Where next for the active electricity distribution system operator? Evidence from a survey of European DSOs and National Regulatory Authorities

Abstract

This paper investigates the relationship between electricity distribution system operators (DSOs) and national regulation authorities (NRAs) over the period to 2025 and beyond, following the implementation of the EU Clean Energy Package and its constituent parts: Electricity Regulation (EU) 2019/943 and Electricity Directive (EU) 2019/944. The context is the drive to change the 'traditional' distribution network from a passive one-way network to an active two-way network, increasingly involved in active procurement of flexibility resources to manage energy and voltage constraints within its geographical area. We conducted two parallel surveys of DSOs and their national regulatory authorities (NRAs) across 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 related to: (1) the future role 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 more active DSO; and (3) best practices that reflect the future DSO. Our findings are consistent with the observation that the move towards a more active role for the DSO remains work in progress for both DSOs and their NRAs, given the fact that the Clean Energy Package has only passed into European Law relatively recently and some Member States are still implementing its provisions.

Keywords: distribution system operator, DSO, Electricity Regulation

JEL codes: L94, L54, L21

1. Introduction

Energy systems are changing to become compliant with the net zero objective being pledged by countries and companies around the world. Electricity distribution system operators (DSOs) are likely to play a crucial role in this transition. As part of this process the 'traditional' distribution network would have to change from a passive one-way network to an active two-way network, increasingly involved in active procurement of flexibility resources to manage energy and voltage constraints within its geographical area.

We can define the active DSO as being one which has moved from being a passive operator of a lower voltage network to a DSO which engages in active grid management and facilitation in the face of rising amounts of distributed energy resources.[1] Being an active DSO encompasses (inter alia) smart metering and data handling, demand side management, active grid management, distributed generation and storage, electric vehicle charging infrastructure, local and regional integration of energy systems and energy efficiency (adapted from CEER, 2015, p.30).

The Electricity Directive (EU) 2019/944[2] 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*". Art. 31 also envisages the possibility that DSOs are allowed to perform activities outside those indicated in the Directive if these are "*necessary for the fulfilment or their obligations*".

The Electricity Regulation (EU) 2019/943[3] aims to promote the achievement of decarbonisation goals, in light of recent technological developments giving consumers a more active role in the electricity

[1] For an extended discussion of the active DSO see Pollitt et al. (2022).
[2] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32019L0944
[3] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2019.158.01.0054.01.ENG&toc=OJ:L:2019:158:TOC

market. Several chapters of Electricity Regulation (EU) 2019/943 are relevant to the future of DSOs. For instance, Chapter IV provides guidance on distribution system operation and sets governance rules and tasks for the newly established EU DSO entity.

The 2019 Electricity Directive and Regulation form parts of the Clean Energy Package (CEP). 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. The heightened level of ambition in the European Commission is well illustrated by the recently developed strategies on sector coupling[4] and hydrogen[5]. More generally, the recent 'Fit for 55'[6] legislative package proposes revisions and initiatives aimed at achieving the targets of EU Green Deal[7], in particular a net reduction in emissions by 55% relative to 1990 levels by 2030. Based on a wide public consultation and impact assessment exercise it concludes that the current policy framework is insufficient to achieve the Green Deal targets by 2050 and that an increased level of ambitions must be established. This suggests that, while the CEP was a significant step forward, it is already in need of review as a result of significant policy developments since 2016.

The aim of the paper is to suggest how regulation of the DSO can be amended and improved to support the pursuit of ambitious environmental objectives and to promote efficiency in local energy systems. 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, in line with the principles and guidelines set out in the 'Fit for 55' package.

The paper seeks to shed light on the following: (1) the future role of the electricity DSO including new roles, coordination with other parties and potential lessons from TSOs; (2) how regulators and EU

[4] https://op.europa.eu/en/publication-detail/-/publication/60fadfee-216c-11ea-95ab-01aa75ed71a1/language-en
[5] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0301&from=EN
[6] https://www.europarl.europa.eu/legislative-train/theme-a-european-green-deal/package-fit-for-55
[7] https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en

institutions can support the move to the more active DSO (as defined above); and (3) current best practices that reflect the future DSO.

We shed light on these issues through two parallel surveys conducted with DSOs and National Regulatory Authorities (NRAs) across Europe, with the aim of looking at the long- to medium-term future of DSOs, going beyond the implementation of current legislation.

Our 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.

Following this section, we provide a brief review of the related literature in Section 2. Section 3 describes our approach to the surveys and the main features of the participants. Section 4 discusses the key findings from the surveys. Section 5 draws some conclusions and offers policy recommendations.

2. Literature Review

The ongoing transformation of the energy system is affecting the traditional network activities of DSO companies in local integrated energy systems, such as congestion management, reactive power, the relationship and information flows with transmission system operators (TSOs) and gas and heat DSOs (see Pereira et al., 2020). In addition, the pursuit of decarbonisation objectives is likely to affect electricity DSOs' activities across energy sectors due to heat decarbonisation and sector integration processes.

The opportunities and challenges arising from a more active role of DSOs have been recently investigated in contributions focussed on the ongoing energy system transformation. The challenges of energy systems integration (ESI) have been investigated (e.g. Jamasb and Llorca, 2019, Cambini et al. 2020a and Oberle et al., 2020) in relation to the economic and regulatory barriers to coordination

across networks of energy vectors. Cambini et al. (2020b) evaluate the experience of ESI project on smart grids, storage and conversion technologies in 6 European countries. In these countries they find low levels of investment in innovation. They also lament that a lack of coordination, data access and flexibility in approaches are significant barriers to innovation. They therefore suggest changes to the regulatory framework to help improve ESI, such as a mixture of input and output-based incentives to promote innovation, while balancing the investment risk between companies and final consumers.

The integration of distributed energy resources (DER) into distribution networks is changing the conventional way used to manage and operate them. This integration means that utility distribution networks need to deal with the intermittency and unpredictability of renewable sources. At the same time DER assets, controllable loads, EV batteries, etc. connected at different voltage levels represent an opportunity for DSOs to solve network constraints, congestion etc. by procuring/contracting flexibility services from them.

Knezović et al., (2017) and Wargers et al. (2018) investigate the effect of EV charging infrastructure on the distribution grid and the role of DSOs in facilitating its grid integration. Both papers highlight the risks associated with charging at peak time but also the opportunities offered by an active involvement of EVs in distribution networks management schemes. Based on a Danish case study, Knezović et al. (2017) highlight the need for regulation which creates incentives for DSOs to procure flexibility services, possibly with the support of local trading platforms. Proka et al. (2020) use the case of a neighbourhood battery initiative in the Netherlands to investigate the benefits that can arise from the collaboration between DSOs and local energy initiatives. However, the realisation of these benefits through a truly collaborative business model requires overcoming the differences in expectations between the parties and the institutionalisation of the structures and practices. Ownership of energy storage facilities is not allowed in EU regulation, but other regulatory authorities have allowed DER ownership by DSOs as they are considered to be better positioned to activate DER than market operators in 'certain circumstances' (Burger et al., 2019a). When DSOs are unable to operate DER

directly, creating the conditions for collaboration with local organisations could provide efficient solutions to the challenges of local grid management due to high levels of locally connected intermittent generation. This development can be achieved through a flexible approach to the regulation of DSO activities.

Using a case study from Denmark, Klyapovskiy et al. (2019) attempt to assess the value of flexibility which can be procured via market processes so that it can be compared to the cost of traditional network reinforcements. In order to create the conditions for market participation by local market actors, reliable predictions about future needs for flexibility services need to be produced on the basis of DSOs' plan for system development. They also suggest that to benefit from market procured flexibility services the planning horizon for the local energy system should be reduced from 10 to 5 years to ensure precision and reliability in the estimates.

Given the increasingly more active role of DSOs in decentralised energy systems the nature of the relationship with TSOs is likely to evolve into a more complex and interactive one, with higher levels of coordination than in the past. Burger et al. (2019b) point out that coordination of investment and operations along the vertical electricity supply chain creates the conditions for a more efficient use of the system. This coordination has traditionally been achieved via price signals under the supervision of balancing authorities, however these arrangements are virtually absent at the local level. For this reason, they identify an important new role for DSOs in promoting local investment in DER and the participation of DER in the local energy system. They state that these incentives can be provided via price signals which can be delivered via variety of different channels, including contract relationships, procurement processes, local markets and regulated tariffs.

