DG MARE

Elaboration of the Atlantic Action Plan

Thematic report “Innovation at the service of a low-carbon economy” - Workshop Atlantic Forum (Brest, 29 & 30 October 2012)

30 November, 2012 (Version 3 (Final version))

A project undertaken by the Consortium comprising:

- *COWI*
- *Ernst and Young*
- *BIOIS*

This report has been drafted by the Consortium, on behalf of DG MARE.

Ernst & Young Quality In Everything We Do

COWI

European Commission

Contents

1 Foreword

The Directorate General for Maritime Affairs and Fisheries (DG MARE) and the Atlantic Forum have initiated a stakeholder consultation process to contribute towards the development of an action plan for the Atlantic Ocean region.

To assist in the development of the action plan, five workshops are being held. For each workshop, a thematic report is provided to inform the discussion and summarise the outcomes.

The purpose of the thematic report is to inform each workshop by providing background information on the workshops' discussion topics. The thematic reports pose questions and suggest potential ideas for future action that can be used as a starting point for discussions. After the workshops, conclusions and comments are incorporated into the thematic reports.

After completion of the workshops, DG MARE will compile recommendations on priority research, investment and policy actions. The Atlantic Action Plan will address the five themes/challenges defined in the Atlantic Strategy (COM (2011) 782):

1. Implementing the ecosystem approach
2. Reducing Europe's carbon footprint
3. Sustainable exploitation of the Atlantic seafloor's natural resources
4. Responding to threats and emergencies
5. Socially inclusive growth

DG MARE has commissioned COWI and E&Y to assist with the development of an Atlantic Action Plan. The work has been launched under the framework contract for impact assessments and evaluations, referenced MARE/2011/01 Lot 1 Maritime Policy.

The objectives of this assignment are to:

- Support the development of the Atlantic Action Plan;
- Prepare its performance monitoring and evaluation modalities (performance framework and indicators);
- Undertake its ex-ante evaluation.

Any suggestions for the thematic are most welcome. Please do not hesitate to contact Ernst & Young (Christina Castella, christina.castella@fr.ey.com) if you have ideas or comments that may encourage and support further development of the thematic report.

2 Introduction and context

The aim of this report was to inform the discussion at the Brest workshop on 29-30 October 2012 and, following the workshop, to summarise the key discussion points and ideas for future action. The theme of the workshop was "Innovation at the service of a low carbon economy" and the topics of discussion included:

- **Marine Renewable Energies:** discussion on different marine energy technologies (including tidal, wave power generators, offshore (floating) wind turbines and thermal ocean energy), research, applications, collaboration between research, testing centres, private operators, and other issues.
- **Sustainable maritime transport**: research on more energy efficient ships of the future ("Greenship"), from design to decommissioning; algae fuel research: reflection on future projects, motorways of the sea, land-sea interface and logistics.
- **Maritime Safety and Security**: Information and Communications Technology (ICT) research on information and surveillance systems, navigational aid.

Each topic has been addressed in a separate subtheme annex, which summarises the baseline situation, trends and outlook into an analysis of gaps and possible ideas for future action. The main body of the report draws conclusions regarding the separate subtheme annexes.

The present report is structured as follows:

- Main body
  - Baseline situation and trends: discussion of future trends and potential directions
  - Workshop discussions
  - Gap analysis: identification of gaps and suggestions for actions to be taken
  - Potential ideas for future action: research and investment priorities, including findings from the workshop held
- Annex per subtheme
  - Context: introduction to the theme, important definitions, etc
  - Baseline situation and trends: discussion on the future trends and potential directions
  - Assessment: identification of gaps and suggestions for actions to be taken

The focus has been on the major trends, rather than local interests, as the Atlantic Action Plan is intended to be an overall plan for the entire region. However, inspiration may be found in local initiatives, which have the potential to be implemented on a larger scale.

This report has been revised based on the discussions at the workshop, and will be used as an information source in the development of the Atlantic Action Plan.

3 Baseline situation and trends

In this section, an overview of the major non-sector-specific trends are provided. Funding mechanisms could also be non-sector-specific, but funding will be discussed in the general document related to the process of the development of the Atlantic Action Plan. Subsequently, a brief analysis is provided for each of the three subthemes addressed within the annexes. The aim is to provide insight into the state of play and the potential for future development of the sectors.

Firstly, the current state and trends of marine energy renewables will be presented. This definition covers both Offshore Wind Energy and Ocean renewable energy. The Final Report on Blue Growth states that ocean energy is still in an early stage of development and has a strong focus on Research and Development (R&D). The key to the future success of blue energy relies upon the rapid development of technological advancements and the successful completion of demonstration projects. The current state and future trends in terms of R&D, demonstration projects and the barriers that need to be overcome collectively are addressed.

Secondly, the sustainable maritime transport sector is introduced. The current market will be described as well as the state of research into more energy efficient ships of the future ("Greenship"); algae fuel research, as well as a reflection on future projects.

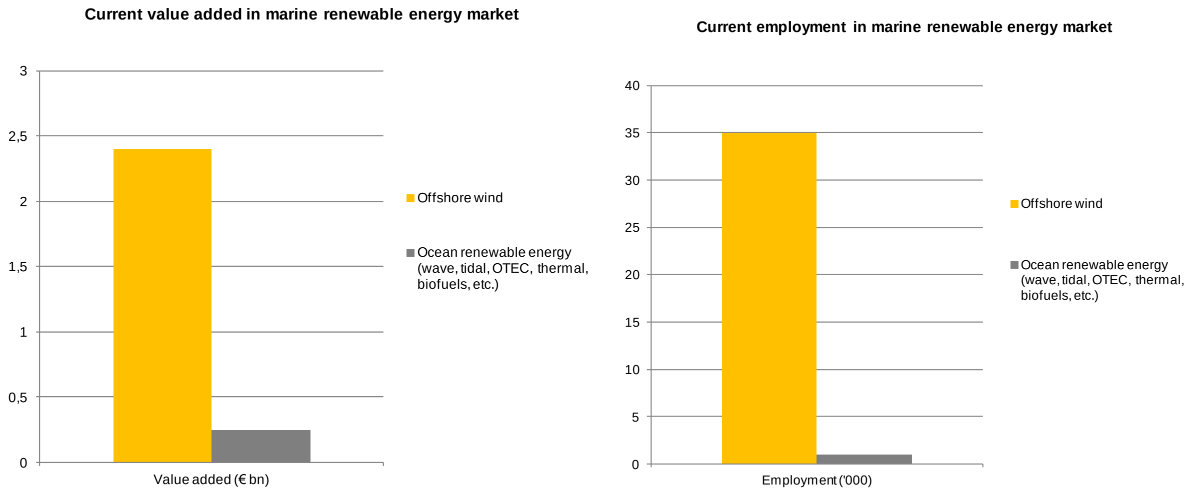
Finally, maritime safety and security is presented. This section focuses particularly on current and future ICT research on information and surveillance systems, and navigational aids.

3.1 Marine energy renewables

3.1.1 Current state and future trends

The most advanced marine renewable energy technology is fixed-based offshore wind, which has reached the stage of full-scale industrial and commercial deployment. The total installed offshore wind capacity amounted to 3.8 GW in 2011, including a 31% growth rate in 2011[1]. This statistic is confirmed by the Blue Growth Final report, which provides the current value added and employment for the sector.

Figure 1: Current size of marine energy renewable sector according to Blue Growth final report



Source:For Offshore wind, EWEA (2010), Eurobserver (2010), EWEA (2011); Share based on MW installed offshore compared to onshore; 2010 investment data as a proxy of GVA only. For Ocean renewable energies: Own estimate based on installed power. Data IEA (2011).

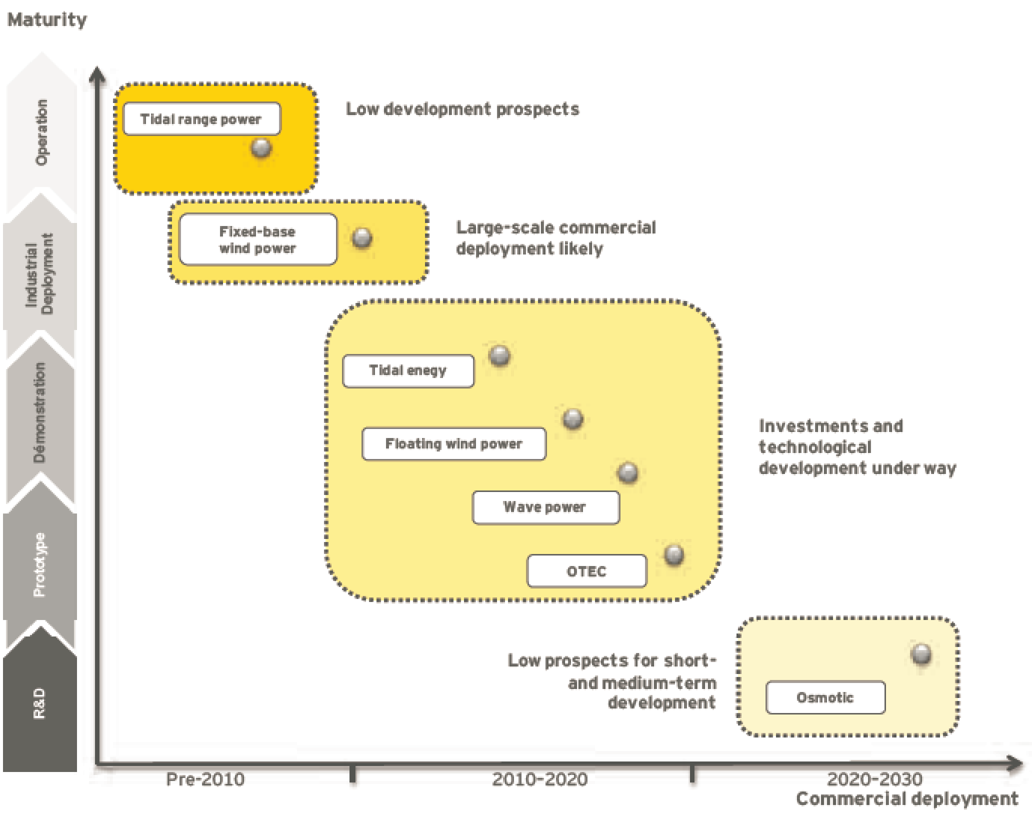
[1] Source: European Wind Energy Association

Ocean energies on the other hand are less mature, despite acceleration in development over the past few years, and remain at the research, prototype or demonstration stage. At a global level, total installed capacity of ocean energy in 2011 is 519 MW, most of which related to tidal power plants.[2]

Apart from fixed-based offshore wind , there are good prospects for growth of floating offshore wind power, which could benefit from operational feedback from fixed-base wind turbines, as well as for marine current (tidal energy). Wave energy is less likely to reach the commercial stage for several years, and is positioned for medium- to long-term market development, along with Ocean Thermal Energy Conversion (OTEC), which is focused mainly on tropical areas. R&D and demonstrated projects for each of these technologies are provided in the subtheme annex.

Therefore the technologies that should be considered for potential commercialisation within a 2020 horizon are floating offshore wind, and marine current (tidal energy).

Figure 2: Marine renewable energy maturity and development prospects



Source: Ernst & Young, 2012, "Ocean energy Opportunities in the French market"

Looking beyond 2020, the International Energy Agency (IEA) has estimated the global total installed capacity of ocean energy in 2050 as 748 GW.[3] In addition to this, there are strong expectations for the offshore wind industry: with targets of 40GW installed in Europe by 2020, representing 170,000 jobs, growing to 150GW installed by 2030, representing 300,000 jobs. By 2050, 460GW is planned to be installed.

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[2] Implementing Agreement on Ocean Energy Systems (OES), Annual Report 2010, International Energy Agency.
[3] OES Vision Brochure, October 2011, An International Vision for Ocean Energy

3.1.2 R&D and demonstration projects

Each Atlantic Member state has its own research and development focus, outlined and summarised in the table below.

Table 1: R&D focus per Atlantic Member State

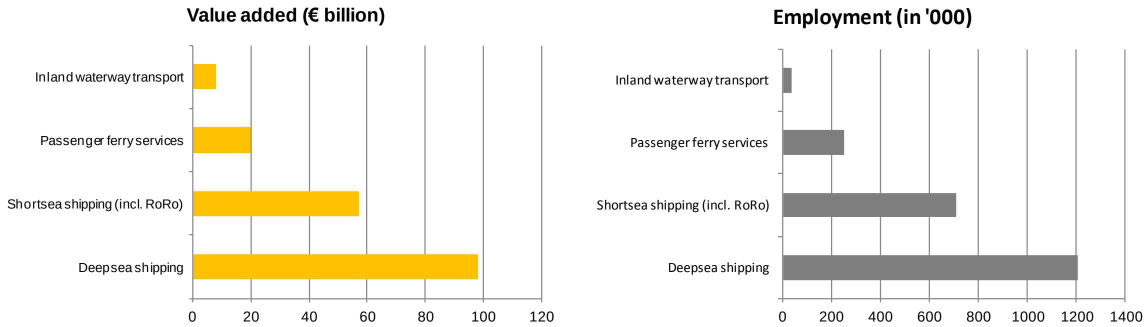
MS	R&D players	Research trend	Test facilities
UK	Universities working in conjunction with technology developers: University of Lancaster (UK), University of Southampton (UK), University of Strathclyde (UK).	Technologies to connect wave and tidal energy to the grid	European Marine Energy Centre (EMEC) New and Renewable Energy Centre (NaREC) Wave Hub
Ireland	Irish Universities, Institutes and Bodies, including UL, UCD, QUB, NUI Maynooth, NUI Galway	Bringing designs from prototype stage to fully operational pre-commercial devices Wave energy and ocean currents are a key focus	Seilean oscillating water column (OWC) device, and the Wavebob device Atlantic Marine Energy Test Site (full scale grid connected wave energy test facility) being developed in County Mayo
France	IPANEMA initiative - comprises 130 members from industry and research Pôle Mer Bretagne and PACA competitiveness clusters Numerous research centres, eg. IFREMER France Energies Marines project involving a broad 54-member consortium of businesses, research and higher education organizations and institutional partners.	Focus on development of marine renewable energy technologies (floating wind turbines, wave turbines, tidal turbines and OTEC) and their market deployment	In France there are five test sites: SEM-REV wave power site at Le Croisic, offshore tidal site off Paimpol-Bréhat, SEENEOH estuarine tidal site near Bordeaux and floating offshore wind power sites at Fos-sur-Mer and Groix.
Spain	participation of TECNALIA in several European projects HIDROFLOT, PIPO Systems and OCEANTEC, industrial companies, R&D centres and universities	PSE-MAR: strategic research aimed at developing three wave energy converting technologies OceanLider: resource assessment, site selection, operation and maintenance, technology development, grid connection and environmental aspects	Santoña Test centre: test site for prototypes of Wave Energy Converters Ubiarco Test Centre: testing site for prototypes of WECs and Floating Wind Turbines (FWT). bimep – Biscay Marine Energy Platform, which will allow full-scale prototype testing and demonstration of renewable marine energy converters
Portugal	Wave Energy Centre (WavEC), Instituto Superior Técnico (IST) Laboratório Nacional de Engenharia e Tecnologia (LNEG). “Pólo de Competitividade e Tecnologia da Energia” (Competitiveness and Technology Centre for Energy)	Offshore wind and wave energy	Pico wave energy plant: part of the European network of R&D infrastructures under MARINET Aguçadoura site: open ocean test site Pilot Zone: wave energy

3.2 Sustainable maritime transport

3.2.1 Current state

Maritime transport is key in creating blue growth and connection the European economies to each other and the World markets. In Europe, the sector generates some €200 billion annually in added value and employs 2.5 million people (see figure below). Specifically, deep and short sea shipping are major economic subsectors for which most employment is on land .[4]

Figure 3: Value added and employment of maritime transport and shipbuilding in the EU



Source: DG MARE, "Blue Growth – scenarios and drivers for Sustainable Growth from the Oceans, Seas and Coasts – final report" 2012

Maritime transport is a major employer directly, but it is equally important in securing employment e.g. in businesses that supply the sector. Technological advances and innovation is on one hand necessary to maintain the existing jobs, but R&D is also a source of job creation - not only direct employment in the sector but also a significant number of indirect jobs.

However, seaborne trade has been affected by the recent economic downturn. The European amount of loaded goods has, nonetheless, remained almost constant since 2006 (approx. 1,100 mt), whereas the amount of unloaded goods fell from approx. 2,100 mt in 2006, to 1,700 mt in 2009 after which small increases were seen. Especially, dry cargo dropped during the crises.[5] In terms of short sea shipping, the Atlantic area account for approximately 14 % of European totals, which is roughly half of the contribution from North Sea and Mediterranean short shipping, respectively.[6]

Four ports in the Atlantic Member States rank in between the 20 largest cargo ports (short and deep sea freight), and they are relatively small relative to the largest maritime hub in Europe, Rotterdam (see table below). Still, marine transportation is dominated by few major ports and shipping companies and a host of smaller ports and Small and Medium Enterprises (SME). Economics of scale are very important in logistics and goods concentrate in transportation hubs.

[4] DG MARE, "Blue Growth – scenarios and drivers for Sustainable Growth from the Oceans, Seas and Coasts. Maritime Sub-Function Profile Report. Short Sea Shipping (1.2)" 2012
[5] UNCTAD: Review of maritime transport 2011
[6] In 2009, Atlantic short sea shipping catered 231 mtonnes out of 1,685 mtonnes of the European short sea shipping sector. (DG MARE, "Blue Growth – scenarios and drivers for Sustainable Growth from the Oceans, Seas and Coasts. Maritime Sub-Function Profile Report. Short Sea Shipping (1.2)" 2012)

Table 2: Atlantic ports between the 20 largest European ports in 2010; the freight they handle, their size compared to the largest European port - Rotterdam - and their ranking in terms of size.

Atlantic port	Gross weight of goods, thousand tonnes, 2010	Size compared to Rotterdam	European rank in 2010	European rank in 2002
Le Havre, FR	65.771	17%	6	6
Milford Haven, UK	42.788	11%	14	16
Southampton, UK	39.365	10%	17	17
Dunkerque, FR	36.309	9%	18	12

Source: Eurostat (mar_mg_am_pwhc)

Shipping has low unit cost in comparison to other transport modes and is competitive at large distances. Fuels make up some 30-40 % of operating costs,[7] and costs are thus largely affected by fuel price fluctuations, but increases in the transport sector's operation costs can enhance shipping's competiveness relative to road on shorter distances.

European shipbuilders have lost ground to Asian competitors, and only specialized shipyards continue to operate out of Europe. In Brittany, the specialised ship-repair business in Brest is a corner stone in France's largest maritime cluster: the 'Pôle de competitivité mer' which is the centre of many R&D activities. This includes private-academia projects related to corrosion control (CORONAV) and environmentally friendly anti-fouling paints (BIOPAINTROP) and many others.

3.2.2 Future trends

In the **maritime transport** sector, technological advances and innovation are necessary to maintain existing jobs, but R&D is also a source of job creation - not only direct employment in the sector but also a significant number of indirect jobs. The maritime transport sector shares the technology platform Waterborne[TP] in an effort to highlight R&D requirements for European competitiveness, innovation and the meeting of regulations like safety and environment.

Continuous efforts are being made in the direction of "**green shipping**", which is integrated in the EU Framework for research and technological development (FP7). In 2012 for example, €24 million are set aside for ensuring safe, green and competitive waterborne transport[8].These efforts have various directions including:

- Emission reduction: exhaust scrubbers and alternative fuels (low sulphur fuels and liquid natural gas)
- Alternative energies: land supply of energy in ports (electrical power outlets), sails and solar panels
- Improved design: energy efficiency, improved design and recycling of materials.

