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Exploring challenges for regional energy governance

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The integrated offshore grid in Europe: Exploring challenges for regional energy governance

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ABSTRACT

The deployment of offshore wind and power transmission in the European North Sea is accelerating. Stakeholders advocate regional governance for the European grid expansion, which may evolve into a pan-European governance and is key to developing integrated, hybrid offshore projects. However, such projects are still scarce. We thus analyze the governance of the North Sea offshore grid expansion using the dimensions of level, implementation obligation, and implementation discretion. Our exploratory approach identifies five challenges. The challenges relate to 1) the interaction of the European and regional levels; 2) the interaction of the national and regional levels; 3) the participation of non-European Union countries; 4) the dependence of regional planning on national development plans, which consider national interests; and 5) the interaction of cost allocation and European financing for Projects of Common Interest. The recent Clean Energy Package proposal extensively reforms the regulation of the European power system. The Package is part of the Energy Union strategy and focuses on the energy and climate policies' governance and the power system operation. Thus, regional governance of offshore expansion is largely unaltered, and our identified challenges remain unaddressed.

1. Introduction

An offshore power grid is developing in the North Seas of Europe in parallel with a significant increase in offshore wind power generation and transmission. Given this development, our main research question is: what are the current challenges for the regional governance of the integrated expansion of the offshore grid? In parallel, to address multiple energy and climate objectives the European Union is implementing the holistic approach of the Energy Union strategy. As a second research question we thus analyze how the Clean Energy Package (the main regulatory reform of the Energy Union) affects these challenges.

The motivation for our analysis is to allow integrated projects for the offshore grid in the European North Sea to compete with non-integrated transmission and generation projects on an equal footing. Our main contribution is the identification of five challenges for the regional governance of integrated offshore expansions in Europe and assessing the impact of the Clean Energy Package.

The analysis is structured according to governance dimensions selected from the literature on governance studies. These are the level (European, regional or national), implementation obligation (binding or not binding) and implementation discretion (rigid or flexible). The regional level has a particular importance in our analysis, for much of the governance of the offshore grid expansion should take place at this level, in line with recent developments concerning the design of the European expansion framework [1,2]. This is the first application of the three dimensions to structure the analysis of the regional governance of offshore expansions.

Fig. 1 summarizes the structure of our analysis of regional governance of the offshore grid expansion in the North Seas. In the remainder of this section we first introduce the integrated North Sea offshore grid. Then, we present the concept of governance and the importance of the regional level. Finally, we briefly present the Energy Union.

1.1. The North Seas offshore grid

We define the North Sea offshore grid as

Abbreviations: ACER, Agency for the Cooperation of Energy Regulators; EEA, European Economic Area; ENTSO-E, European Network of Transmission System Operators for Electricity; HVDC, high-voltage direct-current; NSCOGI, North Seas Countries' Offshore Grid Initiative; PCI, project of common interest; TEN-E, Trans-European Networks for Energy; TSO, transmission system operator; TYNDP, Ten-year Network Development Plan

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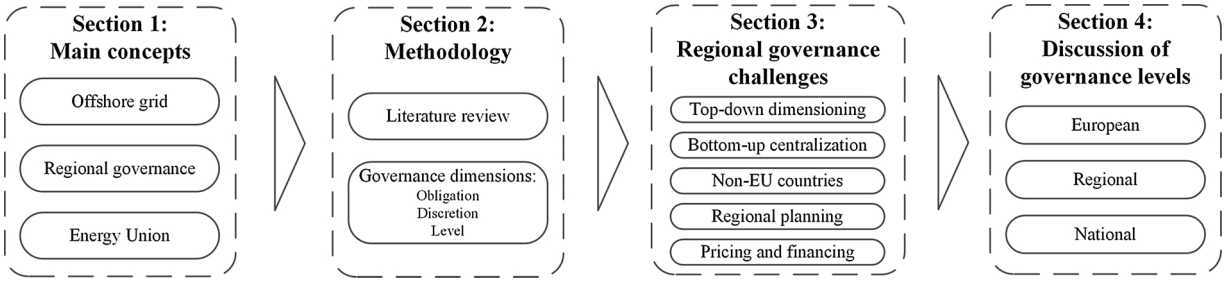

Fig. 1. Analysis of the regional governance of integrated offshore expansions.

the power system in the North Sea combining offshore power generation from renewable sources (particularly wind power) with transmission lines of different technologies.

This grid performs two functions: to interconnect the asynchronous power systems of Scandinavia, Great Britain and continental Europe, and to connect offshore wind farms to these systems. The offshore grid has expanded quickly during the last years due to several drivers: the increased deployment of offshore winds farms; the creation of an internal energy market, which requires increased interconnection capacity; the reliability challenges caused by the expansion of renewable electricity generation in Europe; and innovations in high-voltage direct-current (HVDC) transmission technology, especially voltage-source converters [3–5].

Traditionally, the functions of interconnection and wind farm connection are performed by separate transmission lines, forming a non-integrated (radial) offshore grid. That is, some lines connect offshore wind farms to their national onshore power systems, for example in the Netherlands, while separate lines interconnect the power systems of Scandinavia, Great Britain and continental Europe. However, with a strong expansion of the offshore grid and voltage-source converters technology there is an opportunity to combine these functions in single, integrated lines. This would lead to an integrated offshore grid,

> a grid where the generation and transmission expansion planning considers both conventional and integrated lines, leading to the deployment of the two.

There is significant and recent activity around an integrated offshore grid in the North Seas of Europe. The number of modelling studies has increased in the last years [6–8], a number of political declarations were made and the grid became a priority corridor for trans-European energy networks ([9–11]). Finally, voltage-source converter HVDC for multiterminal grid applications is still going through a phase of strong innovation, as is offshore wind [3,12].

An integrated offshore grid can provide important socio-economic and environmental benefits compared to a non-integrated one. However, it is not necessarily supported by all actors and these benefits can vary significantly according to the model and data used [13]. Thus, the integrated offshore grid is not an end-goal *per se*, and while it must be holistically planned, specific integrated offshore projects should be assessed individually [14,15].

Our study is directly related to (power systems) expansion planning, which we define as

> identifying the most adequate investments in generation and transmission to guarantee the future system reliability given certain energy and climate policy objectives.

As such, these investments consider not only techno-economic efficiency but also social and environmental objectives. Power systems such as the European one currently face a number of challenges, such as the decentralization (unbundling) of the power system functions, increased regional planning, and long and complex permitting procedures [1,16]. In unbundled power systems the system expansion cannot be conducted in a top-down, hierarchical manner due to the multiplicity of actors. Moreover, generation and transmission expansion depends not only on planning, but also other building blocks: the ownership, financing, pricing and operation of the system, which collectively form the governance framework [17]. Because of this we analyze the concept of decision-making through governance, and the need for a governance framework for the offshore grid.

1.2. Governance

The 1st energy package started a process of regulation and centralization of some responsibilities for the power sector at the European level. This was done through bottom-up experimentation and convergence coupled with top-down measures. On one hand, the bottom-up developments are illustrated by the slow emergence of the European electricity target model, characterized by a European market for dispatching electricity supply in the day-ahead timescale (and shorter timescales in the future), and the definition of (often national) single-price zones. On the other hand, the top-down measures include for example the creation of the European Network of Transmission System Operators for Electricity (ENTSO-E) and the Agency for the Cooperation of Energy Regulators (ACER) with the 3rd energy package. Authors agree that this centralization trend will continue, although its speed and form is discussed [4,18–20].

