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Mapping offshore renewable energy governance

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ABSTRACT

This article has an empirical focus on energy transition using the emerging offshore renewable energy (ORE) industries in the context of global governance. First, it explores and assesses pertinent discussions on sustainability and transformation within energy systems and the marine space. Then, it studies potential policy linkages within ORE governance which, although relying on clearly defined objectives and targets (e.g. climate change mitigation, increased share of renewable energy, energy security), could translate into polycentricity and institutional complexity/fragmentation. Previous research has focused on the technical, legal and policy challenges of deploying ORE technologies, however there is not any systematic review of who are its global governors. Certainly, the importance of the International Renewable Energy Agency and other renewable energy intergovernmental institutions has not been overlooked. Nevertheless, there are other international organisations whose mandate extends beyond renewable energy and several non-state actors who claim a role in ORE governance. This article puts forward a comprehensive analysis of the institutional architecture of global ORE governance with emphasis on the EU in order to shed a light on how ORE is being governed and who is involved. Results should advance knowledge on the scope, type and function of the institutions currently governing the exploration and exploitation of offshore renewable resources.

1. Introduction

In the Information Age, modern society relies heavily on activities that require high energy consumption. Consequently, with population growth and economic development comes a higher demand for energy input [1]. Historically, members of the Organisation for Economic Co-operation and Development (OECD) have the highest share of energy intake, and most of these economies have developed based on fossil fuels: oil, coal and natural gas [2]. While oil powers most of the transportation sector, coal and natural gas power most of the electricity. In a nutshell, power plants burn fossil fuels to create electricity which entails large emissions of carbon dioxide, a gas that promotes the greenhouse effect and is often associated with global warming [3].

As a pioneer in climate change mitigation policies, the European Union (EU) has been making efforts to shift from this business-as-usual scenario to a setup that allows countries to limit the increase in global average temperature well below 2 °C above pre-industrial levels, and to pursue efforts to stay below 1.5 °C.[1] "Renewable energy is a fundamental and growing part of the global energy transformation" [4], and combined with energy efficiency, it has the potential to put the world on the 2 °C pathway and on track to achieve several Sustainable Development Goals (SDGs). Ensuring access to (sustainable) energy (SDG7), managing climate change (SDG13) and promoting ocean conservation (SDG14) represent defining challenges of the 21st century and are included in the United Nations' 2030 Agenda for Sustainable Development *Transforming our World* [5]. Turning this Agenda into practice requires innovative thinking and dedicated action from governments—mainly, but not only. States might have the primary responsibility to follow-up and review the SDGs, but there needs to be international cooperation and coordinated action of all stakeholders to achieve solutions to these shared problems [6].

In fact, "looking at intergovernmental processes is only part of the story of governance in any arena" [7]. This idea is reinforced by Avant and colleagues who acknowledge that "[t]he global policy arena is filled with a wide variety of actors – international organisations, corporations, professional associations, advocacy groups, and the like – seeking to 'govern' activity in issue areas they care about"[8]. These active agents are also known as governors. Shove and Walker found that in order to dislodge currently dominant socio-technical regimes[2] and replace them with new configurations, "most recommend the

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[1] Recently formalised by the Paris Agreement, the first-ever universal, legally binding global climate deal.

[2] The energy supply sector is often conceptualised as a socio-technical system consisting of networks of actors such as individuals, firms, civil society organisations, etc., and institutions comprising societal and technical norms, regulations, standards of good practice, and more [9].

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deployment of multiple methods and tools for intervention, also arguing for processes of governance (rather than government), for the involvement of diverse actors and knowledge" [10]. Transitions within socio-technical systems are characterised by changes among several dimensions: technological, material, organisational, institutional, political, economic, and socio-cultural [9]. "[T]ransforming the energy system involves replacing, or supplementing, established technologies with new ones. (…) However, there is a considerable risk that the existing configuration of competence, networks and institutions actually manages to hinder the process of creating variety" [11].

Governance and politics have been previously described as essential "to understanding, analysing, and shaping transformations towards sustainability." [12] Thus it seems plausible that a transformative agenda for sustainable development might require 'transformed governance' [13]. The scale of ongoing change is so significant, and the role of energy in modern life so central, that if the system needs to change, its governance also needs to [14]. In this context, one should perceive 'transformed governance' as a result of the 'governance turn' or "the increasing importance of multilevel decision-making arenas, the involvement of more stakeholders and thus the formation of policy networks and/or networked forms of governance" [15]. This should primarily translate into strengthened governance beyond the state: network-like arrangements of public and private actors, coalitions between business organisations and NGOs, and public-private partnerships [16].

Renewable energy plays a key role in mitigating global greenhouse gas emissions by radically lowering the emissions' profile of the global energy system, therefore it should be at the centre of any strategy for countries to meet their climate goals while supporting economic growth and domestic value creation. The International Renewable Energy Agency (IRENA)[3] has recently issued the REmap report [18] which comprehends a roadmap strategy to double the renewable share in global energy use by 2030. If this were to occur, it could potentially translate into a great reduction in air pollution and large financial savings. These forecasts cover multiple types of sustainable energy sources which are crucial elements for the energy transition, including offshore renewable energy (ORE) or renewable energy produced in the marine environment, namely offshore wind and renewable ocean energy.[4]

ORE governance has been increasingly investigated in the past few years with a recent focus on the legal and policy challenges of developing the industry (e.g. complex permitting, consenting timescales, seabed ownership, Environmental Impact Assessment, grid connection, funding) [20–25]. However, none of these studies seems to: (1) understand the influence of climate change, energy, oceans and potentially other policy domains on the actual scope[5] of ORE governance, (2) systematically identify the full spectrum of institutions and actors involved, and (3) demonstrate the complexity of ORE governance. Therefore, these are the three objectives of this article. It contains a comprehensive analysis of the institutional architecture of ORE governance with emphasis on the EU with the aim of acknowledging who are its governors, which issue areas they cover and which functions they perform.

The article is structured as follows: the Introduction (Section 1) contextualises this study and assesses pertinent discussions on sustainability and transformation within energy systems. The Literature Review (Section 2) summarises the current state of affairs of offshore renewables, and describes the potential linkages between ORE and other issues in the global agenda while exploring notions of polycentricity and fragmentation. The Conceptual Basis (Section 3) defines key concepts used throughout this article such as governance, governance architecture, regime complex, institutional complexity, polycentricity and fragmentation. Next, the Methodology (Section 4) briefly explains the analytical framework used to map the types, functions and issue areas covered by relevant institutions currently governing the exploration and exploitation of offshore wind and renewable ocean energy. Results are shown in Section 5 which also provides a clear visualisation of the governance architecture of ORE. The significance of these results are then addressed in the Discussion (Section 6) which also hints at future research. Finally, Section 7 presents a summary of the main Conclusions.

2. Literature review

Although renewable ocean energy and offshore wind are at different stages of development, the fact that these forms of energy might roughly share the same legal and policy challenges given the resources' attributes and their localised nature justifies studying offshore renewable energy as a whole. Offshore wind energy, the most mature form of ORE, is growing at a remarkable pace as projects move further offshore and potentially to deeper waters due to significant reduction of costs [27] and technological developments such as the Vestas turbine capable of 8 MW power outputs [28] and floating devices [29]. Total offshore wind production already surpasses 14 GW with the North Sea region being considered the global leader in installed and planned capacity. The United Kingdom (UK)[6] is the largest producer (over 5 GW), followed by Germany and Denmark [30].

