OCEAN ENERGY SYSTEMS

ANNUAL REPORT

2011

Implementing Agreement
on **Ocean Energy Systems**

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2011 Annual Report

Published by: The Executive Committee of Ocean Energy Systems
Edited by: Dr. A. Brito e Melo and Dr. J. Huckerby
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CHAIRMAN'S MESSAGE

DR. JOHN HUCKERBY
Aotearoa Wave and Tidal Energy Association
OES Chairman 2009-2012

This year's Annual Report shows the new face of Ocean Energy Systems (OES) and a new Vision for the future of ocean energy. We have updated our name, our logo and launched a completely new website – www.ocean-energy-systems.org, which features even more information than our previous site. Rebranding of OES arose from a requirement to develop a new 5-year Strategic Plan (2012–2016) and a complementary Communications Plan. The purpose of these changes is to raise the profile of OES's vision, work programmes and to ensure that our outputs are more widely valued and used by the ocean energy industry.

During 2010 and 2011 the Executive evaluated the achievements of its previous Strategic Plan and developed a new Strategic Plan to inform its request from the IEA for a 3rd 5-year mandate. The new Strategic Plan has, as its core, the Vision that OES will become:

"The Authoritative International Voice for Ocean Energy"

To articulate and publicize its new role the OES Executive has produced a new brochure entitled the **"International Vision for Ocean Energy"**, which sets out the present status of the ocean energy industry, benefits, cost trends, policies, markets, challenges and opportunities for ocean energy to 2050. The first version of the "International Vision" brochure has been circulated and presented at international ocean energy conferences and workshops at Edinburgh, Montreal, Bali and Bilbao. Further presentations are planned in early 2012 in Kuala Lumpur and Washington. Meanwhile the authors of the first version have been working with the Energy Technology Perspectives modelling group at the IEA in Paris. A revised version of the brochure, with new industry and societal goals that will tie in with the ETP 2012 reports scenarios, will be published by the middle of 2012.

2011 was marked by the entry of the newest member of OES, the Government of the People's Republic of China. Together with Korea and Japan, China is the most active North Pacific member. Two Annexes – on open-sea and tank testing and grid connection – were also completed in 2011 and the Executive approved a new Annex on device performance.

This year the 19 member country reports are supplemented by an additional report from France. Despite the ongoing global financial crisis and investment uncertainties, the reports show that device developments are nearing commercial reality and a growing range of device developments are being tested in the water. There is no substitute for open sea testing and no shortage of projects moving to this stage. Cross-border R & D projects, particularly supported by European Union funding, are accelerating and disseminating the learnings from device developments and deployments, as well as addressing pressing issues, like mooring designs, efficiency improvements, array configurations and grid connections.

The OES was successfully awarded a 3rd 5-year mandate on 29 February 2012, which will run until 28 February 2017. We believe that there is much still to do to encourage our governments and our industry players to seize the opportunity that ocean energy offers to secure energy futures, reduce environmental impacts and meet challenging emissions reductions targets.

After 11 years and a facelift the work of Ocean Energy Systems is just getting started…

EXECUTIVE SUMMARY

OES - Ocean Energy Systems is the short name for the international technology initiative on Ocean Energy under the IEA, known as ***'Implementing Agreement on Ocean Energy Systems'***. This report presents the activities undertaken by the OES for the year 2011.

Chapter 1 is an introductory chapter addressing the organisational aspects of the OES. Chapter 2 gives an overview of the collaborative activities in which the Executive Committee (ExCo) was involved during the year. The work within OES is structured in a number of projects, known as "Annexes", which have well defined objectives, budgets, and time frames. The status reports of the ongoing Annexes are presented in Chapter 3:

- Annex I - Review, Exchange and Dissemination of Information on Ocean Energy Systems
- Annex IV - Assessment of Environmental Effects and Monitoring Efforts for Ocean Wave, Tidal and Current Energy Systems
- Annex V - Exchange and Assessment of Ocean Energy Device Project Information and Experience

This chapter also presents an important activity, the "International Vision Brochure", developed during the year. Projects which were already concluded (Annex II and annex III) are summarised in the Appendix 4.
As in previous years, it is also the aim of the Annual Report for the year 2011 to inform about the international situation on ocean energy. For this purpose, each Executive Committee member provides an overview of national activities. Therefore, in Chapter 4 you can find information from each country member on:

- Strategy and national targets;
- Support initiatives and market stimulation incentives;
- Main public funding mechanisms;
- Relevant legislation and regulation;
- Publications relevant to the ocean energy (OE) sector;
- Overview of government funded Research & Development (R&D);
- Examples of collaborative international projects conducted by each country;
- Operational ocean energy projects;
- New developments on ocean energy.

Since 2008, the Annual Report has included a special section dedicated to articles prepared by invited experts addressing a specific theme. The Annual Reports of previous years presented the following themes, which can be found on the website (www.ocean-energy-systems.org):

- Current status of ocean energy technologies (2008);
- Key technical and non-technical challenges that ocean energy faces and actions that are and could be taken to promote and accelerate deployment of ocean energy (2009);
- Key facilitators for ocean energy (2010).

This year, the theme is "Marine Spatial Planning and Ocean Energy" and 4 articles are presented in

Chapter 5. Marine Spatial Planning (MSP) can prove to be a valuable process to explore and develop ocean-based renewable energy.

In the article **"Marine Spatial Planning: An Idea Whose Time Has Come"**, Charles Ehler, consultant to the Marine Spatial Planning Initiative of UNESCO's Intergovernmental Oceanographic Commission, gives a very comprehensive explanation about Marine Spatial Planning, why it is needed and what are the key elements. The article points out that the principal output of MSP is a comprehensive spatial management plan for a marine area or ecosystem and, as mentioned by the author, the plan moves the whole system toward a "vision for the future". Where are we today? Where do we want to be? How do we get there? What have we accomplished? These simple questions are answered by MSP. The author concludes by stating that while ocean energy has not been a principal driver of MSP so far, the situation is likely to change over the next two decades.

The second article entitled **"Maritime Spatial Planning (MSP) in the European Union and its application to marine renewable energy"** focus on the European Union (EU) context. Anne Marie O'Hagan, a Charles Parsons Research Fellow from Hydraulics & Maritime Research Centre (HMRC), Ireland, outlines the policy basis for MSP in the EU, the principles for a common European approach and the status of MSP in individual Member States. Inclusion of marine renewable energy requirements in MSP depends on the status of the industry in each country. Therefore, different approaches and examples from a few countries are discussed. Also, key considerations for inclusion of marine renewable in MSP are mentioned. One conclusion is that MSP will have significant implications for the development of marine renewables, in general, and for the ocean energy sector, in particular. On the other hand, policy developments are likely to influence the future development and functioning of MSP. These aspects are discussed in the article.

Over the last four years, Oregon, led by the Department of Land Conservation and Development (DLCD), has worked to address, in particular, this marine management challenge by updating the State's existing Territorial Sea Plan (TSP) to include considerations on best locations for future wave energy development. **"Siting Wave Energy on the Oregon Coast: The Oregon Territorial Sea Plan and Siting Analysis Tools"** is the third article by Simon Geerlofs, from Pacific Northwest National Laboratory, as first author, with collaboration from the Oregon Department of Energy and U.S. Department of Energy. The article describes how the relationship between MSP and ocean energy siting has been explored.

Oregon plan is seen as an example to encourage wave energy developers to test and locate devices in Oregon waters. On the other hand, the difficulty and time frames to obtain licenses for deployment and operation of ocean energy projects is presently perceived as the major threat to efficient implementation of this renewable energy (RE) source. In the forth article **'Mountains of "Blue Tape" Are Barriers to United States and New Zealand Marine Renewable Energy Projects'**, Ian Boisvert addresses the obstacles faced by developers to get the necessary approvals for testing a device in the sea by comparing the complex regulatory regimes in New Zealand and the United States. The author points out the need to streamline the permits process, in which difficulties are mainly created by bureaucratic unfamiliarity with marine energy projects and their environmental effects.

Drª Ana Brito e Melo

Executive Secretary

01

INTRODUCTION

1.1 ABOUT THE IEA

The International Energy Agency (IEA) is an autonomous agency established in 1974. The IEA carries out a comprehensive programme of energy co-operation among 28 advanced economies, each of which is obliged to hold oil stocks equivalent to 90 days of its net imports. The aims of the IEA are to:

- Secure member countries' access to reliable and ample supplies of all forms of energy; in particular, through maintaining effective emergency response capabilities in case of oil supply disruptions.
- Promote sustainable energy policies that spur economic growth and environmental protection in a global context – particularly in terms of reducing greenhouse-gas emissions that contribute to climate change.
- Improve transparency of international markets through collection and analysis of energy data.
- Support global collaboration on energy technology to secure future energy supplies and mitigate their environmental impact, including through improved energy efficiency and development and deployment of low-carbon technologies.
- Find solutions to global energy challenges through engagement and dialogue with non-member countries, industry, international organisations and other stakeholders.

To attain these goals, increased co-operation between industries, businesses and government energy technology research is indispensable. The public and private sectors must work together, share burdens and resources, while at the same time multiplying results and outcomes.

1.2 ENERGY TECHNOLOGY NETWORK

The IEA provides a framework for countries around the world, businesses, industries, international organisations and non-government organisations to work together in collaborative multilateral technology initiatives, which enable participants to optimise resources, speed progress and share results. Covering portfolios from basic research to deployment and information exchange on energy supply, transformation and demand, its 42 initiatives (also known as Implementing Agreements) focus on:

- Cross-Cutting Activities (information exchange, modelling, technology transfer)
- End-Use (buildings, electricity, industry, transport)
- Fossil Fuels (greenhouse-gas mitigation, supply, transformation)
- Fusion Power (international experiments)
- Renewable Energies and Hydrogen (technologies and deployment)

These IEA energy technology initiatives – the Energy Technology Network - operates under the guidance of the Committee on Energy Research and Technology (CERT), which has in turn established expert bodies or "Working Parties' to assist with this task. The Renewable Energy Working Party (REWP) is the principal advisory body to the CERT on all matters relating to renewable energies. This particular network comprises ten "Implementing Agreements" on individual technologies:

- Bioenergy
- Geothermal
- Hydrogen
- Hydropower
- Ocean Energy Systems
- Photovoltaic Power Systems
- Renewable Energy Technology Deployment
- Solar Heating and Cooling
- SolarPACES
- Wind Energy Systems

For further information on the IEA, the CERT and the IAs, please consult www.iea.org/techagr.

1.3 OCEAN ENERGY SYSTEMS

The Ocean Energy Systems Implementing Agreement (OES) is an intergovernmental collaboration between countries, to advance research, development and demonstration of technologies to harness energy from all forms of ocean renewable resources, such as tides, waves, currents, temperature gradient (ocean thermal energy conversion and submarine geothermal energy) and salinity gradient for electricity generation, as well as for other uses, such as desalination, through international co-operation and information exchange.
The OES covers all forms of energy generation, in which seawater forms the motive power, through its physical and chemical properties (Figure 1). It does not presently cover offshore wind generation, since seawater is not the motive power (offshore wind is covered by the Wind Energy Implementing Agreement).

