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Published in:
Energy Policy

DOI:
10.1016/j.enpol.2019.01.047

Published: 01/05/2019

Document Version
Publisher's PDF, also known as Version of record

Please cite the original version:
Sunila, K., Bergaentzlé, C., Martin, B., & Ekroos, A. (2019). A supra-national TSO to enhance offshore wind power development in the Baltic Sea? A legal and regulatory analysis. Energy Policy, 128, 775-782. https://doi.org/10.1016/j.enpol.2019.01.047

Energy Policy 128 (2019) 775–782

Contents lists available at ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

A supra-national TSO to enhance offshore wind power development in the Baltic Sea? A legal and regulatory analysis

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ARTICLE INFO

Keywords:
Meshed offshore grid
Supra-national TSO
Electricity market legislation
Network regulation
Offshore wind power

ABSTRACT

Offshore wind power development is expected to play an important role in meeting the EU climate targets. To integrate offshore wind power, advanced offshore infrastructures such as meshed grids are suggested to optimise the grid development. Meshed offshore grids refer to integrated offshore infrastructure where offshore wind power hubs are interconnected to several countries as opposed to radial connection linking the wind farm to one single country and market. However, development of meshed architectures is hindered by the legal and regulatory barriers.

Earlier research has identified the lack of cooperation and misalignments in national legal and regulatory frameworks as being the main risk factors in integrated offshore network investments. The purpose of this article is to investigate whether a supra-national TSO could facilitate regional cooperation and coordinated investments to develop meshed offshore grids.

Several studies have discussed the case of North Seas, but the Baltic Sea region has had less attention despite the large offshore wind development potential. In this paper, a multi-disciplinary approach combining legal dogmatics and regulatory economics is used to identify the existing barriers and the possible solutions. The Baltic Sea countries are used as illustration. We suggest legal and regulatory recommendations that comply with the EU energy policy targets of sustainability, competition and reliability.

1. Introduction

In November 2016, the Paris Agreement came into force committing the parties of the Treaty to hold the increase in the global average temperature to well below 2 °C above pre-industrial levels (Art. 2). Both the European Union (EU) and its Member States have ratified the Treaty. To contribute to the global climate change mitigation and to enable shift to a low-carbon economy, the EU has set its internal climate targets for the years 2020, 2030 and 2050 (COM, 2010 0639; COM, 2010/0639; COM, 2014 15; COM, 2011 885). Updates to 2030 targets are made in the context of Clean Energy Package[1] (European Commission, 2018), and with regard to 2050, the European Commission strives now for more ambitious targets (COM, 2018 773).

The commitments to address climate change and the ongoing energy transition have urged new perspectives to be adopted in energy law research (Heffron and Talus, 2016a). While guaranteeing of security of supply and establishing of competitive markets have been key objectives in energy law already for decades, the sustainability as a part of a larger concept of energy justice has relatively recently begun togain more attention in energy law research (Heffron and Talus, 2016b). As the premises for legal frameworks (energy systems themselves) are changing due to the ongoing energy transition, the core questions of energy law research are changing, too.

During the past few years, there has been growing interest towards theoretical aspects of energy law to define this reshaping field and its legal principles (Heffron et al., 2018). Specifically, the concepts of energy justice and just transition in law – like in other disciplines – has received substantial attention (Heffron and McCauley, 2017; Heffron and Talus, 2016b). In the Clean Energy Package, 'just transition' seems to already become part of the binding law, where it refers to transition

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[1] Clean Energy Package refers to the package of legislative proposals the European Commission gave in November 2016. At the time of writing, all the legislative acts have not been finalised.

https://doi.org/10.1016/j.enpol.2019.01.047
Received 30 April 2018; Received in revised form 15 January 2019; Accepted 18 January 2019

away from fossil-fuel generation towards clean energy system.[2]

Offshore wind power (OW) is considered as one of the key enablers of the transition to clean energy system (IEA, 2016). It has been argued that OW integration could be facilitated by integrated infrastructures such as meshed offshore grids (MOG) (Konstantelos et al., 2017; Cole et al., 2015; De Decker and Kreutzkamp, 2011; Gorenstein Dedecca et al., 2017). A MOG refers to an integrated offshore infrastructure by which OW hubs are interconnected to several countries as opposed to radial connections which link the wind farm traditionally to one single country and market (European Commission, 2016a). MOG consist consequently in hybrid infrastructure, characterised by its dual-purpose (wind power integration and interconnection) and multi-lateral (more than two stakeholders and countries involved) dimensions. This article studies the current legal and regulatory barriers for MOGs as a way to optimise investment in offshore network infrastructure and speed-up OW integration and interconnections across countries.

The article investigates whether introducing of a new kind of transmission system operator (TSO), namely a "supra-national offshore TSO", would be a solution to overcome the identified barriers to MOG development. A multidisciplinary approach combining legal dogmatics and regulatory economics analysis is used to explore the barriers for developing MOG, focusing especially on the financing and cost recovery of the offshore network, and for analysing the potential of the new supra-national offshore TSO. In contrast to most of the earlier research, the article illustrates national regulatory barriers with the Baltic Sea countries.

The article is structured as follows. Section 2 gives background to the research. Section 3 assesses the relevant legal framework by discussing the questions related to the applicable jurisdiction and the challenges associated with the definitions of dual-purpose cables. Section 4 identifies the main barriers arising from the application of multiple regulatory frameworks for grid investments using the BSR countries as a test case. In Section 5, a supra-national offshore TSO is defined and reviewed as a potential solution to overcome the current legal and regulatory barriers. Section 6 concludes.

2. Meshed offshore grids to reach decarbonised integrated markets

In Europe, 25 GW of cumulated offshore wind power (OW) capacity is expected to be connected to European grids by 2020 (Schwabe et al., 2011) compared to the installed capacity of 15.8 GW in 2017 (WindEurope, 2017). This trend is anticipated to grow, supported by technology improvements in HVDC lines and dramatic cost reductions in wind turbine manufacturing (Danish Energy Agency, 2017), which both create opportunities for offshore wind energy to develop farther away from shores. However, OW integration is challenged by the difficulties arising from the grid planning and the large investment needed to build the infrastructure and the sharing of this burden among multiple stakeholders.

