Proceedings of the
22nd International Sustainable Development Research Society Conference

ISDRS 2016

Rethinking Sustainability Models and Practices: Challenges for the New and Old World Contexts

Volume 2 of 3

Edited by:

João Joanaz de Melo, Antje Disterheft,
Sandra Caeiro, Rui F. Santos and Tomás B. Ramos

July 2016

ISRDR 2016 was organized and hosted on behalf of ISDRS
by the Center for Environmental and Sustainability Research,
School of Science and Technology, Universidade Nova de Lisboa

Edited by: João Joanaz de Melo, Antje Disterheft, Sandra Caeiro, Rui F. Santos and Tomás B. Ramos

Title: Proceedings of the 22nd Annual International Sustainable Development Research Society Conference

Subtitle: Rethinking Sustainability Models and Practices: Challenges for the New and Old World Contexts

Volume 2 of 3

Published by the International Sustainable Development Research Society and the Center for Environmental and Sustainability Research, School of Science and Technology, Universidade Nova de Lisboa

Digital edition only

Lisbon, July 2016

ISBN: 978-972-674-791-8

Cover design: Nuno Videira

CENSE - Center for Environmental and Sustainability Research
Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa
2829-516 Caparica
Portugal
Phone: +351-212948397 Fax: +351-212948554
Email: isdrs2016@campus.fct.unl.pt, cense.secretariado@fct.unl.pt
www.cense.fct.unl.pt www.fct.unl.pt

International Sustainable Development Research Society
http://isdrs.org

Experimental projects as learning settings for system building in sustainability transitions: the case of marine renewable energies

Margarida Fontes[1], Nuno Bento[2], Cristina Sousa[3]

[1] LNEG – Laboratório Nacional de Energia e Geologia, margarida.fontes@lneg.pt

[2] Instituto Universitário de Lisboa (ISCTE-IUL), DINAMIA'CET-IUL, Nuno.Bento@iscte.pt

[3] Universidade Portucalense & Instituto Universitário de Lisboa (ISCTE-IUL), DINAMIA'CET-IUL, Cristina.Sousa@iscte.pt

Abstract

The paper addresses the role played by experimental projects in the process of development of new sustainable energy technologies, investigating how they promote learning, both about the technologies and about the economic, social and political processes required to construct a new system. For this purpose it analyses the case of the emerging marine renewable energy technologies, which are complex technologies whose full development and diffusion involves combining a variety of areas (both new and existing) with diverse industrial structures, technological and organisational practices, institutions and cultures, and thus requires mobilising, connecting and aligning substantially different actors. The analysis addresses the experimental projects with Portuguese involvement conducted, over time, in the wave energy and offshore wind energy fields, combining secondary data and interviews with key actors. It focuses on the behaviour of actors, as the entry point to investigate the processes at work. The objective is to understand whether and how sequences of experimental projects and the presence of "intermediary actors" – who connect between projects and conduct "aggregation activities" that turn contextual knowledge into generic knowledge – contribute to learning processes concerning technology stabilisation, actors' alignment and transformation of the institutional framework. The preliminary results offer an overview of the evolution of the most significant actors/networks and provide some indications towards roles played, as well as insights into the nature of learning processes that are at work in the emerging system.

Keywords: Sustainable energy transition; Experimental projects; Learning processes; System building; Renewable energies

1. Introduction

Emerging marine renewable energy technologies (MRET) are expected to contribute, simultaneously, to a sustainable energy transition, by extending the variety and scope of clean energy production, and to an ocean based growth, through the creation of new economic activities that can drive the transformation of traditional/declining industries related to the sea (EC, 2014). However, MRET are still relatively immature, as compared with other renewable energy technologies: there is a number of challenges that need to be overcome before they reach the commercial stage and some uncertainty regarding the way the process will unfold (Magnana et al, 2014). It is therefore important to understand how it is possible to accelerate the development of these technologies and the construction of a new system around them.