However, there are challenges to the extent and speed of centralization due to uncertainty on the most adequate governance framework, the multiplicity of actors, the subsidiarity principle and national sovereignty on the energy mix, and recent uncoordinated and diverging measures to guarantee system adequacy given the increased penetration of renewable energy sources [4,21,22].

Moreover, a decentralized system has a number of advantages over a centralized one [23]. It allows for technological and regulatory experimentation, does not constrain ambitious frontrunners in their decarbonization policies, is more robust to regulatory design errors, and is more adapted to the heterogeneous contexts and preferences of actors.

On the other hand, Bausch et al. [23] list a number of disadvantages of decentralization. First, it may be inefficient, with the duplicated use of resources in the system. Second, the coordination of decentralized and heterogeneous system elements is more complex. Finally, decentralized systems may not internalize the externalities inflicted by one system element to another, and are prone to free-riding of actors.

Hence the evolution of the European power sector and the offshore grid is a combination of centralization and decentralization trends in a context of multiple actors acting at various levels (European, regional, national and sub-national). Because of this, decision-making for the sector needs to be done through governance. We define governance as

> the combination of heterarchical (non-hierarchical) and possibly hierarchical institutions (formal and informal) that guide decision-making in a networked multi-level, multi-actor system.

Several authors survey the many governance theories developed to understand multi-level, multi-actors systems [24–26]. By focusing on different aspects of governance (such as the number of actors or levels,

or the implementation obligation of regulation), one can develop specific theories of how decision-making occurs in a decentralized system. We now focus on the multi-level aspect of governance to demonstrate the importance of regions to the expansion planning of the offshore grid.

1.3. Regional cooperation

Paraphrasing the EC [27], we define a region as

> an area including territory from a number of different countries. . . associated with one or more common features or challenges.

As such, regions are a fluid concept combining both territorial and functional aspects [28]. Cooperation for decision-making at the regional level has a number of advantages over that at the European or national ones. Regions are the natural level for 'problems that one country is unable to tackle alone, or which spill over international boundaries while being too specific in scope to be addressed by general EU rules' [29]. It groups all actors necessary for decision-making while excluding actors not necessary and/or not impacted by the issue at hand. This facilitates the decision-making and implementation of the solutions [30], while not causing externalities beyond the region boundaries. Also, regions allow to account for heterogeneous national specificities [31] while European solutions may not. Moreover, regional decision-making may have synergies with decision-making at other levels, filling authority gaps [32]. Hence, regional initiatives are more feasible and adequate to fostering energy policy cooperation in Europe [1,2,33].

On the other hand, regional decision-making has a number of disadvantages. These include the possibilities of failing to reach targets, free-riding, leakage (such as of carbon emissions), a higher potential for inconsistent and even balkanized policies, and monitoring failures [22,34]. Also, the interest of national actors may block decision-making at the regional level [29,30].

The North Sea offshore grid has a number of specific characteristics which qualify the region as a valid level for decision-making. This even more so considering the significant externalities (both positive and negative) a North Sea country can impose on another, and the increased benefits of an integrated grid compared to a conventional, non-integrated one [6].

The first characteristic is the importance HVDC technology has for the grid, since a multiterminal HVDC leveraging voltage-source converters will be a significant component of an integrated offshore grid. Second, the offshore grid has a greater potential than onshore grids for the integrated expansion of generation and transmission, which does however require greater coordination. Finally, the decentralization of the offshore grid (such as the multiplicity of actors and countries) also requires a stronger coordination of these actors, in a context of regulatory differences between countries which may hinder the development of an integrated grid [13].

Thus, the North Sea region qualifies as an adequate decision-making level for the offshore grid. However, due to its decentralization this process can only occur through governance. Jay and Toonen [35] already indicate that the regional level is central to the governance of the North Sea offshore grid. This is confirmed by the support to regional initiatives and the North Sea in particular from research and multiple European and national actors [2,30,34–36]. Existing regional groups include the North Seas Energy Cooperation and the North Sea regional group of the European Network of Transmission System Operators for Electricity (ENTSO-E), with even a North Sea macro-region being considered [10, 29].

But while regional governance of the North Sea offshore grid for its integrated development is both sensible and desirable, there are several challenges to it. These challenges are discussed in Section 3, while the advantages and disadvantages of regional governance as well as alternative governance levels are discussed in Section 4.

1.4. The Energy Union

To understand the future of regional governance we must understand the main current strategy of the Commission for the European energy and climate policies: the Energy Union. Several institutions and organizations for the European energy system predate the Energy Union strategy, such as the Agency for the Cooperation of Energy Regulators (ACER), the ENTSO-E and the Trans-European Energy Networks (TEN-E) regulation. These contributed to the regulation, expansion planning and operation of the European system, bringing benefits such as 'transparency, interoperability, better monitoring of compliance with EU law, and increased cross-border trading of electricity and gas' [37].

Despite these advances, several issues remained. Measures are necessary to address the conflict between renewable energy penetration and guaranteeing reliability [4,22]. Particularly regarding governance, decision-making is slow with a strong national component, ACER is more a coordination platform than an actual regulator, and transmission system operators (TSOs) are also restricted in their cooperation [37]. The Energy Union successful mobilized actors around these issues and an increased energy solidarity in the EU [38,39].

To integrate the European energy and climate policies to achieve their targets, the European Commission announced in 2015 the Energy Union, a holistic strategy focusing on five dimensions [40]. This strategy was made more concrete with the Clean Energy for All Europeans proposal (Clean Energy Package) presented by the Commission in November 2016. By July 2018 the Clean Energy Package was still going through the European legislative process [127,128]. The reception from actors was mixed, with no consensus on issues such as ambition, comprehensiveness of issues, binding national targets, European and regional governance, planning, support and operation of renewable electricity, fair treatment of new flexibility resources, and capacity remuneration mechanisms [22,33,41–48].

Given the multi-level and multi-actor characteristics of the European energy system, uncertainty and the interaction of the dimensions of the Energy Union, the need for an Energy Union governance framework was identified [37,49]. We cover the characteristics of this specific high-level governance framework for the Energy Union [50] in Section 3.1, while Ringel and Knodt [51] present them more extensively. The governance proposal has the potential to become an integrative tool for all Union dimensions [52], and is both novel and pivotal to the Energy Union success [39,53,54].

Due to the importance of the European governance framework, there are several opinions on the shape it should take. Andoura and Vinois [37] are behind the original concept for the Energy Union. Then, Meyer-Ohlendorf [55]Sartor et al. [56] and Turner et al. [57] analyze the governance of energy and climate policies at the European level, while Steinbacher and Schoenefeld [34] and Umpfenbach et al. [58] address the role of the regional level.

Besides these prescriptive studies, other studies have a more analytical approach. Bausch et al. [23] compare the EU emission trading system and renewable energy policies to study the centralization of European energy and climate policies. Fischer [45,54] highlights the evolutionary (as opposed to revolutionary) aspect of the Energy Union, and the importance of the regulatory details. Leal-Arcas and Rios [33] analyze and commend the holistic, cooperative and transparent nature of the Energy Union. Ringel and Knodt [51] and Szulecki et al. [52] focus on the analysis of the governance instrument of the Energy Union, and finally Talus et al. [59] on the renewable energy target and support schemes.

