basis of the number of DSOs reported by the relevant NRAs in our survey. The figure includes the DSOs who are regulated at the State level rather than just those who are regulated by the national regulator.

03

GENERAL SURVEY QUESTIONS ABOUT THE FUTURE OF THE DSO

3. General survey questions about the future of the DSO

The pursuit of ambitious decarbonisation objectives at the European level and the associated increase in decentralised activity from variable renewable energy resources is creating challenges in network operations and planning at the local, regional and national level across European countries. The ongoing transformation of the energy system has started affecting the traditional network activities of DSO companies managing local integrated energy systems. Activities such as congestion management, reactive power, the relationship and information flows with TSOs[15] and gas and heat DSOs. In addition, the transformation and pursuit of decarbonisation objectives is likely to affect electricity DSOs' activities across a broader range of areas thanks to developments in sectors such as e-mobility and peer-to-peer (P2P) trading, but also across energy sectors due to heat decarbonisation and sector integration processes.

The CEP has started establishing principles and guidelines that will be used by policymakers and market players during the transition to decarbonised energy systems. These principles have been more precisely stated and developed in the Electricity Regulation (2019/943)[16] and the Electricity Directive (2019/944)[17], which will be used by national legislators and regulators to transpose and implement EU legislation nationally. These principles and guidelines envisage new roles being taken by DSOs, although within existing unbundling rules that aim to keep natural monopoly activities separated from potentially competitive areas.

In a traditional centralised energy system, DSOs would mainly be involved in natural monopoly activities with many of them being subject to the economic regulation, which is based on the principles of market liberalisation, developed within the first three energy packages. The CEP envisages a more active role for DSOs as they are identified as neutral market facilitators in the provision of a variety of services supporting the management of their local and regional energy systems, as well as the transmission grid. The emergence of these new roles and services is an opportunity for innovation in regulation, potentially relying on tools such as sandboxes and demonstration projects[18], involving regulators, regulated companies and new market actors, in order to identify efficient and novel regulatory frameworks.

When considering new roles for the DSOs it is important to remember that European DSOs differ substantially both in terms of their size and of the extent to which they are unbundled. This implies that they might not currently have the resources and competences to undertake a new role as 'neutral market facilitators' without outsourcing some of their activities to, or cooperating with, other DSOs in their area.

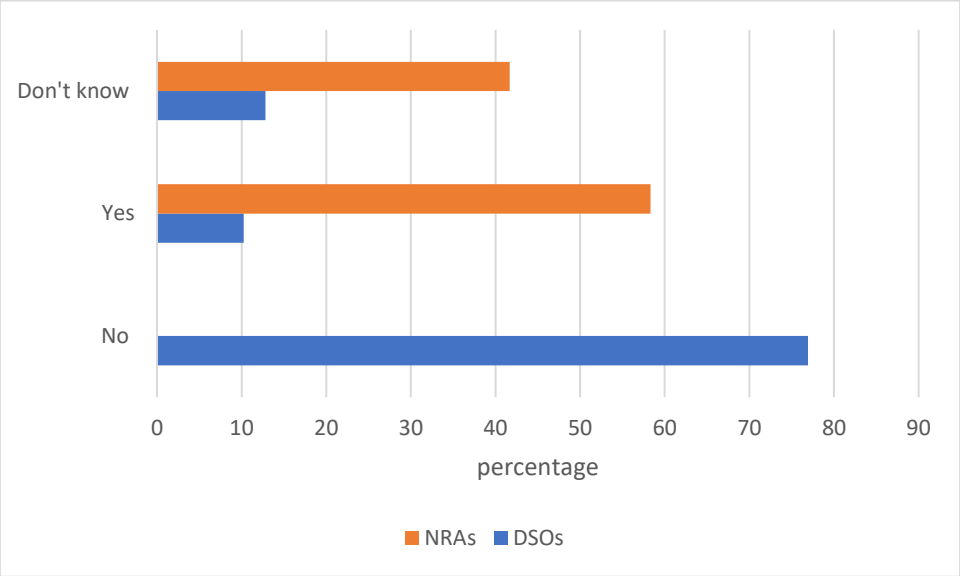
Question 5 in the DSO survey (Question 6 in the NRA survey) addresses the possibility of developing a 'system operator function', distinct from network-based activities which are subject to a well-established and specific regulatory framework.

[15] A discussion of the role of market and regulatory factors in the adaptation of European DSOs can be found in Pereira et al. (2020).
[16] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019R0943&from=EN
[17] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019L0944&from=EN
[18] It should be noted that the small scale of these activities might limit their ability to effect significant changes once scaled up. Sandboxes may not have the scope to really foster change, and demonstration projects may be not scalable if not properly designed.

Is a separate system operation function a requirement for the achievement of decarbonisation objectives? *(Q5DSO, Q6NRA)*

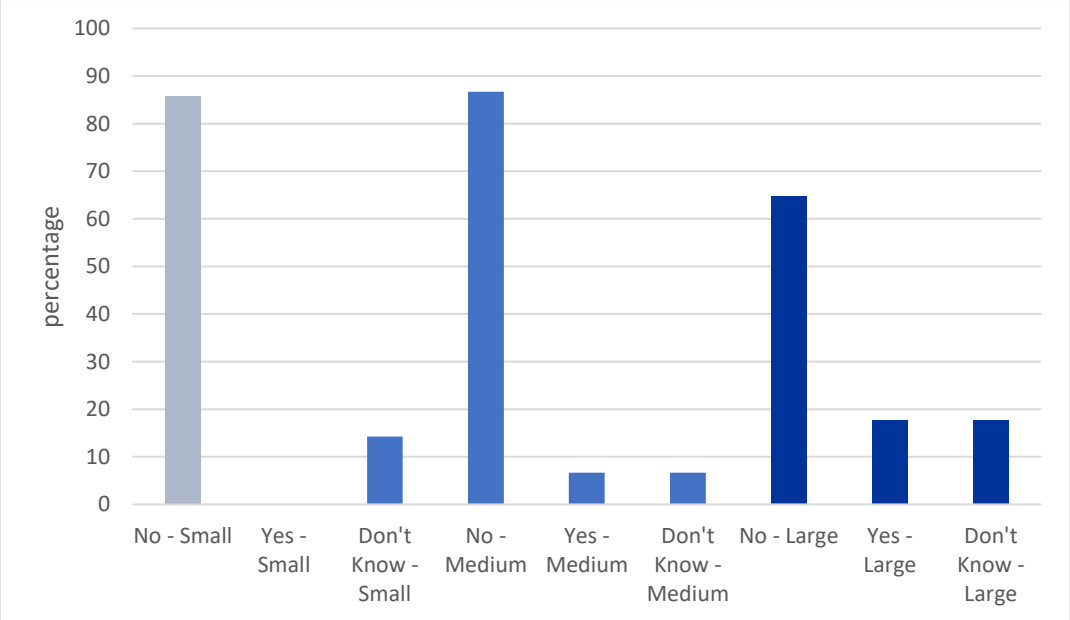
Here, we identify a clear discrepancy in the views of DSOs and NRAs. A clear majority of DSOs (77%) oppose such a separate role, while the majority of NRAs (7 out of 12) are more positive about it, with the remaining 5 unsure whether this separation should be supported.

Figure 5 – Should there be a separate system operation function?



When we look in more detail at responses by DSO size, opposition to a separate SO function is more pronounced, with a large majority of small (86%) and medium DSOs (87%) not supporting it, and only 18% of large DSOs in favour.

Figure 6 – Should there be a separate SO function? DSOs by size



In the additional comments about this question, the need for continued regulation of monopoly activities was highlighted by some DSOs: *"Although stronger elements of competition have been introduced in the provision of network capacity, strong regulatory frameworks and structures are still needed for the active network planning and [for the] operation of the system in real time to make control possible."* Attention was also brought to the fact that small DSOs might need to procure services from other DSOs (however the possibility of them merging was not mentioned).

NRAs, on the other hand, highlighted the key role of DSOs as market facilitators for the provision of services, but also the need for neutrality and independence from non-system operator roles, especially in relation to the procurement of flexibility services. Interestingly, one of the respondents raises the issue of whether the separation of the SO function was "*the most efficient way to mitigate climate change or whether a whole system approach (including gas, heating and cooling) could be more beneficial".* According to another NRA, this function should be established gradually and also be conditional on the development of new business models.

The potential DSO role across a range of distribution grid-connected activities *(Q6-Q13DSO, Q7-Q14NRA)*

The current structure of European distribution networks is characterised by passively operated systems which in the past have required limited active management activities beyond network maintenance and reinforcement, and voltage control. Furthermore, the management of network data is often limited to providing technical information about network conditions. The expected transformation of energy systems due to increased penetration of variable and non-dispatchable generation will require the development of new competences with the possibility that DSOs might need to own and operate new assets, procure new services on a competitive or contractual basis, and manage data from consumers and prosumers. While this transformation is not expected to happen immediately, over a medium- to long-term horizon it should be expected that opportunities will arise for DSOs to be involved in a broader range of activities – relating to e-mobility and gas decarbonisation, for instance – than is currently the case.

A series of questions in our survey attempt to investigate the potential role of DSOs in relation to these emerging areas of activity by considering different forms of DSO involvement including ownership and operation, platform management, market-based procurement, and bilateral contracts. While the current regulatory system limits the ownership options at the distribution level, with DSOs playing the role of neutral market facilitators, the literature on this issue does not have clear-cut answers, with some contributions questioning the benefits of these arrangements in terms of retail competition and network quality. Nillesen and Pollitt (2021) review the theoretical arguments for and against ownership unbundling at the distribution level (in the context of distribution and retailing unbundling) and assess the evidence from New Zealand and the Netherlands showing limited benefits from forced ownership unbundling in these two countries.

The guidelines contained in the relevant articles of the Electricity Directive and the Electricity Regulation with respect to the provision of flexibility services are expected to be carried out by market players via a competitive procurement process facilitated by DSOs (Electricity Directive 2019/944, Art. 32), unless NRAs establish that market-based procurement is not economically efficient (i.e. that it would lead to market distortions and higher congestion). This could be due to the local circumstances in different Member States and would justify considering alternative non-market-based processes. In our survey, on this issue and others, we have suggested a broader set of options beyond market-based procurement in order to account for the experiences and future needs of the different DSOs participating in the survey. We also elicit the views of NRAs who will be required to support the implementation of the CEP at the Member State level.

As some of the proposed options are common to different DSO activities considered in the survey, the tables below attempt to summarise the views of DSOs and NRAs regarding the way in which the different activities could be effectively managed in their jurisdictions.

Table 3 – Electricity DSO's role: summary of DSOs' responses

OPTIONS	ENERGY STORAGE	CONGESTION MANAGEMENT	REACTIVE POWER	EV CHARGING POINTS	P2P TRADING
None	0%	0%	0%	36%	10%
Own	62%	56%	69%	26%	13%
Operate	67%	56%	72%	33%	26%
Competitively procure	79%	82%	67%	33%	21%
Non-market-based procurement	44%	46%	38%	13%	N/A
Manage platform	N/A	44%	31%	N/A	N/A
Provide data	N/A	N/A	N/A	N/A	64%
No response/Not sure	8%	5%	8%	15%	18%

Note: Multiple answers were allowed so the total by column is likely to exceed 100%

Table 4 – Electricity DSO's role: summary of NRAs' responses

OPTIONS	ENERGY STORAGE	CONGESTION MANAGEMENT	REACTIVE POWER	EV CHARGING POINTS	P2P TRADING
None	0%	0%	0%	42%	33%
Own	0%	8%	33%	8%	8%
Operate	25%	17%	50%	8%	8%
Competitively procure	83%	67%	58%	17%	8%
Non-market-based procurement	33%	33%	50%	8%	N/A
Manage platform	N/A	42%	33%	N/A	N/A
Provide data	N/A	N/A	N/A	N/A	67%
No response/Not sure	8%	17%	17%	33%	0%

Note: Multiple answers were allowed so the total by column is likely to exceed 100%

The responses of DSOs and NRAs are broadly consistent in identifying a potential role in different activities with some limitations regarding EV charging points, where 42% of responses from NRAs and 36% from DSOs suggest that DSOs should not be involved. One third of respondents from NRAs also do not support DSO involvement in services for P2P trading. Among both DSO and NRA respondents, more than half (64% and 67% respectively) indicate that DSOs should supply data to support P2P trading activities. A majority of both DSOs and NRAs support competitive procurement of services for energy storage, congestion management, and reactive power. A minority of both DSO and NRA responses also support a role for DSOs in managing platforms for both congestion management (44% and 42% respectively) and reactive power (31% and 33% respectively).

Table 5 – Number of options chosen: DSOs' responses

OPTIONS	0*	1	2	3	4	5
Energy storage	8%	18%	15%	33%	26%	N/A
Congestion management	5%	16%	22%	27%	16%	19%
Reactive power	8%	10%	23%	28%	18%	13%
EV charging points	51%	18%	10%	15%	5%	N/A
P2P platform	28%	41%	15%	10%	5%	N/A
Supply of flexibility	23%	28%	49%	N/A	N/A	N/A

* This category includes those respondents who selected the option 'None', meaning no role for DSOs in this area, and those who did not provide an answer to the question (No answer/Not sure). The percentages for the two options are reported separately in Table 3.

Table 6 – Number of options chosen: NRAs' responses

OPTIONS	0*	1	2	3	4	5
Energy storage	8%	50%	33%	8%	0%	N/A
Congestion management	17%	25%	33%	25%	0%	0%
Reactive power	17%	17%	17%	25%	25%	0%
EV charging points	75%	8%	17%	0%	0%	N/A
P2P platform	33%	50%	8%	8%	0%	N/A
Supply of flexibility	17%	75%	8%	N/A	N/A	N/A

* This category includes those respondents who selected the option 'None', meaning no role for DSOs in this area, and those who did not provide an answer (No answer/Not sure). The percentages for the two separate options are reported in Table 4.

When considering the range of activities in which DSOs could potentially become involved over the medium to long term, we have received additional comments by both DSO and NRA respondents which clarify their position and offer, in some cases, additional points supporting their choices in the survey.

On DSO ownership of energy storage assets, one Italian NRA cites a CBA study from the University of Cagliari which finds no net benefits of DSOs owning storage assets except when storage size is limited or there is low renewable energy (RES) penetration at the low-voltage (LV) level and in rural/remote areas. They also point out that the Electricity Directive leaves limited room for DSOs to own and operate storage assets, but our survey has attempted to consider longer-term issues and therefore options which are not currently included in existing legislation. Some DSO respondents, on the other hand, consider 'own and operate' as the most efficient model, although only as a technical function[19] and not for the purpose of trading energy. Other NRA respondents point out that the 'own and operate' mode will be allowed if specific derogations are identified as in the case of the Scottish isles or depending *"on networks and system needs".*

The common thread across several comments by DSOs regarding **congestion management** is the need to rely on the market-based provision of flexibility services where possible, i.e. where liquid markets exist, and implementing 'administrative allocation' or 'bilateral contracting' where these liquidity conditions are not met. The ownership of assets in the view of several respondents should

[19] This would however require a cost-benefit analysis being undertaken.

be limited to network assets, potentially including batteries but not power to gas. The role of DSOs is also seen as related to the management of data platforms and flexibility registers. Some NRA respondents commented on specific situations in their own country.

The additional comments on the DSOs' role in relation to **reactive power** (in this case from both DSOs and NRAs) focused on the nature of grid-connection contracts and the need to establish clear requirements in these agreements. Several DSOs see their role in the context of both congestion management and reactive power as a technical one involving monitoring and operating control devices, while also procuring services from third parties both via market and non-market processes. It was also suggested by one respondent that DSOs should be allowed to own non-generating assets (such as STACOMS, capacitor banks, synch compensators, etc.) for the purpose of voltage regulation. The case of Finland is interesting in this context as DSOs provide reactive power to business customers who are charged for this service as part of their tariff. One NRA respondent highlighted the fact that reactive power services are localised and might not generate sufficient liquidity for market-based options, although it can be argued that this is not unique to reactive power and can apply to congestion as well.

The responses of 36% of DSO representatives and 42% of NRAs indicate that DSOs should play no role in **EV public charging points** or infrastructure. The associated comments highlight that this is potentially a competitive service which does not require direct DSO involvement, possibly aside from providing connection and allocating capacity, and in situations of proven market failure. It was also pointed out that DSOs should have no involvement in energy trading from these facilities. However, an important role is identified in the provision of technical information about the potential location of charging sites in a similar way to the process for distributed energy resource (DER) connections. Other respondents pointed out that DSOs should take measures that limit the impact of charging activities on the grid and that the cost of connection should reflect the expected cost to the network. Some DSO and NRA respondents indicated that a non-discriminatory approach should be adopted for the connection of EV charging points to the system, in a similar way to other connection requests[20], while acknowledging that ownership of charging points could be allowed in specific and possibly temporary situations.

When considering the potential role of DSOs in **P2P trading** most DSOs and NRAs agree that DSOs need to play an important role in the provision of data about network conditions and metering in order to facilitate sharing and trading. It was pointed out that current unbundling rules would not allow further involvement beyond a neutral role. Indeed, according to the current unbundling rules DSOs are not allowed to be involved in energy sale through local P2P trading platforms. The extent of their required involvement would be limited to post-trading constraint management if these platforms operated as unconstrained markets, as wholesale markets currently do. However, DSOs' direct market involvement might need to be more substantial if local platforms were to operate as constrained markets, which are subject to local network capability limitations (Baker, 2020). Only a few of the respondents envisaged the possibility that DSOs could own and operate platforms for P2P trading.

[20] As requested by Directive 2014/94/UE Art. 4(11)

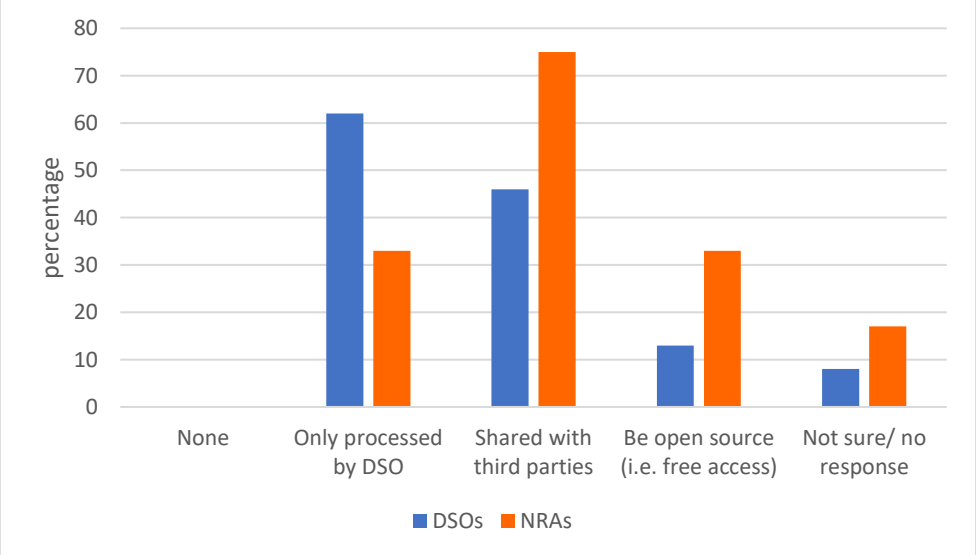
DSOs' role in network data management *(Q9DSO, Q10NRA)*

In the transition from a passive network with unidirectional energy flows, DSOs will need to perform more complex network management tasks involving the monitoring and control of network assets. This requires more demanding data acquisition, monitoring and management process. Furthermore, as **neutral** market facilitators, DSOs will also need to support TSOs and third parties who provide local resources and services through market-based processes. Given the sensitivity of this role it is possible that NRAs might impose additional security requirements on regulated DSOs.

When considering the potential role of DSOs in the management of network data, the views of DSO and NRA representatives differ. While 62% of DSOs' responses favour exclusive management by DSOs[21], 75% of NRA responses support data being shared with third parties, an option supported by 46% of DSOs. Meanwhile, DSO respondents limited the range of acceptable DSO activities to a maximum of two, with a majority (64%) selecting only one option. One of the NRA respondents considered all three options as feasible for DSOs to carry out, while one NRA respondent did not choose any of the options available.

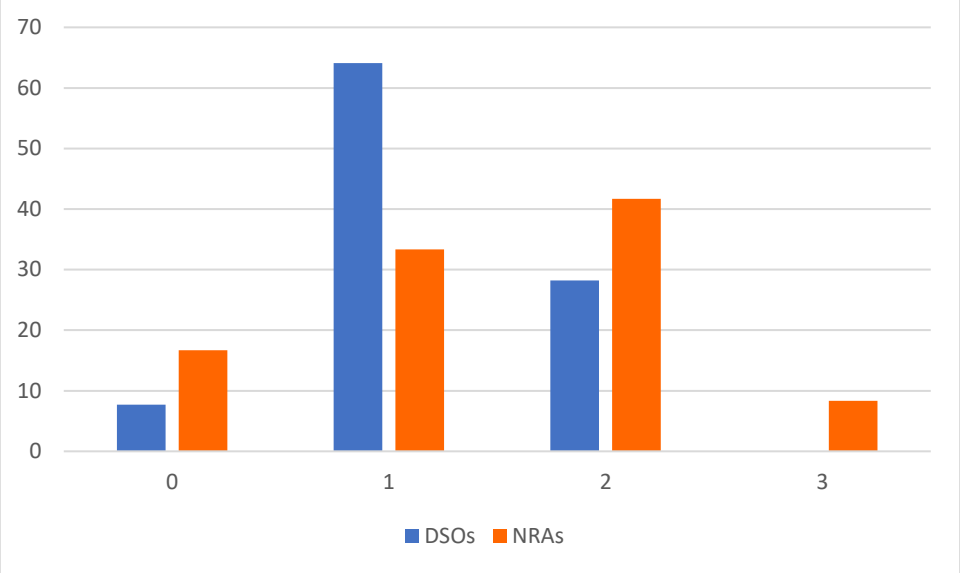
The open comments about DSOs' role in the management and provision of network data focus on the need for data-sharing between TSO and DSO actors, and the role of DSOs in providing data to third parties and market operators involved in supplying services for the grid. One of the respondents pointed out that network data should include technical data about network conditions only, excluding any metering data at point of delivery (data which would require customer consent to be shared with third parties). However, other respondents raised the point that DSOs' future key role as neutral market facilitators implies duties and responsibilities to provide data to market players, potentially generating challenges in terms of ensuring that data protection rules are not violated. It is important to consider, as highlighted by one NRA, that there are different categories of data, some of which could be shared with third parties, potentially in aggregate form, and other data that needs to be kept confidential.

Figure 7 – Electricity DSO role in network data



[21] According to the current regulation (Electricity Directive 2019/944) this option would allow access to data by third parties with prior authorisation by the customer.

Figure 8 – Number of options chosen: network data*

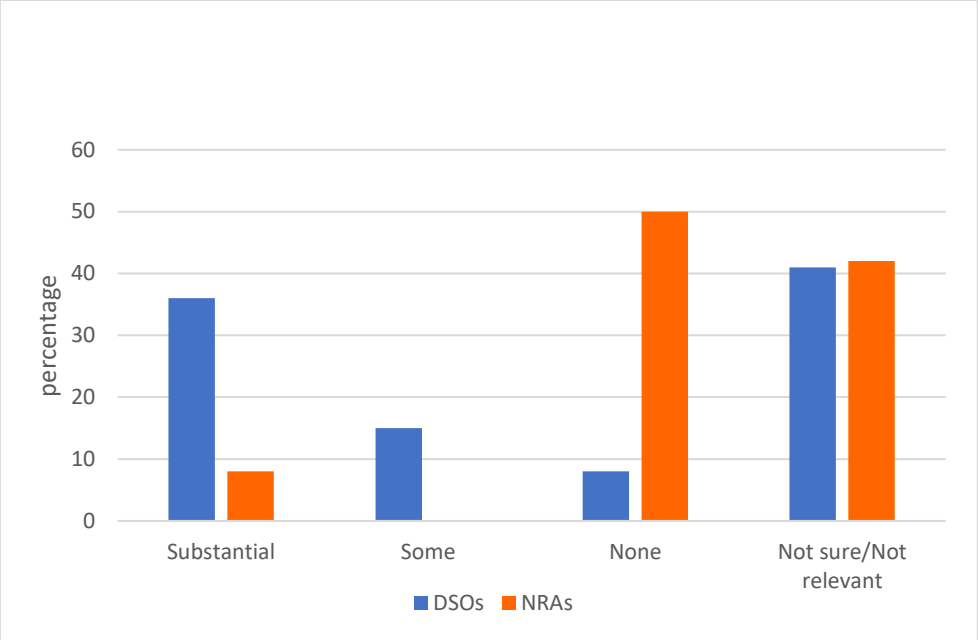


*Note: number of respondents who chose none, one, two or three among the options available for this question. Options were: 'only processed by DSO', 'shared with third parties', 'be open source'.

The role of DSOs in the gas decarbonisation process is seen by respondents in terms of how it supports the heat electrification process, which is likely to create challenges for the electricity system and will require network reinforcement: *"Enabling a larger electrification of final energy consumption, according to EU GHG reduction targets, through grid reinforcement and advanced network operations."* On the gas side there is a recognition that power-to-gas processes can be used as tools for load control.