This paper discusses the role of experimental projects as settings for learning, not only about the technologies, but also about the economic, social and political processes required to construct a new system. Experimental projects have received particular attention in the socio-technical transitions literature, namely in the strategic niche management literature, which identifies socio-technical experiments as the locus for new niche formation and development (Kemp et al, 1998; Hoogma, et al, 2002). Recent advances to this literature, introduced by the socio-cognitive evolutionary perspective to technology development (Geels and Raven, 2006; Raven and Geels, 2010), provide an analytical framework to address this question. This approach moves the

focus from single experimental projects to sequences of projects that build on each other and add to the niche trajectory. It introduces a distinction between the variety of individual experiments and a "global niche level", defined along a social dimension - the emerging community of actors - and a cognitive dimension - the learning processes being enacted. Such learning processes require the conduction of purposeful "aggregation activities" that turn the contextual knowledge generated by individual projects into abstract, generic knowledge that can be shared by the niche community and base de development of new visions and agendas. Special attention is given to the role played by "intermediary actors" that move across projects and conduct aggregation activities (Geels and Deuten, 2006). Finally, an additional dimension – space - has also been added, by proposing that niche communities and their experimental activities and learning processes can span several spatial levels (Fontes et al, 2016).

These processes are expected to influence the niche trajectory and thus to shape the development of the emerging system. The objective of this paper is to explore this question empirically, by looking at the experiments that took place along time in the MRET field and investigate whether and how sequences of experimental projects and the presence of intermediary actors contribute to the development of this niche at two levels; i) by enabling the expansion of the community network; ii) by driving learning processes about the configuration of the new system.

2. Methods

MRET are a particularly interesting setting for this analysis. They are complex technological systems, whose final output entails performing a variety of activities related to the development, production and installation of energy conversion systems, and the operation of energy production facilities. Because this involves areas with no tradition of working together - energy and ocean – it requires connecting and aligning substantially different activities and actors. Moreover technologies have to be demonstrated at full scale in real sea conditions during long periods to prove viability and improve performance /costs. This entails high investment in stages still characterised by technological and market uncertainty, which requires public funding, but also capacity to attract private investors. At this level, energy utilities and other regime actors, which have become increasingly involved with renewable energies (Bergek et al, 2013), have also shown some interest in this emerging field. Finally, the production of energy at sea involves the use of a public space for a new economic activity, requiring regulatory changes (Wright, 2015). It also entails sharing that space with other economic and non-economic activities, which may lead to acceptance problems, namely among local communities. In this context experimental projects are particularly important to start delineating the new system and also negotiating it.

The paper conducts an analysis of the experimental projects, with Portuguese involvement, carried out as part of the process of development and diffusion of two marine renewable energy technologies: wave energy and floating offshore wind. The concept of experiment in transitions literature is relatively broad (Hoogma et al, 2002; Harborne and Hendry, 2007; Frishammar et al, 2015). In this case we look at projects from the initiative of technology developers, whose primary goal is to test and improve the technology, but that, given the system features described above, are expected to go much beyond technological aspects, contributing to actor interaction and learning at a variety of other levels, and reinforcing the supportive network. While the analysis is conducted from a country perspective, it is also acknowledged that processes taking place in the development of MRET have a multi-spatial scope, which is reflected in the conduction of both experimental projects and aggregation activities (Fontes et al, 2016).

The empirical analysis addresses the projects conducted over time, combining secondary data and interviews with key actors. It focuses on the actors involved in these projects and explores their potential influence in the construction of a system (Musiolik and Markard, 2011). The research is divided into three steps. The first step entails analysing all types of projects (research, experimental and structural) funded by national and European programmes in the field of wave energy and offshore wind, with Portuguese participation. Data is obtained from the EUROPA CORDIS database for European projects and from online repositories or official documents for national projects. Particular attention is given to experimental projects (that test or

demonstrate technologies) and to structural projects (meta-projects that collect data about field activities, draw lessons and share information about best practices and obstacles, define future agendas), as proxy to "aggregation activities" (Geels and Raven, 2006). The objective of this step is to uncover the networks that have been formed over time and to identify the key Portuguese actors and the type of connections they establish. In particular we wish to understand which actors have moved along projects over time and pinpoint the type of projects along which they moved, as a first step to identify potential "intermediary actors" (Geels and Deuten, 2006). The second step involves focusing on the sub-set of projects that have conducted experimental activities in Portugal. The objective is to start exploring the role played by these projects in bringing in and aligning new actors, that may become part of the system being built at national level, as well as tracing the international connections being established. The number projects and actors involved in these steps are depicted in Figure 1.