Distribution utilities may be encouraged to opt for less traditional or innovative investments to a different extent depending on the nature of regulatory incentives. For instance, rate of return regulation offers a guaranteed but lower return to the utilities' regulatory asset base, compared to

price-cap regulation, and provides more incentives to develop new infrastructure[8]. On the other hand, price cap regulation can expose DSOs to greater risks that they will not earn a return to an innovative investment which means that a higher return (or risk premium) must be permitted (Alexander and Irwin, 1996; Newbery, 2002, EC, 2019). It is important for NRAs to set an adequate level of rate of return (or increased revenue allowance) that incorporates the risk which helps the utilities to finance their investment programmes (CRU, 2020). However, optimal values of rate of return can be difficult to establish when we refer to innovative investments (EC, 2014). The expansion in the set of roles undertaken by DSOs might also require a change in regulatory benchmarking methods, which refers to the measurement of the potential for cost reduction as part of the incentive regulation method applied by NRAs. It is expected that improvements to the current methodology would encourage more innovative investments or procurement (i.e. flexibility services). For a discussion on potential options and evidence from international experiences see Anaya and Pollitt (2021b).

Our surveys, described in the next section, investigate the position of DSOs and NRAs with respect to the challenges and risks identified in the literature summarised above, in order to consider potential adjustments to the current regulatory environment which can create incentives for experimentation and investment in innovation.

3. Methodology and data

Two similar surveys were designed: one for DSOs (including energy network associations) and another for national regulatory authorities. The surveys aimed to capture their views regarding the three areas which the academic literature identifies as critical for the future development of the sector:[9] (1) the future role 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 active DSO; and (3) best practices that reflect the future DSO. Many of the questions posed to DSOs and NRAs

[8] 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).
[9] For more details see Pollitt et al. (2021).

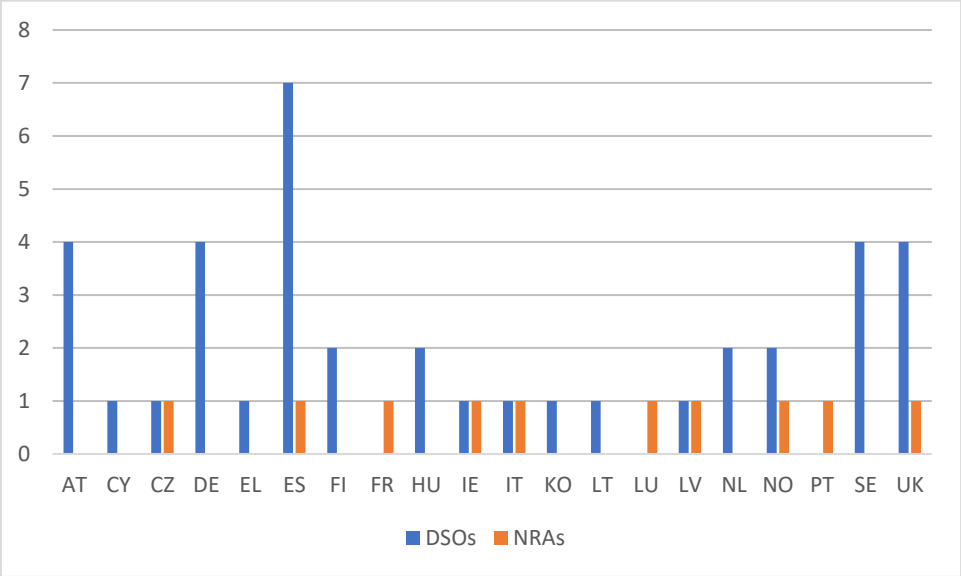
were the same or similar. Those that differed related to what DSOs think of their NRAs, and vice versa. The text of the DSO and NRA questionnaire is provided in Appendix 1 and 2, respectively.

39 NRAs were contacted as potential respondents to the survey. They are members of the Council of European Energy Regulators (CEER) which include the 27 members of the EU, the UK, Norway and Iceland. We also contacted the regulators of the 9 countries with observer status: Albania, Bosnia and Herzegovina, Georgia, Kosovo, Moldova, Montenegro, Republic of North Macedonia, Republic of Serbia and the Swiss Confederation. In addition, we contacted the main DSOs from the same countries either directly or through their trade association. The surveys were carried out over the period August to December 2020 and generated a total of 51 responses from DSOs, energy associations and NRAs, covering 20 European countries.

The overall number of responses from individual DSOs[10] was 37, while 2 responses were from energy networks associations (from the UK and Sweden[11]). For 5 jurisdictions, we have only 1 response which was provided by largest DSO in the country. We also had responses from representatives of 12 NRAs. For 9 countries we have received responses from both DSOs and NRAs[12]. The Spanish regulator oversees the activities of 7 DSOs in our surveys, 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 surveys) and 2 by the Norwegian regulator. The Czech, Irish, Italian, and Latvian regulators oversee the activities of a single DSO each in our surveys. This information is illustrated in Figure 1 below.

[10] According to CEER (2019), in 2018 there were around 2500 DSOs operating in the EU and Norway, of which circa 2200 have fewer 100,000 customers.
[11] 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.
[12] 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).

Figure 1 – Number of respondents by country



In our analysis we have separated the DSOs by size into 3 categories: large DSOs (with more than 1 million customers), medium DSOs (with less than 1 million but more than 100,000) and small ones (with 100,000 or fewer customers)[13]. To illustrate the representativeness of our sample of DSOs Figure 2 presents the proportion of DSO who responded to our survey relative to the total number of DSOs in the country. However, these figures should be taken with caution as the total number of DSO is only an estimated number (source: CEER, 2019 and ARERA, 2019) and refers to the year 2018 rather than 2020 when our survey took place.

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

Figure 2 – Proportion of respondent DSO relative to number of DSOs by country

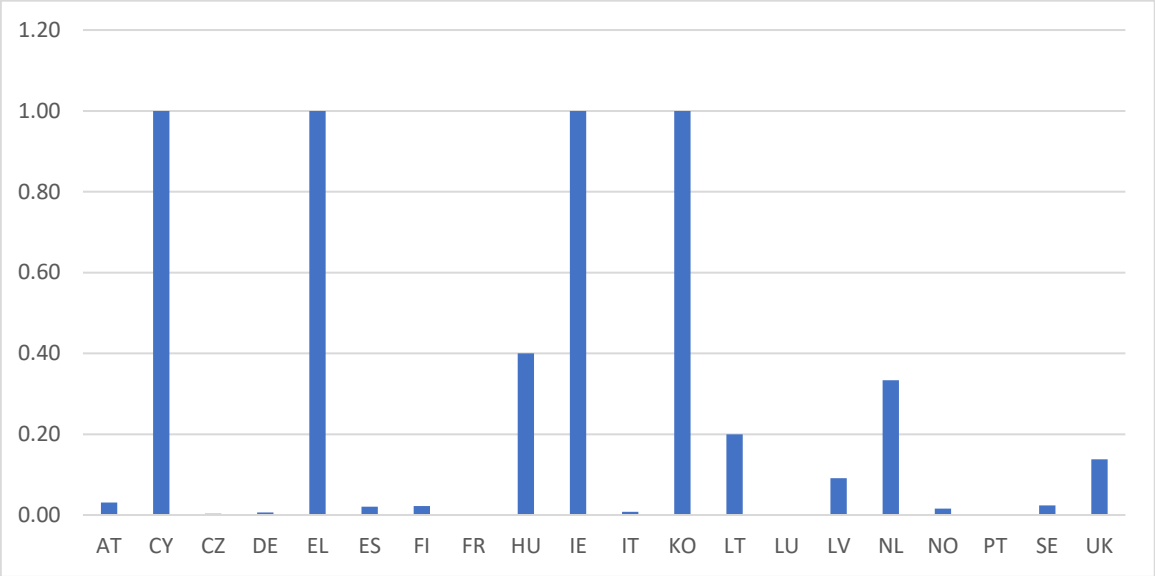
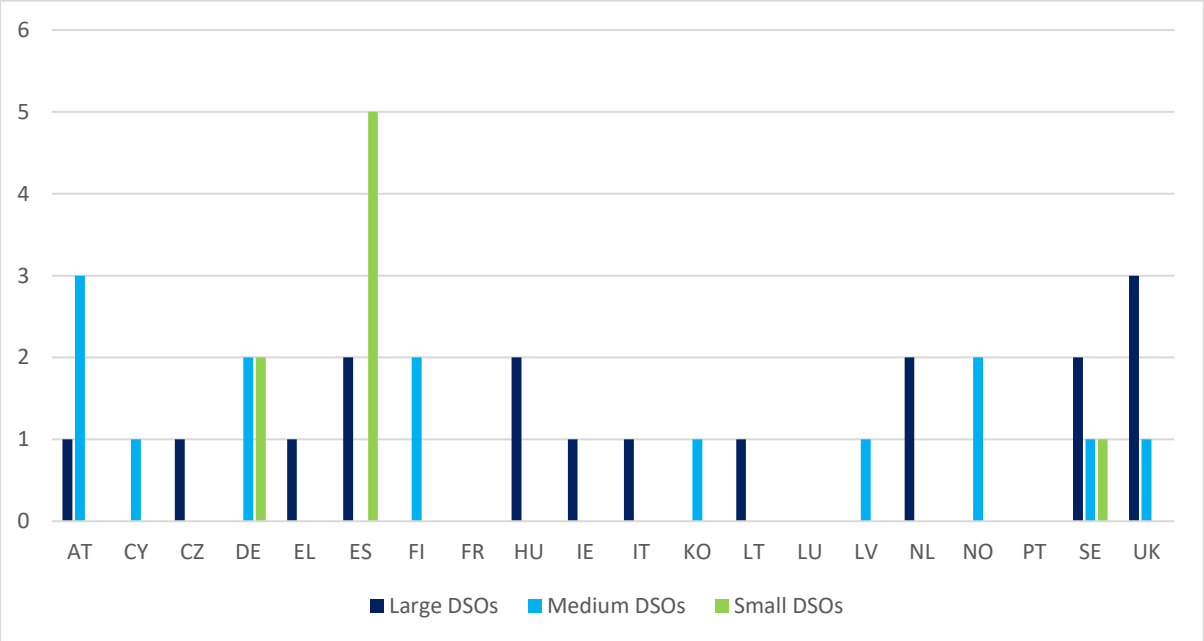