Then, some authors focus on the governance of the power sector [20,60–64]. Other works have focused on the integrated offshore grid: the North Seas Countries' Offshore Grid Initiative provides guiding principles for the development of an integrated offshore grid [65], Jay and Toonen [35] indicate how the offshore grid faces barriers and provides opportunities for marine regional governance, and Meeus [66] analyzes different connection models for offshore wind. The

Topic: Energy Union

Term 1	Term 2
energy union	governance
clean energy package	expansion plan*
clean energy for all Europeans	decision*making
winter package	regional cooperation

Topic: Regional Governance

Term 1	Term 2	Term 3	Term 4
europ*	power	regional	governance
	electricity	north* sea*	expansion plan*

Topic: Offshore Grid

Term 1	Term 2	Term 3	Term 4
north* sea*	offshore	grid	governance
europ*		network	expansion plan*
		infrastructure	

Fig. 2. Literature search terms.

PROMOTioN [67] project looks at financial, regulatory and legal aspects for the offshore grid, Müller [68] and Woolley [69] at legal ones, and Delhaute et al. [70] at barriers for both offshore generation and transmission expansion. Nonetheless, there is a need to analyze the governance challenges for integrated offshore expansions, also in the context of the changes brought by the Clean Energy Package. However, no such research is available, so we now introduce this as our objective.

1.5. Objective

We have seen that the offshore grid and offshore wind have developed significantly in the few years, since the review of Dedecca and Hakvoort [13]. Still, integrated projects are scarce and an integrated grid requires further changes to the European governance framework. As we indicate, there is currently no analysis of the governance challenges for the expansion of the integrated offshore grid in the North Sea, especially considering the changes brought by the Clean Energy Package. Also, due to the youth of the Energy Union, the literature on it is mostly non-peer-reviewed [51].

Our first contribution is highlighting five challenges for a regional governance framework for offshore expansions in the context of the Energy Union, identifying the governance level, implementation obligation and implementation discretion issues behind them. Second, the analysis through governance dimensions we develop provides an initial pathway for the analysis of other governance frameworks, a decision-making mode whose relevance is increasing with the unbundling of power sectors worldwide. Third, we also contribute to understanding the regional level of governance. Its importance is increasing with the regional interconnection of onshore systems in Europe and the US, and the discussion on other offshore grids in Europe, the United States and Asia [71–73].

Given our objective, some aspects are out of scope in our research. First, we do not address developments at the subnational level. Second, we do not analyze other Energy Union dimensions such as energy efficiency. Third, we do not address Energy Union changes related to power distribution and prosumers. Finally, we do not discuss the integration of the offshore power sector with other marine sectors in the context of ecosystem-based marine management [74,75].

The rest of this article is structured as follows. Section 2 presents the methodology, where we select governance dimensions to conduct an analysis of the governance challenges identified in a literature review. Then, Section 3 presents the results: first a short summary of the challenges, and then their detailed analysis. In Section 4 we discuss alternative main levels for governance of the offshore grid, namely the European and national. Finally, in Section 5 we draw overarching conclusions from the identified challenges.

2. Methodology

To analyze the European governance to develop an integrated offshore grid under the Clean Energy Package, we apply a methodology in three steps. First, we conduct a literature review, based on a structured search and further sources familiar to the authors. Second, from governance studies we identify dimensions for governance frameworks, and select the most adequate ones to classify the institutions and organizations relevant to an integrated offshore grid expansion. Finally, we apply the selected governance dimensions to analyze the regional governance challenges for this expansion of the integrated grid.

Our analysis and the literature on the Energy Union consider the Clean Energy Package in its original form, as proposed by the European Commission in November 2016. In the conclusions we comment on the impact of the version of the Clean Energy Package under negotiation by the European Commission, Council and Parliament as of July 2018.

2.1. Literature review

To identify the governance challenges, we conducted a literature review on the Energy Union, regional governance and the offshore grid, which allowed for the compilation of aspects for these topics. Given the large number of aspects identified, it was necessary to concentrate on a select number. Thus, applying our own judgement we selected challenges directly related to two criteria. First, the challenges identified had to relate to the integrated offshore grid, since although relevant, other challenges were deemed too general. For example, this applies to the need for improvements in the ENTSOE cost benefit analysis, as discussed by Bhagwat et al. [76]. Second, the challenges had to relate specifically to the regional level, given the focus of this article on regional governance.

Our structured search on Google Scholar and Scopus combined the terms of Fig. 2 to identify peer- and non-peer-reviewed documents on the above-mentioned topics[a] . To the selected literature we added the

[a] Each term has multiple alternatives in order to identify all relevant documents. We restricted the search to the English documentation published since 2009, when the 3rd Energy Package entered into force. We also excluded documents with a different geographical scope than Europe or the North Seas, those focusing Energy Union dimensions not directly related to the research at hand (such as energy efficiency), and those focusing sub-national regions. * denotes the wildcard for any number of characters.

Clean Energy Package documents [50,77–79], any other relevant documents familiar to the authors, and the presentations of recent Electricity (Florence), Energy Infrastructure and North Seas Energy forums.

2.2. Governance dimensions

One can classify different governance frameworks according to several possible dimensions [80]. We present some of the main dimension groups in the literature governance, in order to select the ones for our regional governance analysis.

Treib et al. [80] develop an extensive categorization of governance according to policy (instruments), politics (actors) and polity (structure). As an example of an analysis structure for policy, the authors categorize legal instruments for governance according to the implementation obligation (binding or non-binding) and the discretion (rigid or flexible). The authors argue that these are the most crucial dimensions for policy instruments in Europe, allowing the analysis of which instruments political organizations use to reach their goals.

Then, Osofsky and Wiseman [32] discuss the dimensions of governance levels (from national to local) and actors involved (public and/or private). They argue for governance structures involving actors from all types and levels, with a focus on the interstitial regional level to provide flexibility. The dimensions selected also allow them to analyze the interests of actors and the conflicts which emerged in the specific organizations studied (covering regional structures for citizen participation, grid reliability standards, and transmission expansion).

Börzel [81] analyzes the European Union governance through the dimensions of the actors involved and rule structure (hierarchical, or non-hierarchical of mutual influence or adjustment). In this way the author highlights the primacy of public actors and the layered combination of rule structures, characterized as the 'combination of negotiation and competition in the shadow of hierarchy'. Benz [82] also analyzes the European Union governance, but prefers the dimensions of the coupling degree of elements of the governance framework, and of the interaction direction. The author discusses the adequacy of governance forms to provide decision-making flexibility, avoiding lock-ins or vulnerability to strategic behavior.

Finally, Soma et al. [83] study regional governance for an ecosystem-based management through the dimensions of integration and cooperation. While integration can vary from being fragmented to coordinated at the regional level, cooperation ranges from the confrontation of economic sectors to them working towards deliberative problem solving. The authors conclude that Europe is moving from a fragmented, confrontational marine regional governance to one that is more coordinated and deliberative. Nonetheless, while they see positive developments in cross-sectoral integration, both dimensions exhibit large gaps.

2.3. Dimensions for regional governance of offshore expansions

For our European regional governance analysis we choose the dimensions used by Treib et al. [80], namely the discretion and obligation dimensions. As seen, the authors indicate that discretion and obligation are crucial to analyze European governance instruments from the policy point of view. This point of view focuses on the policies and their instruments, instead of on actor constellations or the decision-making structures.