In terms of **future shipping fuels**, experts have assessed that natural gas in liquid form can become a viable fuel alternative in the next 5-10 years once the distribution infrastructure is in place.[9] Biofuels are relevant for shipping as for other energy dependent sectors. For instance biofuels based on marine algae have undergone large scale tests,[10] but marine algae applications are still under development and their energy contribution over the next decade is likely to be modest.[11]

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[7] DG MARE, "Blue Growth – scenarios and drivers for Sustainable Growth from the Oceans, Seas and Coasts. Maritime Sub-Function Profile Report. Short Sea Shipping (1.2)" 2012

[8] European Commission: C(2011)5068

9 DG MARE, "Blue Growth – scenarios and drivers for Sustainable Growth from the Oceans, Seas and Coasts. Maritime Sub-Function Profile Report. Short Sea Shipping (1.2)" 2012

[10] For instance, algae fuels powered auxiliary engines Maersk Lines' 300 m long Maersk Kalmer en route between Germany and India (http://www.algaeindustrymagazine.com/maersk-and-navy-test-algae-fuel-on-container-shi/).

[11] Sustainable Energy Ireland: A Review of the Potential of Marine Algae as a Source of Biofuel in Ireland. 2009

In spite of these efforts, the most likely near-future change in shipping fuels will be low sulphide potentially in combination with exhaust scrubbers.[12] Many of the other directions of efforts are still on the test and demonstration level and are therefore unlikely to become widespread in the short to medium run, but these technologies have all the same a growth potential due to the changes that lie ahead for maritime transport.

In order to promote modal shift of transportation towards shipping, links between ports must be well developed, barriers in the logistics sector overcome and port and hinterland infrastructure in place. There is a persisting need to optimize infrastructure with a view to lower costs and strengthen the competitive edge of shipping.

3.3 Maritime safety and security

3.3.1 Current state

Waterborne transport is a key player in worldwide economics. More than 70% of the European Union's external trade and 30 percent of the internal trade is handled by maritime transport.[13] However this requires more efficient transport chains, but more importantly, continued improvements in safety and protection of the environment. The Atlantic is Europe's lifeline for trade. Therefore, Europe's security of supply must be absolutely secure and the trafficking of arms, people and drugs must be stopped.

Ongoing dialogue with the maritime industry is necessary on voluntary measures to promote safety, together with the creation of a business environment in which quality-minded operators are rewarded. Research in the area of **maritime safety** has focused on developing operational and technological concepts capable of meeting the changing needs while enhancing safety and the protection of the environment. Research programmes have focused on topics such as secure container-screening, biometric ID port perimeter security, satellite-based tracking of maritime areas and blue border surveillance. This has enabled a number of maritime security research projects to be undertaken, including SOBCAH, SECCONDD, AMASS, OPERAMAR and UNCOSS.[14]

The EU is already involved in several projects to improve the monitoring of sea areas and vessel traffic in the Atlantic. These include: ARCOPOL + is a project that aims to further improve maritime safety and Atlantic regions coastal pollution preparedness and response against oil and Hazardous and Noxious Substance (HNS) spills through technology transfer, training and innovation.[15]

Furthermore, several cooperation structures and networks on maritime safety have been launched by the Atlantic Area in former programming periods.[16] These include:

- **Green Atlantic for Sustainable Development**: this was part of the 2000-2006 Atlantic Area programme and served as both a process of integration and development of competences and methods aimed at creating a European platform of expertise and action for maritime and environmental safety issues.
- **Emergency Response to Coastal Oil, Chemical and Inert Pollution from Shipping (EROCIPS)**: The EROCIPS Project has worked to strengthen the shoreline response to such incidents, minimising the potential environmental and socio-economic impacts.
- **Improving Coastal and Recreational Waters (ICREW)**: The ICREW project aimed to assist Member States in improving their compliance with the Bathing Water Directive and to provide the tools and techniques to assist Member States to comply with the requirements of the revised Bathing Water Directive.

[12] DG MARE, "Blue Growth – scenarios and drivers for Sustainable Growth from the Oceans, Seas and Coasts. Maritime Sub-Function Profile Report. Short Sea Shipping (1.2)" 2012
[13] EXTRA consortium for DG Energy and Transport, (2001) "Maritime Safety: Results for the transport research programme"
[14] Centre for Strategy and Evaluation Services, "Ex-post Evaluation of PASR Activities in the field of Security and Interim Evaluation of FP7 Security Research, Maritime Security and Surveillance - Case Study", January 2011
[15] ARCOPOL: The Atlantic Regions' Coastal Pollution Response, 15th February 2012
[16] Carvalho, A. (2007), "Maritime Safety and Risks Prevention in the European Atlantic Coast: Challenges for a Transnational Cooperation Framework"

3.3.2 Future trends

Given the size of the Atlantic, there are significant opportunities to improve the efficiency and effectiveness of MS operations in these areas, both within the agencies within each jurisdiction and across jurisdictions through greater cooperation, information exchange and shared analysis.

Future trends that will highlight the need for a coordinated approach include:

- Increased competition for space: this creates increased pressure for environmental protection
- Future shipping: keep dangerous ships away from protected areas (and other industries/activities– maritime spatial planning
- Incentives for quality: Good standard/record gives better routes (including the use of certificates, ”above compliance” standards)
- Trend from compliance culture towards safety culture.

Atlantic regions will benefit from the Common Information Sharing Environment (CISE) currently being developed jointly by the European Commission and EU/EEA member states.[17] It will integrate existing surveillance systems and networks, such as European Border Surveillance System (EUROSUR), for the exchange of information on irregular migration and cross-border crime and the SafeSeaNet system, thereby giving all concerned authorities access to the information they need for their missions at sea. CISE will make different systems interoperable so that data and other information can be exchanged easily through the use of modern technologies. In turn, it will lead to better and cheaper maritime surveillance.

3.4 Summary of baseline trends

The following illustration summarises the research, technology and market trends for each sub-theme.

Table 3: Summary of baseline, in terms of research, technology and market trends

Subtheme	Current overall activity	Research trend	Technology trend	Market trend
Session 1: Marine renewable energies	Growth in sector – prototypes and test centres growing Some technologies approaching commercialisation Differences in advancement per Atlantic State	Focus largely on tidal and offshore wind Component improvements to bring costs down	Different technologies at different stages Commercialisation for wind, tidal mature - Current and thermal at early stage	High investment needed Costly technology Need for appropriate support mechanisms
Session 2: Sustainable maritime transport	High, but lower economic activity in the Atlantic compared to other European waters	Emissions Energy efficiency Alternative fuels	Price competition drive energy efficiency and ship sizes Materials recycling	Increased trade Change fuel prices Potentially more competitive compared to road
Session 3: Maritime safety and security	Trend towards increased cooperation and information exchange Fragmentation of research	Container-screening systems Biometric ID port perimeter security	Data management – gathering, exchanging, integrating, protecting info Shared interoperable	Ongoing security threats, eg. Terrorism, piracy Risk of environmental

[17] COM(2010) 584 final, "Draft Roadmap towards establishing the Common Information Sharing Environment for the surveillance of the EU maritime domain"

efforts	Satellite-based maritime tracking Blue border surveillance	data systems	disaster still exists

4 Workshop discussions

This chapter summarises the discussions held at the workshops for the three subthemes of the Brest event. Where possible, examples of projects that could be implemented at the Atlantic level are provided.

4.1 Marine Renewable Energies

The two working sessions addressing Marine Renewable Energies raised a number of key points that could provide ideas for future action. Each of these points is developed below.

Theme	Discussion point
Close knowledge and data gaps	Networking to improve marine knowledge and observation on marine renewables: Data is sparse and incomplete for the Atlantic as a whole. **Addressing data gaps** can therefore assist in the viability and sustainability of renewable energy solutions. There is a need for **more precise data** on maritime phenomena to optimize the positioning and design of devices so that they can effectively withstand the environment. Furthermore, it is key to improve **knowledge** of energy production, and understand where there is potential and what can be gained, through a mapping of coastal renewable energies (bathymetric surveys, seabirds, etc). Finally, **observation** should lead to a better knowledge of the impact of renewable energy on the environment and ecosystems. Examples of projects may include Atlantic observation network, Mapping/ Catalogue of offshore wind energy in the Atlantic area, Guide to wave capacity, etc.
Cooperate through demonstration projects	**Installation of common test sites**: test sites are essential to move from the demonstration phase to the commercialization phase. Many sites exist, however there are opportunities to **develop better cooperation and coordination**. Focus should be given to **demonstrating a network** or farm of prototype devices rather than individual devices, connected to the electricity grid to test efficacy. This stage currently lacks financing from existing mechanisms as the industrial sector is not willing to assume the risks. Investigations should be undertaken to identify if there is a European public actor that would be capable of investing in these networked pilot sites to demonstrate project viability. Examples of projects may include: (1)Tidal pilot farm: develop the key elements of a commercial tidal farm, including interconnection, operation, economic performance, establishment and consolidation of industrial designs involving marine specialists, SMEs and research institutes, (2) Implementation systems for tidal farms: utilise naval installation resources that are specific to tidal farms to allow the installation of foundations, turbines and cables, (3) Floating offshore wind demonstrator: bring together industrial sector and demonstrate the feasibility of the technology: structure, mooring systems, etc
Strategic and regulatory framework	**An overarching strategy and regulatory framework:** there is benefit to be gained in developing a roadmap for marine renewable technologies. This plan would set out what will be possible and available in terms of technologies in the next 10 years. It would describe in what way the public sector should support production and the sector, such as through transitory buy back schemes. A uniform EU regulation could be needed to simplify the regulatory framework, address the barriers, and facilitate commercial development (during the workshop, it was mentioned that the electricity costs should be homogenized between the MS). Furthermore, demonstrating the viability of technologies and making them competitive with other technologies will require coordinated public policy support.
Marine spatial planning	**Marine spatial planning considerations**[18] must also be taken into account in terms of the standardisation of procedures and planning structures (and lead to efficient licensing).

[18] Discussed in more detail in Bilbao

Integrating offshore and onshore	**Interrelationship between the offshore and onshore sectors:** It is important to: - structure the transport networks, - anticipate connection issues, - work closely with ports and give a particular focus to marine renewable energies storage, and the development of new services in this area. Examples of projects may include: NESCO GI project in the North Sea, investigating an integrated offshore electricity network
Cross sector cooperation and coordination	There is a need for better cooperation and coordination between sectors, public and private, and stages in the industry development lifecycle. There are opportunities for increased exchange between private and public sector actors, and other stakeholders, considering competing interests. Furthermore, the involvement of SMEs and entrepreneurs in the sector needs to be further encouraged, to make the most of their innovate contributions.
Renewable technology solutions	No single technology solution: it was concluded that there is no one solution or technology that can be applied to the Atlantic Region as a whole. An action plan must take into account the opportunities and limitations of each renewable technology for the different zones of the Atlantic. All technologies are relatively complementary; however some will be more suitable than others according to the region/area/phenomena. Nevertheless, there may be an opportunity to develop at least one cooperative European prototype project that affects all Atlantic Member States (no need to plan to many projects: prioritise, as in Japan).
R&D to reduce costs	R&D needs to focus on reducing costs: research efforts should pay attention to reducing the cost of technologies, including maintenance costs, so that they are able to better compete with more established renewable and other technologies in the market. High costs currently present a significant barrier to commercialization, and academics need to be brought together with the industrial sector, to better understand these issues. There is equally a need to prioritize research to reduce uncertainties: including the effect of noise, real data on collision & displacement risks to seabirds, interaction with protected fish species.
Barriers to large scale deployment	Focus needs to turn from technological concept development to addressing the barriers to large scale deployment. There are many different concepts, and thus it is often very challenging to determine which will make it to commercialization stage. Share facilities must be made available so industry can easily access demonstration facilities and investor confidence is encouraged. More specifically, there is a need to develop of self-sufficient energy sources in the islands and outermost regions, such as OTEC, which requires focus of their own.
Public awareness	There is a need to raise public awareness regarding marine renewable energies, and mobilize citizens and industry so that they can play a necessary part in the development of the sector. As part of this, there is a need to have a better understanding on the impacts of marine renewable energies on human activities, such as aquaculture and recreational fishing, and vice versa.

4.2 Maritime Transport

The two working sessions addressing Maritime transport revealed a number of key areas that could provide ideas for future action. Each of these points is developed below.

Theme	Discussion point
Data and knowledge	An important task is to standardise data formats collected. Currently there are very different data and data formats provided according to the needs of various ports, which is very time consuming and results in duplication of effort.

Coordination and cooperation	There is strong foundation of research, but there is a need to broaden and encourage cooperation between research institutions, as well as with industry. Furthermore, there need to be more port to port exchanges, and administrative requirements need to be streamlined. Small alliances of ports could be more attractive to large investors than individual ports working in isolation.
Build on infrastructure	Port infrastructure needs to cope with increased maritime traffic as well as the emergence of new methods and technologies. For this reason, port development projects are critical, and require coordination and input from actors across sectors and geographical areas. Furthermore, industry wants to see that the ports are seriously committed to infrastructure development. The opportunity of floating ports to service larger vessels in the future (that are not accommodated by existing port infrastructure) needs to be investigated.
Some technologies require further investigation	Technologies such as kite, solar, hybrid and wind turbine have not been fully explored to date. They are all known technologies through alternative sectors and purposes. These technologies present opportunities for test facilities to be developed.
Future fuels	Liquefied natural gas provides potential for the Atlantic region as a fuel of the future, and there are examples of its use, however it still lacks a network.
Need to adapt to interventions	Technologies in ships need to foresee developments in legislation and energy supply

4.3 Maritime Safety and Security

The two working sessions addressing Maritime safety and security raised a number of key points that could provide ideas for future action. Each of these points is developed below.

Theme	**Discussion point**
Reinforcing institutional capacity	Strengthen institutional capacity through better risk analysis and decision making by the local/ national administrations and decision-makers: the consequences of maritime risks are much linked to institutional capacity. Whilst priority 11 of the common strategy framework for 2014-2020 is to enhance “institutional capacity and an efficient public administration”, the institutional capacity could be reinforced by complementing technical tools (such as, for instance, Vigisat and the tools developed at EU level including the Common Information Sharing Environment (CISE) and the Information systems managed by EMSA19), with evaluation and decision-making tools. One particular focus area could be the development of tools to assist VTS operators in detecting risk and making decisions. Example of existing projects/ initiatives that could be implemented in the Atlantic region: Baltic Master 1 / Baltic Master 2 (in the Baltic region), Arcopole (in France).
Improve coordination and cooperation	Improve coordination and cooperation, e.g. cooperation between national coastguards, as there is a lot of duplication in maritime surveillance. There is an opportunity to create an Atlantic coordination centre to cope with problems and to know who is doing what in the MS if something occurs. In addition, bilateral cooperation such as through the Franco-British CAMIS (Channel Arc Manche Integrated Strategy) project should be used as the basis for encouraging larger Atlantic regional initiatives. Example of future project that could be implemented in the Atlantic region: create and Atlantic coordination centre to cope with problems and to know who is doing what in the MS if something occurs

[19] EMSA plays a key role through its operational tasks covering satellite oil spill monitoring, vessel tracking, and vessel traffic monitoring, etc. Furthermore, the Common Information Sharing Environment (CISE) integrating existing surveillance systems and networks to give concerned authorities access to information on maritime surveillance activities is of high importance.

Knowledge and sharing of data	Address a number of marine knowledge issues: First of all, there is insufficient sharing of data and a lack of common classification. There is a need to strengthen knowledge and understanding of impacts of events, for example, what is the value (avoided economic costs) of avoiding an oil spill. In addition, there are knowledge gaps in terms of the human factors that result in maritime accidents – this could be investigated through Atlantic cooperation. Finally, initiatives should be undertaken to address a standard format for data.
Pilot projects using available IT systems	Use available information systems for pilot projects to be promoted in the context of a regional Atlantic strategy: Example of existing projects/ initiatives that could be implemented in the Atlantic region: (1) WETREP (in progress in the Atlantic), (2) exercises for example on ship accident/incident reporting (Use SSN training interface to exchange information between MS (MAS, collision, technical problem…)…), on Maritime pollution (Use SSN training interface to exchange POLREPS between MS for pollution exercise, or to exchange dangerous and polluting goods, to monitor the ship movements using the SSN Graphical Interface, etc. (existing exercises in the Baltic regions, especially under Polish initiative), (3) MARSURV-3 project (in progress in the Mediterranean region, which aims to combine specific fisheries information with maritime data available at EMSA), or (4) NAVDAT project which provides digital and encrypted nautical information to mariner by TELEX from shore to sea
Navigation aid and routing	Navigational aid / routing: for example, use existing aids to navigation and possibilities offered by AIS and ENVISIA (system that processes AIS data) to provide efficient and real time information for a better routing of ships. Examples of needs to be considered: (1) Existing beacons equipped with AIS AtoN or collaborative ships equipped with AIS and sensors delivering meteorological and currents information, (2) Meteo and current forecast, (3) On shore service to calculate the best route taking into account environmental accurate information: - less energy , - just in time at the port, (4) Information to optimize route

5 Gap analysis

This chapter includes an overview of the gaps identified during the analysis of the individual subthemes. It also introduces the gaps between what the contextual analysis and the workshop discussions. Gaps are presented under the following headings:

- Policy and legislative framework
- Funding (support)
- Research and development
- Coordination and cooperation

The tables below indicate whether the gap cuts across all subthemes, or whether it relates to a specific subtheme. It also provides an indication of the extent to which each of the identified gaps was addressed by the workshop discussions.

5.1 Policy and legislative framework

Gap	Impact	Discussed during workshop?
Need to ensure strong and stable political framework to attract investor confidence, covering: ▶ Legislation and policy (payment mechanisms) ▶ Grid access ▶ Environmental policies ▶ R&D programmes	Marine Renewable Energies Sustainable Maritime Transport	The Workshop raised the need for a roadmap for marine renewable technologies, setting out what will be possible and available in terms of technologies in the next 10 years. Furthermore, demonstrating the viability of technologies and making them competitive with other technologies will require coordinated public policy support. Detailed issues, such as payment mechanisms and grid access issues however were not developed at length during the workshop due to time constraints.
Policy clarity on the post 2020 regime in order to generate real benefits for researchers, investors in industry and infrastructure	Marine Renewable Energies	The need for post 2020 clarity was raised, however this discussion point was not developed at length
Long term grid access planning, to cope with increased marine renewable energies	Marine Renewable Energies	Grid access and other barriers to large scale development were raised however not discussed in detail
Establishment and use of marine spatial planning	Cross cutting	Marine spatial planning was discussed in detail, particularly in terms of the interrelationship between the offshore and onshore sectors and the standardisation of procedures and planning structures (to lead to efficient licensing).
Policy actions that can ensure future availability and quality of crew on ships	Sustainable Maritime Transport	This gap was not raised during the workshop discussions, but has the potential to be addressed during the Cardiff workshop, focusing on Inclusive Growth
Varied and complex administrative and legal structures across national authorities dealing with surveillance, monitoring, tracking and reporting, impact exchange of information and data management	Maritime Safety and Security	This gap was addressed during the workshop in terms of the identified need to improve coordination and cooperation, as there is a lot of duplication in maritime surveillance. Furthermore, it was revealed that there is insufficient sharing of data and a lack of common classification.

5.2 Funding (support)

Gap	Impact	Discussed during workshop?
Adequate, coherent, streamlined financing mechanisms and schemes to encourage marine renewable energy research and development and bring down costs.	Marine Renewable Energies	During the workshop, there was a strong focus on the importance of R&D in reducing costs, including maintenance costs, so that they are able to better compete with more established renewable and other technologies in the market. It was mentioned that academics need to be brought together with the industrial sector, to better understand these issues, however financing mechanisms were not discussed in detail.
Funding for regional research and technological development activities specific to the Atlantic area (the SEAs-ERA FPT consortium has started doing this, with a dedicated call earlier this year, and this will probably become clearer when their maritime research plan for the Atlantic is adopted).	Cross cutting	Several workshop sessions mentioned the strong foundation of research, but the need to broaden and encourage cooperation between research institutions, as well as with industry. However, once again, there was little discussion on practical financing mechanisms.
Lack of funding of adequate infrastructure in secondary ports is a constraint to further growth[20]	Sustainable Maritime Transport	The issue of port infrastructure was well developed during the discussions. There is a need to cope with increased maritime traffic as well as the emergence of new methods and technologies. For this reason, port development projects are critical, and require coordination and input from actors across sectors and geographical areas. However, funding mechanisms were not specifically addressed.
Funding into developing specialised engineering skills to meet greening of ship technology	Sustainable Maritime Transport	This gap was not raised during the workshop discussions, but has the potential to be addressed during the Cardiff workshop, focusing on Inclusive Growth

5.3 Research and development

Gap	Impact	Discussed during workshop?
Research into technologies to exploit OTEC and salinity gradients, particularly for overseas territories	Marine Renewable Energies	The importance of self-sufficient outermost regions was raised during the workshop on renewables. Discussions focused on developments in Martinique and the Canaries.

