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Integrating demand side management into EU electricity distribution system operation: A Dutch example

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ABSTRACT

The EU goals for renewable electricity cause significant changes of electrical loads in distribution systems, in which most renewable electricity sources are integrated. This poses a challenge for distribution system operators (DSOs) as their networks are not designed for such load changes. DSOs could use networks more efficiently with demand side management (DSM), where consumers of electricity alter their consumption patterns, shifting (production/consumption) loads in the distribution system. In such a setting, consumers would trade DSM services with the DSOs. However, currently, DSOs follow the 'copper plate approach', which assumes the system should have sufficient capacity to ensure that the desired volumes of electricity can be transported. This seeks to guarantee regulated third party access (rTPA) for all system users. Next to rTPA, based on regulated tasks, DSOs should ensure secure, reliable and efficient systems. In doing so, the DSOs are bound by unbundling requirements, which do not allow them to be involved in any activities other than those related to distribution. Therefore, especially production and supply are not allowed. Still, it seems debatable whether EU law allows DSOs to apply DSM, as it has an impact on both the access conditions to the electricity system, and the production, supply and trade of electricity. This article further analyses how DSM relates to the legal framework of DSOs, which obstacles are present, and how DSM could be traded between DSOs and system users.

1. Introduction

When studying energy law, a number of principles can be identified. Heffron et al. for example identified seven principles in energy law: national resource sovereignty, access to modern energy services, energy justice, prudent, rational and sustainable use of natural resources, protection of the environment, human health and combatting climate change, energy security and reliability, and resilience (Heffron et al., 2018). When translating these principles to electricity systems, they should be: secure, reliable, resilient, accessible upon affordable conditions, and with a fair cost-distribution between its users, which is fit for the integration of clean energy sources. However, there might be tension between the different principles. Especially the use of (renewable) energy sources can have a significant impact on the costs and reliability of the existing electricity system. In order to understand this impact, this article first analyses the policy regarding the integration of renewable energy sources in EU electricity systems, and how that impacts the security, reliability, and resilience of such systems, increasing the tension in the 'energy trilemma' in electricity distribution systems. The energy trilemma refers to the balance between affordability, reliability and sustainability of energy systems, and the idea that affordability, reliability and sustainability are (potentially) conflicting interests (see e.g. Heffron and Talus, 2016a, p. 201). Following, the article proposes how the impact could be managed, and analyses how such 'management' relates to EU energy law, especially on the access conditions for the electricity system. In doing so, the implementation of the relevant EU law in the Netherlands is used as a case study, to assess the legal questions in more detail.

2. EU renewables policy and system impact

The EU climate policy goals set by the roadmap for climate stability strive for an almost carbon-free (80%) EU energy system by 2050 (European Commission, 2011), which in turn are also implemented in EU law. The most prominent EU law in this regard is the Renewables Directive (Renewables Directive, 2009), in which an overall policy for the production and promotion of energy from renewable sources in the EU is established and EU Member States (MSs) are required to realize challenging targets for the implementation of renewables in the current electricity system (arts. 3 and Annex I (A) Renewables Directive). Consequently, large amounts of renewable electricity sources (RES) are integrated into EU electricity system.

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2.1. System impact

Although the RES targets aim at positive outcomes they also raise concerns on the ability of the current electricity network to deal with peak loads at distribution level. This intermittency of RES creates issues regarding the amount and schedule of power consumption and production (Kuiken et al., 2018). In addition to the increasing peak loads and intermittency caused by distributed RES there is an increasing demand for electricity at distribution level. This is mainly caused by the electrification of mobility (electric vehicles) and heat (heat pumps) and it causes similar issues to the ones from distributed RES. These issues are likely to cause system problems such as voltage level violations (over or under voltage) and power congestions. In turn, these may lead to increased network losses, shortened lifespan of network equipment, damage to end-user equipment, interrupted supply services, or, in the worst case, network outages. It becomes clear that risks of efficiency losses, system outages, and damage to both network equipment and electrical devices are likely to rise, potentially increasing costs for both system operators (SOs) and consumers. This is particularly a reality in distribution systems, which usually are the point of connection for small to medium scale RES (Ecorys, 2014).

2.2. Demand-side management

Although the issues described could be tackled by increasing the physical capacity of the electricity systems (e.g. thicker cables, heavier transformers etc.), these are expected to be quite significant (CE Delft, 2017). Alternatively, DSOs could try to allocate the existing network capacity more efficiently by applying demand side management (DSM). DSM refers to all actions aiming at changing electricity load profiles for optimization of the power system as a whole, from generation to delivery to end-use. It improves power efficiency and optimises resources allocation so a more efficient use of electricity can be achieved (Gellings, 2009). Yet, if the DSO would be applying DSM, such an activity should be assessed in light of the applicable rules on distribution system operation.

2.3. Distribution system operator and system access

The Electricity Directive (E-Directive) (Electricity Directive, 2009) requires that DSOs are independent from production and supply activities, defines the tasks a DSO should perform as well as how such should be performed. Additionally, the E-Directive establishes a system of regulated Third Party Access (rTPA), which requires DSOs to provide all (potential) system users (SUs) with access to the electricity system upon published tariffs, applicable to every customer, and applied objectively and without discrimination between system users. All these requirements seek to ensure a level playing field for producers/suppliers to access the electricity system to trade electricity, and for consumers to get access upon transparent and comparable conditions.