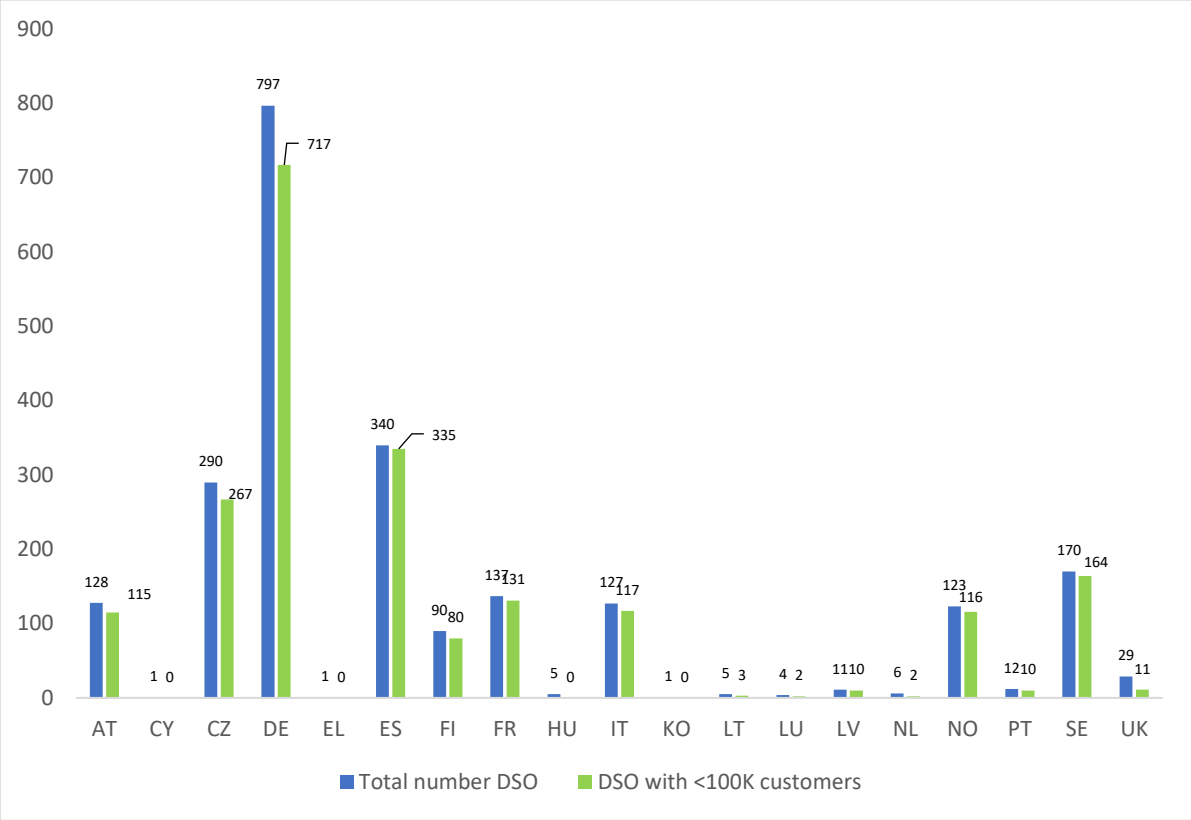
Figure 3 shows the number of DSOs who responded to our surveys by country and size.

Figure 3 – Number of DSO respondents by country and size



For the countries of the respondents, we report the total number of electricity DSOs in blue and the number of electricity DSOs serving fewer than 100,000 customers in green in Figure 4 below. The graph shows that the distribution of DSOs in Europe is characterised by a large number of DSOs in some of the countries, many of whom have fewer than 100,000 customers.

Figure 4 – Number of DSOs by country and size (2018)



Source: CEER (2019) and ARERA (2019)

Table 1 below indicates that the total number of customers served by the DSOs in our surveys is about 125 million, with the large majority served by the large DSOs.

Table 1 – Number of customers of DSO respondents[14]

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

Source: Survey responses.

[14] 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. The number of customers were reported by the DSOs who took part in the survey

More than 2000 DSOs[15] operate across the 12 countries from which we had NRA respondents, serving more than 220 million customers[16]. Thus, the DSO sample that we have obtained covers 40% of customers, while our NRA sample covers 78% of customers, across the 39 countries which are either members or observers of the Council of European Energy Regulators (CEER) [17].

4. Discussion of results

The next session will summarise and discuss the views expressed by NRAs and DSOs who responded to our survey. Section 4.1 will focus on the potential future role of DSOs while Section 4.2 covers the lessons learned from TSO regulation which can inform DSOs' regulation and activities. Section 4.3 discusses how to facilitate the move towards a more active DSO.

4.1 The future of the DSO

The ongoing transformation of the energy system has started affecting the traditional network activities of DSO companies across a broad range of activities and across energy sectors, as a result of 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 and guidelines envisage the possibility of new roles being taken by DSOs, although within existing unbundling rules which aim to keep natural monopoly activities separated from potentially competitive areas.

4.1.1 Views on a separate system operator function and new roles for DSOs

Our first set of survey questions addressed the possibility of developing a system operator function, distinct from network-based activities, subject to a well-established regulatory framework. We also

[15] This figure has been calculated on the basis of the number of DSOs reported by the relevant NRAs in our surveys. The figure includes the DSOs who are regulated at the State level rather than just those who are regulated by the national regulator.
[16] 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.
[17] Answers to the surveys were obtained from 20 of the 39 countries surveyed.

asked DSOs and NRAs about different dimensions of the new roles for DSOs which could potentially be taken up by DSOs in the medium to long term.

There is no distinction between the DSO and Distribution Network Operator (DNO) in European law and practice. DNO is a term used in the UK and UK DNOs are understood to be DSOs in European law. DSOs are overwhelmingly responsible for system operation of their networks. Across Europe the system operator (SO) function is fully integrated into the DSO at the distribution level, hence our question about a separate SO function.

We identify a clear discrepancy in the views of DSOs and NRAs about the need to establish a separate system operation (SO) function as a condition for achieving decarbonisation objectives. A clear majority of DSOs (77%, 30 out of 39) expresses opposition to such a separate role while the majority of NRAs (58%, 7 out of 12) express a positive view[18]. Some of the DSOs pointed out in their comments that small DSOs might need to procure services from other DSOs, while some NRAs highlighted the need for neutrality and independence from non-system operator roles, especially in relation to the procurement of flexibility services.

The expected transformation of energy systems in the transition to net zero will require DSOs to develop new competences with the possibility that they might need to own and operate new assets, procure new services on a competitive basis and manage consumers and prosumers' data. When considering the possibility that DSOs develop new roles it is important to remember that European DSOs differ substantially both in size and in the extent to which they are unbundled. This implies that they might not currently have the resources and competences to undertake the new role of neutral market facilitators without outsourcing some of their activities to, or cooperating with, other DSOs in their jurisdiction. A series of questions in our surveys attempted to investigate these emerging areas of DSO activity considering different forms of DSO involvement.

[18] The SO function may be within or outside the same organisation. DSOs and NRAs were free to interpret the question.