On the other hand, ocean energy technologies have progressed at different speeds. Wave and tidal energy have been actively investigated at the international level for a number of years, whereas research into ocean thermal conversion and salinity gradient are still in the early stages. The urgent demand for clean energy and the great potential of these resources have been the main drivers for increasing interest in the EU [19]. Tidal stream or current devices which resemble submerged wind turbines explore the kinetic energy in tidal currents and are the most developed form of renewable ocean energy generation, fact that can be partially attributed to the higher predictability of tides in relation to waves. Currently, France and the United Kingdom are the EU countries with the highest installed capacity of tidal energy [31].

Harnessing offshore renewable energy is innovative, promising, and it is at the intersection of various concerns and interests [32]. It offers potential job creation and might help with energy security and development agendas, but it is located in a complex and delicate environment and considerable uncertainty remains as to the environmental impacts of the technologies. Notwithstanding, if included in countries' energy mixes, both can certainly contribute to advance carbon mitigation goals and renewable energy targets.

According to Florini, "even by the low standards of most global governance, energy policy fares particularly poorly." [33] As a "cross-cutting issue of transboundary policy-making" [34], energy not only comprises different policy problems but also interacts with different issue areas of global governance (e.g. security, environment, trade, development cooperation). This means that "decisions aimed at other goals often shape energy in an uncoordinated and incomplete way" [34]. Furthermore, energy is not characterised by "a single regime in the formal sense of a coherent framework of principles, rules, norms

[3] The IRENA was created in 2009 following growing concerns over the energy and climate crisis and it is headquartered in Abu Dhabi (United Arab Emirates). The leading states behind IRENA's creation – Germany and, to a lesser extent, Spain and Denmark -, are all founding members of the International Energy Agency (IEA). The IEA, located in Paris (France), has worked on renewables for over three decades. Although its membership is reserved exclusively for developed countries, it is often referred to as the closest we have to a "World Energy Organisation" [17].

[4] According to IRENA [19], the generation of electricity from renewable ocean energies requires the exploration of ocean energy resources such as ocean surface waves, tidal currents, tidal range, deep ocean currents, thermal gradients or changes in salinity.

[5] "The actual scope is the set of issues to which attention is actively being paid by a set of relevant actors" [26].

[6] All UK references throughout this article comprehend assessments made while it was still part of the EU.

and decision-making processes" [7], neither is ORE. There is not one sector-specific international instrument or institutional framework operating at the global level "to deal comprehensively with all dimensions of energy governance" [35], the same applies to offshore renewable energy. Since ORE's regulation is dispersed across various areas of international (and national) law and a plethora of institutional arrangements, potentially representing multiple centres of decision-making authority, we might be facing a polycentric, multi-level system of governance [36] with overlapping issue areas.

As pointed out before, in my understanding, the objectives around which ORE governance is organised stand at the intersection of several policy domains and agendas which have quite complex governance architectures per se, thus any policy linkages between these are, consequentially, governance linkages. First of all, representing a form of energy, ORE is part of the global energy governance (GEG) architecture, more specifically the renewable stream. As a marine activity, it is encompassed by the overarching regime complex for oceans. Given its potential to accomplish several climate change mitigation goals set out by intergovernmental organisations (e.g. United Nations), I would say that ORE governance is deeply intertwined with global climate change governance. Even though there is clear evidence of these linkages, the significance of such interconnections in terms of institutional context and actors remains unknown.

Governing any form of energy requires cooperation between public and private actors. On one hand, "public policymakers constrain private energy producers through regulatory measures and attempts at correcting market failures, (…) set incentives for them to develop or deploy new technologies." [35] On the other hand, private companies as major producers and consumers of energy are key players in the development of new technologies [35]. Additionally, we cannot overlook the "the expertise, monitoring, and implementation capacities of private actors. Non-governmental organisations (…) and social movements also have stakes in energy governance, because it impacts on values they promote, such as socio-economic development, social justice, and ecological sustainability." [35]

It comes as no surprise that energy governance has been described as fragmented by energy source (e.g. oil and gas, nuclear, renewable) [7] and by issue area/policy problem [34]. The fragmented structure of GEG results from different aspects of energy policy-making being dealt with by different bureaucratic silos and analysed by separate groups [34]. Similarly, "effective renewable energy governance (…) has become a major challenge of public international law and EU law due to the fragmentation of the system and the proliferation of institutions." [37] Thus, the governance architecture of renewable energy is perceived as polycentric and very complex due to "lack of cohesiveness of the global and European renewable energy systems, divergent national interests, and a diversity of energy sources." [37] Given that there is no holistic approach to ORE-related issues in global governance either, it is likely that fragmentation is also a characteristic of ORE's governance architecture.

There seems to be political interest for offshore renewables to succeed, this is demonstrated by the growing attention of various key international energy governance institutions, namely: the International Energy Agency and the International Renewable Energy Agency [24]. Notwithstanding, it is important to realise that the creation of specialised renewable energy agencies "raises the spectre of further institutional fragmentation in global energy governance along sectoral lines, with each sector having its own international institution." [17] Of additional importance to this study are also: non-state actors who claim a role in ORE governance by being involved in transnational institutions whose governance goal is in line with the development of offshore renewables (e.g. Renewable Energy Policy Network for the 21st Century (REN21)), and also other relevant intergovernmental organisations whose mandate extends beyond renewable energy (e.g. World Bank). Both categories are often neglected in the academic literature pertaining to offshore renewables, nonetheless they should be considered since they are likely incremental to the complexity/fragmentation of ORE governance.

3. Conceptual basis

Governance comprehends "any and all of the myriad ways in which groups of people attempt to solve collective action problems, deal with externalities, and ensure the provision of public goods." [33] Whereas "'global governance' refers to efforts to deal with a wide range of border-crossing issues involving multiple states and other actors from multiple parts of the world." [33] This includes the work of intergovernmental or international institutions established by governments, but also other/new modes of governance such as agenda-setting, negotiation, self-regulation, implementation and monitoring that can be played by private actors (either alongside public actors or not) which adhere to transnational institutions. These multi-actor responses can provide a 'polycentric order' [38] and form polycentric systems which are characterised by "many centres of decision making and different levels of organisation where participants make many (…) rules that affect the use of a resource system." [39] This results in different actors having authority over one issue and exercising their authority independently through distinct (types of) institutions. Therefore, institutional complexity occurs when "two or more distinct regimes generate interlocking governance structures relating to broad issue areas (e.g., climate, biodiversity) and coevolve" [40]. These international regimes "are defined as principles, norms, rules, and decision-making procedures around which actor expectations converge in a given issue-area." [41]

A few scholars have put forward conceptual and analytical frameworks that directly or indirectly can be applied to the study of this complexity within the energy domain, and within ORE in particular. Raustiala and Victor [42], for example, suggest a regime complex approach to study issue areas characterised by multiple overlapping regimes. The term regime complex refers to "partially overlapping and non-hierarchical institutions governing a particular issue-area" [42] This term is akin to Biermann and colleagues' concept of governance architecture, which they define as "the overarching system of public and private institutions that are valid or active in a given issue area of world politics" [43]. Consequently, by mapping fragmentation within governance architectures, I mean mapping the "patchwork of (…) institutions that are different in their character (organisations, regimes, and implicit norms), their constituencies (public and private), their spatial scope (…), and their subject matter (from specific policy fields to universal concerns)." [43] Fragmentation is considered "an inherent structural characteristic of international relations today." [44] This means that all policy domains display some degree of institutional complexity and thus can be placed on a continuum ranging from low to high fragmentation. This degree of fragmentation depends on several factors, inter alia, the delineation and framing of the issue area in question [44]. It is outside the scope of this article to measure the degree of fragmentation[7] or the performance of the system for ORE governance.