Hybrid offshore infrastructure projects have recently received growing attention. In 2010, ten North Seas countries signed a Memorandum of Understanding launching a North Seas Grid Initiative that aims at becoming one of the building blocks of future European super grid. Also in the North Sea, the Danish and Dutch TSOs, plan to build a power island connecting 30 GW of wind energy for an estimated cost of EUR 15 billion (Energinet.dk, 2017a). In the Baltic Sea, the Kriegers Flak Combined Grid Solution linking Denmark, Germany, and initially Sweden, is actually the first project combining OW connection to cross-border lines to be developed (Energinet.dk, 2017b). Lately, PSE S.A, the Polish TSO, announced a hybrid solution will be considered if OW capacity development is higher than the 4 GW currently planned in the Polish network development plan (Wieczerzak-Krusińska, 2018).

The main economic argument for MOG development is to increase the value of both the interconnector and the offshore wind farms (OWF) by taking advantage of synergy effects, provided that a critical mass of OWF is planned to be connected (De Decker and Kreutzkamp, 2011). Integrated architectures can also significantly reduce the cost to upgrade onshore networks and help to reach a better utilisation factor of the offshore grid. In the Kriegers Flak Combined Grid Solution project, the feasibility assessment showed an increase in the use of the cable from 36% up to 79% (50Hertz et al., 2010). Positive externalities associated with the increase of interconnection capacities are also expected in terms of CO_2 emissions reductions, faster energy transition, stronger price convergences across markets, and increase of welfare across connected countries attributable to the expansion of interconnections.

However, the development of hybrid infrastructure is challenged by the limited degree of coordination in the planning and funding of network infrastructure and opens new questions on grid operation, as pinpointed by the European Commission in the North Sea case (European Commission, 2016a). Institutionally, the lack of mandatory integrated offshore grid planning and dedicated governance bodies have important repercussions on future integrated offshore projects (Gorenstein Dedecca et al., 2017). In addition, the current electricity market rules, both at EU and national level, are not planned to take into account the specificities of hybrid grids. As there is currently a lack of legal definition for MOG, applicable rules are not clear and even the question of applicable jurisdiction rises (Roeben, 2013; Woolley, 2013; Müller, 2015). Notably, the questions relating to how the MOG should be developed and operated, whether the access to grid can be guaranteed for the connected OW (capacity allocation) (Nieuwenhout, 2018) and how the costs should be allocated between different grid users (Tscherning, 2011) rise. Another explanatory reason lies in the different national legal and regulatory frameworks applied to electricity networks development and that result in fragmented investment signals and uneven financial risks (Jay and Toonen, 2015; Knudsen et al., 2015; Fitch-Roy, 2016; Gorenstein Dedecca et al., 2017).

3. In search of jurisdiction and legal definitions

In the legal research, the question of the applicable jurisdiction is usually the first to address, because it determines which rules apply and how a certain project is regulated. If the applicable rules are not clear, the developer may have difficulties to assess the profitability of the project – especially when it comes to regulated activities like the transmission system development and operation.

3.1. Question of applicable jurisdiction

The offshore wind farms and part of the offshore infrastructure in the meshed grid configuration may locate in the Exclusive Economic Zone (EEZ) of a coastal country, which is an important factor when considering the relevant jurisdiction. In the EEZ, the coastal state does not have full sovereignty contrary to territorial waters, but the national jurisdiction can be declared to partly apply. In accordance with the international law of sea, namely United Nations Convention on the Law of Sea (UNCLOS, 1982), the coastal states have sovereign right for economic exploitation of the EEZ, including wind power production and construction of the needed installations (like substations) (UNCLOS Art. 56). However, the right of other states to lay cables in the EEZ is also guaranteed by the UNCLOS if the cables do not relate to the economic activity in the EEZ (UNCLOS, Art. 58; 79 and 87). Thus, interconnectors passing the EEZ can be laid down without consent of the coastal state, with some limited exceptions, whereas the park-to-shore cables may need this consent. Therefore, the national jurisdiction can become differently applied to interconnectors not relating to the

[2] "Just" also includes that economic and social aspects are taken into account when implementing transition. The final formulation of the recast Electricity Market Regulation is not available at the time of writing.

economic activity and park-to-shore cables relating to economic activities (Roggenkamp et al., 2010; Barnes, 2014).

In the light of earlier studies, it seems to be clear that EU law can be applied in the EEZ as long as the Member State has jurisdiction (Roeben, 2013; Talus and Wüstenberg, 2017). Even though the EU does not have jurisdiction independently from its Member States, for example, the directly applicable EU Regulations may become applicable also in the EEZ. In the earlier studies it has been discussed whether the EU or its Member States have powers at all to regulate offshore interconnectors (not relating to economic activities) in the EEZ. However, in practice, the national and EU law is currently applied to offshore interconnectors inside the EU internal market (Müller, 2015; Nieuwenhout, 2018). When considering wind power generation in the EEZ, the coastal state's and EU jurisdiction is even clearer. In addition to the fact that all the coastal European states in the Baltic Sea are EU Member States, this gives us groundings to take the EU law, which has widely affected the national legal regimes, as a starting point.[3]

3.2. A meshed offshore grid in legal terms

Following the terminology of the Electricity Market Directive (Directive 2009/72/EC) and Regulation (EC) No 714/2009, MOGs consist potentially of cross-border 'interconnectors' pursuant to the Electricity Market Regulation, and of park-to-shore cables which are not separately defined in the EU law. In addition, the cables may function simultaneously in both purposes (cross-border interconnectors and OWF connection cables). These dual-purpose cables are currently unknown in the EU electricity market legislation (Müller, 2017; Nieuwenhout, 2018). It can be noted that in the preamble of Commission Regulation (EU) 2016/1447 establishing a network code on requirements for grid connection of high voltage direct current systems and direct current-connected power park modules, the concept of meshed offshore grid is recognised, however, the Regulation does not establish a definition for the grid.

The classification of the cables importantly affects the applicable rules. Regarding interconnectors, the requirements of unbundling, non-discriminatory third-party access, *ex ante* approved terms of access to interconnectors and capacity allocation mechanisms, and tariffs, as well as the regulated use of the congestion incomes become applicable unless an exemption under the Electricity Market Regulation (EC) No 714/2009, Art. 17, is granted. The unbundling requirement for interconnector operators practically means that a new interconnector (or a transmission system) should be operated by an unbundled TSO, or two TSOs, which blocks the solution that a wind power operator would operate the offshore grid. As in part of the Member States such as Finland, Sweden and Poland, connection cables are the responsibility of OWF, there would potentially be several responsible actors for offshore grid infrastructure in the meshed grid.

Despite the involvement of several stakeholders, the national TSOs are the key actors in the MOG development, as they have the responsibility to develop the transmission systems and interconnections to other systems under the current legal frameworks (Directive 2009/72/EC, Art. 12). Therefore, the legal regime directing the investments of TSOs is studied in the following section.

