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Article

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Scientific Papers of the University of Pardubice, Series D: Faculty of Economics and Administration

Provided in Cooperation with:

Faculty of Economics and Administration, University of Pardubice

Suggested Citation: Keypour, Javad (2024) : Legal challenges in developing a digitalised electricity market in the EU: The case of Estonia, Scientific Papers of the University of Pardubice, Series D: Faculty of Economics and Administration, ISSN 1804-8048, University of Pardubice, Pardubice, Vol. 32, Iss. 2, pp. 1-11,
<https://doi.org/10.46585/sp32022091>

This Version is available at:

<https://hdl.handle.net/10419/334838>

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Legal Challenges in Developing a Digitalized Electricity Market in the EU: The Case of Estonia

Scientific Papers of the University of Pardubice, Series D: Faculty of Economics and Administration 2024, 32(2), 2091.
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DOI: 10.46585/sp32022091
editorial.upce.cz/SciPap

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Abstract

Over the past decade, digitalisation has gained significant attention across various European Union (EU) policy areas, particularly in the energy sector. Digitalisation can contribute to greater energy security and sustainability within EU energy systems, especially by reducing fossil fuel dependency and enabling decentralised energy production through micro-renewable generation. However, the digitalisation of electricity markets still faces regulatory hurdles, particularly regarding data management and potential monopolies. This paper addresses these challenges within the Estonian market, with a focus on prosumers' contributions to stabilising the digital electricity market through power generation or demand response. Using document analysis of legal provisions alongside the multi-level perspective model of transition, the results indicate that while smart meters play a crucial role in demand response and surplus electricity exchange, current regulations create a de facto monopoly favouring Estonian suppliers, which undermines prosumers' interests. Additionally, the concentration of data within a few aggregators may impede competition, while the lack of legal obligations for detailed data access hinders consumers' ability to engage in intra-day and balancing markets. The study underscores the need for legal provisions that facilitate data exchange and access for aggregators, while addressing privacy concerns to ensure robust competition. It further recommends establishing obligations for the timely sharing of individual consumer consumption data and defining 'accounting points' to align with EU regulations. Additionally, clear definitions and provisions for data management, competition law compliance, and consumer rights are crucial. By implementing these recommendations, Estonia can strengthen its role as a leader in digitalisation within the EU, promoting a more resilient and sustainable energy system.

Keywords

Sustainability, Smart grids, Digitalisation, EU energy law, Electricity markets

JEL Classification

D42, K21, L94, O38, Q48, Q55

Introduction

A combination of factors, including climate change concerns, geopolitical tensions, and the fear of another energy crisis, has compelled the European Union (EU) to plan for a restructuring of its energy system (Keypour, 2024, p. 10). Considering the definition of energy transition as “a shift in the nature or pattern of how energy is utilised within a system” (Araújo, 2014), the EU's decision implies a transition from a fossil fuel-based energy system to one centred on renewable energy sources (Green, 2018). To accomplish this objective, a transformation towards a digitalised, decarbonised, and decentralised energy system is targeted for completion by 2050. Decarbonisation aims to reduce the use of fossil fuels, while decentralisation seeks to transform the energy production system from a centralised, integrated network to a more dispersed configuration, incorporating micro-renewable generation. Collectively, these efforts have the potential to decrease dependence on fossil fuels, thereby strengthening the EU's energy security and sustainability, with particular benefits for smaller EU member states such as Estonia where energy security issues are more pronounced (Keypour, 2022).

Digitalisation is a crucial component that contributes to both decarbonisation and decentralisation. It enables prosumers—consumers who produce electricity on-site—thereby decentralising the energy system (Fouladi Moghaddam, 2024). The large-scale integration of intermittent renewable electricity generation introduces significant fluctuations on the supply side, necessitating flexible load-shifting strategies, often referred to as demand response mechanisms, to maintain network balance. Implementing these strategies requires a bidirectional exchange of data between consumers and producers, which in turn depends on the digitalisation of infrastructure and the widespread deployment of smart grids and smart electricity meters (Feuerriegel, Bodenbenner, & Neumann, 2016).

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Given that environmental legislation has a positive influence on greening service offerings (Korsakienė & Raišienė, 2022), the European Commission (EC) has taken significant steps to support the digital and green transformation of energy systems. The adoption of Directive 2018/844 (amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency) urges alignment of the Energy Union goals—namely, the Single Energy Market and decarbonisation—with the Digital Single Market. This provides the legal groundwork for promoting smart meters at the Union level. Furthermore, the EC has been working towards the interoperability of solutions and standardisation by establishing the Smart Grids Task Force, which assists with regulatory directions to coordinate the initial steps towards the implementation of Smart Grids in accordance with energy and digital legislation. Recognising the importance of data, the EC has also supported the development and sharing of data in accordance with EU values by proposing the European Data Act, which came into force in January 2024 (European Commission, 2024).

