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PUSHING REGIONS BEYOND THEIR BORDERS

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Global emergence of new technologies: a dynamic analysis of territorial knowledge communities and relational proximity in wave energy

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FCT: OCEANTRANS - O Potencial transformador das tecnologias energéticas oceânicas (PTDC/GES-OUT/30559/2017)

General framework

Wave energy technologies have been experienced a protracted development process with some periods of decline followed by recovery.

No dominant design has emerged yet.
Over time there has been a great variety of competing conversion systems being developed by different actors, mostly small technology intensive companies often in collaboration with universities.

Experimental activities that involve the test of prototypes at different scales and in different conditions (tank, protected sea, open sea) started relatively early in the technology development process – which may explain the high involvement of companies from the beginning.

Currently there are a small number of technologies that have approached the full scale demonstration stage, but commercialisation is still far away. In the meanwhile, new designs keep emerging.

There has been some mortality among technology promoters and thus abandon of technologies.
This can be explained by nature of those promoters. They are small firms highly dependent from external funding, thus relying on policy support that has changed over time (particularly at country level); on private investors that can be easily disappointed by lack of results.

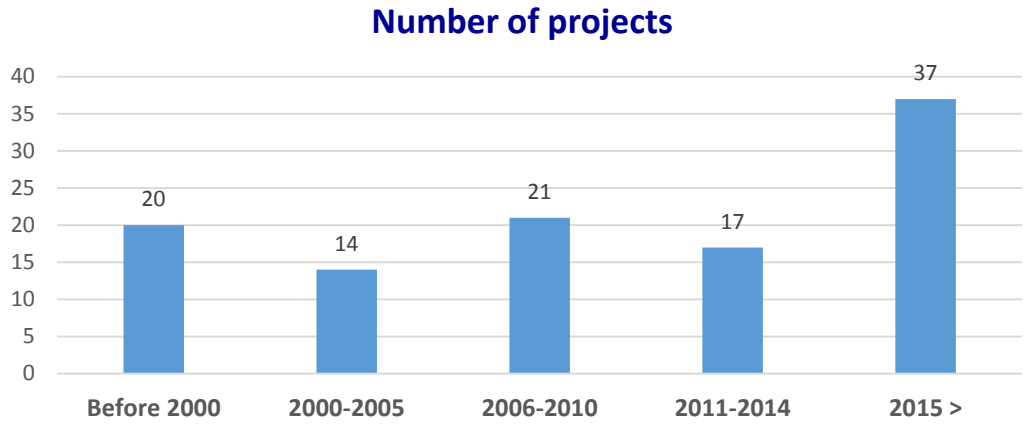
Research question:

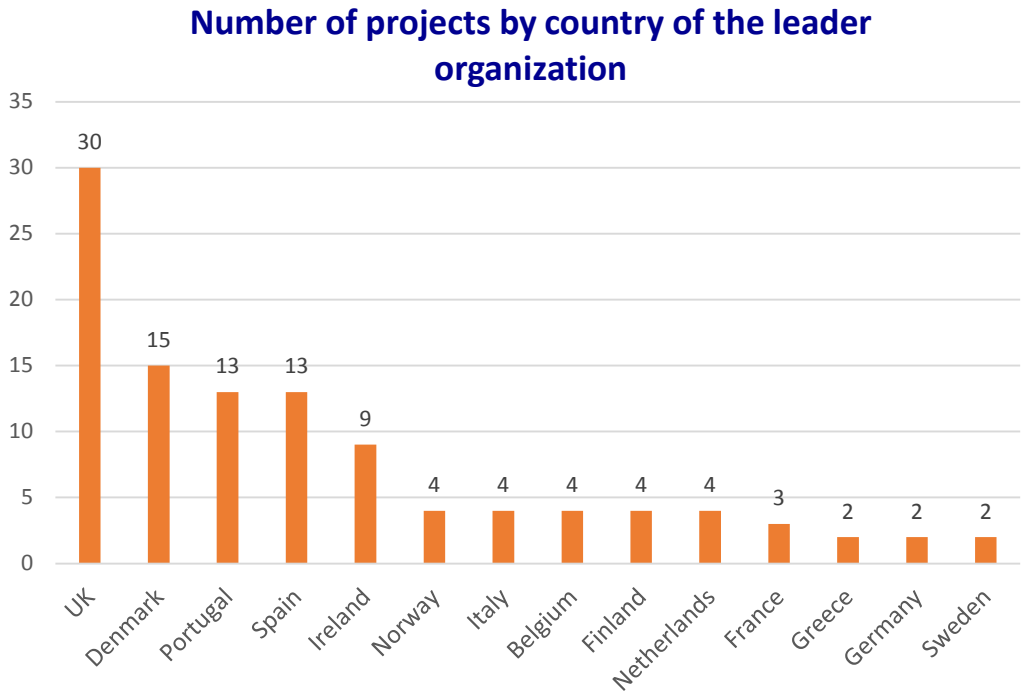
How changes in the territorial knowledge communities in terms of geographical reach, actor composition and relational dynamics co-evolve with the emergence of a new technology?