[3] It should be noted that in the context of Clean Energy Package, for example, Electricity Market Directive (Directive 2009/72/EC), Electricity Market Regulation (EC) No 714/2009 and Renewable Energy Directive (Directive 2009/28/EC) are revised. The new RES Directive has been published at the time of writing whereas the final wordings of the other two are not available. The following discussion is based on the Third Energy Package, which forms the basis for the current national legal frameworks.

4. From European legislation to national implementation

4.1. Overview of the legal framework for transmission and interconnection investment in Europe

In the context of integrated MOG, grid planning and investment activities are coordinated among various stakeholders through signals that are formed in national regulatory frameworks. From an economic perspective, the diverse national regulatory frameworks applying to grid access tariffs, cross-border management and connection costs allocation have the potential to jeopardise MOG development.

In the EU, the legal regime for transmission tariffs is currently laid down in the Electricity Market Directive (2009/72/EC), and further elaborated by the Electricity Market Regulation (EC) No 714/2009. Accordingly, the transmission grid tariffs must be transparent, non-discriminatory, cost-reflective (Directive 2009/72/EC, Art. 32), and should not be distance-related (Regulation 714/2009, Art. 14).

Further rules, specific to interconnectors, are provided in the Regulation (EC) No 714/2009 setting the harmonised principles for capacity allocation across borders, congestion revenues, and the use of these revenues. According to the Regulation, the congestion revenues should be used for "guaranteeing the actual availability of the allocated capacity and/or maintaining or increasing interconnection capacities through network investments, in particular in new interconnectors". However, if the revenues cannot be efficiently used for these purposes, the national regulatory authorities (NRAs) can decide that part of the congestion rents is used to reduce national tariffs. The rest of the revenues shall be placed on a separate account to wait for the possible use (Regulation 714/2009, Art. 16(6)). Pursuant to the Regulation, there should be no specific network charges for the access to cross-border infrastructure inside the EU. Together, these prohibitions to apply a separate tariff in interconnectors and to use the congestion revenues to other purposes than the ones set out in the Regulation cause a situation where other actors than TSOs do not have incentives to develop offshore grids, unless a 'merchant exemption' pursuant to Regulation (Art. 17) is granted. Other costs resulting from cross-border flows and losses that are inherent to the trading of electricity across borders are covered with the inter-TSO compensation (ITC) mechanism, as stipulated in Regulation 714/2009, Art. 13, and the Commission Regulation (EU) No 838/2010.

Finally, the RES Directive (Directive 2009/28/EC) lays down the rules regarding the transmission network investments and connection cost allocation in the case of renewable power generation units.[4] The sharing of costs should also be based on objective, transparent and non-discriminatory criteria. In accordance with the Directive, Member States may require TSOs to bear the costs of technical adaptations in the network fully or partly, but there is no requirement for any special treatment of renewable power generation units compared to other units (Art. 16(4)).

4.2. Identifying the barriers to coordinated investment in integrated offshore grids

The EU-level legal framework for transmission tariffs, congestion management and connection cost allocation leaves the Member States, or NRAs, with a certain degree of freedom in implementation (Vedder et al., 2016). This has resulted in a diversity of rules and incentive instruments for network use and development that reflects the plurality of

[4] New RES Directive (Directive (EU) 2018/2001) was enacted as part of the Clean Energy Package, and the Directive 2009/28/EC will be repealed with effect from July 2021. The discussed rules are transferred to the Electricity Market Directive and Regulation of which final versions are not available at the time of writing (recital 60). As the current national rules are based on the Directive 2009/28/EC, it is used here as a basis for the discussion.

energy policies and national interests (PwC et al., 2016; NSCOGI, 2012b; NSCOGI, 2014; Bhagwat et al., 2017). The prevalence of national interest may ultimately have distorting effects when it comes to investment decisions of both market and regulated actors. It may also damage coordination in trans-national projects.

4.2.1. National grid access tariffs: a risk of market distortions

Currently, a patchwork of different grid access tariffs exist in Europe, reflecting often more political decisions than the real cost distribution of utilities (Honkapuro and Tuunanen, 2012; Eurelectric, 2016), The coexistence of multiple grid access tariffs at the European level has received attention when discussing about the completion of the internal electricity market and the energy transition (CEPA, 2015). In a context of MOG, this topic becomes critical since different grid access conditions apply to a same infrastructure.

In the Baltic Sea countries, grid access tariffs differ quite substantially both in relation to whom they apply and in terms of their design. Only Denmark, Sweden and Finland apply an access fee to generators (ENTSO-E, 2017). The Danish tariff is entirely based on a per unit fee for the energy fed in the network. In Finland and Sweden, a capacity component is in addition paid. In Sweden, this fixed charge is dominant and a locational signal is added to the tariff to drive grid connection to the less constrained lines.

The tariff design affects generators' competitiveness on the market (Vedder et al., 2016). While the energy-based tariff adds a cost that is proportional to the level of production, a capacity-based tariff may be detrimental to generators with low load factor when competing with other power plants, notably producing in baseload. Because the tariff paid by OW operators is ultimately reflected in their bidding strategy, the juxtaposition of different tariffs in an MOG context raise a particular interest because it affects unevenly the business case of generators and send contradictory signals. This is quite clear if an arbitrage must be made between connecting to an infrastructure with grid access fee, or free of charge. Besides, the co-existence of different tariff structures increases investor's perceptions of risk (EWEA, 2016). This gives space to consideration on where to connect – and locate – OWF, supposedly at the expense of economic and environmental optimum.

4.2.2. National interests, congestion rents and investment coordination

Congestion rents reflect the price differential between two market zones when the transmission capacity connecting the zones is scarce. The level of the rent gives the signal that further capacity investment is needed, which will in turn contribute to equalisation of average electricity prices in the neighbouring markets. The economic principle, also basis for the Regulation (EC) No 714/2009 (Art 16(6)), states congestion rents should primarily be utilised to expand cross-border interconnection capacities. However, it is usual that part or all of the rent is allocated to serve other policies, mostly, at maintaining domestic tariffs low for the grid users.

Between 2011 and 2015, only Finland, Poland Latvia and Lithuania used in average more than 90% of their congestion rents to increase their interconnection capacities or saved it for future investment, while Denmark and Germany used more than half of their congestion rent to lower domestic tariffs (European Commission, 2017). Another reason for the sub-optimal allocation of congestion rents is the expected welfare loss resulting from increased interconnection capacities between two market zones showing substantial price differential. In this case, an increase of the average spot price will occur in the country with the initial lowest average price and inversely.