While the EU has been preparing new regulatory frameworks to support digitalisation, new challenges and requirements emerge constantly, necessitating ongoing legal developments, particularly concerning privacy, data protection, and compliance with competition laws. This study, therefore, focuses on the necessary legal and regulatory revisions, especially in Estonia. Given Estonia's position as a forerunner in digitalisation and e-governance within the EU, where studies have also shown it is characterised by a high level of citizens' internet skills and online availability of public services (Ardielli & Halásková, 2015). More precisely, this paper addresses the legal challenges and gaps related to prosumers' contributions to stabilising the digital electricity market through power generation or demand response. The research objective is to make policy or managerial recommendations for improving the legal frameworks governing the digital and sustainable transformation of the Estonian electricity market during the transition period by providing a critical analysis of existing legal structures. Thus, the research question is: what legal and regulatory revisions are necessary to support prosumer contributions in stabilising the digital electricity market in Estonia during the EU's energy transition?

This study uses document analysis—a systematic approach commonly applied to written materials, especially legal texts—together with doctrinal analysis. Document analysis helps establish context through various forms of research information and validate data from alternative sources (Kwon & Park, 2019; Lunde, 2023). After an initial review of the documents to establish a general understanding, relevant content is extracted to support a critical analysis, ultimately interpreting the collective findings (Bowen, 2009). The targeted documents include relevant Directives, Regulations, and national legal texts regulating the Estonian electricity market. Additionally, critical insights from a few experts involved in digitalisation and demand response (DR) have been considered in the critical interpretation of the documents.

This paper is structured as follows: the next section outlines a theoretical framework, drawn from academic literature, detailing the role of legal and regulatory systems in supporting business development during the energy transition, with an emphasis on the digitalisation of the electricity market. Section three presents an analysis of existing legal texts, highlighting the flaws and requirements still needed in the Estonian electricity market. The conclusion subsequently presents the main legal recommendations.

Theoretical Background and Literature Review

Theories of transition have been developed to understand the fundamental changes occurring in society, the economy, and the environment (Geels, 2012; Lorbach, 2010). These theories acknowledge transition as a dynamic process involving the interactions and feedback among subsystems, aimed at steering change towards a desired outcome, such as sustainability (Bellos, 2018). Among various theories, the multi-level perspective (MLP), developed predominantly by Geels (2002), has become one of the most widely used for analysing energy transitions in recent years (Young & Macura, 2023; Markard, Raven, & Truffer, 2012; Kanger, 2021).

MLP posits that transitions are driven by the interplay of factors across multiple levels, encompassing technological, economic, social, cultural, and political dimensions. Thus, the energy transition occurs within a “socio-technical system”—a configuration of actors, rules, and technologies that collectively fulfil the societal function of energy supply, encompassing the regulations governing this transition (Kanger & Sovacool, 2022). According to the MLP model, transitions occur across three levels: niche, regime, and landscape (Geels, 2002). The niche level serves as a platform for developing and experimenting with new ideas and technologies. The regime level involves the existing institutional and socio-technical structures that shape the dominant energy system, including actors, rules, and norms (e.g., legal frameworks). Finally, the landscape level includes broader trends and factors affecting the current system, such as demographic changes, economic developments, societal and environmental changes, and global decisions like climate policies.

In the context of this research, it can be argued that the development and experimentation of digital technologies, specifically smart meters and digital platforms, have primarily occurred at the niche level. Conversely, the regime level supported the existing centralised electricity supply system, which was underpinned by an extensive electricity network and governed by the EU energy acquis and market regulations. While the established regime aimed to maintain the system's traditional functionality, the landscape, influenced by environmental and security concerns,

has begun to shape governmental policies. These policies aim to reduce carbon emissions and enhance the security of supply, thereby promoting the decentralisation of electricity production and the digitalisation of the energy sector.

Despite the regime's resistance, the adoption of the EU's '2020 climate & energy package'—which targeted producing 20% of energy from renewables compared to 1990 levels (European Commission, 2020) — imposed significant policy and legal pressure on the existing system, necessitating restructuring. This facilitated the widespread deployment of solar panels and wind turbines, which, in turn, required a corresponding digital and decentralised electricity system and market. Furthermore, a spectrum of external factors, including high oil prices resulting from geopolitical instabilities in the Middle East in the early 2000s, the growth in carbon pricing (Beveridge & Kern, 2013), and more recently, the Russian invasion of Ukraine, have demanded broader changes in the sociotechnical regime. These changes include new regulations in electricity markets and the proliferation of smart meters, enabling electricity exchange by prosumers. This dynamic is illustrated in Fig. 1.