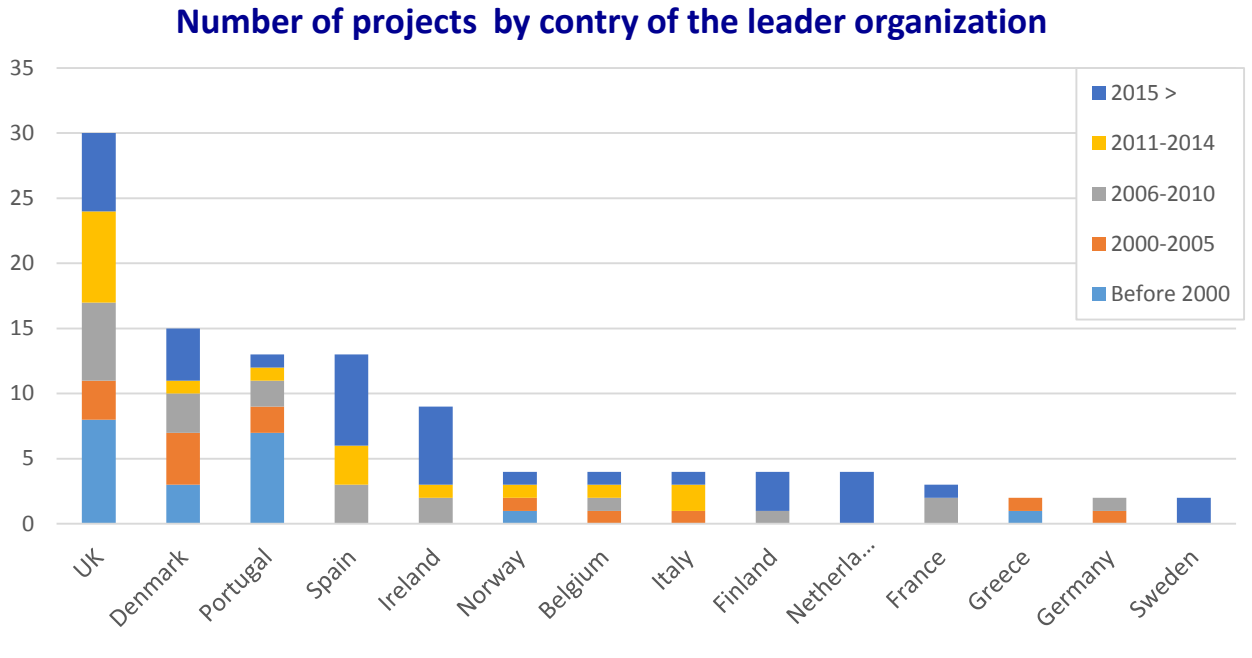
Database:

Support from the European Union started in the early 1990s and the wave energy was formally included in the EU RTD funding programmes in 1993.

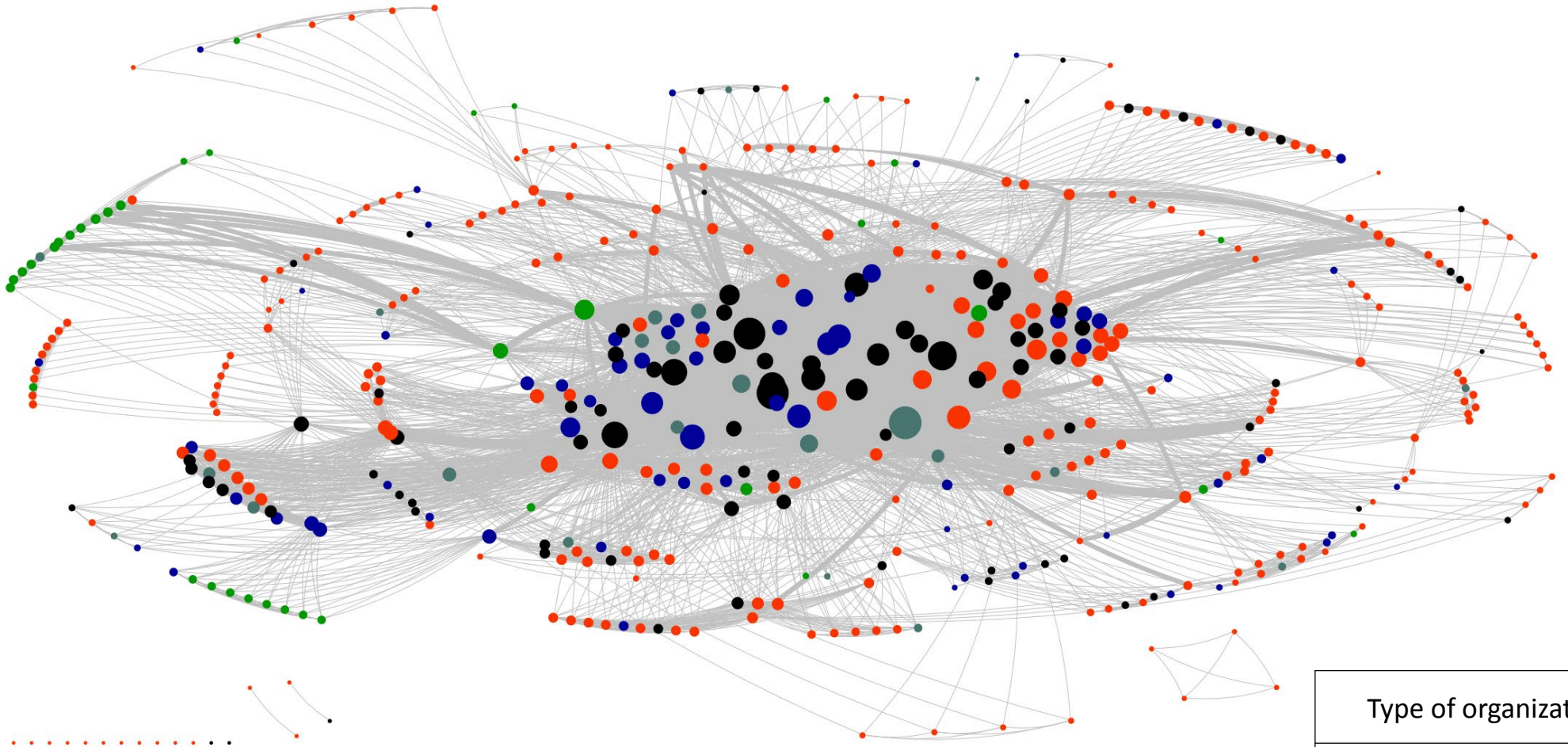
All RTD European projetcts on wave energy 1993-2018.