The guidelines contained in the Electricity Directive and Regulation allow for the possibility that NRAs establish that the 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. Tables 2 and 3 summarise the views of DSOs and NRAs regarding the way in which the different activities could be effectively managed in their jurisdictions.

Table 2 – 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%
Procure non-competitively	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 3 – Electricity DSOs' 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%
Procure non-competitively	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 NRAs (5 out of 12) and 36% of DSOs (14 out of 39) suggest that DSOs should not be involved. An important role for DSOs is identified in the provision of technical information about the potential location of charging sites in a similar way to the process used for DER connections, with a non-discriminatory approach to the provision of connections. One third of respondents from NRAs also do not support DSOs' involvement in services for P2P trading. A larger proportion (64%) of DSO (25) and 8 NRA (67%) respondents believe that DSOs should supply data to support P2P trading activities. Also, most of both DSOs and NRAs express support for competitive procurement of services for energy storage, congestion management and reactive power, while only a minority (44%) among DSOs (17) and 5 NRAs support a role for DSOs in managing platforms for both congestion management and reactive power (31% of DSOs and 33% of NRAS, i.e., 12 out of 39 and 4 out of 12 respectively).

The common thread across several comments by DSOs regarding congestion management is the need to rely on market-based provision of flexibility services where possible, i.e., where liquid markets exist, and implementing administrative allocation or bilateral contracting where the relevant market are not sufficiently liquid. Some NRA respondents however pointed out that congestion and reactive power services are localised and might not generate sufficient liquidity for market-based options.

In the transition from a passive network with one-directional energy flows DSOs will need to perform more complex network management tasks involving the monitoring and control of network assets which require more demanding data acquisition, monitoring and management processes. 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 (24) favour an exclusive management by DSOs[19], 75% of NRAs (9 NRAs) supports data being shared with third parties, an option which receives support from only 46% of DSOs (18).

4.1.2 DSOs' role in the gas decarbonisation process

The role of electricity DSOs in the gas decarbonisation process could be crucial for the achievement of decarbonisation objectives as these are likely to be more efficiently achieved as the result of a coherent energy system integration. However, among our respondents the role of DSOs is seen mainly in terms of support of the process of heat electrification which is likely to create challenges for the electricity system and will require network reinforcement. While 50% of NRAs (6) do not envisage a DSO role in gas decarbonisation, 36% of DSOs (14) think they could have a substantial role, as opposed to just some or no involvement in gas decarbonisation.

When considering the need for more coordination between the electricity and the gas and heating sectors at the distribution level most (56%) DSOs (22) are in favour of such increased coordination with less than a third (31%) who do not support it, i.e. 12 DSOs. About two thirds of NRA respondents

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

(67% or 8 NRAs out of 12) agree that the promotion of such coordination is needed. A large majority of the large DSOs (76%) supports the promotion of more integration across electricity, gas and heating sectors. The views are more diversified across DSOs of smaller size, with only 43% of small and 40% of medium DSOs supporting the proposed increase. These responses however might be due to the fact that sector coordination is already taking place, at least in the activities of the 15 DSOs among our 39 respondents who manage both electricity and gas networks.

4.1.3 The need for increased TSO-DSO coordination

Our question about the role of DSOs in the supply of flexibility services to the TSO focused 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 DSO in the supply of flexibility the views are split among the regulators with 42% (5 NRAs) who support the use of DSOs' own assets and 50% (6 NRAs) who support the use of third parties' DER. Among DSOs, on the other hand, 62% (24) support the use of DSOs' own assets and 64% (25) support the use of third-party assets[20]. Respondents from both NRAs and DSOs mentioned the need for coordination in the procurement of flexibility services as central to the TSO-DSO coordination activity. Regarding the need for regulators to promote increased coordination between TSOs and DSOs, NRA respondents have a unanimous view in favour and 74% of DSOs (29) also in favour of such increased coordination being promoted by NRAs. While most DSOs in our surveys support the promotion of increased coordination between TSO and DSOs by regulators, their comments highlight the need for a regulatory framework which establishes clear roles and responsibilities, which creates common incentives for TSOs and DSOs, and which facilitates data exchanges and data governance. The development of such a regulatory framework might be facilitated by the establishment of the new EU DSO Entity. Aligned incentives and the need for

[20] Please note that respondents were allowed to select more than one option.

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 developments in regulation, for standardised protocols, and for the harmonisation of system operation.

4.2 Similarities with TSO regulation

DSOs are required to manage their networks more dynamically and bear responsibility for their own grids. TSOs, on the other hand, are responsible for ensuring a secure, reliable and efficient electricity transmission system and bear the overall system responsibility[21]. This section explores the potential similarities between current TSO regulation and the way in which the future DSO should be regulated.

DSOs and NRAs were asked whether the SO function of the distribution utility should be separately regulated from the rest of the distribution utility[22], as this separation can bring more transparency and independence in decision-making, even though it can be more costly and may lead to siloing of information. Integration can be viable as well with better aligned incentives for network development, but potentially less transparent[23]. Results from the surveys show that approximately 63% of DSO (25) and NRAs respondents disagree with a separated regulation for the SO function from the rest of the distribution utility. Around 65% (11), 80% (12) and 71% (5) of large, medium and small DSOs representatives respectively are against separate regulation[24], while 58% of NRAs (7) representatives are not sure about this. Some of respondents indicate that separation may add more complexity to current regulation and therefore it would be better to strengthen current regulation instead. On the other hand, a gradual approach is advised depending on the market needs but ownership separation in the case of conflict of interest.

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

[21] For the full list of TSOs responsibilities see Art. 40 of the Directive 2019/944.
[22] This question is open to interpretation, where the SO function can be within or outside the organisation (different company).
[23] See Pollitt (2012) for a discussion.
[24] 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.

management. We want to know whether a similar approach can be followed by DSOs. Looking at the responses, approximately 45% (23) of the respondents agree that "more" use of competitive procurement in network extension or refurbishment is not necessary[25], with 60% (10) of the large DSOs supporting no requirement. Some of the respondents suggest that this is something already done in practice, while others remark that more use will be required for connecting renewables and that regulation should be developed to allow flexibility measures as a real option for network extension. Difficulties in public procurement are also reported, indicating strict and non-flexible enough rules which slow down network development.

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[26] and time of use [27] . Methodologies and cost recovery mechanisms vary according to the regulatory framework from each jurisdiction. Here we want to understand the NRAs' perspective on the use of more cost reflective tariffs by distribution utilities. There is strong support for the use of regulated distribution tariffs as signals to guide the efficient use of the network. 100% of NRA respondents (12) agree with this. There is significant support for distribution tariffs that reflect marginal costs (subject to more data collection), smart meter data could help with this. Some regulators stress the capacity component of the tariff as an economic signal for more efficient use of network, while others point out that customers should be recipients of the savings from having more cost reflective tariffs and that this should be reflected in DSO cost regulation.

DSOs and NRAs were also asked about a set of potential changes to the current investment regime at the distribution level to facilitate more innovative investments. Figures 5 and 6 summarise the responses from both parties.

[25] This excludes the provision of flexibility by third parties via competitive procurement as an alternative to network investments
[26] For instance, in Great Britain, transmission network use of system (TSUoS) charges vary per location.
[27] According to CEER (2019), in 2018 there were around 2500 DSOs operating in the EU and Norway, of which circa 2200 have fewer 100,000 customers.