However, if DSOs would apply DSM, a number of consequences would follow. First, by applying DSM instead of increasing network capacity the DSO might need to refuse access to the electricity system to some users (see further Section 4). Second, by applying DSM the DSO influences consumption patterns. Such influence in turn also impacts production, supply, and trade of electricity. To evaluate these consequences, and assess whether they are permissible, this article analyses the role of the DSO, based on its regulated tasks, and how the use of DSM by the DSO interacts with the relevant regulatory framework. Further, this article assesses which instruments can be used for integrating DSM in system operation and how these relate to the regulatory framework. Provided that EU law mostly offers general guidance on how unbundling, regulated tasks for DSOs, and rTPA should be ensured, this article includes an analysis of the Dutch implementation of these requirements (Electricity Act, 1998), hereafter E-Act. The choice for the Dutch implementation is based on the form of unbundling adopted in the Netherlands: ownership unbundling. Because this is the most extensive form of unbundling (for further background see Chapter 3, Johnston and Block, 2012), this analysis is expected to allow for a clear view of the eminent issues related to the implementation of DSM by DSOs given the strict requirements on separation of distribution, production, and supply.

3. Regulation of distribution system operators

In order to understand how DSM could be applied in the EU, and, as a case study, in the Netherlands, it is first of all important to understand in which (regulated) setting DSM should be implemented. As explained in the introduction, DSOs are independent from production and supply activities. This is a consequence from the liberalization of the EU electricity markets in which distribution and production/supply must be unbundled activities. In this setting, production and supply are market activities, whilst distribution is a regulated activity, reserved for DSOs. This means that DSOs have a regulated monopoly, with the obligation to provide system services to all potential customers. The settings of such services are regulated in terms of price and quality. These determine the conditions under which the DSO's customers, SUs – which can be both consumers and producers/suppliers – can access the electricity system. The obligation for DSOs to provide system services under regulated conditions is linked to a (regulated) right for SUs to access (rTPA) the electricity system. To further unravel how the regulation of DSOs is shaped and what rTPA entails, this section explains how unbundling, the tasks of the DSO, and rTPA are regulated in EU law, and how these regulations have been implemented in the E-Act and relevant delegated legislation.

3.1. Unbundling

The concept of unbundling is understood as requiring (previously) ‘vertically integrated’ companies (a firm which performs activities ranging from production to distribution) to be ‘unbundled’ into a distribution and production and/or supply company (Treacy et al., 2013, p. 61). The E-Directive requires DSOs to be at least legally independent from vertically integrated undertakings (art. 26 E-Directive) to avoid any possible conflict of interest between system operation, and production and supply. To ensure the requirement is fulfilled, SOs must function independently from producers and suppliers, and operate in a transparent manner. More specifically, DSOs should be at least independent in ‘its legal form, organization and decision making from other activities not relating to distribution’ (art. 26(1) E-Directive; Johnston and Block, 2012). This means that DSOs may remain in joint ownership with suppliers or producers, but may not be involved in operation, decision making, funding etc. or any other activity than distributing electricity (art. 26(2) E-Directive). In the Netherlands, unbundling goes beyond the minimum requirements of the E-Directive: the E-Act requires DSOs to be ownership unbundled. In other words, DSOs should be fully separated from production and supply companies (art. 10b E-Act).

3.2. Regulated DSO tasks

The general task of the DSO is 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** electricity distribution system […] with due regard for the environment and **energy efficiency**. [emphasis added]” (art. 25(1) E-Directive).

In this definition, ‘the system’ refers to the ‘distribution system’, used to transport electricity ‘with a view to its delivery to customers’ (art. 2(5)-(6) E-Directive). It should be operated, maintained and developed under 'economic conditions' as well as be 'secure, reliable and efficient'. Whilst the term 'economic conditions' generally refers to market-based conditions and mechanisms (recital 35, 36 and 56 E-Directive), 'secure, reliable and efficient' refer to a wider set of requirements. For example, 'secure' could refer to both technical security and security of supply. In fact, both are defined within EU legislation. Security of supply is defined in the E-Directive (e.g. recital 25 and 44) and Directive 2005/89/EC as the ability of the system to supply customers with electricity as well as the continuous operation of the system itself (Directive, 2005/89/EC, 2006). System security and reliability are further defined in technical standards (arts. 37(1)(h) and (q) E-Directive; Regulation (EC) 714/2009, 2009). Although these are designed by and for TSOs, they also pose requirements on DSOs, seeking to ensure that distribution systems contribute to secure and reliable transmission systems.