It was also noted that gas DSOs might need to ready the system for hydrogen input and be prepared to manage gases of different qualities as part of the decarbonisation process. Ireland offers a good example of a decarbonisation plan that involves both the TSO and DSOs in the implementation of the Climate Action Plan: *"The Irish TSO and DSO have a crucial role to play in the successful delivery of this vision for Ireland's future."* Adding that:*" Ireland's NECP 2021-2030 […] proposes to ban the installation of gas boilers from 2025 and that a review will assess how and when the replacement of oil and gas boilers in existing dwellings (domestic and commercial) could commence. In addition, the plan proposes to design policy to get circa 500,000 existing homes to upgrade to B2 Building Energy Rating and 400,000 to install heat pumps."*

Figure 9 – Electricity DSOs role in gas decarbonisation



DSOs' role in the supply of flexibility services *(Q13DSO, Q14NRA)*

Our question about the role of DSOs in the supply of flexibility services to the TSO focuses on the new tasks likely to be undertaken by DSOs a result of a more complex and dynamic local energy system, however we recognise that network investment might still be required in situations where flexibility services are not supplied by other market actors, such as in local markets characterised by limited liquidity.

Regarding the much-debated role of DSOs in the supply of flexibility, the views are split among the regulators with 42% who support the use of DSOs own assets and 50% who support the use of third parties' DERs. It is interesting to note that 75% of NRA respondents (9 out of 12) selected only one of the two options, while 49% of DSOs selected both, although revealing a slight preference of the use of third parties' assets (64% vs. 62%).

In line with the percentages of responses reported above, different views are expressed in the comments by both groups of respondents. A few respondents see the role of DSOs being limited to the provision of data to facilitate DER's ability to provide flexibility services to the DSOs, while others point to the possibility of DSOs aggregating local flexibility resources offered to the TSO. This view is opposed by respondents who see a role for the current so-called balancing service provider (BSP) as an intermediary rather than this role being given to DSOs. One NRA points out that the role of DSOs should be in clearing third party assets so they are available to TSOs, rather than supplying the services directly, while another indicates the need for more regulation if the options to use 'own assets' or DER assets were to be allowed.

Several comments highlighted the need for good TSO-DSO cooperation in this area, with the suggestion that markets at the distribution and transmission level could be integrated. An expectation was also expressed that the cost of flexibility should be borne by the connected party causing the constraint.

Figure 10 – Electricity DSOs role in flexibility supply

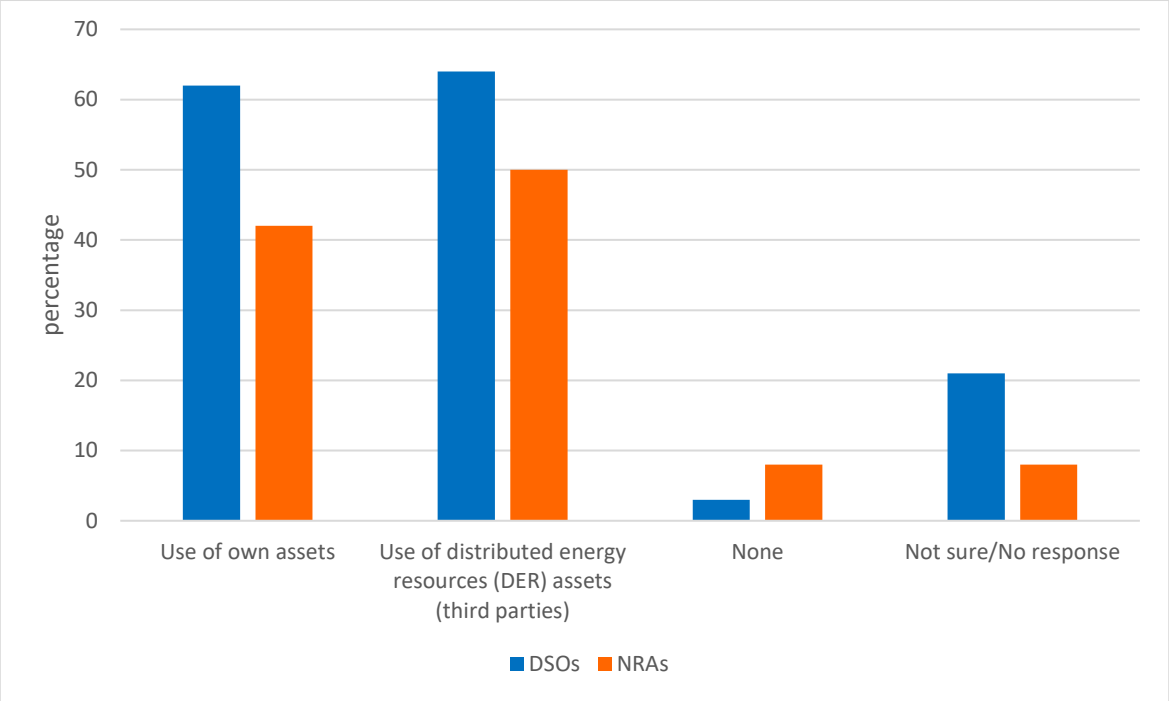
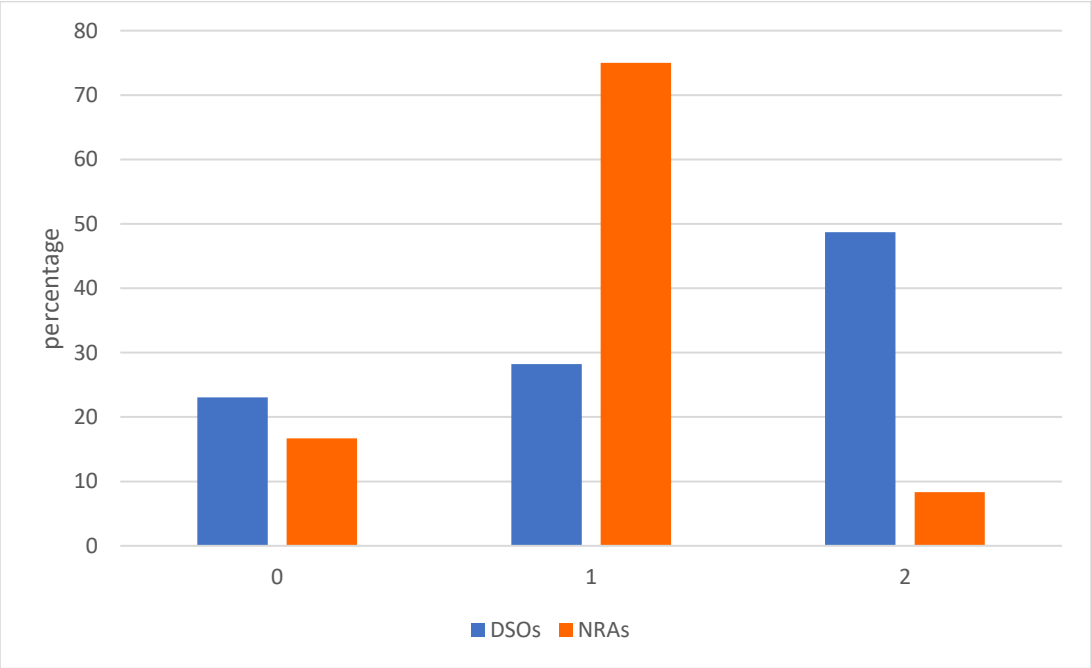


Figure 11 – Number of options chosen: flexibility supply*



*Note: number of respondents who chose none, one or two among the options available for this question. Options were: 'use of own assets' and 'use of DER assets (third parties)'.

Should regulators promote more TSO-DSO coordination? *(Q14DSO, Q15NRA)*

The increased decentralisation of energy systems is likely to affect the respective roles and data flows between TSOs and DSOs in the areas of congestion management and provision of flexibility services, leading to the expectation that a higher degree of coordination will be required. Some of these issues and possible solutions are discussed in Hadush and Meeus (2018) and E.DSO (2019).

Regarding the need for regulators to promote increased coordination between TSOs and DSOs, NRA respondents have a unanimous view in favour. Most DSOs (74%) are also in favour of such increased coordination, with 23% against it. Of those opposing increased coordination by NRAs, 33% are medium-sized DSOs (serving between 100,000 and 1 million customers), 18% are larger (serving more than 1 million customers), and 14% are small DSOs (serving fewer than 100,000 customers).

The different views of NRA and DSO respondents are illustrated by the additional comments they provided. Some common themes can be identified: the need for a **clear legal framework defining roles and responsibilities** for TSOs and DSOs, the need for **coordination in the planning and timing of investment**, **data sharing**, and the **challenges for small DSOs**.

While most DSOs in our survey support the promotion of increased coordination between TSOs and DSOs, in their comments they also highlight the need for a regulatory framework establishing clear roles and responsibilities, and which creates common incentives for TSOs and DSOs, and facilitates data exchanges and data governance. The development of such a regulatory framework might be facilitated by the new EU DSO Entity. An improvement in the efficiency of network codes and their implementation is one of the conditions required for successful TSO-DSO coordination, together with the possibility of developing harmonised long-term investment plans. Several DSOs have mentioned the need for common/compatible incentives, for example in relation to tariffs and system cost allocation. One of the respondents also stressed the need for regulators to consider the rights of companies whose assets are not directly connected to the grid, and their need to receive prompt and reliable information.

Aligned incentives and the need for coordinated network planning are also highlighted in the comments from NRA representatives indicating a general agreement in this area between regulators and regulated companies. NRA respondents also highlight the need for a development in regulation, for standardised protocols, and for the harmonisation of systems operations. Several NRAs also mention the importance of a reliable two-way flow of information. Other respondents suggest a potential mutualisation of tasks, such as data management, across DSOs (especially small ones).

Respondents from both types of organisations mention the need for coordination in the procurement of flexibility services as central to this coordination activity, as well the need to adopt a 'whole system' approach to address the current and future challenges to the energy system.

Figure 12 – Should regulators promote more TSO-DSO coordination?

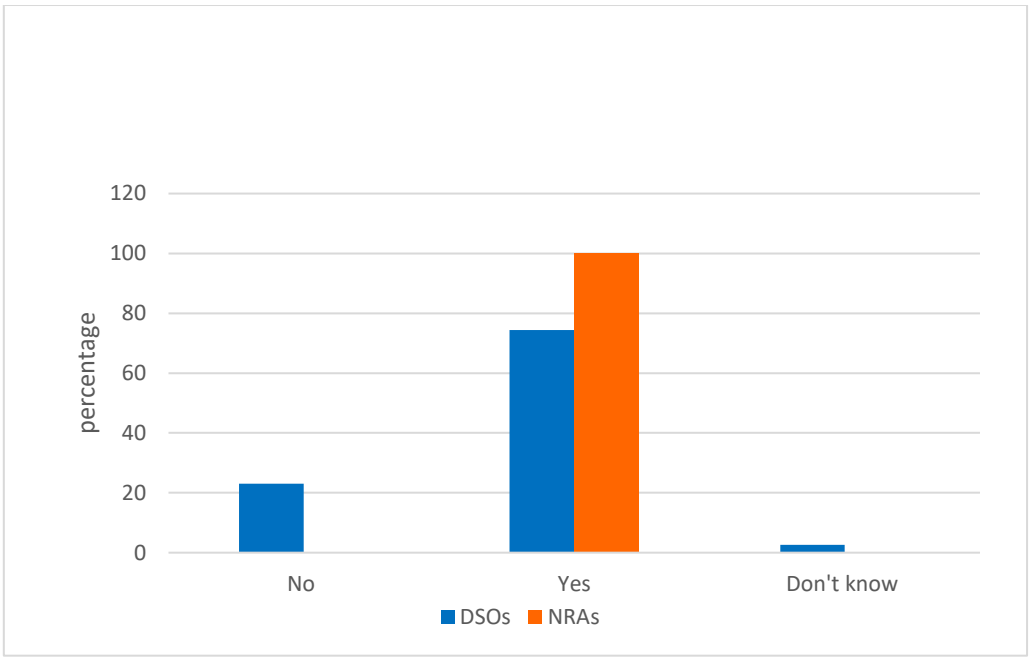
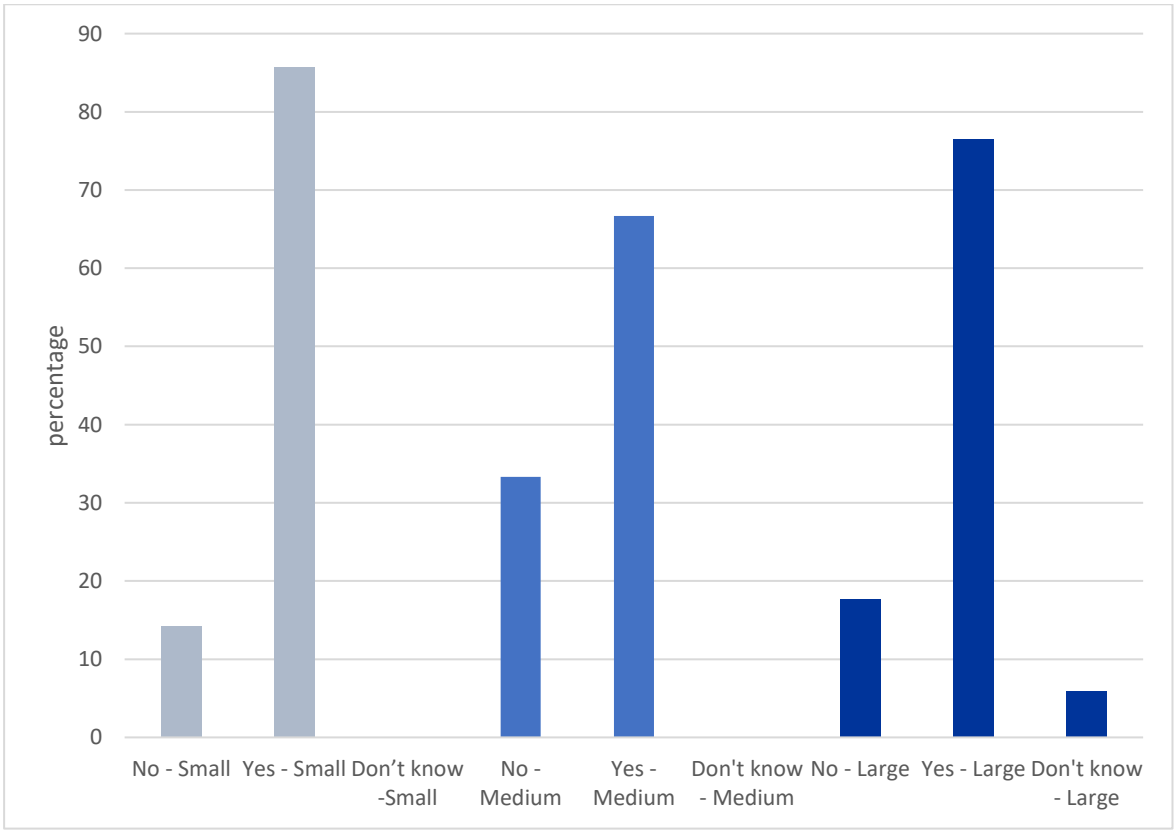


Figure 13 – Should regulators promote more TSO-DSO coordination? DSOs by size



Should regulators promote more coordination across the gas distribution and/or heating distribution and electricity distribution? *(Q15DSO, Q16NRA)*

When considering the need for regulators to promote more coordination between the electricity and the gas and heating sector at the distribution level, most DSOs (56%) are in favour of such increased coordination with less than a third who do not support it (31%). A large majority of the largest companies are among the DSOs (76%) supporting more integration, with 18% dissenting and 6% saying they are uncertain about this type of coordination.

The views are more split among other classes of DSO, with 43% of small and 40% of medium-sized DSOs supporting the proposed increased coordination, and the same percentages (43% small, 40% medium) against it. The negative answers to this question from small and medium-sized DSOs might be due to the fact that sector coordination is already prevalent, as could be the case for the 15 DSOs among our respondents that manage both electricity and gas networks. About two thirds of NRA respondents (8 out 12) agree that the promotion of such coordination is needed with the remaining 4 being unsure.

The open comments to this question offer some additional information about the differing views of companies and regulators. Some common themes can be identified: the need for a '**whole system' approach** to address the challenges of energy transition, **the role of heat networks** and **the potential benefits from harmonised rules and principles**.

The DSOs' responses focus on the need for shared incentives across the two sectors due to the presence of different investment strategies. In a similar way to the implementation issues raised with respect to TSO-DSO coordination, respondents highlighted the need for coordinated planning and data-sharing. The importance of long-term planning to achieve carbon neutral objectives is also mentioned in this context: *"Long-term planning should consider the most cost-effective alternatives while keeping the climate ambitions, avoiding the development of future stranded assets and favouring mature technologies (e.g. electric heat pumps)."* Similar arguments to those raised with respect TSO-DSO coordination are made also in this context with respondents stressing the need for harmonised principles and regulatory regimes.

Suggestions for ways to coordinate the gas, heating and electricity sectors include relying on district heating systems to provide demand-side flexibility and the adoption of holistic models including other utilities, such as water and public lighting. The use of regulatory sandboxes (see also Section 5) is suggested in order to experiment with, and develop, power-to-gas activities.

The NRAs' comments on heat systems include the need to develop efficient district heating infrastructure integrated with other energy systems to improve overall efficiency across all sectors. One respondent points out that, while this coordination is desirable in the logic of a whole system approach, heat networks are currently not regulated in many Member States, so regulators have limited tools available to influence and integrate them at the moment.

Figure 14 – Should regulators promote more coordination between gas distribution and/or heating distribution and electricity distribution than it is currently the case?)

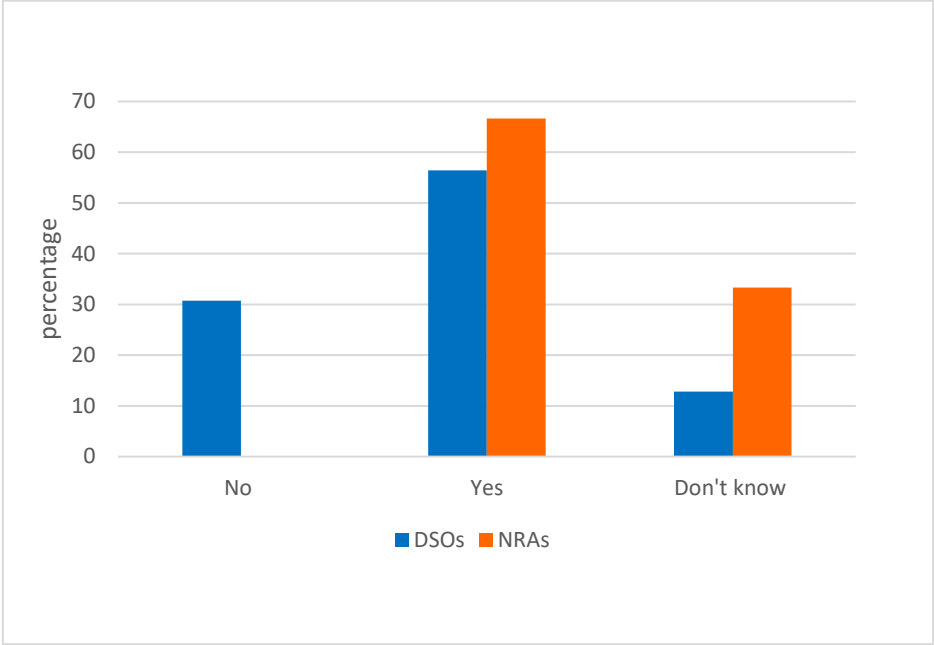
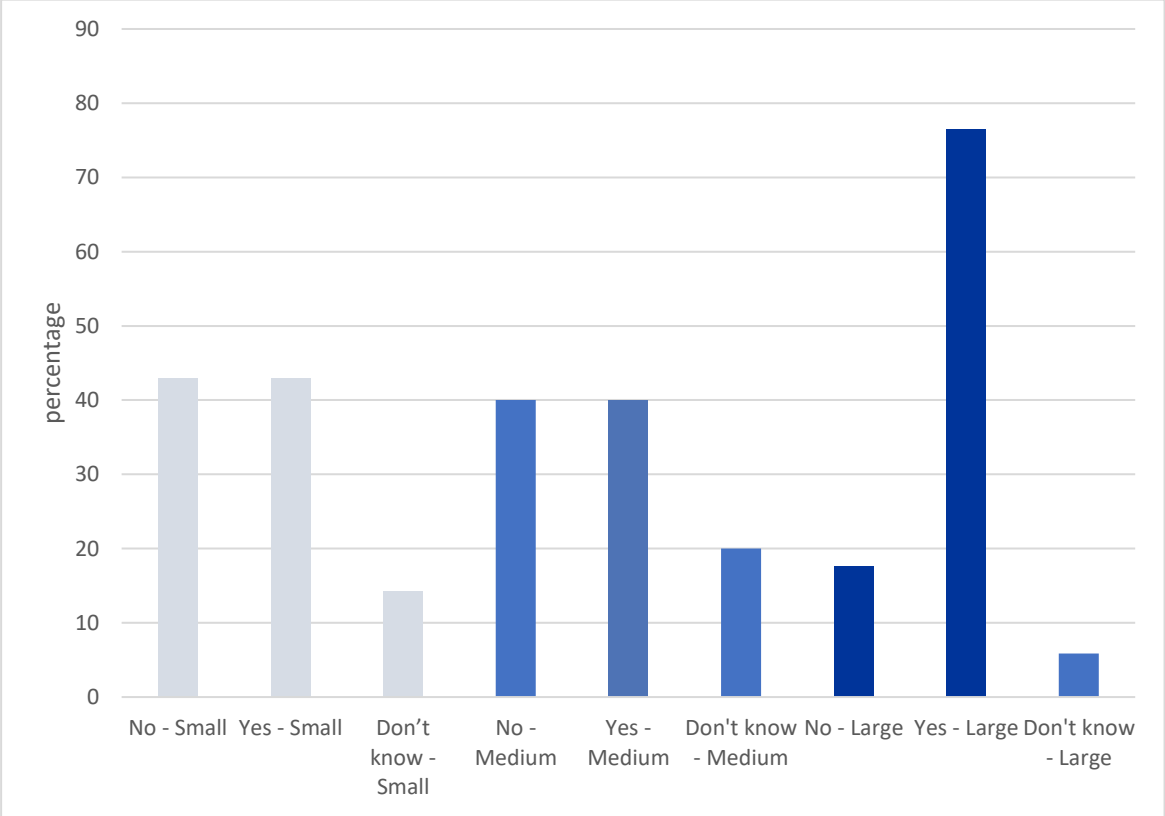


Figure 15 – Should regulators promote more coordination between gas distribution and/or heating distribution and electricity distribution than it is currently the case? DSOs by size



04

LESSONS WE CAN LEARN FROM TSO (AND OTHER) REGULATION

4. Lessons we can learn from TSO (and other) regulation

The integration of more distributed energy resources (DER) into distribution networks is changing the way they are managed and operated. The 'fit and forget' approach is no longer an option. This integration means that utility distribution networks need to deal with the intermittency and unpredictability of renewable sources, reverse power flow, increasing balancing load and generation, and even with the risk of sunk costs[22]. At the same time, DER assets, controllable loads, etc. connected at different voltage levels represent an opportunity for DSOs to solve network constraints, congestion and so on by procuring/contracting flexibility services from them (in line with Art. 32 of the Electricity Directive 2019/944). Accordingly, active management, congestion management and balancing (i.e. ancillary services) of the distribution system are an important part of the discussion. DSOs are required to manage their networks more dynamically and bear responsibility for their own grids. TSOs are responsible for ensuring a secure, reliable and efficient electricity transmission system and thus bear responsibility for the overall system[23]. This section explores the potential similarities between current TSO regulation and the way the future DSO should be regulated.

First, we ask DSOs and NRAs whether the SO function of the distribution utility should be separately regulated from the rest of the distribution utility[24]. Depending on the regulatory framework, the transmission level system operation function may or may not be separately regulated from the owner of the transmission assets. In Europe, most of the TSOs own/operate both, with some exceptions such as NG ESO in Great Britain. While in America, system operators (ISOs/RTOs) are independent organisations and are regulated separately. Both approaches have pros and cons. Separation can bring more transparency and independence in decision-making, even though it can be more costly and may lead to information silos. Integration can be viable as well, offering better-aligned incentives for network development, but also potentially less transparency.[25]

Second, in contrast to distribution utilities, TSOs have been more exposed to the use of more competitive mechanisms for network extensions or refurbishment, reinforcement, balancing and congestion management (e.g. auctions for ancillary services, use of tenders for expanding high-voltage power grids, and auctions for the acquisition/operation of offshore transmission assets[26], etc.). Here, we want to know whether a similar approach (at lower scale) can be followed by DSOs.

Third, tariffs/charges applied by TSOs to the users of the transmission networks and for balancing the system are regulated. Some of these tariffs/charges may vary by location[27] and time of use (more cost reflective). Methodologies and cost-recovery mechanisms vary according to the regulatory framework in each jurisdiction. Here, we want to know the NRAs' perspective on the use of more cost-reflective tariffs by distribution utilities. These tariffs may constitute a minor part of the electricity bill but are relevant for setting DSOs' network cost-recovery plans. This can take different forms, including the use of more dynamic pricing and the degree of stress on the capacity component.