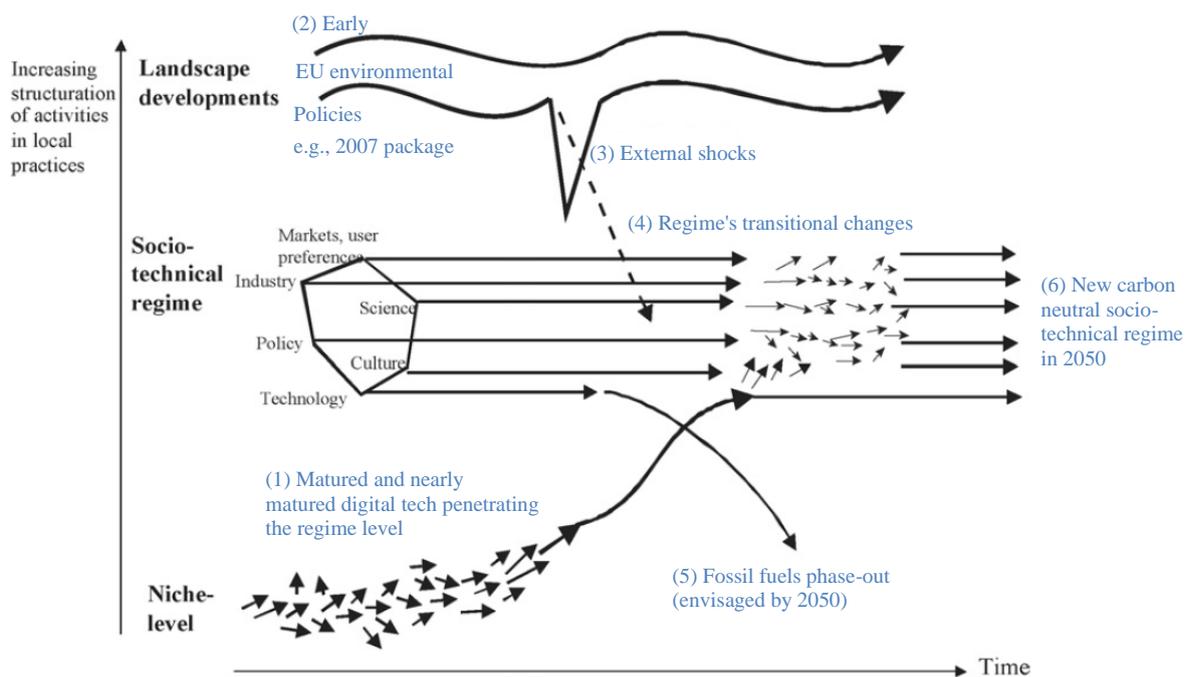


Fig. 1. Energy transition scheme, adapted from Geels & Schot (2007), numbered items added by the author.

Geels and Schot (2007) recognise the importance of rule and regulation changes during transition periods, which facilitate the adoption of technologies developed in niches. They delineate two primary endogenous processes through which these rule changes occur: evolutionary-economic and social-institutional. The evolutionary-economic process involves indirect rule changes through the market selection of product variations. In this process, technological development actors, such as firms and researchers, introduce variations in their products based on strategic choices and investments. If these variations are successful, they gain traction in the market, allowing the new routines to become dominant through differential growth and imitation. For example, it is arguable to say that in Estonia, the implementation of smart meters and the digitalisation of the electricity market exemplify this process. Companies developing smart meters and DR technologies strive to have their varied products accepted in the market, thereby gaining a competitive advantage and integrating into the market. This success leads to changes in regulatory frameworks to support these innovations.

Conversely, the social-institutional process involves actors directly negotiating rules within their communities. This process features interpretative flexibility, where different social groups propose varied solutions to emerging technologies until a dominant interpretation is established through negotiation and coalition building. This socio-cognitive institutionalisation process encompasses shared cognitive frameworks and collective actions within professional and social groups (Geels & Schot, 2007). One can argue that in the case of Estonia, the adoption of smart meters and the framework for selling surplus electricity back to the grid illustrate this process. Various stakeholders, including government agencies, industry professionals, and consumer groups, have engaged in discussions and negotiations to create a regulatory environment that supports these technological advancements. Through conferences, workshops, and policy dialogues, these actors have developed and agreed upon new rules and regulations, facilitating the broader acceptance and implementation of digital electricity market innovations.

Although the Multi-Level Perspective (MLP) perceives technology development as a key factor in transitions, the success of niche technologies in penetrating and dominating the existing regime depends on favourable landscape

pressures that support innovation while limiting the persistence of the current regime and its associated technologies (Kanger & Sovacool, 2022). At the same time, regimes must demonstrate flexibility and adaptability to operationalise new technologies. This is illustrated in Fig. 1, where 'policy' as part of the 'illustrative hexagon regime' evolves during the transition period and re-emerges in the 'new carbon-neutral socio-technical regime in 2050,' as depicted in number (6). Given the importance of this, the required rule and regulation revisions for the digitalisation of the Estonian electricity market are elaborated upon in the following section.