However, Treib et al. [80] also state that 'there are probably many hybrid forms of governance modes that combine elements of different dimensions'. Accordingly, to the discretion and obligation we add the level dimension, due to the importance of the regional level to the offshore grid, as argued in Section 1.3. This 'level' governance dimension can be compared to the 'central locus of authority' dimension of Treib et al. [80].

We now briefly discuss the selected obligation, discretion and level dimensions. The obligation to implement regulation depends not only on the legal instruments stating the obligation but also on the existing enforcement instruments. Obligation can range from binding to non-binding, meaning how much the actors have to respect them. Then, the implementation discretion dimension indicates how much freedom actors have in the regulatory details of the implementation, and goes from rigid to flexible. As Treib et al. [80] argues, obligation and discretion are closely related, but the latter indicates how much implementation flexibility exists in the organizations and institutions, i.e. if the implementation rules are very detailed (i.e. rigid) or provide general guidelines (which are thus flexible). Finally, the level dimension covers the level at which the regulations are implemented, comprising the European, regional and national levels.

Our main research question is 'what are the current challenges for the regional governance of the integrated expansion of the offshore grid?' Additionally, we analyze how the regulatory reform of the Clean Energy Package affects these challenges. To address these questions, another selection of dimensions would be possible, highlighting different challenges of regional governance and possibly focusing on other aspects of the Clean Energy Package. However, we believe the obligation, discretion and level dimensions are the most adequate, compact group for our research questions. We base our choice of governance dimensions on several arguments: our focus on policy and its instruments, as opposed to the actor constellations; the importance of the regional level for our research question; and the previous application of these dimensions on governance studies of the Energy Union and other areas.

Our selection of level, discretion and obligation governance dimensions has been thus applied explicitly or implicitly to other studies on governance. For example, on the governance of the European 2030 renewable energy targets [34,36], of the European Union [84] or of sustainable development [85]. The literature on the Energy Union also confirms the importance of the selected dimensions. Andoura and Vinois [37] advocate for flexible regional initiatives with varying degrees of member involvement and responsibility (that is, member tiers), while Turner et al. [57] on its hand indicate the governance instrument itself must be flexible. To Meyer-Ohlendorf [55] the EU energy and climate framework for the 2020 targets is adequate, combining a high-level of obligation with flexible regulation.

In Section 3 for the first time we apply these dimensions to analyze the European regional governance challenges for an integrated offshore grid. As indicated, we use the literature identified in our review, with a focus on the governance challenges directly related to the integrated offshore grid and the regional level.

3. Challenges for the regional governance of the integrated offshore grid

We first analyze each challenge identified in our literature review through the governance dimensions, and then discuss the advantages and disadvantages of regional governance in Section 4, drawing overarching conclusions in Section 5. Fig. 3 summarizes the methodology and results. Here, the literature review and the three selected governance dimensions allow to identify the five challenges for the governance of integrated offshore expansions.

The challenges are briefly described in Table 1, together with the interaction of different levels and countries. In the following subsections we detail each challenge. The first three challenges relate to every governance building block indicated by Mekonnen et al. [17], while the last two challenges we identify are more specific, relating to certain building blocks.

3.1. Top-down dimensioning challenge: European regulation must balance implementation obligation and discretion at the regional level

As seen in Section 1.2, the European centralization of decision-

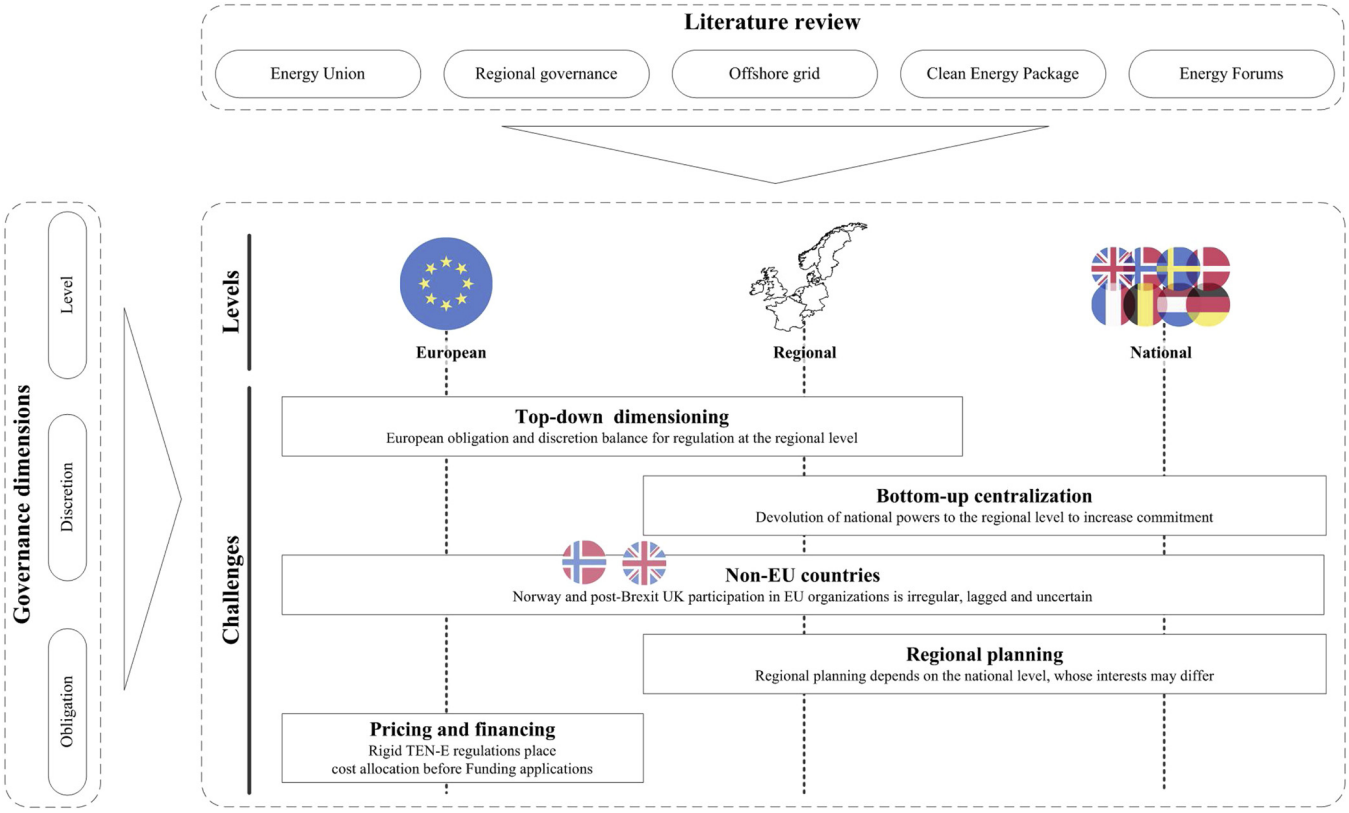

Fig. 3. Methodology and results summary.

making would allow the consideration of expansions beneficial at the continental level (including integrated ones), avoid the divergence of national regulation, internalize national externalities, and promote regulatory stability. On the other hand, complete centralization of governance is impossible due to actor fragmentation and resistance, and the national sovereignty over the energy mix. And in any case, full centralization is undesirable for a number of reasons. First, cooperation at the regional level is simpler. Second, centralization may hinder experimentation or hold back ambitious frontrunners. For example, ACER [86] recommends to remove integrated projects from the ten-year network development plan (TYNDP), such as the 3rd-party Abengoa Northern Atlantic Interconnection or the two conceptual North Sea projects. Finally, decentralization is more robust to design errors and accounts for heterogeneous national characteristics.