Both examples show how national interests can affect trans-national network projects and depart from the economic optimum. Several works using game theory represent national interest preferences in transmission infrastructure development scenarios. They all demonstrate the non-cooperative situations result in significant welfare losses as compared to system-optimal investment and argue for increased centralisation (Buijs et al., 2010; Huppmann and Egerer, 2015; Tangerås, 2012; Daxhelet and Smeers, 2007). Empirical evidence on how national preferences may drive national TSOs' actions, sometimes at the expense of neighbouring countries, have notably been developed by Tangerås (2012). At the regional level, the different treatment of congestion revenue and the interference of other targets with transmission grid development contradict with a clear, economic-based and harmonised signal for future common trans-national networks.

4.2.3. Cost allocation methods for connection and uneven investment risks

Finally, the rules for the distribution of OW connection costs between the TSO and the OW developer is a critical factor for OW integration, as the OW connection costs are significantly higher than for other renewable energies due to their resource-dependency (Weißensteiner et al., 2011). The cost distribution regimes are commonly described as super shallow; shallow or deep connection (González and Lacal-Arántegui, 2016). In a super-shallow approach, the TSO bears the entire cost to build the submarine cable until the point of connection at the offshore substation. The shallow approach means the OW developer bears the grid cost associated to building the new line, whereas the deep approach refers to the situation where the OW developer bears all the network costs including the construction of the line and the potential reinforcement of onshore networks. Both approaches give a locational signal in linking the generator's connection cost to the physical expansion cost of the network, thereby driving cost efficiency on a system perspective, but also creating significant system access difficulties for resource-dependent power plants such as OWFs (Swider et al., 2008).

In the Baltic Sea countries, all three approaches are applied. The three Baltic countries and Sweden use a deep connection approach to connect their OWF. A shallow cost distribution approach is used in Finland, Poland and in near-shore and open door projects in Denmark. A super shallow approach is used in Denmark in recent far-from-shore projects such as Kriegers Flak Combined Grid Solution (Baltic Sea) and Horns Rev 3 (North Sea). Also the new German legal framework for the tendering of offshore wind capacity in the EEZ applies super shallow approach.

In MOG, the connection rules become more critical, both in relation to the signal that is sent to market and regulated actors (level of financial risk) and regarding the homogeneity of this signal on the same infrastructure. The situation where different approaches coexist creates a complex and heterogeneous environment for joint investments. It conducts to an uneven level playing field among the TSOs, which are expected to coordinate their efforts, and generates further distortions among market actors with similar impacts as in the case of diverse grid tariffs.

The entanglement of national interests on top of this investment landscape ultimately adds another layer of difficulty in the development of MOG. Despite the recent efforts towards more converged tariffs, for example in the context of Clean Energy Package (European Commission, 2016b), it is unlikely that the national legal and regulatory regimes would become fully harmonised in the near future (Vedder et al., 2016). Thereby other solutions to enable MOG development should be studied.

The discussion on cost allocation more generally opens the debate on how to efficiently share the infrastructure burden among the TSOs. The economics viewpoint advocates that investment should be proportionate to the effective benefits expected from the infrastructure. A cost (or benefit)-reflectiveness criteria is however uneasy to capture (Reneses et al., 2013). In that respect, the cross-border cost-benefit allocation (CBCA) methodology developed by the ENTSO-E under the Regulation (EU) No 347/2013 (Art. 11) to apportion costs in projects of common interest consists of a possible line of approach in a MOG grid context since it captures multilateral investment constraints and accounts for externalities. Nevertheless, a simple harmonisation and generalization of CBCA methodologies such as advocated in (Bhagwat et al., 2017) seems not to be sufficient to fully address the funding constraint associated with MOG, unless a strong legal framework and appropriate cooperation structures are implemented (Tscherning, 2011).

4.3. Towards more centralised coordination?

Past research demonstrates a high level of cooperation is needed between TSOs to reach efficient regional network development, and argue for the implementation of new frameworks for the planning, development and cross-border cost allocation (Buijs et al., 2010; Huppmann and Egerer, 2015; Tangerås, 2012; Daxhelet and Smeers, 2007).

Some propositions have earlier been made regarding possible new actors to be responsible for the projects with multi-national scope and inside the European legal regime. A regional independent system operator (Konstantelos, Moreno et al., 2017) and cooperation of national TSOs established by an international treaty (Müller, 2015) have been suggested to organise the development and operation of a meshed grid in a more efficient way. NSCOGI (2012a) considered the option of implementing a supra-national TSO in the North Sea but rejected it because it was not considered credible due to its impact on Member States' sovereignty.

Nevertheless, past research has defended the concept of a regional TSO in Europe to overcome the problem of diverging national interests and facilitate coordination. Moselle (2008) suggests the establishment of a new regional TSO with evolving responsibilities; starting with the coordination of short-term regional operation and extending gradually its responsibilities to investment planning. In Kapff and Pelkmans (2010), a centralised European TSO organisation entrusted with a competence to make binding European network and investment plans (in opposition to the current non-binding ten-year network development plan) and monitored by a strong, European regulatory body have been proposed. Kapff and Pelkmans (2010) also argue for the introduction of a compensation mechanism fed by the congestion rents that would address the investment challenge in trans-national projects. Some stand-alone initiatives also step in a similar direction. The Nordic TSOs have in the past used congestion income to fund prioritised investments in the Nordic grid (NORDREG, 2007), but such decisions remain anecdotal. At the EU level, it remains to be seen what affect the rules revised in the context Clean Energy Package will have. Still, full coordination in large, integrated offshore grid projects requires Member States to renounce part of their sovereignty, which can also become a wider trend when creating a functioning internal energy market and the EU Energy Union (Heffron and Cameron, 2016).

5. A supra-national offshore TSO as a possible solution to enhance meshed offshore grid development

Under the current legal frameworks in the BSR, there could be several operators and developers of the different parts in MOG. Depending on the national legislation, these operators can be TSOs, national offshore TSOs, and wind power operators with responsibility for the connection cables. The TSOs usually function within one country, thus there would be several TSOs involved in a MOG project. As discussed above, recent research shows that more coordination is needed to optimise regional grid development and engagement in hybrid projects. In what follows, we discuss to what extent a separate supra-national offshore TSO could facilitate the implementation of MOG.