Figure 5 – Changes to the current investment regime at the distribution level to facilitate innovative investments – DSO responses

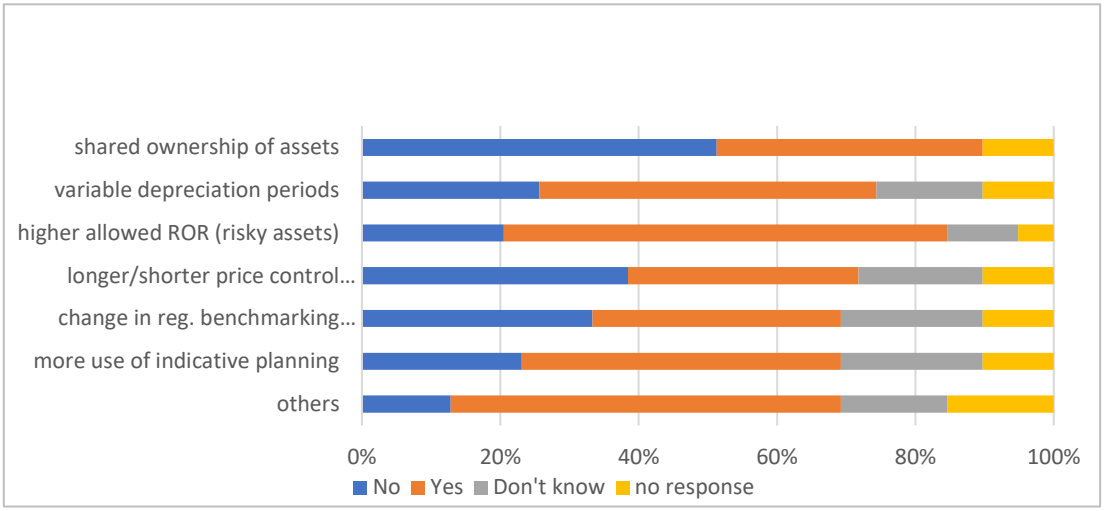
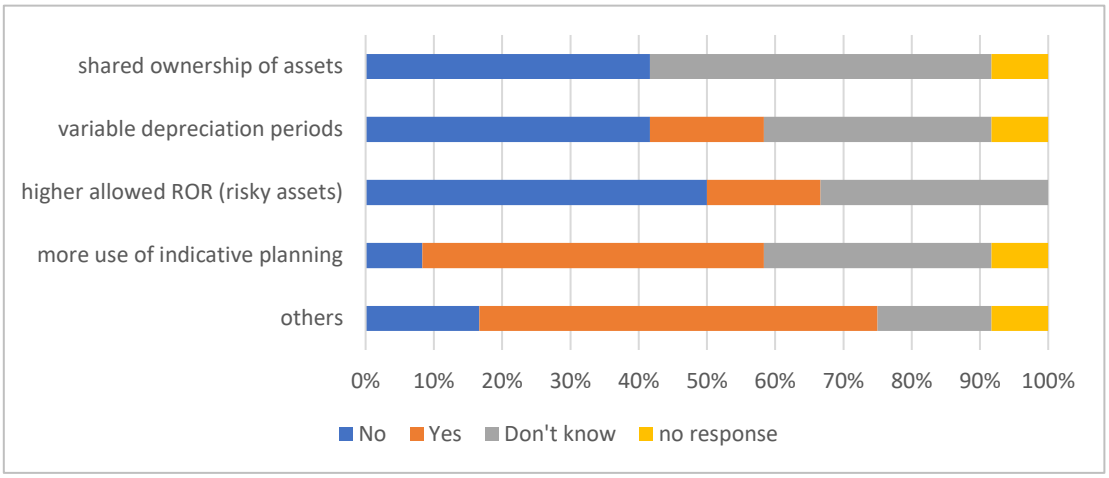


Figure 6 – Changes to the current investment regime at the distribution level to facilitate innovative investments – NRA responses



We find that around half of DSOs (20) disagree with changes that promote shared ownership of assets[28], while around 40% of them (16) support this. Some of them point out that this will support DSO investment related to the energy transition and digitalisation. On the other hand, half of the NRAs (6) are not sure about this change and none of them agree with this, stressing the importance of the role of governance and independence for a more market-facing and proactive role of the DSO.

[28] Assets that can be shared with DSOs, DER operators, system operators. Among them are assets for data management, system reliability (energy storage assets can help with this) and others.

The next category is about the *use of variable depreciation periods*. The length of depreciation periods is especially important when we refer to non-traditional investments including new technology (i.e. shorter rather than longer depreciation periods to reduce risk). Half of the DSOs agree with the use of variable depreciation periods, with a similar number of responses from large DSOs and small and medium DSOs. Those that support this change indicate that this is relevant especially for modern technologies and innovative investments, including smart meters; and to reflect better the reality of different economic lifetimes. Responses from NRAs show that most of the representatives are not sure or disagree with the use of variable depreciation periods and only 2 agree. It should be noted that the use of variable depreciation periods is being considered in future regulation or is already in place in some jurisdictions under specific conditions.

The following category relates to *higher rate of return (ROR) on less traditional or risky assets*. Depending on the size of the rate of return, this can have an impact on the revenue requirements and ultimately for end-customers. Higher rates of return may imply an excess in the cost of capital, then misallocation of resources, while lower rates may cause DSOs to not invest and to operate the network below optimal levels (IPART, 1998). Some DSO assets are relatively large (of the order of several millions of Euros). A higher voltage line within the distribution system, or a large transformer. DSO voltages vary and individual upgrade projects can be expensive. One project that the authors were involved with involved a new tap changer which cost 1.2m Euros. Investing in upgrading a part of the network with an automated line management system could also be millions of Euros. For instance, Ofgem cancelled a number of large distribution projects valued at 18m Euros or more in 2017[29].

We find that most DSOs (25 out of 39) are in favour of a higher allowed rate of return on risky assets, with an important support from the large DSOs (over 70%). Many of them agree that higher rates may be required for new developments such as active network management assets, innovative investments, smart meters, energy storage, large DER, sector coupling, etc. This contrasts with the

[29] https://www.ofgem.gov.uk/publications/ofgem-cuts-ps200m-electricity-distribution-network-company-allowances

NRAs' views, where only 2 of them support the use of higher rate of return on risky assets, while the others are not sure or disagree with it.

The next category is about the use of *longer/shorter price control periods*, which may also be an instrument to manage risks. Responses from DSOs on this topic are mixed, with around 33% (13) of respondents that agree and 38% (15) that disagree with any changes. It is suggested that changes in the price control period need 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).

We want to know the DSOs' views regarding any potential improvement to the current methodology on *regulatory benchmarking* that may encourage more innovative investments or procurement (i.e. flexibility services). There is no agreed view about whether a change in regulatory benchmarking methods is recommended or not, with similar numbers of respondents supporting both sides, approx. 35% (27), while around 20% (8) are uncertain. The use of a totex (total expenditure) approach is suggested for use in benchmarking methods to address network needs and grid investments in the responses by DSOs from Austria, Norway, the Netherlands and the UK energy networks association (ENA). Other DSOs support the use of benchmarking models that describe them more appropriately and the use of benchmarking methods that can be understood by DSOs, also stressing the role of regulators in assisting them if these methods are complex.

Indicative planning 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. Around 45% of DSOs (18) agree with the use of more indicative planning. DSOs remark on the importance of these plans as a signal of transparency and better coordination in order to unlock the value of flexibility. Half of NRAs (6) support more use of indicative planning while 42% (5) are not sure or do not support more use. NRAs point out their support for development plans aligned with the Electricity Directive, the need of more guidance to users by DSOs

regarding network development under different future scenarios, and the need of more coordination between DSOs' network development plans and users.

We also asked respondents about *any other changes to the current investment regime* that they may find important. While traditionally the regulation of energy network has focused on the promotion of cost efficiency, the challenges of the transition to net zero energy systems has highlighted the importance of forms of regulation which can promote innovation. Poudineh et al. (2020) point out that incentive regulation aimed at promoting innovation should take into account to uncertainty associated with the innovation activities undertaken by DSOs[30].

Approximately 55% (22) of the DSOs suggest other alternatives to support innovative investment. These can be grouped as follows: (1) change in regulatory incentive mechanism, (2) incentives for smart solutions and technologies and (3) trials and innovation funding. The first one is the most represented, with half of respondents. Here DSOs point out their preference for a totex approach, a clear connection between risk and return, extra allowed weighted average cost of capital (WACC) for innovation and tailored remuneration schemes in favour of flexibility. On the other hand, more than half of NRA representatives provide additional suggestions including more investment incentives for innovation, targeted innovation funds or cost pass-through projects for innovation that enable market activities, incentives for adopting flexibility solutions, and uncertainty mechanisms[31] that allow additional revenues for DSOs subject to specific conditions (e.g., if costs rise sharply due to an extreme weather event).

We also asked is about the advantages arising from (multi-year) network plans at the distribution level. Most of the respondents find advantages in the use of multi-year product plans. DSOs highlighted the advantages in overall network operation (e.g., reduced cost or clarity about available capacity,

[30] They also point out that such uncertainty might distort the process of allocation of innovation funds when the competing firms have different attitudes to risk (Poudineh et al. 2020, p.166).

[31] This is a change in the regulated revenue allowance which can be triggered if costs increase or decrease by more than a given amount

quantification and location of future RES development and identification of flexibilities), while NRAs were more focused on the benefits that visibility and transparency of network plans bring to different actors.

4.2.1 A comparison of DSO and NRA perspectives

We find some differences between the DSOs and NRAs perspectives regarding to future changes, which are reflected in Figures 7 and 8. While there is some agreement on more use of indicative planning between them, there is no agreement on the use of higher rate of return on risky assets. More than half of DSOs support higher rate of return on risky assets, while half of NRAs do not. Similar views are expressed in relation 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 of views is expressed by NRAs (over 40% or 5 NRAs on average).