Thus, support for accelerated or obligatory centralization in the governance of power systems is mixed [1,2,18,87]. Recognizing the political difficulty of establishing regional cooperation from the top, Gephart et al. [36] propose 'a mix of top-down and bottom-up elements' combining rigid obligation with flexible implementation, as does the ENTSO-E [88].

Governance at the European level must balance the implementation obligation and discretion to guarantee at the regional levels the advantages of centralization, which in some cases the literature finds adequate. The first case is the novel Clean Energy Package governance regulation, leveraging reputational incentives for cooperation [39]. It requires Member States to develop integrated National Energy and Climate Plans and periodic reports, following templates with key indicators. It also includes binding but flexible cooperation of Member States and stakeholder consultations on these plans, with the involvement of the Commission. Finally, it also provides for recourse measures by the Commission in the case of insufficient ambition or delivery of European and/or national targets [39,50,51].

With the Clean Energy Package and the Trans-European Networks for Energy (TEN-E) regulation, both renewable energy projects and transmission Projects of Common Interest (PCIs) benefit from simplified permitting, while still providing countries with flexibility on the implementation of the permitting one-stop shops. Also, the Clean Energy Package promotes the convergence of national capacity remuneration mechanisms and support schemes for renewable energy [78,79]. Finally, binding regulation at the European level requires stakeholder consultations conducted by national regulators, TSOs, the ENTSO-E and ACER. Hence, in many aspects European regulation introduces an

Table 1
Challenges for the regional governance of integrated offshore expansions.

Challenges	Description	Main levels	Countries' involvement
Top-down dimensioning	European regulation must balance implementation obligation and discretion at the regional level	European-regional	All North Sea countries
Bottom-up centralization	Regional cooperation depends on voluntary centralization of national powers to achieve adequate obligation and rigidity	Regional-national	
Non-EU countries	Non-EU countries participation in EU organizations for the governance of power system expansion hinders dimension balance	All	
Regional planning	Binding and rigid regulation make regional plans depend on national ones	Regional-national	
Pricing and financing	Funding and cost allocation are interdependent but unsynchronized due to binding and rigid regulation	European	EU countries

obligation for implementation while providing flexibility.

On the other hand, in several aspects the literature recommends a different approach to implementation obligation and/or discretion. First, while the 15% interconnection target [50] is binding and rigid, it is too simplistic and contains a number of design flaws [89,90]. This is tempered by a recent expert group report, which points towards a correction of the flaws and a periodic revision of the target methodology [91]. Second, the non-binding nature of cross-border cost allocation agreements for PCIs led to many 'bridges to nowhere' in Europe [92].

Third, European organizations such as ACER and ENTSO-E are often mere coordinators, with limited powers and access to data [89,93,94]. For example, the ACER recommendations are generally non-binding, which leads to discrepancies between the national development plans and the TYNDP, shortfalls in ENTSO-E's cost benefit analysis methodology and differences in national economic incentives for transmission and generation projects [76,95–97]. While the Clean Energy Package adds some powers for ACER regarding network codes and operational aspects [77], expansion responsibilities are largely unchanged for ACER, the ENTSO-E and the Commission.

Fourth, transparency and consultation also need to be improved, both for processes which already include consultation and for more opaque ones such as the work of the TYNDP regional groups [18,90], that which indicates that the implementation is not binding or the discretion too flexible. Fifth, despite the ENTSO-E [1] proposal on Regional Electricity Forums for cooperation in policy and operational aspects, the Energy Union proposal does not comprise any regulation for the formalization of regional initiatives [98]. Finally, the obligatory cooperation between neighboring countries established in the maritime spatial planning directive is difficult, slow and vague [68,83].

These examples support an increased obligation and/or rigidity of European regulation affecting the regional or national level, which may be required where national interests may conflict with regional ones, or where detailed guidelines are necessary to avoid divergence of regulation. However, regulatory obligation or rigidity can also be counterproductive for an integrated offshore grid. This is illustrated by the recommendation of ACER [86] to remove 'non-concrete projects' off the TYNDP, including the conceptual 'Northern Seas offshore grid infrastructure' and 'West-East corridor in the North Sea' projects.

Thus, reaping the advantages of centralization at the European level for regional cooperation requires a balanced use of binding and rigid regulation, avoiding the disadvantages of centralization through flexible and if necessary non-binding implementation. Each governance aspect will require the right balance of implementation obligation and discretion, given the potential for regulatory divergence and for conflict of national interests.

While it is acknowledged that the novel Energy Union governance regulation is balanced in these dimensions, there are several examples of obligation or rigidity in transparency and participation, planning, and powers of European organizations. Consequently, rigid regulation which negatively affects integrated offshore projects by discouraging very long-term planning or specific economic incentives should not be binding. For example, the mentioned rigidity in the ACER recommendations on the TYNDP is softened by the fact they are non-binding, still allowing for the inclusion of conceptual integrated projects in the TYNDP.

3.2. Bottom-up centralization challenge: Regional cooperation depends on voluntary centralization of national powers

We indicated the regional level is pivotal for the governance of the offshore grid expansion [35,68,70]. Generally, there is 'widespread consensus on the fact that regional cooperation should be a key element of the Governance process' [99], on which the ENTSO-E [1] agrees. However, a higher obligation and rigidity at the regional level can be necessary to escape the disadvantages of regional cooperation. For example, Müller [68] considers the TYNDP inadequate as an offshore infrastructure plan because its implementation is not binding. Hence, commitment based on a shared vision is emphasized by many actors and researchers, and higher obligation and rigidity can contribute to creating and enforcing commitment [35, 70, 100,101,102].

Nonetheless, there is no agreement on the level of enforcement needed to guarantee actor commitment to an integrated grid or the Energy Union, and on the formalization of the enforcement instruments. The need for formalization of regional cooperation is also not consensual [88,99,103]. For example, the Renewables Grid Initiative questions the transfer of some operational responsibilities under the Clean Energy Package from TSOs to regional organizations [103].

According to Steinbacher and Schoenefeld [34] polycentric governance scholars advocate 'flexible entry and exit from regions', while the [1, 62],) supports the top-down definition of regional initiatives combined with flexible definition of their scope of cooperation. To Meyer-Ohlendorf [55], a 2030 EU energy and climate policy 'governance system that is largely based on political commitments with no legal basis risks undoing much of the success accomplished by the current system', while Andoura and Vinois [37] support binding rules 'properly implemented by the actors in a collective way'. Finally, Danson [30] doubts a North Sea regional initiative will be formalized in the short-term, but questions whether this is necessary at all for cooperation.

Currently, there are multiple active groups fostering the cooperation of North Sea countries. These comprise the North Sea group of the TYNDP, the Northern Seas offshore grid group of the TEN-E, the North Seas Countries' Offshore Grid Initiative (NSCOGI), the North Sea Region Programme, and more recently the North Seas Energy Cooperation initiative sponsored by the Commission (with its associated North Seas Energy Forum). However, participation and any resulting integrated expansion plans are not binding even in initiatives directly related to the integrated offshore grid. Thus, to Müller [68] regional initiatives such as the North Seas Countries' Offshore Grid Initiative are useful but do not have adequate penalties to ensure commitment.