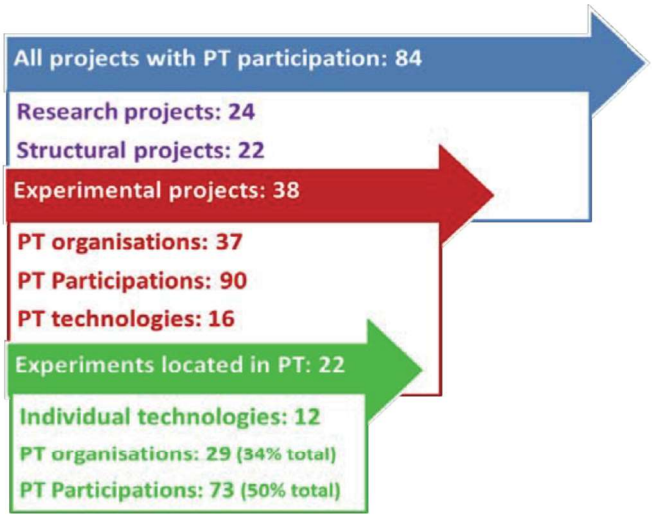


Figure 1. Empirical setting: projects and actors

A third step involves looking in greater detail into two of the main technologies currently under development in Portugal: Waveroller in the case of wave energy and Windfloat in the case of floating offshore wind. This step is justified for two reasons. First, these technologies have a history of experimental activity along diverse stages in Portugal, permitting to trace their evolution and their impact on system construction. Second, it was realised that the network of partners in funded projects does not fully reflect the actual network of actors that participate in the experimental activities effectively conducted, with "non-core" actors going frequently unnoticed when using only this source of information. Thus, in the case of these technologies we will move beyond the funded projects and attempt to identify the principal actors that have been effectively involved in the experimental activities over time, using interviews and a variety of additional sources. In this paper we present mainly results from the two first steps.

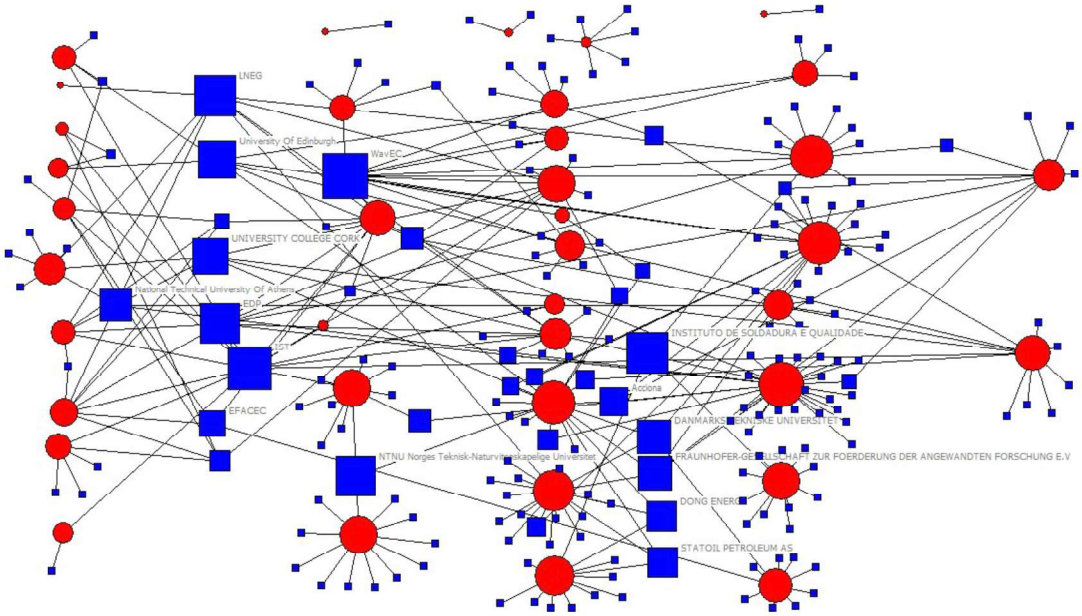
3. Results and discussion

The analysis focuses on the behaviour of actors involved in these projects, as the entry point to investigate the processes at work. Through an actor approach the paper examines: i) changes in the size and composition of niche networks, which provides insights on the contribution of experimental projects to increase (or decrease) the attractiveness of the technological niche and also on their contribution to align actors from different origins; ii) the nature of actors that are involved in the experimental activities, which provides some insights into the extent to which these projects are also providing a setting to learn about market and industrial organisation, societal embeddedness and institution building: iii) the movement of actors (or groups of actors), both across experimental projects and between these and "structural projects" (i.e. projects that involve aggregation activities), which denotes the presence of "intermediary actors", whose presence contribute to reinforce learning processes; iv) the geographical scope of actors' actions and

their influence on the conduction and outcomes of the experimental projects. Some preliminary findings are presented below.