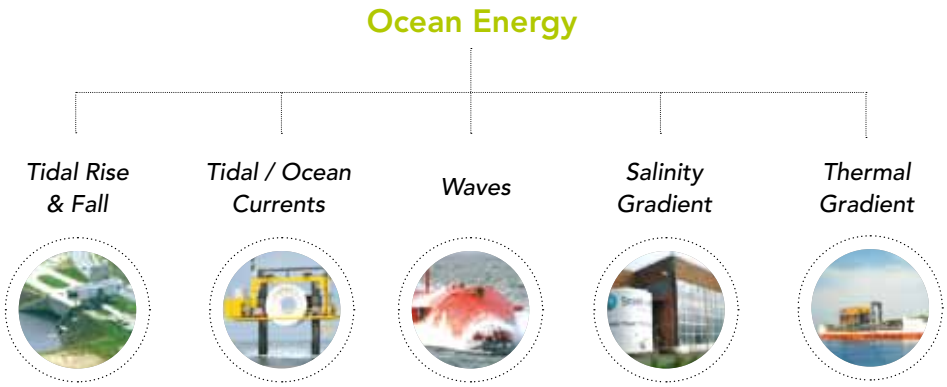


Fig. 1 Principal forms of Ocean Energy

IEA Implementing Agreements (IAs) operate on a 5-year period called a "term". Before completion of a term, an IA's ExCo can apply for a further 5-year mandate. The grant of a new term involves the submission by the ExCo of an End-of-Term Report, summarizing how the IA fulfilled the aims of its past Strategic Plan, and a new Strategic Plan for the next term.
The term of the second mandate of OES expired on 28 February 2012. A request for a new 5-year term, including the End-of-Term Report and a new Strategic Plan, was submitted to the IEA's Committee on Energy Research and Technology (CERT) in July 2011. The CERT granted a third mandate for a 5-year term on 29 February 2012 to run until 28 February 2017.

The OES international co-operation facilitates:

- Securing access to advanced R & D teams in the participating countries
- Developing a harmonized set of measures and testing protocols for the testing of prototypes
- Reducing national costs by collaborating internationally
- Creating valuable international contacts between government, industry and science

The ExCo is continuing to develop a suite of information dissemination tools that will assist the OES in becoming a leading international authority on ocean energy. Ocean energy remains an emerging technology area and will continue to benefit from the existence of the international collaboration mechanism offered under the Implementing Agreement contract.

1.4 STRATEGIC PLAN (2012–2016)

The Strategic Plan for a 3rd term (2012 - 2016) of the OES has been developed within the context of the founding objectives of the International Energy Agency, coherence with the Strategic Plans of CERT and Renewable Energy Working Party and the need for (and agreement to) a globally accepted Vision for Ocean Energy.

The OES Vision:
A new 5-year Strategic Plan was developed by the ExCo through facilitated workshops held at meetings in Wellington (April 2010), Dublin (October 2010) and Washington DC (April 2011). The new Strategic Plan proposes a new International Vision for OES, as follows:

As the authoritative international voice on ocean energy we collaborate internationally to accelerate the viability, uptake and acceptance of ocean energy systems in an environmentally acceptable manner.

Using its unique position as an intergovernmental organisation, the OES role is to:

Connect	organisations and individuals working in the ocean energy sector to accelerate development and enhance economic and environmental outcomes
Educate	people globally on the nature of ocean energy systems, the current status on development and deployment, and the beneficial impacts of such systems, improve skills and enhance research.
Inspire	governments, agencies, corporate and individuals to become involved with the development and deployment of ocean energy systems
Facilitate	education, research, development and deployment of ocean energy systems in a manner that is beneficial for the environment and provides an economic return for those involved.

The OES has also established a set of Organisational Values that guide OES actions:

Integrity	any information provided can be relied upon.
Outcome- oriented	we are driven by pragmatic solutions that enhance the global community.
Knowledgeable	all information is based on fact and we ensure that we always have the most relevant and up-to-date researched facts available.
Inspirational	our performance and our members are committed to providing inspired and collaborative information to accelerate the implementation of environmentally friendly ocean energy systems globally.
Collegial (including a commitment to each other)	we are committed to working professionally with each other in the pursuit of our audacious goal.

Surrounding the OES Vision, and being influenced by the organisational values of OES-IA and its brand values, the new Strategic Plan for 2012 - 2016 identified and prioritises four Critical Success Factors, for which an action plan for the next 5-year tem has been prepared:

- High quality information
- A strong communications programme
- An effective organisation
- Shared capability growth

1.5 COMMUNICATIONS STRATEGY

As part of the request to the CERT for extending the current term of the OES, a Communication Strategy for the OES was prepared and submitted to the CERT. It has been identified that one of the core pillars of the Strategic Plan for the next five-year term of the OES is that of **'A strong communications capability'**. Central to this is a set of brand values that sets the tone and manner of those communications.

Using the organisational values as the core platform, but using the values and direction of IEA as the umbrella to ensure total consistency, the following OES brand values were defined:

Trusted Independent Source	where the information gained is trusted to be up-to-date, free of any commercial or other vested interests, relevant and practical such that reliance on it will enable forward momentum.
Substantiated Knowledge	where the information gained is supported by respected and well researched and documented fact rather that the opinion of the author/supplier.
Inspiring	a relationship with OES will provides inspiring and supportive leadership in the global development of ocean energy systems throughout the total supply chain.
Caring for Society and the Environment	from every perspective the development of ocean energy systems is done in a manner that enhances the global community, protects the environment and provides a base from which improvement to society will emerge.
Collaborative Sharing	we will all succeed as a result of collaboration and sharing in all areas of the ocean energy supply chain. OES will live out this value in all that is does.

02

REPORT OF THE EXECUTIVE COMMITTEE

2.1 MEMBERSHIP

The Implementing Agreement on Ocean Energy Systems (OES) was initiated by three countries in 2001. As of December 2011, 19 countries are members of the OES: Portugal, Denmark, United Kingdom, Japan, Ireland, Canada, the United States of America, Belgium, Germany, Norway, Mexico, Spain, Italy, New Zealand, Sweden, Australia, Republic of Korea, South Africa and China ordered by sequence of joining the Agreement.

China joined the IA on 6 April 2011 and the signatory entity is the National Ocean Technology Centre, Tianjin. Further countries have been invited and are expected to join in the next years, including Finland, France, Brazil, India, the Netherlands, Chile, Indonesia and Nigeria. A key problem is identifying the appropriate parties in each country but the IEA provides valuable support to contact appropriate key contacts in each of these countries. Decision-making processes in some countries also tend to delay completion of the membership process.

The ExCo has an active interest in securing new members and the OES has continued to show steady growth during its ten years of operation and this trend seems set to continue (Figure 2).

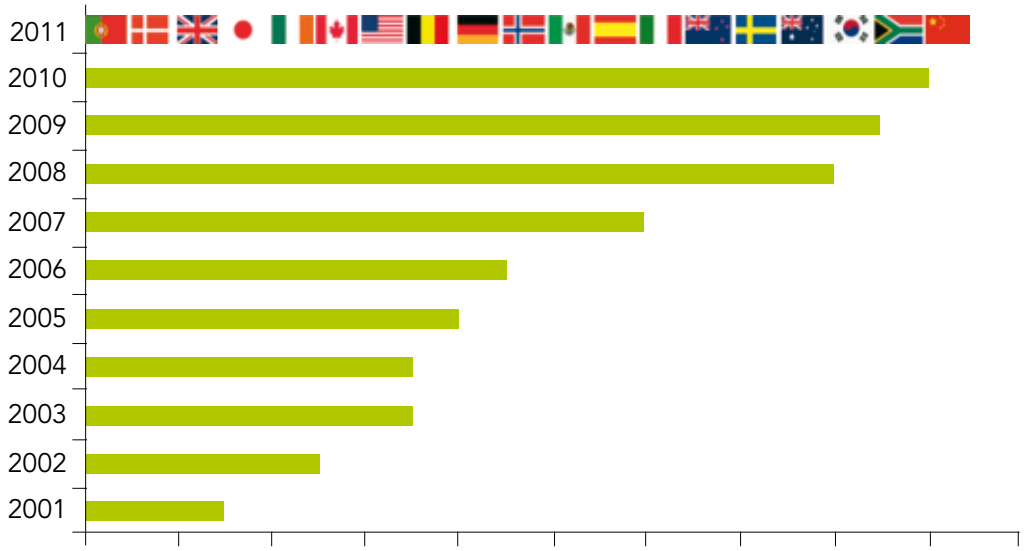


Fig. 2 OES Membership Growth

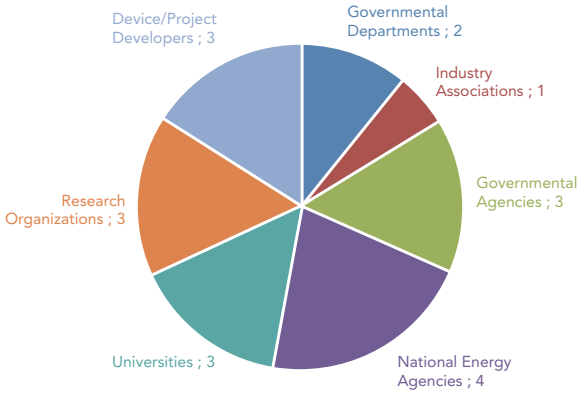


Fig. 3 Diversified representation of interests in the ExCo

National governments appoint a Contracting Party to represent it on the ExCo. The Contracting Party can be a government ministry or agency, a research institute or university, an industry association or even a private company. Governments also nominate alternates, who may represent the government at ExCo meetings, if the nominated representative is unavailable. Consequently there is a diversified representation of interests in the ExCo (Fig. 3). The ExCo considers this diversity to be a key strength of the organization and will strive to maintain this balance of representation.

2.2 EXECUTIVE COMMITTEE MEETINGS

The Executive Committee (ExCo) is the decision-making body of OES and meets twice a year to discuss its work programme and share information among members. In 2011, ExCo meetings were held in Washington DC, USA (26 - 27 April 2011) and in Madeira Island, Portugal (13 - 14 October 2011). Where possible, the ExCo tries to offer hosting opportunities to all members and to time its meetings to coincide with major international ocean energy conferences.

20th ExCo meeting
26 - 27 April 2011, Washington DC, USA

This meeting was hosted by the US Department of Energy (DOE), in Washington, with 16 delegates and guests. This meeting was combined with the 4th Global Marine Renewable Energy Conference (GMREC) in Washington DC sponsored by the OES. Ten of the ExCo representatives presented a 2-hour session at the 4th GMREC, to an audience of over 300 registrants. The Chairman gave an overview of the past and future work of the OES and nine of the representatives gave country activity reports. GMREC delegates were each given a complimentary copy of the 2010 Annual Report, which had been published the week before the GMREC meeting.