Next to secure and reliable, as mentioned above the system should also be 'efficient', which can refer to both economic and environmental efficiency. This is especially so when reading 'efficiency' in relation with 'economic conditions' or 'due regard for the environment and energy efficiency'. We argue that 'efficiency' means both economic, environmental, and energy efficiency. In this context, energy efficiency should be interpreted as the ratio of input of energy versus the output, the performance (art. 2(4) Directive, 2012/27/EU, 2012, hereafter Energy Efficiency Directive). Still, interpreting 'with due regard to the environment' as environmental efficiency, it is unclear what would be the difference between 'with due regard to the environment' and with due regard to energy efficiency'.

Whilst environmental efficiency seems to encompass a broader concept, as it relates to the efficient 'use' of the environment, e.g. the use of natural resources versus the effects of such usage on the environment, energy efficiency seems to be more restricted and fall under the requirement of environmental efficiency; energy supply requires natural resources, and the efficiency with which these are used can be translated into environmental efficiency. Adding to this ambiguity, it should be noted that 'energy efficiency' is not included in the general tasks of the TSO (only with 'due regard to the environment', see art. 12(a) E-Directive, see further European Council, 2008; European Parliament, 2008a, 2008b, 2008c), implying that 'due regard for energy efficiency' would be a specific requirement for DSOs. Yet, when considering e.g. the Energy Efficiency Directive, both are clearly required to include energy efficiency in their system operations (e.g. art. 15(1) Energy Efficiency Directive). Also in terms of effects, there does not seem to be a clear reason why both requirements are specifically distinguished for the DSO. As such, we assume that both point in the same direction.

Still, when considering the general requirement of 'efficiency', economic and environmental efficiency do not necessarily point in the same direction; there can be tension between these two. In order to promote environmental efficiency, investments might be necessary. Whilst these investments are made in short-term, the gains might only become visible on the long-term. To assess the efficiency of such investments, both long and short-term costs and benefits should be considered. If the long-term (negative external) effects are not properly linked to the short-term investments, some investments might not be considered economic efficient, because the positive effects of e.g. energy efficiency are not integrated in the economic efficiency assessment. Yet, for this article we assume that if all external costs are properly integrated into the electricity system, both economic and environmental efficiency can be optimized in short-term (For further background see Rentizelas and Georgakellos, 2014; Streimikiene and Alisauskaite-Seskiene, 2014).

In the Netherlands, the E-Act mostly echoes the provisions of the E-Directive (art. 16(1) E-Act). Nonetheless, it is worth highlighting that the E-Act stresses the importance of the network to be managed in 'the most efficient manner'. Also here, the term could refer to both economic and environmental energy efficiency. If considering the latter interpretation, it can be argued that the DSO should deploy flexibility up to the extent to which it improves energy efficiency, even if based on current methods and methodologies for calculating tariffs it would not lead to increased economic efficiency. Although this could be a relevant point for debate when future legislation is concerned, for the moment, throughout the E-Act and its subsidiary legislations, 'efficiency' mostly implies economic efficiency (for more background see Mulder, 2016). Reading the regulated tasks of the DSO in conjunction with the provisions on remuneration for system operation, these provisions prescribe that the network tariffs are (also) assessed on 'the most efficient quality of transportation' (distribution), and the efficiency of business management (arts. 41 and 41a E-Act; Kleinhout, 2015). When further analysing the tasks of the DSO, these are to take into account measures in the field of renewable electricity, energy savings, demand response, or decentral electricity production to prevent the need for replacing or expanding production capacity, when constructing, restoring, renewing or expanding their networks (art. 16(1)(c) E-Act). When striking a balance between (short-term) economic and energy efficiency, it seems that based on the current regulatory setting the DSO should strive for economic efficiency, but can also justify measures that increase energy efficiency. This ability to include such measures depends on the exact regulation of the DSOs' remuneration schemes (tariffs), and for instance the determination of which effects can be included in the efficiency assessment, and which time-frames should be used for such assessments.

More specific requirements for system operation can be found in the electricity codes (arts. 36 and 26b E-Act). While the E-Act provides the general framework on how the electricity should be operated and how DSOs and SUs should interact, the network codes provide the specific requirements and conditions for DSO-SU interactions. The network codes also form the foundation for the 'connection and transport agreement' (CTA) which is established between the DSO and its SUs, and the general terms and conditions applicable to this agreement.

3.3. Regulated third party access

The electricity system must be secure, reliable and efficient. This is a precondition for a high quality electricity system that can be used upon reasonable conditions, such as at reasonable costs. However, for SUs to actually make use of such a system, they must also be able to access such a system. In this context, access not only means having a physical connection, but also the ability to use the system. The E-Directive grants all (potential) SUs the right to use the electricity system, in which a physical connection is a precondition (arts. 3(3) and 32 E-Directive; ECJ, 2007). Nevertheless, MSs are free to adopt any system that ensures TPA in an objective and non-discriminatory manner (ECJ, 2007, para. 47). Still, the right to access is not an absolute right. SOs may refuse access in cases where there is insufficient capacity in the network. Nonetheless, in such cases duly substantiated reasons must be given, based on objective, technical and economic criteria (art. 32(2) E-Directive). In addition, rTPA does not require access to be provided under the same conditions to all SUs. Conditions must simply be non-discriminatory, meaning that only SUs in the same user class should have the same access conditions (Kruimer, 2011). In order to ensure that access conditions are comparable, connection and transport fees must be 'based on published tariffs', and 'applied objectively and without discrimination between system users'. The methodologies used by the SOs to define such tariffs are regulated by the National Regulatory Authority (NRA) (arts. 32(1) and 37(6)–(7) E-Directive).