Figure 2 illustrates some of the results obtained in step 1, showing the evolution of the experimental projects in wave energy and offshore wind and the networks formed around them over time.

The network reveals the involvement of several types of actors from different countries in the experiments, reflecting the multi-spatial nature of these activities. The size of the actors' nodes reveals their "betweenness centrality", a social network analysis measure that indicates the actors who have participated in many projects that can have diverse network compositions, acting as brokers between other actors. Among the most central actors is a group of Portuguese organisations (both research organisations and regime actors) that entered in the initial periods and maintained their engagement over time. They have acted as "intermediary actors": by participating in a sequence of projects and conveying knowledge between them; and by being involved in "aggregation activities" - both in the context of "structural projects" and (particularly in the case of wave energy) through engagement in field-level, often supranational, collective organisations and networks - to which they brought the experience gained in the experimental activities.



Legend: *Projects* - red circles; *Actors* – blue squares

Time - Each "column" of projects corresponds to a time period:

P1: before 2000; P2: 2000-2005; P3: 2006-2010; P4: 2011-2014; P5: 2015 and after

Actors are positioned in/near the period when they enter for the first time.

Figure 2. Network of experimental projects with Portuguese participation (1992-2015)

Tables 1 and 2 and Figures 3 and 4 illustrate some findings of step 2, which focused on the experimental projects conducted in Portugal. The projects were organised according to the 12 individual technologies that have been object of experimental activities. Only one of these technologies is in the field of offshore wind, which only recently registered some activity in Portugal, even if a Portuguese company is pioneering the emerging area of technologies for deepwaters. This contrasts with wave energy, where Portugal has a longstanding tradition, having been involved since the early 1980s and being one of the pioneers in the experimental activity in this field (Falcão, 2010). Table 1 presents some details of the technologies, namely the number of projects they generated, the data of the first project and whether activities are still pursued, and the nationality of the technology promoter. It shows that the projects involved technologies promoted both by Portuguese actors, and by foreign actors that identified Portugal as a favourable

location, due to a combination of good natural conditions, favourable policies, and the extensive competencies and international networks of local actors (Fontes et al, 2016). The table also shows the number of Portuguese actors involved and their participations (for all the projects relative to each technology) and, since almost all projects included actors from more than one country, it also indicates their weight on the total actors and participations, respectively. Some of these technologies have already been abandoned; others ended-up not being pursued (at least in Portugal), mostly due to changes in the economic and political context associated with the financial crisis. But a small group is still active and is starting new projects. Moreover, after a period of decline, a new generation of Portuguese based technologies is emerging and a new set of foreign promoters is considering the conduction of experimental activities in Portugal, which may generate new experiments in the near future.

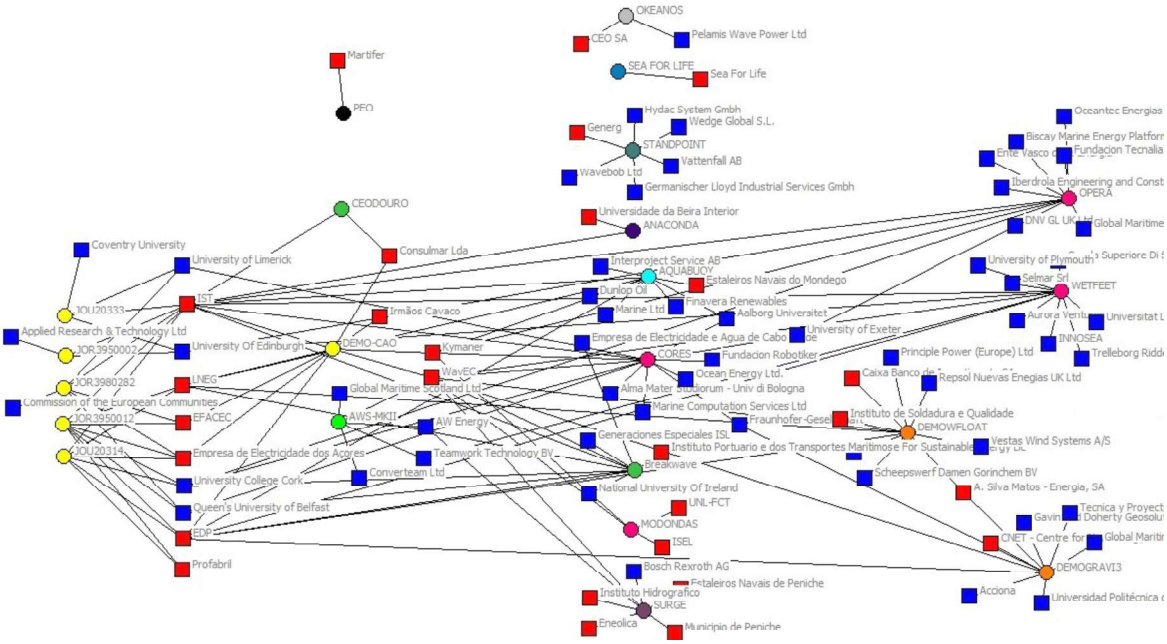
Table 1. Technologies object of the experimental projects conducted in Portugal