[22] This is related to the risks of sunk costs of historical investments not paid-off. An increase in DER may make customers use the distribution network less.
[23] For the full list of TSO responsibilities see Art. 40 of the Directive 2019/944.
[24] This question is open to interpretation, where the SO function can be within or outside the organisation (different company).
[25] See Pollitt (2012) for a discussion.
[26] For different models of responsibility of offshore transmission assets see: Efficient access to offshore wind resources (windeurope.org)
[27] For instance, in Great Britain, transmission network use of system (TSUoS) charges vary per location.

Fourth, we ask the question of six potential changes to the current investment regime applied at the distribution level that may encourage more innovative investments. These are discussed briefly. **Shared ownership or co-ownership of assets** can help to mitigate the risk associated with innovative investments[28], adoption of new technologies, enhanced data management, etc. This type of non-conventional asset can take different forms, such as DER (i.e. battery storage), energy platforms (e.g. GOPACS co-owned by the TSO and DSOs in Netherlands; Nodes co-owned by TSO Holding AS[29] and a DSO), data hubs (e.g. ATRIAS in Belgium's joint initiative of four large DSOs[30]; ElHub in Norway owned by the TSO[31]), etc. Depending on the regulatory framework, some NRAs may or may not envisage the use of asset co-ownership, while DSOs may or may not agree with this.

We also ask DSOs and NRAs about the **use of variable depreciation periods[32].** This is observed in TSOs and DSOs but is generally applied to traditional investments (i.e. substations, transformers, power lines, etc.)[33]. The length of depreciation periods is especially important when we refer to non-traditional investments including new technology (i.e. shorter rather than longer to reduce risk). Due to the fact that DSOs are facing new challenges with the integration of DER and the digitalisation of the distribution system, they also need to explore different kinds of investments. DSOs may be interested in applying differentiated depreciation periods for this purpose, mitigating the risks of stranded assets[34].

An alternative way to deal with innovative investment is by **allowing a higher rate of return** (ROR)[35] on less traditional investments but only when these can be done more cheaply (for the customer). Distribution utilities may or may not be encouraged to opt for less traditional or innovative investments, and regulation plays an important role in this. For instance, ROR regulation (i.e. cost-plus regulation) offers a guaranteed but lower return on the utilities' regulatory asset base, and provides more incentives to develop new infrastructure[36]. On the other hand, price-cap regulation can expose DSOs to greater risks (i.e. high capital costs). This means 'innovative' investments are harder to recuperate so DSOs need to offset the risk with higher returns or a 'risk premium' (Alexander and Irwin, 1996; Newbery, 2002, EC, 2019)[37].

Innovative investments can take different forms, among the more commonly seen are pilot projects. A higher rate of return would help to mitigate the technical and regulatory risk associated with this kind of investment. Depending on ROR size, this can have an impact on the revenue requirements and, ultimately, on end-customers. Higher rates of return may also give rise to excessive investment. It may also imply differential treatment favouring innovative investments over traditional ones, even though both may be able to provide an efficient network solution. On the other hand, rates of return that are too low may put DSOs off investing and operating the network below optimal levels (IPART, 1998). This impact is also linked to the size of investment

[28] For example, shared ownership of energy storage units where the distribution utility can make use of the asset for network reliability and security (i.e. own use), allowing the other co-owner to make profits (i.e. balancing services for the transmission system operator) when the distribution utility does not make use of the storage asset, then the risk of under-use is mitigated. For a discussion of energy storage ownership see Section 9.
[29] Formerly Nord Pool Holding AS.
[30] https://www.atrias.be/about
[31] ElHub manages both metering data and market processes (https://elhub.no/en/about-elhub/what-and-why).
[32] For instance, as part of a menu regulation where the DSO can choose from different depreciation periods.
[33] Depreciation is a major component of the TSO/DSOs' revenue requirements. It can be over 20% in the case of distribution, see: An evaluation of the role of accelerated depreciation in regulation of electricity and gas networks (worldsecuresystems.com)
[34] For instance, an example could be the accelerated depreciation rate of smart meters (when DSOs own and operate them).
[35] There are different methods for estimating the rate of return: weighted average costs of capital (WACC) is one of the most frequently used, for further details about the methods see CEER (2019a).
[36] However, this is not necessarily true when we talk about innovative investments, which are required in the transition to a more active and changing energy market (EC, 2019).
[37] Many European NRAs are currently applying incentive regulations, for a country-level analysis see CEER (2020a).

categorised as non-traditional, which is expected to increase in the coming years. Then it is important for NRAs to set suitable ROR levels (or increased revenue allowance) that incorporate the risk and help utilities to finance their investment programmes (CRU, 2020). However, optimal ROR values can be difficult to establish especially for 'innovative investments' (EC, 2014). We ask both NRAs and DSOs for their views on this topic.

DSOs were asked about their preferences for **longer/shorter price control periods,** which may also be an instrument to manage risks. For instance, TSOs may find longer regulatory periods necessary to address regulatory risk, depending on the type and size of project[38]. There is a trade-off between the selection of shorter or longer periods in terms of (1) certainty but with more periodical revisions (more burdensome) and (2) more established regulation (i.e. continuity) but with greater opportunity for cost differentials (ECA, 2018).

Then we continue with **change in regulatory benchmarking methods**, which refers to the measurement of potential cost reduction as part of the incentive regulation method applied by NRAs. The sophistication of this varies across jurisdictions. We want to know the DSOs views regarding any potential improvement to the current methodology that may encourage more innovative investment or procurement (i.e. flexibility services). This may relate to the way in which OPEX and CAPEX are treated in the selection of smarter solutions, for instance. Regulation could well support the use of flexibility and lower OPEX at the same time, but this may not happen in practice (i.e. flexibility can be costly[39]).

Finally, we ask DSOs and NRAs about **the use of more indicative planning**. This relates to the additional guidance that DSOs and other parties (e.g. DER owners, TSOs, etc.) may need in light of future developments and the configuration of the distribution networks under different scenarios. These scenarios are fundamental for network development plans and should cover a broad range of assumptions (CEER, 2020b). DSOs and NRAs were also asked for **any other changes** to the current investment regime that they may find important.

Fifth, the use of multi-year planning is a common practice by TSOs in Europe (e.g. ten-year network development plan)[40], to be submitted at least once every two years to the regulatory authority. This helps to identify future requirements and actions to guarantee the adequacy of the system and security of supply. Here, we want to explore opinions on a movement to a multi-year planning approach for DSOs, accordingly to Art. 32 (3) of the Electricity Directive 2019/944 which suggests the implementation of the network development plan for DSOs with planned investments for the next five to ten years.

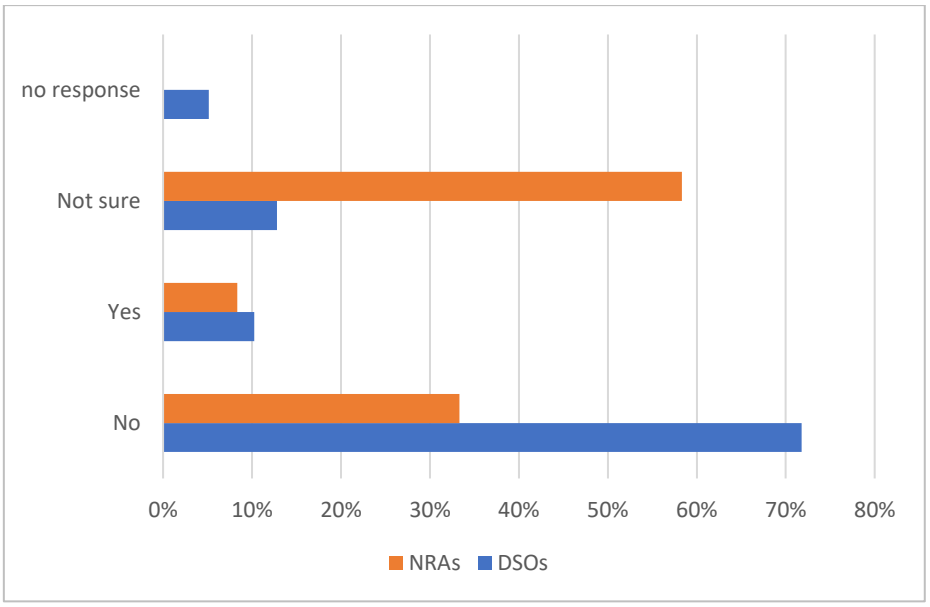
Should the system operator (SO) function of the electricity distribution utility be separately regulated from the rest of the distribution utility? *(Q16DSO, Q17NRA)*

Approximately 63% of respondents (28 out of 39 DSOs[41] and 4 out of 12 NRAs) disagree with a separated regulation for the SO function from the rest of the distribution utility, see Figure 16.

[38] This is particularly true for those categorised as 'projects of common interest' or PCI, (EC, 2014).
[39] Depending on the regulatory treatment, it can be the case that those DSOs that opt for flexibility (i.e. pay to third parties for congestion management or balancing) perform worse in comparison to the benchmark than those that spend more on CAPEX (i.e. network reinforcement), Anaya and Pollitt (2020b).
[40] Mandated since 2009, see Regulation (CE) 714/2009 Art. 8.
[41] The two responses from energy associations have been included in the 39 responses. This consideration applies to the rest of this section.

Around 65%, 80% and 71% of large, medium and small DSO representatives respectively are against separate regulation[42], while 58% of NRA representatives are not sure about this.

Figure 16 – SO function within DSO should be separately registered?



Some respondents indicate that separation may add more complexity to current regulation and therefore it would be better to strengthen current regulation instead. One respondent remarks that this is "*still under consideration";* and refers to the unsuccessful experience of the SO separation from transmission owners in Italy[43]. Other respondents supporting the separation indicate that the SO function is specific and differs from other activities, and that the SO function should therefore be separated from the rest of the DSO. A large DSO mentions that this is already happening in the Czech Republic with specific regulation formula parameters applicable to the SO function. Ownership separation is also suggested by one NRA in the case of conflicts of interest (i.e. between owning assets and selecting optimal solutions to local system operations). It is also advised that DSOs should be provided with more incentives to account for operational savings when assessing investments (i.e. avoiding preferences for big capital expenditures over smarter solutions). A different NRA representative points out that "*it should be regulated, [but] whether a separate regulatory regime is necessary depends on the setup*", while another remarks that the separation would depend on market needs and that it "*should be a gradual option"*.

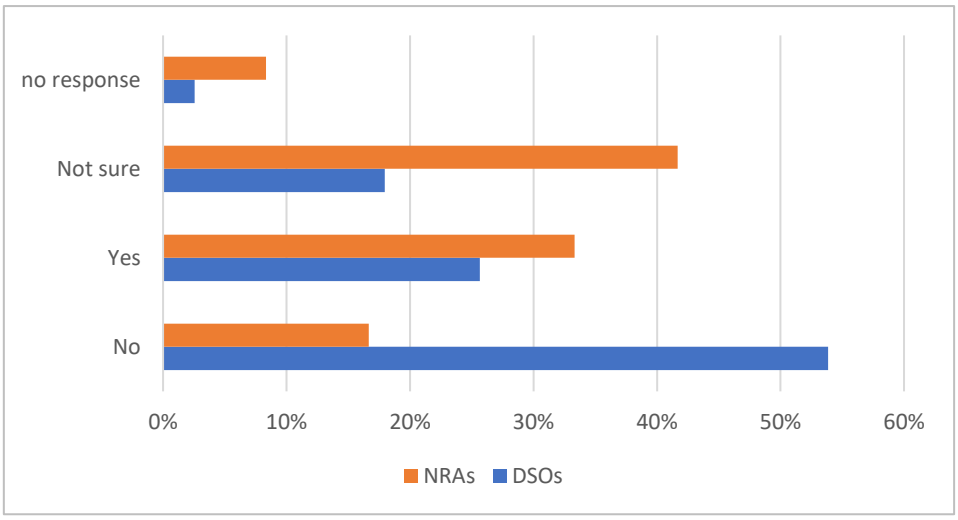
Can there be more use of competitive procurement in network extension or refurbishment? *(Q17DSO, Q18NRA)*

Looking at the survey responses, approximately 45% of the respondents (21 DSOs, 2 NRAs) agree that 'more' use of competitive procurement in network extension or refurbishment is not

[42] In this section, the discussion refers to two categories of DSOs: large DSOs (17) and medium and small DSOs (22) in line with the previous section.
[43] Neutrality can be an issue if the distribution utilities also operate/own generation plants. Regulation may help by ensuring a pure network central focus.

necessary, with 60% of the large DSOs supporting no requirement, see Figure 17[44]. On the other hand, around 42% of the NRAs are uncertain about this.

Figure 17 – More use of competitive procurement in network extension and refurbishment



A couple of respondents state that this is already being practiced with no additional use required, while another indicates that more use will be required for connecting renewables. A medium-sized DSO comments: *"For traditional network investments there should be an obligation for competitive procurement of the investment projects also for small companies. The regulatory regime should be developed so that flexibility measures could be a real option for network extension."*

One NRA raises the use of flexibility products (e.g. congestion management, demand-side response) to defer capital-related projects. A large stated-owned DSO states: *"Public procurement rules are very strict and not flexible enough. This creates difficulties in purchasing network extension or refurbishment work and slows down network development; repurchases increase administration costs."* While one NRA is not sure, suggesting that thresholds in public procurement rules are too high. Another respondent cites competition in onshore transmission networks in the UK as a good example of competitive procurement.

Should more use be made of regulated distribution tariffs as signals for the efficient use of the distribution network? *(Q19NRA)*

There is strong support for the use of regulated distribution tariffs as signals to guide the efficient use of the network. All respondents (represented by 12 NRAs) agree with this. There is significant support for distribution tariffs that reflect marginal costs – but subject to more data collection – in the event of dynamic prices. According to one NRA: *"Ideally, dynamic prices reflecting at least marginal costs should be introduced if information gathering is efficient. If information collection is costly today, then some form of reflecting marginal costs in time of use is still necessary."* Three of the NRAs emphasise the capacity component of the tariff as an economic signal for more efficient use of the network (with the option seen in Italy for households and small customers to adjust

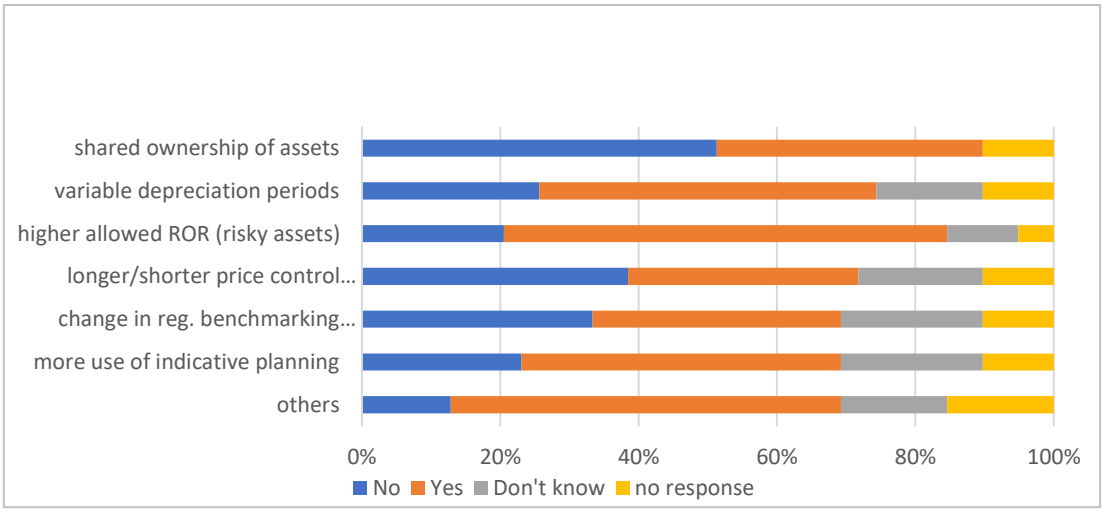
[44] Based on the analysis of the comments provided by the respondents (11 in total), only 2 related the use of competitive procurement to contract flexibility services as an alternative to network investments, 1 respondent to both competitive procurement in network extension or refurbishment and to flexibility services as an alternative to network investments, and the rest (8) to competitive procurement in network assets only (which is already in practice in many of the DSO jurisdictions, i.e. *Official Journal of the European Union* - OJ procurement rules).

their rated capacity). The potential of smart meter data is also acknowledged: *"By using the potential offered by smart meters to identify the peak or high season periods to minimise cross subsidies, as well as by calculating tariffs on the basis of network development marginal costs."* It is also suggested that the savings from having more cost-reflective tariffs should be passed on to consumers (not just accrue to DSOs) and should be reflected in DSO cost regulation. An upcoming measure to encourage EV owners to charge their cars in off-peak hours (i.e. capacity limitation during night hours and holidays) is reported by the Italian NRA[45], and a new access charging regime (i.e. Access & Charging Significant Code Review, SCR) by the British NRA.

Should there be changes to the current investment regime at the distribution level to facilitate more innovative investments? *(Q18DSO)*

Figure 18 summarises the DSOs' responses (including two from energy network associations). Findings per type of respondent and related to each potential change are discussed below.

Figure 18 – Changes to the current investment regime at the distribution level to facilitate innovative investments: DSO responses



Shared ownership of assets (e.g. with other DSOs or with DER operators)

Around half of the respondents (20 out of 39) disagree with changes that promote shared ownership of assets, while around 40% of them support this.

Some of the respondents agree that shared ownership will support DSO investments related to energy transition and digitalisation. This will provide DSOs rights to use private assets (e.g. DER, substations) and will help to capture the full potential of the assets. A large DSO remarks that: *"Regulator[s] must be more active in stating conditions for new possible technology, [or] else there's an uncertainty if investment will be considered as ordinary assets. There must also be incentive/return on capital when investing in innovative investments even if not considered as ordinary CAPEX."* Among some examples of desirable co-ownership provided by the respondents are energy storage, market platform, and ICT/smart control.

[45] See decision 541/2020/R/eel from December 2020: https://www.arera.it/it/docs/20/541-20.htm

Variable depreciation periods

Half of the respondents agree with the use of variable depreciation periods, with a similar number of responses from large (10) DSOs and small and medium DSOs (9 in total). However, a third of small and medium DSOs (7 in total) do not support the use of variable depreciation periods.

Some respondents suggest that shorter depreciation periods are supported especially for modern technologies and innovative investments, including smart meters, IT, large-scale pilot projects, etc. (i.e. gas assets: expected reductions in natural gas usage). A large DSO states: *"Reduction in [the] regulatory depreciation period of assets could favour innovative investments."* The need to have more categories of depreciation periods in order to reflect better the reality of differing economic lifetimes is also suggested. Other respondents state that, due to existing assets with no economic recognition, individual lifetime and depreciation periods are required. An opposite view is given by a large DSO who remarks that: *"By variable period, we understand that every year you receive a different retribution [sic] for individual assets based on different parameters given by the regulator. This has a lot of uncertainty every year, therefore, our answer is NO."*

Higher allowed rates of return (ROR) on some risky assets

Approximately 64% of the respondents (25 out of 39) are in favour of a higher allowed ROR on risky assets, with significant support from the large DSOs (over 70%)[46].

Many of the respondents agree that higher rates (in comparison with the ones applied to traditional investments) may be required for new developments such as active network management assets, innovative investments (i.e. pilot projects, EV charging points), smart meters, energy storage, large DER, sector coupling, etc. A large DSO suggests: *"To ensure proper use of this mechanism, on the one hand the rate of return rate should be higher than the current rate for traditional investments. On the other hand, these innovative investments should not be included under the current limits for CAPEX investment by DSOs in a given year (for example, in the case of caps based on a percentage of GDP)."*

It is also mentioned that a higher ROR may be required for assets that can be used frequently (not necessary associated with innovative investments) and for network extension (i.e. for higher risk clients), etc. A medium-sized DSO indicates that if distribution utilities should not own/operate risky assets then there is no support for higher ROR, while a similar sized DSO remarks that this would depend on the allocation of risks (i.e. between asset owners and their consumers). One of the respondents proposes instead of having a specific high ROR *"to allow a long-term, stable and forward-looking rate of return for all investments on a reasonable level",* which will be able to match the average risk for all investments; with the advantage that all assets are administrated in a similar way though their lifespans.

Longer/shorter price control period

Responses regarding preferences for changes in the current price control periods are mixed, with around 33% of respondents agreeing and 38% disagreeing with any changes (approx. 14 each), while 18% (7 out of 39) don't know.

[46] These results are not surprising. For instance, in a study that involves 14 TSOs and their preferences for addressing more effective regulatory risks (with a focus on PCI risks), around 57% of them find the use of higher rate of return "necessary", 35% "useful" and around 8% "not necessary". An opposite view is observed from the NRAs (9 in total). Approximately 75% of them find the use of higher rate of return "not necessary" and 25% "useful" (see EC, 2014).

According to one respondent, any change in the price control period needs to balance the risks between the degree of uncertainty in forecasting costs (giving a preference for shorter periods) and stronger incentives for innovation (giving a preference for longer periods). One large DSO indicates a preference for shorter periods *"given [the] volatility of transition needs"* while another large DSO suggests that *"longer price control periods give more certainty on investment decisions and the related regulatory framework"*. Another one remarks on how flexibility in the methodology is used to adjust for unexpected changes. Other respondents claim that regulation and continuity between periods are important (especially for longer periods). It is also suggested that small DSOs are more exposed to uncertainties (e.g. via a lack of bargaining power in the acquisition of new immature technologies) and would need special protection from price risk. A couple of respondents suggest no change and that their current period (i.e. six years in Spain) is fine.

Change in regulatory benchmarking methods

Similar to the previous change, there is no agreed view about whether or not a change in regulatory benchmarking methods is recommended or not, with similar numbers of respondents supporting both sides (approx. 35%), while around 20% are uncertain.

The use of a TOTEX (total expenditure) approach is suggested in benchmarking methods in order to have a more unified approach across distribution utilities in the use of both OPEX and CAPEX solutions to address network needs. Other DSOs support better consideration of the use of OPEX (i.e. innovation, R&D, new tasks) and benchmarking models that describe the DSOs appropriately. One DSO remarks that if statistical or econometrics benchmarking methods are used *"there is a risk that the DSOs have difficulties to understand the results and what to do to improve their performance",* highlighting the role of regulators in assisting them with the explanation of the model and interpretation of results; otherwise the use of standard costs (per type of activity) can be an option (currently in use by the Swedish regulator for investments).

It is also suggested to shift towards higher-level comparisons of OPEX, rather than separate assessment of functions (e.g. metering, customer services, etc.). A large DSO in favour of this change remarks that this could help to gain more harmonisation in regulation at the European level, contributing to more uniform market developments. The need for special regulatory treatment when opting for flexibility solutions is highlighted: *"When buying flexibility services, [the] current regulatory regime gives no claw-back of the costs. Costs of flexibility services should be handled outside the efficiency benchmarking tool in order to make buying services a viable option to network investment."* A small DSO points out that the size of the DSO should be considered in the model (i.e. similar companies to be grouped). One respondent reports that there is no need to use a TOTEX approach in current regulation but *"maybe in future because of different developments in the regions of the different DSOs".*

More use of indicative planning, where guidance is given as to the likely future configuration of the network under certain scenarios

Around 45% of the respondents (18 out of 39) agree with the use of more indicative planning, with more than half of small and medium DSOs supporting this (4 and 8 respectively). Around 20% of the respondents are not sure (8 out of 39).

Representatives from DSOs remark on the importance of having those plans as a signal of transparency and better coordination in order to unlock the value of flexibility. A DSO representative suggests: *"Transparency gives incentives to aggregators and others to unlock flexibility and other innovative solutions to an open market in the distribution grid."* Consideration of DER development in distribution planning and the impact of this on the network is also

highlighted. A large DSO mentions the need for *"more forward-looking regulation instead of regulation based on historical results only"*. A respondent from an energy association points out the need for future scenarios at distribution level (DFES[47]) in order to inform planning.

Other suggestions for supporting innovative investment (open question)

Approximately 55% of the respondents (22 out of 39) suggest other alternatives to support innovative investment. We have categorised these as follows:

Change in regulatory incentive mechanism

Approximately half of the respondents recommend changes or improvements to the regulatory incentive mechanism. Among them are the preference for a TOTEX approach (which favours the harmonisation of CAPEX and OPEX)[48], clear connection between risk and return, extra allowed weighted average cost of capital (WACC) for innovation and tailored remuneration schemes in favour of flexibility. One participant remarks on the importance of having a remuneration mechanism that encourages the adoption of flexibility services: *"Any particular risks of opting for flexibility services should be therefore taken into account in the contracting and remuneration scheme to make these alternative solutions viable."* Another emphasises: *"Certainty of regulatory framework and proper allowed revenues need to be guaranteed to distributors, which are going to face new challenges and uncertainties within a scenario characterised by growing RES generation and energy transition."* The introduction of *"an innovative factor"* is suggested too (i.e. an additional of 0.5% of TOTEX) for innovative investments.