In the Netherlands, rTPA has been implemented in line with the requirements of the E-Directive (arts. 23(1) and 24(1) E-Act). Based on these, the DSO must offer a 'connection and transport agreement' to any party that wishes to enter into an agreement with the DSO. A SO can only refuse access in case of lack of capacity (art. 24(2) E-Act). However, if this occurs, the SO should take measures to avoid future refusals (if possible). If refusals threaten to become structural, or in other words, if demand for capacity structurally exceeds available capacity, that is referred to as 'congestion' (Definition Code, 2016). In case of congestion, the SO has to ensure that the capacity issues are solved (see further Section 4.4).

4. Demand side management

As mentioned in the introduction, DSOs have two options for ensuring safe and reliable networks: ensuring network capacity up to peak demand or DSM. The current approach of DSOs is largely based on the first option, also known as the 'copper plate approach', in which virtually any desired transfer of electricity between market parties can be performed. As such, it relies on the assumption that the flow of electricity is not restricted by physical constraints (Pfluger, 2014). When ensuring this constraint-free electricity system, the DSO serves as a market facilitator for the electricity production and supply markets. In this setting, the DSO is able to ensure rTPA and the unbundling requirements. Whilst allowing all SUs to access the system, the DSO is not participating in production or supply in any way; it is simply ensuring sufficient capacity. Nevertheless, this approach might not be the most efficient one in future scenarios of increasing amounts of RES.

The alternative, DSM, has a different focus. Whilst still ensuring security and reliability, it emphasizes efficiency. Sufficient capacity can still be realized via DSM, nonetheless, this capacity should not be based on peak-demand, rather, on a more equally spread load. Yet, DSM does not come without obstacles. It can only work if DSM is able to offer a more efficient alternative than network expansion. DSM also creates scarcity of network capacity, at least at some moments in time (peak-moments) which does not necessarily facilitate the (wholesale) production and supply markets (at national and EU level), or at least could reduce the efficiency of production facilities because of network constraints. Still, although the DSO would not facilitate production and supply markets, it might facilitate the market for flexibility, by creating demand for DSM (flexibility).

In the following subsections, we assess how DSM is defined in law and could be utilized by the DSO; if the DSO could use DSM for system operation and still act in line with the unbundling requirements; how the use of DSM would relate to the regulated tasks of the DSO; and how it would relate to the current regulation of system operation.

4.1. Definition and utilization

In the E-Directive, DSM is defined as:

> "[…]**influencing the amount and timing** of electricity consumption in order to reduce primary energy consumption and **peak loads** by giving precedence to investments in energy efficiency measures, or other measures, such as interruptible supply contracts, over investments to increase generation capacity, if the former are the **most effective and economical option**, taking into account the positive environmental impact of reduced energy consumption and the **security of supply** and **distribution cost** […]" (art. 2(29) E-Directive).

This definition suggests that DSM could be used to increase the efficiency and security of distribution systems (notice the terms marked in bold). Moreover, in order 'to combat climate change' and ensure security of supply, MSs are even required to implement, among other options, DSM for network maintenance (art. 3(10) E-Directive). The E-Directive also encourages DSOs, for example, to use DSM to lower demand for electricity capacity (art. 25(7) E-Directive). The term 'electricity capacity' is not defined in this context. Yet, it could mean both network capacity and generation capacity ('reducing primary energy consumption and peak loads'). For instance, by using DSM, network losses could be reduced and so the need for generation. In this sense, DSOs could use DSM to increase network efficiency to lower network losses. In the Netherlands, this approach seems to be the one adopted. In the E-Act, 'electricity capacity' has been defined as 'production capacity' (art. 16(1)(c) E-Act). Still, this interpretation raises questions as to whether it is permissible for a DSO to use DSM to influence production and supply. In this light, it is relevant to assess how influencing production and supply relates to the unbundling requirements.

4.2. Compatibility with unbundling

According to the unbundling requirements (see Section 2.1), DSOs are not allowed to be involved in activities other than system operation. Nevertheless, whilst using DSM is perfectly in line with the goals of system operation (to ensure secure, reliable and efficient systems), the application of DSM also influences production and supply markets. By re-organizing the amount of active power in a specific time-slot, the conditions for production and supply markets are changed. As such, when using flexibility, the DSO is actively influencing the market for electricity production, supply, and trade. Consequently, in this context the actions of the DSO also impact the demand and supply of electricity, and ultimately, the market price of electricity. In assessing whether this 'influence' is allowed, the object, purpose, and exact wording of the unbundling requirements come into play. The object and purpose have been described in the above sections: to facilitate a level playing field for the production, supply, and trade market by ensuring transparent and non-discriminatory access to the system and being independent from production, supply, and trade. Such influence does not oppose to the object or the purpose since, if the playing field is changed, it is changed on a similar way to *all* market parties. Neither is influence over the electricity market prohibited for the DSO by the wording of the E-Act (see Section 3.1). This is also demonstrated by the obligation for DSOs to purchase electricity for compensating network losses (art. 3.1.2(b) Tariff Code, 2016). This obligation renders the DSOs into the largest electricity consumers in the electricity market. Because the DSOs are the only parties able to reduce demand for electricity based on network losses it seems inevitable that they influence the market for production, supply, and trade of electricity.