Methodology

This study employs a qualitative document analysis incorporated into doctrinal analysis. Document analysis is a systematic procedure used to evaluate written materials, particularly legal documents, to extract pertinent information and interpret data within the study's context (Kwon & Park, 2019; Lunde, 2023). Document analysis involves three steps (Karppinen & Moe, 2019):

1. **Selecting Relevant Sources:** Given that this study focuses on legal analysis, primary sources include the EU energy acquis, which comprises relevant regulations and directives, as well as European Commission communications accessible through Eur-Lex and riigiteataja.ee. Secondary sources, such as journal articles, books, and critical opinions published in various media, were also used as supplementary materials, primarily accessed via Google Scholar.
2. **Access, Collection, and Sampling:** Documents were carefully extracted and reviewed for relevance in light of the study's objectives. The criteria for relevance were defined based on keywords that align with the research's focus areas.
3. **Analysis and Interpretation:** In this final step, the legal frameworks identified in the second phase were initially reviewed. Naturally, not all documents containing the search keywords were directly relevant to the research topic; thus, irrelevant items were excluded from further analysis. The remaining selected legal acts were then examined in depth, focusing on legal provisions addressing similar issues. These provisions were systematically compared, interpreted together, and synthesised to form a coherent regulatory framework, which was then analysed in relation to the research questions.

When conducting legal research, content analysis is typically integrated into doctrinal analysis to enhance the method's effectiveness, particularly in the third step, as it allows for a systematic examination of statutory provisions and other legal principles (Denzin, 2017). Such an investigation can reveal which legal provisions have been developed to support the digitalisation of energy markets and promote prosumer participation. In other words, while document analysis primarily involves the qualitative examination of specific texts or documents related to the research topic to identify prevalent themes within the content, doctrinal analysis is often accompanied by complementary background research, including resources like legal dictionaries, to clarify how the scrutinised legal provisions interrelate to fulfil a specific legislative intent (Roy, 2023; Dalglish, Khalid, & McMahon, 2020; Ali, Yusoff, & Ayub, 2017). Consequently, doctrinal analysis is particularly well-suited to the nature of legal documents, permitting individual document evaluations and an assessment of their contributions to the study's objectives. It also facilitates the exploration of interconnections between the different documents accessed in the second step to develop a comprehensive regulatory analysis (Roy, 2023).

Results

The Eur-Lex database was thoroughly examined to extract the research data relevant to this study. This resource was selected because it provides access to all editions of the Official Journal of the European Union (Official Journal) from the very first issue in December 1952. Additionally, "Estonian laws and state-wide regulations" available on riigiteataja.ee were reviewed to provide a comprehensive understanding of the relevant national legal context. All these documents were systematically scrutinised to identify legal provisions related to the digitalisation of the electricity market, using specific keywords such as 'electricity market,' 'data management,' 'consumer rights,' 'competition law,' and 'market regulations' impacting prosumers and the broader digitalisation process.

The results of the document analysis showed that not all legal acts containing one or more of these keywords can necessarily provide legal provisions to digitalisation. Some documents may appear in the database search simply because they include a keyword a few times without substantively addressing the topic. To address this limitation, all selected documents were re-evaluated using a research-context-based approach aligned with the second step of the content analysis method. Following this, the selected documents were classified into three distinct categories.

The first category consists of documents that contain articles on the relevant keywords but where the legal provisions serve primarily as background or a passing reference rather than explicitly establishing a legal framework for digitalisation. For example, Directive (EU) 2022/2555 addresses "measures for a high common level of cybersecurity across the Union." In this directive, the terms digital and its related expressions, including digitalisation and digital transformation, appear 25 times. Recital 10 of this directive explicitly includes electricity generation facilities, even nuclear plants, highlighting the importance for the author to understand the legal

provisions concerning cybersecurity. However, as indicated by its title, this directive primarily focuses on the regulatory frameworks governing cybersecurity across various sectors, including electricity, without direct implications for shaping the electricity market or business models within it. While such regulatory packages do not directly address or facilitate digitalisation, they should be considered as part of the regulatory background in any analysis of the landscape for the development and growth of prosumers.

The second category comprises directives and regulations foundational to the design of the EU and Member States' electricity market, addressing critical aspects of market design, including digitalisation. An example is Directive 2019/944, which repealed the Electricity Directive in the Third Energy Package (Directive 2009/72/EC) and established rules for the internal electricity market. Recognised as one of the cornerstones of the EU electricity market regulatory framework, these directive and similar documents were examined to extract relevant legal provisions following the aforementioned procedures and then subjected to further analysis. Such regulations legally define major concepts and terms in the electricity market, such as prosumers, and also provide the legal framework for how these terms should be regulated.

Table 1. Classification of Primary Research Results - Legal Documents on Electricity Market and Digitalisation.