Presentations are available at:
http://www.globalmarinerenewable.com/presentations/2011presentations

21st ExCo meeting
13 - 14 September 2011, Madeira Island, Portugal

This meeting was held in Madeira Island, Portugal, with 14 participants and 1 Observer (Nigeria). This meeting was hosted by AREAM, the Regional Agency for Energy and Environment of the Autonomous Region of Madeira and was combined with the Wave Energy Centre's Annual Conference "Offshore Renewable Energy and its Potential for the Outermost Regions" in Madeira so ExCo members were invited to attend. The Chairman presented the OES International Vision for Ocean Energy and two delegates, from Ireland and Korea, presented relevant projects in their countries.

Presentations are available at:
http://en.wavec.org/index.php/85/seminar-wavec-2011

2.3 WORK PROGRAMME & MANAGEMENT

The collaborative research carried out by the OES ExCo is structured in Annexes to the Work Programme Activities (Table I). With the exception of Annex I (Dissemination), which is mandatory, membership of Annexes is voluntary and participation is by both cost-sharing and task-sharing. Shorter duration projects or "Activities" are usually financed by the Agreement Common Fund, while the Annexes, with typical durations of 2 to 3 years have a specific budget, managed by an Operating Agent (OA), to which only participants in the Annex contribute.
Two annexes (Annex II and Annex III) were completed in March 2011, when their final reports were submitted. A new project, Annex V, was initiated in September 2011.
During 2011 a new Activity - the development of an **'International Vision for Ocean Energy**' - was supported by the Common Fund. Further details on active Annexes and Activities are given in Section 3 and the completed Annexes are summarised in Appendix 4.

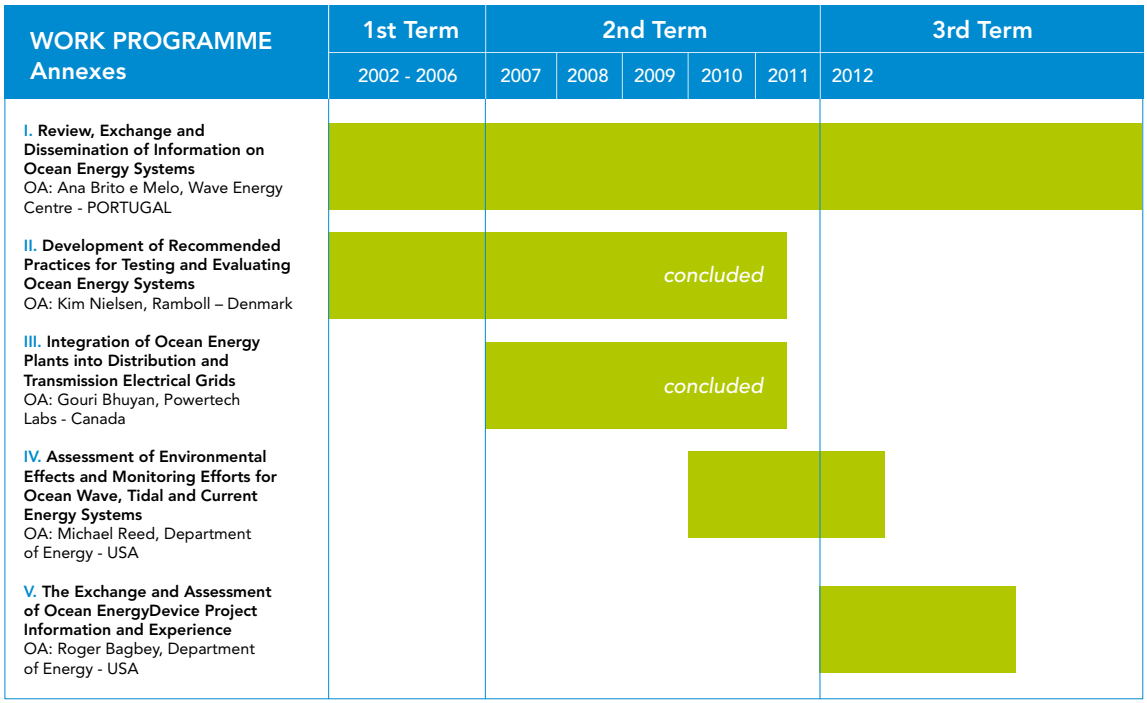


Table 1: OES Research Projects (status: Dec. 2011)

The ExCo is presently developing a number of new proposals for Annexes and Activities on topics of common interest to participants, which will be developed and discussed with more detail during the 2012 ExCo meetings.

Contracting Parties pay an annual membership fee to the Agreement Common Fund, which covers administrative expenses incurred in connection with the ExCo, including the expenses of the Operating Agent for the Annex I on Dissemination Activities. The present membership subscription fee is €7,000,

The ExCo elects a Chair and two Vice-Chairs, who serve a 2-year term. Together with the Secretary, who is the only paid member of the ExCo, the Chair and Vice-Chairs form the Cabinet, which manages the day-to-day decision-making to implement the annual work programme and Agreement Common Fund budget approved by the ExCo. The Cabinet also has a leading role in representing the IA at IEA meetings and workshops and making presentations at international conferences.

2.4 COLLABORATION WITH IEA INITIATIVES

The OES ExCo continued to co-ordinate its activities with relevant IEA meetings and initiatives. Where possible the ExCo is represented at these meeting by members of the Cabinet or delegates. Any meeting attended by the Cabinet in an official capacity, using Agreement Common Funds, is subject of a meeting report to the ExCo by the representative member.

CERT WORKSHOP "Energy Storage Issues and Opportunities"
15 February 2011, IEA Paris

The aims of this workshop, organised by the IEA Committee on Energy Research and Technology (CERT) was held to explore state-of-the-art R&D activities on energy storage and their relevance for the market and the industry with a view to bring together stakeholders to catalyse partnerships and activities, share experience on best-practice technologies and policies and review progress on low-carbon technology deployment to help identify key gaps in energy storage relevant policy making and international co-operation.

Proceedings of the workshop:
http://www.iea.org/work/workshopdetail.asp?WS_ID=498

Joint IEA REWP and RETD workshop "Renewable Energy – from Analysis to Action"
15 - 16 March 2011, IEA Paris

During this 2-day workshop jointly organized by the Renewable Energy Working Party (REWP) and Renewable Energy Technology Deployment (RETD) Implementing Agreement, 10 experts gave keynote speeches and a further 17 experts participated in facilitated discussions. In addition, around 150 invited participants in the workshop contributed with questions and comments during the discussions, around the question "How can the key stakeholders – Finance, Policy and Industry - work together to deliver the expected contribution from renewables to energy security and climate change mitigation?"
The overall objective of this event was to transmit this sense of urgency for immediate action and co-operation. The outcome of the workshop was intended to guide the priorities the IEA's REWP and RETD and inform policy makers, investors and industry in undertaking the steps necessary over the next few years.

Proceedings of the workshop:
http://www.iea.org/work/workshopdetail.asp?WS_ID=502

Second IEA Energy Technology Network Communication Workshop
19 April 2011, IEA Paris

This workshop was the second in a series of events designed to examine strategic and cross-cutting communication issues identified by the IEA Committee on Energy Research and Technology (CERT). It focused on optimising expertise within the IEA's wider energy technology network of working parties, experts' groups and multilateral technology initiatives (Implementing Agreements), involving specialists of worldwide renown.
This workshop addressed the growing influence of public opinion on decision-taking that governs implementation of projects involving the energy technologies with which the network deals. Specialists' presentations presented ways to reach key stakeholder groups and turn public resistance into public trust, notably through heightened awareness of societal benefits and mechanisms for sharing those benefits more equitably. A primary goal of this event was to produce practical guidelines for more effective communication strategies that fully integrate techniques to secure public acceptance.

Electricity Coordination Group (ECG) Meeting
20 April 2011, IEA Paris

The Electricity Coordination Group (ECG) held a 1-day meeting to discuss opportunities for collaborative activities and invited all Implementing Agreements to participate. The IEA Smart Grids Roadmap was presented and brief updates on ongoing work by each Implementing Agreement was presented.

Proceedings of the workshop:
http://www.iea.org/work/2011/ecg/agenda.asp

60th Meeting of the IEA REWP
27 - 28 September 2011, Washington DC.

At the 60th IEA Renewable Energy Working Party (REWP) meeting, the OES Chairman presented the OES ExCo's request for a 3rd 5-year mandate by reviewing the previously submitted End-of-Term Report and new 5-year Strategic Plan.

IEA CERT-ETP2012 Energy Systems Workshop: Integrated energy systems of the future
7 - 8 November 2011, IEA Paris

This workshop was hosted by the IEA Committee on Energy Research and Technology (CERT), with the aim to demonstrate the need for holistic approaches that address issues from energy sources to end-use – and everything in between – using a "systems approach" to energy system analysis and planning. This workshop was attended by CERT members, implementing agreements and private sector organisations. The targeted outcomes included to present and solicit input on initial Energy Technology Perspectives 2012 energy systems analysis.

Proceedings of the workshop:
http://www.iea.org/work/workshopdetail.asp?WS_ID=540

2.5 SPONSORSHIP

Ocean Energy Systems provides financial and Non-financial sponsorship to a number of organizations and ExCo members sit on a number of relevant Steering Committees.

International Network on Offshore Renewable Energy (INORE)

INORE is a network for postgraduate researchers working with issues related to offshore renewable energy: wave, tidal and offshore wind energy. INORE brings together researchers from around the world to meet, collaborate and share knowledge.

The OES Executive Committee encourages this network and at the last ExCo meeting, the ExCo unanimously agreed to provide annual sponsorship to INORE, particularly to develop membership in new regions, including Asia and the Pacific.

Global Marine Renewable Energy Conference (GMREC)

OES provided non-financial sponsorship to the 4th annual GMREC conference, which was held in Washington DC on 28-29 April 2011. During a Special Session nine OES representatives gave country reports to the large audience. OES will sponsor GMREC 2012, which will again be held in Washington DC on 25-26 April 2012.