The *implementation obligation and rigidity can partially be established by top-down regulation* at the European level. However, this is limited for a number of reasons, as discussed in the top-down dimensioning challenge. Given the gap in and importance of regional commitment that the literature indicates, *obligation and rigidity at the regional level must be partly achieved by voluntary centralization of powers* by North Sea countries, as proposed by Müller [68]. This will be more pressing once initiatives such as the North Seas Energy Cooperation delivers actionable, integrated expansion plans. *The present challenge thus requires countries to relinquish powers for the regional benefit, possibly to their disadvantage* (which is further discussed in Section 3.5). Although the Commission plays an important role sponsoring the North Seas Energy Cooperation initiative, this is not formalized in any way in the Clean Energy Package. Moreover, regional initiatives are also not addressed in the integrated National Energy and Climate Plans as a mean to incentivize regional cooperation and the centralization of national powers – the plans just indicate specific cooperation measures, for example on renewable energy or interconnection.

3.3. Non-EU countries challenge: between full and no participation in EU organizations for the governance of the power system expansion

The ENTSO-E [62] highlights the necessity to involve strongly-interconnected non-EU countries in regional initiatives for operation. It also calls for the participation of European Economic Area (EEA), European Free Trade Area and Energy Community members in its proposed Regional Electricity Forums [1].

For the North Sea, Norway and the UK are indeed pivotal for regional cooperation [30,104]. Specifically for the integrated offshore grid, many important pilot projects require either or both countries, such as the UK-Benelux or UK-Norway clusters [105]. Also, Dedecca

et al. [6] demonstrated that national vetoes to an integrated grid have a negative impact to European welfare. Finally, beyond the specific participation of these countries in the offshore grid governance, this could provide a more general solution to the involvement of non-EU countries in the European energy sector [106] and in other future offshore grids such as in the Mediterranean. Thus, there is both the necessity and interest in involving Norway and the UK in the offshore grid governance.

Norway is a full member of the ENTSO-E, the Council of European Energy Regulators and the North Seas Energy Cooperation, as well as an observer in ACER [10,104]. Moreover, the adoption of the Third Energy Package in 2017 by the European Free Trade Agreement will allow Norway to become a full member of ACER [104,107]. However, as a non-EU country it is not part of the TEN-E groups [11].

As for the UK, it is currently a full member of all of the above-mentioned organizations, but with Brexit its place is still uncertain. None of the existing solutions for non-EU countries are applicable to the UK, namely membership of the European Economic Area or Energy Community, or tailored agreements as for Switzerland [106,108,109]. Full participation in European organizations such as ACER, ENTSO-E and regional initiatives are possible, as long as energy and environmental legislation are continuously adopted into British law, and to Froggatt et al. [106] the UK is likely to incorporate the Clean Energy Package before Brexit. Moreover, actors generally indicate it is in the interest of the UK and Norway to exert as much influence as possible in European energy decision-making [104,106]. Also, many relevant regional initiatives and organizations such as the North Seas Energy Cooperation and Forum require no formal obligation on being a Member State, which provides flexibility for the participation of the UK or Norway. Nonetheless the uncertainty engendered by Brexit impacts the participation of the UK in the integrated offshore grid governance.

The participation spectrum on formal EU organizations and institutions goes from full (exclusive to Member States) to no participation (with the country being always a 3rd-party and establishing specific bilateral agreements). While Norway is closer to full participation, the lag in the adoption of EU regulation and its status as an European Economic Area member impose limits to this. On the other hand, the EU and the UK will need to find a solution which will likely be closer to the other end of the spectrum, though the UK will want to remain in the internal electricity market [106].

Full participation in European and regional organizations entails a higher obligation and rigidity, which provides some of the advantages of centralization at these levels. However, this comes at the cost of flexibility – thus the exit of the UK from these organizations may provide greater flexibility for the deployment of the integrated offshore grid. However, the complete exit of the UK from European organizations is unlikely. Thus, *there is a challenge regarding Norway and the UK: their involvement lies somewhere in the middle of the participation spectrum, restricting the advantages of either higher or lower implementation obligation and/or discretion*. While solutions theoretically exist for this challenge, the EU regulation adoption lag (for Norway) and the lack of clear solutions (for the UK) leave it a relevant and pressing issue, given the importance of these countries to integrated offshore projects. However, *the Energy Union does not change the current framework for the involvement of non-EU countries in energy and climate organizations and institutions.*

3.4. Regional planning challenge: Binding and rigid regulation make regional plans depend on national ones

So far, we have indicated challenges which can theoretically be addressed. We will now discuss two challenges arising from contradictory regulation at the European level, which are not solved by the Clean Energy Package. The first one is related to the regional planning of integrated projects. This challenge is connected to the bottom-up centralization challenge, but is moreover particular to the governance building block of planning and relates to specific contradictory regulatory issues as indicated.

To Dedecca et al. [6,14] in order for integrated projects to compete with non-integrated transmission and generation projects on an equal footing, they need to be explicitly considered at the regional level in the planning phase. Many actors advocate the deployment of integrated pilot projects as a first step towards an integrated grid, promoting cooperation, innovating, and reducing uncertainty [10,105]. However, we indicated that there are currently only a handful of integrated projects in different development stages. Moreover, the lead time for the development of pilot projects is long - in an optimistic time frame new ones would be commissioned only after 2025 [15]. Given the scarcity and lead time of integrated projects, it is thus necessary to identify and plan them as soon as possible in order to start the deployment of an integrated offshore grid and reduce uncertainty.

The North Sea regional group of the TYNDP did include some offshore integrated projects in the North Sea, Atlantic and Irish channel in its last investment plan [110]. In addition, the integrated projects of the Kriegers Flak Combined Grid Solution and the COBRA interconnector (which considers the connection of offshore wind farms) are currently being implemented with support of the TEN-E regulation [111]. Also, the North Seas Energy Cooperation initiative plans to develop an integrated offshore plan and concrete proposals for pilot projects by 2019 [112,113].

Nonetheless, these concrete examples are few, which is partly due to the regional planning challenge, as follows. Currently, projects in the TYNDP regional investment plans originate exclusively from the national development plans or from the proposal of independent developers. However, national regulators and thus TSOs are required to consider the national interest for expansion planning. This leads Gaventa [90] to recommend that national regulators need to be authorized to consider regional interests and priorities. For example, the Britib (Britain-Iberia) offshore interconnector linking Spain to the UK through France was 'rejected by the ministry' [86], and thus not included in the Spanish national development plan. Also, independent developers are less likely to develop integrated projects than regulated TSOs. For example, Meeus [66] indicates that the 'TSO model' is the most suitable in order to develop an integrated offshore grid, as opposed to a 'generator model'. Moreover, for a project to qualify as a PCI, it needs to be included in the TYNDP[b] . Hence, TYNDP and TEN-E groups play a passive role, not being able to set regional objectives, or solicit or propose new projects [90].

Hence, regional planning for integrated projects is dependent on plans developed at the national level, where the national interest may conflict with the regional one. This constitutes the regional planning challenge, where integrated projects face a barrier due to a contradiction arising from current regulation. Moreover, due to various regulatory and methodological differences this set-up also leads to an increasing inconsistency between the TYNDP and national development plans, as identified by ACER [86,114]. This 'raises doubts on the credibility and feasibility of the implementation of many TYNDP projects' [89].