4. Methodology

Keohane and Victor's [46] method of mapping the regime complex for climate change only included inter-state institutions. A different approach is suggested by Abbott [47] who places transnational schemes operating for climate change governance in a triangle shape divided into seven zones (illustrating the different types of institutions or

[7] There is still considerable debate on how to measure the degree of fragmentation within governance architectures, and although some indicators have been studied (e.g. network constellations, discourse analysis), their operationalisation along with the interpretation of results requires further research [45].

combinations of actor types) to show the results of his mapping. Furthermore, Abbott stated that if one were to combine Keohane and Victor's mapping with his governance triangle, one would get the *true climate change regime complex*. This is what Pattberg and colleagues did, they called it the *true governance triangle* for climate change [45] and forests [48]. The authors adopted Keohane and Victor's vision that it should comprise the relevant intergovernmental institutions plus Abbott's idea of incorporating the expanding array of transnational institutions as well. By merging these two approaches, we get a more comprehensive way of mapping fragmentation in environmental governance architectures [49], which is why I decided to apply it to offshore renewable energy in this article.

Firstly, this framework envisions the creation of a database of institutions that perform different governance functions to achieve a specific governance goal: the development and deployment of offshore renewable energies. As suggested by Abbott, I map and classify different institutions according to the type of actors involved (e.g. intergovernmental bodies, business firms, civil society organisations (CSO), and varied combinations of public and private stakeholders[8]) and their governance function(s): standards and commitments, operational, information and sharing, or financing. I add identifying the core issue area or policy domain of each institution as an extra step. When deciding to include an institution in this database and later on in the triangle, the following criteria apply:

(a) These are currently active international[9] or transnational[10] institutions since they operate in more than one country;
(b) They take on one or two main governance functions because they actually undertake to steer the conduct of target actors toward a collective goal;
(c) This collective goal is to directly[11] and intentionally promote the development and/or deployment of ORE;
(d) They should be considered institutions of governance even though many of them engage primarily in information sharing, financing, or operational activities rather than standard setting.

The mapped schemes appear significant not only on public and policy discussions but also online databases such as the Non-State Actor Zone for Climate Action (NAZCA)[12] and scholarly literature aimed at taking stock of the global governors of climate change and renewable energy [26,34,37,45–47,50–52]. Much like these scholars, I do not purport to include every single organisation governing ORE, I rather intend to capture the diversity of institutions, issue areas, functions and actors involved. Additionally, it is worth stating that I comprehend developers, owners and operators of ORE (e.g. Siemens, ENGIE) as actors, not institutions, as classified by Wieczorek and other [53]. Therefore they will not appear in the governance triangle, notwithstanding I expect them to be members of some of these governance institutions.

Secondly, the operationalisation of this analytical framework includes visualising the overall architecture using a triangle shape which emphasises the type of actors involved and their functions. Institutions are placed in the triangle in accordance with the identity of their constituent actors, not all of the actors that participate in the scheme, but rather its founding members and members with decision-making power. Ultimately, an institution is classified as: *State* which includes individual states and collections of states or intergovernmental organisations (Zone 1); *Firm* which includes individual business firms, groups of firms and industry associations (Zone 2); *CSO* which includes individual CSO as well as CSO coalitions and networks (Zone 3); or *Collaborative*, containing two types (Zones 4, 5 and 6) or all types of actors (Zone 7).[13] Apart from this organisation, the placement of the institutions within each zone is random.

The governance function[14] of each institution is also classified according to Abbott's framework: *Standards & Commitments* include rule-making, mandatory compliance, standards for measurement and disclosure of activities, and voluntary commitments or RSS standards which govern the quality of projects.[15] *Operational* schemes focus on, for example, project development and implementation, skills enhancement and best practice dissemination (which may require some incidental standard-setting). Forums for *Information and Networking* provide technical consulting and information services to build capacity, share knowledge, and support local government. Finally, *Financing* is a specific type of operational activity, and its meaning is straightforward.

The information provided at each institution's website (e.g. “About”, “Mission”) is fundamental to assess its governance function(s), the issue area(s) it addresses and the actors involved. Moreover, in some instances the “Members” section of these institutions' websites along with their reports were screened in search for other institutions that could be relevant for this mapping.

5. Results

Considering the true governance triangle of ORE governance (Fig. 1) and the detailed database of relevant arrangements available in Appendix, it is clear that most of the institutional complexity lies in Zone 1 which represents the public sector. More than half of the institutions of ORE governance are state-led (56.4%) or involve state's collaboration (72.7%). Nonetheless, evidence that non-state actors play a significant part in ORE governance should not be overlooked. Although important institutions such as IRENA and IEA are state-led, key governance institutions operating for these types of renewable energy are private-led, for example, WindEurope and the Ocean Energy Europe (OEE). Furthermore, there is evidence that (offshore) wind energy is not only more mature in terms of installed capacity but it is also more institutionalised than renewable ocean energy.[16] According to my findings, whilst there are five institutions dealing solely with wind energy (although not offshore wind exclusively), two European and three with global scope, there are only two dedicated solely to ocean energy, one international and one European: IEA's Ocean Energy Systems (OES) and Ocean Energy Europe (OEE), respectively. A quick analysis of these seven specialised institutions (five for wind energy and two for ocean energy) and their members (total of 1038 members in all seven institutions) highlights some of the pivotal private actors involved in ORE governance (members of both wind and ocean energy institutions), namely Siemens, EDF France, ENEL Green Power, ENGIE and more (Table 1). The low number of shared members (below 2%) between wind and ocean energy institutions suggests that their governance

[8] E.g. partnerships, networks, organised exchange of experience and plans, voluntary commitments, ecolabels.

[9] Moreover, since my focus is on the European Union, I also include regional institutions operating at the EU level.

[10] I include not only legal regimes, but also public and private initiatives, financial support mechanisms, eco-labels and voluntary agreements and commitments since these represent examples of new modes of governance mainly initiated by non-state actors. However, I exclude research institutes and think tanks.

[11] This may include institutions whose mandate is not primarily focused on ORE but because of the linkages between policy goals (as described previously), they still claim a role in ORE governance (inter alia, climate change mitigation, renewable/clean energy promotion, ocean conservation).

[12] More information available on: http://climateaction.unfccc.int/.

[13] All three actor groups are defined broadly, so that among them they encompass virtually all participants in transnational governance.

[14] Like Abbott, I consider the primary activity or in some cases two primary activities of a scheme, relatively to the way they pursue ORE's governance goal.

[15] I consider that eco-labels and soft law, among other schemes, also have this function.

[16] For example, whilst an European Technology and Innovation Platform on Wind Energy (ETIPWind) has already been established to connect Europe's wind energy community, the European Commission is still working on developing an ETIPOcean (for more information: http://cordis.europa.eu/project/rcn/205421_en.html).