Composition: diversity of organizations



TYPE OF ORGANIZATIONS:

- Firm
- Government
- Collective
- University
- Research & Tecnology

Nº OF EDGES:

14

1

DEGREE:

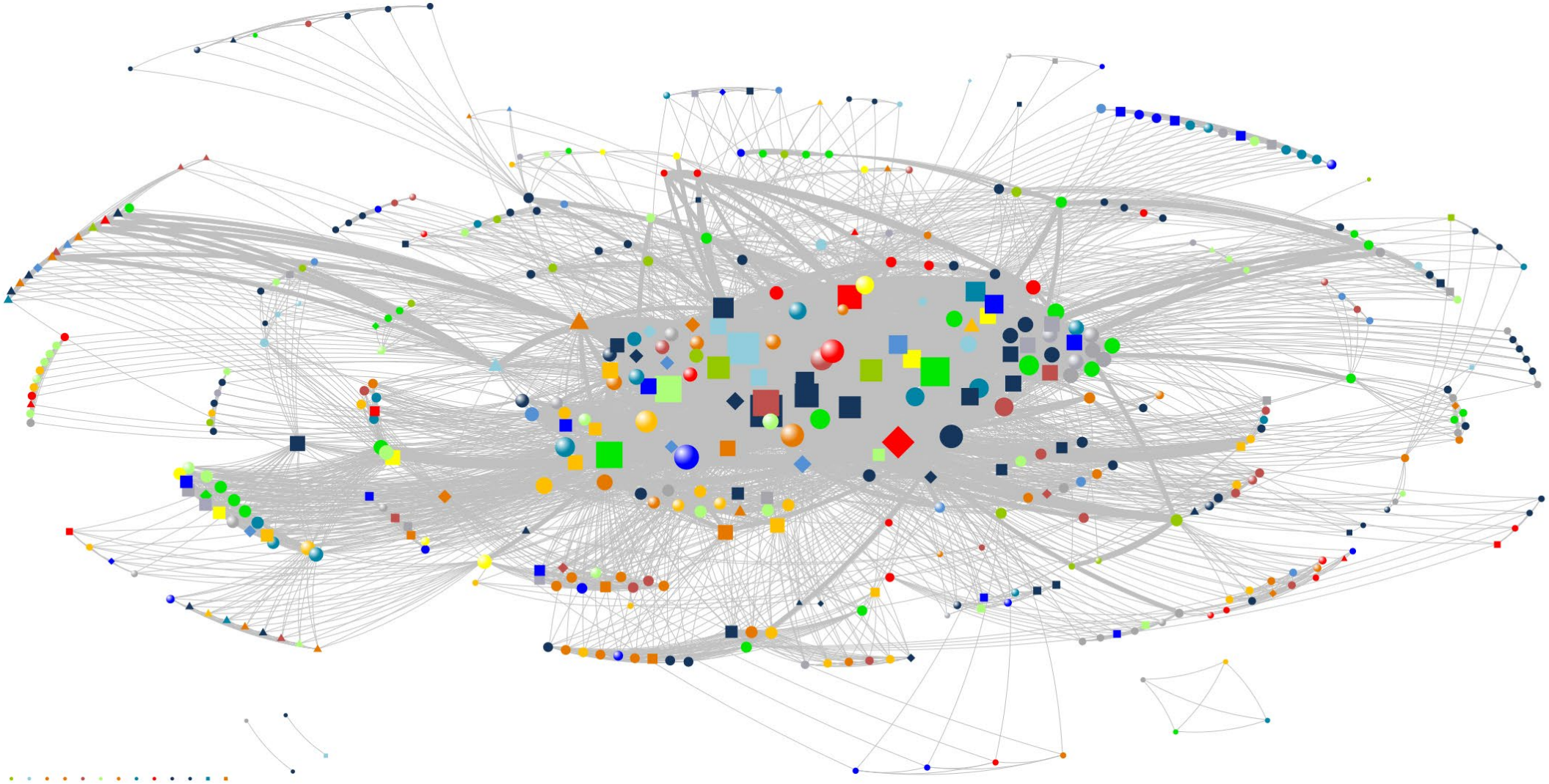
0 | 97 | 208

Type of organizations	Number of organizations
Firm	266
University	88
Research & Tecnology	67
Government	37
Collective	23
Total	**481**

Degree and Betweenness Centrality by Organization and Country

Organization	Country	Organization Type	Degree	Betweenness Centrality
WAVEC - Offshore Renewables	Portugal	Collective	208	16509.4
UNIVERSITY OF EDINBURGH	UK	University	202	11228.3
UNIVERSITY COLLEGE CORK, NATIONAL UNIVERSITY OF IRELAND	Ireland	University	197	13581.9
AALBORG UNIVERSITET	Denmark	University	162	9113.1
DANMARKS TEKNISKE UNIVERSITET	Denmark	University	135	4757.0
ECOLE CENTRALE DE NANTES	France	University	134	3298.0
NTNU NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET	Norway	University	134	9010.2
FRAUNHOFER GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG	Germany	Research & Tecnology	120	3532.0
IST	Portugal	University	110	4615.6
UNIVERSITY OF STRATHCLYDE	UK	University	110	1038.4
LNEG	Portugal	Research & Tecnology	107	2760.3
FUNDACION TECNALIA RESEARCH & INNOVATION	Spain	Research & Tecnology	105	2321.8
IT POWER LTD	UK	Firm	105	4101.1
IFREMER INSTITUT FRANCAIS DE RECHERCHE POUR L'EXPLOITATION DE LA MER	France	Research & Tecnology	99	727.9
CHALMERS UNIVERSITY OF TECHNOLOGY	Sweden	University	97	2984.3
UPPSALA UNIVERSITET	Sweden	University	95	1448.1
CONSIGLIO NAZIONALE DELLE RICERCHE	Italy	Research & Tecnology	93	4837.7
UNIVERSITY OF EXETER	UK	University	92	1920.8
QUEEN'S UNIVERSITY OF BELFAST	UK	University	80	2014.2
DHI	Denmark	Firm	76	1197.7
ENTE VASCO DE LA ENERGIA	Spain	Government	76	4496.7
WAVE DRAGON APS	Denmark	Firm	76	2011.9
STICHTING ENERGIEONDERZOEK CENTRUM NEDERLAND	Netherlands	Research & Tecnology	75	1048.1
TECHNISCHE UNIVERSITEIT DELFT	Netherlands	University	74	3486.6
TEAMWORK TECHNOLOGY BV	Netherlands	Firm	73	591.9
ECOFYS B.V.	Netherlands	Firm	67	192.5
EDF	France	Firm	67	336.7
TECHNISCHE UNIVERSITAET MUENCHEN	Germany	University	66	1383.9
UNIVERSITEIT GENT	Belgium	University	66	942.4
UNIVERSITY OF PLYMOUTH	UK	University	65	950.6
CENTRE FOR RENEWABLE ENERGY SOURCES	Greece	Research & Tecnology	64	2828.2
EUROPEAN MARINE ENERGY CENTRE LTD	UK	Collective	63	219.9
EU-OEA	Belgium	Collective	62	391.7
NATIONAL TECHNICAL UNIVERSITY OF ATHENS	Greece	University	61	1201.7
STICHTING MARITIEM RESEARCH INSTITUUT NEDERLAND	Netherlands	Research & Tecnology	59	3402.4
UNIVERSITY OF SOUTHAMPTON	UK	University	57	72.5
SPOK APS	Denmark	Firm	54	324.2
ENEL INGEGNERIA E RICERCA SPA	Italy	Firm	53	468.1
OCEAN ENERGY LTD.	Ireland	Firm	53	38.1
NATIONAL UNIVERSITY OF IRELAND	Ireland	University	51	428.8