Many indicate that the future governance framework should change to consider the regional and European interest. Hence, to ACER [115] the regulatory framework of the future will 'support economic investment in networks, without discriminating between national and cross-border projects, to the benefit of consumers'. De Clercq et al. [61] proposes that in the long-run all project assessments (regulated or not) should be conducted by an independent regulator. A shift to improved regional planning is advocated also by Delhaute et al. [70], Müller [68] and Gaventa [90].

Therefore, the European regulation as revised by the Clean Energy Package maintains a binding process whose rigidity makes regional plans dependent of the national level and does not provide the

[b] Annex III.2(3) of the TEN-E regulation [111]

flexibility for the consideration of integrated projects. Providing a level-playing planning field for integrated projects requires addressing this challenge, which is pressing given their scarcity and development lead time.

3.5. Pricing and financing challenge - European PCI funding and cost allocation are interdependent but unsynchronized

The pricing and financing challenge follows naturally from the regional planning challenge of Section 3.4. There we indicate that the planning of integrated projects must consider the regional interest. However, there can be a strong asymmetry of welfare distribution among countries and actors, with integrated projects possibly reducing the welfare of some North Sea countries. Hence, the distribution of costs and benefits among hosting and neighboring countries is one of the main barriers to an offshore grid [6,70,116]. In the cases where a hosting country is harmed by an integrated offshore project, cross-border cost allocation is necessary to align the country's interests to the regional one. Also, adequate public financing is an important issue for integrated offshore and transmission projects in general [117]. TEN-E guidelines allow for cross-border cost allocation in PCIs and provide financing from the Connecting Europe Facility [11], and the Clean Energy Package maintains this cost allocation and financing measures for Projects of Common Interest basically unaltered.

ACER recommendations and ENTSO-E guidelines set up the implementation discretion for cost allocation [96,118]. Hosting TSOs are responsible for reaching an agreement, with ACER acting as a recourse decision-maker. ACER recommends that countries positively affected by the project above a significance threshold of 10% of positive net benefits contribute through cost allocation, but this is non-binding. Usually, PCI investment costs are equally split among hosting countries, with exceptions such as the Estonia-Latvia interconnection, which did have a non-standard (10/90%) allocation of costs [119]. Non-standard cost allocation agreements are a relevant instrument to enable integrated offshore projects in the future, but there are only a few cross-border electricity PCIs with non-standard cost allocation.

In addition, many electricity PCIs make extensive use of the Connecting Europe Facility grants to cover a financing gap of up to 75% [119]. Cost allocation agreements are a requirement for, and thus take place before any Facility funding applications [11]. Hence, all projects depending on Facility funding assume ex-ante that the application will be successful. However, this may not be the case, generating a finance gap, which would compromise the agreed-upon cost allocation and consequently the project. We name this asynchronicity between the cost allocation and the Connecting Europe Facility the *pricing and financing challenge*, a challenge mentioned by multiple stakeholders [120–122]. Erdem [121] supports changes to the TEN-E regulation to conduct the cost allocation and funding applications in parallel and with the cooperation of European and national organizations responsible for the decision. Another solution would be to develop ex-ante adjustments conditional on the funding application outcome, but this is not consensual. For example, ACER [123] is against cost allocation being 'conditional on potential future public funding', although it tolerates 'ex-ante defined adjustments' for cost deviations.

Despite the lack of consensus on the solution, the challenge does exist: while applying for Connecting Europe Facility funds is not mandatory for PCIs and thus not binding, the TEN-E regulation is rigid in this financing aspect, placing cost allocation agreements before Facility applications. This despite them being interdependent, with several electricity PCIs depending on Facility funding. The TEN-E regulation does allow for ex-ante agreements on the reallocation of costs pending on the ex-post realization of the PCI benefits, but although encouraged by ACER this is little used and does not solve the uncertainty arising from the possible rejection of the application to Facility funds. An aspect which further complicates reaching adequate cost allocation agreements for the offshore grid are the current shortcomings of cost-benefit analysis methodologies [76]. Although we do not discuss it further, for this relates not only to offshore but also to onshore transmission projects, the current shortcomings impede the acceptance of cost-benefit analyses by all parties. This lack of trust in the cost-benefit analyses consequently compromises reaching adequate and acceptable cost allocation agreements, as indicated in the evaluation of the TEN-E regulation [124].

4. Comparison and evolution of governance levels

Section 1.2 indicated that the centralization trend currently observed in the European power sector is a combination of top-down measures with bottom-down experimentation and convergence. Furthermore, the section notes that this centralization trend will continue, although actors in the sector debate over its form and speed, and that several challenges to this centralization exist. The challenges arise from the uncertainty on the most adequate governance framework, the multiplicity of actors, the subsidiarity principle and national sovereignty on the energy mix, and recent uncoordinated and diverging measures to guarantee system adequacy (e.g. capacity remuneration mechanisms) given the increased penetration of renewable energy sources exist [4,21,22].

Decentralization also exhibits several advantages, including of technological and regulatory experimentation, not constraining ambitious frontrunners in their decarbonization policies, robustness to regulatory design errors, and flexibility to heterogeneous contexts and preferences of actors. On the other hand, decentralization can be inefficient, entails a more complex coordination among actors, may not internalize externalities, and is susceptible to free-riding [23].

Due to these considerations, actual decision-making in the European power sector is conducted through governance, combining different hierarchical and non-hierarchical institutions. This article discussed several challenges to the regional energy governance of the offshore grid, where the governance levels played a central role in the analysis, together with the obligation and discretion governance dimensions. In this section we further discuss the levels of governance and the adequacy of the regional one versus the alternatives.

Defining at which level(s) this decision-making should take place warrants the assessment of alternative approaches and of the compatibility of regional governance with them. Although the regional level is central for expansion planning in the North Sea, it is not the only one. Thus, European policy makers and researchers may advocate cooperation at the other levels: the European and the national, which will always play a role.

It must be indicated that although expansion governance at the European, regional and even national level involves the analysis of comprehensive expansion plans covering several projects at the level in question, each project should posteriorly be assessed by its individual costs and benefits in order to be implemented [6]. Thus, any expansion governance approach is a two-step process, where planning is conducted in the appropriate level in the first step and projects evaluated and implemented individually at the second.

National cooperation is bilateral, between two Member States (and project developers), and generally project-specific. Given the current trend of the centralization of European expansion planning in Europe, policy makers and researchers generally do not advocate a return to bilateral cooperation. Hence, the most interesting discussion centers on the advantages of regional versus European energy governance.

Regarding the comparison to European governance, several authors indicate regional decision-making is subject to failure to reach European targets and free-riding, is more susceptible to inconsistent or even balkanized policies, and national actors may block decision-making at the national level, among other disadvantages [22,29,30,34].

The e-Highway2050 project supports governance at the European level. It recommends as one of the regulatory principles for the governance of the European electricity network in 2050 that 'the expansion

of the cross-border transmission grid in Europe shall be coordinated centrally following a combined top-down and bottom-up approach, taking into account the needs and requirements of the countries involved through close cooperation with the national TSOs'. The second principle states that 'cross-border investment proposals should be assessed and approved centrally, by European institutions with executive powers, in accordance with Member States, while respecting national authorization procedures' [61].

Hence, support for the formalization of regional cooperation in the North Sea and in the European energy system in general is only partial [18,60,62,125]. Also, formalization in the form of a North Sea macro-region is unlikely in the medium-term [29]. Moreover, concrete integrated offshore projects are still scarce, and essentially bilateral [35]. The few examples include the Kriegers Flak Combined Grid Solution between Denmark and Germany, and the COBRA interconnector between Denmark and the Netherlands, for which studies were conducted for the possible connection of offshore wind [17,111].