[20] DG MARE, "Blue Growth – scenarios and drivers for Sustainable Growth from the Oceans, Seas and Coasts. Maritime Sub-Function Profile Report. Short Sea Shipping (1.2)" 2012

Fragmentation of research efforts	Cross cutting	The fragmentation of research efforts across sectors was recognised in the workshop sessions. There is a particular need for better cooperation and coordination between sectors, public and private, and stages in the industry development lifecycle. There are opportunities for increased exchange between private and public sector actors, and other stakeholders, considering competing interests.
Focus on innovative components and equipment that offer advantages when used at scale	Marine Renewable Energies	It was recognised that the involvement of SMEs and entrepreneurs in the sector needs to be further encouraged, to make the most of their innovate contributions. Furthermore, a key focus was on the need for **demonstrating a network** or farm of prototype devices rather than individual devices, connected to the electricity grid to test efficacy, and move towards commercialisation.
Cooperation between national and European technology platforms	Cross cutting	Technology platforms were raised during the Maritime Safety and Security workshop, in relation to the CISE project and the need to use available information systems for pilot projects to be promoted in the context of a regional Atlantic strategy; however, discussion on technology platforms during the other sessions was lacking.
Further research into green shipping, which poses as both a challenge and opportunity to the sector, in order to develop in a highly competitive market	Sustainable Maritime Transport	Green shipping was discussed at length, as well as the need for further research into technologies such as kite, solar, hybrid and wind turbine, which have not been fully explored to date. These technologies present opportunities for test facilities to be developed.
Advanced Integrated Ship Control (ISC) systems to improve the competitiveness and safety of ship operations.	Maritime Safety and Security	The workshop presented case studies addressing navigational aid / routing: for example, use existing aids to navigation and possibilities offered by AIS and ENVISIA (system that processes AIS data) to provide efficient and real time information for a better routing of ships.
There is a need for further investment to improve technologies for secure containers (e.g. equipped with Intrusion Detection Sensors, electronic seals and data device reading capabilities)	Maritime Safety and Security	The development of technologies for secure containers was not mentioned during the workshop on Maritime Safety and Security.
The need for improved surveillance of port perimeters and investment in research on new technologies to facilitate this, such as biometric ID to secure areas	Maritime Safety and Security	The need for improved surveillance of port perimeters was not mentioned during the workshop on Maritime Safety and Security.

5.4 Coordination and cooperation

Gap	Impact	Discussed during workshop?
Cross-border cooperation not carried out at the same level in all sea areas around the EU	Cross cutting	It was recognised that cooperation is heterogeneous across Europe. In the context of Maritime Safety and Security, the UK-France cooperation in the Channel was referred to as an example of cooperation. However, national and regional differences were not discussed at length.
Regional coordination of research and technological development activities in the Atlantic Ocean	Cross cutting	It was recognised that there is a need for better cooperation and coordination between sectors, public and private, and stages in the industry development lifecycle. There are opportunities for increased exchange between private and public sector actors, and other stakeholders, considering competing interests. Furthermore, the involvement of SMEs and entrepreneurs in the sector needs to be further encouraged, to make the most of their innovate contributions.
Interaction, sharing and knowledge transfer between different sectors and/or business associations. Science policy interface for knowledge/evidence-based policy-making.	Cross cutting	It was mentioned that data is sparse and incomplete for the Atlantic as a whole, and therefore there is a need to a**ddress data gaps**. Furthermore, it is key to improve **knowledge** of energy production, and understand where there is potential and what can be gained, through a mapping of coastal renewable energies (bathymetric surveys, seabirds, etc).
Consolidation, optimisation of existing infrastructure and coordination between ports to target investments.	Sustainable Maritime Transport	The discussions during the workshop raised a need for more port to port exchanges, and administrative requirements to be streamlined. Small alliances of ports could be more attractive to large investors than individual ports working in isolation.

6 Potential ideas for future action

6.1 Marine Renewable energies

Taking into account gaps uncovered through a literature review and the discussions held during the workshops, three key ideas for future action have been identified. Each of these will be developed further to assist in identifying concrete actions.

6.1.1 Observation networks

One of the most important gaps raised during the workshops was the need to address data and knowledge gaps in Atlantic ocean zones. This could potentially be done through the establishment of observation networks. Europe must address the geographical areas where there are gaps in data and knowledge. Two complementary approaches could be through ship data collection and on site observatories. Firstly, it would be necessary to undertake an inventory, then identify gaps, then collect, then observe.

6.1.2 Cooperate through demonstration projects

Atlantic stakeholders should consider establishing a network or farm of prototypes connected to the electricity grid. Example of projects could include the following:

- Tidal pilot farm: develop the key elements of a commercial tidal farm, including interconnection, operation, economic performance, establishment and consolidation of industrial designs involving marine specialists, SMEs and research institutes

- Implementation systems for tidal farms: utilise naval installation resources that are specific to tidal farms to allow the installation of foundations, turbines and cables

- Floating offshore wind demonstrator: bring together industrial sector and demonstrate the feasibility of the technology: structure, mooring systems, etc

6.1.3 Integration of offshore and onshore

Given marine spatial planning conflicts, the Atlantic stakeholders should develop projects to better link the offshore and onshore sectors: structuring the transport networks, anticipate connection issues, and working closely with ports. An example is the NESCO GI project in the North Sea, investigating an integrated offshore electricity network.

6.2 Maritime Transport

The literature review analysis and discussions held during the workshops have resulted in the identification of three key ideas for future action. Each of these will be developed further to assist in identifying concrete actions.

6.2.1 Port network

An area for potential in addressing the competitiveness of maritime shipping in the Atlantic is to develop a port network with an allocation of specific competencies. The objective of the network will be to improve and make the sea transport more advantageous. Within the network the information should be readily available to the user, e.g. the timing and the cost of transport.

6.2.2 Port infrastructure development

Port infrastructure needs to cope with increased maritime traffic as well as the emergence of new methods and technologies. For this reason, port development projects are critical, and require coordination and input from actors across sectors and geographical areas. Furthermore, industry wants to see that the ports are seriously committed to infrastructure development.

6.2.3 Research and testing new energy sources

There is a need for Atlantic stakeholder to support the development of new energy sources for transport in the regions by creating a centre of excellence and a test facility. Technologies such as kite, solar, hybrid and wind turbine have not been fully explored to date. They are all known technologies through alternative sectors and purposes. These technologies present opportunities for test facilities to be developed.

6.3 Maritime Safety and Security

Taking into account gaps uncovered through a literature review and the discussions held during the workshops, three key ideas for future action have been identified. Each of these will be developed further.

6.3.1 Atlantic Coordination Centre

Improve coordination and cooperation, e.g. cooperation between national coastguards, as there is a lot of duplication in maritime surveillance. There is an opportunity to create an Atlantic coordination centre to cope with problems and to know who is doing what in the MS if something occurs.

6.3.2 Strengthen institutional capacity through cooperation projects

The consequences of maritime risks are much linked to institutional capacity. Institutional capacity could be reinforced by complementing technical tools (such as, for instance, Vigisat and the tools developed at EU level including the Common Information Sharing Environment (CISE) and the Information systems managed by EMSA21), with evaluation and decision-making tools. There is opportunity to develop regional cooperation projects to strengthen the institutional capacity to face emergencies (as for instance the Baltic Master 1 & 2 project), and establish an “Emergency chart” for the Atlantic area.

6.3.3 Develop pilot projects using existing IT systems

Atlantic stakeholders should use available information systems for Atlantic specific pilot projects. Examples of existing projects/ initiatives that could be implemented in the Atlantic region include, (1) WETREP (in progress in the Atlantic), (2) exercises for example on ship accident/incident reporting (Use SSN training interface to exchange information between MS (MAS, collision, technical problem…)…), on Maritime pollution (Use SSN training interface to exchange POLREPS between MS for pollution exercise, or to exchange dangerous and polluting goods, to monitor the ship movements using the SSN Graphical Interface, etc. (existing exercises in the Baltic regions, especially under Polish initiative), (3) MARSURV-3 project (in progress in the Mediterranean region, which aims to combine specific fisheries information with maritime data available at EMSA), or (4) NAVDAT project which provides digital and encrypted nautical information to mariner by TELEX from shore to sea.

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[21] EMSA plays a key role through its operational tasks covering satellite oil spill monitoring, vessel tracking, and vessel traffic monitoring, etc. Furthermore, the Common Information Sharing Environment (CISE) integrating existing surveillance systems and networks to give concerned authorities access to information on maritime surveillance activities is of high importance.

7 Annexes

8 Subtheme 1 - Marine renewable energies

8.1 Scope of this annex

This section provides an overview of the status of research and innovation in relation to the different technologies developed. It also broadly covers the regulatory framework and challenges facing further advances in each of the industries. Based on this setting of the scene, suggestions of possible future research and investment/policy actions have been made.

Session 1: Research and development, coordination and cooperation, interdependencies with related sectors and maritime spatial planning implications

The first session addressed research, applications, and collaboration between research, testing centres and private operators. It also looked at interdependencies with related sectors, and in particular on maritime spatial planning implications.

Session 2: The different systems and technologies, and their particular potential for development in the Atlantic Area

The second session addressed the different systems and technologies, and their potential for development in the Atlantic region. Six main technologies have been considered in this thematic report:

- Tidal range energy
- Marine current
- Wave energy
- Floating wind turbines
- Ocean thermal energy
- Osmotic

Each of these technologies is at a different phase of development, and each offers a varying level of potential for the Atlantic region. The stage of development and potential offered for each technology in the Atlantic region is explained in this annex.

Scope of workshop

Successful deployment of large scale offshore renewable energy will only eventuate if challenges are addressed, such as grid connections to link the main production centres to the point of consumption, as well as high investment costs. This and other barriers to large scale deployment are presented in this document, however these issues were discussed in more detail during the subsequent workshop in Bilbao.

8.2 Introduction to the potential of marine renewable energies in the EU and the Atlantic

Marine renewable energies, i.e. ocean energy (tidal range, marine current, wave, ocean thermal) and offshore wind, present significant potential to respond sustainably to the future energy demand in Europe.

The International Energy Agency (IEA) has estimated the global total installed capacity of ocean energy in 2011 at 519 MW, most of which related to tidal power plants.[22] Although the other existing projects are at the demonstration stage, the potential for ocean energy development - estimated at 748 GW by 2050[23] - is vast. In addition to this, there are strong expectations for the offshore wind industry: with targets of 40GW installed in Europe by 2020, representing 170,000 jobs, growing to 150GW installed by 2030, representing 300,000 jobs. By 2050, 460GW is planned to be installed.

Marine renewable energies present significant potential to respond to the future demand for energy in Europe in a sustainable manner. In fact, it is estimated that 0.1% of the energy in ocean waves could be capable of supplying five times the entire world's energy requirements.[24] In addition, marine renewable energies present the potential to reduce greenhouse gas emissions, enhance autonomy of European energy supply, and produce significant economic and social benefits through the creation of jobs.[25]

Europe could have a leading position in the ocean energy landscape, since the European Commission's roadmap plans for an installed capacity of 3.6 GW by 2020 and 188 GW by 2050 which would represent 15% of Europe's energy mix. The market could reach €90 billion by 2030 with an annual market of €15 billion. Ocean energy also offers substantial employment potential of 160,000 direct jobs by 2030,[26] and more than 470,000 direct and indirect jobs by 2050[27] according to the European Ocean Energy Association (EU-EOA). For example, the French renewable energy sector is still not mature, however it is anticipated that marine renewable energies (across all technologies) will generate 3 jobs per megawatt installed.[28] This would result in the creation of 18,000 jobs in this sector by 2020.

The European Commission's commitment to developing marine renewable energies is one of the key features of its policy to achieve the EU 2020 targets and make Europe's economy greener. The EU is seeking to source 20% of its energy from renewable sources by 2020 (see table below, showing National target for Ocean Energy by 2020). Furthermore, it is currently estimated that by 2050, a substantial proportion of Europe's electricity supply could be provided by renewable ocean energy generated off the Atlantic coast.[29]

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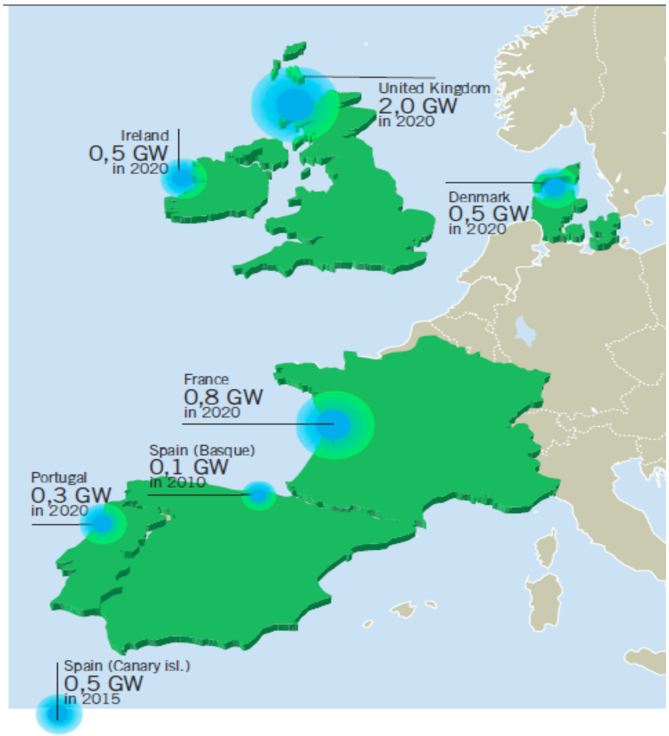
[22] Implementing Agreement on Ocean Energy Systems (OES), Annual Report 2010, International Energy Agency.
[23] OES Vision Brochure, October 2011, An International Vision for Ocean Energy
[24] EC, Research and Innovation: Ocean Energy, http://ec.europa.eu/research/energy/eu/research/ocean/index_en.htm
[25] COM(2012) 271 final, "Renewable Energy: a major player in the European energy market"
[26] An international Vision for Ocean Energy, Ocean Energy Systems, October 2011.
[27] Ocean Energy, European Ocean Energy Roadmap 2010-2050, European Ocean Energy Association, 2010.
[28] According to Competition Cluster "Pôle Mer Bretagne".
[29] Submission to EC from Ireland's cross-Government Marine Coordination Group, chaired by the Department of An Taoiseach and including the CEO of the Marine Institute, "An Integrated Maritime Policy for the European Union (2007): A proposal for an Integrated Strategy for the Atlantic"

Figure 4: National Targets for Ocean Energy in Europe



The European Atlantic seaboard is arguably one of the world's richest areas in terms of wind, wave and tidal energy generation.[30] This is why the Atlantic strategy[31] argues the potential of the Atlantic's powerful waves and strong tides needs to be exploited, asserting that the predictable nature of energy from tides can complement the fluctuating energy from wind.

Given the potential of renewable energy sources, Marine energy has attracted mostly large scale utilities, energy agencies, and industrial companies making investments in the sector over the past years.

However there are challenges that need to be addressed to encourage research and innovation in this area. One of these areas is the EU power grid, and the concern that it will not cope with the added capacity as more projects near full-scale sea trials and supply electricity to the grid. Some utilities depend on significant investment in expansion of grid capacity before they will consider increasing their marine plans. Furthermore, there are legislative and regulatory challenges, due to varied technology and regulatory standards, and the lack of a comprehensive policy framework.

Some of the key drivers for the future success of the industry in the Atlantic region therefore include:

- cross-border coordination and governance to put the right conditions in place to encourage and facilitate research and development activities,
- mobilizing the economic, technical and scientific capabilities of the region to confront challenges in a unified manner
- ensuring inter-connectivity (the European Electricity Grid) to move energy from where it is produced (Atlantic seaboard) to where it is needed (the urban and industrial centres of the EU).

8.3 Baseline situation and trends

This section provides an overview of the current state and recent developments relating to some key technologies. It also describes the status of cooperation and collaboration as regards research and development. Furthermore, it mentions the impacts of research and development on other related sectors, as well as maritime spatial planning implications.

[30] Marine Institute and Marine Board ESF, "A draft Marine Research Plan for the European Atlantic Sea Basin, SEAS-ERA WP 6.1", October 2011

[31] COM(2011) 782 final, "Defining a Maritime Strategy for the Atlantic Region"

8.3.1 EU cooperation and collaboration in marine energy

International initiatives to coordinate and support the sector are emerging but still scattered.

The **European Renewable Energy Council** brings together the major European renewable energy industry, trade and research associations active in the field of photovoltaics, small hydropower, solar thermal, bioenergy, ocean & marine, geothermal, wind energy, and solar thermal electricity, and is the European umbrella organisation.

In the specific area of marine renewable energies it is represented by **EU-OEA (European Ocean Energy Association).** The EU-OEA was established in 2006, and comprises 70 members, including Alstom, DCNS, EDF, Rexroth, Statkraft, and research organizations. Its core objective to strengthen the development of marine energy in Europe.

In the area of marine renewables research and development, there are also several European wide bodies. The **European Energy Research Alliance** (EERA) is a group of leading organizations in the field of energy research. EERA aims to strengthen, expand and optimize EU energy research capabilities through the sharing of national facilities in Europe and the joint realization of pan-European research programmes. Within EERA, there is an **Ocean Renewable Energy Group** (EERA-Ocean). This joint programme on Ocean Energy brings together the University of Edinburgh (UK), Technalia (ES), Wavec (PT), IFREMER (FR), ENEA (IT), HMRC (IE), SINTEF/MARNTEK (NO), and Fraunhofer (DE) and is based around six key research themes:[32]

- Resource
- Devices and Technology
- Deployment and Operations
- Environmental Impact
- Socio-economic Impact
- Research Infrastructure, Education and Training

Finally, the Ocean Energy Systems Implementing Agreement (OES) was launched in 2001 to provide a framework for international collaboration in energy technology R&D, demonstration and information exchange in the fields of ocean wave and tidal current energy. Until now the IEA-OES numbers 19 contracting parties.

8.3.2 European partnerships for marine energy R&D

Many marine energy cooperation initiatives are driven through the FP7 (7th Framework Programme for research and technological development). The “Regions of Knowledge” initiative aims to strengthen the research potential of European regions, in particular by encouraging and supporting the development of regional “research driven” clusters, associating universities, research centres, enterprises, and regional authorities. These calls for projects are also contributing to structure the sector by facilitating exchanges between players and fostering joint projects.

Table 4: Selection of the key recent FP7 funded European wide R&D initiatives

Name	Description	Funding	Timeline	Leader
MaRINET - Marine Renewables Infrastructure Network for Emerging Energy Technologies - www.fp7-marinet.eu	Access at no cost to 42 marine renewable energy testing facilities in Europe	FP7	Start: April 2011, 4 years.	UCC (Ireland)

[32] EERA, Joint Programme on Ocean Energy, http://www.eera-set.eu/index.php?index=29

WAVETRAIN 2 - Initial Training Network for Wave Energy Research Professionals - www.wavetrain2.eu	Marie Curie initial training network for Wave Energy	FP7	Start: October 2008, 45 months	WavEC (Portugal)
MARINA Platform – Marine Renewable Integrated Application Platform - www.marina-platform.info	Wind and Ocean Energy combination research.	FP7	Start: January 2010, 4,5 years	ACCIONA (Spain)
H2OCEAN – Development of a wind-wave power open-sea platform equipped for hydrogen generation with support for multiple users of energy - www.h2ocean-project.eu	Wind and wave power energy, H2 generation, multi-trophic aquaculture.	FP7	Start: Jan 2012, 3 years	AWS Truepower (Spain)
TROPOS - Modular Multi-use Deep Water Offshore Platform Harnessing and Servicing Mediterranean, Subtropical and Tropical Marine and Maritime Resources - www.plocan.eu	Design multiuse offshore platforms where ocean energy plays a key role	FP7	Start: February 2012, 3 years	PLOCAN (Spain)
ORECCA - Offshore renewable energy conversion platforms	Framework for knowledge sharing ; roadmap for research activities in the context of offshore renewable energy	FP7	March 2010 to August 2011	Fraunhofer IWES

8.3.3 National cooperation and initiatives for marine energy R&D

UK

The UK is one of the leading centres for research and development in marine energy technology, with many **renowned universities working in conjunction with technology developers**. These include the University of Lancaster (UK), University of Southampton (UK), University of Strathclyde (UK).

