A Supra-National TSO to Achieve Offshore Meshed Grids Infrastructure in the Baltic Sea: A Legal-Regulatory Point of View

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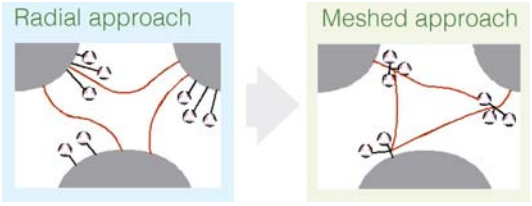
The electricity network investment need (EUR 420 billion by 2050 according to [1]), associated with ambitious renewables integration targets, requires to investigate hybrid architectures such as 'offshore meshed grids' (OMGs). OMGs are dual-purpose infrastructure that combine the functions of offshore wind farm (OWF) connection and cross-border interconnection and that span across multiple countries and actors, i.e. independent wind farms operators and national transmission system operators (TSOs) (Figure).



Offshore Meshed Grids to Address European Energy Targets

OMG have gained a growing attention both from European institutions and utilities. The European Union (EU) actively supports several initiatives which contribute to shedding light on a large array of technical, institutional, administrative, legal and economic conditions for OMG development. In 2010, the North Seas Grid Initiative project was launched, followed by the PROMOTioN project and, more recently, the Baltic InteGrid project. Utilities are also engaging in hybrid projects such as the Kriegers Flak Combined Grid Solution project and the future Power Island hybrid project [2]. The Polish TSO, PSE S.A, announced a hybrid offshore grid solution will be considered if offshore wind development is higher than the 4 GW currently planned [3].

The main arguments for OMG are to connect more wind energy while supporting cross-border exchange of electricity, thus tackling the three pillars of the EU energy policy: RES penetration (sustainability), markets integration and system reliability [4]. At the power system level, OMGs optimise the use of the grid infrastructure. The dual-purpose characteristic of OMG increases the network's utilisation factor as compared to a classical radial connection and thereby represents a strong economic argument for development. In addition, OMG would enable the development of large-scale OWF located far away from shore and therefore would not interfere with public acceptability. However, in spite of the expected benefits, the uptake of OMG is slow and remains limited to a small amount of stakeholders.

Past research concludes such situation results from unsuited legal and regulatory frameworks [5]–[10] and studies OMG development using technical-economic optimisation methods based on the assumption that regulatory barriers are removed [11]–[13]. Using the Baltic Sea basin as a case study, our study analytically reviews the main barriers to OMG development by combining legal dogmatics and regulatory economics and addresses how to remove them. Our main contribution is to propose a solution at the crossroad between the two disciplines.

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This research is part of the Baltic InteGrid project, which received funding from the Interreg Baltic Sea Region Programme 2014-2020.

An Unsuited Legal Framework...

Within the legal perspective, difficulties arise from the lack of explicit definition for OMG [14]–[18]. In the EU electricity market law, the high-voltage power cables are basically differentiated according to the purpose and the operator of the cable: the cables considered as part of a transmission system operated by a TSO, and the connection lines and cables linking a connection point (production unit or a consumption place) to the network. The division of regulated assets and private assets vary between the national legal frameworks. Connection cables, if considered as unbundled assets by national legal frameworks, are the responsibility of OWF operators and follow the private investment decisions. Interconnectors are, if not exempted, regulated assets that must comply with the requirements of TSO unbundling. The costs of interconnectors are recovered mainly through national grid tariffs and by congestion incomes.

The cables of OMG serving dual-purpose are currently not delineated. The dual-purpose nature of OMG and the multiplication of applicable rules due to the different co-existing national legal framework at the sea basin level affect inevitably actors' legal and financial responsibilities and risks. Currently, the parties have no incentives, nor necessarily even possibility, to invest in dual-purpose cables [19].

… That Creates Regulatory Barriers and Prevents Investment

Because national legal frameworks and TSOs' regulation are tightly embedded, regulatory economics gives the right conceptual framework to assess the repercussions of the lack of explicit definition. The poor harmonisation across national transmission grid tariffs and the different connection approaches for OWF are the two main factors that hinder coordinated investments in hybrid projects (see table).

Different tariffs applied to a single infrastructure result in different behaviours from the stakeholders in response to: the tariff levels (what proportion of the tariff pay each category of grid user, consumer vs.