Incentives for smart solutions and technologies

Many respondents agree that innovation and new technologies (including energy storage) should be encouraged by regulators including investment in the digitalisation of the network. According to one respondent: *"An innovation incentive for digitalisation investments should be recognised by regulators. This is key for DSOs to invest in digitalisation."* Energy storage is seen as one of the technologies to be taken into consideration for future innovative investment, but there is also a need to explore other options. One respondent points out that there is a *"need for sufficient possibilities to explore new technological solutions not yet in [the] scope of regulated activities, under own responsibility when the market does not supply such solutions".*

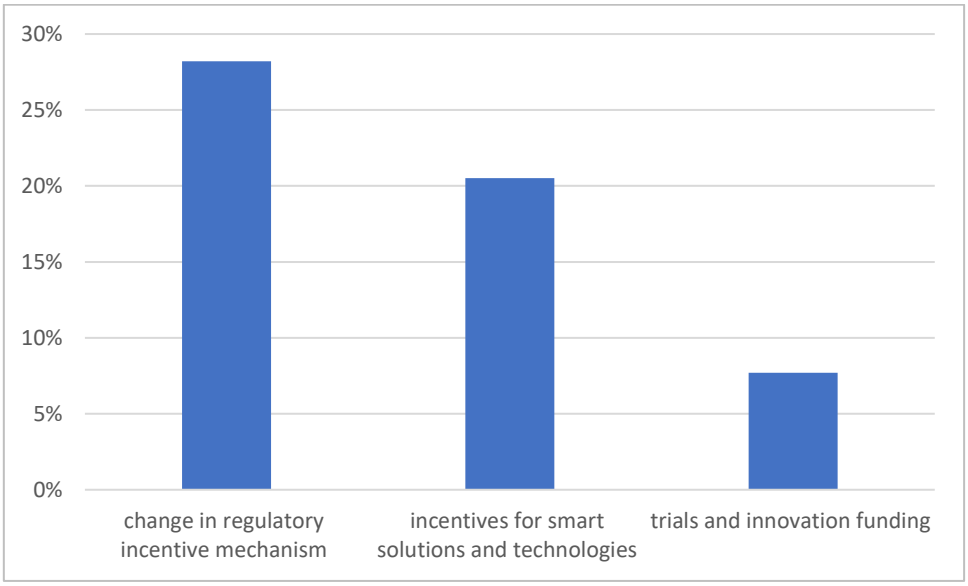
[47] Distribution utilities from the UK are developing distribution future energy scenarios (up to 2050) in order to identify the future electricity requirements and the actions needed to meet them.
[48] In Great Britain, through the RIIO-ED1 TOTEX allowance, distribution utilities are financially incentivised to trade-off between operational costs and capital costs to reduce total costs. This occurs due to the equalisation of incentives to reduce opex and capex (fixed for each distribution utility for the regulatory period). Great Britain introduced the first TOTEX regulation in 2010.

Trials and innovation funding

Respondents recommend the need for regulatory support for pilot projects (and quick approval of them, too), sandboxes and support for R&D initiatives. Others are in favour of dedicated funds for innovation. Further details about trials and regulatory sandbox-type regimes are provided in Section 5.

Figure 19 summarises the answers per type of category.

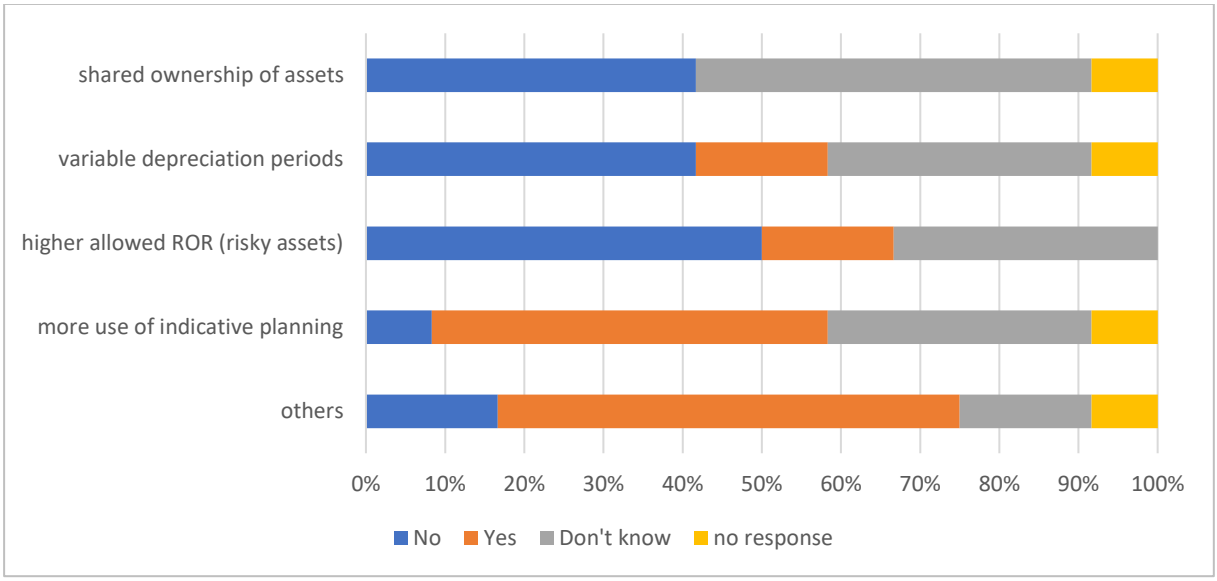
Figure 19 – Other suggestions for supporting innovative investments



Should there be changes to the current investment regime at the distribution level to facilitate more innovative investments? *(Q20NRA)*

Figure 20 summarises the responses from the NRAs regarding specific changes to the current investment regime that favour more innovative investments made by distribution utilities. A summary of key findings is provided for each of them.

Figure 20 – Changes to the current investment regime at the distribution level to facilitate innovative investments: NRA responses



Shared ownership of assets (e.g. with other DSOs or with DER operators)

Half of the NRAs (6 out of 12) are not sure about this change and none of them agree with it. Only two NRAs offer comments against this. According to one NRA, and based on the requirement of the Clean Energy Package, *"the role of governance and independence is crucial for the DSO to successfully fulfil the new, more market-facing and pro-active role"*. The Norwegian NRA states that shared ownership is already allowed in different forms (i.e. Elhub, AMS data-gathering solutions) and in line with the regulation all acquisitions made by the DSOs have to be market-based (with few exceptions).

Variable depreciation periods

Most of the NRA representatives are not sure or disagree with the use of variable depreciation periods (9 out of 12), and only two agree. Some NRAs provide additional insights here. One of the NRAs indicates that the use of variable depreciation periods for different assets would be appropriate but *"this should match the economic life of the assets".* Another one points out that it is already in use in Italy to *"promote the refurbishment of obsolete electrical uprights owned by DSOs in old buildings",* while another announces that the use of variable depreciation periods has been considered in the new regulatory framework in Spain. A fourth NRA acknowledges that DSOs in Norway already can "*choose depreciation periods for all assets*" subject to accounting rules and regulations.

Higher allowed rates of return (ROR) on some risky assets

Only a couple of NRAs support the use of higher ROR on risky assets[49], while the others (10 out of 12) are not sure or disagree with it. One NRA representative who opposes this mentions that *"Italy already experimented [with] extra-WACC for categories of higher risk or higher benefit investments and it proved to be too biased towards over-capitalising".* Another NRA emphasises that it is not required because *"the regulatory rate of return is applied for the asset base as a whole"*. Of the

[49] Some examples of risky assets are provided by DSOs in response to this question, see p. 47.

two NRAs supporting a higher ROR, one suggests that this would be applicable only for *"risky innovations"* and the other states that a differentiated ROR has already been set for smart meters.

More use of indicative planning, where guidance is given as to the likely future configuration of the network under certain scenarios

Half of the NRAs (6 out of 12) support more use of indicative planning while five of them are not sure or do not support more use (with one not responding). One NRA indicates that TSOs already publish a medium-term development plan (the SDDR) and that *"a similar document should be developed by the DSO according to Art. 32 of the Electricity Directive of CEP".* A second NRA also relates the development plans for DSOs according to the Electricity Directive and suggests that NRAs may help to adopt it. While yet another NRA remarks on the need for more guidance to users by the DSOs regarding *"indications of how the network might develop under different scenarios"* and sharing of evidence of *"network forecasts based on scenarios"* (with some progress on this). The need for more coordination between DSOs' network development plans (within the same region) and network users is also noted.

Other suggestions for supporting innovative investment (open question)

More than half of NRA representatives (7 out of 12) provide additional suggestions. Some of them recommend more *"investment incentives for innovations"* and a *"specific targeted innovation fund or cost-through projects for innovation that enable market activities".* Another suggests incentives for DSOs to opt for flexibility solutions rather than traditional ones *("hard assets")*. While another one proposes *"the use of uncertainty mechanisms"* that allow additional revenues for DSOs when a set of conditions are met, and the development of *"an agile investment framework"*, both to be introduced in the next price control (5th price review) by the Irish regulator (CRU). Some others refer to the promotion of pilot projects "*as a source of knowledge for the whole system*" and the need for some types of innovation with "*regulatory guidance*" (i.e. Elhub in Norway). Another mentions the "*innovation stimulus package*" under the RIIO framework in the UK.

What do you see as the major advantages arising from multi-year network plans (or network plans) at the distribution level? (open question) *(Q19DSO, Q21NRA)*

A total of 32 DSOs and 11 NRAs responded to this open question. Most of them find advantages in the use of multi-year product plans, with some exceptions (i.e. difficult to apply due to the short-term demand of grid customers). Based on the responses, we have categorised the main advantages as follows:

Enhanced development plans, investments, and predictability

The advantages recognised in this category (by around 40% of respondents) are focused on the identification of future challenges by DSOs (including network constraints), future developments (i.e. renewables, EV charging stations), better predictability (including financial), stability, and transparency in cost developments. Some DSOs suggest that the multi-year plans should be differentiated by voltage levels (with a preference for the HV level) and recognise the difficulties in forecasting for all of them. A large DSO points out that *"planning of investments shows what funding is needed in [the] short, medium and long term. It also shows when congestion can be lifted, and it gives […] clarification to the public of the investment policy of the DSO".*

Another DSO remarks on the importance of the practicality of the multi-year plans: *"Network plans should be the result of an efficient procedure that gives an overview of grid development in a sufficiently detailed, but also practical way. Both the details of the network development and the*

consultation procedure should be kept as lean as possible." An NRA states that the identification of network constraints, due to multi-year plans, creates *"locational signals to locate future consumers and producers"* while another emphasises *"their contribution to an optimal use of resources".*

Visibility and transparency

Around 12 respondents (7 of them NRAs) identify the visibility and transparency of distribution network plans as the main advantage of having multi-year network plans, which allows identification of opportunities by different actors via the provision of information (on time). According to one of the energy associations, multi-year network plans provide *"more certainty for customers, more agility [for] networks [to] invest in various wire and non-wire solutions, better visibility".* A medium-sized DSO finds as one of the main advantages *"more transparency about cost development".* While some NRAs highlight as the main advantages transparency on network development (including network reinforcement), on flexibility potential in the distribution system, and on investment decisions. Another NRA suggests that the major advantages are *"both DSO-internal (higher awareness of future challenges) and DSO-external (transparency for network users)".*

Integration and use of distributed energy resources (DER)/renewable electricity sources (RES)

A group of DSOs find the main advantage of multi-year planning to be information about current and future developments in DER/RES, including flexibility opportunities. A large DSO identifies as one advantage *"the integration of DER capacity, new capabilities of management"*, while another large DSO highlights *"early indication of flexibility opportunities"*. Yet another DSO indicates as the major advantage the accurate quantification and allocation of future renewable energy development, while a large DSO highlights the opportunity that multi-year planning brings *"to better synchronise renewables and grid expansion".*

Improved coordination

Some of the respondents, mainly DSOs, suggest that multi-year plans can improve coordination between market players including the TSOs and other infrastructure providers, especially related to the identification of capacity issues and consideration of joint investment decisions. A small DSO suggests that coordination can help to identify *"local, regional or national grid capacity issues"*, while another identifies the main advantage as *"the coordination with other infrastructure providers like water, heating, telecom (FTTH, FTTB[50])".* One NRA suggests that multi-year plans *"promote consistency in investment decisions with [the] TSO or other DSO[s]".*

Stakeholder engagement

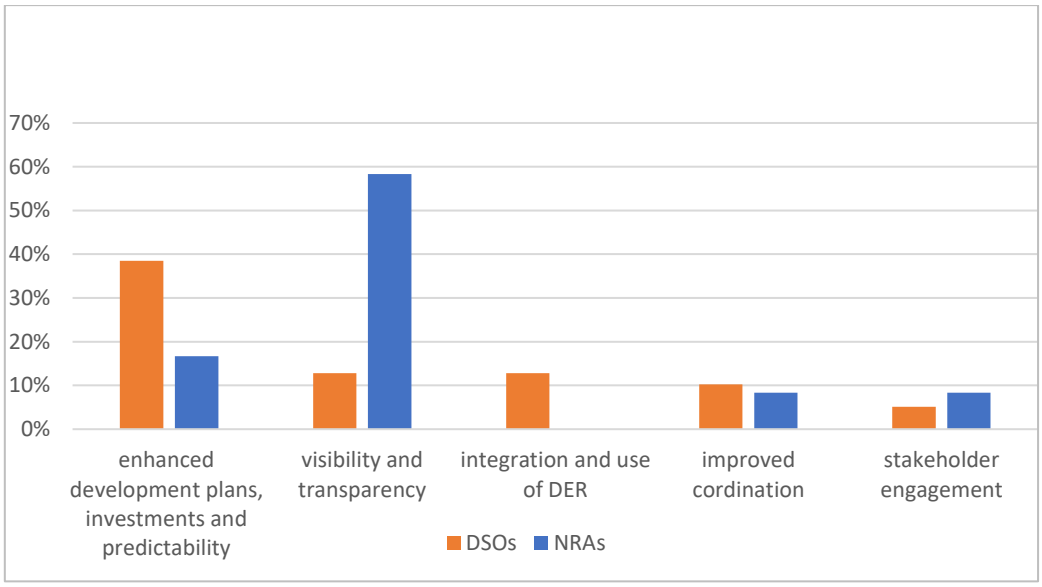
A small number of respondents find stakeholder engagement relevant in supporting the development of different network options by distribution utilities. A large DSO points out that *"gaining support from all stakeholders involved for all major infrastructure investments, to be achieved through four-year development plans"*. While an NRA representative indicates that multi-year plans will provide more information to the industry and that more stakeholder inputs will be considered.

The summary of responses per type of respondent is provided in Figure 21. It is observed that DSOs highlight the advantages in overall network operation (technical, financial), while NRAs are

[50] FTTH: fibre to the home, FTTB: fibre to the business.

more focused on the benefits that visibility and transparency of network plans bring to different actors.

Figure 21 – Major advantages arising from multi-year network plans at distribution level



A comparison of DSOs and NRAs perspectives *(Q16-Q18DSO, Q17-Q20NRA)*

Both DSOs and NRAs were asked whether they supported various potential future changes, summarised in Figures 22 and 23. We find some differences between them. While there is some agreement on more use of indicative planning between them (with around 50% favourability in both cases), there is no agreement on the use of higher ROR in risky assets. More than half of DSOs (25) support higher ROR in risky assets, while half of NRAs (6) do not, something similar applies to the use of variable depreciation periods. On the other hand, while most of the DSO representatives express a clear position on a specific change (agree or disagree), more uncertainty is expressed by NRAs (over 40% on average).

Figure 22 – Summary of DSO responses (Q16-Q18 DSO)

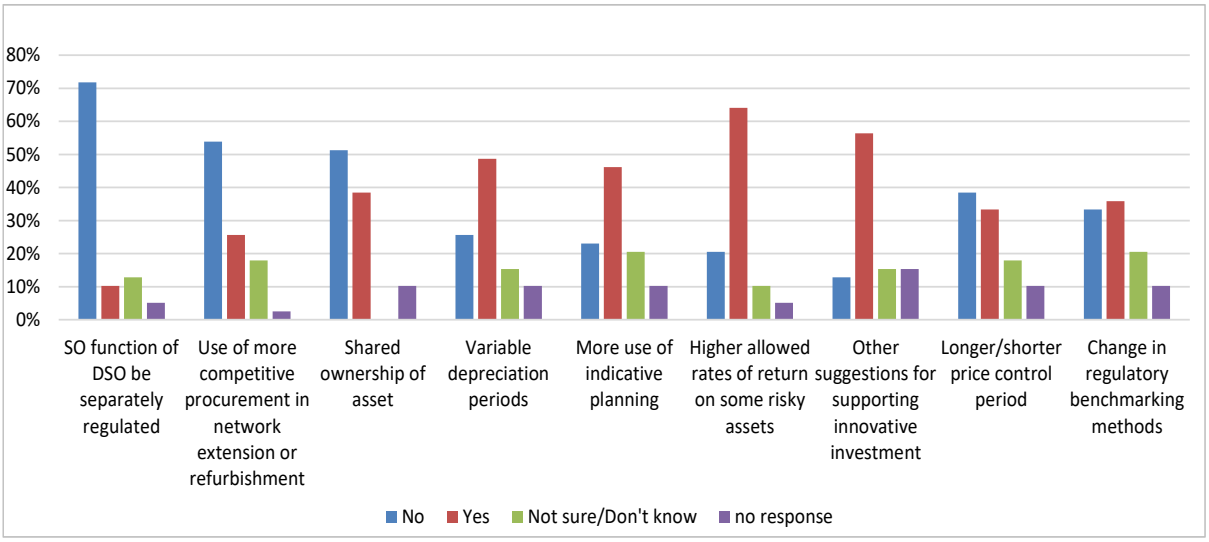
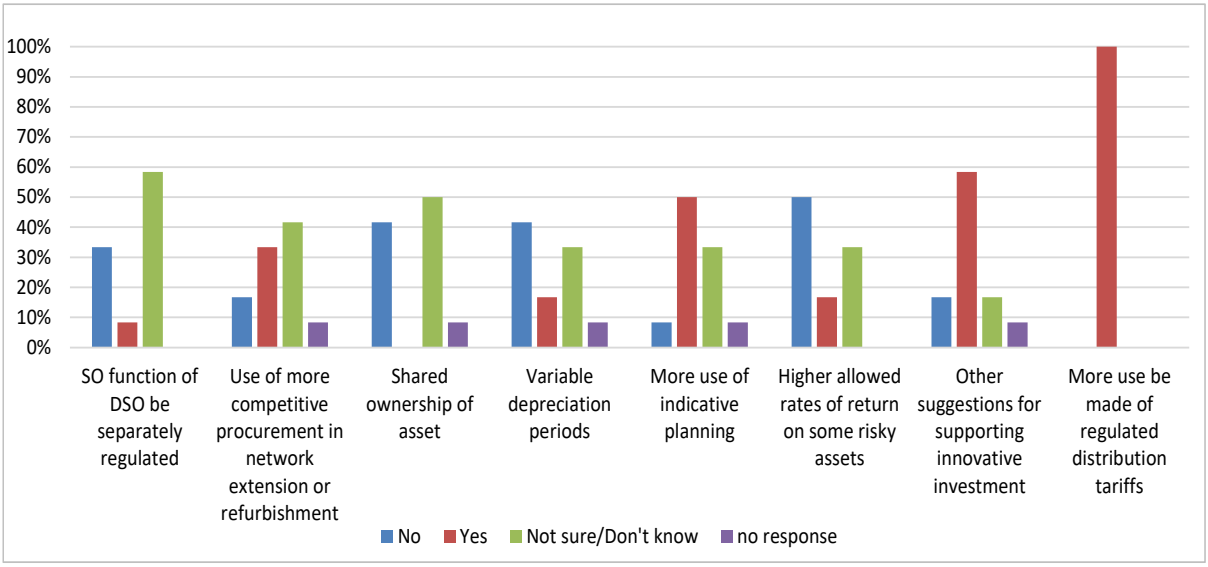


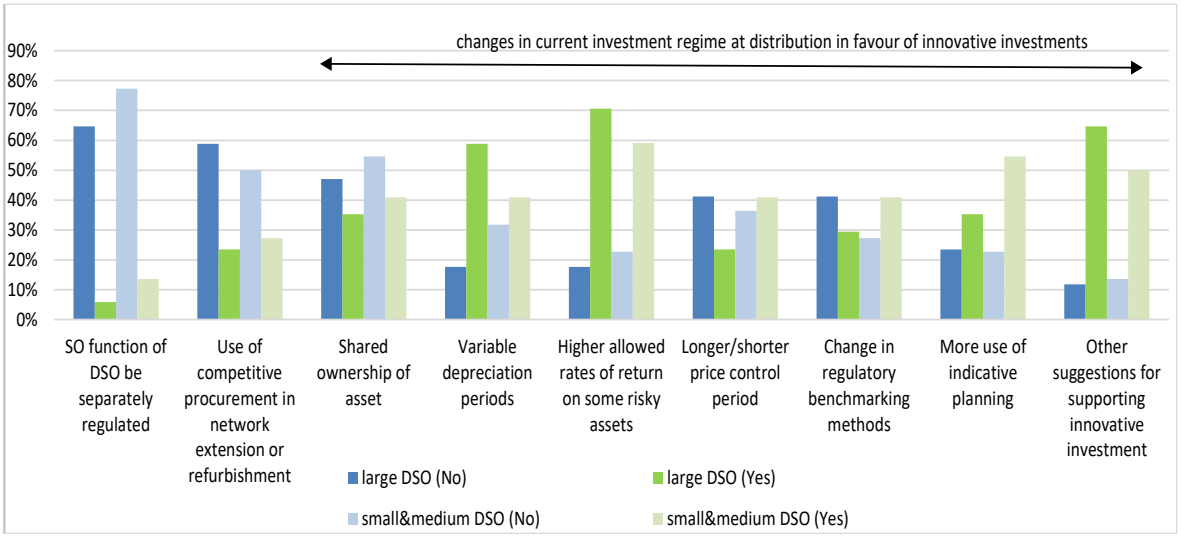
Figure 23 – Summary of NRA responses (Q17-Q20 NRA)



Large DSOs versus small and medium-sized DSOs

A comparison of the responses in Figures 21 by size of DSO respondent (large versus small and medium) shows that there is general agreement in the responses provided, with only a few exceptions. Figure 24 below summarises the responses ('no' and 'yes' only). There is strong agreement on the 'no' to regulatory separation of the SO function and also on the use of higher ROR on risky assets (over 60% and 50% respectively). There are also similar results across both types of DSOs in the use of competitive procurement in network extension or refurbishment, suggesting that more competitive procurement is not required (this excludes the provision of flexibility by third parties via competitive procurement as an alternative to network investments), with more mixed views in the case of shared ownership of assets. On the other hand, an opposite view is also observed. While more than 40% of large DSOs disagree with the use of longer/shorter price control periods and on a change in regulatory benchmarking methods, representatives from small and medium-sized DSOs (around 43%) support both potential changes.

Figure 24 – A comparison of responses from large, small and medium-sized DSOs



05

HOW TO FACILITATE THE MOVE TOWARDS A MORE ACTIVE DSO

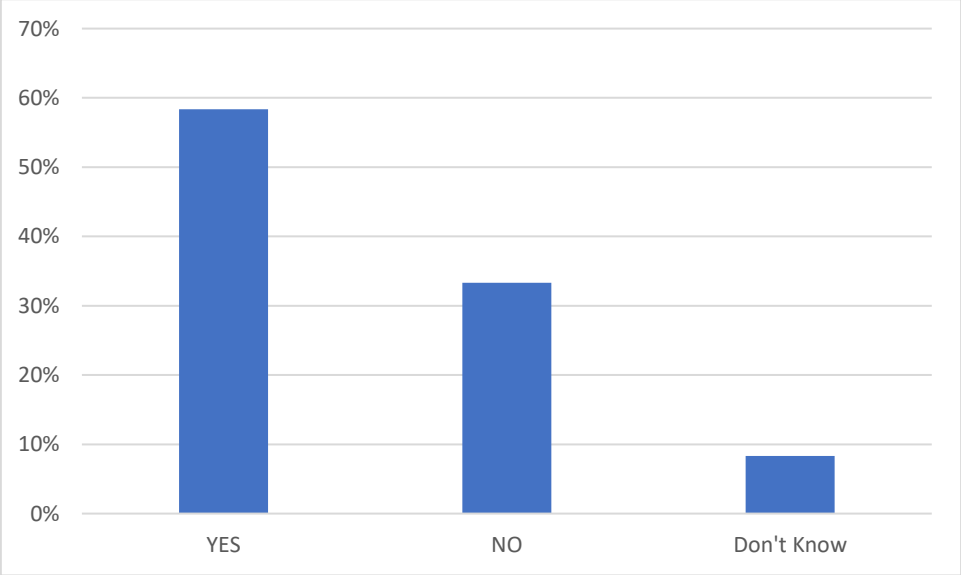
5. How to facilitate the move towards a more active DSO

We now move to a set of questions where we ask NRAs and DSOs how regulators (and EU institutions) could support the move to the DSO. We include some questions to establish some context; and ask regulators what they are doing to promote a more active role for the DSO in their jurisdiction. The literature highlights examples of good practice in R&D funding allowances by regulators, but the picture is patchy across Europe.[51]

Does your jurisdiction promote R+D funding for the future of the DSO? *(Q22NRA)*

We begin with whether NRAs specifically allow for R+D funding for DSOs to experiment with projects to do with the future of the DSOs. It may, of course, be the case that other funding mechanisms for R+D around the future of the DSO exist (such as direct government funding for research and development) outside the control of the regulator, but the reason to ask about this is that regulatory initiatives to promote R+D projects are thought to be a powerful source of industry learning.[52] In our survey, NRAs were therefore asked whether their jurisdictions promoted research and development funding for the future of the DSO. Most of our surveyed NRAs did, but a significant minority (4 out 12) did not.