There are also **comprehensive test facilities**, at the European Marine Energy Centre (EMEC) in Orkney and the New and Renewable Energy Centre (NaREC) in the North East, and a shared facility, Wave Hub, off the coast of Cornwall.

Many UK companies are also developing technologies to **connect wave and tidal energy to the National Grid**.[33]

SuperGen Marine

The Sustainable Power Generation and Supply Initiative (SuperGen) is a large, collaborative research programme, which addresses the challenges of sustainable power generation and supply. It involves the Robert Gordon University, Edinburgh University, Heriot-Watt University, Lancaster University and Strathclyde University – as well as 20 national and international marine energy and electricity supply companies.

UKERC Marine Energy Technology Roadmap

The UK Energy Research Centre (UKERC) has created three tools to help policymakers and researchers review the current status of UK energy research and development, and identify the key research challenges. These are:

- Research Register – an online searchable database of energy-related awards and projects
- Landscape – a summary of energy-related research activities and capabilities in the UK
- Roadmaps – the sequence of research (and other) problems to be overcome before new technologies can be commercially viable.

[33] UK Department of Energy and Climate Change, Research and Development in Wave and Tidal Energy, http://www.decc.gov.uk/en/content/cms/meeting_energy/wave_tidal/research/research.aspx

Marine Renewable Energy Research Advisory Group

The Marine Renewable Energy Research Advisory Group has published a wave and tidal stream energy monitoring and research strategy. Its objective is to ensure that critical environmental information is collected during the demonstrator phase of wave and tidal stream technology deployment, to inform strategic decisions on future leasing rounds and consenting of individual developments.

Ireland

There are numerous **Irish Universities, Institutes and Bodies undertaking research projects** related to Ocean Energy. SEAI has funded 31 projects aimed at bringing designs from prototype stage to fully operational pre-commercial devices, four of which have continued into 2012.[34] The key universities, institutes and bodies are highlighted below.

Table 5: Universities, institutes, bodies and their research focus

Body	Focus
Ocean Energy Researchers' Workshop 2009	At the Ocean Energy Researchers' Workshop in October 2009, the National Ocean Energy research priorities were explored. Industry representatives presented their specific requirements and researchers showcased relevant research.
Hydraulics and Maritime Research Centre - UCC	The HMRC is a centre of excellence for Ocean Renewables research. It provides research facilities to developers of ocean energy devices, and offers the only expertise for wave simulation in Ireland, with a Wave Flume and an Ocean Wave Basin.
Wave Energy Research Team – UL	Through the Marine Robotics Research Centre, the UL Wave Energy Research Team is involved in projects on ocean currents and tidal stream and turbine research.
Wave Energy Research – UCD	The UCD School of Electrical, Electronic and Mechanical Engineering are investigating grid applications and the integration of wave energy into the national grid.
Wave Power Research Group – QUB	The Wave Power Research Group in Queen's University Belfast is involved in tide and wave power research. The group worked closely with Marine Current Turbines Ltd. on the deployment of the SeaGen tidal device in Strangford Lough.
Wave Energy Research - NUI Maynooth	NUI Maynooth undertakes research on hydrodynamic modelling and control technologies associated with wave energy converters.
Wave Energy Research - NUI Galway	The oceanographic modelling team works on numerical modelling projects that have ocean energy applications.

France

In 2008 and 2009, the IPANEMA initiative for the development of a scientific and industrial offshore renewables sector was established. It comprises 130 members from industry and research (its founding partners are the MEDDTL, ADEME, IFREMER, the Lower Normandy, Brittany, Pays-de-la-Loire, Upper Normandy, PACA, La Réunion and Rhône-Alpes Regions, EDF and DCNS).[35]

More recently, a working group of industrialists and university laboratories and the SER, promoted by the DGEC and DGCIS, has been working to define a strategy for scaling up offshore renewables into a competitive export sector generating employment and added value. This aim will be supported thanks to the research capacities of two world-class competitiveness clusters on marine technologies (Pôle Mer Bretagne and PACA) and numerous research centres, including IFREMER in particular. [36]

Furthermore, IFREMER is leading the France Energies Marines project involving a broad 54-member consortium of businesses, research and higher education organizations and institutional partners. This project aims to support the development of marine renewable energy technologies (floating wind turbines, wave turbines, tidal turbines and OTEC) and their market deployment.

France Energies Marines has three components: a research centre with multidisciplinary teams working under public-private partnerships to overcome technological obstacles and to integrate ocean energy systems into environmental and social policy development; a resource and training centre and a shared and facilitated access

[34] Energy Ireland, Outlook for ocean energy, http://www.energyireland.ie/outlook-for-ocean-energy
[35] Ernst & Young, 2012, "Ocean energy Opportunities in the French market"
[36] Ernst & Young, 2012, "Ocean energy Opportunities in the French market"

to test sites (SEM-REV wave power site at Le Croisic, offshore tidal site off Paimpol-Bréhat, SEENEOH estuarine tidal site near Bordeaux and floating offshore wind power sites at Fos-sur-Mer and Groix).[37]

Spain

Spain is participating in several international initiatives on promoting ocean energy, including WAVEPLAM. This project, led by EVE (the Basque Energy Agency), aims at developing tools, establishing methods and standards, and creating conditions to speed up introduction of Ocean Energy into the European renewable energy market.

R&D activities are coordinated with other European partners through participation of TECNALIA in several European projects funded by the European Commission within the seventh framework programme, such as EquiMar (www.equimar.eu), CORES (http://hmrc.ucc.ie/FP7/ cores.html) or Wavetrain2 (www.wavetrain2.eu).

At national level, PSE-MAR is a strategic research project funded by the Ministry of Science and Innovation (MICINN) aimed at developing three different wave energy converting technologies, a test and demonstration site and guidance on non-technical issues. This project, coordinated by TECNALIA, comprises three developers (HIDROFLOT, PIPO Systems and OCEANTEC), industrial companies, R&D centres and universities.[38]

In the Canary Islands, a general marine research infrastructure - the Canary Islands Oceanic Platform (PLOCAN) - is under development, which could host ocean energy projects.

In 2009 the Ministry of Science and Innovation commenced the OceanLider programme. Led by Iberdrola Ingeniería y Construcción, it includes several marine energy R&D activities including resource assessment, site selection, operation and maintenance, technology development, grid connection and environmental aspects. It brings together 20 industrial partners, 24 research centres for a total budge of 30M€ (15M€ public funding).[39]

Portugal

Portugal is participating in several R&D activities and projects through the Wave Energy Centre (WavEC), Instituto Superior Técnico (IST) and Laboratório Nacional de Engenharia e Tecnologia (LNEG). About 25 full-time researchers are active in these three R&D centres. There are other smaller research groups which are also active.[40]

The R&D activity in Portugal has been developed under nationally funded projects and EC funded projects. National projects include:[41]

- Methodologies for Design, Monitor and Update Strategic Roadmaps: Application to Marine Energies Development in Portugal (Roadmapping Offshore Renewables in Portugal)
- Technology Observatory for Offshore Energy (OTEO)
- Wave Energy Acoustic Monitoring (WEAM)

In addition, there is the PCTE – "Pólo de Competitividade e Tecnologia da Energia" ("Competitiveness and Technology Centre for Energy" - ENERGYIN), which was set up in 2009 as non-profit association to promote Technology Development and Innovation in the Portuguese Energy Sector.

8.3.4 National test centres for marine energy R&D

UK

European Marine Energy Centre

The European Marine Energy Centre (EMEC) in Orkney, Scotland, was established to speed up the development of marine power devices from the prototype stage to the commercial market place. It runs a testing centre and develops recognised industry standards for testing and certifying marine energy devices. The Government and

[37] France Energies Marines, http://www.france-energies-marines.org/
[38] European Ocean Energy Association, "Position Paper Towards European industrial leadership in Ocean Energy in 2020"
[39] Ruiz-Minguela, P (2012), Ocean Energy Activities in Spain, Head of Wave Technology at Tecnalia
[40] European Ocean Energy Association, "Position Paper Towards European industrial leadership in Ocean Energy in 2020"
[41] European Ocean Energy Association, "Position Paper Towards European industrial leadership in Ocean Energy in 2020"

other public sector organisations have invested around £15 million in EMEC and its two marine laboratories. Currently, it has five grid-connected wave-testing berths and five tidal testing berths, with a total capacity of 20MW.[42]

Wave Hub

Wave Hub, opened in the 2010 in Cornwell, south west England, provides shared offshore infrastructure for the demonstration and proving of arrays of wave energy generation devices over a sustained period of time. It consists of an electrical hub on the seabed 16 kilometres off the north coast of Cornwall in South West England to which wave energy devices can be connected. The 12-tonne hub is linked to the UK's grid network via a 25km, 1300 tonne subsea cable operating at 11kV.[43]

The National Renewable Energy Centre (NaREC)

NaREC, located in Blyth, north east England, is a leading land based research and development facility for new, sustainable and renewable energy technologies. It works to support the evolving energy industry and transform new technologies into commercial successes. NaREC works within a large network of academic, industrial, non-government, Government and trade organisations.[44]

Ireland

In 2006 SEAI and the Marine Institute created a scale prototype test site on the north side of Galway Bay 1 mile east of An Spideal. Two devices have been in the water at the site: Ocean Energy Ltd.'s Seilean oscillating water column (OWC) device, and the Wavebob device, a prototype of which was first installed in 2006. The site forms part of a wider research infrastructure – SmartBay – supporting innovation in the field of marine ICT – sensing, data management and communications.[45]

To complement this existing test site, a full scale grid connected wave energy test facility is being developed in County Mayo, west of Belmullet, off Annagh Head. The Atlantic Marine Energy Test Site will enable assessment of performances of wave energy devices under open sea conditions in terms of electricity generation and survivability.

France

In France there are five test sites: SEM-REV wave power site at Le Croisic, offshore tidal site off Paimpol-Bréhat, SEENEOH estuarine tidal site near Bordeaux and floating offshore wind power sites at Fos-sur-Mer and Groix.[46]

SEM-REV is a fully fitted wave energy test facility, managed by Ecole Centrale de Nantes (ECN), intended to test and improve the efficiency of Wave Energy Converters (WECs) at an early stage of development. The 1km^2 wide offshore area is located north of Le Croisic peninsula and faces the Guérande Bay.

The Paimpol-Brehat Tidal Farm off the coast of Paimpol-Brehat in North Brittany, is set to become the largest tidal array in the world once all its four turbines are operational in 2012. The power generated from the farm will be capable of serving 4,000 households. The idea to build the facility was first brought up by Electricité de France (EDF) in 2004, after France formally banned coal mining. Construction work at the tidal farm began in 2008.

Operated by Energie de la Lune, SEENEOH Bordeaux is a tidal estuarine test site and will be operational in spring 2013. SEENEOH's test area is located only a few hundred meters from the shore. This proximity allows for reduced machine deployment costs and ease of access for test monitoring and turbine maintenance activities. The grid connection has a maximum total capacity of 250 kW.

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[42] UK Department of Energy and Climate Change, Research and Development in Wave and Tidal Energy, http://www.decc.gov.uk/en/content/cms/meeting_energy/wave_tidal/research/research.aspx
[43] UK Department of Energy and Climate Change, Research and Development in Wave and Tidal Energy, http://www.decc.gov.uk/en/content/cms/meeting_energy/wave_tidal/research/research.aspx
[44] UK Department of Energy and Climate Change, Research and Development in Wave and Tidal Energy, http://www.decc.gov.uk/en/content/cms/meeting_energy/wave_tidal/research/research.aspx
[45] Marine Institute, Galway Bay Wave Energy Test Site, http://www.marine.ie/home/aboutus/organisationstaff/researchfacilities/Ocean+Energy+Test+Site.htm
[46] France Energies Marines, http://www.france-energies-marines.org/

The Gulf of Fos floating offshore wind test site, MISTRAL, is part of a joint effort funded under the EC FP7 programme, also including the development of a vertical axis wind turbine prototype (INFLOW project). Consultation and development activities, including environmental studies and geophysical studies, will be lodged by the end of 2012. The test site is expected to be completed and fully operational by 2014.

Groix Floating Offshore Wind Test Site is being developed jointly with the Winflo project, led by Winacelles (Nass&Wind Industrie, DCNS, Vergnet), which consists in the deployment and operation of a precommercial floating wind farm. The test site is due to be operational by 2016 with the test of a first floating offshore wind turbine planned to start shortly after.

Spain

In Cantabria there are two relevant test projects:[47]

Santoña Test centre: The regional Government of Cantabria has the objective of developing a test site for prototypes of Wave Energy Converters. The Testing Field Area would accommodate up to 10 WEC devices with a maximum combined power of 1.5MW.

Ubiarco Test Centre: The objective of this project is to develop a testing site for prototypes of WECs and Floating Wind Turbines (FWT). The Testing Field Area will allocate up to four Floating Substations, up to 4MW each, which will provide connection to a maximum of four devices. These two test facilities will be supported by "The Great Maritime Engineering Tank" that is being built in the Scientific and Technological Industrial Park of Cantabria which will integrate experimental management, a system of physical modelling and a system of numerical modelling.

In the Basque Country, the Basque Government is developing through EVE, its energy agency, a test facility, bimep – **Biscay Marine Energy Platform**, which will allow full-scale prototype testing and demonstration of renewable marine energy converters up to 20MW. The environmental permit is granted, and the industrial permit and the concession as maritime terrestrial public domain are submitted. bimep is integrated in MaRINET, an EU funded programme that brings together an infrastructure network with 42 facilities from 28 partners spread across 11 EU Member States.

Portugal

Three support infrastructures for offshore renewable energy exist or are planned in Portugal: Pico wave energy plant, the Aguçadoura site, and the Pilot Zone.[48]

Pico wave energy plant project is owned and managed by the Wave Energy Centre, a private not-for-profit organisation. Pico plant is part of the European network of R&D infrastructures on ocean energy under the MARINET project. Under this project European researchers may be funded to develop R&D activities at Pico plant.

The **Aguçadoura** is the open ocean test site where the AWS prototype in 2004 and the Pelamis farm in 2008 were tested. It consists of a land station with electric power equipment to deliver energy to the grid and data acquisition equipment, a 4MW underwater electrical cable and three grid connected berths at 45m water depth, which will be used to deploy the 2.3MW Windfloat floating offshore wind prototype in 2011.

The **Pilot Zone** is a large area off the west coast (about 400km2) being developed for wave energy. Special feed-in tariffs will be applied under this regime. The pre-commercial phase applies between 4MW and 20MW per technology with a total of 100MW at national level. The total installed capacity in the commercial phase will reach 250MW.

8.3.5 EU Policy and Regulatory framework

The Energy Strategy 2020 states that the European Commission will promote energy research infrastructures including marine renewable energy, which is considered to have a great potential. The Energy Roadmap 2050

[47] European Ocean Energy Association, "Position Paper Towards European industrial leadership in Ocean Energy in 2020"
[48] European Ocean Energy Association, "Position Paper Towards European industrial leadership in Ocean Energy in 2020"

builds on the single energy market, the implementation of the energy infrastructure package and climate objectives as outlined in the 2050 low carbon economy roadmap.

Directive 2009/28/EC, "Renewable Energy Directive" is designed to ensure the achievement of the 2020 renewable energy targets. To achieve the 20% target, the Renewable Energy Directive set mandatory national targets. In order to reach these targets, Member States may operate support schemes and apply measures of cooperation (Articles 3, 6 to 9). Building on the national renewable energy action plans, the support systems put in place by Member States and the continuous investment in R&D, Europe's renewable energy sector has developed much faster than foreseen at the time of drafting the Directive. Renewable energy producers are becoming significant players in the energy market.

The Directive foresees a post-2020 roadmap in 2018, however some stakeholders have already been asking for clarity regarding policy developments after 2020.

R&D and innovation framework

Research and development (R&D) funding continues to be crucial to support technology innovation and development. Resources are scarce and must be well targeted to the appropriate research phase. Member States have spent €4.5bn on renewable energy R&D over the last 10 years with EU spending, €1.7bn from the FP6, FP7 & EERP and €4.7bn in EU Cohesion policy funds (2007-2013).[49]

The two main programmes defining EU's contribution to driving developments in key energy technologies are the **Strategic Energy Technology (SET)** plan and the **Horizon 2020 research programme**. Other instruments include revenues from auctioning EU ETS emissions allowances.[50]

Furthermore, for 2014-2020 the EC has proposed a significant concentration of **EU Cohesion Policy** efforts on renewable energy and energy efficiency, as well as a strong focus on R&D and innovation. A coordinated approach to technology development is necessary to developing new renewable energy technologies that can play a significant role in diversifying the energy mix.

8.3.6 National policy and regulatory frameworks

UK

The UK Government has established a Marine Energy Programme, focusing on enhancing the UK marine energy sector's ability to develop and deploy wave and tidal energy devices at a commercial scale, and enable the UK Marine Energy sector to move from prototype testing to commercial deployment over the coming 5 years.

The Marine Energy Programme Board, which draws together key stakeholders from across the marine energy sector including utilities, industrials, technology developers, financiers and the Devolved Administrations, will play a central role in advising what actions the Programme should address to advance the industry.

Furthermore, the Government has set out a vision for marine energy in the UK to encourage the clustering of activities through marine energy parks, that aims to bring together manufacturing, expertise and other activities to drive the marine sector forward to commercialisation.

Ireland

In 2008 the Irish Government set up the Ocean Energy Development Unit (OEDU), as part of the Sustainable Energy Authority of Ireland (SEAI), to advance the sector, implement the ocean energy strategy, administer the Prototype Development Fund to industry, support the Hydraulics and Maritime Research Centre (HMRC), develop a grid connected wave test site, manage the conduct of an SEA for Wave, Tidal and Offshore Wind and stimulate supply chain mobilization.

[49] COM(2012) 271 final, 6 June 2012, "Renewable Energy: a major player in the European energy market"
[50] COM(2012) 271 final, 6 June 2012, "Renewable Energy: a major player in the European energy market"

France

In 2004 the French Agency for the Environment and Energy Management (ADEME) undertook an analysis of the different types of ocean energy technologies, estimating the present and future costs.

The French Government developed a Multi-Annual Investment Plan (PPI) in 2009 to identify the resources required to develop renewable energy sources, including ocean energy. In 2010, through the implementation of the binding provisions in the RES Directive 2009/28/EC, the French government produced an ambitious National Renewable Energy Action Plan (NREAP) that reaffirms its involvement and commitment in the sector.

Spain

The Spanish Government's "Renewable Energy Action Plan 2011-2020" aims to have 10MW of installed capacity of ocean energy by 2016 and 100MW by 2020. Regional Governments of several areas (the Basque Country, Cantabria, Asturias, Galicia and the Canary Islands) are, in addition, promoting the installation of test facilities and demonstration projects. Two of them have set targets on Ocean Energy so far: the Basque Country plans 5 MW of installed power by 2010, and the Canary Islands considers 50 MW by 2015.

Portugal

The Portuguese National Renewable Energy Action Plan (NREAP) sets out very ambitious targets. The recent Cabinet Resolution No. 29/2010, of 15 April, which approved the latest National Energy Strategy (NES 2020), continues to attribute a pivotal role to renewable energy in the energy strategy and the targets that have been delineated for this sector, with a very significant impact on the Portuguese economy. Portugal has created a series of financial and fiscal measures to support investment in renewable energy. These measures have been dynamised further with the creation of differentiated tariffs for electricity produced in renewable plants, feed-in tariffs (FIT), according to the degree of maturity of the various technologies that are available in the national market.

8.3.7 National marine renewable energy support schemes and incentives

UK

Support for research and development has been available through the Research Council, Technology Strategy Board, the Carbon Trust, the Energy Technologies Institute and the Scottish Government.

The Government also provides early-stage research and development funding for marine energy through the Research Council's SuperGen Marine programme.

In addition to grant support, to help develop and commercialise wave and tidal technology, the UK provides revenue support to the deployment of wave and tidal technologies through the Renewables Obligation (RO).