TECHNOLOGIES	No. projects	Tech promoter	First PT experiment	PT Actors		PT Participations	
				No.	% Total	No.	% Total
WAVE ENERGY							
Active							
PICO (1)	6	PT	1992	11	61.1	25	73.5
WAVEROLLER (2)	1	FI	2007	5	71.4	5	71.4
OWC (3)	4	PT	2008	6	19.4	12	29.3
Discontinued (4)							
AWS	1	UK	2005	1	20.0	1	20.0
FLOW	1	PT	2005	1	100.0	1	100.0
BREAKWATER	2	PT	2005	6	54.5	7	58.3
PELAMIS	1	UK	2006	1	50.0	1	50.0
WEGA	1	PT	2011	1	100.0	1	100.0
Not started (5)							
AQUABUOY	1	UK	2006	5	50.0	5	50.0
WAVEBOB	1	UK	2009	1	16.7	1	16.7
ANACONDA	1	UK	2009	2	100.0	2	100.0
OFFSHORE WIND							
Active							
OFFSHORE (6)	2	PT/US	2011	8	40.0	10	45.5

(1) A Pilot Plant was installed and has been in operation since the 1990s, but is currently under repairs.
(2) The 1st experiment conducted in 2007 was funded by private investors; only the second was funded by an EU project (in 2009). A new (pre-commercial) project was recently funded by the NER 300 EU mechanism and is expected to be installed in PT in 2017.
(3) Includes two international projects where the Portuguese OWC technology is being tested in combination with other technologies, from different (foreign) promoters, which explains the weight of non-PT actors.
(4) AWS and Pelamis were discontinued in PT but pursued elsewhere. Pelamis promoter went out of business. AWS is still operating and it is one of the technologies being tested in combination with the OWC, as referred in (3).
(5) Projects were conducted, but real sea experimental activities never started, mostly due to firms' inability to obtain the additional investment required.
(6) Encompass two different technologies being promoted by the same company: Windfloat (already tested at full scale) & GRAVI3 (whose sea level test is still being prepared). For Windfloat a new (pre-commercial) project was recently funded by NER 300 and is expected to be installed in PT in 2017.

Figure 3 presents the network of organisations involved in these experiments, distinguishing between Portuguese (red) and foreign (blue) actors. The extensive participation of foreign actors reflects the highly international nature of this field. The graphic shows an increase in the number of new actors, which reaches a peak in the period 2006-2010, registering a reduction during the

financial crisis. It also shows that Portuguese actors that entered in early periods maintained their involvement in the subsequent projects, some of them moving between technologies.



Legend:

Projects: circles; each colour corresponds to a technology

Actors: squares; Red - Portuguese actors; Blue – foreign actors

Time: Each "column" of projects corresponds to a time period:

P1: before 2000; P2: 2000-2005; P3: 2006-2010; P4: 2011-2014; P5: 2015 and after

Actors are positioned in/near the period when they enter for the first time

Figure 3. Network of experimental activities taking place in Portugal (1992-2015)

The network expansion encompasses both core actors, i.e. actors directly involved in the development of the technology and external actors that join the emerging system. This is confirmed by Figure 4 that presents the actor participations by type of actor. It shows the involvement of two new types of actors: "coalition actors", that is, external actors, usually large incumbent companies, which are gained to support the new technologies as partners or investors; and "complementary actors", that is, actors from other sectors, in particular from energy and sea-related industries, which bring competences in downstream areas (Steen and Weaver, 2014). It should nevertheless be pointed out that the actual involvement of complementary actors, as well as of actors included in the "society" category, is likely to be higher that indicated by these numbers. In fact, a preliminary exploration of the experimental activities effectively conducted in the context of the technologies being examined in detail in step 3 (Waveroller and Windfloat), has revealed a much higher number of non-core actors involved in a great variety of activities. However, these tended be to contractors or supporters, rather than partners in funded projects. This group included, namely, several companies from those sea-related sectors to whose revitalisation MRET are expected to contribute (OTEO, 2014). This finding reinforces the idea that experimental projects are effectively contributing to bring into the system and align a set of heterogeneous actors, providing "blue-prints" for the new value chain being built.