Linking the use of DSM by the DSO to the role of the DSO as a neutral market facilitator also provokes the question of how should the DSO behave in its role of market facilitator. Therefore, the next subsection assesses how the DSO could or should act to facilitate 'the (flexibility) market'.

4.3. Market facilitation

The DSO can facilitate the market for DSM in multiple ways. One is to 'create' scarcity of network capacity by not expanding existing infrastructure when needed. In this setting, the DSO could use (reward) DSM to avoid congestion. However, when scarcity in network capacity exists, there is a demand for (local) flexibility, DSM. As such, the value of the latter increases, and assuming a well-functioning market in which scarcity is identifiable to SUs, the incentive for investments in DSM also increases. Nevertheless, another important side effect might come into play: if DSM is used to avoid network expansion, electricity might get 'locked' in lower system levels, reducing the mobility of electricity and flexibility. Consequently, potentially large quantities of flexibility could, in theory, be used on other system levels, yet, cannot be transported to these levels. Alternatively to applying DSM, the DSO could ensure sufficient capacity with the goal to allow flexibility to be easily transported through the system. The latter basically maintains the copper plate, whilst the first takes a fundamentally different stand. Arguably, the latter seems perfect, as it could serve the production and supply markets as well as the flexibility markets. Still, it reduces the efficiency of the electricity system (Nykamp, 2013). This brings to question the balancing of security, reliability and efficiency, and the assurance of access to SUs up to 'reasonable' demand.

The above balancing question seems solvable by providing clear and proper market incentives on local levels. For example, by translating the costs made in a specific area to the SUs connected in that area, the SUs can either opt for DSM, lowering their demand for (peak) network capacity and avoiding an increase in their network tariffs, or refuse DSM by not lowering their demand for capacity (voluntarily), and in turn leading to capacity expansion, and an increase in network tariffs. The trade-off for SUs here would be based on a number of factors, such as the willingness and ability to provide DSM, hence, invest in DSM. Additionally, the DSO plays an important role in providing incentives, e.g. by proposing a clear and transparent market in which the value of flexibility is clear to SUs, and to inform SUs about the long-term consequences of e.g. network expansions versus DSM. Notably, the trade-off can be very difficult as the value of flexibility is not only based on local conditions, but also on the demand in other system levels, e.g. the market for balancing capacity at transmission level, which has a much higher liquidity.

Nevertheless, regardless of the ability and willingness of SUs, at the moment, the current tariff-setting methods render such incentives almost impossible. Currently, transport tariffs in the Netherlands are based on the actual peak (of used capacity) for a period of one month (kW^{max}), on the contracted peak (for capacity usage) ($kW^{contracted}$), on the amount of transported electricity (use of capacity, expressed in kWh), or simply on the physical capacity of the connection (kW) (art. 3.7 Tariff Code). The exact composition (and amount) of the tariffs is based on which type of SU is considered. In the Tariff Code, SUs are classified on the basis of their connected system level (e.g. 230/400 V, to which most household customers are connected), though their exact location is irrelevant for the amount of their tariffs. System costs are socialized amongst classes of SUs, regardless of their location. If local incentives ought to be included in the current tariffs, the tariff-setting methods need to be amended. Yet, it seems questionable whether such local incentives would be allowed from an EU law perspective. The E-Directive defines small customers as one user class and prescribes that MSs should take measures to protect customers in remote areas, which are commonly faced with higher infrastructure costs due to low population densities (art. 3(3) and (7) E-Directive). This implies solidarity amongst small customers, which makes it difficult to allow for different treatments of small customers.

Still, assuming local incentives can be included in DSM schemes applied by the DSO, other potential obstacles can be found in rTPA. When applying DSM, the DSO allocates (part of) its available (scarce) capacity in a specific part of its system. Regardless of whether capacity is scarce, the DSO will alter the access conditions for (some) SUs. Currently, the DSO must avoid putting in use capacity allocation mechanisms. Consequently, the applicable regulatory framework does not provide for capacity allocation as modus operandi for DSOs.

4.4. Capacity allocation as modus operandi

In the current regulatory framework that applies to DSOs, these are expected to ensure sufficient capacity in order to avoid refusals of access (art. 24(2) E-Act). In practise, it means that the DSO will ensure capacity up to peak demand, plus some overcapacity to avoid future capacity issues. Nevertheless, although the DSO avoids capacity scarcity as much as possible, in some occasions demand for capacity can rise rapidly. For example, if a SU makes significant changes to its installation, or decides to install significant amounts of PVs, demand for capacity can rise rapidly. In such a situation, the DSO will increase capacity. Yet, it might be unable to do so in a short term. For these cases, the DSO will have to allocate the available capacity. This type of 'capacity allocation' is referred to as 'congestion management' (for analogy with cross-border congestion see, for example, Vedder et al., 2016).