Figure 25 – Does your jurisdiction promote R+D funding for the future of the DSO?

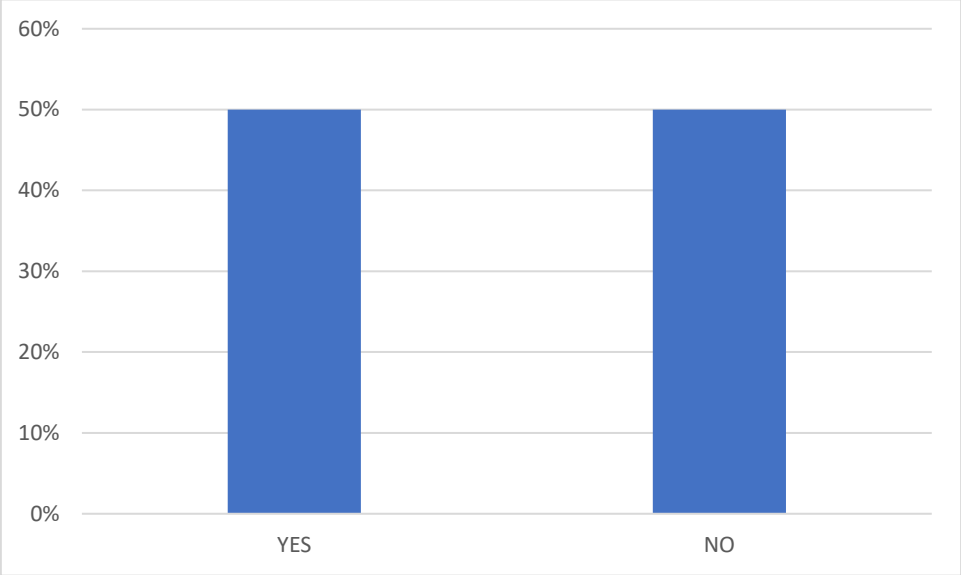


[51] See Meeus and Saguan (2011) for some good examples.
[52] See Cambini et al. (2020) who discuss the strengths and weaknesses in European countries' approaches to innovation funding in energy: and Jamasb et al. (2020) who compare funding mechanisms for energy R+D.

Does your jurisdiction have a regulatory sandbox-type regime to encourage new business models? *(Q23NRA)*

Regulatory sandboxes[53], of the type pioneered by Ofgem[54] in Great Britain, allow discussion of new business models and technologies with the regulator in order to understand how and if the existing regulatory regime can facilitate their introduction to the system. Where this has been tried, this acts as a way of getting expert advice on how actual and potential market participants can negotiate the regulatory regime. Thus, NRAs were asked whether they had a regulatory sandbox-type regime which considered new business models (and by implication any new technologies associated with them). Our sample is equally split, with six NRAs having such a regime and six not.

Figure 26 – Does your jurisdiction have a formal regulatory sandbox-type regime to encourage new business models?

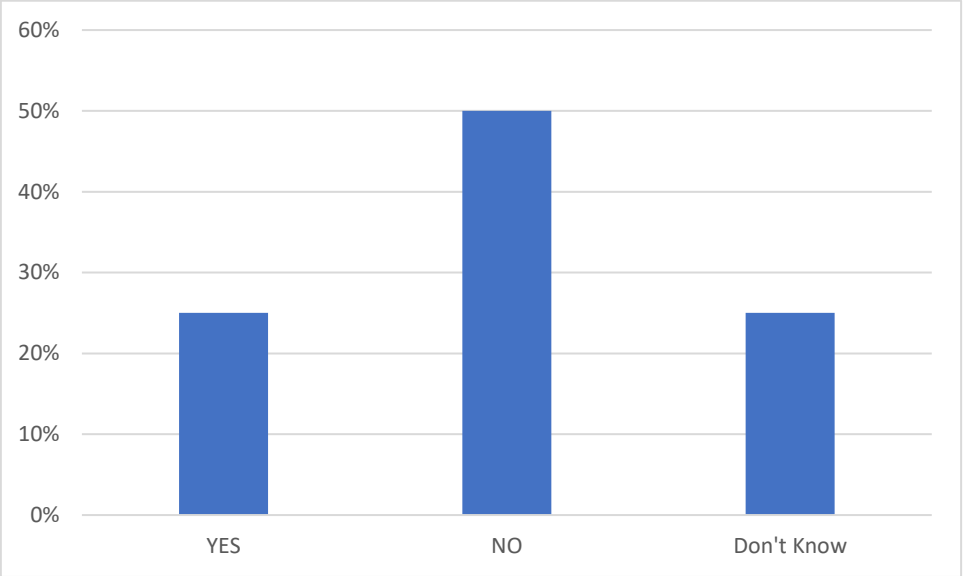


Has your regime granted a derogation from normal DSO regulation to facilitate a 'future of the DSO' trial? *(Q24NRA)*

Related to the question of whether the regulatory regime encourages market entry by new firms, who might be capable of providing flexibility, is the issue of whether normal rules can be relaxed to facilitate a trial at the DSO level, via a specific derogation from the existing rules. In general, it is important to point out that derogations in the rules are not a good thing, because they may result in unfair treatment of network customers. Hence, they should be used sparingly or the rules should be written in such a way as to allow reasonable experimentation as a matter of course. We asked NRAs if they had given such a derogation: only 3 out of 12 NRAs reported that they had definitely granted a derogation for a DSO trial, 6 definitely had not.

[53] See van der Waal et al. (2020), who discuss the merits of such an approach and makes suggestions as to how it can be done more effectively.
[54] See https://www.ofgem.gov.uk/publications-and-updates/what-regulatory-sandbox

Figure 27 – Has your regime granted a derogation from normal SO regulation to facilitate a 'future of the DSO' trial?



How are NRAs promoting capacity building at the DSO? *(Q25NRA)*

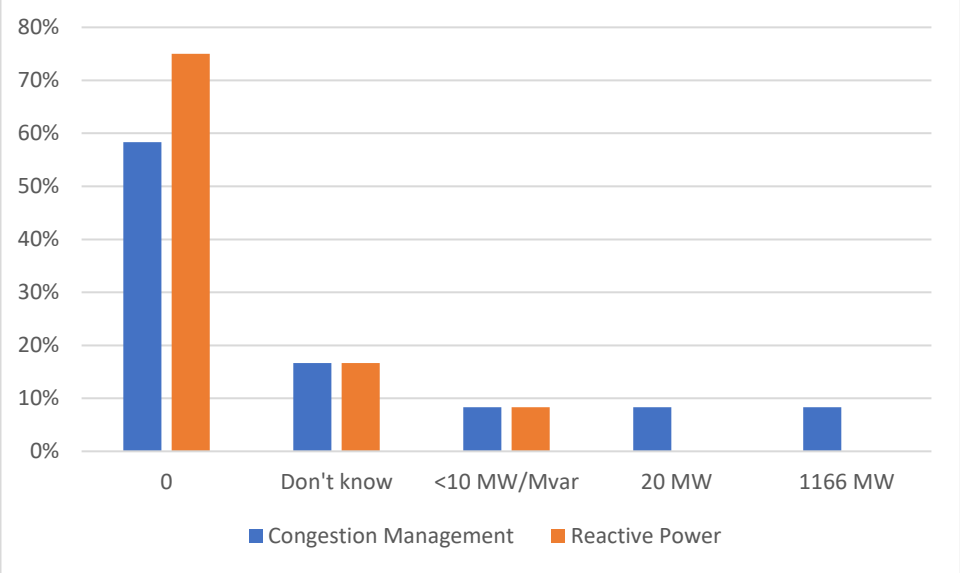
A related issue is capacity building (in the managerial sense of the term) at the DSO level itself and how NRAs are actually encouraging DSOs to develop their capability to meet future challenges. We asked NRAs if they could give examples of how they were supporting this. Five NRAs were able to give examples of how capacity building at the DSO-level was being promoted.

One reported that, as part of its upcoming price review of DSOs, allowed revenues would "*include the necessary funding to develop and strengthen the skills, abilities, processes and resources within the DSO's organisation"*. Another noted the *"application of a variable rate of return on capital depending on the size of the company*". A third reported that it was giving *"visibility to network bottlenecks and future developments"* in order to promote *"consistency in investment decisions with [the] TSO or other DSOs*". A fourth mentioned allowances for R+D funding. The final NRA mentioned its role in the steering group guiding the future of the DSO initiative as part of the national energy networks association.

How much competitive procurement by DSOs is occurring in NRA jurisdictions? *(Q26NRA)*

We then asked how much competitive procurement was actually being undertaken within NRA jurisdictions at the moment. Nine out of 12 surveyed NRAs report little to no competitive procurement of congestion management and reactive power. One NRA reported a significant amount of procurement of congestion management only (1166 MW in 2020), and another reported competitive procurement of reactive power only.

Figure 28 – Current annual size of competitive procurement by DSOs



The above responses indicate that while a majority of our surveyed NRAs are supporting the emergence of an active DSO with R+D allowances, a significant number are not formally encouraging sandbox activities and specific derogations from existing regulation. Overall, there is very little actual competitive procurement of ancillary services at the distribution level, apart from in one jurisdiction for congestion management (not reactive power).

What do DSOs want their regulators to do? *(Q20DSO)*

We now turn to the DSO survey to get the DSO perspective on how regulation might better facilitate the move to the DSO. DSOs were explicitly asked: What suggestions, if any, would you give on how the regulator in your jurisdiction might better support your company in its role in the energy transition? This question built on Q18DSO/Q20NRA which offered a menu of specific changes to the regulatory regime which might facilitate more innovative investments.

This produced a range of responses, which brought out a number of issues, some of which were highlighted in the previous section. First, DSOs questioned whether there were any incentives in and around the revenue allowances for monopoly DSOs, and the extent to which these encouraged non-CAPEX solutions. Second, there was the issue of the incentives to innovate and the general regulatory support for innovative solutions. Third, there were issues raised around the active role of the NRA. Fourth, points were made about whether current regulatory arrangements were sufficiently flexible.

Revenue allowances

Several DSOs make points about the need to get the regulatory revenue incentives (and hence their level of remuneration) right. One comments on the need for *a "a future funding mechanism that encourages the correct investment solution (conventional/smart/market-based) irrespective of a capital versus a revenue decision"*. Another comments: *"As it is today, the DSO gets paid for investing in the grid, but not for investing in other solutions."* This might involve the introduction of *"a fixed component in distribution tariff"*. Another advocates "*flexible price control arrangements"* and yet another "*more agile price controls*" and a third wants to "*encourage and not punish early*

investments". But this contradicts another respondent who wants *"longer periods of stable regulation"*.

Incentives to innovate

DSOs express the view that innovation needs to be rewarded. One reports that this implies a *"higher WACC and shorter depreciation period for innovative investment"*. Another links this to sector coupling, advocating the need to *"stimulate the extended use of existing gas infrastructures but compensate for accelerated depreciation"*. A couple of responses explicitly call for their regulator to make more use of regulatory sandboxing for research. One issue raised is the conflict between existing profits and encouraging new entrants which need to be addressed: *"[T]here should be no winners or losers. If new agents such as the aggregators have to enter […] the sector, the distributor must receive sufficient incentives in all aspects so that it can make way for new entrants."*

A more active NRA

Some DSOs expect NRAs to play a key role in promoting smarter solutions publicly: *"The whole discussion about usage of flexibility resources instead of network investment would need a strong regulator that could lead the discussion."* Thus NRAs could encourage early engagement and *"timely involvement of stakeholders and society in the process and discussions on changes in tariff etc."* This could be done by, inter alia, *"regulation road maps" and "having an ongoing, open dialogue […] to get a common understanding."* In some jurisdictions, there was a stated potential for conflict at the DSO level between national regulation and regional administrations, which needs to be resolved.

Flexibility of current regulatory arrangements

Some jurisdictions don't allow flexible connections to the distribution grid (i.e. connections where export/import capacity available to a DER is restricted in return for lower grid fees) and this was noted as discouraging smarter and cheaper connections (which avoid the need for wider grid reinforcement). One respondent said DSOs should be allowed to own and operate congestion management infrastructure, such as storage devices, and operate a local market platform to be able to procure flexible energy for balancing the grid and avoiding congestion: *"Pragmatically, NRAs should evaluate the possibility to include new types of assets (such as equipment for data transmission via optical fibre and 5G wireless networks, IoT sensors, real-time monitoring devices, artificial intelligence systems etc.) among the categories admitted for recognition in the RAB of the DSO."*

What are DSOs doing themselves to build their own capabilities for the future? *(Q21DSO)*

We then turned to what DSOs are doing to develop their own capacity to become a more active DSO. They were asked: Give a good example of how your company is promoting capacity building (in the managerial capability sense above) at the DSO.

This produced a range of responses, which brought out a number of issues. First, there was attention to staff training. Second, there were improvements to network planning. Third, there was investment in network capacity and the energy transition itself. Fourth, there was an emphasis on R+D and new experiments.

Staff training

One DSO notes that it is providing: *"One-on-one or group training that increases personal knowledge and skills surrounding an issue. Individuals receive the tools they need to take meaningful actions and help educate others in our company."* For another: *"The company has defined a training plan for its professionals for the incorporation of new technologies into the electricity distribution network."*

Network planning and stakeholder dialogue

One DSO notes that it is: *"Producing DFES (Distribution Future Electricity Scenarios) documents and data with support and information from local stakeholders, indicating forecast volumes of LCTs and their impact on the network."* Another DSO says it is planning for its internal needs over a ten-year perspective. Two DSOs are helping others with their energy planning: *"We are helping our public stakeholders in developing their so-called Regional Energy Strategies. Planning and building infrastructure is part of that process."* While another stresses the importance of *"having dialogue with regional and local representatives from society and customers and also transmission operator and other involved DSOs".*

Investment in network capacity and the energy transition

One DSO is undertaking *"extensive security of supply investments and investments to increase the capacity of the network to enable the connection of renewables".* Another is *"facilitating a faster deployment of charging points to encourage the uptake of electric vehicles by providing network connections"*. One says *"the company is taking on the new role of the DSO by providing capital for investment in network digitalisation, training existing staff in the company"* and another is making *"investments to increase capacity and improve the quality of supply to ensure increased demand from society, together with investments in network digitalisation and automation".* One of the national DSO trade associations reports: *"We are running local flexibility markets … as BaU* [business as usual]".

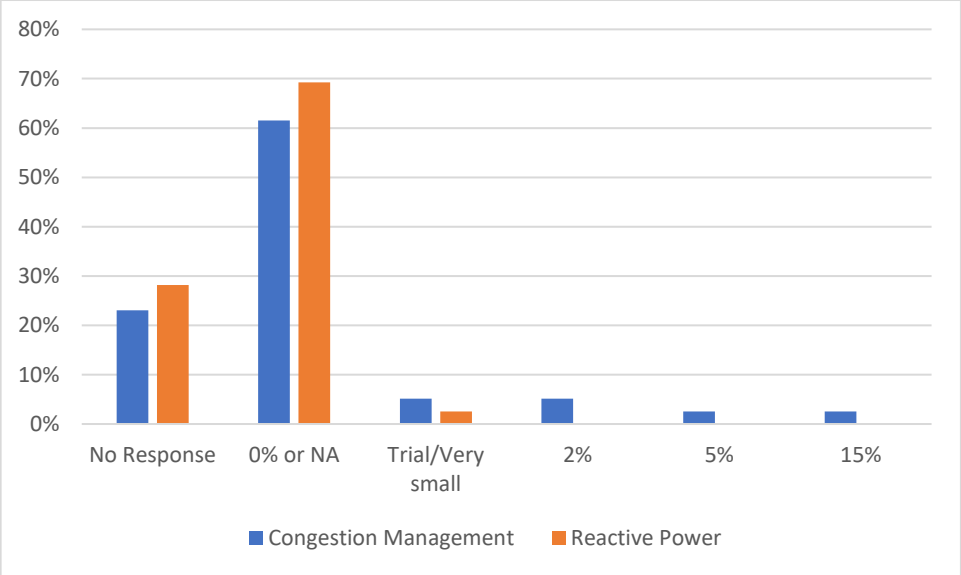
R+D and experimentation

One DSO notes that its storage project *"aims to break down barriers for customers connecting energy storage which can benefit the customer as well as the network/system".* Another notes it is *"running local flexibility markets"*, while another is building capacity *"by R&D, performing relevant pilots (use of flexibility instead of investments, new roles for the DSO) and by hav[ing] office representatives in Brussels*". Another is *"incorporating new talent and creating an innovation department that will be the laboratory for new ideas and tests for the new investments that will be made on the grid".*

What is the current size of company competitive procurement for congestion management and reactive power? *(Q22DSO)*

DSOs in our survey say they are doing a lot to build capacity and become more active DSOs. The specific question needs to be asked as to how much actual competitive procurement of services they are doing.

Figure 29 – Share of DSOs reporting levels of competitive procurement (relative to peak demand)



This suggests that in line with the NRA survey, only a few of our covered jurisdictions (most notably the UK) and a few of our respondent DSOs are actually doing any significant procurement of congestion management at the moment. On reactive power, only one DSO (out of 39) respondent reports any competitive procurement of reactive power. Some of our respondents point out that one reason that competitive procurement is non-existent is that their grids are not currently suffering from congestion.

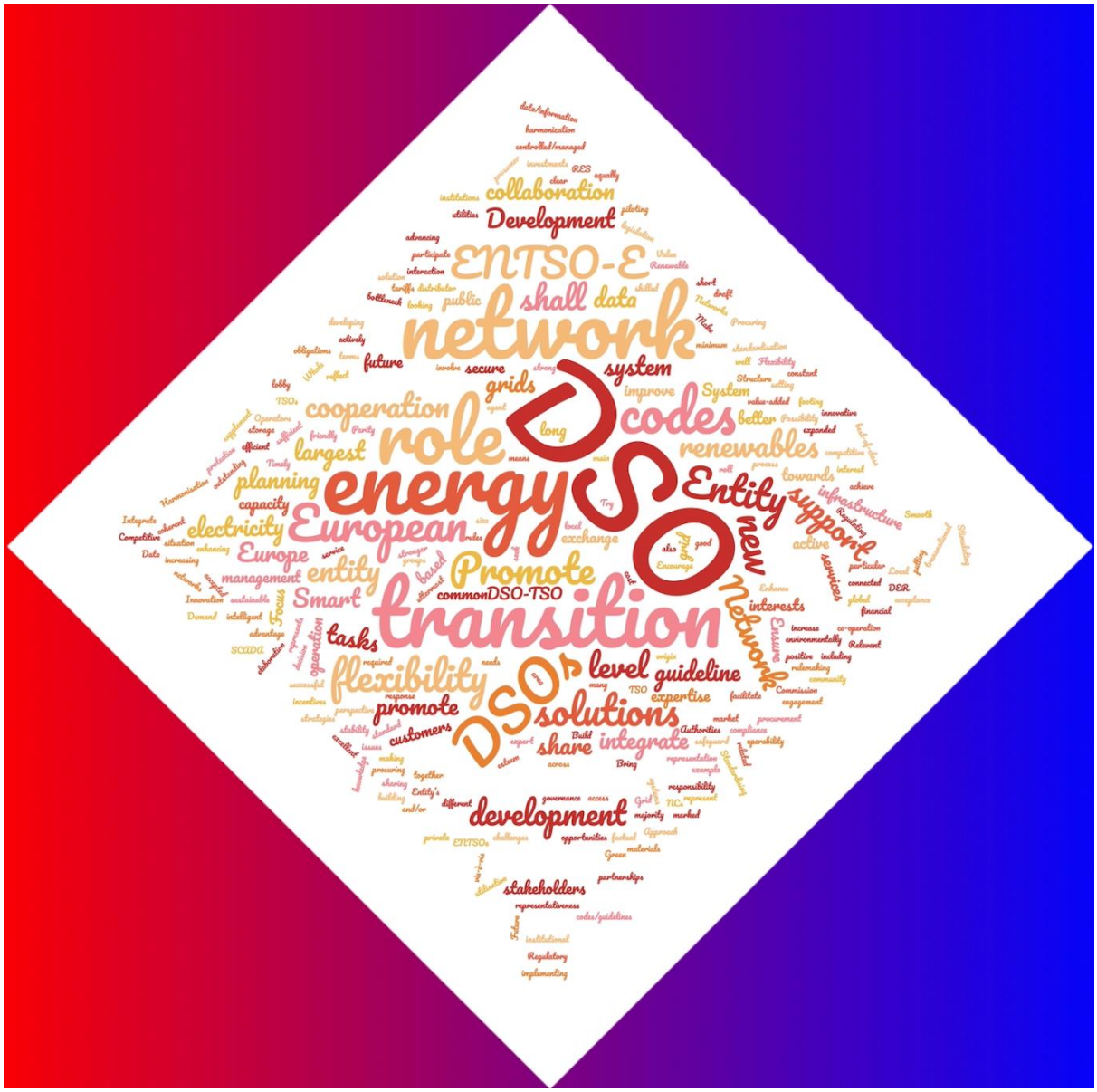
How can the new EU DSO Entity help promote the role of the DSO? *(Q23DSO, Q27NRA)*

Next, we wanted to explore the EU level and gather DSO and NRA perspectives on the recent creation of an EU-wide DSO Entity (formally: The EU DSO Entity)[55], to mirror ENTSO-E at the transmission level, under Art. 52 of Regulation 2019/943. This Entity has been created as part of the Clean Energy Package, so the issue is what should it do and what mistakes should it avoid. Both DSOs and NRAs were asked: The EU is creating a new 'DSO Entity' to mirror ENTSO-E. What three areas should this Entity focus on to promote the role of the DSO across Europe? What mistakes do you foresee it might make?

This question produced a number of remarks from DSOs, depicted in the following word cloud.

[55] https://www.eudsoentity.eu

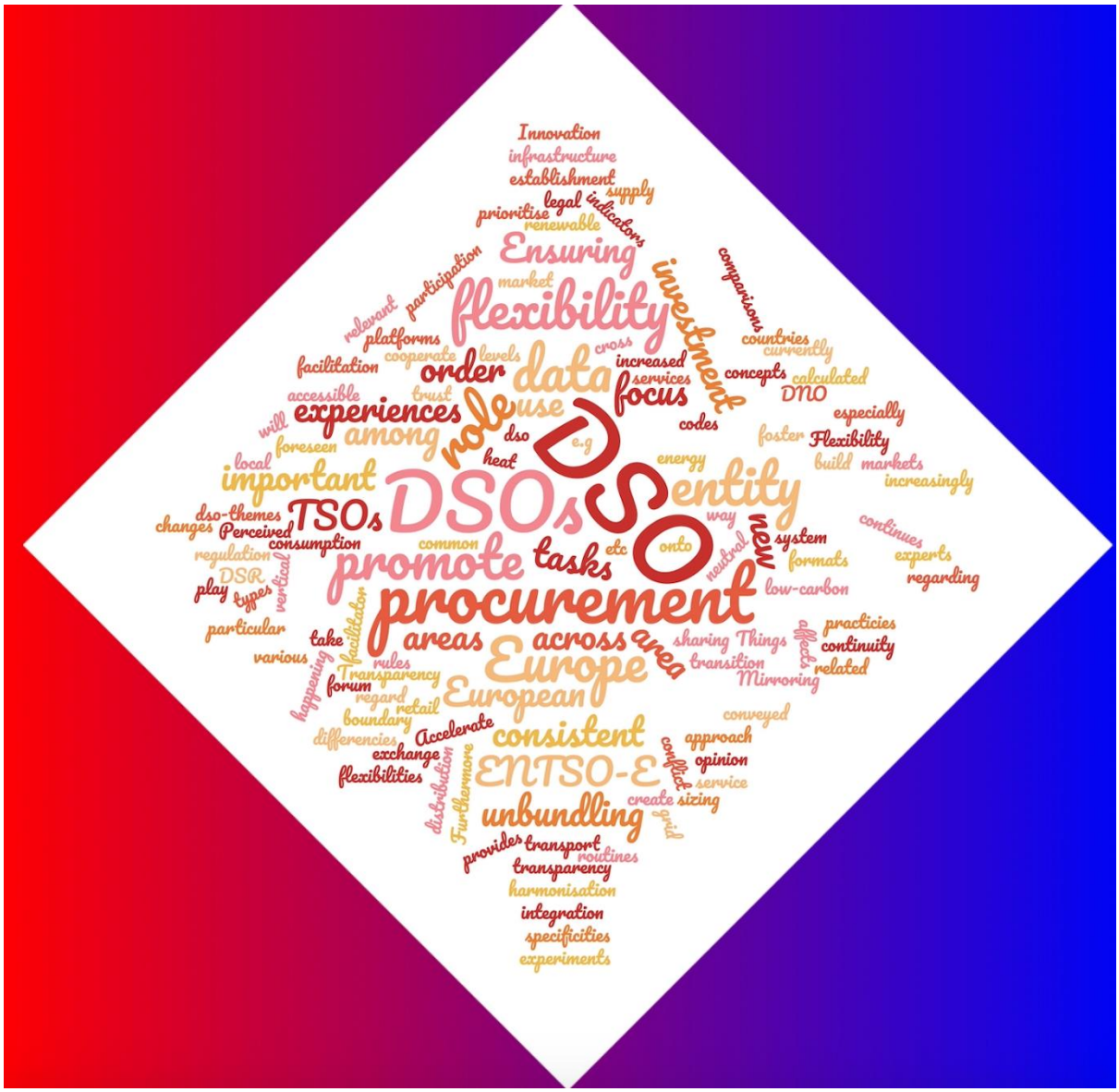
Figure 30 – DSOs word cloud



This shows that the most common suggestions were around the DSO Entity promoting flexibility, supporting the drafting of network codes, promoting the energy transition, and network solutions.