Currently in England, Wales and Northern Ireland wave and tidal generation receive two ROCs (Renewable Obligation Certificates) per MWh while in Scotland, tidal energy receives three ROC and wave energy five ROCs.[51]

In June 2011 the Department announced investment of up to £20 million in wave and tidal power to help develop marine energy technologies from the prototype stage to demonstration of arrays of devices.

Ireland

The Irish government allocated a financial package for marine energy administered by a new Ocean Energy Development Unit (OEDU) based within the Sustainable Energy Authority of Ireland (SEAI), covering support for device developers, enhancement of test facilities and development of grid-connected test facilities. The Irish government has financed or is financing a total of 15 Irish companies, for the most part through the Prototype Development Fund administered by SEAI.[52]

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[51] UK Department of Energy and Climate Change, The Renewables Obligation, http://www.decc.gov.uk/en/content/cms/meeting_energy/renewable_ener/renew_obs/renew_obs.aspx

[52] European Ocean Energy Association, "Position Paper Towards European industrial leadership in Ocean Energy in 2020"

The Government recently launched an integrated marine plan, which identifies offshore renewable energy as an emerging business development opportunity. The incentive to develop marine energy is supported by the €220 per MWh REFIT price for ocean energy. Announced in 2009, it will last 15 years.

France

France introduced feed in tariffs (FIT) in 2001. For Marine energy there is a **20 year FIT of 150 €/MWh**. In addition, there is a tender system for large renewable projects, incentives (Fiscal and investments), and indirect schemes (e.g. tax on polluting activities).[53]

France's wind tariffs (2008 wind power FIT Order) are currently being assessed by the country's Supreme Court on the basis of state aid; a negative outcome could mean the cancelation of FITs for the wind sector. [54]

The call for tenders for the development of 3 GW of **offshore wind** power capacity, which closed in January 2012, represents a market estimated at €10 billion for the various players. In April 2012, four wind farm contracts worth approximately €2b and totaling approximately 2GW of capacity were awarded. [55]

There are also concerns that the Government's second offshore tender looks likely to be delayed until early 2013.

Spain

In January 2012, the Spanish Council of ministers implemented a temporary suspension of the renewable energy feed-in-tariffs (FIT) for new installations in Spain, due to fiscal challenges and lower credit ratings. The government will not give any economic incentive to fund new renewable installations, and the relevant administrative and funding systems will be suspended.

Portugal

The Portuguese Government promotes energy renewables mainly via feed-in tariffs for renewable electricity, direct subsidy payments (PRIME-Programme) and tax incentives. For wave energy, there is a 15 year maximum support amounting to 26 -7.6 €cents/ kWh, whilst for offshore wind it is 7.4 €cents/ kWh.[56]

8.3.8 Interdependencies

To accelerate the development of the marine energy market, lessons can be learnt from other sectors that have developed market viability. This should assist in overcoming technological and other barriers in order to facilitate the sector's development. In turn, development of the sector will have second order effects on other industries.

Maritime Spatial Planning implications

Offshore wind, wave and tidal energy in particular share synergies in relation to governmental marine policies, marine stakeholders and spatial constraints. More specifically, ocean energy development should be included in maritime spatial planning, which is taking place increasingly at a European level.

Some international Maritime Spatial Planning instruments have been developed in the last years but they do not necessarily take into consideration the specific features of offshore renewable energies. Several factors in the development of marine energy technologies will have maritime spatial planning implications.

International Maritime Spatial Planning is currently not constraining the construction of offshore wind farms or their connection to shore. However, offshore space is a limited resource and the increasing offshore capacity reduces the available space.[57]

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[53] Rousseau, N. "Ocean Energy: A European Perspective"
[54] Renewable energy attractiveness indices, Ernst & Young, August 2012
[55] Rousseau, N. "Ocean Energy: A European Perspective"
[56] EREC, "Portugal : Renewable Energy Policy Review"
[57] Seanergy 2020, October 2011, "Offshore Renewable Energy and Maritime Spatial Planning: Recommendations for Adaptation and Development of Existing and Potentially New International Marine Spatial Planning Instruments"

Grid connections

Electricity network connections will have to be planned to enable major ocean energy power delivery. Grid connection issues are common to many forms of renewable energy plant, in particular offshore wind which requires major investment for infrastructure upgrades.

Offshore oil and gas

Manufacturing processes need to be developed, automated and optimized with knowledge transfer from, and industrial cooperation with, other sectors, primarily offshore oil and gas.

Petroleum industry

Hywind, the world's first full-scale floating wind turbine, demonstrates the potential for technology transfers and synergies with other industrial sectors, such as the petroleum industry. For example, the turbine rests on a huge ballasted tube, a technology frequently used in the petroleum sector.

Shipbuilding

Ocean energy technologies (especially tidal range) rely on civil engineering and fabrication techniques that are commonly used in the shipbuilding industry and the offshore oil and gas sector.

Bio-fuels

Early stage research is ongoing to develop new bio-fuels derived from algae cultivated in the ocean. Ocean energy devices could potentially be used to grow these new bio-fuels. Furthermore, electricity produced from the ocean could be used to produce hydrogen from seawater, which could also be used as a fuel for vehicles replacing oil.

Forestry and Agriculture

Europe's well managed forestry and agriculture sectors will benefit greatly from new market opportunities as the bio-energy market develops, together with other sectors of the whole bio-economy.

The expected rise in the use of biomass after 2020 heightens the need to use existing biomass resources more efficiently and to accelerate productivity growth in agriculture and forestry in a sustainable manner. At the same time it is important to reduce deforestation and forest degradation and help ensure the availability of biomass at competitive prices.

Desalination plants

In the long term, ocean energy power plants could be used for the production of drinking water through desalinisation. This would be a major asset for populations that have limited access to drinking water, in particular in the tropics. Some studies suggest that a 2 MW power plant could produce 4,300 cubic meters of desalinated water for drinking and irrigation each day.[58] This process has been reported particularly for ocean thermal energy conversion, but could possibly be extended to other technologies.

Heating and cooling

Looking further in the long term, ocean energy has the potential to be used for heating and cooling of buildings near the coastline. This opportunity however require further investigation, since minimal research has been undertaken, apart from in the field of ocean thermal energy conversion (OTEC), where pumping cold water from the depths of the ocean could enable cheap refrigeration and environment-friendly air-conditioning.

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[58] Block and Lalenzuela 1985, cited in Europe Ocean Energy Association, (2009), "Draft European Ocean Energy Roadmap"

8.3.9 Overview of marine energy renewable technologies

Tidal range energy

- Tidal energy involves exploiting the natural rise and fall of the level of oceans and seas. The vertical water movements associated with the rise and fall of the body of water, and horizontal water motions (tidal currents), accompany the tides.
- Potential energy associated with tides can be harnessed by building barrages (dam-like structure) or other forms of engineering constructions across an estuary in an area with a large tidal range. The generation cycle means that, depending on the site, power can be delivered twice or four times per day on a highly **predictable basis**.[59]
- Tidal energy is a mature market that has reached the commercialisation stage. **Within the Atlantic region, France and the UK have sufficiently high tidal ranges of over 10 metres.**
- Despite this level of maturity, at present only 4 tidal barrages operate as commercial power plants in the world. The largest of these is in South Korea (254 MW), installed in September 2011, which took over from the French **La Rance Barrage (240 MW) which has produced 600GWh/year since 1966.[60]** The other two installations are in Canada and China.
- The UK has carried out several projects, including the installation in 2003 of a first turbine (Seaflow) for exploiting tidal currents in Devon, followed by SeaGen, which was the first full-scale tidal flow power station to be connected to the grid to produce electricity for consumption. However, the UK Government put its Severn Tidal project on hold in 2010, citing that "costs would be high, and a scheme would have to have a strategic need compared to other ways of meeting our need for renewable energy".[61]
- On the whole, **very few projects are in progress**, due to **high investment costs**, and environmental impacts, and development potential is **considered limited**.

Marine current energy

- Marine current energy devices harness the kinetic energy of the water particles in a tide, much like tidal current. There are a number of different technologies for extracting energy from marine currents, including horizontal and vertical axis turbines as well as others such as, venturis and oscillating foils.
- The resource is highly predictable but also highly localized, the most suitable sites being those where ocean currents are particularly strong.
- At present, marine current energy is at an **early stage of development** - various pilot plants are in operation or about to be installed. There are no commercial grid-connected turbines currently operating.[62]
- The potential for marine current turbines in Europe is estimated to exceed 12 000 MW of installed capacity. The **Atlantic coast offers great potential, especially along the coastlines of France and the United Kingdom** which experience intense currents (150 to 300 KW prototype at sea, demonstration of 1 MW underway, the outputs for projects expected in 2015 are between 300 and 2000 MW).[63]
- **Potential sites have been identified off mainland France** (e.g., Raz Blanchard, Passage du Fromveur, Raz de Sein, Héaux de Bréhat, Raz de Barfleur) and **overseas territories**.[64]
- Several prototypes are now being developed in a context of **proliferating technological development.** EDF, for example, is testing a tidal energy farm using OpenHydro technology off Paimpol-Bréhat on the

[59] European Ocean Energy Association, Tidal Energy, http://www.eu-oea.com/technology/tidal-energy/
[60] European Ocean Energy Association, Tidal Energy, http://www.eu-oea.com/technology/tidal-energy/
[61] UK Department of Energy and Climate Change, Written Ministerial Statement on energy policy: Chris Huhne, 18 October 2010, http://www.decc.gov.uk/en/content/cms/news/en_statement/en_statement.aspx
[62] European Ocean Energy Association, Ocean (Marine) Current, http://www.eu-oea.com/technology/ocean-marine-current/
[63] European Ocean Energy Association, Ocean (Marine) Current, http://www.eu-oea.com/technology/ocean-marine-current/
[64] Ernst & Young, 2012, "Ocean energy Opportunities in the French market"

Brittany coast, with a total capacity of 2 to 3 MW to be fed into the grid starting in 2012. The first turbine, assembled at the DCNS shipyard in Brest, was immersed in October 2011.[65]

- These developments clearly point to an imminent market launch and commercial deployment as early as 2015.

Wave energy

- The sector has recently experienced a **resurgent interest** in Europe. Today, wave energy conversion is being investigated in a number of EU Member States. The Atlantic coast offers **high development potential and many prototypes have already been tested** (Wavedragon, Pelamis, SEAREV).[66]
- Many onshore projects are operating, such as the Pico Island plant in the Azores or the Islay plant in Scotland. In France, the S3 innovative wave power project developed by SBM Offshore France, in association with IFREMER and the Ecole Centrale de Nantes, was selected for the Research Demonstrator Fund (Investments for the Future Program/ADEME).[67]
- However, these technologies allowing operations in shallow and deep-water zones are st**ill in the research and development stages**, with some devices already being tested.
- Although wave energy technology is less mature than wind power or tidal energy, it could make **very large contributions** to energy production by 2050, with worldwide potential estimated at 29,500 TWh/year by OES (Ocean Energy Systems).
- However, the diversity of concepts (e.g., in-stream or oscillating water column systems, floating platforms, integrated systems), and uncertainty as to which will eventually come onto the market make it **difficult to assess their costs and market schedule.**[68]
- The most important objective for the wave energy sector is to **deploy full size prototypes to prove performance at sea and to bring the technology to a point where it becomes comparable with other renewable energy technologies such as wind energy**.

Floating wind turbines

- Floating wind turbines sit in deep water far from land, and therefore benefit from more powerful winds whilst at the same time avoiding many of the issues that afflict existing wind farms. They arguably should be more economic to install than existing offshore turbines, which sit on fixed foundations in the seabed. They could minimise problems with planning, as well as having less impact on shipping, military radar and coastal seabird populations.
- Floating windmills are a recent technology for which there are several competing concepts, adapted to different sea depths for specific sites. **None of these have reached the commercialisation stage**. However there are a number of **projects ongoing to develop and test the technological innovations** (spar buoys, semi-submersible floating platforms, tension-leg platforms).[69]
- Tests on **Hywind**, the world's first full-scale floating wind turbine, began in Stavanger, of the Norwegian coast in September 2009. The project demonstrates the potential for technology transfers and synergies with other industrial sectors, such as the petroleum industry. For example, the turbine rests on a huge ballasted tube, a technology frequently used in the petroleum sector. Since its commissioning in 2010, Hywind has generated 15 MWh, and the structure's resistance to marine conditions (waves, winds) has been assessed. The first pilot farms are planned off the Scottish coast and should be operational by 2015.
- In early December 2011, **WindFloat**, a semisubmersible wind turbine, was moved into position off the coast of Portugal by EDP Renewables. **It is the world's first floating platform facing the Atlantic and the first offshore turbine installed without the use of heavy lift vessels.** According to EDP and Seattle-based Principle Power, partners in the project, the pilot produced 1.7 gigawatts of energy per hour (GWh) during its first 6 months of operation, enough to supply power to 1,300 families. The platform sits six kilometres off the coast of Povoa do Varzim, close to Porto in northern Portugal. Its capacity at 2

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[65] Ernst & Young, 2012, "Ocean energy Opportunities in the French market"
[66] INTERREG IIIB 'ATLANTIC AREA' 2000-2006, Appraisal for the development of cooperation in the field of marine energy, February 2009.
[67] Ernst & Young, 2012, "Ocean energy Opportunities in the French market"
[68] Ernst & Young, 2012, "Ocean energy Opportunities in the French market"
[69] Ernst & Young, 2012, "Ocean energy Opportunities in the French market"

megawatts (MW) is just below the average of offshore wind turbines in Europe, which was 3.6 MW at end-2011, according to the European Wind Energy association.[70]

- In terms of pilot projects, **WINFLO** is a floating offshore wind turbine with over 3 MW capacity, designed for depths of more than 50 meters. A project piloted by Nass & Wind, in association with Vergnet, IFREMER, DCNS and ENSTA Bretagne, is developing a demonstrator to be tested in 2013, with the first commercial wind farms planned for 2020.[71]
- In terms of research and development, **VERTIWIND** is aiming to develop a new vertical-axis wind turbine design. This new architecture is designed by Nenuphar, which has also developed a new technology for manufacturing the blades and has patented a floating wind farm design.[72]
- **Britain is also seen as a key market for such technology** because of the **consistent winds around its coast.** In June 2012, the UK government announced that it would need to build up to **7,000 wind turbines at sea to help meet EU renewable energy targets.**

Ocean thermal energy (OTEC)

- The principle of ocean thermal energy conversion (OTEC), which involves using the heat stored in the oceans to generate electricity, originated in France in 1881. Due to solar heating, the top layer of the water is much warmer than deep ocean water.
- Where the temperature difference between the warmer, top layer of the ocean and the colder, deep ocean water is about 20°C, the conditions for OTEC are most favourable. This means that only tropical waters have the right conditions.
- As a result, this technology has **not been considered at this stage for the Atlantic coast (cold water), however there may be potential in European outermost regions,** such as French Guiana, Martinique and Guadeloupe, which are in the scope of the Atlantic Strategy.
- Today, DCNS (France) and Lockheed Martin (USA) are the leading industrial players. After completing feasibility studies at La Réunion and Tahiti, DCNS was due to set up an onshore prototype on La Réunion in early 2012. DCNS is also working in partnership with the regional authority of La Martinique and STX France on an OTEC 10 MW pilot, which should be commissioned in 2016.[73]
- This technology has real potential to contribute to energy self-sufficiency on islands, where energy costs are very high.

Osmotic energy

- Osmotic energy technology uses the energy available from the difference in salt concentrations between seawater and freshwater. These resources are therefore found in large river estuaries and fjords.
- The technology is still in the early research and development stages. Statkraft is one of the few industrial players in this sector, having set up the world's first prototype osmotic power plant, in Norway.[74]
- The key to further development lies in optimizing membrane characteristics. Today, they generate only a few watts per square meter.
- The small number of players working on this technology and the need to improve membrane performance and reduce costs thus point to development prospects in the longer term.

8.3.10 Maturity of technologies

Given the maturity of the various technologies (see figure below) and the potential of the different resources, several of these ocean technologies could contribute significantly to a more diverse global energy mix in the medium to long term.

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[70] Marine Renewable Energy, Portugal seeks EU funding for more wind turbines, http://www.marine-renewable-energy.com/newsflashes/portugal-seeks-eu-funding-for-more-wind-turbines-1806
[71] Ernst & Young, 2012, "Ocean energy Opportunities in the French market"
[72] Ernst & Young, 2012, "Ocean energy Opportunities in the French market"
[73] Ernst & Young, 2012, "Ocean energy Opportunities in the French market"
[74] Ernst & Young, 2012, "Ocean energy Opportunities in the French market"

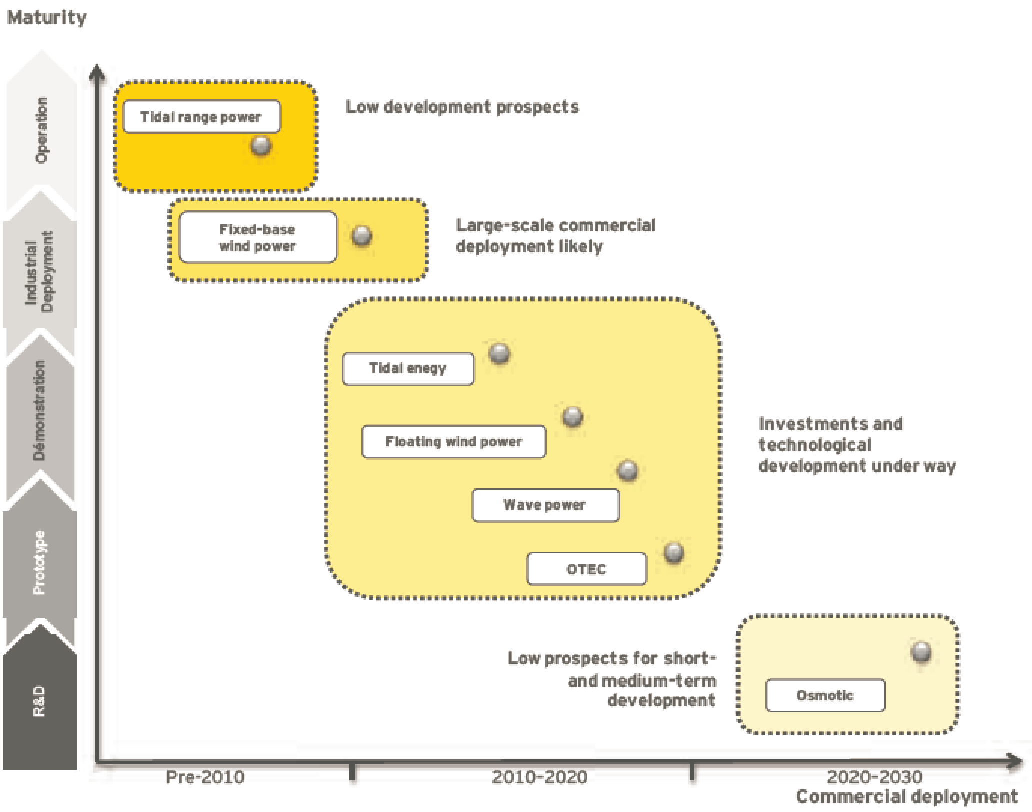
The most advanced is fixed-based offshore wind, which has reached the stage of full-scale industrial and commercial deployment. The total installed offshore wind capacity amounted to 3.8 GW in 2011, including a 31% growth rate in 2011[75].

The ocean energies on the other hand are less mature, despite acceleration in development over the past few years, and remain at the research, prototype or demonstration stage. At a global level, total installed capacity of ocean energy in 2011 is 519 MW, most of which related to tidal power plants.[76]

Apart from fixed-based offshore wind , there are good prospects for growth of floating offshore wind power, which could benefit from operational feedback from fixed-base wind turbines, as well as for marine current (tidal energy). Wave energy is less likely to reach the commercial stage for several years, and is positioned for medium- to long-term market development, along with OTEC, which is focused mainly on tropical areas.

Therefore the technologies that should be considered for potential commercialisation within a 2020 horizon are floating offshore wind, and marine current (tidal energy).