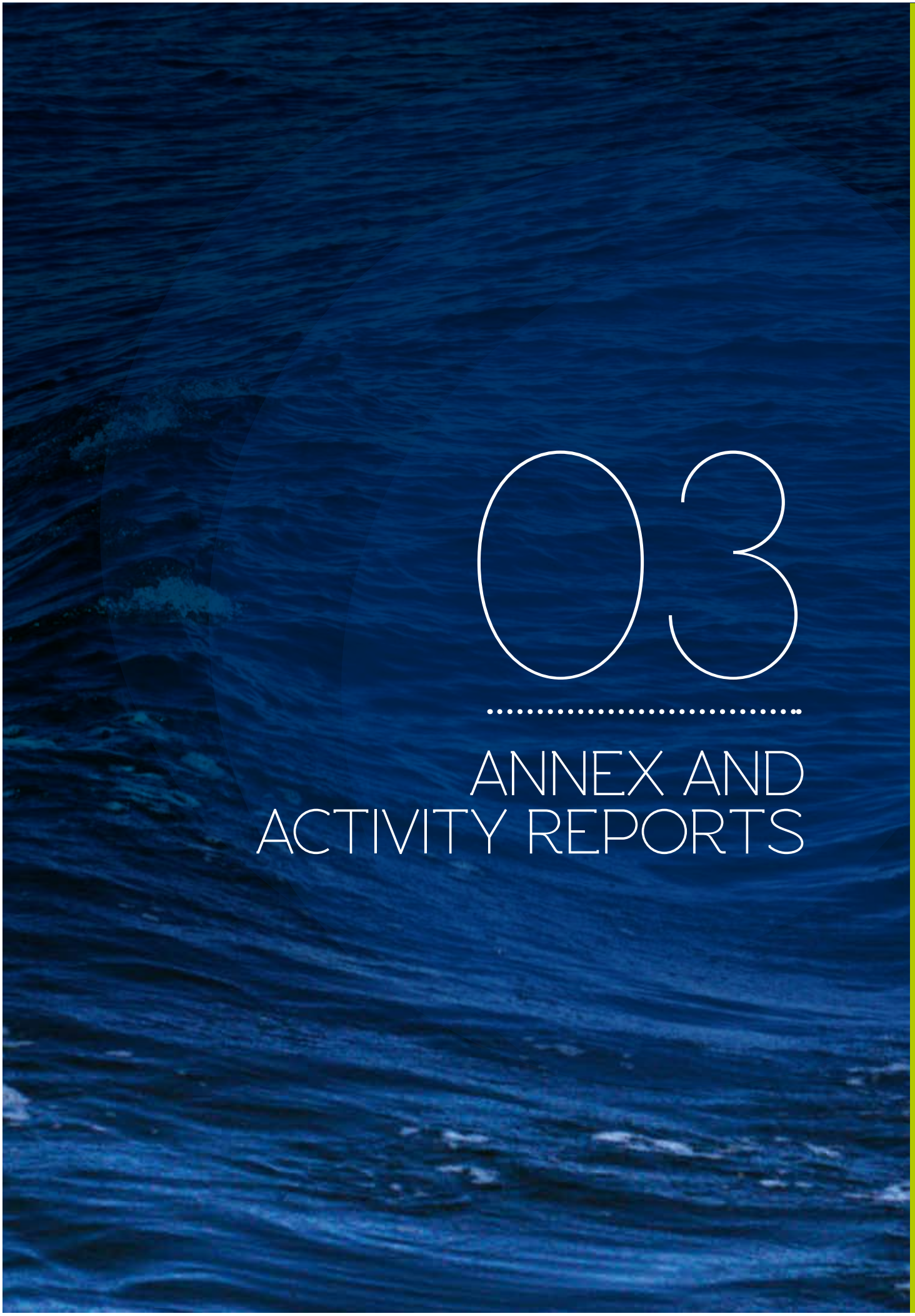
European Wave and Tidal Energy Conference (EWTEC)

OES provided non-financial sponsorship to the 9th EWTEC conference, which was held at Southampton University on 5-9 September 2011. The German Alternate to OES gave a presentation on the "International Vision for Ocean Energy".

International Conference on Ocean Energy (ICOE)

OES was a non-financial sponsor of the ICOE 2010 conference, held in Bilbao in October 2010.

The ExCo has committed OES to be a non-financial member of the ICOE 2012 conference, which will be held on 17 – 19 October 2012 in Dublin, Ireland. ExCo members are supporting the conference organizer, the Sustatinable Energy Authority of Ireland (SEAI), and serving on the ICOE 2012 Steering Committee and the ExCo will give presentations on the "International Vision for Ocean Energy" and country reports at this important biennial conference.



03

ANNEX AND ACTIVITY REPORTS

ANNEX I

Review, Exchange and Dissemination of Information on Ocean Energy Systems

Operating Agent

Ana Brito e Melo, Wave Energy Centre, Portugal

Duration

Annex I is a mandatory Annex of the OES work programme, which has been running since the formation of the OES. It is presently the only Annex funded from the Agreement Common Fund.

Objective

The objective of this task is to collate, review and facilitate the exchange and dissemination of information on the technical, economic, environmental and social aspects of ocean energy systems. Access to this information should facilitate further development and adoption of cost-effective ocean energy systems. In addition, the results of this task aim to facilitate identification of further annexes, as well as continuing to promote information exchange.

Progress in 2011

New Visual Identity for the OES

One of the proposals arising from the Communications Strategy developed during 2010 – 2011 was a new visual identity for OES to increase awareness and understanding of the OES by the ocean energy industry and the general public. During 2011, external experts were engaged to develop this new visual identity. A complete rebranding exercise was initiated, which included a complete 'bottom-up' re-design of the OES website to appeal to a wide range of audiences, both technical and non-technical.

Corporate identity guidelines explaining how the OES is presented in various settings was prepared as well as a set of specific elements: a new logo with variations for use in different areas, graphical elements (standard components to be used in communication), letterheads and templates for PowerPoint presentations and newsletters.

New Logo and Name

In order to facilitate a discussion online around the new graphical profile, a mini-website or intranet with a "login" functionality for each member was created, through which members were invited to comment on the identity elements. Drafts of logos and taglines were presented and discussed. At the 20th ExCo meeting, the following were unanimously approved:

Name & Acronym: Ocean Energy Systems (OES)

Logos & Tagline:

OES OCEAN ENERGY SYSTEMS

OES OCEAN ENERGY SYSTEMS
An IEA Technology Initiative

OES OCEAN ENERGY SYSTEMS
Power from the Ocean

URL: http://www.ocean-energy-systems.org

Launch of the New Website

Given the international nature of the OES and the wide geographic spread of its member countries, it was agreed that an effective website should form a key part of OES's Communications Strategy. The online presence of OES is an extension of the role of the organisation and is likely to be the single most important tool at its disposal. Therefore, the OES website at www.ocean-energy-systems.org was redesigned during 2011.

Publications

A professionally edited and printed Annual Report is produced each year and 1,000 copies are widely distributed. This is intended as the flagship document for OES's activities and a marker for industry development. It includes a collection of 4-5 invited papers by international experts on specific themes and national reports from each member country.

Following a new initiative in October 2010, the 6-page Bulletin issued each semester continued to be published in 2011, with a new design. It is available online and was distributed to a wide range of audience in all member countries.

In 2011, the new brochure "International Vision of Ocean Energy" was published; this one is presented in a separate subsection.

The following is a list of further publications during 2011:

- J. Huckerby, J. Villate, E. Sweeney and A. Brito-Melo, 2011. "Implementing Agreement on Ocean Energy Systems: Next Five Years", Proceedings of the 9th European Wave and Tidal Energy Conference (EWTEC), Southampton, United Kingdom, 4 - 9 September 2011.
- J. Villate, J. Huckerby, E. Sweeney and A. Brito-Melo, 2011. "A Multilateral Technology Initiative on Ocean Energy", published by the OCEANS'11 IEEE Conference, Santander (Cantabria), Spain, 6-9 June 2011.
- J. Huckerby, 2011. IEA OPEN Energy Technology Bulletin, Article Issue No. 81, December 2011.

OES Database

A database was initiated during 2011, which compiles the following information from each member country:

- Ocean energy policy (national strategy, major funding schemes, market support and investment initiatives, regulatory initiatives);
- Technologies – projects in the water and respective developers, location, scale, etc.;
- Open sea testing infrastructures;
- Level of national investment.

Participation in International Events

Dissemination of OES activities has been an ongoing process, through the presence of OES representatives in well-known conferences related to ocean energy. Such events are the best way to spread awareness about the OES role and activities. The table below lists the different events in 2011 where OES was represented:

Event	Local	Date
Conference "Energy from the Sea"	Madrid, SPAIN	21 Feb
4th Annual Global Marine Renewable Energy Conference	Washington, USA	28 - 29 April
OCEANS'11 IEEE Santander Conference	Santander, SPAIN	6 - 9 June
International Student Energy Summit 2011 (ISES 2011)	Vancouver, CANADA	9 -11 June
International Society of Offshore and Polar Engineering 2011 (ISOPE 2011)	Hawaii, USA	19 - 24 June
EWTEC 2011 - Ninth European Wave and Tidal Energy Conference and exhibition	Southampton, UK	5 - 9 September
Annual Conference of the Wave Energy Centre	Madeira, PORTUGAL	15 September
WREC - World Renewable Energy Regional Conference	Bali, INDONESIA	17 - 19 October
International Seminar "Energy and Industry"	Bilbao, SPAIN	10 - 11 November

ANNEX IV

Assessment of Environmental Effects and Monitoring Efforts for Ocean Wave, Tidal and Current Energy Systems

Operating Agent

Michael Reed (USA Delegate), United States Department of Energy (DOE), USA

Duration

This Annex started in January 2010 and is due to be completed in December 2012.

Objectives

A wide range of different ocean energy technologies and devices are currently in development around the world. However, the data that does exist on the possible environmental effects of these technologies are dispersed amongst numerous different countries, researchers and developers. The objectives of Annex IV are to:

1. Expand baseline knowledge of environment effects and, particularly, environmental monitoring methods.
2. Ensure that this information is widely accessible.
3. Highlight any ongoing mitigation strategies.
4. Foster efficient and timely government oversight and public acceptance of ocean energy development.

To accomplish these objectives, Annex IV member countries will collaborate to create a searchable, publically available database of research and monitoring information to evaluate environmental effects. The database will include existing syntheses, ongoing monitoring and research projects, case study reports compiled as part of this effort, and select relevant pieces of analogous information from other ocean industries. Annex IV will address ocean wave, tidal and ocean current energy development, but not ocean thermal energy conversion (OTEC) or salinity gradients. The construction of the database will be followed by a comprehensive report with a worldwide focus on monitoring and mitigation methods, including findings from the database, the results of experts' workshops, and lessons learned from select case studies.

Participants

Operating Agent *(partners)*	United States: Department of Energy (Federal Regulatory Commission) (Bureau of Ocean Energy Management)
Technical Consultants	Pacific Northwest National Laboratory (US) Wave Eenrgy Centre (Portugal) University of Plymouth (UK)
Member Countries	Canada, Ireland, New Zealand, Norway, Republic of Korea and Spain

Achievements and Progress in 2011

During 2011, the project's technical consultants developed a data input form for metadata regarding research and monitoring of ocean energy environmental effects, based on advice from the experts' workshop held in 2010. This form[1] was reviewed by Annex members prior to distribution to developers and relevant researchers around the world.