In the Netherlands, congestion management is defined as a set of measures to solve a situation in which network capacity is insufficient to provide access under all foreseeable circumstances (Definitions Code, 2016). This is to be performed according to a fixed protocol, described in the Netcode (Netcode, 2016). First, the DSO must release an announcement, stating at least the expected area, duration, and cause of the congestion. Also, the total contracted and available transport capacity in the expected congestion area and plans for avoiding future congestion must be stated. After the announcement, the DSO assesses whether sufficient flexibility is available to solve the congestion. If this seems to be the case, the DSO can request SUs to provide bids for DSM services. If such a request does not result in sufficient bids, the DSO can pose requirements on its SUs for making available flexibility to solve the congestion (art. 4.2.5 Netcode). Yet, the above described 'congestion management' does not seem to offer a fitting solution for long-term capacity allocation by the DSO. This is because, if there is a congestion, it should be dealt with and prevented in the future. As such, from the perspective of the congestion management setting fixed by the Netcode, scarcity seems to be inadmissible.

Nevertheless, the fact that the congestion management mechanism cannot be used does not preclude capacity allocation as a whole. Based on the regulatory tasks of the DSO, it seems permissible (or even desirable) to perform capacity allocation to increase the efficiency of the electricity system (see Sections 3.2 and 4.1). On the other side, the reason for the congestion management scheme to be in place is to ensure rTPA: to avoid refusals of access by the DSO (art. 24(2) E-Act) and to avoid system security and reliability issues in period between the identification of congestion and the capacity expansion solving the congestion. The follow-up question, therefore, seems to be what qualifies as a refusal of access, or perhaps, what qualifies as access; should that be access up to all desired demand, regardless of the consequences (costs), or can such access be limited? Moreover, if such access can be limited, who decides 'how much' capacity each SU should receive, and are all SUs in comparable user-classes entitled to the same amount of capacity? In order to assess these questions, we identify two options the DSO can apply. The first is voluntary allocation, in which the DSO invites SUs to lower their demand, using a market based mechanism to allocate the available capacity. In this setting, SUs are free to make a bid. If sufficient SUs are willing to lower their demand for capacity, not all SUs have to be flexible. It can be compared to the invitation the DSO sends according to the congestion management procedures. The second option is involuntary allocation, in which the DSO caps the physical capacity and SUs can access this capacity based on their willingness to pay. In this setting, all SUs have to bid for capacity

With voluntary allocation, SUs collectively have the freedom to decide whether or not to accept higher network tariffs to participate in DSM. However, two issues exist: the first is that SUs are addressed as collective when it comes to network tariffs. It is already mentioned above that the current division of classes does not allow for local incentives. Yet, if such local incentives could be provided, it remains difficult to assess how capacity issues are influenced. In other words, it is difficult to define the extent to which SUs are able to actually decide on whether they prefer investing in capacity expansion (higher network tariffs) or DSM. For individual SUs to assess whether they are willing to invest in DSM, they require clarity on the demand for DSM; they should be able to assess whether such an investment would be profitable. If the decision to invest is e.g. based on local market conditions (i.a. DSO demand for DSM for a specific system level), the business case might change drastically if DSM does not provide sufficient capacity reduction to tackle congestions. Then the DSO would rather invest in capacity expansions, increasing the general network tariffs, but lowering the (local) demand for flexibility. This would drastically change the 'business-case' for SUs to invest in DSM. Also the certainty related to the investment in DSM might be too low to persuade SUs to actually make investments based on local conditions. This seems a difficult problem from a coordination perspective. However, from a rTPA perspective voluntary allocation seems less difficult to assess. If SUs are willing to reduce their use of the electricity system at agreed terms and conditions, it seems difficult to argue a violation of the rTPA requirements. Yet, if the DSO and the SU would agree on the terms and conditions for refusal, hence, the terms and conditions for access, with the current interpretation of rTPA, access would still be provided 'as desired' by SUs.

An alternative to voluntary allocation would be involuntary allocation. Currently, this is governed by the congestion management scheme described above. Even without the *de jura* application of such a scheme, e.g., by allocating without congestion, or allocating with congestion on the long term, it is questionable whether rTPA would allow for this allocation. In all these settings, the DSO decides whether scarcity should be allowed and whether and how DSM should be applied. Besides, all settings would result in situations in which the DSO can refuse access based on insufficient capacity or to increase efficiency. Nevertheless, in the current regulatory setting, rTPA does not allow for such refusals.