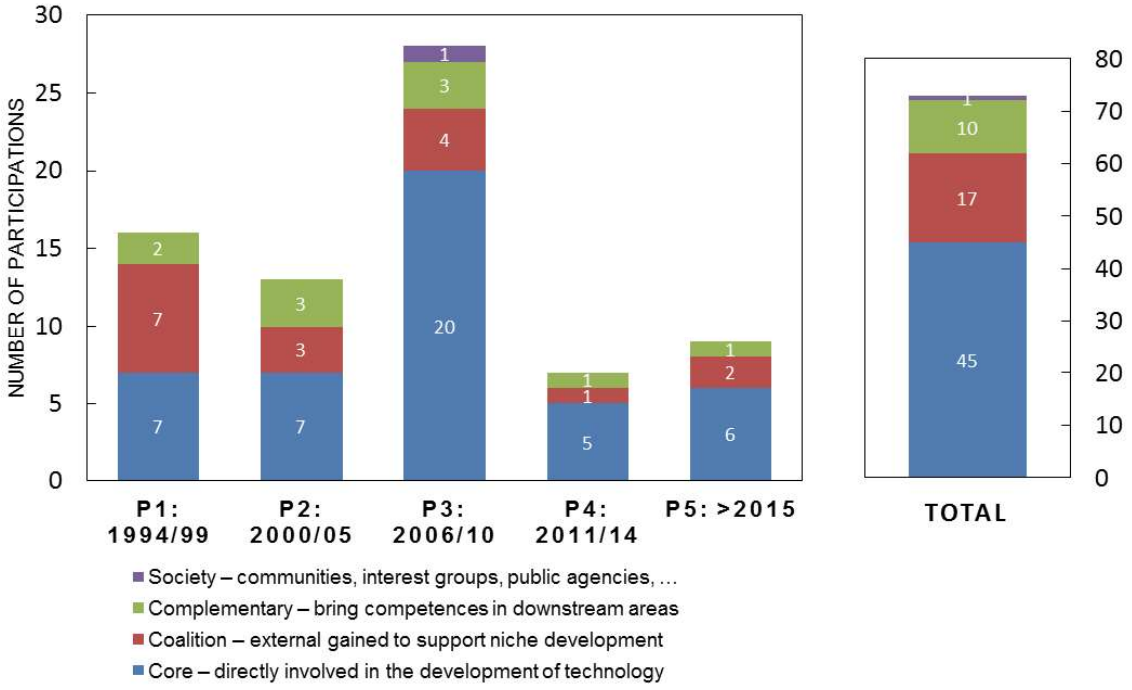


Figure 4. Portuguese actor participation in experiments conducted in Portugal, by period and type of actor (1992-2015)

Finally, Table 2 identifies the individual actors that moved between projects - distinguishing between those that only moved along projects within the same technology and those that also moved across technologies – and indicates the actors that were equally involved in "aggregation activities". Both the actors and the pattern of their activity are similar to the ones identified in the analysis of experimental projects in general (Figure 2), confirming the "intermediary" role played by a group of organisations. Different types of core actors perform this role, from research organisations and technology developers, to the collective organisation formed to speak for the new field. But it is also interesting to notice that a regime actor (the energy utility) is in this group, having become engaged early as a supportive (coalition) actor and becoming, over time, a core actor with activity in both wave energy and, particularly, floating offshore wind.