5.1. Coordination through international or EU law?

In the earlier studies, the enhanced coordination through a European level binding network and investment plans and supervision have been discussed (Kapff and Pelkmans, 2010). However, the concept of supra-national TSO established under the EU law has not, in our understanding, been researched earlier.

A lot of attention has been paid to study the applicability of definitions under the EU electricity market law and the rising barriers. An important part of the identified legal barriers relate to the EU level legislation, specific rules and definitions, part of which has been given in the form of Regulations directly applicable in the Member States. Despite the fact that many of the challenges relate to the EU level regime, the studies have not generally suggested amendments to the applicable substantive EU legislation. On contrary, an international treaty and exemptions from EU law have been suggested (Woolley, 2013; Müller, 2015, 2017).

We argue that it is worth to research also the EU level alternatives to find clear and transparent solutions to the current challenges because of the following reasons:

- In practice, the EU law regulates also the offshore interconnectors, inside the EU internal market, even with the freedoms guaranteed under the UNCLOS.
- Many of the current definitional challenges originate from the EU law. A wide interpretation of the current definitions of the EU law may be used to some extent but also creates legal uncertainties (Nieuwenhout, 2018).
- The EU level regime could possibly help to overcome the challenges originating from the prioritising of national interests.
- The EU legislation could also guarantee that the EU institutions, like ACER, could be involved in the cases national regulatory authorities cannot reach consensus in the needed regulatory decisions. If a regional regime is established by a treaty, the EU institutions do not necessarily have competence.

In what follows, we discuss further the idea of one single operator in an MOG, namely a supra-national offshore TSO that refers here to an unbundled actor established in accordance with the EU law applicable in all Member States in the BSR.

5.2. Definition of a supra-national offshore TSO in legal terms

In the EU, all new TSOs should be ownership-unbundled from generation and supply activities, and 'each undertaking which owns a transmission system acts as a transmission system operator' (2009/72/EC), Art. 9). Thus, the ownership of the transmission system and transmission system operation go hand in hand. This is taken as a starting point when defining a supra-national TSO.

In this article, a supra-national offshore TSO refers to *'a transmission system operator which operates an offshore transmission system extending to several Member States' exclusive economic zones and territorial waters, and which is responsible for the tasks of a transmission system operator'*.

The speciality of the supra-national TSO would be the extension of one TSO's operational area from one single country to the maritime areas (EEZ and territorial waters) of several countries. It is however notable that already under the current TSO regime, an operator of one interconnector has been considered to function as an 'offshore TSO' (European Commssion, 2014; Energimarknadsinspektionen, 2016), and basically its narrow, interconnector-wide operational area extents to two Member States' territorial waters and EEZs. Despite this, there are currently no offshore TSOs operating a MOG, which is the *ratio* behind the first definition. To clarify the meaning of the first definition, we consider a meshed offshore transmission system as '*a transmission system extending to several Member States' exclusive economic zones and territorial waters, and which is not operated by the national transmission system operators. The offshore transmission system includes the offshore transmission cables and other structures needed for the power transmission, until the substations of offshore electricity generation units'*.

An offshore transmission system would deviate from a traditional transmission system so that it would connect only offshore electricity generators and host cross-border power exchanges. No consumption places would be connected in the offshore transmission system. However, it would not necessarily be meaningful to implement these limitations into the definition, because in some cases it could possibly be reasonable to connect also consumption units to the grid in the middle of the sea (Roggenkamp et al., 2010), or to couple wind energy generation with storage such as proposed in the Power Hub island project.

5.3. From coordination to a single actor

If the offshore infrastructure was considered as a transmission system as its entirety, the definitional jungle of different cables could be avoided. The cables in the offshore transmission system would clearly be operated by one single operator, whereas the OW operators would be responsible only for the connection until offshore substations. Compared to the current situation where several participants (TSOs, offshore wind power operators and even separate connection cable operators could be involved), a supra-national TSO would streamline the organisation of MOG projects.

As discussed earlier in this article, discrepancies in the national regulation of TSOs currently lead to sub-optimal development of MOGs. Introducing a supra-national TSO addresses the lack of harmonisation, which can be expected to directly facilitate investments. If there were only one operator and one applicable set of non-distance based tariffs and connection cost-allocation methods in the same sea area, the current challenges related to the market distortions affecting OW location and resulting from uneven legal and regulatory conditions would be eliminated. The same would apply to the investment barriers attributable to the different levels of investment risks associated with national and non-harmonised investment incentives. As such, a supra-national offshore TSO solves two critical risk factors associated with the efficient hybrid infrastructure development, namely having different sets of framework conditions for cost sharing and recovery.

Introducing a supra-national offshore TSO would also lower the hurdles caused by the diversity of national interests. The centralisation of grid planning and development of an MOG as well as the uniformity in investment and cost-allocation rules could help to further promote a regional, and even European, perspective in network development. In case there is one single operator for which incentives are not based on purely national interests and which is by law enforced to take into account regional, long-term objectives, the creation of MOG could be more likely.

5.4. New challenges

Even though the main benefit of the supra-national TSO is to facilitate the offshore grid development, new challenges also arise. First of all, the way of financing the investment in and operation of the supra-national TSO's infrastructure should be specified. As the offshore transmission system would mainly host cross-border exchanges, it could receive revenues from ITC mechanism already under the current regime, but the question of grid access tariffs is more complex. It should be solved whether a supra-national offshore TSO could collect separate tariffs without disturbing the cross-border electricity trade and cooperation with other TSOs. Despite the new definition for offshore transmission system, it would still provide 'interconnectors' linking national TSOs. A new offshore tariff regime for the use of interconnectors would thus be in contradiction with the current legislation. In the North Sea, the use of state aid in the context where (national) transmission tariffs would not be adequate to cover the costs of the offshore parts of the grid has been discussed (Müller, 2017). In the case of a supra-national TSO, the share of state aid would become large, if the tariff question was not properly solved. Thus, state aid is not considered as a suitable solution in the longer run.

The supervision of the supra-national TSO should also be properly arranged to ensure that the TSO complies with the applicable rules, including the economic regulation. The NRAs are currently responsible for approving the TSOs' tariffs or tariff methodologies (Directive 2009/72/EC, Art. 37). In the event a supra-national TSO would function in the several Member States' area, the NRAs should coordinate their decision-making. Detailed rules for the operation and economic regulation of a supra-national TSO should practically be laid down at the EU level, to avoid national differences in regulatory decisions. ACER could be involved in the decision making when the NRAs cannot reach consensus. Another, perhaps more straightforward and politically unrealistic solution is that ACER would directly be entrusted with the surveillance task, as suggested by Kapff and Pelkmans (2010).