The NRA responses emphasise the need to learn from ENTSO-E (the parallel transmission company organisation at the European level), provide a European voice for DSOs, and promote competitive procurement of services.

Figure 31 – NRAs word cloud



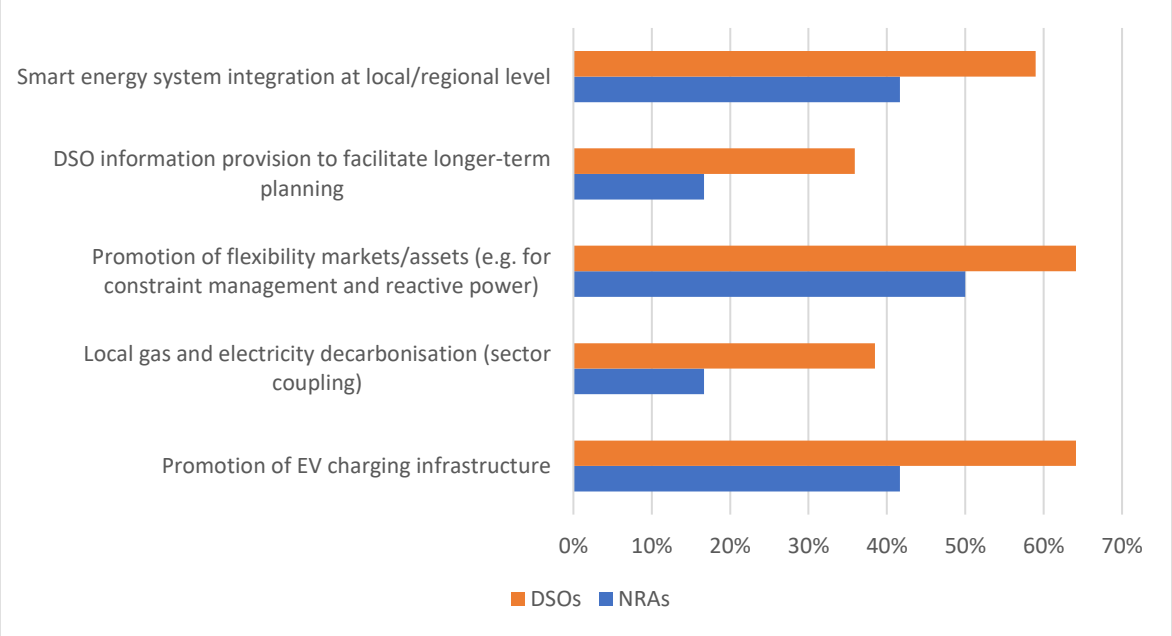
In terms of mistakes that the new Entity might make, DSO respondents are most concerned that it would not take into account the specific conditions of the country's distribution system (12 out of 39 respondents mention this). DSO concerns are also expressed about how representative the new Entity would be, that it might engage in lobbying, and that it would be overly bureaucratic and mismanaged. NRA respondents variously expressed concern that it would not promote competitive solutions and take due account of national differences, with one NRA even noting that apparently similarly sized DSOs in its own jurisdiction exhibited very different characteristics in terms of customer base and the impact of DER.

What useful trials do DSOs and NRAs know about inside their own jurisdiction? (Q24DSO, Q28NRA)

Given the huge amount of activity around the DSO and the many trial and research projects going on across Europe, we wanted to ask which of these projects our DSOs and NRAs would recommend as being significant. This follows recent academic reviews of innovative trials in the future of the DSO.[56] We asked about projects in their own jurisdiction and ones in other countries. Both DSOs and NRAs were asked to give at least one example of the most interesting 'future of the DSO' projects/initiatives that they are aware of inside of their own jurisdiction with respect to the following: smart energy system integration at the local/regional level; DSO information provision to facilitate longer-term planning; promotion of flexibility markets/assets (e.g. for constraint management and reactive power); local gas and electricity decarbonisation (sector coupling); and promotion of EV charging infrastructure. Some of these areas overlap (for instance, smart energy system integration and sector coupling) and this is reflected in the overlapping nature of some the examples that survey respondents offer.

We find that NRAs seem unwilling or unable to name specific projects in their jurisdiction that are considered interesting. This may have been because there is reluctance to single out particular projects, given their position as a neutral party. DSOs did rather better, often citing their own projects, though less than half mention any project on sector coupling or information provision. The number in brackets is where more than one survey respondent mentioned a particular project.

Figure 32 – Percentage of respondents naming example projects in their jurisdiction



[56] See Anaya and Pollitt (2020a).

Promotion of EV charging infrastructure

DSOs put forward the following specific projects:

- *E-Laad Foundation, Netherlands*[57] *(2)*
- *URCHARGE in Linz, Austria*[58]
- *VLOTTE, Austria*[59]
- *NKM Mobilitas, Hungary*[60]
- *Public Charging points in Munster, Germany*
- *i-DE National Plan, Spain*

NRAs do not name any of the above projects. There is one specific project suggestion from one country out of the 12 regulators responding, but this project is not named by any of our responding DSOs.

Local gas and electricity decarbonisation (sector coupling)

DSOs suggest the following specific projects:

- *Oosterwolde and Lochem experiments in Netherlands distributing H2 to consumers*[61]
- *NEW 4.0, Germany*[62]
- *Local energy management concept at NKM, Hungary*
- *Research at Lapareenta University, Finland*
- *Strategy for District Heating Munster, Germany*

NRAs do not name any of the above projects. Again, there is one specific project suggestion from one country out of the 12 regulators responding, but this project is not named by responding DSOs.

[57] https://www.elaad.nl
[58] https://www.linzag.at/portal/de/ueber_die_linzag/projekte/urcharge
[59] https://www.vlotte.at
[60] https://www.mobiliti.hu/emobilitas
[61] https://www.alliander.com/en/news/more-investment-in-the-grids-and-launch-of-hydrogen-pilots/ and https://fuelcellsworks.com/news/europe/kiwa-and-alliander-are-building-a-demo-hydrogen-house/
[62] http://www.ceem-dauphine.org/assets/dropbox/270918_Dauphine_Hans_Schaefers_HAW_Hamburg_OFATE_et_CEEM_DFBEW.pdf

Promotion of flexibility markets/assets (e.g. for constraint management and reactive power)

DSOs mention the following projects:

- *Norflex, Norway[63] (2)*
- *Project Interflex Eindhoven, Netherlands[64]*
- *Energy storage pilot by Elenia and Fortum, Finland[65]*
- *Caruna/Fortum storage facility in Inkoo, Finland[66]*
- *IREMEL, Spain[67]*
- *Coordinet, EU[68]*
- *Three H2020 projects: GOFLEX[69] (local flexibility market), FLEXITRANSTORE[70] (multiple flexibility providers to TSO and DSO), DELTA[71] (innovative flexibility aggregation), EU*
- *H2020 Project: OneNet, EU[72]*
- *Project Prendt, Austria[73]*
- *ENKO Flexibility Platform, Germany[74]*
- *ENA Open Networks Project, UK[75]*
- *Reactive Power Nodal Controller, UK[76]*
- *Energy communities in Munster, Germany*
- *i-DE allowing connections when there is no granted capacity access, Spain*
- *Nijmegen and Neerrijnen, Netherlands experiments*

Six projects are named by NRAs as interesting projects, including two of the above.

[63] https://www.ae.no/en/our-business/innovation/the-norflex-project/thepowergridofthefuture/
[64] https://interflex-h2020.com/interflex/project-demonstrators/the-netherlands/
[65] https://www.fortum.com/media/2020/05/fortum-and-elenias-battery-pack-stores-electricity-power-outages-and-maintaining-electricity-network-balance
[66] https://www.caruna.fi/en/en/about-us/responsibility/inkoo-electricity-storage
[67] https://www.grupoomi.eu/en/news-activities
[68] https://coordinet-project.eu/projects/project
[69] https://www.goflex-project.eu
[70] http://www.flexitranstore.eu
[71] https://www.delta-h2020.eu
[72] https://cordis.europa.eu/project/id/957739
[73] https://innoloft.com/news/39420
[74] https://www.strommarkttreffen.org/2019-03-15_Gerbaulet_Using_ENKO_for_infeed_management.pdf
[75] https://www.energynetworks.org/creating-tomorrows-networks/open-networks
[76] https://www.nienetworks.co.uk/future-networks/level2/our-innovation-projects/nodal-controller

DSO information provision to facilitate longer-term planning

DSOs suggest the following specific projects:

- *Finnish network development plan concept*[77]
- *ENA's digital systems map*[78]
- *Data Analytics for Better Asset Management: i-DE, Spain*

Two NRAs suggest the importance of their support for network development planning.

Smart energy system integration at local/regional level

DSOs suggest the following specific projects:

- *Smart Grid Architecture Model, EU*[79] *(2)*
- *H2020 Project: iElectrix, EU*[80]
- *Elenia's next generation smart meter roll out, Finland*[81]
- *Smart Otaniemi Project, Finland*[82]
- *ASCR: Aspern Smart City Research, Austria*[83]
- *DG Demonet biosphere park Großes Walsertal in Vorarlberg, Austria*[84]
- *EDA Platform in Austria*[85]
- *GOPACS, Netherlands*[86]
- *Local pilot at Zsombo, Hungary*
- *Smart Cities Initiative: i-DE, Spain*

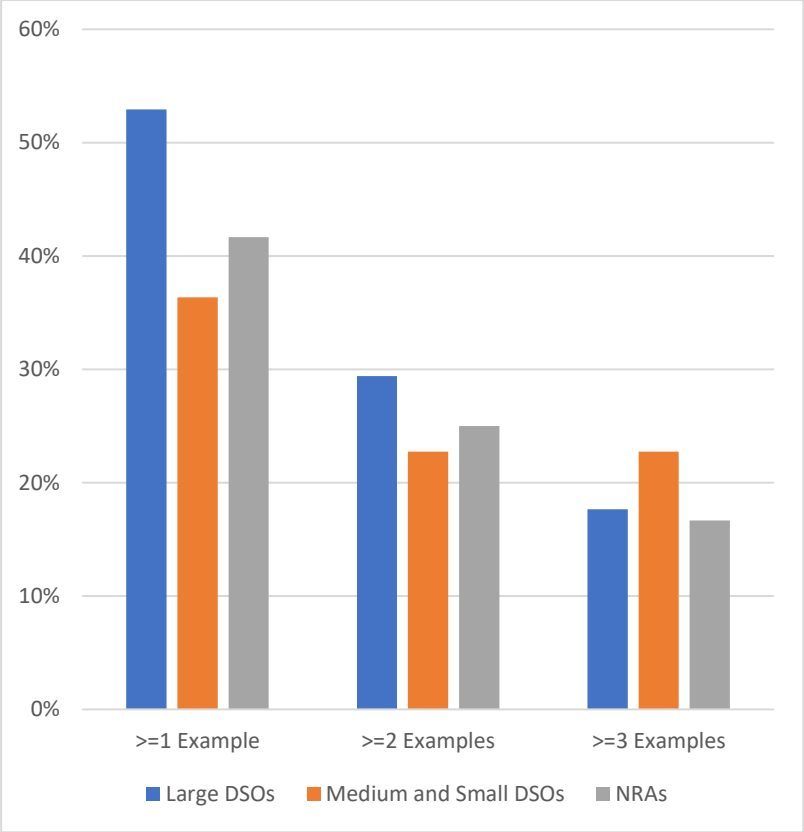
NRAs do not name any of the above projects. There are two specific project suggestions from 2 of the 12 regulators responding, but these projects are not named by responding DSOs.

What useful trials do DSOs and NRAs know about outside their own jurisdiction? *(Q26DSO, Q30NRA)*

The survey questions then explore projects outside respondents' own jurisdiction. This is important because a major role of an organisation like ENTSO-E has been to spread best practice across European electricity transmission entities. Many trials at the distribution level are small and focused within a local distribution system. A starting point for identifying dissemination issues (i.e. spreading the learnings from projects) is the extent to which DSOs and NRAs are aware of projects outside their own jurisdictions. Both DSOs and NRAs were therefore asked: Give up to three examples of the most interesting future of the DSO projects/initiatives that you are aware of outside of your own jurisdiction, if any.

[77] https://www.fingrid.fi/en/grid/development/main-grid-development-plan-for-2017--2027/
[78] https://youtu.be/MyZs0wxc0OI
[79] https://ec.europa.eu/energy/sites/ener/files/documents/xpert_group1_reference_architecture.pdf
[80] https://ielectrix-h2020.eu
[81] https://www.aidon.com/elenia-a-new-generation-of-smart-metering-system-with-sonera-and-aidon/
[82] https://smartotaniemi.fi
[83] https://www.ascr.at/en/
[84] https://www.ait.ac.at/en/research-topics/smart-grids/projects/dg-demonet-validation/
[85] https://www.ponton.de/b2b-integration/eda/
[86] https://gopacs.eu

Figure 33 – Percentage of DSOs and NRAs citing extra-territorial examples



Just over 40% of DSOs and NRAs offer at least one example on an interesting project/initiative outside their own jurisdiction, and only around 25% of DSOs and 17% of NRAs (2 out 12) could give three examples of projects outside their own jurisdiction. Medium-sized and small DSOs were more likely to give no examples than large DSOs.

Projects outside their own jurisdiction mentioned by DSOs include:

- *Open Networks in the UK[87] (3)*
- *INTERRFACE: connecting platforms across Europe[88] (2)*
- *IFLEKS: focused on consumption and peak load forecasts in Norway[89] (2)*
- *Nodes in Norway[90]*
- *GOPACS in the Netherlands[91]*
- *Mitnetz: Renewable curtailment alternative, Germany (uses Nodes platform)[92]*
- *Netzentwicklungsplan 2030, Germany [93]*
- *Sthlmflex: Market-based TSO-DSO coordination through regional flexibility market in Sweden (uses Nodes platform)[94]*
- *Scottish Power in the UK[95]*
- *Intraflex by WPD in the UK[96]*
- *H2FUTURE of Voestalpine, Austria[97]*
- *VPP in Australia[98]*
- *Innovation projects in the UK (unspecified)*

Thus projects in the UK are mentioned by 6 respondents, in Norway by 3, European projects by 3, in Germany by 2; Australia, Sweden and Norway and Netherlands are mentioned by 1 each. The Nodes platform is mentioned 3 times (twice indirectly).

[87] https://www.energynetworks.org/creating-tomorrows-networks/open-networks
[88] http://www.interrface.eu/The-project
[89] https://www.statnett.no/en/about-statnett/research-and-development/our-prioritised-projects/iflex--price-sensitivity/
[90] https://nodesmarket.com/about/
[91] https://gopacs.eu
[92] https://www.mitnetz-strom.de
[93] https://www.netzentwicklungsplan.de/de/netzentwicklungsplaene/netzentwicklungsplan-2030-2019
[94] https://www.svk.se/sthlmflex
[95] https://www.spenergynetworks.co.uk/pages/our_innovation_projects.aspx
[96] https://www.westernpower.co.uk/downloads-view-reciteme/114967
[97] https://www.voestalpine.com/group/en/media/press-releases/2019-11-11-h2future-worlds-largest-green-hydrogen-pilot-facility-successfully-commences-operation/
[98] https://arena.gov.au/projects/agl-virtual-power-plant/

NRAs mentioned:

- *Coordinet, EU (2)*[99]
- *BRIDGE, EU*[100]
- *EvolvDSO, EU*[101]
- *TDX-Assist, EU*[102]
- *Ofgem initiative on SO at DSO level, UK*[103]
- *enera, Germany*[104]
- *New York REV*[105]
- *New England ISO*[106]

In addition, they also mention Open Networks in the UK and GOPACS in the Netherlands which are noted by DSOs.

What are the biggest barriers facing current DSOs to a more active DSO? *(Q25DSO, Q29NRA)*

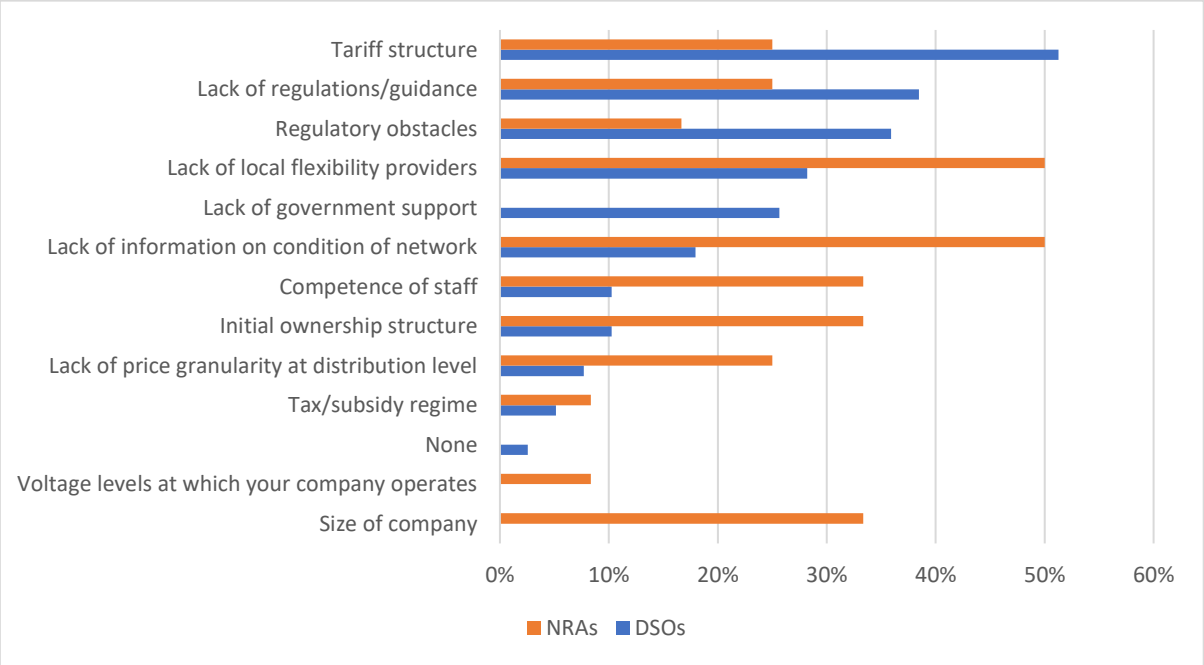
Next, we asked about the barriers to a more active DSO world, from the company and regulator perspective. Both DSOs and NRAs were asked: Thinking about moving to a world of a more active role for the DSO, what are the three biggest barriers for your company, if any?

We offered a menu of choices. Just over half of responding DSOs think that the tariff structure is among the biggest barriers for their company becoming a more active DSO[107]. This is followed by regulatory obstacles and/or a lack of regulation. Only one DSO thinks there are no obstacles. One suggests in the free text response that a lack of the ability to offset CAPEX and OPEX savings, thereby incentivising non-wire solutions, is an issue within their regulatory regime.

Among our 12 NRAs, unsurprisingly there is some contrast with the DSOs on what the barriers are; relatively few think that the tariff structure and nature of regulation are the biggest problems. They agree that a lack of local flexibility providers is an issue. Interestingly, four NRAs worry about the size of their companies and competence of their staff, while no DSOs consider firm size as a top three issue.

[99] https://coordinet-project.eu/projects/project
[100] https://www.h2020-bridge.eu/wp-content/uploads/2017/06/Brochure-of-BRIDGE-projects-V11-Revised.pdf
[101] https://www.edsoforsmartgrids.eu/projects/edso-projects/evolvdso/
[102] http://tdx-assist.eu
[103] https://www.ofgem.gov.uk/publications-and-updates/ofgem-position-paper-distribution-system-operation-our-approach-and-regulatory-priorities
[104] https://www.sinteg.de/en/showcases/enera
[105] https://www.nypa.gov/innovation/initiatives/rev
[106] https://www.iso-ne.com
[107] This is in line with Anaya and Pollitt (2020b) who find that network tariff structure is one of the top three regulatory changes to be considered in the adoption of more flexibility solutions by DSOs.

Figure 34 – Top three barriers facing companies in the move to DSO



Both DSOs and NRAs were asked: **Are there any other comments about the future of the electricity DSO that you would like to make?** *(Q27DSO, Q31NRA)*

In free text responses, two DSOs mention the need for a greater role of the DSO in sector coupling. Another asks for more regulatory commitment to promoting the DSO as a key enabler of the energy transition. Interestingly, one DSO asks for its regulator to define *"neutral enough"* in its role in the energy transition, indicating the conflict between the role of the DSO as a neutral facilitator versus an active promoter of the energy transition.

NRAs mention the need for even stricter unbundling rules around the DSO in the future and the need for clear cost allocation at the DSO level as well as for forward-looking charges.

06

DETAILED COUNTRY COMPARISON OF REGULATORY ENVIRONMENT SUPPORTING THE ACTIVE DSO

6. Detailed country comparison of regulatory environment supporting the active DSO

In this section we offer a detailed comparison – drawing on our survey data – of six countries included in our NRA survey in terms of the nature of the regulatory environment supporting the development of a more active DSO. These countries were chosen from the 12 for which we had responses from the NRAs. Among those selected were the three countries that reported positive competitive procurement of congestion management or reactive power (France, Great Britain and Norway) and three other broadly representative EU countries: Italy, Latvia and Sweden.

Table 7 - Detailed country comparison

	FRANCE	GREAT BRITAIN	ITALY	LATVIA	NORWAY	SWEDEN
MARKET SIZE (Peak Demand in 2019)	88.5 GW	58.7 GW	58.8 GW	2 GW	23.7 GW	23.20 GW
NUMBER OF DSOs (regulated by NRA)	121	6	127	11	120	174
NUMBER OF CUSTOMERS CONNECTED TO DSOs (reported by NRA)	36 million	30 million	37 million	0.8 million	3 million	5.4 million
ANNUAL PROCUREMENT OF CONGESTION MANAGEMENT (reported by NRA)	<10 MW	1166 MW	0	N/A	c.20 MW (via pilot projects/ trials)	Information not collected by regulator
ANNUAL PROCUREMENT OF REACTIVE POWER (reported by NRA)	<10 MVar	0	0	N/A	0	Information not collected by regulator
NOTABLE DSO INNOVATION PROJECTS NAMED BY DSOs FROM OTHER JURISDICTIONS IN SURVEY		Open Networks, Intraflex			IFLEKS, Nodes	Sthlmflex
REGULATORY INNOVATION FUNDING MECHANISM FOR DSOs	Yes	Yes	Yes	No	Yes	No

NATURE OF INNOVATION FUNDING	Yearly budget for R+D set in the tariff	Innovation funding mechanism, sharing factor on TOTEX in incentive regulation	Small levy collected via tariffs for general research in power system, c.70m)		Up to 0.3% of the DSO's regulatory asset base	
EXISTENCE OF REGULATORY SANDBOX	Yes	Yes	Yes	No	Yes	No
REPORTED USE OF DEROGATION	Don't Know	Yes	Yes	No	Yes	No
COUNTRY RANKING IN FACTORS THAT RECOGNISE ROLE OF FLEXIBILITY SERVICES (rank in Origami 2019)	8th =	1st =	6th =	None	12th =	12th =
LEADING DSOs (rank in SP 2020 index)	Enedis (16th)	UKPN (1st) WPD (3rd), SPEN (9th), NPG (10th), ENWL (17th), SSEN (21st).	e-distribuzione (8th)	None	None	Vattenfall (47th)
ELECTRICITY DIRECTIVE 2019/944 TRANSPOSED INTO NATIONAL LAW (according to Eur-LEX and CEER 2020 country reporting)	Eur-LEX: Implemented	CEER: Implementation due by 31/12/2020	Eur-LEX: Implemented	Eur-Lex: Implemented	CEER: Not reported	Eur-LEX: Not implemented

Sources for peak demand: RTE (2020, p. 15)[108], National Grid ESO (2020, p. 57)[109], TERNA (2020, p. 12)[110], Entso-e (2019, p.12)[111], NVE (2020, p. 37)[112], Svenska kraftnät (2020, p. 7)[113]

Note: For each country we report a number of size metrics, including peak demand, number of DSOs regulated by the NRA and the number of DSO customers. We can see that even for this sub-sample, there is considerable variation in size (from France to Latvia), which is highly suggestive of the challenges of implementing a common approach to the future of the DSO across Europe. Many DSOs are small and even in Latvia, with only 0.8m customers there are 11 DSOs.