Category	Legal Act	Description
Background Legal Acts	Directive 2022/2557	On the resilience of critical entities
	Directive 2024/1788	Common rules for the internal markets for renewable gas, natural gas and hydrogen
	Regulation 2019/941	On risk-preparedness in the electricity sector
	Directive 2004/101/EC	Establishing a scheme for greenhouse gas emission allowance trading within the Community
	Directive 2022/2555	Measures for a high common level of cybersecurity across the Union
Electricity Market Fundamental Legal Acts	Regulation 2024/1735	Establishing a framework of measures for strengthening Europe's net-zero technology manufacturing ecosystem
	Regulation 2022/869	Trans-European Networks for Energy (TEN-E)
	Regulation 2021/523	Establishing the InvestEU Programme
	Regulation 2019/943	The internal market for electricity
	Regulation 2015/1017	European Fund for Strategic Investments
	Directive 2023/959	Establishing a system for greenhouse gas emission allowance trading within the Union
	Directive 2019/944	Common rules for the internal market for electricity
	Directive 2018/2001	The promotion of the use of energy from renewable sources (RED II)
	Directive 2023/2413	Promotion of energy from renewable sources, amending Directive (EU) 2018/2001, Regulation (EU) 2018/1999 and Directive 98/70/EC
	Directive 2024/1711	Improving the Union's electricity market design, amending Directives (EU) 2018/2001 and (EU) 2019/944.
	Regulation 2023/956	Establishing a carbon border adjustment mechanism
	Regulation 2019/942	ACER establishment
Regulation 2024/1747	Amending Regulations (EU) 2019/942 and (EU) 2019/943 as regards improving the Union's electricity market design	
RT I 2003, 25, 153	Estonian Electricity Market Act	
Network Codes and Guidelines	Regulation 2017/1485	Establishing a guideline on electricity transmission system operation
	Regulation 2017/2195	Establishing a guideline on electricity balancing
	Regulation 2017/2196	Establishing a network code on electricity emergency and restoration
	Regulation 2016/1719	Establishing a guideline on forward capacity allocation
	Regulation 2015/1222	Establishing a guideline on capacity allocation and congestion management
	Regulation 2016/1447	Establishing a network code on requirements for grid connection of high voltage direct current systems and direct current-connected power park modules
	Regulation 2016/631	Establishing a network code on requirements for grid connection of generators
	Regulation 2016/1388	Establishing a Network Code on Demand Connection

Finally, the third category includes network codes (technically, guidelines) that address technical matters within the electricity network. These are regulations that have been developed since 2015 and are largely procedural in nature, outlining terms and conditions that actors, such as Transmission System Operators (TSOs), are required to develop (Meeus, 2020, p. 8). Network codes and guidelines should also be considered as a complementary source of interpretation for the second category, depending on their application.

Discussion: Analysing the Estonian Electricity Market

Smart meters play a pivotal role in the digitalisation of electricity markets by enabling bidirectional data communication (Dąbrowski, 2022). They enable consumers to monitor and manage their energy consumption in detail, primarily through demand response—defined as “changes in electric demand by end-use customers from their normal consumption patterns in response to changes in the price of electricity over time, or to incentivise payments designed to reduce electricity use during periods of high wholesale market prices or when system reliability is jeopardised” (US Department of Energy, 2006). Moreover, once the smart infrastructure is fully developed, it enables bidirectional energy and data flow, allowing prosumers to exchange excess electricity through the network (Kabalci, 2016). This fosters new businesses within the electricity market, where prosumers and network operators can benefit. However, the full realisation of this goal remains contingent upon removing legal hurdles, including potential infringements of EU competition law, the lack of legal obligations for detailed data access, and legal issues related to data management, which will be addressed in the following sections.

Potential infringement of the EU competition law

The widespread deployment of smart meters, particularly in DR schemes, plays a pivotal role in enhancing grid stability. Smart meters provide network operators with a more comprehensive, accurate, and near real-time view of electricity consumption and generation patterns, enabling them to make more informed decisions for grid management (McKenna, Richardson, & Thomson, 2012). By facilitating continuous monitoring of energy flows, smart meters empower operators to detect fluctuations promptly, thereby supporting the grid’s resilience, especially during peak demand periods or unexpected supply shortfalls. However, the integration of renewable energy sources, such as solar and wind, adds complexity to this task. The inherent intermittency of renewables generates surplus electricity at unpredictable intervals, which must be actively managed by network operators to prevent grid instability (Dato, Durmaz, & Pommeret, 2020). Similarly, as prosumers contribute surplus energy to the grid, often in localised clusters, operators face the challenge of balancing these varied inputs. Effective management requires a sophisticated infrastructure capable of dynamic, responsive adjustments to grid loads, which necessitates both technological advancements and regulatory support (Meeus, 2020, p. 88). Additionally, accommodating the influx of prosumer-generated electricity into the grid places additional operational burdens on network operators, who must ensure that the system remains stable while accommodating fluctuating inputs from diverse sources. This burden increases significantly with the volume of renewable energy being introduced at multiple points across the network, requiring enhanced grid flexibility and real-time coordination capabilities (Diahovchenko, Kolcun, Čonka, Savkiv, & Mykhailyshyn, 2020).