Collection of metadata has begun, with the goal of completing initial population of the database by the summer of 2012. Pacific Northwest National Lab has also been working to complete the initial version of

1 http://mhk.pnnl.gov/wiki/images/c/cb/Annex_IV_Metadata_Form.pdf

the Annex IV database for distribution and initial review by member nations by the end of 2011. Annex participants will provide feedback to the Annex IV project team about database design and functionality. The project team has also started to identify several case study projects around the world (to be evaluated in the final report) and is working to collect data regarding environmental monitoring and/or mitigation that has occurred at these sites.

Activities Planned for 2012

Year 3 (2012) of the project will focus on completing population of the database, development of a final analysis and case studies; completion of preliminary, draft, and final reports; a second experts workshop to evaluate and comment on the content and functionality of the database, and distribution of the final report. The final report will highlight potential environmental effects, evaluate the information collected via the database, describe specific case studies, identify monitoring and mitigation strategies employed by those case studies, and discuss key lessons learned. The Annex IV database will be housed and maintained online by PNNL in conjunction with the U.S. Department of Energy's Tethys knowledge management system for marine and hydrokinetic environmental effects.

ANNEX V

Exchange and Assessment of Ocean Energy Device Project Information and Experience

Operating Agent

Michael Reed (USA Delegate), United States Department of Energy (DOE), USA

Duration

This Annex entered into force on October 1, 2011 and is due to run until December 2015.

Introduction and Scope

This Annex aims to facilitate the exchange and assessment of ocean energy project information and experience from participating member countries in order to foster a better understanding and accelerate the development of ocean energy technologies.

At this early stage of ocean energy development there are many different configurations for marine energy converters and they each have their advantages and disadvantages. In addition, there are many competing approaches for modeling and testing these devices individually, or in arrays, at subscale and at full size. Furthermore, there are no generally accepted methodologies for design and cost analysis of these ocean energy machines.

The sharing of project data and computational assessment methods will allow the participants to determine the most promising approaches for analysis, design, testing, cost estimation, and operation of these devices based on the collective experience of the group. This will facilitate of an understanding of the current state of the ocean energy industry world-wide, and provide the ability to determine the expected performance of a device, and ultimately, the potential to achieve competitive cost of electricity (COE) as new systems evolve.

Objectives and Expected Results

The overarching objective of the proposed Annex is to accelerate the development and deployment of ocean energy technology through a multi-country exchange of available ocean project information and experience to allow the participants to understand the current state of knowledge in the field, and to develop a consistent method of assessing the performance and cost of ocean energy conversion systems.

The primary focus of these efforts will be to develop an assessment of the fundamental knowledge in the following 4 Topical Areas:

1. Methods for estimating and verifying the ocean energy resources and characteristics, including instrumentation types and deployment methods to capture resource data.
2. Methods for modeling the interaction of ocean energy devices with the resource and verifying the results.
3. Methods for modeling and experimentally verifying energy capture, power system efficiency, and the resulting loads including extreme loads, from the interaction of the device and the resource.
4. Methods for estimating and validating the cost and performance for ocean energy device arrays, including component, subsystem, and the electrical cable and supporting installation, operation, and maintenance, to lead to an assessment of the total cost of electricity.

Work programme

This new annex is to be executed in three tasks as follows:

Task I - Establish the structure and outcomes of the annex, to include a plan of actions & milestones (POAM) that identifies resource-specific meetings and product plans, potentially broken down to: 1) Wave; 2) Tidal; 3) Current; 4) OTEC; and 5) Hybrid and others.

Task II - Data Definition working group meetings to identify eligible projects and data sets to be exchanged, and to define required characteristics and formats for information that will form the basis of the annex. Participants will establish the required data to be presented for projects and to describe the empirical and computational methods by which the data was obtained. In addition, this task will include planning for the Task III presentation of projects. This task will last up to 18 months, will overlap with Task III over the last 6 to 18 months, and will include as two or three meetings to refine the details of data collection and application.

Task III - Exchange Workshops to present project information, experience, and data to the participating members, as well as the integration of the resulting data into computational models to assess system performance, reliability and costs, resource characterization, and hydrodynamic interaction between the ocean resource and devices both individually and in arrays.

Costs

The US proposed to act as the operating agent, and to underwrite the costs associated with managing and leading the annex. The cost for the participants is limited to the cost of the time and effort dedicated to the annex.

Working Groups

The Operating Agent will chair the program working closely with the other participants. Some participants will be asked to chair one of the Project Workshops, depending on interest and expertise. Each Working Group will plan and develop a specific work program for their topical area which results in a final report intended for publication in the public domain. The reports will summarize the data presented and make recommendations for the evolving methods to assess data and develop performance results. This annex is nominally planned for four Working Groups, with the exact number determined by the number of projects deemed appropriate and meaningful to the annex objectives.

NEW ACTIVITY

International Vision for Ocean Energy

Leaders of the Activity:

Dr. John Huckerby (Chairman of OES) and Mr. Henry Jeffrey (UK Alternate) with help from Ms. Brighid Jay and Mr. Jonathan Sedgwick (Edinburgh University).

Duration

This Activity was commissioned in late 2010 and the first phase was completed with the publication of the **"International Vision for Ocean Energy"** brochure at a marine energy assembly in Edinburgh on 7 October 2011. A second phase of activity was approved by the Executive of 14 September 2011 and this work will be completed by mid-2012.

Objectives

The objectives of this Activity are to develop targets and publish a succinct brochure, which sets out the OES Executive Committee's views of the potential for and development of ocean energy to 2050. The first brochure sets out some specific and measurable goals for ocean energy, relating to job creation and emissions reductions. The second version will update these social goals with electricity capacity and generation targets.

Achievements in 2011

The first version of the "International Vision" brochure was presented to the OES Executive at its Washington DC meeting in late April 2011. The ExCo proposed some modifications, which were incorporated and approved at its next meeting in Madeira in September 2011. The brochure was printed and distributed at four international ocean energy meetings:

7 October 2011: Supergen Marine 3rd Annual Assembly - Edinburgh
17 October 2011: World Renewable Energy Congress - Bali
1 November 2011: OREG 2011 Annual Conference - Montreal
10 - 11 November 2011: Energy and Industry Symposium - Bilbao

The brochure sets out proposed targets for ocean energy development, the first global maps of ocean energy resources, technology developments, cost reductions, synergies with other industries, markets, policies, challenges for ocean energy. It also sets out the Vision and Mission of OES in developing ocean energy. Concurrently with the publication of the brochure the project team has been working with the IEA's Energy Technology Perspectives 2012 modelling team to incorporate ocean energy into their modelling for the first time. The benefit to OES of this co-operation is that we will develop coherent scenarios of the development of ocean energy to 2050, which will be integrated with all other generation developments.

Activities Planned for 2012

The second version of the brochure is due to be published in the 2nd quarter of 2012 and the Executive plans to roll it out at the following international ocean energy conferences:

25 - 27 April 2012: Global Marine Renewable Energy Conf. - Washington DC
21 - 24 May 2012: IEEE Oceans 2012 Conference - Yeosu, Korea
26 - 27 June 2012: EU Ocean Energy Association Conf. - Brussels
5 - 7 September 2012: OWEMES Conference 2012 - Rome
19 - 21 October 2012: International Conference on Ocean Energy - Dublin

The aim is to publicize the "International Vision" in each OES member country.

04

COUNTRY REPORTS

4.1 Member Countries
(ordered by sequence of joining)

PORTUGAL

Paulo Justino, Laboratório Nacional de Energia e Geologia, IP (LNEG)

OCEAN ENERGY POLICY

Strategy and National Targets

During 2008, the Government appointed REN – Redes Energéticas Nacionais (National Energy Network) S.G.P.S., S.A. to create a company to manage the Wave Energy Pilot Zone. In 2010, the Government approved the minutes for the contract with REN – Resolution from the Council of Ministers no. 49/2010 (1 July), which led to its signature. A company named ENONDAS was created to manage the Pilot Zone. In 2011, the Government acknowledged the need to open ENONDAS capital to private initiatives.

Main Public Funding Mechanisms

There are two main public funding mechanisms:
FAI - Innovation Support Fund (Fundo de Apoio à Inovação) intended primarily to finance the national scientific system in the field of innovation and technological development, primarily in the area of renewables, mainly wind power.
The Foundation for Science and Technology (FCT) is the main Portuguese national agency responsible for continuously promoting the advancement of scientific and technological knowledge, exploring opportunities that become available in any scientific or technological domain, including marine energy.

Relevant Legislation and Regulation

Public discussion on the "Plano de Ordenamento do Espaço Marítimo - POEM" (http://poem.inag.pt/), the Portuguese Marine National Plan, was concluded. This plan aims to survey all the activities to be deployed in Portuguese waters, to order the uses and activities of the maritime space, to ensure the sustainable use of resources and to set up the parameters of sustainable development for each activity in the maritime space.

RESEARCH & DEVELOPMENT

Government Funded R&D

The Government acknowledged the need to maintain a group on a national laboratory, **Laboratório Nacional de Energia e Geologia, IP (LNEG)**, performing research and development on ocean energy. The ocean energy group has been working on the improvement of its capability to suitably model the energy conversion chain (from waves to electrical energy). The group has been working on the performance improvement of point absorbers with hydraulic and pneumatic power take-off (PTO) equipment (self-rectifying air turbines), namely on what concerns the hydrodynamic performance as well as geometry optimization and PTO control. As a partner of the ORECCA project, LNEG has carried out the assessment of wind and wave resources for the offshore European Atlantic area. The improvement of a Geographical Information System (GIS) database, developed at LNEG for site selection of wave energy farms, has continued to provide guidance for installation of wave energy devices in the country.
Research has been going on at Instituto Superior Técnico, Technical University of Lisbon, on the hydrodynamics of wave energy converters of OWC type, involving numerical modelling and model testing. Two groups have been developing two different types of floating OWC converters: (i) A buoy enclosing a

U-shaped duct where a water column oscillates by action of the wave-induced buoy motions in heave, surge and pitch. (ii) An axi-symmetric spar-buoy device consisting of a buoy with a tail tube open at its bottom end, that oscillates essentially in heave. Both converters are equipped with self-rectifying air turbines. In addition, numerical modelling and optimization was performed on the IPS buoy wave energy converter, following work of previous years.
The work on OWCs at Instituto Superior Técnico has been complemented by the development of a new type of self-rectifying air turbine: the so-called biradial turbine, whose rotor is of radial flow type. This included numerical modelling and optimization as well as model testing with a 0.5 m diameter rotor.
Since 2008, research has been going on at Instituto Superior Técnico on the hydrodynamic modelling of marine current turbines (MCTs) of the horizontal axis type. The work has concentrated on the development of computer codes for the design and analysis of this type of turbines.

Participation in Collaborative International Projects

International co-operation in Portugal exists mainly in the scope of European Union (EU) funded projects. The Wave Energy Centre (WavEC), a private non-profit association, has been leading a European partnership designed to provide a high quality platform for training young applied researchers in relevant areas of wave energy. The Wavetrain2 (2009-2012) follows the successful Wavetrain RTN (2004 – 2008).
Other major projects in which Portugal has been involved in EU consortiums, the last two initiated in late 2011, include:

EQUIMAR (2008-2011) - Equitable Testing and Evaluation of Marine Energy Extraction Devices in terms of Performance, Cost and Environmental Impact. EU 7FP funded (STREP programme). WavEC participated in this project.