In terms of competitive procurement of congestion management and reactive power, only Great Britain has significant procurement and then only for congestion management (not reactive power). This is in a relatively large electricity market with a small number of DSOs.

The link between competitive procurement of flexibility services and regulatory support for innovation is clear in the table. The three jurisdictions reporting competitive procurement – France, Great Britain and Norway – all have regulatory innovation funding mechanisms, which are relatively generous, allowing for extra revenue to be collected to fund innovation projects. They

[108] pdf_BE201_EN-1.pdf (rte-france.com)
[109] download (nationalgrideso.com)
[110] PROVISIONAL DATA OF THE ITALIAN ELECTRICITY SYSTEM_2019_EN_WEB_8d7f8db3334aef3.pdf (terna.it)
[111] https://eepublicdownloads.entsoe.eu/clean-documents/Publications/Statistics/Factsheet/entsoe_sfs2018_web.pdf
[112] RME Rapport (nve.no)
[113] kraftbalansen-pa-den-svenska-elmarknaden-rapport-2020.pdf (svk.se)

also have regulatory sandboxes and two of them report the definite use of derogations from normal regulatory rules to support innovation. These countries do well on independent country assessments of their use of market procurement for DSO services (from Origami, 2019 (Table 3), which we discuss later). Great Britain is significantly ahead in its actual competitive procurement of congestion management relative to the size of its market (1166 MW on a peak demand of 58.7 GW in 2019). This is reflected in its ranking on competitive procurement and in the ranking of all six of its DSOs among the top companies in the world for smart grid innovation on another independent ranking (from SP 2020, discussed below). Great Britain also has notable innovation projects (Open Networks and Intraflex) which have attracted interest from other countries.

While the Great Britain situation is noteworthy, the table shows that Norway, without an identifiable leading DSO, is still making progress with competitive procurement and doing well on its national ranking. It is also giving rise to an environment where there are noteworthy innovation projects (IFLEKS and Nodes), which have attracted interest from outside of Norway. Several Swedish projects are also attracting attention, in spite of the absence of a regulatory innovation funding mechanism or a regulatory sandbox, suggesting that there may be other routes to providing support for a more active DSO. Equally, Italy with a supportive environment in terms of innovation funding and a regulatory sandbox does not have any reported competitive procurement of congestion management or reactive power by DSOs.

We also report some detail on progress in implementation of the CEP. Eur-LEX helpfully records progress with the transposition into national law of the Electricity Directive (2019/944). Of the four Member States in our table, three are reported (as of 10 February 2021) to have transposed (at least some) of the Directive into national law. Sweden has not done so, and Great Britain reports that it is in the process of transposing the Directive into national law by 31/12/20 in its 2020 annual country report to the Council of European Energy Regulators (CEER) (Ofgem, 2020). Norway's NVE does not mention the Directive in its 2020 annual country report to CEER. This suggests that even for this sub-sample of countries, full implementation of the CEP is a work in progress.

07

SUMMARY OF KEY FINDINGS OF THE SURVEYS

7. Summary of key findings of the surveys

Using the survey results from the three previous sections, we can summarise our respondents' answers to the three starting questions.

7.1 How can and should the system operator (SO) function of the DSO be defined and regulated?

The majority (77%) of DSOs (65% of large, 87% of medium and 86% of small DSOs) do not support the prospect of a separate SO function, while 7 out of 12 (58%) NRAs do support it.

Views are split between NRAs and DSOs about the DSOs' potential role in data management with 75% of NRAs (in this case 9 out of 12) supporting data being shared with third parties, while 62% of DSOs are in favour of exclusive management of network data.

There are concerns among both DSOs and NRAs regarding DSOs' involvement in EV charging point management and P2P trading activities. Some 5 out of the 12 NRAs (42%) surveyed indicate that DSOs should have no role in the EV charging point infrastructure, while 64% of DSOs and 67% of NRAs indicate that DSOs should only provide the relevant data to support P2P energy trading.

Half of the 12 responding NRAs do not envisage a DSO role in gas decarbonisation, while 36% of DSOs think they could have a substantial role.

The views of both NRAs and DSOs are split regarding the possibility of DSO ownership of assets for the supply of flexibility, with a slight preference for only using (rather than owning) DER assets among DSOS (64% vs. 62%), while 50% of NRAs support the use of (third party) DER assets.

All the 12 NRAs support an increased level of coordination between TSOs and DSOs and 8 out of 12 are in favour of promoting more sectoral coordination. Just under three quarters (74%) of DSOs support an increased level of TSO-DSO coordination, while their views are more divided regarding greater sectoral coordination. Some 43% of small DSOs are in favour and 43% do not support the need for more sectoral coordination, while 40% of medium-sized DSOs are in favour and 40% do not support it. Around three quarters of large DSOs support more TSO-DSO coordination (76%) but also more coordination across sectors (76%).

7.2 What can regulators and EU policymakers learn from transmission system operator (TSO) regulation that can be translated down to the DSO?

Most DSOs (72%), especially the medium and small ones (80% and 71% respectively), are against a separate regulation for the SO function within the DSO, while more than 50% of NRAs (7) are not sure.

More than half of DSOs (21) do not see as necessary the use of more competitive procurement in network extension or refurbishment, while 42% of NRAs (5 out of 12) are uncertain.

There is unanimity among our NRAs in support for the use of more regulated distribution tariffs as a signal for the efficient use of the distribution network.

In the evaluation of responses given by DSOs and NRAs to a set of potential changes to the current investment regime at distribution level to facilitate innovative investments, we find widespread support across DSOs (64%) for the use of higher rates of return on risky assets, followed by use of variable depreciation periods (50%), and shared ownership of assets (40%). By contrast, half of

NRAs disagree with the use of higher rates of return and are not sure about shared ownership of assets. There is agreement about the use of more indicative planning by DSOs and NRAs (with around 50% supporting both cases).

In the response to other suggestions for supporting innovative investments, half of DSOs suggested a "change in regulatory incentive mechanism".

Multi-year network plans at distribution level were seen to have advantages for DSOs and NRAs. DSOs liked their 'predictability' and NRAs their 'visibility and transparency'.

In general, our DSOs seem surer of what they want in terms of regulation, while our NRAs are more uncertain. Large, small and medium DSOs are generally in agreement on most issues.

7.3 How can regulators support the capacity of the DSO to operate and coordinate the system?

A sizeable 8 out of 12 NRAs surveyed report that they do facilitate funding of R+D on the future of the DSO; 6 have a regulatory sandbox and 3 have definitely granted derogations from their regulation to allow a 'future of the DSO' trial. By contrast, 4 NRAs did not facilitate or fund such a trial, while 6 did not have a regulatory sandbox, and further 6 had not granted a derogation for these developments. This suggests that some NRAs could do more to support the future of the DSO. This is in line with the observation that the vast majority of both NRAS and DSOs surveyed currently have zero competitive procurement (33 out of 39) of congestion management or reactive power (38 out of 39).

Again by contrast, DSOs variously suggest that they want their regulators to do more in terms of revenue allowances, provision of incentives to innovate, NRA promotion of smart solutions, and increasing the flexibility of current regulatory arrangements.

DSOs themselves record that they are variously promoting staff training, network planning and stakeholder dialogue, investment in network capacity, and engaging in R+D and experimentation.

In terms of the new EU DSO Entity, DSOs variously want it to promote flexibility, support the drafting of network codes, and promote the energy transition and network solutions. NRAs suggest it can learn from ENTSO-E, provide a European voice for DSOs, and promote competitive procurement. A total of 12 of the 39 DSOs surveyed express concerns about the Entity's ability to reconcile the diverse situations of different DSOs across Europe.

Knowledge of DSO-related R+D experiments and projects within jurisdictions (and more generally) varied widely. DSOs are better informed or more willing to name innovative projects than NRAs, but 22 of the 39 surveyed DSOs struggled to name any noteworthy projects. Larger DSOs are more aware of projects outside their jurisdiction than smaller ones.

In terms of barriers to a more active DSO, DSOs themselves thought that tariff structure (51%) and regulatory barriers (36%) are among the most significant. By contrast, NRAs are most concerned about a lack of potential providers of flexibility (6 out of 12) and a lack of information on the state of the network (again 6 out of 12).

08

CASE STUDIES OF THE MORE ACTIVE ROLE OF THE DSO

8. Case studies of the more active role of the DSO

Under the headings that follow we provide an interesting example of a project demonstrating how DSOs can play a more active role. These examples were first put forward by the DSOs during the survey process. In each case, we give a brief description of the project and its relevance to the future of the DSO, and we evaluate what issue it is addressing in terms of barriers to the emergence of a more active DSO.

Promotion of EV charging infrastructure

E-LaadNL Foundation, Netherlands[114]

The E-LaadNL Foundation is a "knowledge and innovation centre in the field of smart charging infrastructure" which brings together all of the grid operators (both the TSO and DSOs) in the Netherlands to promote the use of electric vehicles. It undertakes research in five areas: smart charging, interoperability, testing, data analytics and behavioural research on smart charging.

They have a comprehensive 'to do' list on what is required to promote smart use of EVs.[115] These include ensuring all electric vehicles are interoperable between different charging points; optimising the capacity of smart charging infrastructure via combined grid operator smart charging signals (including capacity rates); allowing grid companies to contract for smart charging (including via a dynamic grid tariff); specification of priority in charging (including when EV loads can be disconnected); sharing of manufacturer-based information about the state of charge in EV batteries; specification of open access and standards within the smart charging ecosystem; promotion of appropriate cyber-security standards; providing incentives to make use of energy storage in EVs by changing household electricity tariffs; improvements to price transparency to promote optimal EV charging; and changes to energy taxation to facilitate bi-directional charging.

Local gas and electricity decarbonisation (sector coupling)

Oosterwolde and Lochem experiments in Netherlands with H2[116]

Dutch DSO Alliander is addressing congestion problems on its network with a project to convert surplus electricity generation from a solar farm into hydrogen. The hydrogen is then stored for use in hydrogen vehicles. The project will involve a 1-2 MW electrolyser being installed near a solar farm in the Oosterwolde area to relieve a nearby substation.[117] Another Alliander project involves supplying hydrogen to heat historic buildings in a neighbourhood of Lochem.[118] This involves taking 10-15 households off the natural gas network and using their local gas infrastructure to distribute hydrogen.[119]

[114] https://www.elaad.nl
[115] ElaadNL (2020).
[116] https://www.alliander.com/en/news/more-investment-in-the-grids-and-launch-of-hydrogen-pilots/
And https://fuelcellsworks.com/news/europe/kiwa-and-alliander-are-building-a-demo-hydrogen-house/
[117] See
https://www.topsectorenergie.nl/sites/default/files/uploads/TKI%20Gas/publicaties/Overview%20Hydrogen%20projects%20in%20the%20Netherlands%20versie%201mei2020.pdf
[118] https://www.kiwa.com/en/media/news/2020/kiwa-and-alliander-are-building-a-demo-hydrogen-house/
[119] https://www2.dgmarket.com/Notice/35575587

Promotion of flexibility markets/assets (e.g. for constraint management and reactive power)

Norflex, Norway[120]

The Norflex project is a joint project of Statnett, two local electricity distribution companies and energy suppliers, the Nodes market platform, and data company Enova. It is looking at how distributed energy resources can be aggregated to support local flexibility and also participate in the national frequency response market. The project is running from 2019-2021. Different technological solutions are being trialled in three separate locations, and the aim is to examine how congestion can be avoided, voltage problems reduced and grid planning improved.[121]

DSO information provision to facilitate longer-term planning

ENA's digital systems map[122]

It is important to ensure that energy network data is standardised and available to stakeholders. The Energy Networks Association (ENA) of UK and Ireland – which includes all electricity and gas networks in the UK and Ireland – has been leading an initiative to create digital map of the energy system. This is part of the ENA Data Working Group that has come out of Recommendation 5 of the UK government's Energy Data Task Force Report[123], which recommended the creation of a "*unified digital system map*".

A work in progress, this map is being designed to be interoperable, independent and make use of existing datasets. The unified map will show who owns what on the network, where the electricity and gas network assets are and where distributed generation is located. Most of the underlying data is already available. Such a tool can show things such as where network capacity exists to add distributed generation to the network or how EV charging points might be exploited to make use of existing network capacity. However, the process has already revealed issues such as a lack of standardisation of the underlying information being collected and made available by different DSOs.

Smart energy system integration at local/regional level

Smart Otaniemi Project, Finland[124]

This project is coordinated by the VTT research institute in Finland. Smart Otaniemi brings together stakeholders across the Otaniemi area, which is part of Espoo near Helsinki. The project is linked to the circular economy[125] and has recently completed a two-year initial phase consisting of three projects.

The first project examined flexibility using VTT buildings as testbeds to examine the ability to exploit existing building space heating, warm water, heat pumps through building automation, or remote monitoring while not interfering with user needs. The project explored new aggregator models and uncovered issues with ownership, building roles and permitting, and associated issues in cost allocation and how to interface between different actors.

[120] https://www.ae.no/en/our-business/innovation/the-norflex-project/thepowergridofthefuture/
[121] https://www.fingrid.fi/globalassets/dokumentit/fi/sahkomarkkinat/kehityshankkeet/local-flexibility-nordics-june2020.pdf
[122] https://youtu.be/MyZs0wxc0OI
[123] Energy Data Taskforce (2019).
[124] https://smartotaniemi.fi
[125] See http://uutiskirje.vttmail.fi/archive/show/4097060?video=true#5f7c6cd0b0111

The second pilot project was on smart EV charging. This involved the aggregation of multiple charging points and the building of a sub-aggregator model to manage small groups of users, with a view to participating in the national Frequency Containment Reserve market. The project identified the potential for using 35 EV charging points at a local factory linked to artificial intelligence (AI). Issues identified included the need to tackle problems with data-sharing and the building of a use case for real estate owners to install smart charging.

The third pilot was on data sharing, via a 5G network, and focused on how to make the data collection reliable. This involved a real-time monitoring system of a test network, use of drones, installation of an outage-free power supply for a base station, processing of EV charging information, and smart cooling to maintain user comfort. The difficulties identified included the need for secure data transfer, a lack of appropriate data infrastructure and the importance of 'fair play' contracts with respect to value creation from data provided. The project highlighted that energy data markets can be created but commercialisation of energy data remains challenging, especially in the presence of multiple data providers.

The striking thing about all of the above projects is that they are at relatively early stages of development. Those that involve demonstrating sector integration (Smart Otaniemi), or sector coupling (the Alliander Hydrogen projects in Oosterwoode and Lochem) remain small pilot projects involving a handful of customers. However, those that involve all of the DSOs in a country do exhibit attempts to more comprehensively address issues concerning data (ENA Digital Systems Map) and electric vehicles (ElaadNL). This suggests that when DSOs work together within a jurisdiction, more significant progress may be possible. Some of these larger, sector-wide projects may also benefit from direct NRA involvement in the steering committee (which is the case for the ENA's Open Networks Project in GB), in a way that is not the case for smaller projects.

09

SCENARIOS

9. Scenarios

In this section, we outline a number of scenarios where we discuss the extent to which existing European legislation and its national manifestation is facilitating a more active role for the DSO. In each scenario, we offer a perspective from the literature and from the types of issues raised by our surveys.

9.1 The role of the DSO in coordinating public EV charging points

A local, regional or national government wishes to install a large number of public charging points in its area, could it ask the DSO to do this?

Access to public re-charging facilities is seen as key to the widespread adoption of electric vehicles. Ahead of a major uptake of electric vehicles, this is not happening without implicit or explicit subsidy. Even in the long-run it remains unclear if there is a viable business model for many charging points, unless there is a clear co-benefit (such as at a workplace or a supermarket). Charging points are expensive and benefit from both economies of scale and scope (in both installation and use) and access to low-cost capital. The 2019 Electricity Directive (944, Art. 33) only allows DSOs to own and operate EV charging points under certain conditions. These include their procurement by a suitable tendering procedure and their being operated subject to third-party access rights. Interestingly, 36% of DSOs in our survey suggest that they should have no role in public EV charging points. The Luxembourg regulator reports that, according to its national law, the DSOs have been given a formal role in the provision of a national charging infrastructure.

Knezovic et al. (2017) discuss the barriers to the proactive integration of EVs into the distribution grid. They identify a number of barriers which, if removed, might facilitate the increased roll-out and active engagement of EVs in the distribution system. They make the following points with respect to the regulation of DSOs: that regulatory barriers to the use of EV aggregators and to their flexibility need to be removed; longer-term incentives to innovation need to be given to DSOs; distribution tariffs need to be revised to include energy charges which would benefit the use of EVs; new roles in active grid operation and data management with respect to EVs need to be assigned; and that current regulatory incentives need to be revised in order to fully incentivise the use of the flexibility that EVs might provide.

The Netherlands provides a good example of some of these issues raised by national current regulations. There is active promotion of public EV charging points and good progress, relative to other European countries, in the roll-out of EVs. However, a significant number of the charging points in the Netherlands were installed and owned by electricity distribution companies, via EVnetNL[126], even though there are other owners of EV charging points in the country. The government wants to install 1.7m charging points for 1.9m vehicles by 2030.[127] Clearly, many of these will not be viable commercially. ElaadNL (2020) discusses the ways in which regulation needs to be changed to facilitate more EVs in the Netherlands. For example, they note that the ability of a grid operator to use charge points smartly depends on the regulatory freedom they have to make use of differentiated grid pricing and flexible contracts with parties who supply power to EV owners via the charging points. Grid connection agreements with charge point operators need to allow contracts with flexible capacity, as well as flexible rates and/or bandwidth (higher payments for consumption above a certain amount).

[126] https://www.evnet.nl
[127] https://www.dutchnews.nl/news/2020/07/e30m-spend-on-charging-points-should-get-electric-car-sales-moving/

9.2 The role of the DSO in decarbonising gas supply in their area

A national, regional or local government wants to coordinate the decarbonisation of its electricity and gas systems within its jurisdiction, what role can it ask the electricity DSO to play in this?

Oberle et al. (2020) point out that currently electricity, gas and heating networks are (usually) subject to separate planning processes by their respective network owners. This raises important questions as to how their combined infrastructure expenditure (€5 billion of capital expenditure per year in Germany alone) is being allocated and what the scope for joint optimisation is. While heat pumps may be technically efficient, if customer inconvenience is disregarded, repurposing the gas network makes more sense if it is taken into account. Over time, the scope for electricity-gas integration may increase as hydrogen or e-gas is used. Distribution networks should be planned, developed and operated in tandem. Oberle et al. (2020) emphasise the need for increased harmonisation of taxation and regulation across the two networks to facilitate efficient energy choices at the customer premises level.

Some 41% of the 37 electricity DSOs in our sample are also gas distribution companies. For them, the joint decarbonisation of electricity and gas is already an issue. However, the DSO survey also revealed that for 27% of the electricity only DSOs[128] gas decarbonisation was not felt to be an issue. However, politicians are grappling with the issue of joint decarbonisation of both electricity and gas networks. Hence, the EU's major push on sector coupling. In individual European countries, political parties have spotted governance gaps which might need to be filled. For instance in the UK, the Labour Party has proposed both the nationalisation of the currently privately owned electricity and gas distribution network companies and their reorganisation into joint electricity and gas network companies based on the current areas of the electricity DSOs[129].

The Energy Network Association in the UK has identified a number of areas where the separately owned gas and electricity distribution network owners can work together, as part of their Open Networks project, cited by some of our survey participants. The Open Networks project, Whole Energy Systems Workstream, examines joint decarbonisation of electricity and gas. This workstream is examining whole systems cost-benefit analysis, real-time operations and forecasting, whole system planning (in particular what the gas system should look like within the Future Energy Scenarios produced by the TSO), investment planning and network resource data analysis. While not much seems to have been published on this to date, it is interesting to note that in the appendices to its DSO Implementation Plan, the ENA makes multiple references to the role of the DSO in working with gas networks.[130]

We note that while the Electricity Directive (2019/944, Art. 31 (9) and Art. 33 (1)) puts an obligation on electricity DSOs to cooperate with the TSO and with owners of EV re-charging points, there is no requirement to cooperate with gas DSOs or TSOs in the Directive.

[128] This percentage includes both those who replied that DSOs should have no role in gas decarbonisation and those who replied that this issue was not relevant.
[129] See Labour Party (2019).
[130] See, for example, ENA (2020a).

9.3 The role of the DSO in the optimisation of local electricity storage assets

A single battery array (or other discrete DER asset) could solve all local grid-management problems at 'least cost' without the need for an expensive network upgrade, what should be the role of the incumbent DSO in the provision and operation of this asset?

Proka et al. (2020) discuss what the role of the DSO should be in local energy storage. They make the important point that the DSO may be a necessary party in the business model behind a neighbourhood battery. This is in contrast to the narrow interpretation of the Electricity Directive which says that only a stand-alone business model, not involving the DSO, should be permitted[131]. Indeed, several of the examples given by respondents to our survey mention local battery projects which involve both the DSO and a generator/retailer. These include: the Caruna/Fortum storage facility and Elenia/Fortum batteries in Finland; and Project Prendt battery involving Linz Netz in Austria. Other potentially third-party, DSO-owned DER assets appear in our survey, including the Nodal controller owned by NIE providing services to the TSO. These assets are not named in the Electricity Directive.

Proka et al. (2020) outline different potential business models in storage involving the DSO, including 'DSO contracted' where ownership remains with the DSO but commercial parties can take control of it for differing periods of time; changing the distribution charging arrangements to reflect the value of peak shaving; and using the asset as a regulated balancing authority. They also highlight that the Electricity Directive 2019/944 (Art. 36 on ownership of storage facilities by distribution system operators) leaves room for interpretation on what exactly the role of the DSO might be in local energy storage, and national energy law could interpret the Directive in more or less restrictive ways.

We are currently in an experimentation phase with local energy markets and commercial procurement of flexibility services. While our DSO and NRA surveys have highlighted local spot market projects for flexibility (e.g. GOPACS), the reality is that, apart from in the UK, there is relatively limited procurement of both constraint management and reactive power from third parties. Several NRAs also worry about the lack of local competition in flexibility markets. Most of the (limited) procurement that has been done involves longer term rather than spot market transactions. Once the period of experimentation is over, we will have a clearer idea on the relative cost and efficacy of different types of local DER service provision. At that point, it is possible that DSO flexibility asset ownership (full or partial), with or without commercial operation of the asset (or an equivalent long-term contract to provide such services) might be cheaper and more reliable than a fully decentralised solution in many circumstances and jurisdictions across Europe.

9.4 The role of the DSO in indicative planning

Local electricity stakeholders, in particular DER, want guidance on the likely development of the electricity system in their locality over the period of any potential investment in flexibility provision, how should DSO indicative planning be improved?

Our survey does not cover the views of the DER themselves, whose informal feedback is often that they need more time to prepare their offers should the DSO request flexibility from them. This is because of a lack of useful indicative planning information from the DSO. This is a question which is addressed in Klyapovskiy et al. (2019). They point out that DSOs face an increasingly uncertain

[131] 2019/944 Art. 36(1). Derogations can be permitted in the Directive, for instance if storage assets are fully integrated network components (Art. 36 (4)).

future as the amount of DER on their networks increases. This implies that traditional planning approaches are no longer fit for purpose, because they rely on a conservative 'worst case' approach which would be very expensive to implement with traditional solutions in the face of wide bounds around what the future DER on the network might look like. Klyapovskiy et al. (2019) discuss the need for state-of-the-art planning tools to address the move from passive distribution networks (PDNs) to active distribution networks (ADNs). These need to involve a multi-stage process from data collection to the implementation of the plan, which takes account of emerging information and opportunities.

Our survey has highlighted the role of the 10-year development plan which DSOs often produce as part of this improved planning process in order to facilitate a more active network. The Electricity Directive (2019/944 Art. 32(3)) does require network plans to be published. DERs (actual and potential) need to know what the forecast needs of the network are in order to position themselves to be able to respond.

A state-of-the-art planning process which both gives forward guidance to DER and involves an iterative process of adjusting to emerging reality and response to stakeholders. This process starts with good network data. The ENA's Digital Energy Systems Mapping, referred to in the previous section is a good example of the sort of coordinated approach to improving data that is needed to facilitate a better planning process in a situation where DER might be in a position to respond to emerging network needs.

While indicative planning is important, it does need to be fit for purpose and it will have to evolve in response to the reality of what is possible and the regulatory context in which it sits. Klyapovkiy et al. (2019) point out the importance of high-level starting objectives in the planning process in determining the outcome (e.g. an objective of maximising DER participation vs maximising customer benefit) and the fact that decisions made at each stage of a multi-stage process will have impacts on the final outcome. They also envisage a process of moving from a passive network, to a semi-active network (which is now), to an active network (in the near future) and on to an integrated energy system (in the distant future). In this distant future electricity, heat, gas and transportation will be co-optimised for whole system performance.

9.5 The role of the DSO in promoting bottom-up innovation

An NRA and its national and local governments want its DSO(s) to be more innovative and proactive in the energy transition, but what exactly should be the role of the DSO in promoting bottom-up innovation?