Given such difficulties in network management, Article 15(f) of Directive 2019/944 (the Electricity Directive) requires active consumers to bear financial responsibility for the imbalances they cause in the electricity system. However, this provision can be discouraging for small residential prosumers. Regulation 2019/943 provides a derogation for power-generating facilities with an installed capacity of less than 400 kW, provided they generate electricity from renewable sources. This regulation allows such active consumers to sign a balance bid, shifting their imbalance responsibility to another market participant called a balance responsible party (BRP), which can be a TSO, a supplier, or an aggregator (Meeus, 2020, p. 88). In the Estonian electricity market, the TSO, Elering, has set a minimum threshold of 1 MW for balancing bids (Elering, 2018). This means that small and mid-size active consumers, who usually ask for less balancing volume, have to find another BRP as they are unable to engage in direct deals with their TSO. These prosumers include, in particular, residential electric heating, which is projected to contribute the majority of flexibility by 2030 (Armenteros, Heer, Fiorini, & Slot, 2022), and must therefore consider alternative options. Additionally, Article 44 of the Estonian Electricity Market Act requires those unable to bear imbalance responsibility to have a contract with the so-called open supplier (OS). Within § 3(1) of the same Act, open supply is “the sale to a market participant of the total amount of electricity needed by the market participant or, in order to ensure the balance of a market participant, the sale to the market participant of an amount of electricity that the participant lacks in a trading period or the purchase from the market participant of surplus amount of electricity during a trading period.” Therefore, an OS—acting as a BRP—ensures that shortfalls of electricity are covered, and excess electricity is purchased.

One can realise that this provisional requirement creates a *de facto* monopoly favouring Estonian suppliers and undermining the active consumers’ interest in demand response deals. This is mainly due to the lack of clarity regarding remuneration to open suppliers for their imbalance costs. Within the existing legal frameworks, electricity suppliers could claim that consumers’ reduced consumption through demand response has caused revenue losses. Consequently, suppliers may argue that they should forgo the benefits of demand response to the extent that they can potentially embed conditions within their supply contracts preventing consumers from entering into

agreements with independent aggregators under the pretext of compensating for alleged losses (Kukk, Meeliste, & Van Nuffel, 2023, pp. 8-10). Such a potential supplier-favoured monopoly acts against the development of the flexibility market, a business nested within the electricity market digitalisation.

Monopolies in the electricity market can also arise as an externality of digitalisation. Under Articles 101 and 102 of the Treaty on the Functioning of the European Union (TFEU), the EU's competition law aims to prevent monopoly positions that harm consumer interests, particularly by ensuring a market structure where multiple firms can compete on price and service quality (Keypour & Ahmadzade, 2022; Ellison & Harrison, 2021). However, achieving such a competitive landscape becomes increasingly complex in digital economies, where economies of scale, network effects, and data dependency significantly impact market dynamics (Crémer, De Montjoye, & Schweitzer, 2019). For instance, P2P electricity trading platforms facilitate direct exchanges between electricity producers and consumers, particularly prosumers. These platforms create substantial economies of scale, as their cost of service provision decreases significantly with an increase in user numbers. This is mainly because, as platforms grow, network externalities make them even more attractive to users, thus consolidating incumbents' market positions. This consolidation poses a barrier to new entrants and inhibits traditional forms of competition, where a large number of firms can co-exist and compete. Consequently, this monopolistic dynamic—driven by user dependency on existing networks and a lack of platform interoperability—creates "incumbency advantages" for dominant players, challenging the open-market principles established by Articles 101 and 102 TFEU (Crémer, De Montjoye, & Schweitzer, 2019).

Moreover, aggregator platforms, which coordinate distributed energy resources (DERs) and demand response within the grid, further demonstrate how digitalisation can foster monopolistic externalities. These platforms often connect multiple stakeholders—such as consumers, grid operators, and DER providers—into two-sided markets. One can expect that the credibility of an aggregator increases with user base growth, like any other digital platform, especially as they leverage big data and AI tools to improve operational efficiencies and predict user demand patterns (Crémer, De Montjoye, & Schweitzer, 2019). This process of data accumulation could arguably result in a feedback loop where early-established aggregators continuously strengthen their market position by providing more accurate services based on proprietary data, thereby deterring new entrants who lack similar data resources. Such dynamics risk monopolising control over grid services and reduce the potential for new aggregators to emerge and compete effectively. This can become a major concern especially in smaller markets like Estonia, where only three aggregators currently operate (Elering, 2022).

The implications of these network effects and data monopolies extend beyond market concentration. For one, platforms incentivise user retention by offering free or discounted access, creating a barrier for new aggregators who may lack the data resources to compete on comparable terms. As a result, consumers are less likely to share their data across multiple platforms due to privacy concerns, thereby further entrenching the positions of incumbent aggregators. In this context, platforms could exploit their market dominance to offer exclusivity deals or restrict multi-homing options, limiting users' freedom to choose between competing services. This scenario aligns with the theory of platform economics, where the combination of increasing returns to scale, network externalities, and data dependency inherently drives market consolidation (Fouladi Moghaddam, 2024).

In response to these challenges, the EU's existing competition framework—primarily designed for traditional industries without significant network effects or data-driven externalities—may require adaptation. Regulators must consider new guidelines tailored to digital platform markets, potentially introducing data-sharing mandates or enforcing interoperability requirements to counteract monopolistic tendencies (Weyl & White, 2014). Such measures could address the complexities of digitalisation in the energy sector and uphold the competition principles enshrined in the TFEU. Without these adjustments, digital platforms in the electricity market risk distorting competition, impeding the development of a flexible and open energy market in Europe.