Figure 5: Marine renewable energy maturity and development prospects



Source: Ernst & Young, 2012, "Ocean energy Opportunities in the French market"

8.3.11 National state of play for marine renewable energy sector

All 27 Member States submitted (during 2010 and early 2011) a National Renewable Energy Action Plan (NREAP) as provided by Article 4 of the Renewable Energy Directive (2009/28/EC), in which the contribution of renewables are quantified in order for each Member State to reach its binding 2020 target. The 17 Coastal States of the 4 European sea basins (North Sea, Baltic Sea, Mediterranean Sea and Atlantic Coast) covered by the project announced quantitative objectives for offshore renewable energies and some of them identified the area dedicated to Offshore Renewable Energy (ORE) activities.

[75] Source: European Wind Energy Association
[76] Implementing Agreement on Ocean Energy Systems (OES), Annual Report 2010, International Energy Agency.

The table below shows the Atlantic States target, compared with their potential sea area (EEZ area), and where a geographical zone for ORE has been identified, the proportion this area represents in the sea area.[77]

Table 6: Atlantic Member State Offshore Renewable Energy targets in National Renewable Energy Action Plans

MS	2020 target	ORE area needed to meet 2020 target	EEZ area	ORE area	% of ORE area in EEZ	Installed OWF	% of installed capacity vs 2020 target
UK	18 GW *UK target for 2020 as currently expressed by the Government is 18 GW by 2020*	3300 km²	773 676 km²	So far approx 49.2GWe of leases issued (39602 km²)	5.1%	1525 MW	8.5%
Ireland	Wind: 550 MW Wave & Tidal: 75 MW	55 km²	410 310 km²	6 areas identified for potential ORE deployment: 9800 to 12500 MW	0.3%	25.2 MW Consented OWF: 1600 MW	4 %
France	6000 MW	600 km²	AC & EC: 334 604 km² MS: no claimed EEZ	AC & EC: 533 km²	0.2%	0 MW	0 %
Spain	3000 MW	300 km²	AC: 683 236 km² MS: no claimed EEZ	Not delimited A zoning exercise identified potential areas in accordance to environmental restrictions	-	0	0 %
Portugal	Wind: 75 MW Wave & Tidal : 250 MW	7.5 km²	1 714 800 km²	Wind: 1300 km² (fixed WT) + 16100 km² (floating WT) Wave&Tidal: 3800 km²	1.2%	Wind: 0 MW Wave & Tidal: 0.4 MW	0 %

The percentages of installed capacity with regard to the 2020 targets highlight the early stage of ORE deployment.

The column “Needed ORE area to meet 2020 Target” verifies whether enough has been zoned to satisfy the 2020 target. France it is the only Member State for which the ORE area currently delimited is not sufficient to satisfy the2020 target.

8.4 Assessment

This section addresses key challenges and issues that need to be addressed as an Atlantic region (or even at EU level) in order to ensure the future for marine renewable energies. Following each challenge or idea, a list of suggested questions for the workshop discussions is provided.

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[77] Seanergy 2020, October 2011, “Offshore Renewable Energy and Maritime Spatial Planning: Recommendations for Adaptation and Development of Existing and Potentially New International Marine Spatial Planning Instruments”

8.4.1 Better collaboration and coordination of R&D in the Atlantic region

Whilst each Atlantic Member State appears to be investing in research and development activities to advance the marine renewable energies sector, there appear to be improvements to be made in terms of cross-border collaboration and coordination of efforts.

The European Atlantic Area hosts a number of **Centres of Excellence** in marine and maritime research and innovative SMEs which it needs to effectively mobilise.[78] The skills and expertise of these Centres/SMEs needs be better harnessed and coordinated to provide a catalyst for creating new markets industries linked to activities such as renewable ocean energy; marine biotechnology and marine technology.

For marine technologies to succeed, much attention needs to be paid to technical risks in design, construction, installation and operation. Given technical barriers due to minimal experience and demonstration resulting in a lack of information and understanding regarding performance, lifetime, operation and maintenance of technologies and power plants, there needs to be mutual learning and knowledge sharing across Member States and sectors.

Importing knowledge and experience from other industry sectors, such as offshore oil and gas, including risk assessment procedures and engineering standards is of great importance. Rigorous and extensive testing, including single components, sub-assemblies and complete functional prototypes are still necessary to establish the new technologies. Risk reduction will be required to leverage private investment.

Large deployment can be successful with the convergence of technologies, thus reducing the number of isolated actors and allowing technology development to accelerate. Industrial R&D should be moving in parallel with continuing academic R&D. Large farms should demonstrate their performance and reliability and become technical evidence to industries, academia, associations, governments and the public.

Suggested questions at Session 1 of the workshop:

- **What existing Atlantic fora can be used to assist in better coordination of R&D across MS borders?**
- **Which European/Atlantic projects can be used as best practice examples for cooperation in marine energy R&D?**
- **How can knowledge and experience from other MS and sectors be leveraged to advance marine energy R&D?**

8.4.2 Effective policy and regulatory framework

Effective regulation in the renewable energy is important as it can facilitate development and sustainable deployment of renewable energy technologies. Directive 2009/28/EC of April 2009 deals with energy from renewable sources. It contains an obligation for Member States to prepare National Action Plans. In this context, MS spell out the expected contribution to their 2020 target.

Despite the strong framework to 2020, the Energy Roadmap 2050 suggests that growth of renewable energy will drop after 2020 without further intervention due to their higher costs and barriers compared to fossil fuels. Early policy clarity on the post 2020 regime will generate real benefits for investors in industry and infrastructure as well as for renewable energy investors directly.[79]

[78] Submission to EC from Ireland's cross-Government Marine Coordination Group, chaired by the Department of An Taoiseach and including the CEO of the Marine Institute, "An Integrated Maritime Policy for the European Union (2007): A proposal for an Integrated Strategy for the Atlantic"

[79] COM(2012) 271 final, "Renewable Energy: a major player in the European energy market"

A major challenge is that technology is advancing at a faster pace than policy. There are few coherent and considered regulatory frameworks. Even leading jurisdictions such as the UK (and Scotland in particular) face a number of issues, and obtaining consents for a project can take years and cost millions.

The development of some marine renewable energy technologies is at the key stage of commercialisation, so it is essential to develop an appropriate regulatory/legislative framework. Success of the industry depends on government policies to support development and deployment and the development of a comprehensive policy framework.[80]

On top of this, the economic crisis has made investors cautious about the energy sector. In Europe's energy markets, the growth of renewable energy depends on private sector investment, which in turn relies on the stability of renewable energy policy.

Suggested questions at Session 1 of the workshop:

- **What are the key factors for an appropriate regulatory framework that encourages the development of the marine renewable energies sector?**
- **What are the bottlenecks and how can they be addressed in a coordinated manner?**
- **How can Atlantic MS learn from each other to standardise regulatory frameworks?**
- **What lessons can be learnt from other countries' experience with public and private investments in ocean energy (especially in the USA, Canada, Australia, Japan)?**

8.4.3 Improving support schemes

The cost of renewable energy is not determined solely by the resources - project costs are also driven by administrative costs and capital costs, such as complicated authorisation procedures, lengthy planning processes and fear of retroactive changes to support schemes, which combine to increase project risk. Such high risks, particularly, in countries with stressed capital markets, result in a very high cost of capital, raising the cost of renewable energy projects and undermining their competitiveness.[81]

Furthermore, the success of demonstrating prototypes motivates the support of government and private investment in both technology and project deployment. However, development and operating costs are still beyond the capacities of small and medium enterprises, and therefore only the largest industries are involved in marine energy.

An appropriate balance of revenue support and capital grants is necessary to facilitate the transition from demonstration to commercial deployment. This includes incentives for investors (investment tax credits), incentives for end-users (investment and production tax credits) and feed-in tariffs that would make high-cost, precommercial installations attractive to investors and the end-users.

Simple administrative regimes, stable and reliable support schemes and easier access to capital (for example, through public supports schemes) will contribute to the competitiveness of renewable energy. In that context, the European Investment Bank and national public institutions can play a key role. Today, most renewable energy technologies benefit from national support schemes, but these cover only a small share of the energy market (less than a third of the 19% of electricity from renewable energy).[82]

In some Member States, changes to support schemes have lacked transparency, have been introduced suddenly and at times have even been imposed retroactively or have introduced moratoriums. For new technologies and investment still dependant on support, such practices undermine investor confidence in the sector. For example, in January 2012, Spain temporarily suspended all feed-in tariffs for new installations of renewable due to the financial crisis.

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[80] Clean Energy Council, Marine Energy Sector Report, 2011
[81] COM(2012) 271 final, "Renewable Energy: a major player in the European energy market"
[82] COM(2012) 271 final, "Renewable Energy: a major player in the European energy market"

Moreover diverging national support schemes, based on differing incentives may create barriers to entry and prevent market operators from deploying cross-border business models, possibly hindering business development.[83]

Suggested questions at Session 1 of the workshop:

- **What marine renewable energy technologies are cost prohibitive today, and what can be done to address these high costs?**
- **What are examples of successful support schemes? What are the key components?**
- **Is there scope for improving and/or standardising support schemes to encourage cross-border market operators?**

8.4.4 Improving grid connections

All marine renewable technologies need infrastructure, and many also need sea cabling and connections. Marine renewables are different from traditional models for transmission, in that resources can be far from the grid and therefore transmission charges can pose an issue.

The increase in energy renewables will require further investment in distribution grids, which have been designed to transmit electricity to final consumers, but not to absorb generation from small producers. The majority of the existing power grid was built in an era in which electricity systems were predominantly national, power generation was sited relatively close to the points of consumption, and power flows and supplies were relatively controlled.

With the exception of coastal Member States, such as Portugal and the south west region of the UK that have high voltage transmission lines available close to shore, coastal communities lack sufficient power transmission capacity to provide grid access for any significant amount of electricity that can be generated from marine energy.[84] A key area of research is focusing on the development of smart grids.

Suggested questions at Session 1 of the workshop:

- **What pan-European initiatives provide an opportunity to address grid connection in a coordinated manner?**
- **How can collaborative research into smart grids, through the Smart Grids European Technology Platform, encourage advances in this area?**

8.4.5 Spatial use conflicts

With the advent of the deployment of marine energy technologies, coastal management is a critical issue to regulate potential conflicts for the use of coastal space with other maritime activities. Some international Maritime Spatial Planning instruments have been developed in the last years but they do not necessarily take into consideration the specific features of offshore renewable energies. Several factors in the development of marine energy technologies will have maritime spatial planning implications.

[83] COM(2012) 271 final, “Renewable Energy: a major player in the European energy market”

[84] Strategy Energy Technologies Information System (SETIS), Marine Energy, http://setis.ec.europa.eu/newsroom-items-folder/ocean-energy

Suggested questions at Session 1 of the workshop:

- **How can we ensure a successful relationship between coastal populations, users of the sea and energy professionals?**
- **What policies need to be implemented to encourage the sustainable development of coastal regions, and to take into account industrial and European strategies concerning energy, safety and acceptance?**
- **How can marine spatial planning instruments be coordinated to resolve conflicts, regulate competing uses, and achieve optimal site selection?**

8.4.6 Technology research and development in Atlantic states

Given the maturity of the various technologies and the potential of the different resources amongst the different Atlantic Member States, several of these ocean technologies could contribute significantly to a more diverse global energy mix in the medium to long term. The best prospects for growth in the next 10 years are offshore wind power (fixed-base and floating) and tidal energy. OTEC development will concentrate on the tropical zones. Wave energy is unlikely to reach the commercial stage for several years, and is positioned for medium- to long-term market development.[85]

Large-scale investments in research and development are needed to generate innovative and competitive technologies to achieve these installed power and job creation objectives. A well-structured industrial sector and qualified workforce are also of critical importance.

Suggested questions at Session 1 of the workshop:

- **Tidal: how can high investment costs be addressed for this mature technology? Are France and UK the most viable sources?**
- **Marine current: what is the status of researching into grid connection? How can R&D in this developing sector be capitalized on outside of France and the UK?**
- **Wave: investigation into costs and market schedule of different concepts ? how can the current prototypes be taken to the next stage?**
- **Floating windmill: what is the status of R&D into the different technological innovations? Can lessons from Portugal and France be applied to other MS?**
- **OTEC: Can prototype project in La Réunion assist R&D in other areas?**
- **Osmotic: Are there and opportunities to develop osmotic energy technology in the Atlantic Region?**
- **How can lessons learnt in one Atlantic MS regarding technological advancement (eg. wave and tidal in UK, OTEC and offshore wind in France) be transferred to other Atlantic MS?**
- **What can be done collaboratively to lower the costs of grid connections and equipment, to develop test sites combining laboratory and pre-commercialization work, and to make procedures more flexible?**
- **What does the Atlantic area have to do to develop a first mover competitive position in marine renewables?**

[85] Ernst & Young, 2012, “Ocean energy Opportunities in the French market”

8.5 Possible recommendations

This section provides a list of the research areas and investment/policy actions identified during the desktop analysis. These have been compared with the ideas raised during the workshop in order to develop a list of priority ideas for future action in section 6.1.

Research areas

- Focus on innovative components and equipment that offer advantages when used at scale
- Research into equipment or methods that assist in scaling-up technology into farms or arrays, such as specialist installation and maintenance vessels and electrical connection equipment.
- Develop new manufacturing processes to reach high volume productions
- Develop installation, operation and maintenance methodologies to provide further cost reduction
- Encourage demonstration programmes of full-scale projects, coastal onshore prototype test sites and facilities
- Technologies to exploit OTEC and salinity gradients, particularly for overseas territories
- Strengthen industry-research collaborations
- Increase cooperation between national and European technology platforms

Investment/policy actions

- Setting Atlantic region renewable energy objectives and decarbonisation targets beyond 2020
- Reform national support programmes to promote cost reductions. There is a need to achieve better consistency and simplification across the EU, thereby reducing administrative costs for the industry.
- Increase number of testing facilities to test ocean energy devices components and systems
- Demonstrate grid integration techniques at an industrial scale and address long term grid access planning
- Address more efficient consent procedures to build on past experience that are proportional to the size of projects
- Establish and use marine spatial planning to identify optimal installation sites.
- Increase cooperation through working groups covering public administrations and industry to address measures to overcome barriers

9 Subtheme 2 – Sustainable maritime transport

The maritime transport sector consists of passenger and short sea and deep sea cargo shipping and the supportive businesses and infrastructure, including shipyards and ports. The subtheme deals with two main topics:

- Maritime transport; the land-sea interface of shipping and its relation to ports, roads and railways, but also environment, clustering, connectivity, and logistics;
- Green shipping: Research and design efforts in order to develop more energy efficient ships with low environmental impacts in terms of emissions, fuels, and the design and decommissioning of ships.

9.1 Context

Maritime transport is key in creating blue growth and connection the European economies to each other and the World markets. In Europe, the sector generates some €200 billion annually in added value and employs 2.5 million people (cf. figure below). Especially, deep and short sea shipping are major economic subsectors for which most employment is on land .[86] Transport on rivers and other inland water bodies is not discussed further here.

Figure 6: Value added and employment of maritime transport and shipbuilding in the EU

Source: DG MARE, "Blue Growth – scenarios and drivers for Sustainable Growth from the Oceans, Seas and Coasts – final report" 2012

Maritime transport is a major employer directly, but it is equally important in securing employment e.g. in businesses that supply the sector. For instance in France, the merchant vessels and passenger ships alone employ some 20,000 people directly but there are also 40,000 employees in both French ports and the shipbuilding industry. In addition, approximately 3,600 work in maritime research.[87]

Parallel to this, the UK maritime sector – ports, shipping and maritime businesses services – accounts for 230,000 direct jobs and almost the same indirect employment.[88] Indirect jobs are found in companies supplying goods and

[86] DG MARE, "Blue Growth – scenarios and drivers for Sustainable Growth from the Oceans, Seas and Coasts. Maritime Sub-Function Profile Report. Short Sea Shipping (1.2)" 2012
[87] 2009 data; The French Maritime Cluster; http://www.european-network-of-maritime-clusters.eu/publications/18.pdf
[88] 2009 data; Maritime UK: *The economic impact of the UK's Maritime Services Sector*, 2011, prepared by Oxford Economics

services for the maritime sector (raw materials; shipping services; communications; accounting). In Spain, the maritime sector provides employment for roughly 460,000 and another half a million indirectly.[89]

This indicates that the sector's direct activity generates at least the same amount of jobs in supply sectors etc. Technological advances and innovation is on one hand necessary to maintain the existing jobs, but R&D is also a source of job creation - not only direct employment in the sector but also a significant number of indirect jobs.

Figure 7: Economic effects of the Port of Southampton, UK

The activities of the Port of Southampton involve cruises, roll-on/roll-off vehicle transport, container shipping, bulks as well as import of fresh produce. It handles 300 cruise ships and 37 mtonnes of cargo. Excluding defence and oil activities, the port generates:

- Direct jobs: 5,100
- Nationwide total of direct and indirect jobs: 14,160
- Turn over of port businesses: £772m per year
- GDP effect: £1.75m per year

The main sectors benefiting from the Port's supply chain include the purchase, maintenance and repair of equipment and the distribution of fuel.

Source: Marine Southeast: Economic impact of the Port of Southampton, 2011. Prepared by Atkins.

Maritime transport

The water bodies of Europe cater to a substantial range of traded goods: the short sea transport sector - intra-European shipping - is responsible for some 40 % of all transport within the EU.[90] Short sea shipping connects Atlantic ports with other European ports and links of road and rail networks across the seas.

Growth in short sea cargo volumes results from two main drivers: economic development but also modal shift as short sea shipping is an alternative to road and rail based transport. From a sustainability point of view, shipping is promoted as a mean to reduced traffic emissions and congestion on land. Still, moving goods on sea rather than land also involves emissions of harmful substances often close to densely populated areas.

In order to promote modal shift of transportation towards shipping, links between ports must be well developed, barriers in the logistics sector overcome and port and hinterland infrastructure in place. There is a persisting need to optimize infrastructure with a view to lower costs and strengthen the competitive edge of shipping.

Green shipping: Energy and emissions

Emissions of SO_2, NO_x and particles from ships are the focus of regulation by the International Maritime Organisation, EU[91] and MS through e.g. emission control areas (ECAs). Environmental developments include scrubbers on exhaust pipes but also the use of fuels with low content of sulphur. CO_2 emissions are tackled by means of more energy efficient ships with regards to engines and ship design as well as greener fuels such as liquid natural gas (LNG).

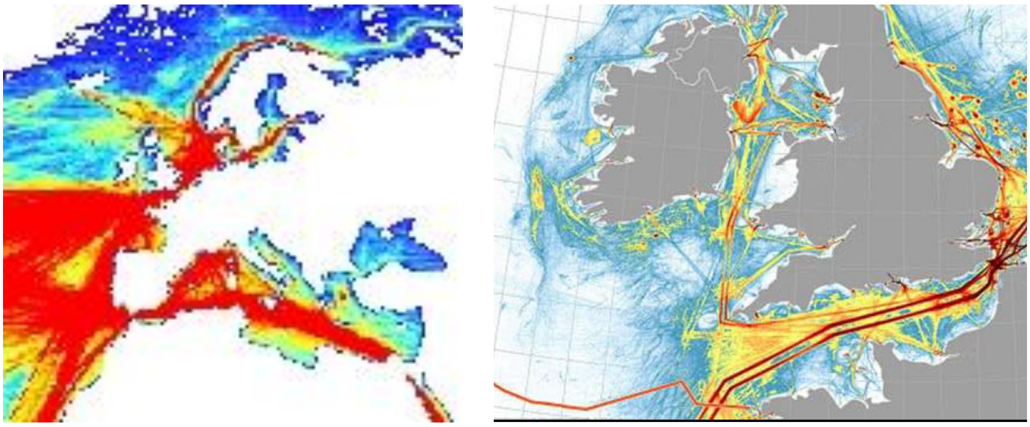
Maritime transport is international in its nature and nations tend not to regulate their merchants' fleet. Instead, international bodies - primarily the International Maritime Organisation under the UN and to some extent the EU - put in regulation on maritime transport.