Figure 7 – DSOs summary of responses

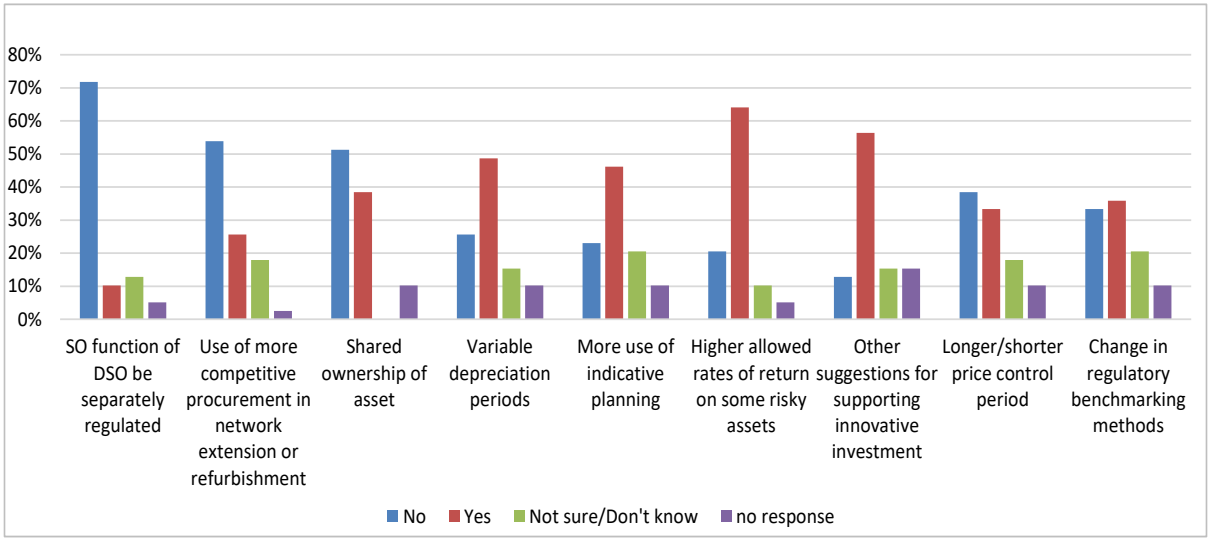
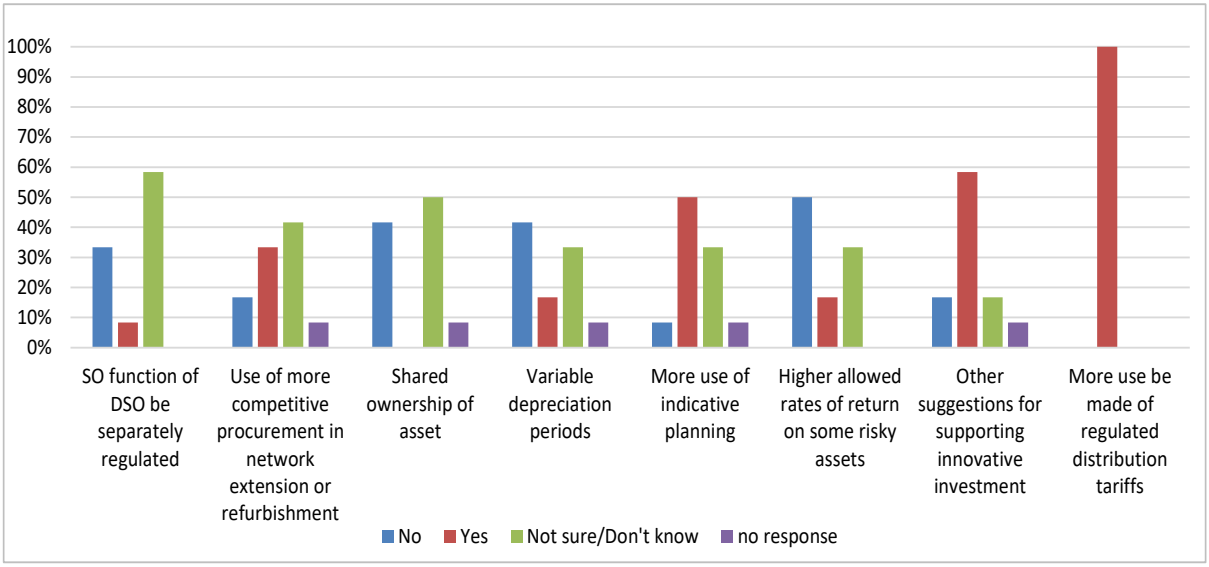


Figure 8 – NRAs summary of responses



4.2.2 Large DSOs versus small and medium DSOs

A comparison of the responses by large versus small and medium DSO respondents shows that in general there is agreement, with a few exceptions. There is strong agreement on not having regulatory separation of the SO function and also on the use of higher rate of return on risky assets (over 60% and 50% respectively). There are also similar results across all types of DSOs in the use of competitive procurement in network extension or refurbishment, suggesting that more competitive procurement is not desired by our respondents[32], with more mixed views in the case of shared ownership of assets. Opposite views are observed between large and smaller DSOs: 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; around 43% of small and medium DSOs support both potential changes.

4.3 How to facilitate the move towards a more active DSO

In the next section we discuss a set of questions which were asked to NRAs and DSOs about how regulators (and EU institutions) could support the move to the active DSO. We also asked regulators what they are doing to promote a more active role for the DSO in their jurisdiction. The literature highlights some examples of good practice in R&D funding allowances by regulators, such as those

[32] This excludes flexibility solutions as an alternative to network investment

mentioned by Meeus and Saguan (2011), but the picture is patchy across Europe. Based on an international comparison of schemes aimed at promoting innovation in network industries Mirnezami (2021) evaluates three potential schemes for the promotion of innovation on a theoretical basis. The schemes are: (1) individual incentive contracts, (2) competitive innovation funds and (3) cooperative innovation programmes. The conclusion of the paper is that aal the schemes are potentially effective but the first one is information-intensive and therefore more challenging to implement. In this section we discuss evidence about the second type of scheme as it emerges from the responses to our survey, while in the conclusions section we recommend schemes aimed at promoting collaboration across DSOs (especially those of relatively small size).

4.3.1 Support to innovation from NRAs

NRAs respondents were asked whether they specifically allow for R+D funding for DSOs to experiment with projects to do with the future of the DSOs. 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.[33] We therefore asked NRAs whether their jurisdictions promoted research and development funding for the future of the DSO. Most of our surveyed NRAs did, but a significant minority did not.

Regulatory sandboxes[34], of the type pioneered by Ofgem[35] 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. As Figure 9 shows our sample is equally split.

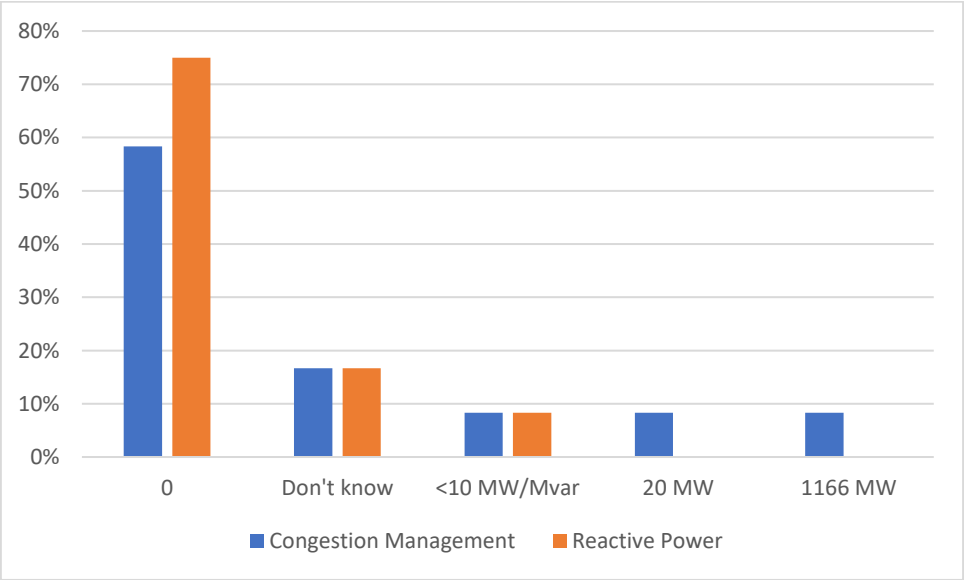
[33] See Cambini et al. (2020b) who discuss the strengths and weaknesses in European countries' approaches to innovation funding in energy: and Jamasb et al. (2020) who compare funding mechanisms for energy R+D.
[34] See van der Waal et al. (2020), who discuss the merits of such an approach and makes suggestions as to how it can be done more effectively.
[35] See https://www.ofgem.gov.uk/publications-and-updates/what-regulatory-sandbox

A related issue is whether normal rules can be relaxed to facilitate a trial at the DSO level, via a specific derogation. In general, 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. We asked NRAs if they had given such a derogation: only 3 NRAs reported that they had definitely granted a derogation for a DSO trial, 6 definitely had not.