In addition, it is questionable whether involuntary allocation allows the DSO to perform its role as a market facilitator. Using flexibility to avoid capacity expansions and focussing on local network issues (hence, efficiency) also reduces the overall mobility of electricity within that area. In the case a distribution system is operating close to its capacity limits, flexibility cannot be transferred to other (higher) system levels – assuming flexibility is required in the 'same direction' (either increase or decrease of production or consumption) – since the capacity to do so might be lacking. In such situations, the flexibility is 'trapped' in one region, whilst it might be needed in other ones. Consequently, these reductions might well lower the overall efficiency of the electricity system as a whole (ACM, 2017). From an SU perspective, it also limits the trade options, as their flexibility might not be deliverable to some market parties, located in other parts of the system. However, in this setting a transport-bottleneck will always exist somewhere. The question is when and where these are allowed. This also touches upon a more general policy discussion that underpins this article: to which extent should we maintain the copper plate approach? In the end, this requires striking a balance between meeting reasonable demands for capacity (ensuring rTPA) and efficiency. To do so, a transparent mechanism should be developed to assess when capacity needs to be expanded and when it should be capped and (re)allocated (for further background see Gómez, 2013).

5. Agreement forms

The above sections question whether DSOs can integrate DSM in their system operation in the light of the current legal framework. Assuming a clear and transparent method can be found to apply DSM, and capacity still is extended if demanded, the answer is affirmative. However, the next question is how DSOs could acquire the required DSM services from its system users. The answer lies in different types of trade forms which are or could be applied between DSOs and their system users. For instance, the CTA (see Section 3.2) could be used for integrating flexibility into the system operation. Another option would be to use dedicated DSM agreements between SUs (or a service provider on their behalf) and the DSO, in which they agree on the terms for DSM. Such agreements can be standardized, tailor made, or framework agreements, which set terms for ongoing trade. Dedicated DSM agreements can also be channelled through a trading platform in which flexibility is traded via clearing houses (spot markets). Flexibility could also be traded by using existing market platforms, such as power exchanges (PXs). Yet, current PXs do not take local conditions into consideration. As an example, the Dutch EPEX Spot does not allow for local (distribution) elements to be taken into account (EPEX Spot, 2017a, 2017b). As such, PXs cannot be used for direct trading of flexibility between DSOs and SUs. Yet, a service provider could act as an intermediate between DSOs and system users, taking into account local conditions, and arranging for the flexibility to be integrated in the PX via regular electricity trade. In this scenario, flexibility would be exchanged indirectly via the PX and the relevant agreement for the trade between the DSO and the system users would be the service agreement, with the service provider acting as an intermediate.

In order to further explore the general potential of the above described arrangements for trading DSM between SUs and DSOs, we first focus on the CTA. Thereafter, we consider the dedicated DSM agreements that can be used alternatively or in addition to the CTA.

5.1. Connection and transport agreement

At first sight, the CTA seems highly suitable for trading DSM services between the DSO and SUs. The main reason is that this agreement exists between every individual SU and its connecting DSO. The CTA includes the terms and conditions for the physical connection to the distribution system and the transport services required for using the connection. Although this agreement could be very suitable for integrating flexibility into system operation, provided that the financial terms of the CTA are set in the Tariff Code, currently the CTA cannot be used for such purposes (see Sections 4.3 and 4.4 and Ouden et al., 2016).

In order to allow DSM to be integrated into the CTA, the Tariff Code needs to be amended. The Tariff Code should allow for a 'flexibility component' to be included. This component should account for the time of usage. A practical way of including such a component is by attaching a profile to each CTA, in which, for each moment in time, the maximum (or desired) consumption or production is stated in order for the DSO to optimize the efficiency of the available capacity. If SUs are unable to adhere to such a profile, they need to buy bandwidth, which would allow them to move away from the profile. As an alternative to including a flexibility component, the CTA could also be turned into a model, comparable to the current supply agreement model (see art. 95na E-Act). In the Netherlands, consumers have the right to a regulated model supply agreement, but are free to have any other agreement with their supplier. This setting could also be applied to the CTA. Yet, having different types of CTAs and using different methods and methodologies for calculating tariffs would make it difficult (but certainly not impossible) to ensure non-discriminatory and transparent conditions for the CTA (art. 95 m(1) E-Act). It would require the DSO to have models, or at least methods, for ensuring that similar SUs are tariffed at a similar (non-discriminatory) and transparent manner. This also requires the NRA (*Authoriteit Consument en Markt* – ACM) to be involved in setting the tariffs structures and creating legal certainty for both the DSO and system users (arts. 32–43 Electricity Act). However, as mentioned, before the CTA could include flexibility, the current Tariff Code needs to be amended.