The guidelines for the division of responsibilities between the national and the supra-national TSOs should also be given at the EU level to ensure that the offshore TSO would actually be given opportunity to function. Some new contractual arrangements between the costal TSOs and a supra-national offshore TSO would probably still be needed, constituting a risk of efficiency loss in the short term. In the legislation, the objectives of the offshore transmission system operation, taking into account the long-term regional welfare, should be laid down. Within the stated safety and expediency conditions, the national legislators or NRAs could still be allowed to refuse the functioning of a supra-national TSO in the Member State's area, to ensure reliability and efficiency of the power system.

Finally, despite the fact that grid operation matters are out of the scope of this article, it can be noted that operational issues could also occur. In principal, a supra-national offshore TSO would be, as a TSO, subject to the applicable network codes and guidelines such as Commission Regulation (EU) (2017/2195) (balancing) and Commission Regulation (EU) (2017/1485) (system operation). Requirements relating to balancing activities, for example, can be challenging to arrange for an entity operating only an offshore grid, which in addition connects variable OW to the power system. Enhanced short-term coordination with other TSOs would probably be needed.

5.5. Discussion on the supra national TSO solution

The introduction of a supra-national TSO would support MOG development by creating a level playing field for TSOs' investment and by removing market distortions among OW operators. In addition, the emphasis of national interest over the regional ones could be diminished.

In general, strong and well-harmonised EU level legislation would be a precondition for the efficient implementation of supra-national offshore TSO. This would require new provisions clarifying which general TSO rules are applied to the supra-national offshore TSO and which specific rules it should follow. Some of the rules could be better to impose through directly applicable instruments to avoid national discrepancies in implementation.

Compared to the advantages, implementing of this completely new 'layer' of grid to the power system can prove to be too burdensome and complex. There may be also easier solutions, from the point of view of both political acceptance and the legal coherence, than the introduction of a supra-national TSO. However, the EU level solutions are worth to be studied further to avoid the potential flaws of regional "ad hoc solutions" that are based on the exemptions from the current legal framework (Müller, 2017).

6. Conclusion and policy implications

Integrated grid solutions have the potential to become a building block for offshore wind exploitation in future decarbonised systems. Currently, however, the lack of clear legal definitions for dual-purpose infrastructure results in uncertainties regarding the applicable rules. In addition, the diversity of national regulatory frameworks for transmission grid development has negative impacts on the investment environment of both regulated TSOs and wind power developers. The prioritising of national interests that often prevails in energy policies may also hamper implementation of projects with primarily regional benefits.

If the EU wishes to promote integrated and decarbonised electricity systems across national boundaries, its policy makers need to have a clear understanding of the diverse options enabling this ambition. In this paper, we explore whether the introduction of a supra-national offshore TSO could help to overcome the identified legal and regulatory barriers. While the earlier studies have focused mainly on the solutions based on a multi-lateral treaty, this study fills the research gap related to the European level solutions and anchors the discussion in the EU legal regime. To clarify the potential status and tasks of a supra-national offshore TSO, the article introduces new legal definitions for a supra-national offshore TSO and for a meshed offshore transmission system. In addition, the potential benefits and new challenges occurring from the introduction of a new type of TSO are critically reviewed.

Based on this study, a supra-national offshore TSO would not provide a straightforward solution to address all the current challenges related to the meshed offshore grid development. However, it could help to overcome some of the main barriers relating to the grid investments and the lack of level playing field for offshore wind power developers. The new challenges occurring from the introduction of a supra-national TSO relating to its regulation and monitoring would be substantial, though. While this article does not aim to provide a comprehensive analysis of the applicability of a supra-national TSO, it opens new angles to the further research and discussion.

Along with the transition to clean energy system, the research questions in energy law are changing. As new solutions in the energy sector are breaking through, the legislation should be up to date and enable the implementation of these solutions. Today, energy law covers also these new currents in the sector. By studying and critically reviewing the possible solutions to overcome the current barriers for clean energy transition, this article contributes to the contemporary energy law research. Regarding the principles of contemporary energy law, as defined by Heffron et al. (2018), the study can be seen to relate especially to the principle of the protection of the environment, human health and combatting climate change and the principle of prudent, rational and sustainable use of natural resources.

Acknowledgments

This article was written as part of the research of the Baltic InteGrid project (registration number: R1.255, project number: #R018), which received funding from the Interreg Baltic Sea Region Programme 2014–2020, part-financed by the European Regional Development Fund. The Baltic InteGrid explores the potential of meshed offshore grids in the Baltic Sea region. The content of the article reflects the authors'/partners' views and the EU Commission and the MA/JS are not liable for any use that may be made of the information contained therein.