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 (such as funding to the DSO to develop 'skills, abilities, processes and resources').

Regarding competitive procurement 9 NRAs reported little to no competitive procurement of congestion management and reactive power. One NRA reported a significant amount of procurement of congestion management only, and another reported competitive procurement of reactive power only (see Figure 9).

Figure 9– 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, others 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 only.

4.3.2 DSO perspectives on the move to a more active DSO

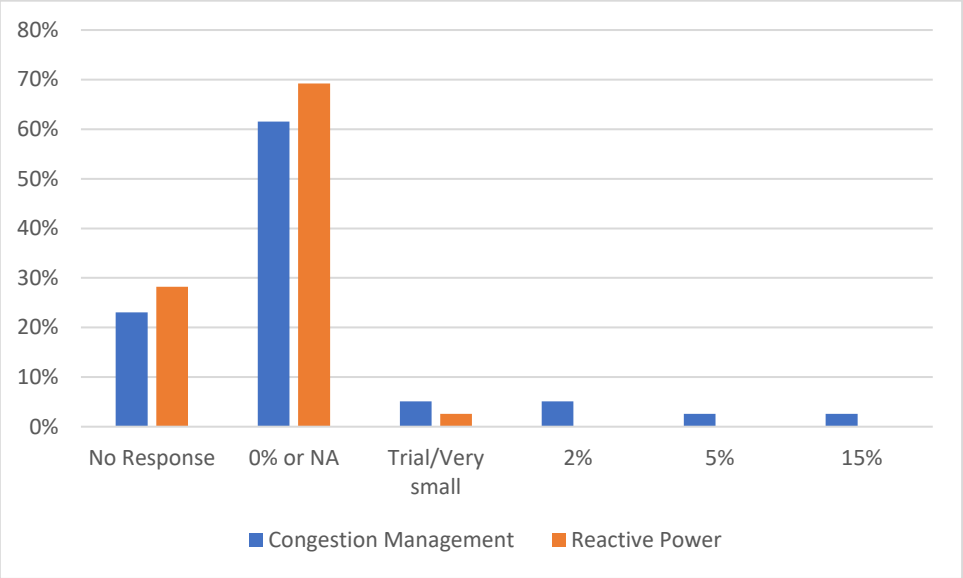
DSOs were explicitly asked in our survey what suggestions they would give on how the regulator in their jurisdiction might better support their company in its role in the energy transition.

First, some 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, the incentives to innovate and the general regulatory support for innovative solutions were mentioned. Third, there were issues raised around the active role of the NRA. Fourth, points were made about whether current regulatory arrangements were sufficiently flexible.

We then turned to what DSOs are doing to develop their own capacity to become a more active DSO, leading to a range of responses. There was attention to staff training, improvements to network planning, investment in network capacity and the energy transition itself and an emphasis on R+D and new experiments. DSOs in our survey say they are doing a lot to build capacity and become more active DSOs, however when asked a specific question how much actual competitive procurement of services they are doing they revealed that 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 (see Figure 10).[36]

[36] 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.

Figure 10 – Share of DSOs reporting levels of competitive procurement (relative to peak demand)



4.3.3 NRA and DSO views on the prospects for the new EU DSO Entity

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)[37], to mirror ENTSO-E at the transmission level. This Entity has been created as part of the CEP, so the issue addressed in our survey is what should it do and what mistakes should it avoid.

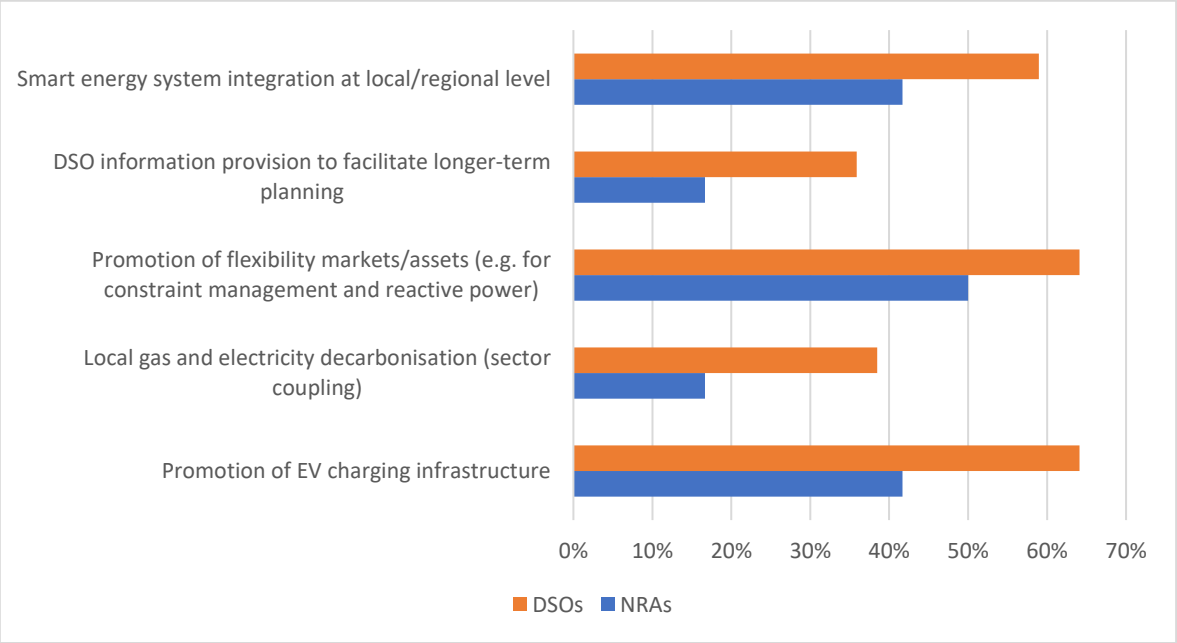
The NRA responses emphasise the need to learn from ENTSO-E (the parallel transmission company organisation at the European level), provide a European voice for DSOs, and promote competitive procurement of services. In terms of mistakes that the new entity might make, DSO respondents are most concerned that it would not take into account the specific conditions of the country's distribution system. 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 or across DSOs of apparently similarly sized DSOs.

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

4.3.4 DSO and NRA learning from innovation from future of the DSO trials

Given the huge amount of activity around the DSO and the many trial and research projects going on across Europe, we asked our respondents which project they would identify as significant.[38] Both NRAS and DSOs were asked about projects in their own jurisdiction and ones in other countries 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[39]. NRAs seemed unwilling or unable to name specific projects in their jurisdiction that are considered interesting (see Figure 11). This may have been because there is reluctance to single out particular projects, given their position as a neutral party. DSOs often cited their own projects, though less than half mentioned any project on sector coupling or information provision.

Figure 11 – Percentage of respondents naming example projects in their jurisdiction

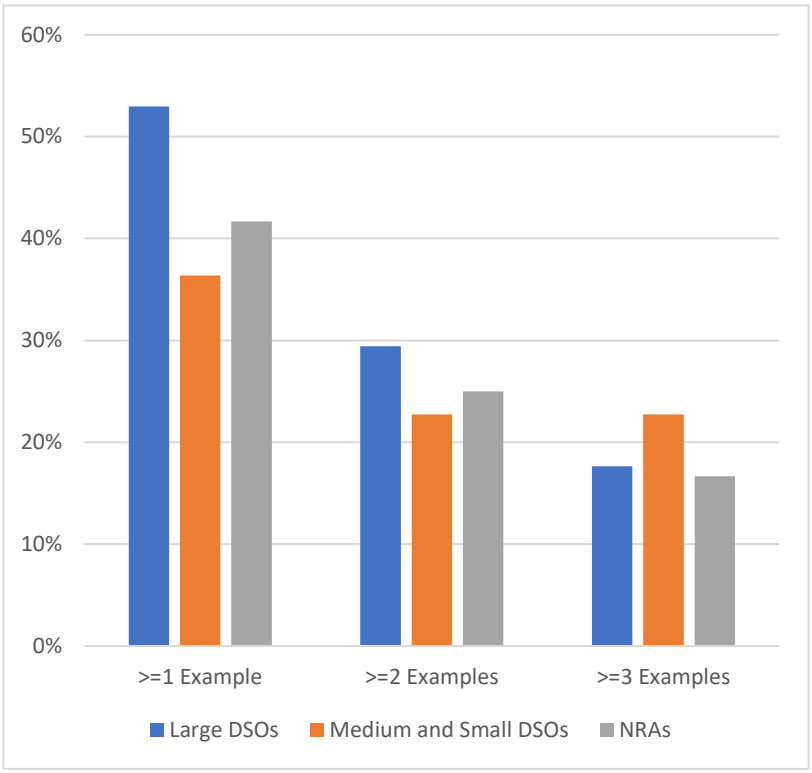


[38] This follows recent academic reviews of innovative trials in the future of the DSO (see Anaya and Pollitt, 2021a).