The question remains of the most appropriate level to govern the offshore grid expansion. Expansions in the offshore grid will unavoidably affect all parts of the power system. In this way, the offshore grid impacts even remote European countries. However, compared to North Sea countries these impacts will be more limited and infrequent. Moreover, the impact is often positive and affects certain neighboring countries much more than others. For example, Dedecca et al. [6] identify significant positive welfare effects for Spain, Italy and Poland in certain offshore expansion scenarios, while other countries are not impacted. Nieuwenhout and van Hout [126] also find Spain benefits from the integrated offshore grid, even though it would prefer a conventional, non-integrated one. The interests of neighboring European (and non-European) countries may be taken into consideration through other measures, such as consulting significantly-affected countries, and only at necessary times, thus not over-complexifying decision-making.

Moreover, stable regional governance frameworks provide several advantages over ad hoc, project-specific cooperation between North Sea countries. Regional governance avoids the duplication of resources in the case of several specific projects between the same group of countries. Also, it allows cooperation on issues which are not project-specific. For example, the North Seas Energy Cooperation initiative works on issues such as maritime spatial planning, the planning of the integrated offshore grid, standards and technical rules, the alignment of support schemes for offshore wind, and synergies with the offshore oil & gas sector [10].

In this way the advantages of governance at the regional level outweigh the advantages of focusing on other levels, especially on project-specific cooperation. By expanding the level from the national to the regional, it is possible to include affected countries, internalize externalities and develop tailored governance solutions to the offshore grid which account for its characteristics. The main argument not to further move to the European level (yet) is to maintain the governance solution tailored to the regional level and to not over-complexify decision-making.

But the assessment of the most adequate level for expansion governance must take into account dynamic considerations, i.e. the future evolution of this governance framework. Regional governance could lead in the future to a unified pan-European governance of expansions (offshore or otherwise) as advocated by the e-Highway2050 project. This must go hand-in-hand with other trends in the European power sector such as the development of a European energy system model for expansion planning coupling the electricity and gas sectors and all geographic regions. On the other hand, a project-specific approach is more incompatible with a regional one, since the analysis of the individual offshore projects' costs and benefits would not internalize the regional benefits and costs of integrated expansions. Hence the current decision-making centralization trend observed in the European power sector could lead to the evolution from regional towards pan-European governance, but not to national governance (barring a broader crisis in the governance of the European Union). And this only if the European governance manages to still provide the flexibility required to deal with regional characteristics.

5. Conclusions

Regional governance is attracting attention as the adequate decision-making mode to conduct expansions for the European and other multi-level, multi-actor power systems. Focusing on policies and their instruments, we apply the analytical structure of implementation obligation and discretion of regulation at different levels, for a number of governance challenges for the integrated offshore grid expansion. We use our judgement to select these dimensions based on several arguments detailed in Section 2. Moreover, we base our identification of the challenge according to their relation to the governance building blocks and to the levels, but alternative categorizations could be defined. Nonetheless, the chosen categorization structures adequately the challenges and clearly communicates them to the reader.

Our main research question was: what are the current challenges for the regional governance of the integrated expansion of the offshore grid? The offshore grid is a 'blank slate' where these challenges are prominent because of the importance of regional expansion and the potential for integrated projects. This contrast to onshore grids, which are more developed, limiting the possibilities for integrated projects.

The first two challenges we identify deal with the interaction in the governance structure of the European and national levels with the regional one. In this way, they are centered on the vertical interaction of governance (between the levels). In contrast, the non-EU countries challenge deals with the participation of these countries in the European governance of expansion. Thus, it concerns mainly the horizontal interaction of countries in European, regional and national organizations.

The last two challenges we identify are more specific than the first three. Beyond involving the interaction of particular levels, they concern specific governance building blocks – planning, and financing & pricing, respectively. These challenges indicate contradictions arising from particular regulations of the European governance of offshore expansion.

Subsequently, after identifying these challenges we asked how the regulatory reform of the Clean Energy Package affects them. We indicate the governance proposal does bring positive but limited changes to the top-down dimensioning challenge. However, the Clean Energy Package measures affecting the European power sector focus the energy and climate targets governance, and the power system operation. Thus, the regional governance of expansions remains largely unchanged, and most of the challenges we identify are unaddressed.

Our analysis only identifies the challenges, but we now make some considerations in how to tackle them. For this, one must consider how fast European regulation can be modified. The offshore grid governance expansion framework and projects exhibit significant inertia. As seen, new integrated projects will take a decade or more to develop, and the Energy Union governance revision will take place only in 2026. Also, the Commission conducted an evaluation of the TEN-E regulation in 2017, but prioritized non-legislative changes [124].

Hence, non-binding and flexible governance regulation and measures are all the more important because implementing and modifying them is faster. An example of a flexible, non-binding measure would be the development by ACER of guidelines on the inclusion of concept integrated projects in the Ten-Year Network Development Plan (and consequently as Projects of Common Interest). On the other hand, the bottom-up centralization challenge highlights the limitations of top-down regulations and measures, by stressing the importance of achieving sufficient obligation through the voluntary centralization of powers to the regional level.

By July 2018 the European Commission, Parliament and Council trilogue reached an agreement on parts of the Clean Energy Package,

such as the governance and renewable energy regulations. The amendments proposed by the Council or Parliament contain some advances in specific points of the original Commission proposal. For example, on the planning and reporting of investment strategies and of infrastructure projects other than for transmission and distribution (i.e., including generation and storage). It also includes further details on the European financing mechanism for renewable energy projects, and on involving previously-existing regional cooperation organizations such as the North Seas Countries' Offshore Grid Initiative. Additionally, the Parliament proposals establish a multilevel climate and energy dialogue platform and the possibility of involvement of European Economic Area members in the Energy Union governance. These could enhance the regional cooperation and the participation of stakeholders such as civil and business organizations. However, the final regulations are not published yet, and they are anyhow insufficient to adequately address the challenges.

Moreover, this article discusses the difference and compatibility of governance at the European and regional levels. Once governance at the regional level matures and collaboration on cross-border projects in Europe increases, regional cooperation could evolve towards pan-European governance. A central pre-condition for this will be that sufficient maturity is achieved to reduce the complexity of decision-making at the European level (such as with adequate planning models). Also, European governance must be sufficiently flexible to account for regional characteristics. This will address one of the main arguments for currently focusing governance at the regional level.

Finally, our analysis using the dimensions opens up relevant areas of research for the offshore grid and regional governance of expansions. To begin with, the first three challenges (which are more general) can be further detailed for each of the governance building blocks of Mekonnen et al. [17] concerning specific regulations and their obligation and discretion. Second, the regional interconnection of onshore systems (in Europe and the US) and the discussion on other offshore grids (in Europe, the United States and Asia) is gaining momentum [71–73]. Our methodology can therefore be broadened and replicated to other regional grids, further advancing regional expansion planning theory. Third, the consideration of governance at the regional level can be assessed versus pan-European approaches considering various criteria, building for example on the work of De Clercq et al. (2015). Finally, the single-sector focus can be broadened to research cross-sectoral integration in marine governance [83], following the research agenda proposed by van Tatenhove et al. [75].

Declaration of interest

None.

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