Geography: diversity of locations



Countries*	
Portugal	
Spain	
Italy	
Greece	
France	
UK	
Ireland	
Netherlands	
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Denmark	
Norway	
Sweden	
Other countries	

Only the most significant countries were colored.

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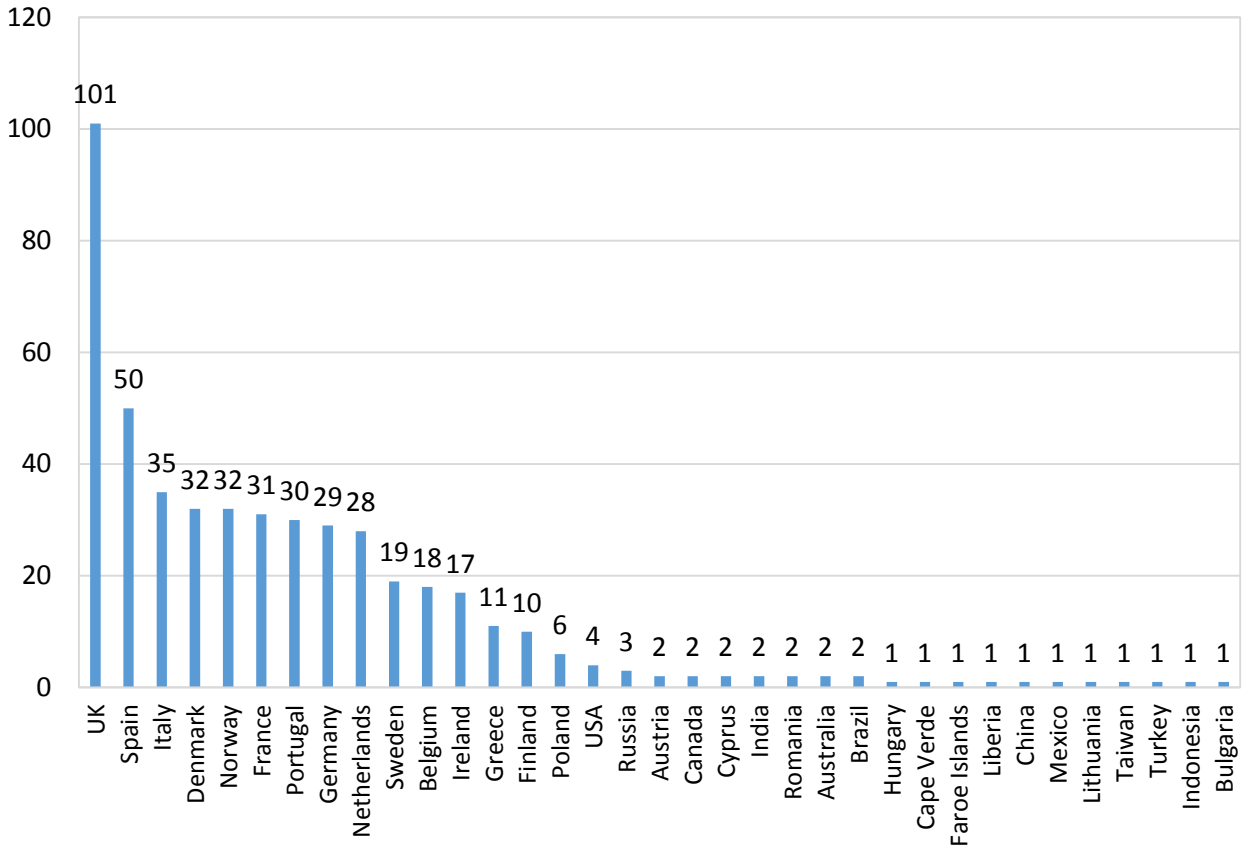
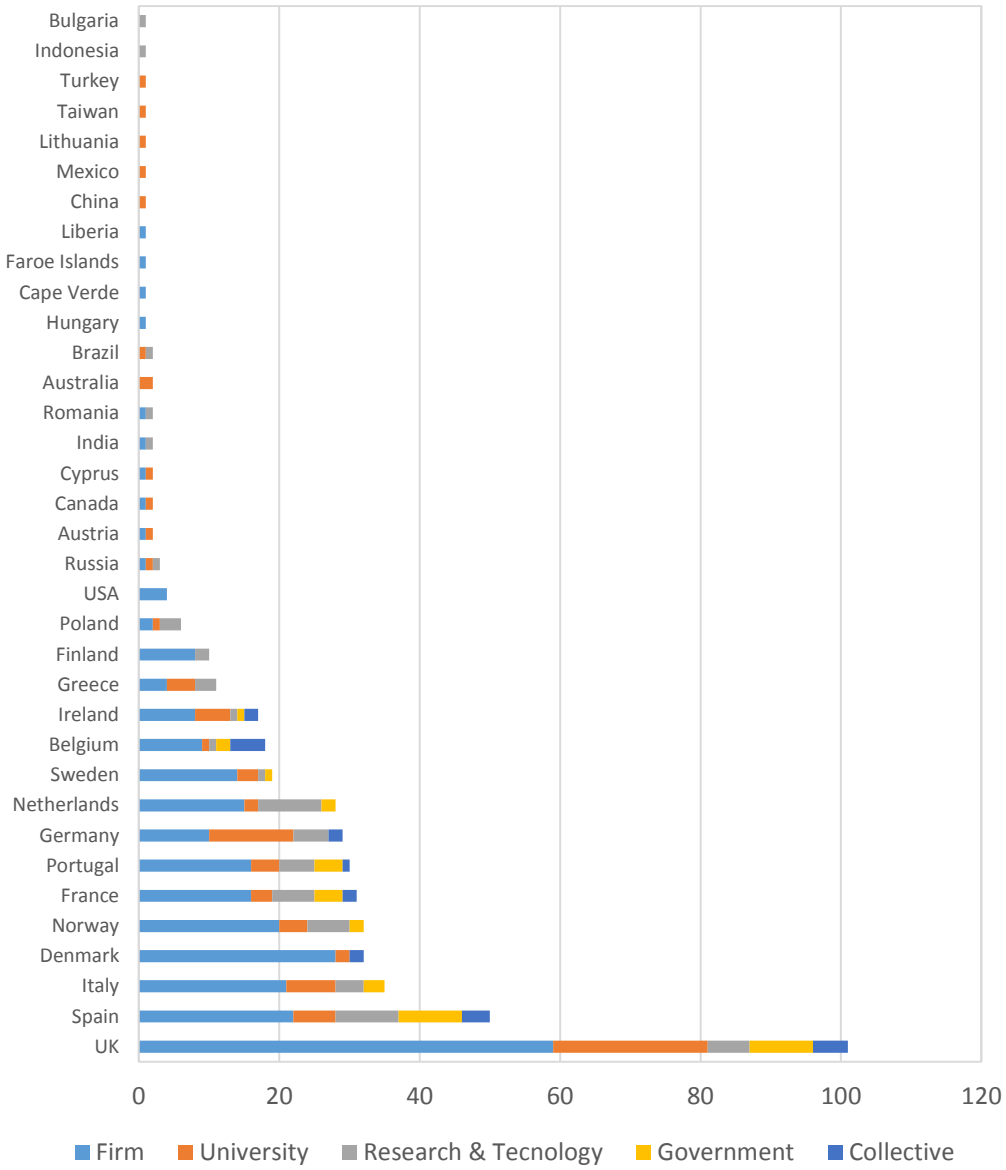
Geography: diversity of locations