[39] 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 respondents offer.

The surveys questions then explore projects outside respondents' own jurisdiction (with results shown in Figure 12). 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 is the extent to which DSOs and NRAs are aware of projects outside their own jurisdictions.

Figure 12 – Percentage of DSOs and NRAs citing extra-territorial examples



Just over 40% of DSOs (16) and NRAs (5) offer at least one example on an interesting project/initiative outside their own jurisdiction, and only around 25% of DSOs (10) and 17% of NRAs (2) 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.

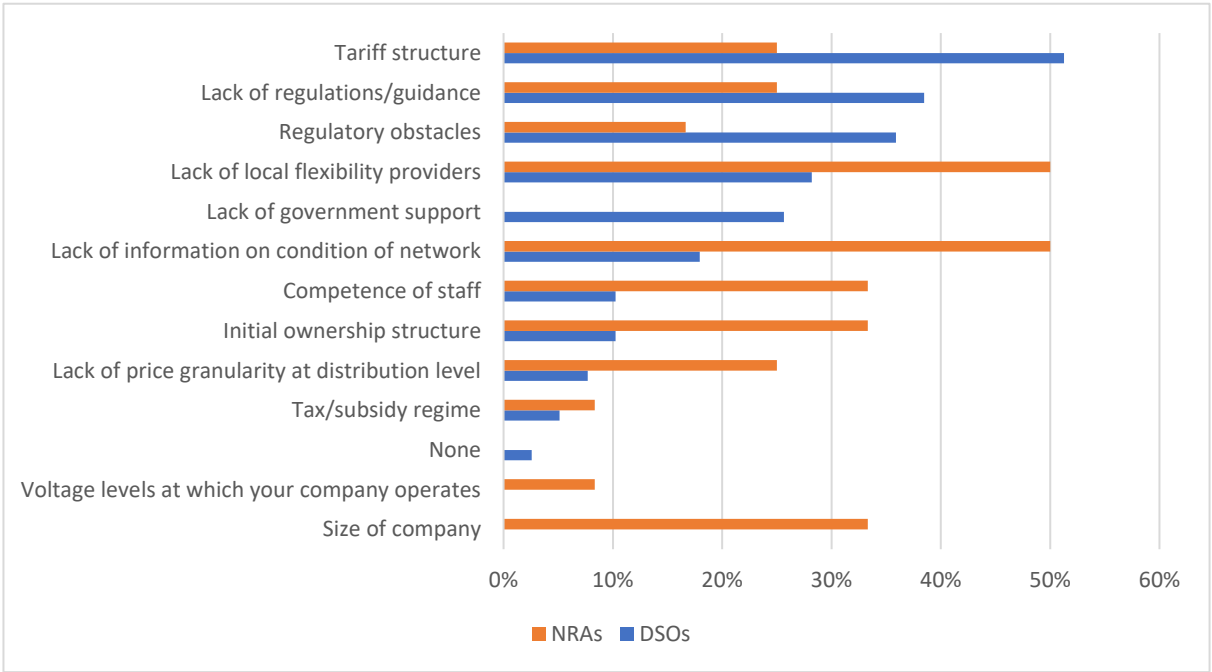
Projects in the UK are mentioned by 6 respondents, in Norway by 3, European projects by 3, in Germany by 2; Australia, Sweden and Norway and Netherlands are mentioned by 1 each. The Nodes platform is mentioned 3 times (twice indirectly).

4.3.5 Views on the biggest barriers facing current DSOs to a more active DSO

Finally, we asked about the three main barriers to a more active DSO world, from the company and regulator perspective. We offered NRAs and DSOs a menu of choices (see Figure 13) from which they could choose a maximum of three. Just over half of responding DSOs think that the tariff structure is among the biggest barriers for their company becoming a more active DSO[40]. This is followed by regulatory obstacles and/or a lack of regulation. Only one DSO thinks there are no obstacles.

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.

Figure 13 – Top three barriers facing companies in the move to DSO



[40] This is in line with Anaya and Pollitt (2021b) 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.

5. Conclusions and policy implications

This paper has sought to shed light on the following: (1) the future role 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 more active DSO; and (3) current best practices that reflect the future DSO.

The findings emerging from our parallel surveys allow us to identify a few differences of opinion between DSOs and NRAs at the European level and to develop policy recommendations for a regulatory framework which supports the development of an efficient and smart decentralised energy system. Our evidence (on (1) above) is consistent with the observation that the move towards a more active 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 focussed on trials which are themselves often at early stages and/or small. In order to promote the expansion at scale of the trials and demonstration projects better information about the financial implications of the trials (ideally via cost-benefit analysis) should be developed and disseminated across DSOs. The newly established EU DSO entity has the potential to play a critical role in this dissemination work as discussed below.

DSOs and NRAs are not fully aligned on how the movement towards a more active DSO should be supported (under (2) above). This is hardly surprising since DSOs - legitimately – want higher returns on their investments for higher perceived technical and regulatory risk and NRAs are - legitimately - concerned to protect consumers from unnecessary expenditure. The detailed country evidence from our surveys seems to indicate that the countries with established regulatory funding mechanisms for DSO innovation are those with notable amounts of competitive procurement of congestion management and reactive power.

This initial and preliminary evidence seems to indicate that existing NRAs in the different Member States can play an important role in promoting innovative DSO activities by establishing explicit funding mechanisms for this purpose.

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) and 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 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. A clearer but potentially more flexible definition of DSOs role both at the national and European level might however facilitate the evolution towards a more active DSO and create the correct incentives for DSOs to undertake innovative activities in well-functioning decentralised systems

There are a large number of projects underway at the local, national and EU level examining the future of the DSO, in which DSOs are involved (under (3) above). Many of these are intellectually exciting, but few are well known outside their own jurisdiction. This raises the question of how the extensive learning that is arising from individual experiments related to the future of the DSO will be diffused across Europe. There should be a major role for the EU DSO Entity in evaluating, collating and spreading useful learning from future of the DSO related projects and using these to inform grid code development and its other areas of responsibility.

It is sometimes said, including by several of our respondents, that the Clean Energy Package (CEP) has clarified the role of the DSO. However, we find significant disagreement in the answers to our questions about the future of the DSO between and within our sample of NRAs and DSOs. This suggests that both within and between European countries 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.

Since our survey was carried out the 'Fit for 55 package'[41] (July 2021) and the 'Gas Package'[42] (December 2021) have been published but not enacted. These seek to promote the net zero ambition of the EU and the decarbonisation of the gas grid in line with net zero. It remains to be seen if these, in their final form, will clarify further the role of the electricity DSOs, even though this is not their focus. We hope to follow-up on this in future work.

When considering the potential new roles for the DSOs it is important to remember that European DSOs differ substantially both in terms of their size and the extent to which they are unbundled. This implies that they might not currently have the resources and competences to undertake the new role of neutral market facilitators without outsourcing some of their activities to, or cooperating with, other DSOs in their area. Europe's experiment with deep and continuing unbundling of both electricity and gas networks from the rest of the energy system continues to raise questions as to whether co-ordination across the energy system, as required by the active DSO, could be better promoted by a more relaxed approach to vertical and horizontal integration of networks. Together with more competitive innovation funding programmes, the promotion of collaboration among DSOs and some relaxation of existing national and EU-level regulation might be required to bring about a more responsive and flexible decentralised energy system, although this might require time and coordination across Member States.

[41] See: https://www.consilium.europa.eu/en/policies/green-deal/fit-for-55-the-eu-plan-for-a-green-transition/
[42] See: https://ec.europa.eu/commission/presscorner/detail/en/IP_21_6682

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Appendix 1: DSOs' questions

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 one example of 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 three biggest barriers 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 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: NRAs questions

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 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 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)