[89] 2005 data; includes some 39,000 employed in fisheries; Clúster marítimo español: *A shared platform to achieve the future*
[90] DG MARE, "Blue Growth – scenarios and drivers for Sustainable Growth from the Oceans, Seas and Coasts. Maritime Sub-Function Profile Report. Short Sea Shipping (1.2)" 2012
[91] E.g. the EU Sulphur Directive and the 2012 public consultation on "Including maritime transport emissions in the EU's greenhouse gas reduction commitment"

9.2 Baseline – trends

Seaborne trade has been affected by the recent economic downturn. The European amount of loaded goods has, nonetheless, remained almost constant since 2006 (approx. 1,100 mt), whereas the amount of unloaded goods fell from approx. 2,100 mt in 2006, to 1,700 mt in 2009 after which small increases were seen. Especially, dry cargo dropped during the crises.[92]

Figure 8: Maps of ship density in Europe (left) and the English Channel and Irish Sea (right). Darker colour indicates greater density of maritime transport (AIS-data).



The maps above show the great density of ships off the European Atlantic coasts. However, most of these vessels have their call elsewhere and only pass through the Atlantic. In terms of short sea shipping, the Atlantic area account for approximately 14 % of European totals, which is roughly half of the contribution from North Sea and Mediterranean short shipping, respectively.[93]

The table beneath lists the major Atlantic ports in comparison to their European counterparts. Four ports in the Atlantic Member States rank in between the 20 largest cargo ports (short and deep sea freight), and they are relatively small relative to the largest maritime hub in Europe, Rotterdam. Other significant Atlantic ports include Nantes Saint-Nazaire, Sines and Rouen. Still, marine transportation is dominated by few major ports and shipping companies and a host of smaller ports and SMEs. Economics of scale are very important in logistics and goods concentrate in transportation hubs.

Table 7: Atlantic ports between the 20 largest European ports in 2010; the freight they handle, their size compared to the largest European port - Rotterdam - and their ranking in terms of size.

Atlantic port	Gross weight of goods, thousand tonnes, 2010	Size compared to Rotterdam	European rank in 2010	European rank in 2002
Le Havre, FR	65.771	17%	6	6
Milford Haven, UK	42.788	11%	14	16
Southampton, UK	39.365	10%	17	17
Dunkerque, FR	36.309	9%	18	12

Source: Eurostat (mar_mg_am_pwhc)

[92] UNCTAD: Review of maritime transport 2011

[93] In 2009, Atlantic short sea shipping catered 231 mtonnes out of 1,685 mtonnes of the European short sea shipping sector. (DG MARE, "Blue Growth – scenarios and drivers for Sustainable Growth from the Oceans, Seas and Coasts. Maritime Sub-Function Profile Report. Short Sea Shipping (1.2)" 2012)

The Atlantic Member States cover approximately 20 % of all European passenger dis-/embarkments to which the ferries across the English Channel contribute substantially.

Shipping has low unit cost in comparison to other transport modes and is competitive at large distances. Fuels make up some 30-40 % of operating costs,[94] and costs are thus largely affected by fuel price fluctuations, but increases in the transport sector's operation costs can enhance shipping's competiveness relative to road on shorter distances. This tendency can be intensified by congestion on land infrastructure and environmental regulation. Still, a crucial question for the future is how the sector's ability to compete will be affected by increased costs due to e.g. environmental requirements.

European shipbuilders have lost ground to Asian competitors, and only specialized shipyards continue to operate out of Europe. In Brittany, the specialised ship-repair business in Brest is a corner stone in France's largest maritime cluster: the 'Pôle de competitivité mer' which is the centre of many R&D activities. This includes private-academia projects related to corrosion control (CORONAV) and environmentally friendly anti-fouling paints (BIOPAINTROP) and many others.

The maritime transport sector shares the technology platform Waterborne[TP] in an effort to highlight R&D requirements for European competitiveness, innovation and the meeting of regulations like safety and environment.

EU initiatives on maritime transport

The *European Maritime Transport Space without Barriers* aims at simplifying administrative procedures for maritime transport and which can a stepping stone for a 'Blue Belt' of free maritime movement in and around Europe[95].

Four *Motorways of the sea* corridors are set up under the Trans-European Network (TEN-T) in order to establish floating infrastructures as competitive alternatives to land transport. In the Atlantic area, the Motorway of the Sea of Western Europe leads from Portugal and Spain via the Atlantic Arc to the North Sea and the Irish Sea:

The EU Marco Polo programme funds sustainable freight focused at projects and actions that promotes shift in transport modes from road to ship and rail; this includes Motorways of the sea. An attempt to remove several billion tonne-km off the French road network was established by the Fresmos project between St. Nazaire in France and Gijon in Spain. The parallel Ro-Ro Past France project was set up as a seaborne motorway between Bilbao, Spain, and Zeebrugge in Belgium where each sailing carries up to 200 unaccompanied trailers[96]. Together with the Gulf Stream (Santander, Spain to Poole, UK) and Reefer Express (Bilbao, Spain to Tilbury, UK and Rotterdam, Netherlands) projects, these routes are very likely to have increased interconnectivity among the Atlantic economies and moved great amounts of goods from land to sea transport modes.

In addition to Motorways of the sea, the land based infrastructure development under TEN-T has improved connections to hinterland, thus investment in maritime transport will benefit from hinterland connectivity and vice versa.

The TEN-T will develop infrastructure at two levels in the 2014-2020 period towards a comprehensive and a core network, respectively. The core network to be completed by 2030 is shown in the map below. The core network aims at connecting 83 main European ports with hinterland (rail and road links) along ten priority corridors. The map illustrates the prioritised land corridors and port infrastructure in the Atlantic area. It is clear that major investments along the Atlantic can be expected towards 2030 and pre-identified core projects comprise both a port/rail upgrades between Lisbon (Sines port) and Strasbourg and between Dublin via the Channel to Paris and Brussels[97].

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[94] DG MARE, "Blue Growth – scenarios and drivers for Sustainable Growth from the Oceans, Seas and Coasts. Maritime Sub-Function Profile Report. Short Sea Shipping (1.2)" 2012

[95] COM(2012) 494 final: Blue Growth - opportunities for marine and maritime sustainable growth

[96] http://ec.europa.eu/transport/marcopolo/files/success-stories/motorways_of_the_sea_ro_ro_past_france_en.pdf

[97] DG MOVE: List of pre-identified projects on the core network in the field of transport, 2011 (http://ec.europa.eu/transport/themes/infrastructure/connecting/doc/revision/list-of-projects-cef.pdf)

Figure 9: TEN-T core network in 2030 (bold lines indicates projects completed in 2011), Source: DG MOVE: Connecting Europe: Putting Europe's economy on the move. 2011

Figure 10: CAMIS: INTERREG project across the English Channel

> *Channel Arc Manche Integrated Strategy* project is a Franco-British co-operation that 2009 through 2013 brings together 13 partners in establishing an integrated marine strategy. On transport and intermodality the projects seeks to:
>
> - Establishing a co-ordinated mapping tool of freight and passengers transport links and transport investment
> - Identifying synergies between road, rail, air, and sea investments
> - Promoting joined up planning and investment in hinterland connectivity

The EU supported Aux-Navalia project gathers the shipbuilding industry and auxiliary businesses in Portugal, Spain and the UK in enhancing competitiveness and innovation capacity. Activities involve creating networks and collaboration in the Atlantic area, joining forces in the improvement of technology uptake, financial instruments, and internationalisation.

Green shipping: Energy and emissions

Maritime shipping emits less green house gas than road based transportation. On tonne of goods moved one kilometre causes an emission of approximately 110 g of CO_2 on road as compared to some 20 g on rail and 15 g on the sea[98]. Emission regulation and technological development in the land transport sector has driven pollution down. Modal shift towards shipping is a causal element, but the same time SO_2 and NO_x from international shipping is on the rise and is forecasted to surpass emissions from land and domestic shipping by the end of this decade (see figure below).

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[98] European Environmental Agency: http://www.eea.europa.eu/data-and-maps/figures/specific-co2-emissions-per-tonne-1

Figure 11: Emission forecasts in Europe

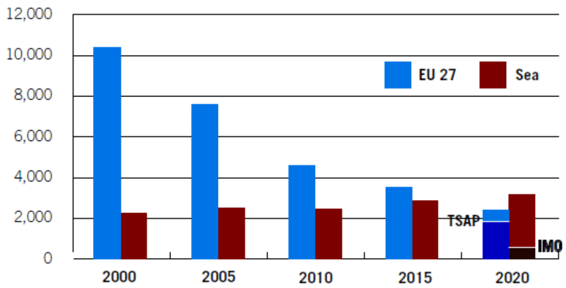

Figure 1: Emissions of SO_2 2000–2020 (ktonnes).

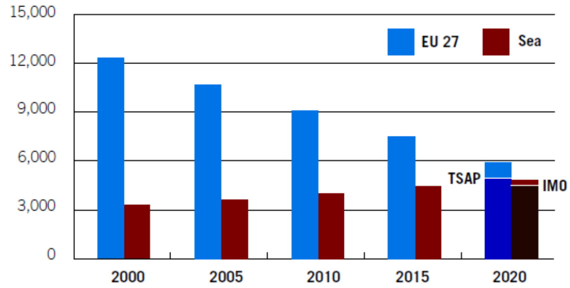

Figure 2: Emissions of NOx 2000–2020 (ktonnes).

Note: EU27 = land based emissions (incl. domestic shipping)
Sea = emissions from international shipping
TSAP = Target from EU Thematic Strategy on Air Pollution (2006)
IMO = Expected outcome for implementing preliminary IMO-agreement (2008)

Source: Seas at Risk et al.: Air pollution from ships, 2008

Continuous efforts are being made in the direction of "green shipping". These efforts have various directions including:

- Emission reduction: exhaust scrubbers and alternative fuels (low sulphur fuels and liquid natural gas)
- Alternative energies: land supply of energy in ports (electrical power outlets), sails and solar panels
- Improved design: energy efficiency, improved design and recycling of materials.

Green shipping is integrated in the EU Framework for research and technological development (FP7). In 2012 for example, €24 million are set aside for ensuring safe, green and competitive waterborne transport.[99]

Figure 12: Green Sea Port Energy Centre - an example of emission reductions in the Atlantic area

The Green Sea Port Energy Centre has just been launched in Vigo, Spain, targeted at lowering emissions from the almost 1,900 vessels that visit the port annually. A land based installation will provide natural gas based heat and electricity as a clean air alternative to the ships' own power supply. The Centre's goal is to develop small unit technology that is comparatively cheap and flexible which make it especially suitable for small and medium size ports.

Source: The Galician Maritime Cluster

Experts have assessed that natural gas in liquid form can become a viable fuel alternative in the next 5-10 years once the distribution infrastructure is in place.[100] Biofuels are relevant for shipping as for other energy dependent

[99] European Commission: C(2011)5068

sectors. For instance biofuels based on marine algae have undergone large scale tests[101], but marine algae applications are still development and their energy contribution over the next decade is likely to be modest.[102]

In spite of these efforts, the most likely near-future change in shipping fuels will be low sulphide potentially in combination with exhaust scrubbers[103]. Many of the other directions of efforts are still on the test and demonstration level and are therefore unlikely to become widespread in the short to medium run, but these technologies have all the same a growth potential due to the changes that lie ahead for maritime transport.

Shipping is a major consumer of fuels and raw materials, e.g. steel is a major input into shipbuilding and the largest container ships (18,000 TEU) need approx. 60,000 tonnes of steel for hulls etc., which makes concepts of ship dismantling, recycling of materials and cradle-to-cradle highly relevant. Intelligent material use is fundamental in sustaining cost effective shipping in the future. To this end, the EU launched a proposal earlier this year on ship recycling; basically establishing a system of survey, certification and authorisation for large commercial vessels under flag of an EU Member State, covering their whole life cycle from construction to operation and recycling.[104] Generally speaking, regional/EU regulation of shipping is nonetheless a balancing act as shipping is highly globalised and flag state can be changed easily.

Still, greener shipping is also a way for private actors to differentiate themselves. The leading shipping company Maersk Line has for instance introduced a cradle-to-cradle approach and set strict energy targets in their "The World's largest ship" project aimed at constructing 18,000 TEU vessels by 2014. See also box below.

Based in La Rochelle, France, *Alt.En.* is a small technology provider working with alternative energy in green shipping. It produces small ferry boats with zero or low green house gas emissions. Research and development include reducing hull drag, optimisation of weight and using electric propulsion. Al*t.En* markets passenger catamarans for public transport carrying up to 150 passengers.

STX France bases its innovative *Ecorizon* project on the Atlantic coast, in the Saint-Nazaire yard. The R&D activities evolve around energy, air emissions, water, waste and sustainable design integrated in a green life cycle development upon which STX France has introduced to 305 m cruise ship concept *Eoseas* illustrated below.

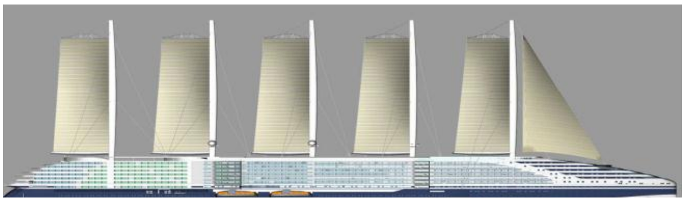

Figure 13: "Alt. En" and "Ecorizon" - examples of green shipbuilding in the Atlantic area

Source: www.alternativesenergies.com and www.stxeurope.com

9.3 Assessment

Many of the challenges and opportunities that the Atlantic maritime transportation sector faces are common across the EU. Many of these issues are focal points for ongoing international, national and EU initiatives.

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[100] DG MARE, “Blue Growth – scenarios and drivers for Sustainable Growth from the Oceans, Seas and Coasts. Maritime Sub-Function Profile Report. Short Sea Shipping (1.2)” 2012

[101] For instance, algae fuels powered auxiliary engines Maersk Lines' 300 m long Maersk Kalmer en route between Germany and India (http://www.algaeindustrymagazine.com/maersk-and-navy-test-algae-fuel-on-container-shi/).

[102] Sustainable Energy Ireland: A Review of the Potential of Marine Algae as a Source of Biofuel in Ireland. 2009

[103] DG MARE, “Blue Growth – scenarios and drivers for Sustainable Growth from the Oceans, Seas and Coasts. Maritime Sub-Function Profile Report. Short Sea Shipping (1.2)” 2012

[104] European Commission: COM/2012/0118 final - 2012/0055 (COD)

However, some aspects are more specific to the Atlantic areas. Below, a list of characteristics and needs for sustainable and intermodal transport is given.

- Well-regulated and mature, privately driven sector. Trade and logistics are very much driven by economic activity and transport patterns and modes are direct results of operators' drive to serve transport needs and lower cost. Nonetheless, maritime transport is a backbone in the Atlantic economy and adequate policies and framework must be ensured.
- Maritime transportation in the Atlantic area is significant, but ports, amounts of goods handled and the development of intermodal transport is lower than in the North Sea and Mediterranean, which reveals an Atlantic potential for growth but also indicates the major completion from neighbouring regions.
- Lack of adequate infrastructure in secondary ports is a constraint to further growth[105], as the ports of the Atlantic area are only attractive if they are well equipped and adequately connected to hinterland.
- For short sea shipping to be competitive, the preservation of a larger number of smaller but well equipped ports is essential. Consolidation, optimisation of existing infrastructure and coordination between ports are necessary to target investments.
- The Atlantic maritime transportation sector faces a major challenge in curbing future environmental requirements and continue to develop in a highly competitive market. In consequence, green shipping is a challenge but also an opportunity to the sector, i.e. an area of Atlantic differentiation in a competitive transportation sector.
- Environmental aspect must be even more integrated in ship design, operation and dismantling as well as in design of ports and infrastructure systems
- Skilled seamen were short in supply and recruitment for a career at sea was difficult during the 2000s, but the drop in economic activity and trade has eased off the issue. Still, there is a potential need for policy actions that can ensure future availability and quality of crew on ships. Also, the greening of ship technology requires major input of specialised engineering skills.

[105] DG MARE, "Blue Growth – scenarios and drivers for Sustainable Growth from the Oceans, Seas and Coasts. Maritime Sub-Function Profile Report. Short Sea Shipping (1.2)" 2012

9.4 Possible recommendations

The workshops of the Atlantic Forum are essential in providing recommendations that a directly linked to the prevailing reality that Member States face along the Atlantic coast. The box below presents strategic directions for the naval ancillary industry in the Atlantic area (Galicia, Portugal and United Kingdom) on research, technological development and innovation (RDI). The Aux-navalia project has identified actions that can promote competitiveness and innovation capacity of the Atlantic maritime industry.

Figure 14: Strategic actions for the naval auxiliary industry identified in the Aux-navalia project

DESIGN	• Advanced tools and simulators for design. • Standard communications systems between different databases, software modules and company ERP systems.
PRODUCTION, ASSEMBLY AND INSTALLATION.	• Use of management systems and software tools to improve communication between the shipyard and the ancillary industry. The aim is to facilitate the efficiency exchange of information and integrate the different processes of the value supply chain (design, production, assembly, etc.). • Standardization and modularization of components through the analysis and transfer of the best practices from other sectors. • Use of new technologies and production methods. • Automation and robotic systems production.
REPAIR AND MAINTENANCE	• Improve the usability of the ships through preventive maintenance actions, monitoring and control systems, etc. • Techniques for ship recycling.
NEW MATERIALS	• Develop new materials (stronger, lighter, anti-corrosion, etc.)
TRANSVERSALS POLICIES	• Training in quality, environment and prevention. • Knowledge management. • RDI management.

Source: Aux-navalia: RDI road map of the EAA naval ancillary industry - Vision 2020, 2011

This section provides a list of the research areas and investment/policy actions identified during the desktop analysis. These have been compared with the ideas raised during the workshop in order to develop a list of priority ideas for future action in section 6.2.

Research areas

- Strategic work should be made in order to find the Atlantic strengths within green shipping.
- Development of Atlantic platforms (networks, ICT etc.) that optimise infrastructure and promotes modal shift.

Investment/policy actions

- Continued, strategic investments in maritime infrastructure and optimisation of existing infrastructure.
- Development of short sea shipping including the West Atlantic Motorway of the Sea: closer organisation between Atlantic ports (inter-port services, regional shipping lines, shared facilities) and operators is needed to ensure competitive capacity.
- Take actions to establish an Emission Control Area (ECA) in the Atlantic to deal with sulphur and nitrogen emissions from shipping. Strengthen MS and EU action in IMO negotiations.

Suggested questions for the workshop

- **Which Atlantic administrative barriers hamper growth in within maritime transportation?**
- **Is there a need for specific actions on maritime transportation skills and competences?**
- **What infrastructure investments can improve the network?**
- **What are the Atlantic area's green shipping strongholds? Examples?**
- **Best practice examples of coordination between ports and operators?**
- **What actions can make environmental and safety framework a stepping stone rather than a barrier?**
- **Can the Atlantic host high value niches of maritime transport? E.g. green ports that are certified and set high requirements to the products handled and the social and environmental performance of ships.**

10 Subtheme 3 – Maritime safety and security

10.1 Context

10.1.1 Political impetus to address maritime safety and security

In 1999, the ship MV Erika sank off the coast of France, causing a major environmental disaster. The cost of the clean-up was close to a billion euros, and the EU feared that similar catastrophes might be waiting to happen. Only three years later in 2002, the Prestige oil tanker sank off the northern coast of Spain, once again causing millions of euros of damage to the environment. Following these two disasters, the EU called on Member States to take urgent and decisive action to counter the threat of oil spills. They also acted as a reminder to decision-makers that Europe needed to invest in better preparation for a large-scale oil spill, i.e. above-and-beyond the resources available at individual Member State level. Proposals for stricter shipping controls immediately followed.

In relation to maritime security, following the seizure of the Achille Lauro cruise ship in 1985, there was much speculation that an increased number of security incidents would follow. In recent years, the maritime industry has been broadly evaluating security at its facilities and voluntarily taking appropriate actions to improve security based on shipping trade area, geographic location, potential risk to workers and the surrounding communities, and potential risk attacks. Terrorism and political agendas are the latest trend in motivation for stealing cargo and ships, and modern pirates are increasing the violence and the severity of the attacks. However, it took the tragic events of 11 September 2001 for the maritime community to agree the need for international maritime security requirements.