References

50Hertz; Energinet.dk; Svenska Kraftnät, 2010. Kriegers Flak combined grid solution. Joint feasibility study. 24 February 2010.
Barnes, A.-R., 2014. Energy sovereignty in Marine spaces. Int. J. Mar. Coast. Law 29 (4), 1–27.
Bhagwat, P., et al., 2017. Economic framework for offshore grid planning. WP7 Intermediate Deliverable. PROMOTioN Project – Progress on Meshed HVDC Offshore Transmission Networks. June 2017.
Buijs, P., Bekaert, D., Belmans, R., 2010. Seams issues in European transmission investments. Electr. J. 23 (10), 18–26. https://doi.org/10.1016/j.tej.2010.10.014.
CEPA, 2015. Scoping Towards Potential Harmonisation Of Electricity Transmission Tariff Structures. Final Report. Agency For Cooperation Of Energy Regulators (ACER) (August 2015).
Cole, S., et al., 2015. Cost-benefit analysis of a coordinated grid development in the North Sea. 2015 IEEE Eindh. Power. Power. 2015.
COM, 2010. 0639, Communication from the Commission to the European Parliament, The Council, The European Economic and Social Committee and the Committeeof the Regions – Energy 2020 A strategy for competitive, sustainable and secure energy. COM(2010) 639 final. 10.11.2010.
COM, 2011. 885, Communication from the Commission to the European Parliament, The Council, The European Economic and Social Committee and the Committeeof the Regions – Energy Roadmap 2050 COM(2011) 885 final, 15.12.2011.
COM, 2014. 15, Communication from the Commission to the European Parliament, The Council, The European Economic and Social Committee and the Committeeof the Regions – A policy framework for climate and energy in the period from 2020 to 2030, COM(2014) 15 final. 22.1.2014.
COM, 2018. 773, Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee, the Committee of the Regions and the European Investment Bank, A Clean Planet for all A European strategic long-term vision for prosperous, modern, competitive and climate neutral economy, COM (2018) 773 final, 28.11.2018.
Commission Regulation (EU) 2016/1447, Commission Regulation (EU) 2016/1447 of 26 August 2016 establishing a network code on requirements for grid connection of high voltage direct current systems and direct current-connected power park modules, OJ L 241, 8.9.2016, pp. 1–65.
Commission Regulation (EU) 2017/1485, Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation, C/2017/5310, OJ L 220, 25.8.2017, pp. 1–120.
Commission Regulation (EU) 2017/2195, Commission Regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing, C/2017/7774, OJ L 312, 28.11.2017, pp. 6–53. Available at: 〈http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?Uri=CELEX:32017R2195&from=EN〉.
Commission Regulation (EU) No 838/2010, 2010. Of 23 September 2010 on laying down guidelines relating to the inter-transmission system operator compensation mechanism and a common regulatory approach to transmission charging. OJ L 250 5–11.
Danish Energy Agency, 2017. Technology Data for Energy Plants. August 2016, latest update June 2017.
Daxhelet, O., Smeers, Y., 2007. The EU regulation on cross-border trade of electricity: a two-stage equilibrium model. Eur. J. Oper. Res. 181 (3), 1396–1412.
De Decker, J., Kreutzkamp, P., 2011. Offshore Electricity Infrastructure in Europe Offshore Electricity. A Techno-Economic Assessment 3E (coordinator), dena, EWEA, ForWind, IEO, NTUA, Senergy, SINTEF Final Report., Available at: 〈http://www.ewea.org/fileadmin/ewea_documents/documents/publications/reports/OffshoreGrid_report.pdf〉.
Directive (EU) 2018/2001, Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources, OJ L 328, 21.12.2018, pp. 82–209.
Directive 2009/28/EC, Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC, OJ L 140, 5.6.2009, pp. 16–62.
Directive 2009/72/EC, Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC, OJ L 211, 14.8.2009, pp. 55–93.
Energimarknadsinspektionen, 2016. Föreläggande vid vite avseende hantering av inkomster från tilldelning av sammanlänkning. 2016-06-09. Available at: 〈https://www.ei.se/Documents/Nyheter/Nyheter2016/Baltic_Cable.pdf〉.
Energinet.dk, 2017a. kæmpe kunstig ø midt i nordsøen: tre lande undersøger om fremtidens havmøller kan kobles på sandø på dogger banke. Available at: 〈https://www.energinet.dk/Om-nyheder/Nyheder/2017/04/25/Kampe-kunstig-o-midt-i-Nordsoen-Tre-lande-undersoger-om-fremtiden〉 (Accessed 3 March 2018).
Energinet.dk, 2017b. Kriegers Flak - Combined Grid Solution. FORVENTES I DRIFT: 1.1.0001. Available at: 〈https://en.energinet.dk/Infrastructure-Projects/Projektliste/KriegersFlakCGS〉 (Accessed 23 April 2018).
ENTSO-E, 2017. ENTSO-E Overview of transmission tariffs in Europe: Synthesis 2017. June 2017.
Eurelectric, 2016. Network tariffs: A EURELECTRIC position paper. Available at: 〈https://www.nve.no/energy-market-and-regulation/network-regulation/network-tariffs/〉 (Accessed 14 September 2016).
European Commission, 2018. Commission welcomes Council adoption of new rules on Renewable Energy, Energy Efficiency and Governance. Available at: 〈https://ec.europa.eu/info/news/commission-welcomes-council-adoption-new-rules-renewable-energy-energy-efficiency-and-governance-2018-dec-04_en〉.
European Commission, 2016a. Political Declaration on energy cooperation between the North Seas Countries., p.7. Available at: 〈http://europa.eu/rapid/press-release_IP-16-2029_en.htm〉.
European Commission, 2016b. Study on regulatory matters concerning the development of the North Sea offshore energy potential. PwC; Tractebel Engineering; ECOFYS. Project No: 2016.3011. January 2016. Available at: 〈http://bookshop.europa.eu/en/study-on-regulatory-matters-concerning-the-development-of-the-north-sea-offshore-energy-potential-pbMJ0416250/〉.
European Commission, 2017. Study supporting the Impact Assessment concerning Transmission Tariffs and Congestion Income Policies. Final Report. May 2017. European Commission, (May 2017).
European Commssion, 2014. STELLUNGNAHME DER KOMMISSION vom 29.8.2013 nach Artikel 3 Absatz 1 der Verordnung (EG) Nr. 714/2009 und Artikel 10 Absatz 6 der Richtlinie 2009/72/EG – Deutschland – Zertifizierung der TenneTOffshore 1. Beteiligungsgesellschaft mbH. C(2013) 5631 final. 2.
EWEA, 2016. EWEA Position Paper on Network Tariffs and Grid Connection Regimes (Revisited). European Wind Energy Association (EWEA) (March 2016).
Fitch-Roy, O., 2016. An offshore wind union? Diversity and convergence in European offshore wind governance. Clim. Policy 16 (5), 586–605.