SOWFIA (2010-2012) - "Streamlining of Ocean Wave Farms Impact Assessment" aims to facilitate the development of European wide, coordinated, unified and streamlined environmental and socio-economic Impact Assessment (IA) tools for offshore wave energy conversion developments. Wave farm demonstration projects will be studied in each of the collaborating EU nations. WavEC is participating in this project.

FAME (2010-2012) - "The Future of the Atlantic Marine Environment" - financed by the EC INTERREG IV programme, with the aim to link the protection of natural values, specifically biodiversity (avifauna) with economic activities at the European Atlantic Ocean. WavEC is participating in this project.

Aqua-RET2 (2009-2011) - "Dissemination activities and transfer of technology in the ocean energy sector" (EU - Leonardo da Vinci - Lifelong Learning Programme). WavEC participated in this project.

ORECCA (2009-2011) - The goals of the ORECCA project (Off-shore Renewable Energy Conversion Platforms – Coordination Action) are to create a framework for knowledge sharing and to develop a roadmap for research activities in the context of offshore renewable energy that are a relatively new and challenging field of interest. LNEG and WavEC participated in this project.

CORES (2008-2011) - "Components for Renewable Ocean Energy Systems". EU 7FP funded (RTD programme). This project concentrated on the development of a toolbox of the wave to wire simulations to be applied to the OE Buoy Technology, developed by the Irish company Ocean Energy Ltd. Within the framework of CORES project, Instituto Superior Técnico carried out the aerodynamic design of an impulse air turbine with controlled guide vanes that was installed at the Backward-Bent Duct Buoy (BBDB) OWC converter, and tested at Galway Bay, Ireland, in Spring 2011. IST, WavEC and Kymaner participated in this project.

WAVEPORT (2009-2012) - "Demonstration & Deployment of a Commercial Scale Wave Energy Converter with an Innovative Real Time Wave by Wave Tuning System" (EU FP7 programme), with the aim to demonstrate a large scale grid connected, 600kW peak rated, Powerbuoy Technology. WavEC is participating in this project.

SURGE (2009-2011) - The European Project SURGE (Simple Underwater Renewable Generation of Electricity) is funded by the EC under FP7 and intends to test and assess the second generation of the

Finnish WaveRoller device, near Peniche. After testing the prototype WaveRoller1 at full-scale at the European Marine Energy Centre (EMEC), in Scotland and in Portugal, AW-Energy, owner of the technology, will install and test its second prototype in Portuguese waters. WavEC and ENEÓLICA are participating in this project.

MARINET (2011-2015) - The aim of this project is to coordinate research and development at all scales (small models through to prototype scales from Laboratory through to Open Sea tests) and to allow access for researchers and developers into facilities, which are not universally available in Europe. WavEC offers the Pico Plant, as a testing facility for air turbines.

TROPOS (2011-2015) - "Modular Multi-use Deep Water Offshore Platform Harnessing and Servicing Mediterranean, Subtropical and Tropical Marine and Maritime Resources". The aim is to develop a floating modular multi-use platform system for use in deep waters. WavEC is participating in this project.

TECHNOLOGY DEMONSTRATION

Operational Ocean Energy projects

Pico Plant (Azores)

On the Island of Pico, Azores, WavEC runs an OWC (Oscillating Water Column; www.pico-owc.net) type wave energy plant, presently among the very few functional wave power plants worldwide. Whereas 2010 had been a very successful year with the plant operating in autonomous mode for 3 months, yielding a total of 1425 operational hours and 45MWh fed into the grid, a severe generator failure halted operations until 2012. At present, efforts are focused to attract funding for preparing the plant as open test centre, as one full-scale turbine duct in the structure is available. Pico OWC is a unique structure, allowing testing commercially-sized turbines and auxiliary equipments (up to ~700 kW). Despite its recent inclusion in the large-scale infrastructure project MariNET and the proof of technology demonstrated over the last 1-2 years, the plant requires substantial investment (~ €1.5 million required in short term) in order to enable another 5-10 years of service.

New Developments

ENEÓLICA is actively participating in the demonstration and deployment of a new WaveRoller unit to be placed nearshore Peniche (100 km north of Lisbon). The construction of the steel foundation for the three wings was delayed, due to late adaptations in the design. Nevertheless, the project has advanced significantly and wing construction in Peniche shipyards has started. WavEC continued its environmental baseline work and dissemination efforts together with Peniche municipality. The new planning foresees deployment in the spring of 2012.

Kymaner is a small-medium enterprise focused on the demonstration of the validity of the oscillating water column approach for the exploitation of wave energy. During 2011, the company concentrated on commissioning and test in Galway Bay (Ireland) of an efficient and innovative impulse turbine for the ¼ scale Ocean Energy Ltd device in the context of the FP7 CORES project and development of offshore modules for a new OWC concept, designed for cost effectiveness and compactness.

Sea for Life is a Portuguese company that aims to develop and commercialize wave energy technology. It has in its premises a wave tank that is being used to test the WEGA concept to harness wave energy. Its project - WEGA - wave energy gravitational absorber, started in 2010, is currently being developed by the company.

DENMARK

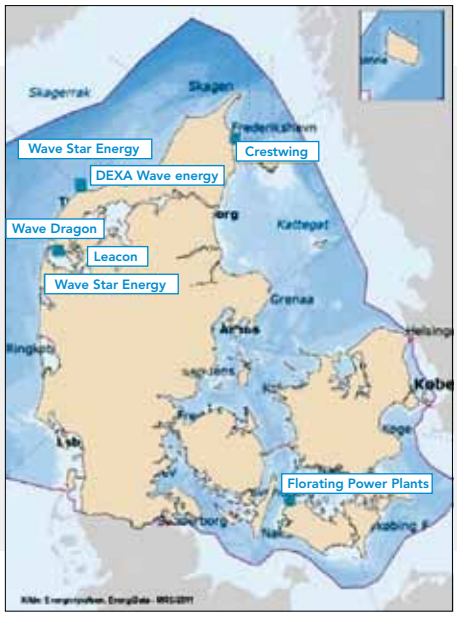
Kim Nielsen, Ramboll

INTRODUCTION

Denmark has two grid connected wave energy plants operating at sea, the 110 kW Wavestar at the test site DanWEC and the 170 kW Floating Power Plant including three windmills (33 kW) operating in the most sheltered sea in the southern part of Denmark.

In 2011, two new small scale prototypes were deployed at sea, the DEXAWAVE energy converter at Hanstholm and Crestwing in Kattegat. The scale models of Wave Dragon and Wavestar that had been tested in Nissum Bredning were removed in 2011.

The map shows the location of the Danish wave energy systems. A description of the individual projects permits can be found on the webpage of the Danish Energy Agency.



Location of permits for Danish wave energy projects 2011

> *In 2011, two new small scale prototypes were deployed at sea, the DEXAWAVE energy converter at Hanstholm and Crestwing in Kattegat.*

OCEAN ENERGY POLICY

Strategy and National Targets

A new Danish strategy for development of wave energy was initiated in 2011, funded by EUDP. The project is lead by Aalborg University and carried out as a Partnership involving Danish wave energy developers, research institutions and other partners interested in wave energy in Denmark. The project will identify and prioritize joint areas for development between developers of Danish wave power projects. The new strategy will be launched by mid 2012.

Presently, there are no targets for installed wave power in Denmark, as it is seen immature. To help mature the technology Energinet.dk has developed a standardized excel-based tool to calculate the cost of energy in a range of ocean locations. From now on, the use of this calculation tool will become obligatory in order to obtain funding and help justify the development in areas that can improve the systems toward more cost effective solutions.

Support Initiatives and Market Stimulation Incentives

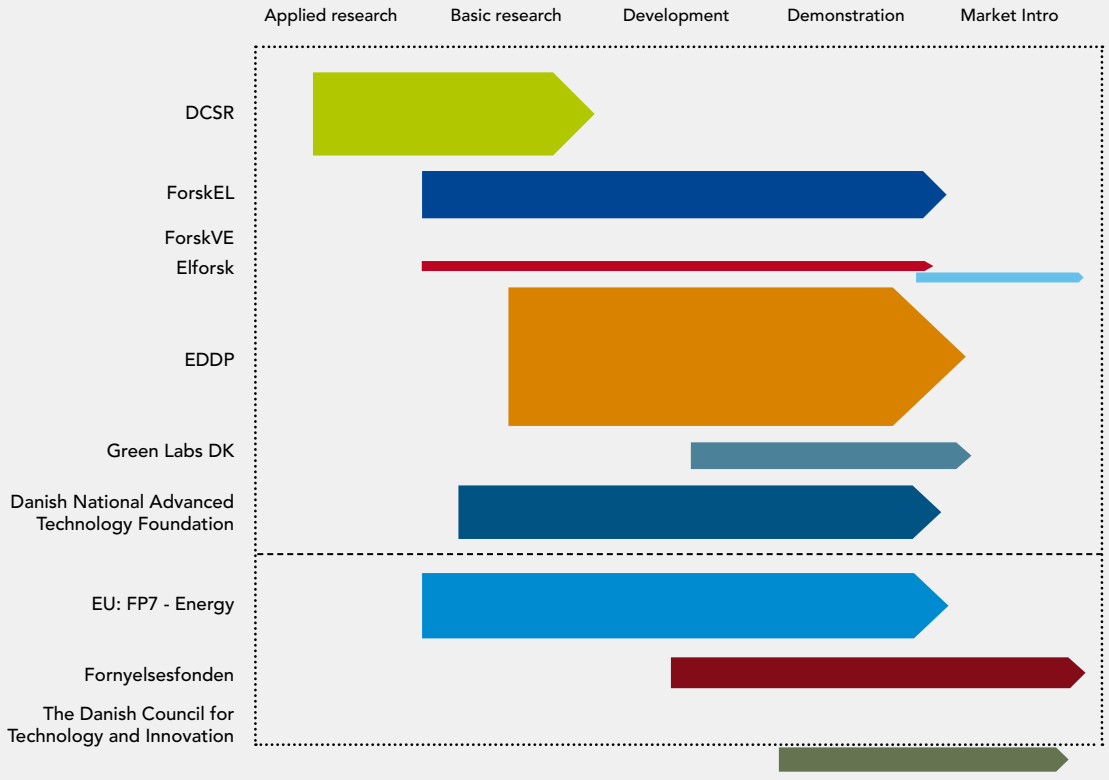
The "Network for improving Danish participation and access to EU funding within the sphere of renewable offshore energy" was operational in 2011 with the objectives to maintain and strengthen the strong Danish position within offshore renewable business and research; to influence the European Commission's FP7 priorities on offshore renewable energy; to increase the share of funding to Danish offshore renewable partners through FP7. The partners in the project are Offshore Center Danmark, LORC, Aalborg University, Risoe-DTU, and South Denmark EU Office. The project has a budget of about €0.45 million funded by the Danish Strategic Research Council.
Further, DanWEC is developing its service areas in preparation towards becoming a national Greenlab for development and testing of wave energy prototypes and components.