	Grid tariff			Connection
	Tariff for generator	Tariff structure	Locational component	cost mainly borne by
Denmark	Yes	Energy only	no	TSO
Estonia	No			OWF
Finland	Yes	Energy-based	no	TSO/OWF
Germany	No			TSO
Latvia	No			OWF
Lithuania	No			OWF
Poland	No			TSO/OWF
Sweden	Yes	Capacity-based	yes	OWF

generator); structures (what distribution between fixed and variable costs); and the presence of locational components. In the Baltic Sea countries, only the generators connected to the Nordic countries' grid must pay a tariff, which substantially differs in its structure and cost components. When assessing the suitability of grid tariffs to promote OMGs, the tariffs' interaction with the intermittency of the electricity generated by the wind farm is the key parameter to consider. Tariffs with a large share of fixed costs and using locational components are, *ceteris paribus*, riskier for OW operators to invest in as compared to simple energy-based tariff (for more details, see [20]).

The way OWF's connection costs are distributed between TSO and OWF operator defines who bears the investment risk and also directly affects the viability of the OW project (for a review of the different approaches and their implication see [21]). Launching an OMG initiative in the Baltic Sea without prior alignment in connection cost allocation and access tariff would inevitably result in distorting OWF investments, incentivising connection to the German, Polish or Danish grid, supposedly at the expense of economic and or environmental optimum. For wind energy experts [22], current regulatory frameworks increase investor's perceptions of risk. At the TSO's level, the multiplicity of cost distribution and recovery methods ultimately creates an uneven level playing field among TSOs and conflicts with the completion of a joint coordinated investment project. The entanglement of national interests on top of the investment landscape identified in [17], [19], adds another layer of difficulty before reaching a common agreement on the development of OMG.

Introducing an Independent Offshore TSO

Against this background, the introduction of an independent offshore TSO is investigated to circumvent and enable OMG. First, practically concentrating the grid investment decisions to one entity could solve problems relating to the allocation of costs between several TSOs and OWFs. Accordingly, the investment decisions could become more straightforward. Second, the suboptimal investment incentives for OWFs could at least partly be avoided as there would be a level playing field originating from the clear division of tasks between OWF operators and offshore TSO. In addition, regional approach instead of contradicting national interests could be easier to implement through one entity than by several entities involving in the projects. The introduction of a supra-national offshore TSO would require new legal definitions at the EU level – and harmonisation at some extent – and, for example, the question of offshore grid financing and implementation of right incentives should be solved in this context.

Discussion

The development of offshore meshed grids in Europe has taken its first steps almost a decade ago, but the progress is still hindered by regulatory and legal barriers. This article has focused on the main economic barriers for OMG construction in the Baltic Sea region and stressed out how limited harmonisation of the regulatory framework for transmission system connection cost distribution and cost recovery leads to sending uneven signals to market actors, therefore distorting investment decisions and to creating uneven levels of risk for TSOs at the regional scale. While some energy producers have advocated a shift of grid operation and capital investment activities to the market actors, involving more separated activities and a multiplication of stakeholders, we highlight the need for coordinated actions, pervading to OMG projects, conflicts with such tendency. According to our analysis, the introduction of an independent offshore TSO could address the identified problems in centralising development decisions while responding to a single regulatory framework. However, new questions also arise, mainly relating to the governance of this actor: the introduction of a supra-national TSO necessitates to design a legal framework to implement and monitor its functions, in respect with the EU law and national sovereignty.

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IAEE Student Chapter Leaders Meeting

With the aim of driving forward products and services IAEE offers for student members, the leaders of ten student chapters and IAEE's student representative met in the course of the 41st International Conference in Groningen.

One objective of the meeting was to increase awareness of each other's events and to discuss possible collaboration between student chapters.

Another important item on the agenda was a discussion about how IAEE could retain former students after their transition into professional life, which resulted in a list of ideas of better services for students and young professionals. Among those was the intention of building a mentoring program where seniors provide advice and knowledge to younger members. Furthermore, young professionals could benefit from networking opportunities (e.g. business cocktails) and the student chapter leaders agreed that IAEE's job bank service should be improved including an increase in jobs offered.

Last but not least, the recently established working paper series of USAEE and IAEE aims at increasing the circulation, visibility, and impact of research within the IAEE community and could be of great interest for PhD students and young professionals.

To better point out services and events and to improve communication as a whole, IAEE is setting up a social media team which is currently looking for volunteers who are motivated to contribute.