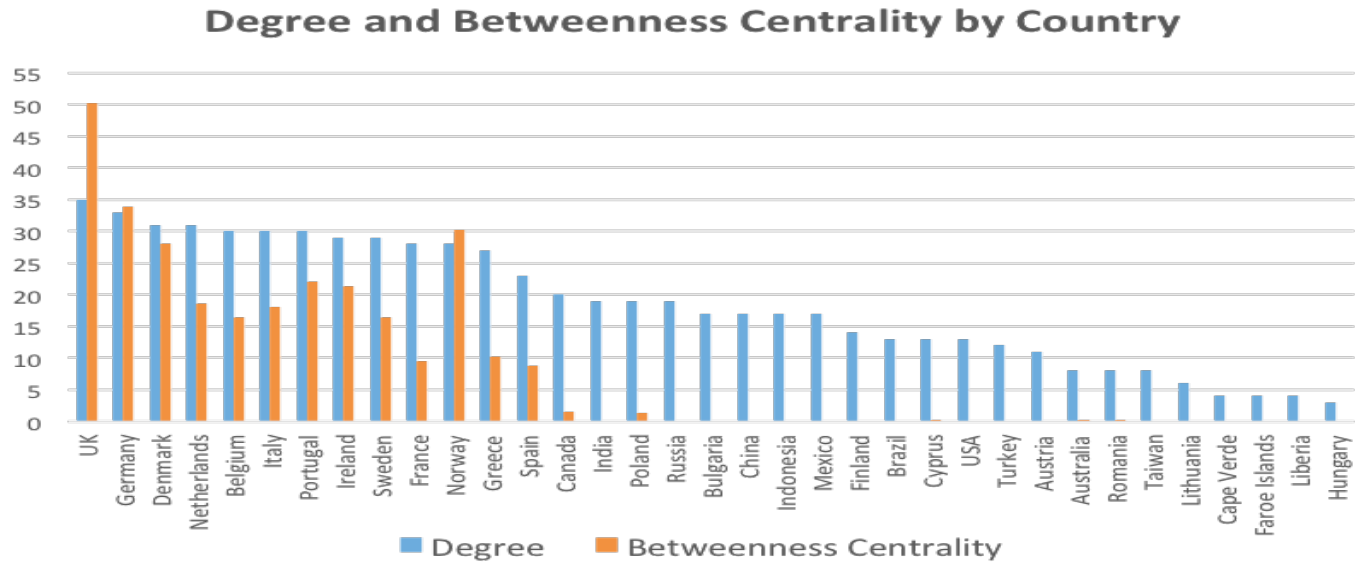
Number of organizations by country

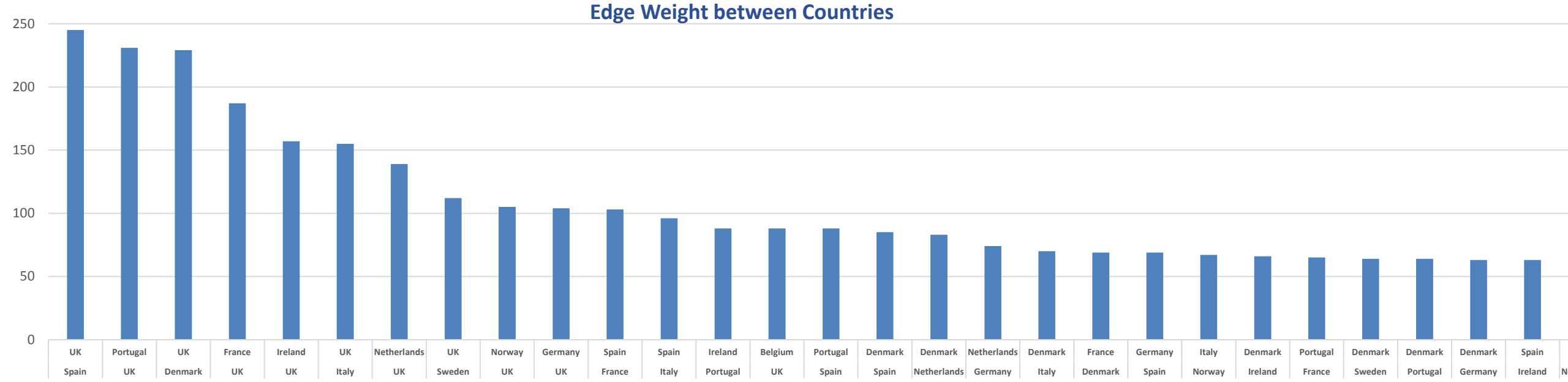


Type of organization by country

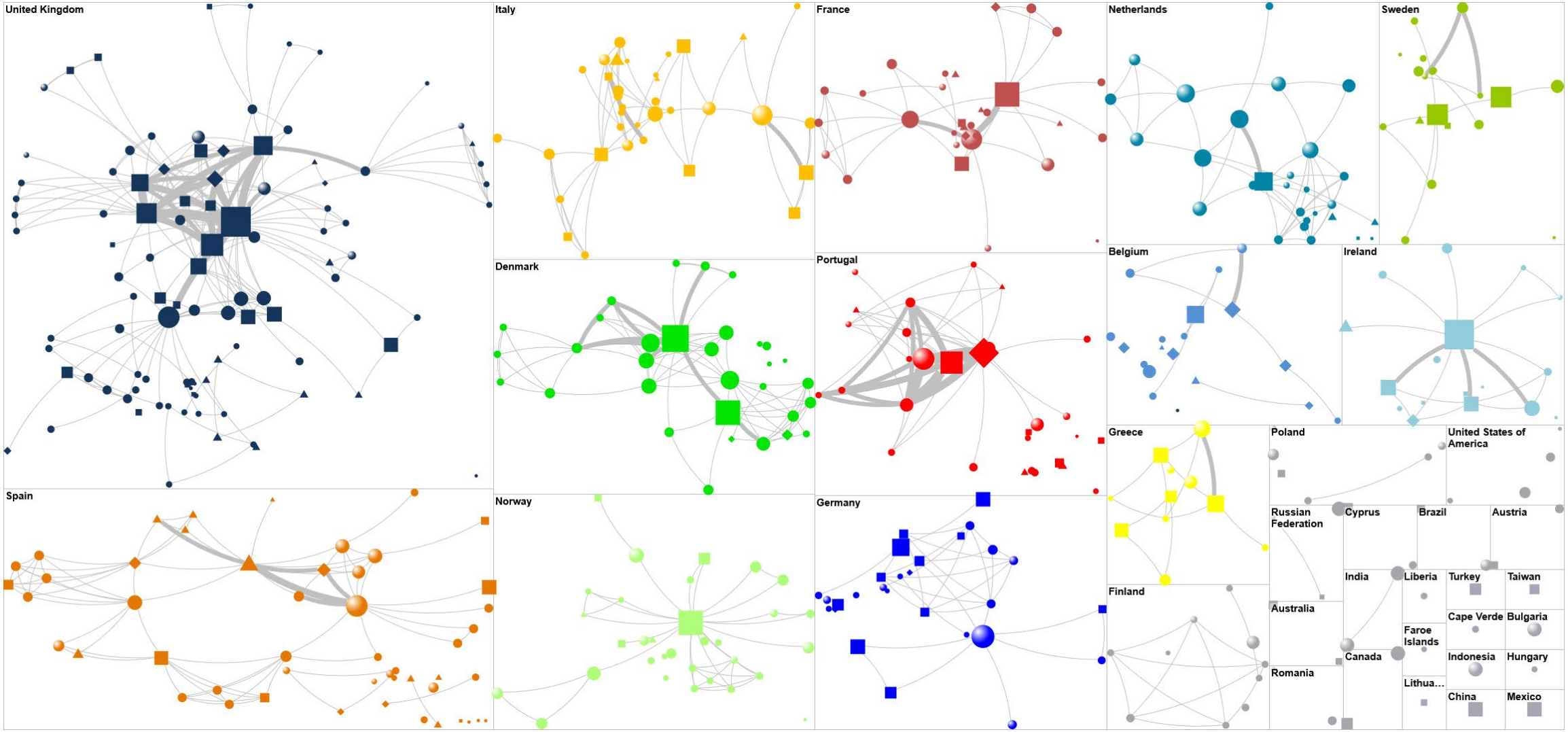


Geography: centralities and edge weight between countries





Geographyc proximity: the national scale maters



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Transnational behaviour:

The early development was concentrated on a few countries in the Atlantic area (UK, Portugal, Ireland, Denmark). Over time some new countries – mostly among those with Atlantic coasts (where the wave resource is better) - become involved in the activities. Some new entrants become more important (e.g. Spain), while others reduced their relevance (e.g. Portugal).

From the beginning the activities had some transnational nature and an international community was formed and strengthened over time around a number of collective actions: first dedicated conferences, scientists mobility, joint projects; latter collective networks and organisations (e.g. OES Implementing Agreement on Ocean Energy Systems in the context of the International Energy Agency (2001); European Ocean Energy Association (2006); Ocean Energy Forum (2012) in the EU context; European Technology & Innovation Platform for Ocean Energy (TP-Ocean later ETIP Ocean).

Some collaborations between organisations – at country level or across countries - were maintained over time (stable networks of collaboration). Similarly, partnerships formed around specific technologies (or different generations of the same type of technologies) remained stable over time. These partnerships can involve both firms and other organisations.