Lack of legal obligations for detailed data access

A high roll-out rate of smart meters is crucial for increasing prosumer participation in the electricity market, but it is not sufficient. Smart meters should share data at an appropriate frequency (e.g., hourly or 15-minute intervals) and with sufficient granularity (reflecting individual consumption, not aggregated data from multi-unit consumers) (Huang & Zhu, 2016; Feuerriegel, Bodenbenner, & Neumann, 2016). Despite the mandate for smart meters in the Grid Network Code and the high adoption rate among Estonian household consumers (99.8%), many residential and commercial energy consumers still face practical limitations. These arise from the absence of their own grid connection agreement, as they rely on a 'master' connection agreement held by another consumer (Konkurentsiamet, 2022, p. 78). This situation is particularly common in old residential buildings with separate apartment units in Estonia, large supermarkets, and shopping centres with multiple shops. As a result, individual electrical devices, such as large boilers, which require separate meters to share consumption data and improve demand management, are unable to fulfil this role. Given that no regulations make it compulsory to have separate "metering points" for each consumer, it has been suggested to include corresponding legal provisions within the Network Code for Demand Response (ENTSO-E, 2023). Under the current definition of 'locational information,' the accounting point is referenced but not defined.

The accuracy of the shared data can be discussed from the time interval perspective, i.e., its frequency. Although Regulation (EU) 2017/2195 mandates network operators to transition to 15-minute remote reading at all metering points by 1 January 2031, the current Estonian Network rules for the operation of the electrical system specify and obliges that remote reading devices must transmit measurement data to the network operator only once a day in each trading period via the data communication network (Kukk, Meeliste, & Van Nuffel, 2023). This delay impedes consumers' ability to respond promptly to intra-day price fluctuations. As a result, they are constrained to pay fixed day-ahead prices to their suppliers or BRPs. Consequently, this mismatch between the timing of data availability and pricing mechanisms leads to a reluctance among consumers to engage in intra-day and balancing markets, as they cannot take advantage of the more granular and potentially beneficial pricing information that would otherwise be available (Kukk, Meeliste, & Van Nuffel, 2023). This indicates a need for greater adoption to align with the EU regulation, especially because providing data at 15-minute intervals is crucial for prosumers and aggregators to fully leverage dynamic intra-day pricing.

Legal Hurdles of Data Management

As smart meters gather granular, real-time consumption data from households, they generate extensive insights that could reveal much about consumers' behaviours and routines. For example, usage patterns can reveal when a home is occupied, the types of devices in use, and even specific routines within the household. Such data can pose privacy risks if re-identified or mishandled by third parties involved in data processing. Research indicates that as the granularity of consumer usage data increases—a necessary step for improving demand response services, as discussed previously—consumer data privacy becomes increasingly vulnerable (Eibl & Engel, 2015). This underscores the urgent need for robust regulatory frameworks to rigorously protect and ensure consumer privacy.

Article 23(3) of the Electricity Directive stipulates that rules and data storage for the Directive must comply with relevant EU directives, explicitly highlighting the necessity of data processing in accordance with Regulation (EU) 2016/679 on General Data Protection (GDPR). Under the GDPR, prosumers in private households are classified as "data subjects," and any information processed by smart meters that can identify a natural person falls under the category of "personal data." The GDPR imposes stringent conditions for processing personal data, requiring explicit consent from the data subject and adherence to principles outlined in Article 5 of the GDPR. The GDPR makes a distinction between data controllers and data processors: Article 4(7) defines a data controller as a "natural or legal person, public authority, agency, or other body which, alone or jointly with others, determines the purposes and means of the processing of personal data." Meanwhile, a data processor is defined as a "natural or legal person, public authority, agency, or other body which processes personal data on behalf of the controller," according to Article 4(8). Controllers and processors have distinct obligations, which are further detailed in Articles 24–43 (Antonov, et al., 2021).

To fulfil these obligations, Elering developed a data hub, Estfeed, which anonymises consumers' data to facilitate data exchange among market participants, including charging point operators, aggregators, balance providers, and network operators. This data hub aims to restrict data access based on each actor's role (Elering, 2022). However, the diverse nature of actors and their roles in the smart grid system complicates the identification of data controllers and processors. Additionally, the management of Estfeed by a single operator, Elering, who both defines the terms of data access and stores data for 12 years, has made the case more complex in Estonia. A brief field study conducted as part of this research has not indicated any serious conflicts of interest arising from Elering's overlap of these two roles. However, because the terms and conditions governing data access are defined by a single dominant actor who is also the Estonian TSO, future conflicts of interest may arise among market participants—especially if demand response becomes more prevalent. Such a development could lead consumers to have serious concerns regarding the security and privacy of their data, which should be addressed within data management regulations to prevent such risks.

Conclusion

Given the dynamics of transition delineated by the Multi-Level Perspective (MLP) model, legal and regulatory revisions are essential for promoting the application of new technologies and the growth of related markets in the transition era. This study critically analysed the laws and regulations governing the Estonian electricity market, aiming to identify the necessary modifications or additions to support the expansion of digitalisation and related businesses in Estonia, particularly in light of the country's prominent role in the global digitalisation movement.