5.2. Dedicated DSM agreement

Alternatively to the CTA, dedicated forms – such as (bilateral) DSM agreements or (DSM) market platforms – could be used. Both would have the same purpose: in this case, trading DSM services between the DSO and SU (or service providers on their behalf, see e.g., USEF, 2015). Nevertheless, despite their common purpose, considerable differences exist. When using bilateral DSM agreements, e.g., ancillary service contracts (see Eid et al., 2016; Lanz et al., 2011; Mäntysaari, 2015), SUs could trade directly with the DSO (for further background see Ramos et al., 2016). Although these agreements can be standardized, they offer plenty of room for tailor made conditions. A possible downside of bilateral DSM agreements is that they are less transparent, making it more difficult to relate them to the CTA and the rTPA requirements (see Sections 4 and 5.1). When using market platforms, DSOs and SUs interact via a platform, in which both parties make a bid, typically expressed in the quantity of 'service' they desire, the quality (type of service, normally standardized), and the price they are willing to buy or sell that quantity of a specific service (for more details also see Koliou, 2016). In the end, the market price is set and the market is cleared by the market operator (clearing house). In this indirect form of trade, the advantages are that the conditions are clear in advance, the platforms are easy to use, and the financial risks of the trading parties are lower. In general, selling parties have to deliver to the clearing house (who is responsible for making their payments), and the clearing house has to deliver to the buying parties (which pay the clearing house). If one of the parties is in default, the clearing house has to bear the risk, at least in first instance (also see, Ranci and Cervigni, 2013). Nevertheless, this reduced risk has a price which is integrated into the service costs of the clearing house. Furthermore, trading platforms mostly use standardized services. Although standardized services make all bids more comparable, they might restrict competition by using service definitions that are too narrow, e.g., excluding demand and supply from the platform (for further background, Telyas, 2014). In this case, a solution could be to ensure that the market operator regularly has an open season to define the scope and breadth of services.

6. Conclusion and policy implications

This article looks into the tension between some of the energy law principles (see Introduction and further Heffron et al., 2018) translated to electricity systems in relation to the EU renewable and sustainability energy policy. More specifically, this article focusses on the energy trilemma – the tension between affordability, reliability and sustainability in electricity distribution systems – and how energy law can be used to regulate an acceptable balance in it (Heffron and Talus, 2016a). In this context, although rTPA and unbundling are important regulatory measures in EU energy law that impact price and quality of electricity distribution services, it might be that these cause the tensions between the elements of the energy trilemma to rise. For this reason the article analyses how such tensions (and their consequences) could be mitigated in electricity distribution systems by means of integration of DSM in system management (small customers). This requires connecting the different principles, and analysing how they interact, which tensions exist between them, and how energy law can mitigate such tensions (Heffron and Talus, 2016b).

As a general conclusion of this article it can be stated that DSM offers chances for the DSO to add to a fair balance in the energy trilemma by optimizing the performance of its regulated tasks, ensuring the security, reliability, and efficiency of the electricity system. Yet, the integration of DSM into the DSO's system operation does not come without challenges. Whilst the use of DSM by the DSO does not seem to conflict with the unbundling requirements and seems to be an adequate tool for optimizing the performance of the regulated tasks of the DSO, the current interpretation of rTPA clearly restricts its use. In tackling such restrictions, two options can be identified: 1) stick to the existing interpretation and look for leeway; 2) opt for an alternative interpretation of rTPA, hence, the concept of 'access'. In either scenario, careful decisions have to be made regarding how the DSO could integrate DSM into its system operation. In order to make such decisions, also the role of the DSO needs to be considered; how can the DSO act as a neutral facilitator? Currently, this role is mainly seen as market facilitator, in which the DSO has to ensure a copper plate to comply with its regulatory tasks. However, in a scenario in which DSM is utilized, a different interpretation could be given to the role of market facilitator. In such an interpretation, 'market' does not necessarily mean 'production and supply market', it could also mean 'market for flexibility'.

Following the question which role the DSO would have to play would be what the users of the electricity system prefer. This is a societal question, which can approached on a central (national) level, or on a local (distribution system) level. This question is a difficult question to answer, especially considering the local variaties in distribution systems and their connected users. Some system users would be willing and able to provide DSM, others not. In any setting applying DSM, there will be a reallocation of system costs, those providing DSM paying less (but having to compensate their investments in flexible equipment), those not providing DSM having to compensate the reduction in costs for the DSM providers. This redistribution influences the accessibility of consumers to the electricity system, potentially quite significantly. In relation to the legal framework, it relates to how rTPA is implemented, i.a. how system tariff methodologies are designed (costs are distributed) and integrated into the CTA. This balancing question, how to safeguard the different interests, especially reliability of the system and affordability for system users, needs to be addressed and the answers should be used to fine-tune the current legal framework.

In sum, DSM is a promising tool for optimizing system efficiency, increasing the overall affordability of the electricity system, and ensuring sustainability. Yet, in order to harvest the promises of DSM and integrate DSM into system operation and the relevant laws regulating such operation, a number of policy questions need to be addressed first. Most prominently, it should be considered how we want to approach system access. Is this a given right that should be facilitated up to every desired level, regardless of the consequences, and based on socialization to level-out the most inefficient costs? Or would an approach in which the users of the electricity system are given incentives to contribute to (the overall) system efficiency be more desirable? In addition, the role of the DSO should be considered; should the DSO simply follow capacity demands, or should it also steer for the highest possible efficiency rates of capacity usage at distribution level, perhaps transmission, or even EU level? All these questions relate to the energy trilemma, and more specifically the principles mentioned in the introduction: security, reliability, resilience, efficiency, the environment, and the accessibility of the electricity system to its customers. How important are all these principles, and how should the balance be made if conflicting interests exist? Once these questions have been properly addressed in the light of DSM utilization by the DSO, the legal framework analysed in this article could be redesigned (fine-tuned) into an enabler for DSM, contributing to a more efficient electricity system.

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