Sea-level experimental activities can be very costly, much beyond the capacity of most technology developers. To address this problem a number of shared test infrastructures started being built. These can be created by countries or by consortia joining countries/organisations and are at least partly funded by the European or national funds. These infrastructures become “hubs” were several technologies, from different countries are tested – and the organisations/countries that host tend to concentrate projects.

Despite the international nature of the field, the experimental projects are very much "territorialised" (even if the partners can originate from different countries) in the sense that they require the creation of infrastructures and that the technologies may need to be in place for some time in order to prove reliability in the sea conditions. They may also rely to greater or lesser extent in suppliers from the region (whether or not partners in the projects).

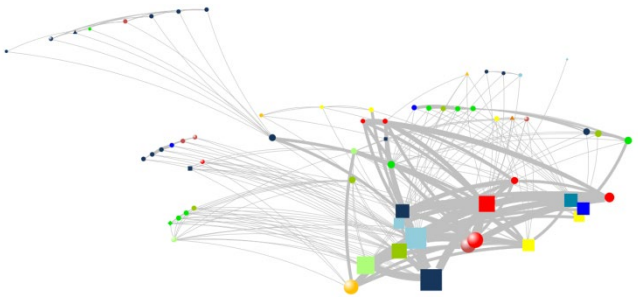
Recent evolution

During the period of decline that followed the financial crisis - and that was also associated disappointment among funders given the failure of the technology to fulfil its (possibly exaggerated) promises – there was an attempt within the community to identify the principal problems and to devise strategies to address them.

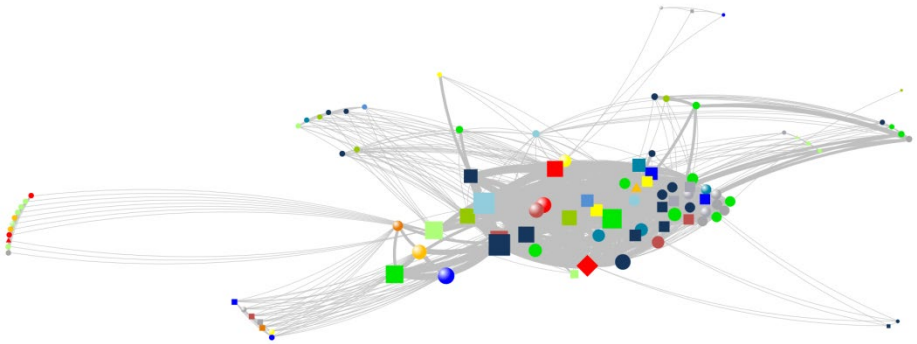
This led to a number of recommendations about the way to organise R&, that were incorporated in the policies and in the calls for projects launched at EU level. This had some effect on the more recent direction of technology development.

Geographic dynamics: an increase in the number of orgnizations from diferent coutries involved