The research focused on the significance of smart meters in demand response and the trading of surplus electricity in the exchange market generated by prosumers. The findings warned of the formation of monopolies in flexibility balance bids due to the contractual frameworks provided by the Estonian TSO and suppliers, which could potentially force prosumers to overlook bidding with aggregators. Therefore, it is recommended to review the conditions of the bids to prohibit the imposition of restrictions in the contracts that limit the freedom of choice for prosumers in balancing. Additionally, during the digitalisation process, the concentration of data within a few specific aggregators could generate externalities that conflict with EU competition laws, thereby impeding the entry

of new aggregators into the demand response market. Legal provisions are essential for enabling data access for aggregators, safeguarding privacy, and fostering competition to benefit consumers.

Furthermore, the results of this study indicate that, despite existing legal provisions for accessing and sharing consumption data, additional legal measures are needed to establish obligations for the creation and timely sharing of individual consumer consumption data. It would also be beneficial to introduce a definition for 'accounting point', addressing scenarios where the accounting point may not correspond to the connection point on the public grid. Legislation should also mandate the installation of smart meters at appropriate intervals for all consumers, ensuring that each consumer has an accounting point. Finally, consumers should be permitted to install metering devices for individual appliances and share the resulting data to facilitate active participation, with the validity of such data being recognised by relevant regulations.

A review of the GDPR in the context of electricity market digitalisation and smart meter deployment reveals that Article 22 of the GDPR mandates measures to allow data subjects to intervene in automated decision-making processes, which is particularly relevant in the context of smart meters. Ensuring accountability for GDPR breaches, such as erroneous billing or privacy infringements, requires clear identification of operators and processors. This underscores the crucial role of national supervisory authorities in enforcing legal responsibilities within the smart grid framework, as outlined in Member States' legal provisions, such as the Estonian Electricity Market Act. This implies that relevant regulations and protocols for the data hub need to be transparent, for example, through the separation of the controller and processor roles. Such an aim can be achieved if the national regulatory authority or another independent body assumes the role of the controller.

This study has highlighted how the digitalisation of the electricity market within the EU presents substantial potential for enhancing efficiency, reducing costs, and fostering innovative business models. However, this transformation is accompanied by significant challenges, particularly concerning legal and regulatory governance. While this paper has examined specific legal aspects of digitalisation, further research is essential to illuminate the complexities that remain.

A primary legal challenge in the digitalisation of energy markets is the governance of data. Developing data frameworks that are FAIR (Findable, Accessible, Interoperable, and Reusable) is crucial to promoting innovation and collaboration across the sector (Judson, Soutar, & Mitchell, 2020). While this study has addressed certain facets of data governance, it has not fully explored the legal codes and licenses that inhibit open data exchange. Future research should investigate legal reforms and the creation of new governance models that facilitate more open and flexible data-sharing environments, while also balancing privacy and security concerns.

Additionally, this research did not delve deeply into aspects of digitalisation that may not be as pressing in smaller states such as Estonia but may be more relevant in larger EU Member States. These include distributional challenges requiring legal and policy interventions in larger states, such as the uneven distribution of digital skills and access, particularly among older and rural populations, which may exacerbate existing inequalities. Current market dynamics might result in uneven innovation outcomes, where only the most lucrative segments benefit from personalised energy services, potentially disadvantaging vulnerable groups (Judson, Soutar, & Mitchell, 2020). Future research should explore legal frameworks and policy measures to ensure equitable access to digital energy services and technologies, addressing both financial inequalities and gaps in digital capability.

Furthermore, this study has only touched on the legal aspects of cybersecurity in the context of digitalisation. Broader challenges warrant further investigation. As digitalisation advances, the exposure of both physical and digital critical infrastructures (CIs) to cyber risks increases, revealing significant gaps in the existing cybersecurity regulatory framework (Markopoulou, 2023). The inclusion of smart meters and other Internet of Things (IoT) devices in cybersecurity measures remains insufficient, despite their critical role in energy systems. Current regulations under Directive (EU) 2022/2555 and the Directive on the resilience of critical entities do not adequately address these components, highlighting the need for a more comprehensive legislative approach that incorporates cybersecurity by design and privacy by default for smart metering systems (Markopoulou, 2023). Ensuring a secure cyberspace for digitalisation is crucial, and the electricity market is no exception. Therefore, future research should assess the adequacy of current legislation and propose amendments to ensure that digital energy infrastructures remain resilient against evolving cyber threats.

In conclusion, the digitalisation of the European electricity market offers both significant opportunities and substantial challenges. Addressing the identified legal and regulatory issues requires an interdisciplinary approach that integrates insights from law, policy, and technology. Future research should focus on developing flexible governance frameworks capable of adapting to the dynamic nature of digital markets, ensuring that the benefits of digitalisation are equitably distributed across all sectors of society.

Acknowledgement

The author acknowledges the support provided by the Chancellery of the Riigikogu (Foresight Centre) for this study. Special thanks are extended to Märt Masso for his support and constructive comments during the

implementation of the project and subsequent debates. Additionally, the author is grateful to Kalle Kukk for providing additional analysis and information, whose insights significantly enriched this research.

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