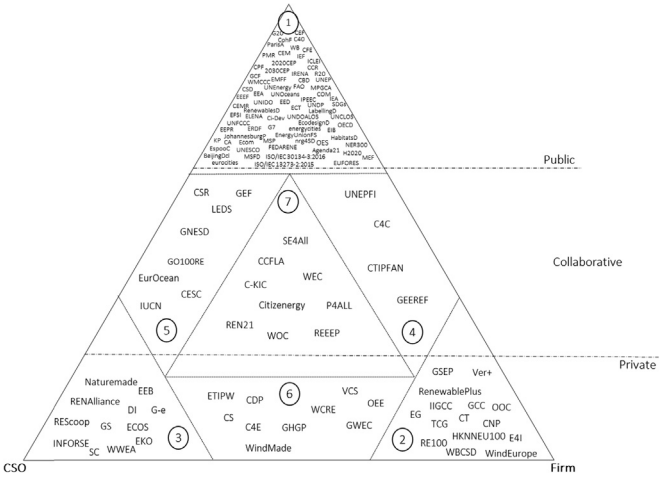

Fig. 1. The true governance triangle of offshore renewable energy comprising international and transnational institutions.

might involve different private actors (including different project developers), however they seem to have the same public ones given that there are virtually no specific state-led institutions for either.

Table 2 shows the distribution of functions across all seven zones of the triangle. Despite the fact that Zone 1 of the triangle has the largest representation of almost all functions except for Standards and Commitments + Financing which is inexistent in the whole sample, and Operational + Financing which only one institution in Zone 2 performs, generally each of the 133 institutions tends to engage in only one of the four primary functions (74.3%). In terms of functional differentiation or as an attempt to associate specific governance functions to different zones of the triangle (Fig. 2), it can be argued that standards and commitments are heavily promoted by both public and private institutions, but not nearly as much by collaborative initiatives. The difference being that states lead by creating binding regulation applicable to ORE, whilst the private tier provides certification schemes for renewable energy. It is also noteworthy that financing is mainly provided by state-led institutions or collaborative initiatives where states are present. Furthermore, we must acknowledge the substantial

Table 1
List of members shared by wind and ocean energy-specific governance institutions.

	Institutions						
Members	**WindMade**[a]	**WWEA**	**WindEurope**	**GWEC**	**ETIP**	**OEE**	**OES**[b]
DNV GL	X	X	✓	✓	✓	✓	X
Siemens	X	X	✓	✓	✓	✓	X
ABB	X	X	✓	X	✓	✓	X
Asociación de Empresas de Energías Renovables (APPA)	X	X	✓	✓	X	✓	X
EDF France	X	X	✓	X	✓	✓	X
ENEL Green Power	X	X	✓	X	✓	✓	X
Offshore Wind and Other Marine Renewable Energies in Mediterranean and European Seas (OWEMES)	X	✓	X	✓	X	✓	X
RenewableUK	X	X	✓	✓	X	✓	X
Syndicat des Énergies Renouvelables	X	X	✓	✓	X	✓	X
Tecnalia	X	X	✓	X	X	✓	✓
AXYS Technologies Inc	X	X	✓	X	X	✓	X
DCNS	X	X	✓	X	X	✓	X
ENGIE	X	X	✓	X	X	✓	X
L'Agence Régionale - Pays de la Loire Territoires d'Innovation	X	X	✓	X	X	✓	X
Offshoreenergy.dk Renewables	X	X	✓	X	X	✓	X
ORE Catapult	X	X	✓	X	X	✓	X
Ramboll	X	X	✓	X	X	✓	X
Scottish Development International	X	X	✓	X	X	✓	X
SgurrEnergy	X	X	✓	X	X	✓	X

X = not a member; ✓ = member.

[a] WindMade is a global consumer label identifying products and companies made with wind energy. Thus, its 51 members are actually WindMade certified companies and organisations. It is interesting to see that none of the private actors identified as common to offshore wind and ocean energy institutions seem have this certification.

[b] Even though IEA's Technology Cooperation Programme on Ocean Energy Systems is classified as an intergovernmental institution, some of the 25 members/governments are represented by national research institutes or industry associations or even private companies. Thus technically it is a collaborative initiative.

Table 2
Breakdown of the governance functions found within each zone of the triangle.

Zone	**Functions**										
	Standards & Commitments	Operational	Information & Networking	Financing	Standards & Commitments + Operational	Operational + Information & Networking	Information & Networking + Financing	Standards & Commitments + Information & Networking	Standards & Commitments + Financing	Operational + Financing	**Total**
1	28	4	10	15	2	7	2	7	0	0	75
2	8	2	3	0	0	1	0	0	0	1	15
3	6	1	1	0	0	3	0	1	0	0	12
4	0	0	1	2	0	1	0	0	0	0	4
5	0	1	4	1	0	0	0	2	0	0	8
6	2	3	0	0	1	3	0	1	0	0	10
7	1	1	3	2	0	1	0	1	0	0	9
Total	45	12	22	20	3	16	2	12	0	1	**133**