Table 2. Actors that moved between projects: individual actor participation by period

Name of actor (type)	Type organisation	P1	P2	P3	P4	P5	Total	Across Techs?	Structural Projects?
IST (core)	University	5	2	5		2	14	Yes	Yes
WAVEC (core)	Collective		2	5	1	2	10	Yes	Yes
EDP (coalition, later core)	Regime (Utility)	2	1	2	1	1	7	Yes	Yes
LNEG (core)	Research	2	1	2	1		6	Yes	Yes
Kymaner (core)	Tech developer		1	3		1	5	Yes	Yes
EFACEC (coalition)	Regime (Energy)	2	1				3	No	No
Consulmar (complem.)	Firm (Proj. Eng.)	1	1				2	Yes	No
A. Silva Matos (complem.)	Firm (Manufact.)				1	1	2	No	No

4. Discussion

The preliminary analysis of the experimental projects conducted in the MRET field permitted to

obtain an overview of the most significant networks of actors, their changing composition over time and also the position achieved by some actors in those networks. These results provide some indications towards roles played and some insights into the nature of learning processes that are taking place in what concerns the configuration of the new system.

These insights concern, first of all, the structuring of the community network. The results show that experimental projects bring, into the emerging system, new actors, beyond the core group directly engaged in the development of the technologies; and contribute to their alignment, which is a critical step in the emergence of a new system (Cooke, 2012). In fact, the projects revealed new opportunities to organisations in adjacent areas, both established companies (e.g. in energy or sea-related activities) and new companies with transversal technologies (e.g. underwater robotics). In the case of actors in complementary areas, sequences of projects – even if they concern different technologies – not only provide immediate revenue opportunities, but can raise expectations about future markets and thus provide an incentive for new competence acquisition/adjustment (Caniëls and Romijn, 2008). These projects also create a context where heterogeneous actors start developing closer relationships and learn to operate together (Frishammar et al, 2015). Since continuity is critical to consolidate those effects, the reduction of activity registered during the financial crisis has been detrimental to the system evolution, even if the ongoing recovery appears to be creating new expectations. Finally, the continued location of experimental projects in particular sites (due to attractive conditions in terms of natural resources or local support; and/or strategic investments of their promoters) favoured a growing involvement of local organisations and is inducing embryonic clustering processes in at least two regions, with impacts on regional development and also a positive influence upon the public acceptance of marine renewable technologies (Coenen et al, 2010).

Projects were also found to be instrumental to attract incumbent companies, as investors or partners. The involvement of these companies is important since they bring resources and legitimacy, which are critical in a field still characterised by great uncertainty and where experimental costs are extremely high. But it can also have a downside, since these actors may show a lower commitment, and even abandon, if the results are below expectations (Bakker and Budde, 2012). They may also have their own agenda and attempt to influence the development trajectory according to their interests (Bergek et al, 2013). The involvement of Portuguese incumbent organisations in some of the technologies analysed provided examples of these positive and negative effects.

Finally, experimental projects were also found to enable and reinforce interactions between actors from diverse countries, driving a variety of exchanges at different spatial levels, which were further consolidated through the supranational performance of "aggregation activities" (Fontes et al, 2016). This multi-spatial nature of the field not only provided conditions for extensive knowledge flows, but also increased the opportunities for resource access (in the case of core actors) and for business (in the case of complementary actors). However, an excessive reliance on local experiments of technologies promoted by foreign developers also has its downsides. In fact, these actors tend to have lower motivation to resort to local (non-core) actors, thus reducing the local learning effects and also tend to show a lower commitment, often moving away if more favourable conditions emerge elsewhere (Løvdal and Neumann, 2011).

On the other hand, the research has provided important insights into the key role played by some actors in the process of learning about the configuration of the new system. As proposed by the socio-cognitive perspective (Geels and Raven, 2006), it was possible to identify a set of "intermediary actors", who were found to play the expected a role as conveyors of "local" knowledge obtained in individual projects (conducted at national and international level) and of abstract knowledge produced in the context of aggregation activities (Geels and Deuten, 2006). But, more importantly, the results suggest that these actors also act as coordinators in what concerns system structuring: they carry both experience on new modes of organisation and governance, and a "portfolio" of partners that form an emerging structure for the system; and they effectively shape the actual implementation in practice of the agendas being produced through aggregation activities.

5. Conclusion

This paper addressed the role played by experimental projects in the process of development of the emerging marine renewable energy technologies, investigating how they promote learning, not only about the technologies, but also the economic and social processes required to construct a new system. The research focused on the behaviour of the actors involved in these projects in order to understand the processes that are contributing to the structuring of the emerging system.

The paper presented preliminary findings of the research being conducted in what concerns: i) the early structuring of the community network, including the attraction and alignment of heterogeneous groups of actors; ii) the learning processes taking place as part of the configuration and governance of the new system and, particularly, the roles being played in this process by a set of actors – the "intermediary actors" - that move between projects, produce, codify and convey knowledge at various levels, and also act as coordinators of the system structuring process.