González, J.S., Lacal-Arántegui, R., 2016. A review of regulatory framework for wind energy in European Union countries: current state and expected developments (Available at). Renew. Sustain. Energy Rev. 56, 588–602. https://doi.org/10.1016/j.rser.2015.11.091.
Gorenstein Dedecca, J., Hakvoort, R.A., Herder, P.M., 2017. Transmission expansion simulation for the European Northern Seas offshore grid. Energy 125, 805–824.
Heffron, R., Cameron, P., 2016. Conclusion, the future of EU energy. In: Law. Cameron, P., Heffron, R. (Eds.), 2016, Legal Aspects of EU Energy Regulation, 2 ed. Oxford University Press, pp. 684–695.
Heffron, R.J., et al., 2018. A treatise for energy law. J. World Energy Law Bus. 11 (1), 34–48.
Heffron, R.J., McCauley, D., 2017. The concept of energy justice across the disciplines. Energy Policy 105, 658–667 (November 2016).
Heffron, R.J., Talus, K., 2016a. The development of energy law in the 21st century: a paradigm shift? J. World Energy Law Bus. 9 (3), 189–202.
Heffron, R.J., Talus, K., 2016b. The evolution of energy law and energy jurisprudence: insights for energy analysts and researchers. Energy Res. Soc Sci. 19, 1–10. https://doi.org/10.1016/j.erss.2016.05.004.
Honkapuro, S., Tuunanen, J., 2012. Tariff scheme options for distribution system operators.
Huppmann, D., Egerer, J., 2015. National-strategic investment in European power transmission capacity (Available at). Eur. J. Oper. Res. 247 (1), 191–203. https://doi.org/10.1016/j.ejor.2015.05.056.
IEA, 2016. Nordic Energy Technology Perspectives 2016: Cities, flexibility and pathways to carbon-neutrality. International Energy Agency (IEA). April 2016. Available at: ⟨http://www.nordicenergy.org/wp-content/uploads/2016/04/Nordic-Energy-Technology-Perspectives-2016.pdf⟩.
Jay, S.A., Toonen, H.M., 2015. The power of the offshore (super-) grid in advancing marine regionalization. Ocean Coast. Manag. 117, 32–42.
Kapff, L., Pelkmans, J., 2010. Interconnector investment for a well-functioning internal market What EU regime of regulatory incentives? Bruges Eur. Econ. Res. Pap. BEER n°18 (2010) 18, 41.
Knudsen, J.K., Jacobsen, G.B., Kielland Haug, J.J., 2015. Towards a Meshed North Sea Grid Policy challenges and potential solutions from a Norwegian perspective. NSON Political Challenges. WP 3 NSON: Political challenges.
Konstantelos, I., Pudjianto, D., et al., 2017. Integrated North Sea grids: the costs, the benefits and their distribution between countries. Energy Policy 101, 28–41.
Konstantelos, I., Moreno, R., Strbac, G., 2017. Coordination and uncertainty in strategic network investment: case on the North Seas Grid. Energy Econ. 64, 131–148. https://doi.org/10.1016/j.eneco.2017.03.022.
Moselle, B., 2008. Reforming TSOs: using the "Third Package" Legislation to Promote Efficiency and Accelerate Regional Integration in EU Wholesale Power Markets. Electr. J. 21 (8), 9–17.
Müller, H.K., 2015. A Legal Framework for a Transnational Offshore Grid in the North Sea. In Energy & Law Series Vol. 16. Intersentia, p. 436.
Müller, H.K., 2017. Can we build it? Yes we can: a legal analysis of how to enable a transnational offshore grid. In: Roggenkamp, M.M., Banet, C. (Eds.), European Energy Law Report XI. Intersentia, Cambridge, pp. 145–164.
Nieuwenhout, C., 2018. EELR XII Ceciel Nieuwenhout Offshore Hybrid Grid Infrastructure (final)., pp. 1–14.
NORDREG, 2007. Congestion Management Guidelines. Compliance Report 8/2007. Nordic Energy regulators (NordREG). September 2007.
NSCOGI, 2014. Cost allocation for hybrid infrastructures Deliverable 3 – Final version. The North Seas Countries' Offshore Grid Initiative (NSCOGI). July 2014.
NSCOGI, 2012a. Recommendations for guiding principles for the development of integrated offshore cross border infrastructure – Deliverable 2 – WG 2 – Market and Regulatory issues - Final report. 23/11/2012, p.11.
NSCOGI, 2012b. Regulatory Benchmark – Final Report Working Group 2. The North Seas Countries' Offshore Grid Initiative (NSCOGI). 13/01/2012.
Regulation (EC) No 714/2009.of the European Parliament and of the Council of 13July 2009 on conditions for access to the network for cross-border exchanges in electricity and repealing Regulation (EC) No 1228/2003, OJ L 211, 14.8.2009, pp. 15–35.
Regulation (EU) No 347/2013,Regulation (EU) No 347/2013 of the European Parliament and of the Council of 17 April 2013 on guidelines for trans-European energy infrastructure and repealing Decision No 1364/2006/EC and amending Regulations (EC) No 713/2009, (EC) No 714/2009 and (EC) No 715/2009, OJ L 115, 25.4.2013, pp. 39–75.
Reneses, J., Rodríguez, M.P., Pérez-Arriaga, I.J., 2013. Electricity tariffs. In: Pérez-Arriaga, I.J. Ed (Ed.), Regulation of the Power Sector. Springer, London, pp. 397–441 (London).
Roeben, V., 2013. Governing shared offshore electricity infrastructure in the northern seas. Int. Comp. Law Q. 62 (4), 839–864.
Roggenkamp, M.M., et al., 2010. Market and regulatory aspects of trans-national offshore electricity networks for wind power interconnection. Wind Energy 13, 483–491.
Schwabe, P., Lensink, S., Hand, M., 2011. IEA wind task 26. Wind Energy 1–122. (Available at). ⟨http://www.nrel.gov/docs/fy11osti/48155.pdf⟩.
Swider, D.J., et al., 2008. Conditions and costs for renewables electricity grid connection: examples in Europe. Renew. Energy 33, 1832–1842.
Talus, K., Wüstenberg, M., 2017. Risks of expanding the geographical scope of EU energy law. Eur. Energy Environ. Law Rev. 26 (5), 138–147.
Tangerås, T.P., 2012. Optimal transmission regulation of an integrated energy market. Energy Econ. 34 (5), 1644–1655.
Tscherning, R., 2011. The European offshore supergrid and the expansion of offshore wind energy in Germany, Ireland and the United Kingdom: legal, political and practical challenges. Eur. Energy Environ. Law Rev. 76–87.
UNCLOS, United Nations Convention on the Law of the Sea (UNCLOS). Montego Bay, 1982.
Vedder, H., et al., 2016. EU energy law. In: Roggenkamp, M., Redgwell, C., Ronne, A., del Guayo, I. (Eds.), Energy Law in Europe, 3rd ed. Oxford University Press, pp. 187–366.
Weißensteiner, L., Haas, R., Auer, H., 2011. Offshore wind power grid connection — the impact of shallow versus super-shallow charging on the cost-effectiveness of public support (Available at). Energy Policy 39 (8), 4631–4643. https://doi.org/10.1016/j.enpol.2011.05.006.
Wieczerzak-Krusińska, A., 2018. Prezes Polskich sieci elektroenergetycznych: inwestycje wzmacniające sieć. Wywiady 1–13. (Available at). ⟨http://www.rp.pl/Wywiady/304109920-Prezes-Polskich-Sieci-Elektroenergetycznych-Inwestycje-wzmacniajace-siec.html&cid=44&template=restricted⟩.
WindEurope, 2017. Offshore wind in Europe: key trends and statistics 2017. February 2018.
Woolley, O., 2013. Governing a North Sea grid development: the need for a regional framework treaty, 14 competition & Reg. network Indus. 73 (2013). C. R. Netw. Ind. 14 (1), 73–97.