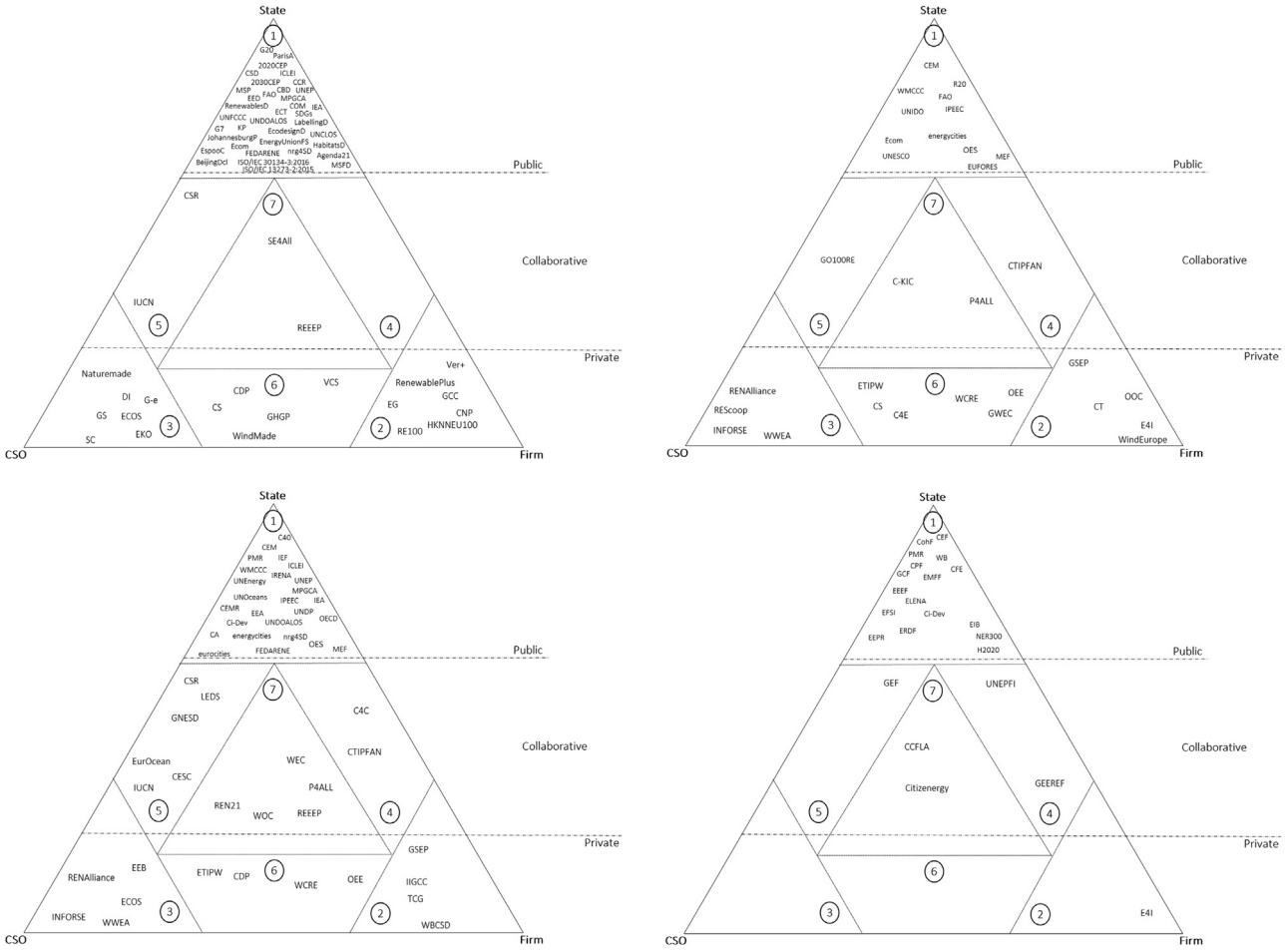

Fig. 2. Breakdown of the main ORE governance triangle into four sub-triangles illustrating the distribution of the four main functions adopted by these institutions (some appear in more than one sub-triangle given their dual function in regards to ORE governance). Figure 2.1. (top-left) ORE governance sub-triangle representing all of the institutions in different zones that perform a standards and commitments role in ORE governance. Figure 2.2. (top-right) ORE governance sub-triangle representing all of the institutions in different zones with operational functions in ORE governance. Figure 2.3. (bottom-left) ORE governance sub-triangle representing all of the institutions in different zones that perform information and networking activities for ORE governance. Figure 2.4. (bottom-right) ORE governance sub-triangle representing all of the institutions in different zones that provide financing for ORE governance.

number of information-based schemes in all zones of the triangle which corroborates the importance of new modes of governance and non-state actors within global governance, and ORE in particular.

In this article I hypothesise that offshore renewable energy is connected with (and may even represent one of the linking elements of) several SDGs, particularly climate change, energy and oceans. After mapping the institutional apparatus for ORE governance and the issue areas it covers, the actual scope and objectives of ORE's development seem to include: energy security, promotion of renewable energy (namely wind and ocean energy), economic development and international cooperation, climate change mitigation, environmental protection, and ocean conservation (Fig. 3). The most prominent issue areas within ORE governance, according to the number of institutions for each are: climate change and renewable energy (each representing 22% of the overall architecture), followed closely by energy (19%), and environment (15%). Each institution in the triangle tends to act mainly in one specific policy arena, however different types of institutions (in distinct zones of the governance triangle) touch upon multiple issues in different proportion (Fig. 4). Again, most of the eight issue areas are well represented in Zone 1 of the governance triangle. The only potential association between issue areas and types of institutions seems to be between wind energy and the private tier since all of the wind energy-specific schemes that were mapped are in Zones 2, 3 and 6. State dominance over the remaining issues seems to be higher for the issue of 'Development' and arrangements classified as 'Other', these mostly represent funds and banks and thus it makes sense that they are found exclusively under the mandate of states.

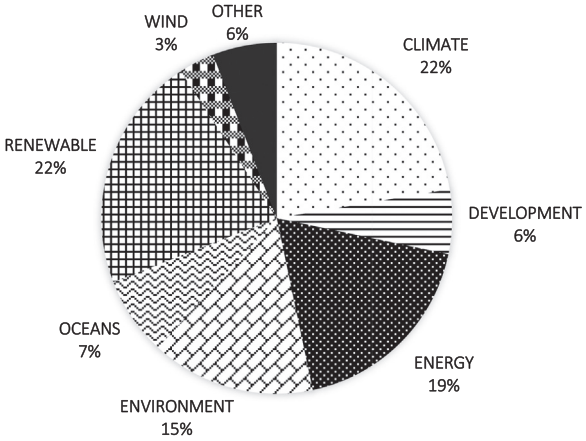

Fig. 3. Summary of the main issue areas addressed by institutions within ORE governance.

6. Discussion

The first goal of this article was to understand how the development and deployment of offshore renewable energy intersect with the institutional architectures of climate change, energy, oceans and potentially other policy domains. Thus the second goal had to be mapping the