10.1.2 EU Policy regarding marine safety and security

Following these environmental disasters, the EU created a number of Directives and Regulations addressing maritime safety:

- Directive 2002/59/EC of the European Parliament and of the Council of 27 June 2002 establishing a Community vessel traffic monitoring and information system and repealing Council Directive 93/75/EEC [Official Journal L 208 of 5.8.2002].
- Regulation (EC) No 1406/2002 of the European Parliament and of the Council of 27 June 2002 establishing a European Maritime Safety Agency
- Directive 2005/35/EC of the European Parliament and of the Council of 7 September 2005 on ship-source pollution and on the introduction of penalties, including criminal penalties, for pollution offences [Official Journal L 255 of 30.9.2005].
- Directive 2009/16/EC of the European Parliament and of the Council of 23 April 2009 on port State control [Official Journal L 131 of 28.5.2009].
- Directive 2009/15/EC of the European Parliament and of the Council of 23 April 2009 on common rules and standards for ship inspection and survey organisations and for the relevant activities of maritime administrations

Specific to the Atlantic Region, the OSPAR convention for the Protection of the marine environment of the North-East Atlantic also provides the framework for marine safety issues.

The EU has developed a number of measures including an immediate ban on single-hulled oil tankers carrying heavy grades of oil from entering the waters of the European Union with only double-hulled tankers allowed to sail into ports from 2015. In relation to standards for ship inspection, there are more than 50 organisations worldwide which define their activities as providing marine classification, but only 12 classification societies are presently recognised by the European Union (Official Journal C 135/04 of 19 June 2007).

At the international level, the International Convention for the Prevention of Pollution from Ships (MARPOL) is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. The MARPOL Convention was adopted on 2 November 1973 at IMO. The Protocol of 1978 was adopted in response to a spate of tanker accidents in 1976-1977. The Convention includes regulations aimed at preventing and minimizing pollution from ships - both accidental pollution and that from routine operations.

In terms of maritime security, the International Maritime Organization (IMO) in December 2002 adopted new international maritime security requirements in the SOLAS Convention 1974, new Chapter XI-2, and a new International Ship and Port Facility Security (ISPS) Code. Until then, the majority of terrorist surveillance, and response measures, put in place throughout the EU have been as a result of individual action at Member State level. These include measures to protect against terrorism in the maritime sector which vary significantly across the EU.

Following adoption of the new IMO security regime, EU Member States agreed the need for measures at Community level. The following Regulations and Directives have been put in place:

- Regulation (EC) No 725/2004 of the European Parliament and of the Council of 31 March 2004 on enhancing **ship and port facility security**. The purpose was to introduce and implement in a harmonised manner measures aimed at enhancing the security of ships engaged on international voyages and domestic shipping, including associated port facilities.
- Directive 2005/65/EC on **enhancing port security**, laying down procedures for conducting Commission inspections in the field of maritime security at the level of each Member State and of individual port facilities and relevant Companies.
- Regulation (EC) No 324/2008, to incorporate procedures for **monitoring Member States' implementation of the Directive jointly with the Commission's inspections** under Regulation 725/2004. On the basis of this legislation, the Commission conducts inspections to verify the effectiveness of national quality control systems and maritime security measures, procedures and structures at each level of each Member State and of individual port facilities and relevant companies.

The Commission is assisted by a Regulatory Committee (**Maritime Security Committee - MARSEC**) acting in accordance with the regulatory procedure. MARSEC is a Regulatory Committee established by virtue of Article 11 of Regulation (EC) No 725/2004 and it also assists the Commission with regard to its activities under Directive 2005/65/EC. The Regulatory Committee is chaired by the Commission and consists of experts representing all Member States. Periodical exchange of information between Member States and Norway and Iceland, has taken place. Best practices and indications on national instructions have been shared in this forum and, most importantly, it was recently agreed to create a mechanism for secure mutual information where each Member State could inserts sensitive information i.e. security levels adopted, threat evaluations and others topics relevant for the security of European shipping.

Furthermore, the Commission meets regularly the **Stakeholder Advisory Group on Maritime Security (SAGMaS)** which is a forum where the stakeholders can express their views on the work of the Regulatory Committee, MARSEC. The Commission will consider inviting to meetings of SAGMaS any stakeholder organisation that is a European or international (and not merely a national) organisation, and has a demonstrable professional interest in the subject of maritime security (as covered by EC legislation), and in the view of the Commission will offer an added value to the subjects under discussion at the particular meeting of the Committee.

10.1.3 European Maritime Safety Agency (EMSA)

EMSA was established in 2003, following the fallout from the Erika (1999) and the Prestige (2002) accidents and their resulting oil spills. EMSA provides technical assistance and support to the European Commission and Member States in the development and implementation of EU legislation on maritime safety, pollution by ships and maritime security. It has also been given operational tasks in the field of oil pollution response, vessel monitoring and in long range identification and tracking of vessels.

EMSA was established by Regulation (EC) No 1406/2002 as a major source of support to the Commission and the Member States in the field of maritime safety and prevention of pollution from ships, and subsequent amendments have refined and enlarged its mandate.

In relation to maritime security, EMSA's mandate is to provide technical assistance to the Commission, including in the performance of the Commission's inspection tasks, in respect of ships, relevant companies and Recognised Security Organisations (RSOs) authorised to undertake certain security-related activities. These inspections started in 2005 with the Member States' National Administrations, for which the Commission requested EMSA's participation in relation to the ships' part. EMSA participated in the first inspections of ships in 2006 and in 2007 the first inspections of shipping companies and RSOs have taken place.

10.1.4 EU tools to address maritime safety and security

CleanSeaNet (www.cleanseanet.emsa.europa.eu) is a satellite-based monitoring system for marine oil spill detection and surveillance in European waters. The service is maintained by the European Maritime Safety Agency (EMSA) and provides a range of detailed information including oil spill alerts to Member States, rapid delivery of available satellite images and oil slick position.

The legal basis for the CleanSeaNet service is Directive 2005/35/EC on ship-source pollution and on the introduction of penalties, including criminal penalties, for pollution offences (as amended by Directive 2009/123/EC). EMSA has been tasked to work with the Member States in developing technical solutions and providing technical assistance in relation to the implementation of this Directive, in actions such as tracing discharges by satellite monitoring and surveillance.

SafeSeaNet (www.emsa.europa.eu/operations/safeseanet) is a European Platform for Maritime Data Exchange between Member States' maritime authorities, is a network/Internet solution based on the concept of a distributed database. SAFESEANET's main objective is to aid the collection, dissemination and harmonised exchange of maritime data. The network assists communication between authorities at local/regional level and central authorities thus contributing to prevent accidents at sea and, by extension, marine pollution, and that the implementation of EU maritime safety legislation will be made more efficient. SAFESEANET covers EU Member States plus Iceland and Norway and involve a number of different authorities per country, both at local and central level.

SafeSeaNet already provides an integration of mandatory declarations from ships and a gateway to signals from their Automatic Identification System (AIS) picked up by coastal stations. Fishing vessels are tracked through the Vessel Monitoring system and the Long Range Identification and Tracking system allows all passenger and cargo ships above 300 tonnes within one thousand nautical miles of the European coast to be monitored.

EU **Long Range Identification and Tracking (LRIT) (http://emsa.europa.eu/operations/lrit)** identifies and tracks EU flagged vessels worldwide and integrates them into the wider international Long Range Identification and Tracking system. The system was initially set up for the purposes of maritime security, but was soon extended for use in areas such as Search and Rescue (SAR), maritime safety and protection of the marine environment. Ships send automatic position reports every 6 hours, which are received by satellite, and securely transferred to data centres which manage LRIT information on behalf of flag States.

THETIS (https://portal.emsa.europa.eu/web/thetis) is the inspection database on Port State Control. This information system is crucial for the implementation of the new regime, which is laid down in the new Directive 2009/16/EC on Port State Control. The system serves both the EU Community and the wider region of the Paris Memorandum of Understanding on PSC (Paris MOU) which includes Canada, Croatia, Iceland, Norway and the Russian Federation. To facilitate planning of inspections, the new system is linked to the Community's SafeSeaNet (SSN) system.

STCW Information System (https://portal.emsa.europa.eu/web/stcw) provides information on maritime administrations and MET establishments in the EU, including maritime programmes, number of students and graduates. When fully operational it will provide numerical information on certificates of competency and endorsements issued by the EU Member States. The target is to have accurate information on the number of seafarers available to be employed on EU registered vessels and information on the countries where they were educated, trained and certified.

10.1.5 Integrated Maritime Surveillance

Integrated Maritime Surveillance is one of the five pillars of the Integrated Maritime Policy, and is about providing authorities interested or active in maritime surveillance with ways to exchange information and data, thereby making surveillance cheaper and more effective.

Currently, EU and national authorities responsible for different aspects of surveillance – e.g. border control, safety and security, fisheries control, customs, environment or defence – collect data separately and do not necessarily share them, resulting in duplication of data collection activities.

Therefore, at European and at national level there is a need to integrate the co-ordination and inter-operability of the Member States ability to exercise sovereignty in European waters.

In this regard, good progress has been made with Member State co-operation in the area of maritime safety, security and surveillance, in particular in relation to:

- emergency at sea responses (including search and rescue);
- pollution response (including catastrophic events), environmental protection, fisheries enforcement;
- improved vessel traffic management and information; and
- maritime security and surveillance at sea (including border control, counter-narcotics, human trafficking, smuggling and other forms of organized crime).

10.2 Baseline – trends

Waterborne transport is a key player in worldwide economics. More than 70 percent of the European Union's external trade and 30 percent of the internal trade is handled by maritime transport.[106] However this requires more efficient transport chains, but more importantly, continued improvements in safety and protection of the environment. The Atlantic is Europe's lifeline for trade. Therefore, Europe's security of supply must be absolutely secure and the trafficking of arms, people and drugs must be stopped.

Ongoing dialogue with the maritime industry is necessary on voluntary measures to promote safety, together with the creation of a business environment in which quality-minded operators are rewarded. The framework for maritime safety research has been established through a number of policy communications and legal instruments.

Some of these measures of the EU include the following:

- improved identification and monitoring of all ships approaching and sailing in European waters and ports;
- simplified and harmonised procedures for the provision and use of information on hazardous or polluting freight, through the use of electronic data interchange (EDI)
- the mandatory use of voyage data recorders (maritime black boxes) and automatic identification systems to facilitate accident investigation and traffic monitoring and control
- the establishment of common databases and methodologies for maritime safety and accident investigation

10.2.1 Research trends for maritime safety

Research in the area of maritime safety has focused on developing operational and technological concepts capable of meeting the changing needs of the demand side while enhancing safety and the protection of the environment. Research can be divided into several categories:[107]

- Development of logistic concepts and systems;
- Introduction of innovative designs, technologies and working practices for safer ship operations;
- Development of efficient traffic management systems for sea and river operations;
- Education, human factors and improvements to the working environment; and

[106] EXTRA consortium for DG Energy and Transport, (2001) “Maritime Safety: Results for the transport research programme”
[107] EXTRA consortium for DG Energy and Transport, (2001) “Maritime Safety: Results for the transport research programme”

- Reduction in environmental risks and the promotion of environmentally friendly operations.

The EU is already involved in several projects to improve the monitoring of sea areas and vessel traffic in the Atlantic. These include: ARCOPOL + is a project that aims to further improve maritime safety and Atlantic regions coastal pollution preparedness and response against oil and Hazardous and Noxious Substance (HNS) spills through technology transfer, training and innovation.[108] Previously identified gaps in the HNS knowledge will be addressed and further incorporated into local and regional contingency planning to contribute to build a reasonable and efficient response. Innovative tracking, forecasting and decision support tools will be adapted to the needs of local and regional authorities that will be trained on their application.

Given the size of the Atlantic, there are significant opportunities to improve the efficiency and effectiveness of MS operations in these areas, both within the agencies within each jurisdiction and across jurisdictions through greater cooperation, information exchange and shared analysis.

Future trends that will highlight the need for a coordinated approach include:

- Increased competition for space: this creates increased pressure for environmental protection
- Future shipping: keep dangerous ships away from protected areas (and other industries/activities– maritime spatial planning
- Incentives for quality: Good standard/record gives better routes (including the use of certificates, ”above compliance” standards)
- Trend from compliance culture towards safety culture.

10.2.2 Atlantic cooperation in maritime safety

Several cooperation structures and networks on maritime safety have been launched by the Atlantic Area in former programming periods.[109]

Green Atlantic for Sustainable Development: this was part of the 2000-2006 Atlantic Area programme and served as both a process of integration and development of competences and methods aimed at creating a European platform of expertise and action for maritime and environmental safety issues. GASD focused on three top priorities for maritime safety:

- Fostering a new level of cooperation for a transnational project addressing this world- scale issue
- Building on experience and concentration of know-how to create the first European platform of expertise in maritime safety, with international exposure
- Developing activities with significant added value in science and technology to attract the business, experts, investors and innovation that play an integral role in maritime safety sciences and activities.

Emergency Response to Coastal Oil, Chemical and Inert Pollution from Shipping: The EROCIPS Project has worked to strengthen the shoreline response to such incidents, minimising the potential environmental and socio-economic impacts. EROCIPS is the first transnational initiative to focus on the need for local and regional governments to pursue an integrated approach to emergency response for coastal pollution incidents. Partners from along the Atlantic Coast of Europe have worked together, using their experience and expertise, to develop a common understanding of the risks faced and to produce suggested protocols, tools and guidance material to improve existing coastal pollution response plans.

Improving Coastal and Recreational Waters: Improving Coastal and Recreational Waters (ICREW) was a project funded by the European Union’s INTERREG IIIB programme for the Atlantic Area. It involved nineteen partner organisations and five Atlantic Area Member States: France, Ireland, Portugal Spain and UK. The ICREW project aimed to assist Member States in improving their compliance with the Bathing Water Directive and to provide the tools and techniques to assist Member States to comply with the requirements of the revised Bathing Water Directive. The project ran from April 2003 to April 2006.

[108] ARCOPOL: The Atlantic Regions’ Coastal Pollution Response, 15th February 2012

[109] Carvalho, A. (2007), “Maritime Safety and Risks Prevention in the European Atlantic Coast: Challenges for a Transnational Cooperation Framework”

10.2.3 Research trends in maritime security

FP7 Security Research, Maritime Security and Surveillance

Following the implementation of the PASR Preparatory Action on Security Research in 2004-2006 by the European Commission, an EU Security Research Programme (ESRP) was included for the first time in the RTD Framework programme in FP7. The objectives of FP7 Security Research are to: make Europe more secure for its citizens, strengthen industrial competitiveness; promote research excellence and state-of-the-art; prevent the fragmentation of research efforts and to strengthen critical mass. FP7 SEC provides support for transnational collaborative research in a number of areas, including maritime security. Research topics relating to maritime security, such as secure container-screening, biometric ID port perimeter security, satellite-based tracking of maritime areas and blue border surveillance, have been addressed in a number of work programmes. This has enabled a number of maritime security research projects to be undertaken, including SOBCAH, SECCONDD, AMASS, OPERAMAR and UNCOSS.[110] Key research topics have included:

- container-screening systems
- biometric ID port perimeter security
- satellite-based maritime tracking
- blue border surveillance

Maritime Surveillance, a contribution to integration and data sharing

Atlantic regions will benefit from the Common Information Sharing Environment (CISE) currently being developed jointly by the European Commission and EU/EEA member states.[111] It will integrate existing surveillance systems and networks, such as European Border Surveillance System (EUROSUR), for the exchange of information on irregular migration and cross-border crime and the SafeSeaNet system, thereby giving all concerned authorities access to the information they need for their missions at sea. CISE will make different systems interoperable so that data and other information can be exchanged easily through the use of modern technologies. In turn, it will lead to better and cheaper maritime surveillance.

COM(2010) 584 final sets out the Roadmap towards establishing the Common Information Sharing Environment for the surveillance of the EU maritime domain. A regional approach has also envisaged, with the setting up of pilot projects such as BLUEMASSMED in the Mediterranean or MARSUNO in Northern Europe to allow for participation on the part of applicant and associate Member States in accessing this joint platform.

10.3 Assessment

This section addresses key challenges and issues that will need to be addressed as an Atlantic region (or even at EU level) in order to ensure a safe and secure maritime environment. Given the broad expanse covered by the Atlantic Arc, there are significant opportunities to improve the efficiency and effectiveness of member States operations in these areas, both within the agencies within each jurisdiction and across jurisdictions through greater cooperation, information exchange and shared analysis. There are a number of challenges that must be overcome:

10.3.1 Maritime security

The follow preliminary gaps have been identified in relation to maritime security:

- Administrative structures: the administrative structure of national authorities dealing with surveillance, monitoring, tracking and reporting actions are varied and particularly complex.

[110] Centre for Strategy and Evaluation Services, "Ex-post Evaluation of PASR Activities in the field of Security and Interim Evaluation of FP7 Security Research, Maritime Security and Surveillance - Case Study", January 2011
[111] COM(2010) 584 final, "Draft Roadmap towards establishing the Common Information Sharing Environment for the surveillance of the EU maritime domain"

- There is a lack of wide-area maritime surveillance, using integrated satellite and sea-based technologies and networked sensors. In the open seas, there is only partial coverage, and a need for continuous and persistent surveillance
- Cross-border cooperation is not carried out at the same level in all sea areas around the EU: cooperation is standard practice in some domains of offshore activity.
- There is limited interoperability between sectoral stakeholders and systems
- There is a need for further investment to improve technologies for secure containers (e.g. equipped with Intrusion Detection Sensors, electronic seals and data device reading capabilities)
- Maritime Surveillance systems have been developed mainly for maritime safety purposes, and were not designed with sufficient attention to security aspects
- Legal issues: Interlinking maritime surveillance systems presupposes thorough consideration of diverse legal issues related to the exchange of information collected for different purposes and from different sources.
- Data confidentiality and the protection of personal data are also key issues. Work towards an integrated maritime surveillance network needs to define at least the nature of the data involved, the purposes (and the methods) of the exchange and the potential recipients of the data, as well as incorporating the necessary safeguards with regard to the confidentiality and security of (certain) data and the protection of personal data, where this may be relevant.
- Fragmentation of research efforts

10.3.2 Maritime safety

Even though the role of Regions in dealing with pollution varies greatly from one Member State to another, the fight against pollution is one area in which Regions often have very significant responsibilities. The coordination of European and national authorities with Regions is all the more necessary because of this.

The Atlantic Strategy should build on existing initiatives at national, bilateral, regional and EU level, and support greater cooperation across a range of areas within the Maritime Safety, Security & Surveillance space, to the benefit of the Member States involved and the EU as a whole.

The key priorities to address for maritime safety are:

- data management, in particular in the fields of gathering, exchanging, integrating and protecting information.
- cross-border cooperation
- ensuring that existing Community maritime safety legislation is enforced / reinforced, while demanding greater involvement by the Regions in the implementation and follow-up of maritime safety policies.

10.4 Possible recommendations

This section provides a list of the research areas and investment/policy actions identified during the desktop analysis. These have been compared with the ideas raised during the workshop in order to develop a list of priority ideas for future action in section 6.3.

Research areas

- Advanced Integrated Ship Control (ISC) systems to improve the competitiveness and safety of ship operations.
- Mapping and preparedness for maritime accidents, such as oil spills and development of systems for recovery of floating oil
- Structural safety of vessels and their safe use and operations
- Promotion of research at the interface between marine and maritime sectors as is being elaborated by the WATERBORNE Technology Platform, including the development of ICT based maritime safety, security and surveillance systems;

- Developing integrated ocean services for navigation, ship routing and risk assessment.
- Share experiences and set up a network of experts on response to pollution incidents, good practices for managing waste in ports, evaluation and measuring of the impact of pollution
- Develop tools to evaluate the impact of economic activities on the sea environment, with special attention to the role of ports.

Investment/policy actions

- Common information-sharing environment to improve situational awareness in the EU maritime domain.
- Ensuring effective coordination and the integration of different national authorities involved in maritime (border) surveillance at national and EU levels
- Strengthening cooperation with neighbouring third countries
- Invest in infrastructure for receiving and processing satellite data, both for natural risk and law-breaking activities
- Atlantic coordination centres for emergency response

Suggested questions for the workshop

- **What should be the guiding vision of cooperation projects?**
- **What partnerships should be created to initiate relevant projects in the area of maritime safety?**
- **How can we use maritime safety & security as a key driver for regional development?**
- **How to capitalize on regional experiences and know how in maritime safety & security to make Europe a global pole of excellence?**
- **How can public and private partnerships encourage sustainable economic development and reliable responses to maritime safety & security?**