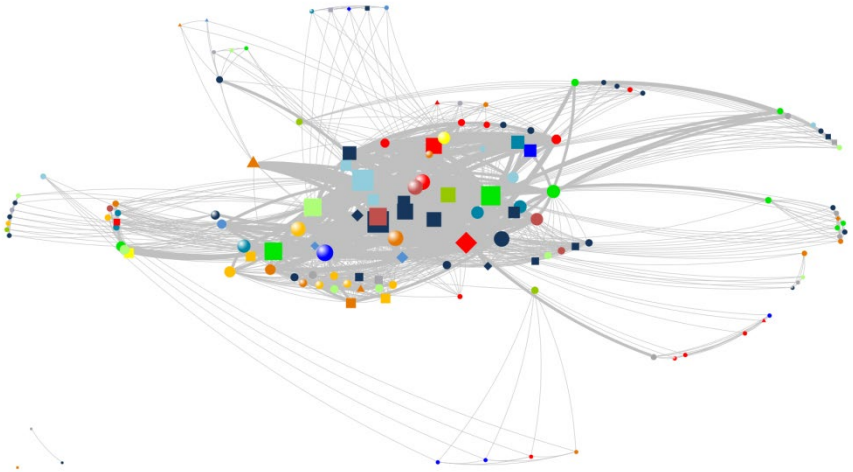
Before 2000



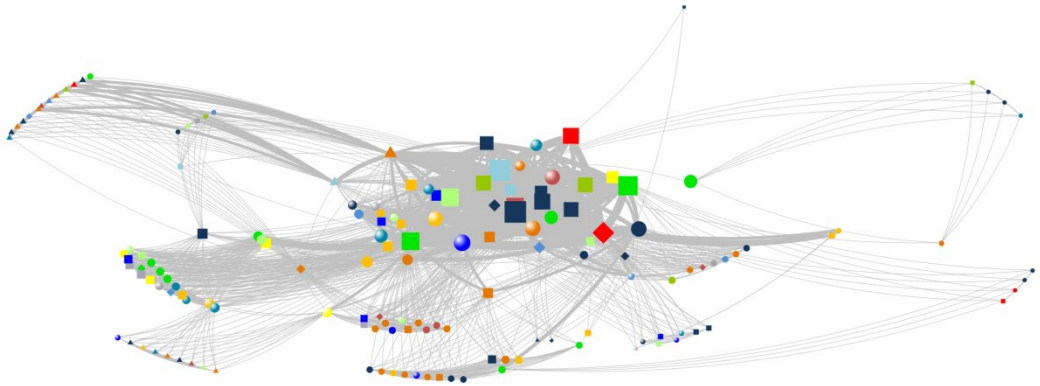
2000 -2005



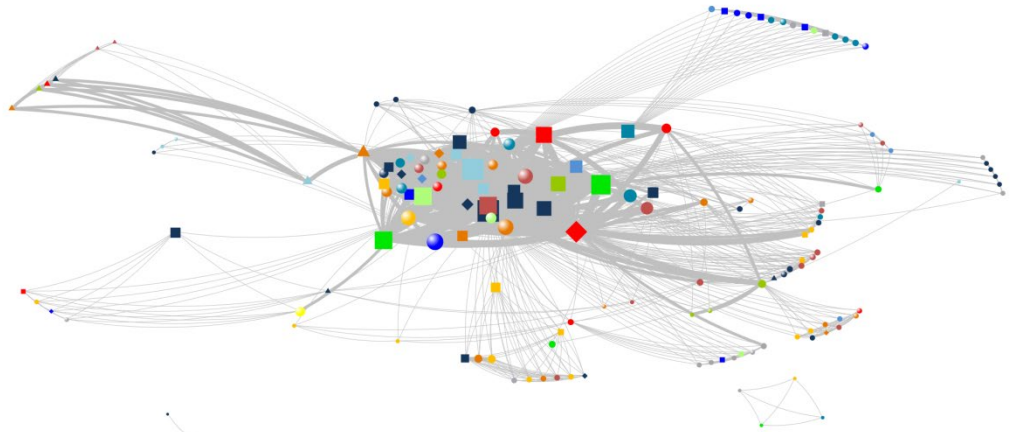
2006-2010



2011-2014



> 2015



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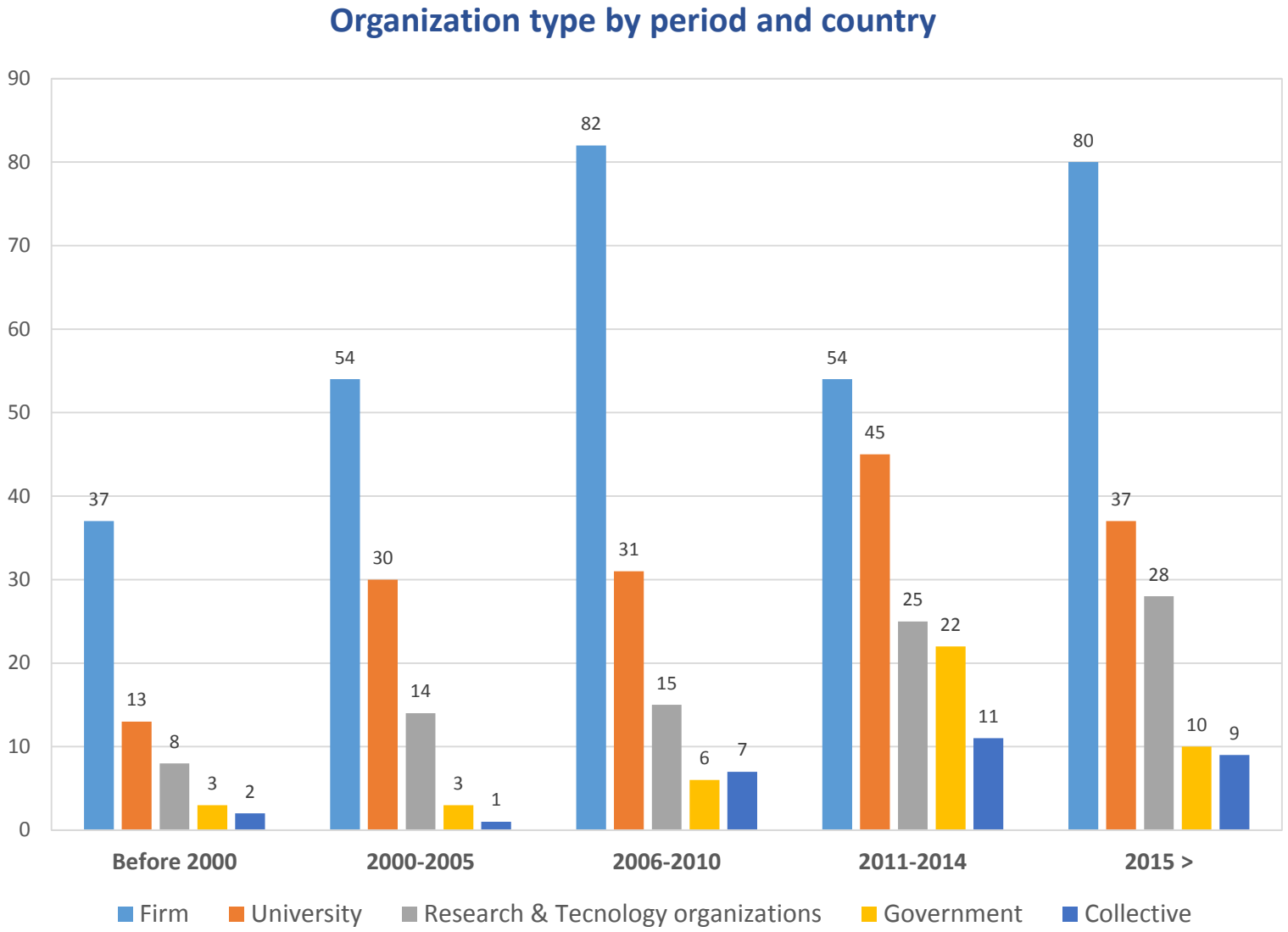

Evolution

Before 2000s

- Early activities – few projects / few countries.

Around 2000:

- a number of technologies start experimental development projects.
- the first international collective organization aiming at promote the field developments (OES-IEA) is formed.

2006 ->

- The European Association is created.
- There is a new upsurge in technology designs being experimented in the main countries involved.

2011 ->

- Impact of financial crisis: investors abandon; policies are reduced in some countries; several technology developers experience difficulties and some go out of business.
- But this decade shows collective efforts to make an assessment of the problems and to define strategies for accelerating development.
- This includes EU level actions (European Commission launches Blue Growth Strategy & Blue Energy Action Plan; Ocean Energy Forum and Technology & Innovation Platform for Ocean Energy (TP Ocean) are created with mission of proposing strategies; Ocean Energy ERA-NET to coordinate funding) and also actions in several countries.

2015 ->

- These actions create conditions for recovery.
- Funding increases (at least at European level).
- New technologies start experimental projects.
- Roadmap for Ocean Energies (2016).
- Review of Blue Growth Strategy (2017).
- H2020 launch calls specific for marine energies in general (2015); for wave energy (2018).

Future research development:

Which specific spatial and actor configurations contribute the development of new interdependences between existing industries and the emerging technology, promoting its structuration?