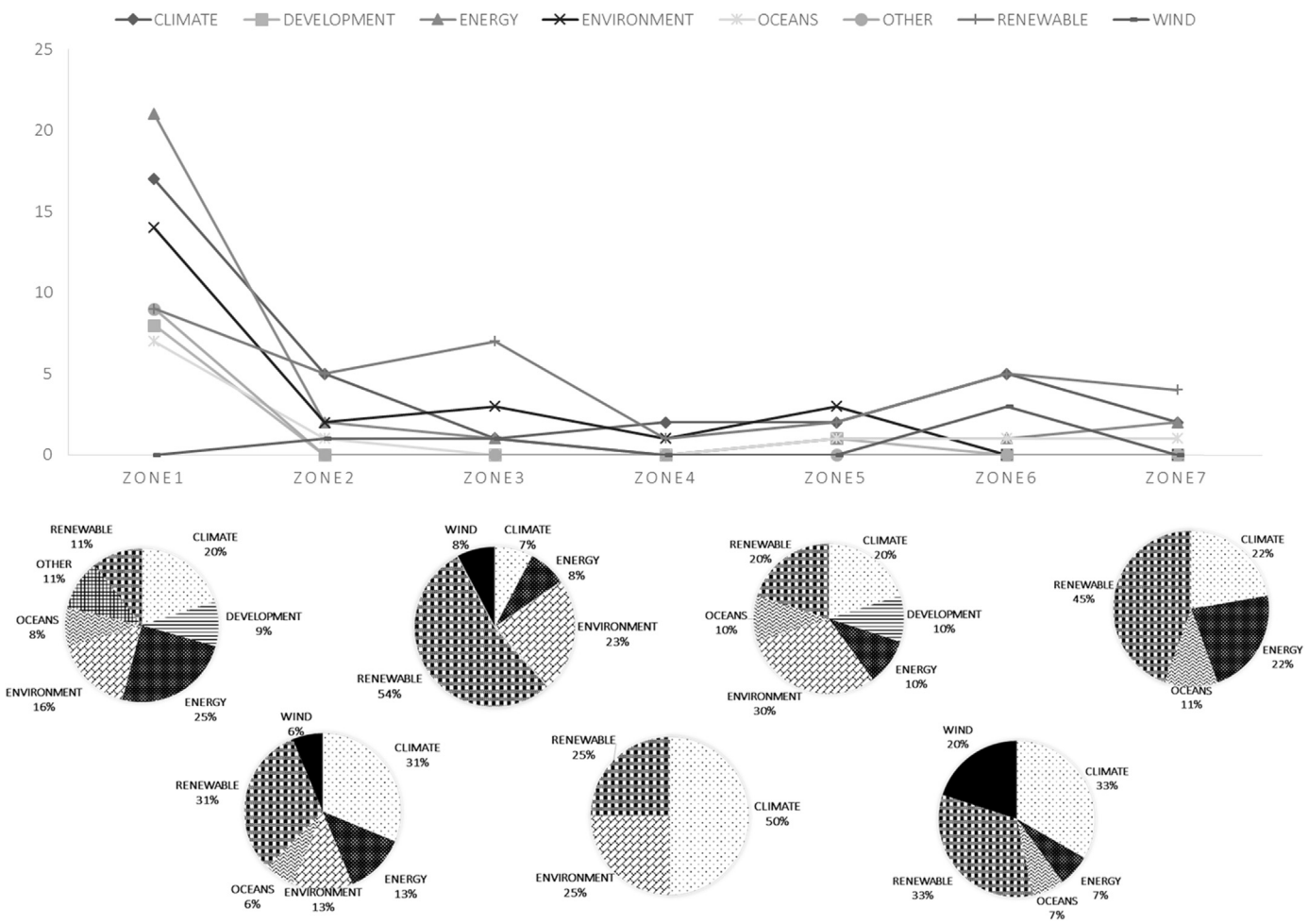

Fig. 4. Distribution of issue areas by zones of the ORE governance triangle. The graph displays the variation of the number of institutions of each issue area in the different zones. The supplementary pie charts depict the relative frequency percentages of the different issue areas within each zone (if an issue area is not represented in a pie chart, it means that its frequency is zero within that zone).

full spectrum of institutions involved in ORE governance at the international level with emphasis on the EU. As an established leader in installed capacity of offshore renewables, the EU constitutes a great case to study the types of institutions that govern ORE, the issue areas they cover and the functions they perform. Finally, the last goal was to visually demonstrate the complexity of ORE governance by showing its true governance triangle, and assess if the notions of polycentricity and fragmentation apply.

Results corroborate the argument that ORE governance is driven by various regime complexes or governance architectures that deal with different issues areas. This article started by acknowledging ORE's potential to help accomplish at least three SDGs: access to clean energy, managing climate change, and ocean conservation. Nonetheless, findings support the idea that the actual scope of ORE governance can go beyond these goals. Offshore renewables are recognised and supported by institutions trying to improve energy security such as the International Energy Forum (IEF) and Energy4Impact, and Clean Energy Ministerial (CEM), Sustainable Energy for All (SE4ALL) and Power for All (P4ALL) that also work to increase the share of renewable energy around the globe. ORE is not only a significant part of climate mitigation commitments (e.g. 2030 Climate and Energy Framework, Covenant of Mayors for Climate & Energy), but it is also included in economic development agendas (e.g. Carbon Initiative for Development) and funds (e.g. Global Energy Efficiency and Renewable Energy Fund, Cohesion Fund), environmental protection projects and initiatives such as ICLEI – Local Governments for Sustainability and the Global Network on Energy for Sustainable Development, and taken into consideration by organisations working on ocean conservation (e.g. World Ocean Council, Our Ocean Challenge).

Therefore, the initial policy linkages were confirmed as governance linkages that increase the complexity of ORE governance, especially in the public domain. Public arrangements that are aimed at, inter alia, environmental protection, conservation of the marine environment and energy governance perform activities that influence ORE's growth and thus are active parts of ORE's governance architecture, even if they were not created with that intention at first. This is particularly true for international regimes that due to their mandate intrinsically include offshore renewables, such as the Espoo Convention and the United Nations Convention for the Law of the Sea (UNCLOS). Therefore, this diversity and complexity of state-led institutions seem to derive from the fact that most of these institutions have incrementally claimed overlapping functions in regards to ORE governance in the absence of any hierarchical organisation. While there are specific private-led institutions for wind and ocean energy, there are virtually no public arrangements that specialise. The private schemes are essentially industry associations comprised of project owners, technology developers and research organisations that seem to perform the same types of functions (according to Abbott's classification) that states do, except for financing (at the international level).

Van de Graaf and Colgan suggest that “the ‘retreat of the state’ is overstated in many narratives of globalisation” [26], my results indicate that this is also true for ORE governance at the EU level, nevertheless there is strong “evidence that non-state actors have come to play a more important role in issues of public policy.” [33]

Ultimately, characterising institutions as more or less relevant in ORE governance or defining "the 'core' of the regime complex depends significantly on which objective(s) are at issue." [26] If one focuses on energy-related matters, institutions such as IEA, IPEEC or WEC will stand out, depending on their function as well. If instead one ponders on climate change arrangements which may provide standards or commitments for ORE, the UNFCCC or the Paris Agreement are crucial, if not central. If one puts emphasis on funding, then the World Bank, the European Investment Bank and several EU funds (e.g. EMFF) become more relevant. As such, theoretically, "there is no single core to the complex; instead, there are multiple cores around which organisations cluster based on their objectives and activities" [26], and therefore the governance system for ORE is indeed polycentric.

Koster and Anderies [39] comprehend polycentricity as a characterising feature of successful energy transitions based on Elinor Ostrom's claims that intentional change should be a multi-agency effort [39]. Notwithstanding, the authors point out the need for "[m]inistries and departments (…) to communicate with each other to coordinate implementation and avoid overlap." [39] If one defines a fragmented governance system as a patchwork of issue areas characterised by overlapping regimes (i.e. multiple institutions have authority over each issue) with overlapping functions (i.e. different institutions have the same role) in the absence of hierarchical coordination, then ORE governance, as I frame it, seems to be fragmented. I tend to agree with Zürn's opinion that "it is not fragmentation per se, but rather the *coordination* (or lack of it) of fragmented or differentiated institutions" [54] that can be problematic. Nevertheless, further empirical analysis is necessary to evaluate the position of all of these institutions and their interplay within the whole governance system for ORE, for example, by comparing their members. It might be the case that different actors adhere to different institutions which seem to have overlapping functions as a type of forum shopping [43].

The mapping exercise presented in this article is useful and necessary to visualise and understand governance systems that have not developed as fast and/or efficiently as the innovative activities/technologies they represent. It contributes to the literature on governing socio-technical transitions by validating Steiner and colleagues' argument that "[t]raditional models of developing international policy and organisational frameworks through exclusive intergovernmental processes would not provide an effective response" [51] not only to renewable energy in general, but also to ORE's need for cohesion, focus, coordination and critical mass. "A multi-stakeholder approach is far likely to harness the significant potential of non-state actors to promote RE in partnership with governments" [51]. This is demonstrated by the fact that non-state actors have held themselves responsible for filling an institutional governance gap within ORE, creating the few governance institutions that deal specifically with wind or ocean energy, inter alia, OEE, GWEC, ETIPWind, WWEA and WindEurope, all representing the ORE industries. Some of these institutions might engage in lobbying given their vital information-sharing, networking and advocacy roles, often communicating the industry's concerns to intergovernmental bodies and trying to influence processes of agenda-setting and policy-making.

At the same time, these article's findings are a reminder that one should not be seduced by "the rush to study new forms of governing 'beyond', 'below', and 'outside' the state-dominated (…) regime," [55] as we "risk neglecting the continuing importance of policymaking activities at the *national* level." [55] The fact that Zone 1 of ORE's governance triangle is still the most populated and provides a great representation of all identified functions and issue areas demonstrates the key role of states in accommodating this energy transition. I suggest that future research focuses on different jurisdictions to assess if polycentricity and fragmentation are also verified at the national level, and ultimately examine which and how governance structures contribute for the success of the offshore renewables' industries.