Faced with ambitious government policy and a lack of clear regulatory guidance about the exact actions to be taken and when, how should DSOs seek to innovate? Makholm (2020) makes an interesting observation about the difference between smart grid innovation in the US and Europe. He observes that it is led by the regulator in the Europe, while it is led by the company in the US. In Europe, it is often a regulatory objective to promote innovation and encourage 'smart solutions' and regulatory incentives are designed to do this. In the US, it is often left to companies to make innovative investments on the basis that they can earn a return from them, within their existing regulatory arrangements. Our survey suggests that several NRAs are promoting DSO innovation with both incentives and sandboxes and that a significant number of our surveyed DSOs want more regulatory support for innovation.

How well is Europe doing in smart grid innovation? SP Group[132] provides a helpful survey of 85 DSOs in 37 countries on 7 sets of metrics for 2020: customer empowerment and satisfaction, security, green energy, monitoring and control, data analytics, supply reliability, and DER integration. The survey scores each of the DSOs out of 100. Europe is showing improvement in 2019 over 2020, but is still some way behind the US (an average 70.18% vs. 76.28%). UK Power Networks is the highest-ranking company, with 4 UK and 1 Italian company in the top ten. Also in the top 10 are 4 from the US and 1 from Australia. European utilities do outperform the US on supply reliability and green energy, but lag behind on the other measures, significantly so on security and data analytics. This suggests that there are still many good lessons for Europe to learn from North America. Indeed, it is striking that only 2 respondents (one NRA and one of our trade associations) mentioned lessons from outside Europe in their responses.

On the other hand, how are DSOs innovating in the adoption of flexibility solutions in supporting the grid? A study performed by Origami (2019) looks at 18 countries/states from Europe (8), Asia (3), North America (3), South America (2), and Oceania (2). It evaluates their progress in relation to key flexibility service projects. The study ranks the countries/states based on 5 metrics: (1) traditional balancing services, (2) demand side management, (3) committed to flexibility investment in innovation and trials (government and/or regulator support), (4) existing flexibility pilot projects, and (5) flexibility services as business as usual. Each metric is ranked between 0 (no evidence) and 10 (evidence), and figures are then aggregated to estimate the overall per country/state. A comparison of the overall score indicates that GB and California rank first, followed by Australia and Texas. According to the study, these are among the few countries/states where flexibility solutions are business as usual (for specific services). This again suggests the need for Europe to pay attention to developments in the US and Australia. Looking at individual metrics, GB ranks first and the Netherlands and Germany second in the fourth metric overall, which indicates the strong support that network operators get to innovate via pilot projects.

From the two studies above we observe that the leading position of the 6 GB DSOs in the SP Group ranking (at 1, 3, 9, 10, 17 and 21) and in the Origami (2019) ranking, where GB ranks equal first overall. This is likely a result of the specific innovation allowance funding which is permitted within the GB price control arrangements, and of the network innovation competitions, under which most of this allowance is distributed. These bidding arrangements have promoted a healthy competition between the DSOs for both the funding and for ideas to promote smart grid thinking. They have been positively reviewed by the GB regulator Ofgem as to the value for money that they represent for electricity consumers.[133] It is also the case that TOTEX incentive regulation in GB, which allows both OPEX and CAPEX savings to be rewarded, has also encouraged flexibility service procurement to reduce capital investment requirements. We note that while the Electricity Directive (2019/944) makes reference to its support for innovative services, innovative pricing and innovative companies (including sanctioning the use of tariff methodologies to fund innovation, in Art. 18.2), it is silent on the mechanisms for regulators to promote innovation itself.

Other studies provide a global perspective and offer an indication of relative openness in innovation, energy system performance and effective energy transition, which may influence the DSO behaviour. How are national jurisdictions progressing on these indicators? Cunliff and Hart (2019) build the global energy innovation index from three component indexes: option generation, scaled-up and social legitimation[134] in 23 countries. They find that 6 European countries are among

[132] https://www.spgroup.com.sg/what-we-do/smart-grid-index
[133] Poyry and Ricardo (2016) evaluated the £500m spent under the Low Carbon Networks Fund innovation funding from 2010-2015. This showed significant positive net benefits.
[134] With 50%, 25% and 25% weights, respectively. The three of them are built from a total of 14 components, with specific weights too. For details, see Cunliff and Hart (2019, p. 7).

the top 10, Norway ranks 1, Finland 2, France 5, Germany 7, the UK 9 and Denmark 10; while USA ranks 4[135]. According to a study performed by the World Economic Forum that measures the energy transition index (ETI[136]) in 115 countries, only European countries are among the top 10, and of those only 5 are G20 countries (Sweden ranks 1, Switzerland 2, Finland 3, the UK 7 and France 8), while USA and Australia rank 32 and 36 respectively. Both studies show that European countries are leading in innovation and energy transition. However, it is important that Europe's leading position on the energy transition generally, does not promote complacency on the specific issues related to DSO innovation, where there are leading DSOs outside Europe.

[135] This is explained by the fact that USA invests the most to support energy clean energy innovation with around US$ 6.8bn in 2018 (more than China and Japan combined).
[136] ETI involves two metrics: country's energy system performance and energy transition readiness. Both have the same weight (50%) and for each one a set of sub-metrics have been defined and scored too. For details, see WEF (2020, p. 45).

10

CONCLUDING REMARKS

10. Concluding remarks

This report seeks to shed light on the nature of optimal regulation of the DSO over the period to 2025 and beyond. We defined this at the beginning as being about identifying whether there are directions in which current regulation of the DSO might be developed and would likely lead to an improvement in societal welfare. Our survey responses do allow us to make observations on how regulation might be developed and improved over this period.

Electricity Regulation EU (2019/943) and Directive (2019/944) (and their national implementing legislation) are reasonably new and it will take time for them to have a significant impact on European DSOs. As we report, there are many ongoing research projects and NRAs, national Energy Network Associations and individual DSOs are exploring novel ideas on the future of the DSO.

Our survey is consistent with the observation that the move towards a more active role for the DSO remains a work in progress for both DSOs and their NRAs. While many DSOs and NRAs are doing things that are in line with the commitment of the EU to an expanded role for DSOs, there is little evidence that this has progressed very far in measurable terms, apart from in the UK. Most DSOs have no competitive procurement of congestion management or reactive power. Much research activity is focused on trials which are themselves often at early stages and/or small.

DSOs and NRAs are not fully aligned on how the movement towards a more active DSO should be supported. This is hardly surprising since DSOs rightly want higher returns on their investments for higher perceived technical and regulatory risk, and NRAs are legitimately keen to protect consumers from unnecessary expenditure. Many of our surveyed DSOs want more regulatory support in terms of higher rates of return or specific revenue allowances in return for higher perceived risks, while NRAs remain more uncertain about the potential for the more active DSO, and some are reluctant to provide financial or indeed technical support in the form of a regulatory sandbox or regulatory derogations. The detailed country evidence from our survey seems to indicate that the countries with established regulatory funding mechanisms for innovation by DSOs are those where competitive procurement of congestion management and reactive power is more prevalent.

There is a clearly articulated concern about the prospects for the new EU DSO Entity among some DSOs and NRAs. While it can learn from its transmission level equivalent (ENTSO-E), enhance the role of the DSO across the EU and promote flexibility solutions, there is a worry that it will struggle to reconcile the very different situations of DSOs across Europe. There is an identified tension between it providing a unified voice and promoting a nuanced set of policies. There is also a wide range of views within and between DSOs and NRAs on the desirable direction of travel for the further regulation and separation of the system operation function within existing distribution utilities.

There are a large number of projects underway at local, national and EU levels examining the future of the DSO. Many of these are intellectually exciting, but few are well known outside their own jurisdiction. NRAs and smaller DSOs seem to be less willing or able to name projects whose results may be worthwhile. This raises the question of how the extensive learning/lessons arising from individual experiments related to the future of the DSO will be diffused across Europe. Strikingly, only 1 out of 12 NRAs and 1 out of 39 DSOs mentioned developments outside Europe as being of interest. This is in spite of the fact that there are many other DSOs (particularly in the US and Australia) who are among the leaders on elements of smart grid development, as evidenced by a few reports carrying out international comparisons on energy transition which are mentioned in

this report. There should be a major role for the EU DSO Entity in evaluating, collating and spreading useful information and experiences from projects related to the 'future of the DSO', and using these to inform grid code development and other areas of responsibility.

It is sometimes said, including by several of our survey respondents, that the CEP has clarified the role of the DSO. However, we find that there is significant disagreement on the answers to our questions about the future of the DSO between and within our sample of NRAs and DSOs. This suggests that there is work for NRAs and DSOs to do in clarifying the best way forward for the DSO. If the CEP represents a movement towards optimal regulation its interpretation and implementation need to be clarified further.

Our scenarios highlight areas for future development in European policy towards the DSO, specifically:

The Electricity Directive (EU) 2019/944 does not put any requirement on electricity DSOs to coordinate across gas and electricity networks or offer any guidance on innovation funding arrangements related to the future of DSOs. **There is work to do in this area in the light of emerging European policy towards the future of gas and sector coupling.**

Directive (EU) 2019/944 is potentially open to wide interpretation on the role of the DSO in storage and in EV charging, when its optimal role in different circumstances remains unclear. **There are circumstances where the DSO should have a leading role in the development and provision of storage and EV charging facilities.**

Finally, there is also work to do in providing evidence of clear consumer benefit to support the emphasis in the Directive (and Regulation 2019/943/EU) on competitive procurement of certain flexibility services. **NRAs, therefore, need to prioritise evaluation of the evidence on the value of various competitive mechanisms for the procurement of such services.**

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APPENDICES

Appendix 1

CERRE SURVEY

Questions on the Future of the Electricity DSO

Dear DSO

This is a survey about the future of the regulation of electricity Distribution System Operators (DSOs) being conducted on behalf of CERRE in collaboration with GEODE and other partners.

DSOs are widely recognised to be playing an increasingly important role in the energy transition and it is important to understand how the regulatory environment can best support them and what lessons might be drawn from emerging experience. The survey is being sent to DSOs across Europe to collect their views on the issues behind the future of the regulation of DSO in the period up to and beyond 2025 and the questions are not necessarily limited by existing EU legislation (such as the Clean Energy Package). We intend to include the results of the survey in a report that will be published. You might be interested to know that as part of this study a parallel survey of national energy regulators across Europe is also being conducted.

We very much appreciate the time taken to fill in this questionnaire and hope that its results will serve to better inform both national and EU policy towards the DSO.

Yours sincerely

Michael Pollitt, Monica Giulietti, Karim Anaya

Of behalf of CERRE

I. QUESTIONS ABOUT YOUR COMPANY

1. **Contact information**

2. **Which country is your primary country of operation?**
   (This is an open question; please type your answer here)

3. **What is the size of your company in terms of number of connected customers?**
   (This is an open question; please type your answer here)

4. **At what voltage levels does your company operate?**
   (This is an open question; please type your answer here)

II. GENERAL QUESTIONS ON THE FUTURE OF THE ELECTRICITY DSO

5. Should regulators encourage an increasingly separate system operation (SO) (as has happened over time in many jurisdictions at the transmission level between transmission operation and system operation) function within the electricity DSO?

- ☐ Yes
- ☐ No
- ☐ Don't know

If yes, how far should the separation go?

(Q. 6-13) What should the electricity DSO role be in?
Can tick all that apply

(6) *Electrical energy storage*

- ☐ Own
- ☐ Operate
- ☐ Competitively procure services
- ☐ Procure non-marked based (i.e. bilateral contracts)
- ☐ None
- ☐ Not sure
- ☐ Other (please specify)

(7) *Congestion management*

- ☐ Own assets
- ☐ Operate assets
- ☐ Competitively procure services
- ☐ Procure non-marked based (i.e. bilateral contracts)
- ☐ Manage platform
- ☐ Not sure
- ☐ Other (please specify)

(8) *Reactive power*

- ☐ Own assets
- ☐ Operate assets
- ☐ Competitively procure services
- ☐ Procure non-market-based (i.e. bilateral contracts)
- ☐ Manage platform
- ☐ Not sure
- ☐ Other (please specify)

(9) *Network data*

- ☐ Only processed by DSO
- ☐ Shared with third parties
- ☐ Be open source (i.e. free access)
- ☐ None
- ☐ Not sure
- ☐ Other (please specify)

(10) *Public EV charging points*

- ☐ Own assets
- ☐ Operate assets
- ☐ Competitively procure services
- ☐ Procure non-market based (i.e. bilateral contracts)
- ☐ None
- ☐ Not sure
- ☐ Other (please specify)

(11) *Gas decarbonisation*

- ☐ Substantial
- ☐ Some
- ☐ None
- ☐ Not relevant
- ☐ Not sure
- ☐ Other (please specify)

(12) *Peer-to-peer trading*

- ☐ Own platform
- ☐ Operate platform
- ☐ Procure platform (i.e. use of a third-party platform)
- ☐ Provide data
- ☐ None
- ☐ Not sure
- ☐ Other (please specify)

(13) *Supplying flexibility (e.g. constraint management or reactive power) to the transmission level system operator*

- ☐ Use of own assets
- ☐ Use of distributed energy resources (DER) assets (third parties)
- ☐ None
- ☐ Not sure
- ☐ Other (please specify)

14. Should regulators encourage more coordination between electricity transmission and electricity distribution than is currently the case?

- ☐ Yes
- ☐ No
- ☐ Don't know

If yes, how?

15. Should regulators encourage more coordination between gas distribution and/or heating distribution and electricity distribution than is currently the case?

- ☐ Yes
- ☐ No
- ☐ Don't know

If yes, how?

16. Should the system operator (SO) function of the electricity distribution utility be separately regulated from the rest of the distribution utility?

- ☐ Yes
- ☐ No
- ☐ Don't know

If yes, in what areas?

17. Can there be more use of competitive procurement in network extension or refurbishment?

- ☐ Yes
- ☐ No
- ☐ Don't know

If yes, in what areas?

18. Should there be changes to the current investment regime at the distribution level to facilitate more innovative investments?

Shared ownership of assets (e.g. with other DSOs or with DER operators)

- ☐ Yes
- ☐ No
- ☐ Don't know

If yes, give a specific example of where a change is needed

Variable depreciation periods

- ☐ Yes
- ☐ No
- ☐ Don't know

If yes, give a specific example of where a change is needed

Higher allowed rates of return on some risky assets

- ☐ Yes
- ☐ No
- ☐ Don't know

If yes, give a specific example of where a change is needed

Longer/shorter price control period

- ☐ Yes
- ☐ No
- ☐ Don't know

If yes, give a specific example of where a change is needed

Change in regulatory benchmarking methods

- ☐ Yes
- ☐ No
- ☐ Don't know

If yes, give a specific example of where a change is needed

More use of indicative planning, where guidance is given as to the likely future configuration of the network under certain scenarios

- ☐ Yes
- ☐ No
- ☐ Don't know

If yes, give a specific example of where a change is needed

Other suggestions for supporting innovative investment

- ☐ Yes
- ☐ No
- ☐ Don't know

If yes, give a specific example of where a change is needed

19. What do you see as the major advantages arising from multi-year network plans at the distribution level? Please specify.
(This is an open question; please type your answer here)

III. HOW REGULATORS AND EU INSTITUTIONS CAN SUPPORT THE MOVE TO THE DSO

20. What suggestions, if any, would you give on how the regulator in your jurisdiction might better support your company in its role in the energy transition?
(This is an open question; please type your answer here)

21. Give a good example of how your company is promoting capacity building at the DSO.
(This is an open question; please type your answer here)

22. What is the approximate current annual size of competitive procurement by your company of the following?

Congestion management (in MWs, by value, as % of system peak demand)

Reactive power (in MVars, by value)

23. The EU is creating a new 'DSO Entity' to mirror ENTSO-E. What three areas should this Entity focus on to promote the role of the DSO across Europe? What mistakes do you foresee it might make?
(This is an open question; please type your answer here)

IV. CLOSING QUESTIONS

24. Give at least <u>one example</u> of the most interesting 'future of the DSO' projects/initiatives that you are aware of inside of your own jurisdiction with respect to the following:

Promotion of EV charging infrastructure

Local gas and electricity decarbonisation (sector coupling)

Promotion of flexibility markets/assets (e.g. for constraint management and reactive power)

DSO information provision to facilitate longer-term planning

Smart energy system integration at local/regional level

25. Thinking about moving to a world of a more active role for the DSO, what are the <u>three biggest barriers</u> for your company, if any?

- ☐ Initial ownership structure
- ☐ Size of company
- ☐ Competence of staff
- ☐ Voltage levels at which your company operates
- ☐ Lack of information on condition of network
- ☐ Lack of regulations/guidance
- ☐ Regulatory obstacles
- ☐ Tariff structure
- ☐ Tax/subsidy regime
- ☐ Lack of price granularity at distribution level
- ☐ Lack of government support
- ☐ Lack of local flexibility providers (i.e. providers of local constraint management or reactive power services)
- ☐ None
- ☐ Other (please specify)

26. Give up to three examples of the most interesting 'future of the DSO' projects/initiatives that you are aware of <u>outside</u> of your own jurisdiction, if any.
(This is an open question; please type your answer here)

27. Are there any other comments about the future of the electricity DSO that you would like to make?
(This is an open question; please type your answer here)

Appendix 2

CERRE SURVEY

Questions on the Future of the Electricity DSO

Dear NRA

This is a survey about the future of the electricity Distribution System Operator (DSO) being conducted on behalf of CERRE.

DSOs are widely recognised to be playing an increasingly important role in the energy transition and it is important to understand how the regulatory environment can best support them and what lessons might be drawn from emerging experience. The survey is being sent to national regulatory authorities across Europe to collect their views on the issues behind the future of the DSO in the period up to and beyond 2025 and the questions are not necessarily limited by existing EU legislation (such as the Clean Energy Package). We intend to include the results of the survey in a report that will be published. You might be interested to know that as part of this study a parallel survey of DSOs across Europe is also being conducted. The intention is that this survey should inform suggestions for medium-term developments in existing legislation.

We very much appreciate the time taken to fill in this survey and hope that its results will serve to better inform both national and EU policy towards the DSO.

Yours sincerely

Michael Pollitt, Monica Giulietti, Karim Anaya

Of behalf of CERRE

I. QUESTIONS ABOUT YOUR JURISDICTION

1. **Contact information**

2. **Which country/NRA do you represent?**
   (This is an open question; please type your answer here)

3. **How many electricity DSOs do you currently regulate?**
   (This is an open question; please type your answer here)

4. **How many network users are connected to electricity DSOs?**
   (This is an open question; please type your answer here)

5. **Which voltage levels are operated by your electricity DSOs?**
   (This is an open question; please type your answer here)

II. GENERAL QUESTIONS ON THE FUTURE OF THE ELECTRICITY DSO

6. Should regulators encourage an increasingly separate system operation (SO) (as has happened over time in many jurisdictions at the transmission level between transmission operation and system operation) function within the electricity DSO?

- ☐ Yes
- ☐ No
- ☐ Don't know

If yes, how far should the separation go?

(Q. 7-14) What should the electricity DSO role be in?
Can tick all that apply

(7) *Electrical energy storage*

- ☐ Own
- ☐ Operate
- ☐ Competitively procure services
- ☐ Procure non-market based (i.e. bilateral contracts)
- ☐ None
- ☐ Not sure
- ☐ Other (please specify)

(8) *Congestion management*

- ☐ Own assets
- ☐ Operate assets
- ☐ Competitively procure services
- ☐ Procure non-marked based (i.e. bilateral contracts)
- ☐ Manage platform
- ☐ Not sure
- ☐ Other (please specify)

(9) *Reactive power*

- ☐ Own assets
- ☐ Operate assets
- ☐ Competitively procure services
- ☐ Procure non-market-based (i.e. bilateral contracts)
- ☐ Manage platform
- ☐ Not sure
- ☐ Other (please specify)

(10) *Network data*

- ☐ Only processed by DSO
- ☐ Shared with third parties
- ☐ Be open source (i.e. free access)
- ☐ Not sure
- ☐ Other (please specify)

(11) *Public EV charging points*

- ☐ Own assets
- ☐ Operate assets
- ☐ Competitively procure services
- ☐ Procure non-market based (i.e. bilateral contracts)
- ☐ None
- ☐ Not sure
- ☐ Other (please specify)

(12) *Gas decarbonisation*

- ☐ Substantial
- ☐ Some
- ☐ None
- ☐ Not relevant
- ☐ Not sure
- ☐ Other (please specify)

(13) *Peer-to-peer trading*

- ☐ Own platform
- ☐ Operate platform
- ☐ Procure platform (i.e. use third-party platform)
- ☐ Provide data
- ☐ None
- ☐ Not sure
- ☐ Other (please specify)

(14) *Supplying flexibility (e.g. constraint management or reactive power) to the transmission level system operator*

- ☐ Use of own assets
- ☐ Use of distributed energy resources (DER) assets (third parties)
- ☐ None
- ☐ Not sure
- ☐ Other (please specify)

15. Should regulators encourage more coordination between electricity transmission and electricity distribution than is currently the case?

- ☐ Yes
- ☐ No
- ☐ Don't know

If yes, how?

16. Should regulators encourage more coordination between gas distribution and/or heating distribution and electricity distribution than is currently the case?

- ☐ Yes
- ☐ No
- ☐ Don't know

If yes, how?

17. Should the SO function of the electricity distribution utility be separately regulated from the rest of the distribution utility?

- ☐ Yes
- ☐ No
- ☐ Not sure

If yes, in what areas?

18. Can there be more use of competitive procurement in multi-year network extension or refurbishment?

- ☐ Yes
- ☐ No
- ☐ Don't know

If yes, in what areas?

19. Should more use be made of regulated distribution tariffs as signals for the efficient use of the distribution network?

- ☐ Yes
- ☐ No
- ☐ Don't know

If yes, how?

20. Should there be changes to the current investment regime at the distribution level to facilitate more innovative investments?

Shared ownership of assets (e.g. with other DSOs or with DER operators)

- ☐ Yes
- ☐ No
- ☐ Don't know

If yes, give a specific example of where a change is needed

Variable depreciation periods

- ☐ Yes
- ☐ No
- ☐ Don't know

If yes, give a specific example of where a change is needed

Higher allowed rates of return on some risky assets

- ☐ Yes
- ☐ No
- ☐ Don't know

If yes, give a specific example of where a change is needed

More use of indicative planning, where guidance is given as to the likely future configuration of the network under certain scenarios

- ☐ Yes
- ☐ No
- ☐ Don't know

If yes, give a specific example of where a change is needed

Other suggestions for supporting innovative investment

- ☐ Yes
- ☐ No
- ☐ Don't know

If yes, give a specific example of where a change is needed

21. What do you see as the major advantages arising from network plans at the distribution level? Please specify.
(This is an open question; please type your answer here)

III. HOW REGULATORS AND EU INSTITUTIONS CAN SUPPORT THE MOVE TOWARDS A FUTURE ELECTRICITY DSO

22. Does your jurisdiction promote research and development (R+D) funding for the future of the DSO?

- ☐ Yes
- ☐ No
- ☐ Don't know

If yes, by what mechanism(s)?

23. Does your jurisdiction have a formal regulatory sandbox-type regime to encourage new business models?

- ☐ Yes
- ☐ No
- ☐ Don't know

If yes, give one good example of an idea encouraged by this

24. Has your regime granted a derogation from normal DSO regulation to facilitate a 'future of the DSO' trial?

- ☐ Yes
- ☐ No
- ☐ Don't know

25. **Capacity building at the DSO. Give a good example of how this can be/is being promoted.**
(This is an open question; please type your answer here)

26. **What is the approximate current annual size of the competitive procurement by DSOs in your jurisdiction of the following?**

Congestion management (in MWs, by value, as % of system peak demand)

Reactive power (in MVars, by value)

27. **The EU is creating a new 'DSO Entity' to mirror ENTSO-E. What three areas should this DSO Entity focus on to promote the role of the DSO across Europe? What mistakes do you foresee it might make?**
(This is an open question; please type your answer here)

IV. CLOSING QUESTIONS

28. **Give at least one example of the most interesting 'future of the DSO' projects/initiatives that you are aware of inside of your own jurisdiction with respect to the following:**

Promotion of EV charging infrastructure

Local gas and electricity decarbonisation (sector coupling)

Promotion of flexibility markets/assets (e.g. for constraint management and reactive power)

DSO information provision to facilitate longer-term planning

Smart energy system integration at local/regional level

29. **Thinking about moving to a world of a more active role for the DSO, what are the three biggest barriers for the DSOs in your jurisdiction, if any?**

- ☐ Initial ownership structure of DSO
- ☐ Size of companies
- ☐ Competence of DSO staff
- ☐ Voltage levels at which DSOs operate
- ☐ Lack of information on condition of network
- ☐ Lack of regulations/guidance
- ☐ Regulatory obstacles
- ☐ Tariff structure
- ☐ Tax/subsidy regime
- ☐ Lack of price granularity at distribution level

☐ Lack of government support

☐ Lack of local flexibility providers (i.e. providers of local constraint management or reactive power services)

☐ None

☐ Other (please specify)

30. Give up to three examples of the most interesting 'future of the DSO' projects/initiatives that you are aware of <u>outside</u> of your own jurisdiction, if any.
(This is an open question; please type your answer here)

31. Are there any other comments about the future of the electricity DSO that you would like to make?
(This is an open question; please type your answer here)

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