Main Public Funding Mechanisms

The different Danish funding mechanisms that support all renewable energy technologies in Denmark range from basic and applied research at university level, through R&D activities, demonstration activities, and market introduction, as it is shown on the figure below. The thickness of each arrow indicates the relative size of the annual budget within each programme totalling about €150 million in 2011. A detailed description on how these funds have been invested in projects is described in the annual report (Energi 2011). To obtain funding, all projects have to submit an application based on programme specific guidelines and the best applications are funded based on the ratings given by assigned evaluators.

Relevant Legislation and Regulation

Permits to install wave energy pilot plants in Denmark can be obtained by applying to the Energy Agency. The permit for a site specific test period will be given if certain requirements are fulfilled, including environmental impact assessment.



Danish energy research programmes 2011 (Energi 2011)

Relevant Documents Released

Most relevant documents are in Danish, however Energinet.dk provides annual fact sheets with overview of the different technology areas, including wave energy, which are relevant, as well as the overview reports concerning funded projects, i.e. (Energi 2011).

RESEARCH & DEVELOPMENT

Government Funded R&D

The Structural Design of Wave Energy Devices (SDWED) is a research alliance supported by the Danish Council for Strategic Research (DSF) over a five-year period (2010 – 2014) with about €3 million. The project is coordinated by Aalborg University. The project consist of five interactive work packages aiming at improving and integrating the use of numerical design tools in the wave-to-wire modelling and reliability assessment of wave energy converters and improve the state-of-the-art designs.
In 2011, Wave Dragon team received funding from EUDP to the first phase of a full-scale 1.5 MW demonstrator project, at the test centre DanWEC, Hanstholm. This involves a certified design of the device and a detailed feasibility study of the project.
Further, Wave Dragon/Spok has been involved in European projects such as WavePlam, Equimar, Wavetrain2 (under which it has two trainees working).
Leancon work on the 1:10 OWC scale model for Nissum Bredning is progressing and the prototype expected to be installed in the spring of 2012.
ResenEnergy has received a ForkEL PSO grant for a study of the "Lever Operated Pivoting Float" (LOPF) wave energy electricity producing buoy. The experiments will take place at AAU test facility.

Participation in Collaborative International Projects

Denmark is participating in the preparation standards and guidelines under IEC TC 114. A Danish working group under Danish Standards representing developers, experts from Aalborg University, Dong Energy, Sterndorff Engineering and Ramboll are participating in the different international working groups.
Danish developers have been involved in European Union (EU) projects, such as Equimar, CORES, ORECCA, MARINET, AquaGEN and Wavetrain2.

TECHNOLOGY DEMONSTRATION

Operational Ocean Energy Projects

WaveStar Energy includes two point absorbers of 5 meter diameter and has been operating in Hanstholm for more than 2 years producing power to the grid. The day-to-day production is presented at the project webpage and monthly reports can be downloaded. These data are used to determine the payment agreed with Energinet.dk for the electricity produced. WaveStar has an installed generator power of 110 kW and the maximum production measured is 39 kW.
During the summer of 2011, **DanWEC** introduced guided wave energy tours, including visits to the Wavestar, via a 400 meter long gangway about 4 meters up in the air. This has proved to be a unique way to promote wave power and also an unforgettable experience for families, schools, business trips and prominent visitors, such as our EU Commissioner Connie Hedegaard, The Danish Climate and Energy Minister and the Royal Prince of Denmark who visited Wavestar during 2011.
Wavestar is presently involved in a number of R&D activities aimed at increasing the performance and lowering the costs. This included development of improved control strategies and material research into the use of high performance concrete for the structures. Further, Wavestar is leading a EU funded strep project including partners from the UK, Spain, and Poland.

Wavestar in operation (www.wavestarenergy.com)

Floating Power Plant (FPP) prototype includes 140 kW wave power and 33 kW wind power. Tests have been continued in 2011. In April 2011, Floating Power Plant announced, in cooperation with Bridgeworks Capital, Oregon, US, the joint creation of a U.S. company, Floating Power Inc., to commercialize the Danish company's Poseidon Wave/Wind Energy Platform.
The Oregon company holds exclusive rights to Poseidon installations throughout the U.S. Government facilities worldwide. In Europe, FPP has initiated its up-scaling activities and is currently setting up a consortium with key industrial partners for a full-scale deployment in 2014.

Floating Power plant (www.floatingpowerplant.com)

In Europe, FPP has initiated its up-scaling activities and is currently setting up a consortium with key industrial partners for a full-scale deployment in 2014.

DEXAWAVE installed a scale 1:5 prototype at DanWEC Hanstholm during 2011. The sea trail so far has provided practical experience with the mooring and hydraulic PTO under extreme conditions.
DEXAWAVE has entered an agreement with Malta to develop 3 full-scale wave energy converters (of about 250 kW) followed by additional 24 converters. A small 1:10 demo was transported and installed in Malta as a show case in July 2011.
Presently, DEXAWAVE has installed a wave-rider buoy at the location in Malta to provide wave resource and design data as a basis for evaluating the business case Blue Ocean Energy®.

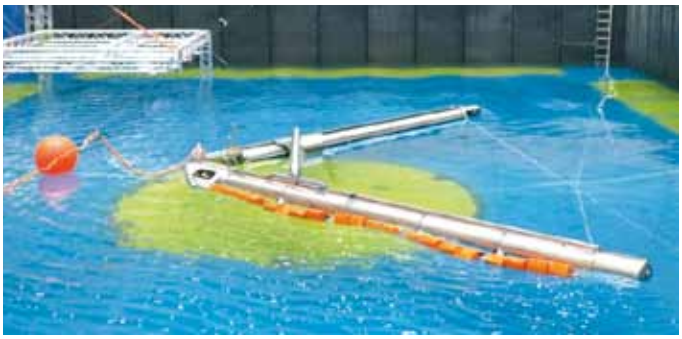
DEXAWAVE being towed in place at DanWEC Hanstholm (www.dexawave.com)

CrestWing is a hinged raft that was tested at Aalborg University´s wave tanks in 2008 and at DHI in 2010/11. In addition, dry tests of the mechanical PTO have been carried out. A scale 1:5 model was, during 2011, deployed in open sea offshore Frederikshavn.

CrestWing Deployed September 2011 (www.waveenergyfyn.dk)

New Developments

WEPTOS is a new approach in wave energy design integrating two strings of "Salters Ducks" each driving a common shaft. Further, it can alter the angle between the two "legs" in such a way that widespread it can catch much energy in ordinary wave conditions and as the sea gets more extreme it can fold to a slimmer structure and thus reduce the loadings and power rating. During September 2011, its scale model was tested in the new and large Spanish facility Cantabria Coastal and Ocean Basin (CCOB).



WEPTOS being tested in Spain September 2011 (http://weptos.com)

The inventor – Erik Skaarup – has bought his patent back, starting a new company **WavePlane Energy Ltd.** With this company, the plan is to redesign, build a new 200 kW full-scale WavePlane.

UNITED KINGDOM

Alan Morgan, Department of Energy and Climate Change

INTRODUCTION

The UK Government and the Devolved Administrations of Scotland, Wales and Northern Ireland continue to provide significant support for the development and deployment of wave and tidal energy technologies. The UK Marine Energy Programme is focusing on enhancing the UK marine energy sector's ability to develop and deploy wave and tidal energy devices at a commercial scale by concentrating on key areas that affect the sector such as:

- Support needed for small scale arrays and early commercial deployment;
- Planning and consenting issues;
- Knowledge sharing.

Both the UK Government and the Scottish Government have consulted on plans to increase the incentives available for wave and tidal energy generation through the Renewable Obligation banding reviews. Both Governments are proposing to equalise the incentives for wave and tidal stream at 5 ROCs per MWh.

Additional funding has also been invested to support the deployment of arrays of wave and tidal devices through the UK Governments £20 million Marine Energy Array Demonstrator (MEAD) and the £18 million Scottish Government's Marine Commercialisation Fund.

The European Marine Energy Centre (EMEC) has now 12 of its 13 full-scale test berths contracted to leading wave and tidal energy developers and by the end of 2011 it is expected that 10 different prototype technologies will be undergoing trials simultaneously in the waters off Orkney. The facility has recently been enhanced through the addition of two nursery sites – 1 wave and 1 tidal – where developers can test devices at less than full-scale. There is an increased pipeline of device deployment at the EMEC providing strong evidence of the considerable progress that has been made in the sector.

OCEAN ENERGY POLICY

Strategy and National Targets

The UK Government established a new UK Marine Energy Programme in January 2011, which is focusing on enhancing the UK marine energy sector's ability to develop and deploy wave and tidal energy devices at a commercial scale.

The key areas that the Marine Energy Programme will focus on are:

- Support needed for small scale arrays and early commercial deployment;
- Planning and consenting issues;
- Knowledge sharing though a Marine Intelligence Network.

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

The Coalition Government has set out a real vision for marine energy in the UK to encourage the clustering of activities through marine energy parks, which aims to bring together manufacturing, expertise and other activities to drive the marine sector forward to commercialisation. The South West and Caithness &

Orkney are developing proposals for Marine Energy Parks to be established in their regions that meet their particular needs.
The Department of Energy and Climate Change's (DECC) UK Renewable Energy Roadmap published in July 2011 estimates that, in "central range" modelling, commercial scale deployment would reach in the order of 200-300MW by 2020 (lower than some previous estimates). However, recent estimates still support large potential for wave and tidal stream post-2020 – perhaps 27GW (9-43GW) by 2050.

SCOTLAND
To accelerate the progress towards the commercial deployment of wave and tidal stream projects – this activity will focus on the leased sites totalling 1.6 GW within the Pentland Firth and Orkney Waters and the other leased areas around Scotland.

WALES
Based on Wales' natural advantages in areas such as wind and marine renewable resources, our aim will be to generate up to twice as much electricity annually from renewables by 2025 as we use today with about 40% of this from marine.

NORTHERN IRELAND
In March 2011, The Crown Estate announced the process for the first Offshore Renewable Energy Leasing Round in Northern Ireland (NI) waters and sought developers views on how best Northern Ireland's resource could be developed. In December 2011, The Crown Estate sought Expressions of Interest from developers for within two parallel leasing rounds for offshore wind (up to 600MW) and tidal stream (200MW). It is expected that development rights could be offered by the summer of 2012 and that projects would be taken forward to contribute to the Northern Ireland 2020 target of renewable electricity consumption of 40% by 2020.