7. Conclusions

Who governs offshore renewable energy? This was the question that prompt me to investigate the complexity of offshore renewable energy governance at the international level, emphasising the scope and activities undertaken by its governance institutions. This article puts forward important conceptual and analytical approaches to understand and analyse offshore renewable energy governance. It provides a snapshot of the current institutional architecture of global ORE governance as an attempt to demonstrate how notions like polycentricity and fragmentation unfold, and hopefully paves the way for better governance which "has always been about managing complexity and uncertainty" [56].

In conclusion, there is evidence that the policy and governance linkages between ORE and other issue areas might be the cause of the polycentricity and fragmentation found within ORE governance. A polycentric and fragmented governance system is not necessarily a problem, but it can be if there is no coordination across different types of institutions, issue areas and functions. ORE governance at the EU level is dominated by states, but interestingly, the few specific institutions that exist for wind and ocean energy are private-led (except for IEA-OES), and they seem to perform the same governance functions that states do, except for financing. This confirms the importance of non-state actors in ORE governance and might be an indicator of their growing relevance in more areas of global governance. On the other hand, these findings might suggest that coordination is necessary not so much among private actors but instead on the public tier where a more significant number of international institutions dealing with energy, climate change, renewables and the environment seem to have incrementally developed overlapping mandates in regards to ORE governance. Perhaps if more existing institutions fostered the participation and engagement of both public and private actors (only 16% of mapped ORE governance arrangements are collaborative), within and across issue areas, then policy coherence, market stability and collective action coordination among ORE stakeholders would improve.

Appendix A. Database of ORE governance arrangements (last updated on February 2017)

Type: Public = State (Zone 1); Private = Firm (Zone 2), CSO (Zone 3) or Firm/CSO (Zone 6); Collaborative = State/Firm (Zone 4), State/CSO (Zone 5) or State/Firm/CSO (Zone 7).

Function: 1 = Standards and Commitments; 2 = Operational; 3 = Information and Networking; 4 = Financing; 5 = Standards and Commitments + Operational; 6 = Operational + Information and Networking; 7 = Information and Networking + Financing; 8 = Standards and Commitments + Information and Networking; 9 = Standards and Commitments + Financing; 10 = Operational + Financing.

Issue Areas/Policy Arenas	Acronym	Name of the Institution	Zone	Type	Function
CLIMATE CHANGE	KP	Kyoto Protocol	1	Public	1

CLIMATE CHANGE	ParisA	Paris Agreement	1	Public	1
CLIMATE CHANGE	**UNFCCC**	United Nations Framework Convention on Climate Change	1	Public	1
CLIMATE CHANGE	**CCR**	carbon*n* Climate Registry	1	Public	1
CLIMATE CHANGE	**R20**	Regions of Climate Action	1	Public	2
CLIMATE CHANGE	**C40**	C40 Cities Climate Leadership Group	1	Public	3
CLIMATE CHANGE	**CFE**	Carbon Fund for Europe	1	Public	4
CLIMATE CHANGE	**CPF**	Carbon Partnership Facility	1	Public	4
CLIMATE CHANGE	**GCF**	Green Climate Fund	1	Public	4
CLIMATE CHANGE	**CA**	Climate Alliance	1	Public	6
CLIMATE CHANGE	**WMCCC**	World Mayors Council on Climate Change	1	Public	6
CLIMATE CHANGE	**PMR**	Partnership for Market Readiness	1	Public	7
CLIMATE CHANGE	**MPGCA**	Marrakech Partnership for Global Climate Action	1	Public	8
CLIMATE CHANGE	**CNP**	Carbon Neutral	2	Private	1
CLIMATE CHANGE	**Ver+**	VER+ Standard	2	Private	1
CLIMATE CHANGE	**CT**	Carbon Trust	2	Private	2
CLIMATE CHANGE	**IIGCC**	Institutional Investors Group on Climate Change	2	Private	3
CLIMATE CHANGE	**TCG**	The Climate Group	2	Private	3
CLIMATE CHANGE	**DI**	Europeans for Divest-Invest Global Movement	3	Private	1
CLIMATE CHANGE	**C4C**	UN Caring for Climate	4	Collaborative	3
CLIMATE CHANGE	**CTIPFAN**	Climate Technology Initiative Private Financing Advisory Network	4	Collaborative	6
CLIMATE CHANGE	**CSR**	Compact of States and Regions	5	Collaborative	8
CLIMATE CHANGE	**GHGP**	Greenhouse Gas Protocol	6	Private	1
CLIMATE CHANGE	**VCS**	Verified Carbon Standard	6	Private	1
CLIMATE CHANGE	**CDP**	Carbon Disclosure Project	6	Private	8
CLIMATE CHANGE	**CS**	WWF Climate Savers	6	Private	5
CLIMATE CHANGE	**CCFLA**	The Cities Climate Finance Leadership Alliance	7	Collaborative	4
CLIMATE CHANGE	**C-KIC**	Climate-KIC	7	Collaborative	2
CLIMATE CHANGE /DEVELOPMENT	**LEDS**	Low Emission Development Strategies Global Partnership	5	Collaborative	3
CLIMATE CHANGE/ ENERGY	**2020CEP**	2020 Climate and Energy Package	1	Public	1
CLIMATE CHANGE/ ENERGY	**2030CEP**	2030 Climate and Energy Framework	1	Public	1