Those findings offer a first understanding of the processes that mark the construction of the new system. They will now need to be further developed, by going in greater detail into the actual activities that took place as part of the development of the technologies being object of experimental activities, namely by identifying the full set of actors involved and by defining more clearly the roles played and their influence on the configuration of the (emergent) system.

References

Bakker, S., Budde, B., 2012. Technological hype and disappointment: lessons from the hydrogen and fuel cell case. Technology Analysis & Strategic Management, 24, 549-563.

Bergek, A., Berggren, C., Magnusson, T., Hobday, M., 2013. Technological discontinuities and the challenge for incumbent firms: Destruction, disruption or creative accumulation? Research Policy, 42, 1210-1224.

Caniëls, M.C.J., Romijn, H.A., 2008. Supply chain development: insights from strategic niche management. The Learning Organization, 15, 336 – 353.

Coenen, L., Raven, B., Verbong, G., 2010. Local niche experimentation in energy transitions: A theoretical and empirical exploration of proximity advantages and disadvantages. Technology in Society, 32, 295–302.

Cooke, P., 2012. Transversality and Transition: Green Innovation and New Regional Path Creation. European Planning Studies, 20, 817-834.

EC, 2014. Communication on Blue Energy - Action Needed to Deliver on the Potential of Ocean Energy In European Seas and Oceans by 2020 and Beyond. European Commission, Brussels.

Falcão, A., 2010. Wave energy utilization: A review of the technologies. Renewable and Sustainable Energy Reviews, 14, 899–918.

Fontes, M., Sousa, C., Ferreira, J., 2016. The spatial dynamics of niche trajectory: the case of wave energy. Environmental Innovation and Societal Transitions, 19, 66-84.

Frishammar, J., Söderholm, P., Bäckström, K., Hellsmark, H., Ylinenpää, H., 2015. The role of pilot and demonstration plants in technological development: synthesis and directions for future research. Technology Analysis & Strategic Management, 27, 1-18.

Geels, F., Deuten, J., 2006. Aggregation activities. Local and global dynamics in technological development: a socio-cognitive perspective on knowledge flows and lessons from reinforced concrete. Science and Public Policy, 33, 265-275.

Geels, F., Raven, R., 2006. Non-linearity and expectations in niche-development trajectories: ups and downs in Dutch biogas development (1973–2003). Technology Analysis & Strategic Management, 18, 375-392.

Harborne, P., Hendry, C., Brown, J., 2007. The development and diffusion of radical technological

innovation: The role of bus demonstration projects in commercializing fuel cell technology. Technology Analysis & Strategic Management, 19, 167–87.

Hoogma, R., R. Kemp, J. Schot, Truffer, B., 2002. Experimenting for sustainable transport: The approach of strategic niche management. London: Routledge.

Kemp, R., Schot, J., Hoogma, R., 1998. Regime shifts to sustainability through processes of niche formation: The approach of strategic niche management. Technology Analysis & Strategic Management, 10, 175–95.

Løvdal, N., Neumann, F., 2011. Internationalization as a strategy to overcome industry barriers: An assessment of the marine energy industry. Energy Policy, 39, 1093-1100.

Magnana, D., Tzimas, E., Hanmer, C., Badcock-Broe, A., MacGillivray, A., Jeffrey, H., Raventos, A., 2014. SI-ocean strategic technology agenda for the ocean energy sector: From development to market, 11th International Conference on the European Energy Market, DOI: 10.1109/EEM.2014.6861284.

Musiolik, J., Markard, J., 2011. Creating and shaping innovation systems: Formal networks in the innovation system for stationary fuel cells in Germany. Energy Policy, 39, 1909–1922.

OTEO, 2014. Offshore Renewable Energy – Current Status and Future Perspectives for Portugal. Observatório Tecnológico para as Energias Offshore, INEGI, Porto.

Raven, R., Geels, F., 2010. Socio-cognitive evolution in niche development: Comparative analysis of biogas development in Denmark and the Netherlands. Technovation, 30, 87-99.

Steen, M., Hansen, G.H., 2014. Same Sea, Different Ponds: Cross-Sectorial Knowledge Spillovers in the North Sea. European Planning Studies, 22, 143-133.

Wright, G., 2015. Marine governance in an industrialised ocean: A case study of the emerging marine renewable energy industry. Marine Policy, 52, 77-84.