CLIMATE CHANGE/ ENERGY	**COM**	Covenant of Mayors for Climate & Energy	1	Public	1
CLIMATE CHANGE/ ENERGY	**C4E**	CLIM4ENERGY	6	Collaborative	2
DEVELOPMENT	**ERDF**	European Regional Development Fund	1	Public	4
DEVELOPMENT	**UNIDO**	United Nations Industrial Development Organisation	1	Public	2
DEVELOPMENT	**UNDP**	United Nations Development Programme	1	Public	3
DEVELOPMENT	**OECD**	Organisation for Economic Cooperation and Development	1	Public	3
ENERGY	**EEEF**	European Energy Efficiency Fund	1	Public	4
ENERGY	**EEPR**	European Energy Programme for Recovery	1	Public	4
ENERGY	**EcodesignD**	Directive establishing a framework for the setting of ecodesign requirements for energy-related products	1	Public	1
ENERGY	**EED**	Energy Efficiency Directive	1	Public	1
ENERGY	**EnergyUnionFS**	Energy Union Framework Strategy (A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy)	1	Public	1
ENERGY	**LabellingD**	Directive on the indication by labelling and standard product information of the consumption of energy and other resources by energy-related products	1	Public	1
ENERGY	**ECT**	International Energy Charter/Energy Charter Treaty	1	Public	1
ENERGY	**UNEnergy**	UN Energy	1	Public	3
ENERGY	**IEF**	International Energy Forum	1	Public	3
ENERGY	**CEF**	Connecting Europe Facility	1	Public	4
ENERGY	**ELENA**	European Local Energy Assistance	1	Public	4
ENERGY	**Ecom**	Energy Community	1	Public	5
ENERGY	**energycities**	Energy Cities	1	Public	6
ENERGY	**IPEEC**	International Partnership for Energy Efficiency Cooperation	1	Public	6
ENERGY	**IEA**	International Energy Agency	1	Public	8
ENERGY	**E4I**	Energy 4 Impact (former GVEP International)	2	Private	10
ENERGY	**GSEP**	Global Sustainable Electricity Partnership	2	Private	6
ENERGY	**GS**	Gold Standard Energy	3	Private	1
ENERGY	**Citizenergy**	Citizenergy	7	Collaborative	4
ENERGY	**WEC**	World Energy Council	7	Collaborative	3
ENERGY/ CLIMATE CHANGE	**MEF**	Major Economies Forum on Energy and Climate	1	Public	6
ENERGY/ DEVELOPMEN-T	**Ci-Dev**	Carbon Initiative For Development	1	Public	7
ENERGY/ ENVIRONMEN-T	**FEDARENE**	European Federation of Agencies and Regions for Energy and the Environment	1	Public	8
ENERGY/ ENVIRONMEN-T	**GNESD**	Global Network on Energy for Sustainable Development	5	Collaborative	3
ENVIRONMENT	**EEA**	European Environment Agency	1	Public	3
ENVIRONMENT	**EspooC**	Espoo Convention	1	Public	1
ENVIRONMENT	**HabitatsD**	Habitats Directive	1	Public	1
ENVIRONMENT	**CSD**	United Nations Commission on Sustainable Development	1	Public	1
ENVIRONMENT	**SDGs**	United Nations Sustainable Development Goals	1	Public	1
ENVIRONMENT	**FAO**	Food and Agriculture Organisation of the United Nations	1	Public	5
ENVIRONMENT	**UNEP**	United Nations Environment Programme	1	Public	8
ENVIRONMENT	**CBD**	United Nations Convention on Biological Diversity	1	Public	1
ENVIRONMENT	**ICLEI**	ICLEI - Local Governments for Sustainability	1	Public	8
ENVIRONMENT	**nrg4SD**	Network of Regional Governments for Sustainable Development	1	Public	8
ENVIRONMENT	**GCC**	Green Circle Certified	2	Private	1
ENVIRONMENT	**WBCSD**	World Business Council for Sustainable Development	2	Private	3
ENVIRONMENT	**SC**	SOCIALCARBON	3	Private	1
ENVIRONMENT	**ECOS**	European Environmental Citizens' Organisation for Standardisation	3	Private	8
ENVIRONMENT	**EEB**	European Environmental Bureau	3	Private	3
ENVIRONMENT	**UNEPFI**	UNEP Finance Initiative	4	Collaborative	4
ENVIRONMENT	**GEF**	Global Environment Facility	5	Collaborative	4
ENVIRONMENT	**IUCN**	International Union for Conservation of Nature	5	Collaborative	8

ENVIRONMENT/ DEVELOPMEN-T	**CohF**	Cohesion Fund	1	Public	4
ENVIRONMENT/ DEVELOPMEN-T	**Agenda21**	Agenda 21	1	Public	1
ENVIRONMENT/ DEVELOPMEN-T	**JohannesburgP**	Johannesburg Plan of Implementation	1	Public	1
OCEANS	**EMFF**	European Maritime and Fisheries Fund	1	Public	4
OCEANS	**MSFD**	EU Marine Strategy Framework Directive	1	Public	1
OCEANS	**MSP**	Marine Spatial Planning Directive	1	Public	1
OCEANS	**UNOceans**	UN Oceans	1	Public	3
OCEANS	**UNDOALOS**	UN Division for Ocean Affairs and the Law of the Sea	1	Public	8
OCEANS	**UNCLOS**	United Nations Convention on Law of the Sea	1	Public	1
OCEANS	**EurOcean**	European Centre for Information on Marine Science and Technology	5	Collaborative	3
OCEANS	**OOC**	Our Ocean Challenge	2	Private	2
OCEANS	**WOC**	World Ocean Council	7	Collaborative	3
OCEANS/ RENEWABLE	**OEE**	Ocean Energy Europe	6	Private	6
OCEANS/ RENEWABLE	**OES**	IEA's Technology Collaboration Programme on Ocean Energy Systems	1	Public	6
OTHER	**EIB**	European Investment Bank	1	Public	4
OTHER	**EFSI**	European Fund for Strategic Investments	1	Public	4
OTHER	**H2020**	Horizon 2020	1	Public	4
OTHER	**UNESCO**	United Nations Educational, Scientific and Cultural Organisation	1	Public	2
OTHER	**WB**	World Bank	1	Public	4
OTHER	**G20**	Group of 20	1	Public	1
OTHER	**G7**	Group of 7/8	1	Public	1
OTHER	**CEMR**	Council of European Municipalities and Regions	1	Public	3
OTHER	**eurocities**	Eurocities	1	Public	3
RENEWABLE	**GEEREF**	Global Energy Efficiency and Renewable Energy Fund	4	Collaborative	4
RENEWABLE	**NER300**	NER 300	1	Public	4
RENEWABLE	**RenewablesD**	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	1	Public	1
RENEWABLE	**ISO/IEC 30134–3:2016**	ISO/IEC 30134–3:2016 Information technology - Data Centres - Key performance indicators. Part 3: Renewable energy factor	1	Public	1
RENEWABLE	**CEM**	Clean Energy Ministerial	1	Public	6
RENEWABLE	**EG**	European Green	2	Private	1
RENEWABLE	**HKNNEU100**	HKN NEU100	2	Private	1
RENEWABLE	**RenewablePlus**	RenewablePLUS	2	Private	1
RENEWABLE	**EKO**	EKOenergy	3	Private	1
RENEWABLE	**G-e**	Green-e Energy	3	Private	1
RENEWABLE	**Naturemade**	Naturemade Star	3	Private	1
RENEWABLE	**GO100RE**	Global 100 Renewable	5	Collaborative	2
RENEWABLE	**P4ALL**	Power For All	7	Collaborative	6
RENEWABLE	**ISO/IEC 13273–2:2015**	ISO/IEC 13273–2:2015 Energy efficiency and renewable energy sources	1	Public	1
RENEWABLE	**BeijingDcl**	Beijing Declaration on Renewable Energy for Sustainable Development	1	Public	1
RENEWABLE	**EUFORES**	The European Forum for Renewable Energy Sources	1	Public	2
RENEWABLE	**IRENA**	International Renewable Energy Agency	1	Public	3
RENEWABLE	**RE100**	RE100	2	Private	1
RENEWABLE	**INFORSE**	International Network for Sustainable Enegy	3	Private	6
RENEWABLE	**RENAlliance**	REN Alliance	3	Private	6
RENEWABLE	**REScoop**	REScoop	3	Private	2
RENEWABLE	**CESC**	Clean Energy Solutions Centre	5	Collaborative	3
RENEWABLE	**WCRE**	World Council for Renewable Energy	6	Private	6
RENEWABLE	**SE4All**	Sustainable Energy for All	7	Collaborative	1
RENEWABLE	**REEEP**	Renewable Energy and Energy Efficiency Partnership	7	Collaborative	8
RENEWABLE	**REN21**	Renewable Energy Policy Network for the 21st Century	7	Collaborative	3
WIND/ RENEWABLE	**WindMade**	WindMade	2	Private	1
WIND/ RENEWABLE	**WWEA**	World Wind Energy Association	3	Private	6

WIND/ RENEWABLE	**WindEurope**	WindEurope (former EWEA)	6	Private	2
WIND/ RENEWABLE	**ETIPW**	European Technology & Innovation Platform on Wind Energy	6	Private	6
WIND/ RENEWABLE	**GWEC**	Global Wind Energy Council	6	Private	2

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