Support Initiatives and Market Stimulation Incentives

The UK Government's main market support mechanism is through the Renewables Obligation (RO). Following its banding review, the Government launched its public "Consultation on proposals for the level of banded support under the Renewables Obligation for the period 2013-17" for England and Wales, on 20 October 2011. The Government is proposing to introduce 5 ROCs for wave and tidal stream energy up to a 30MW project cap for deployment in the period to 2017. The new bands will come into effect on 1 April 2013. This RO banding review is specifically set for the deployment from 2013 to 2017. Beyond 2017, it is the intention that marine technologies will continue to be supported via the proposed FiT (feed-in tariff) with a *Contract for Difference* support mechanism, which the UK is introducing under Electricity Market Reform, which should provide greater clarity and long-term vision for investors. The public consultation has now closed.
In June 2011, the Department announced it is investing up to £20 million in a Marine Energy Array Demonstrator (MEAD) scheme to help support the demonstration of arrays of wave and tidal devices, building on the Department's previous £22 million Marine Renewable Proving Fund and other Government support. The scheme is expected to open in the spring of 2012 and, subject to a value for money assessment, will support up to two projects to test prototypes in array formations – the final development stage in generating large scale electricity from marine power prior to commercial roll out.

SCOTLAND
The Scottish Government has consulted on plans to increase the incentives available for tidal energy generation through the Renewable Obligation Scotland banding review. The proposal is to equalise the incentives for wave and tidal stream at 5 ROCs per MWh.
The Scottish Government has now announced further funding through an £18 million Marine Commercialisation Fund to support the deployment of the first commercial arrays in Scotland. The scheme will be launched early in 2012.

NORTHERN IRELAND
Invest NI, DETI's economic development body, is working with ReGen South West, Scottish Highland and

Islands and Renewable UK to develop a UK-wide supply chain model for wave and tidal energy based on The Crown Estate supply chain model for offshore wind energy. It is expected that the model will be agreed by the Spring of 2012.

Main Public Funding Mechanisms

The Energy Generation and Supply Knowledge Transfer Network (http://ktn.innovateuk.org/web/energyktn) should be the first port of call for enquiries about funding and other opportunities. However, brief summaries of some of the organisations that support innovation at its different stages are given below:

- the **Research Councils** UK Energy Programme provides funding for basic strategic and applied research into a wide range of technology areas: http://www.rcukenergy.org.uk/
- the **Technology Strategy Board** supports medium-size research and development projects using tech nology-specific research calls: http://www.innovateuk.org/
- the **Energy Technologies Institute** is a public-private partnership that invests in developing full-system solutions to long term energy challenges: http://www.lowcarboninnovation.co.uk/EnergyTechnologiesInstitute.aspx
- the **Carbon Trust** offers a wide range of support for low carbon innovation mainly in the pre-market arena: http://www.carbontrust.co.uk/Pages/Default.aspx

SCOTLAND

The Scottish Government continues to provide significant support for the development and deployment of wave and tidal energy projects in Scotland. Projects receiving support through the £13 million WATERS are making good progress and those supported through the previous WATES scheme have now concluded.

WALES

The main source for large funding in Wales, both revenue and capital, is via the Convergence & Competitiveness Fund administered by the Welsh European Funding Office (WEFO) on behalf of the Welsh Government. The Welsh Government is in discussion with the EU Commission to consider a structural fund programme post 2013 and how it might support the sector.

Relevant Legislation and Regulation

The Government concluded in its Offshore Energy Strategic Environmental Assessment (OESEA2) that there are no overriding environmental considerations to prevent the leasing of wave and tidal energy devices, provided that appropriate measures are implemented that prevent, reduce and offset significant adverse impacts on the environment and other users of the sea. The OESEA2 opens up the whole of UK waters for potential deployment of marine energy devices.

SCOTLAND

- Renewable Obligation (Scotland) Act

WALES

- Marine and Coastal Access Act
- EU Convergence Funding Legislation

NORTHERN IRELAND

- The Department of the Environment progressed proposals for the NI Marine Bill for devolved marine environmental issues and it is planned to introduce the Bill to the NI Assembly in 2012.

Relevant Documents Released

SCOTLAND

- Consultation on Renewables Obligation (Scotland) Banding Review

WALES

- Welsh Government Energy Policy Statement: Low Carbon Revolution (March 2010)

NORTHERN IRELAND

- During 2011 and to facilitate the TCE Crown Estate leasing Round, DETI published Offshore Regional Locational Guidance to assist regulators, developers and stakeholders.

RESEARCH & DEVELOPMENT

Government Funded R&D

The **Supergen Marine** consortium secured continuation funding for Phase 3, supporting a further five years of research from October 2011. The consortium brings together the core Universities of Edinburgh, Queen's Belfast, Strathclyde and Exeter as well as several associate Universities. Supergen Marine will conduct world-class fundamental and applied research that assists the marine energy sector to accelerate deployment and provide the highest quality of doctoral training. Further information can be found at: www.supergen-marine.org.uk/drupal/

The **Technology Strategy Board**, in partnership with Scottish Enterprise and the Natural Environment Research Council (NERC), are investing over £10 million in new research and development to help demonstrate that wave and tidal energy can be generated at scale, and with lower energy production costs.

Marine Energy – Supporting Array Technologies is a competition for collaborative R&D funding that will support the applied research, experimental development and demonstration of innovative technologies that solve common issues faced by those developing and deploying the first marine energy arrays. The competition will seek proposals for research and development projects that address themes such as: tidal array cabling, subsea electrical hubs, installation and maintenance vessels for tidal arrays, navigation and collision avoidance and anti-fouling & corrosion. There is also an Open theme for projects that target common marine energy challenges not covered by the above themes. The competition opens on 5 March 2012. The deadline for registration is 10 April 2012 and expressions of interest must be submitted by 17 April 2012. See at http://www.innovateuk.org/content/our-focus-areas/energy-generation-and-supply/marine-energy-supporting-array-technologies.ashx

The **Energy Technologies Institute (ETI)** announced plans to take wave energy to the next level with a project to design and demonstrate a low-cost wave energy converter system. The project will be commissioned in two phases, the first providing a fully detailed design concept for a wave energy converter system capable of delivering at least 10MW of power before a second phase where the new innovations are developed and demonstrated at full-scale at sea. It will also assess the potential market opportunities of the technologies in the UK and abroad. It is expected that the project will start in summer 2012 with the first phase lasting approximately 12 months. Further information can be found at:www.eti.co.uk/request_for_proposals/view/18

The new 3MW marine drive train test rig "Nautilus", which is currently under construction at the N**ational Renewable Energy Centre (Narec)**, will become operational during 2012. Narec will perform accelerated lifetime testing of whole nacelles and their individual drivetrain components, such as gearboxes, generators and bearings for wind and tidal turbine devices. It is planned that the facility, once operational, will perform the testing of turbines in accordance with IEC and ISO standards or customer requirements and that the facilities will achieve ISO17025 accreditation by The United Kingdom Accreditation Service (UKAS) once certification standards for controlled environment testing are finalised.

SCOTLAND

The £13 million WATERS programme is ongoing.

WALES

The Assembly Government has recently published the findings of its 3 year project, the Marine Renewable Energy Strategic Framework (MRES). The MRES project has investigated the potential marine energy resource areas within Welsh Territorial Waters by device type, identified the associated constraints tied to

those areas and considered potential scenarios for the sustainable development of the available resource. The MRES is an aid to development, ensuring Wales gets the right device in the right place, providing developers with key information to inform EIAs and, by carrying out the constraints work, helping to reduce the consenting risk for developers. The findings show that even when the various environmental and technological constraints are taken into account, there is still the potential for Welsh waters to produce enough energy to power up to two million homes per year.

Participation in Collaborative International Projects

The UK is a member of the EU Member State Ocean Energy Interest Group, which has recently published a report "Towards European industrial leadership in Ocean Energy in 2020"in collaboration with the European Ocean Energy Association, calling for funding and support from the EU Commission to drive forward marine energy. The report is a high level statement of our collective willingness to work together and cooperate in this technology area and also of our keenness to form a strategic partnership with the European Commission, to achieve a strong European ocean energy industry and capability to secure low carbon, jobs, skills and growth.
The ORECCA (Offshore Renewable Energy Conversion Platform Coordination Action) Project is an EU FP7 funded collaborative project.

SCOTLAND
Four Scottish-based bids are currently being assessed by the European Investment Bank for support through the NER 300 programme for deployment of early stage commercial arrays.

WALES
Wales is a member of the Renewable Energy Regions Network (RENREN), which aims to identify policy choices that will improve regional frameworks for renewable energy expansion. 14 partners from across Europe are collaborating to this end, since regions will play a big part in helping the EU and its member states achieve their 2020 renewable energy targets and related greenhouse gas reduction targets. Wales' specialism within RENREN is ocean energy.

TECHNOLOGY DEMONSTRATION

Operational Ocean Energy Projects

At EMEC:
- Pelamis P2 750 kW Machine (Commissioned by Eon) installed
- Pelamis P2 750 kW Machine (Commissioned by Scottish Power Renewables) installed
- Aquamarine Power Limited – Oyster 800 Stage 1 installed
- Wello Oy Penguin 500 kW wave converter installed
- Open Hydro 250kW Open Centred tidal turbine deployed
- Open Hydro – 600kW turbine deployed (not grid connected)
- Tidal Generation Ltd 500kW tidal turbine deployed
- Atlantis Resources Corporation AR1000 1 MW tidal turbine deployed
- Scotrenewables SR250 floating tidal turbine deployed
- Hammerfest Strom 1MW tidal turbine deployed
- Voith Hydro tidal turbine

Projects at other locations:
- MCT/ SeaGen (Strangford Lough, Northern Ireland) - deployed and operational since 2008
- Limpet Oscillating Column (Islay, SW Scotland) - deployed and operational since 2001
- Pulse Tidal (mouth of the River Humber) - deployed their 100kW "Pulse-Stream 100" in 2009.

New Developments

Following £8 million of UK Government investment, the European Marine Energy Centre (EMEC) commissioned three new grid connect berths (2 tidal and 1 wave) and opened its two nursery sites (1 wave and 1 tidal with 2 berths each). Already a number of developers are contracted to use the scale test site facility to deploy their devices www.emec.org.uk/

Planned deployments at EMEC:

- **Seatricity** wave energy converter – deploying in the Spring of 2012.
- **Kawasaki Heavy Industries** tidal turbine – deploying in 2013.
- **Bluewater** tidal technology – deploying in 2012.

Neptune Renewable Energy – deployment of 500kW prototype has recently started piling work in the Humber to prepare for the deployment of the Neptune Proteus, a tidal stream power device, in 2012.

Falmouth Harbour Commissioners (FHC) have signed a lease to create FabTest, a new wave energy 'nursery' test site in Falmouth Bay on the south coast of Cornwall. FabTest, which is not grid-connected, offers a pre-consented area in Falmouth Bay licensed to test up to three devices and will enable wave energy generation device developers to conduct sea trials of their devices in moderate seas, close to port facilities. It is a stepping stone to the deployment of arrays of devices at the Wave Hub testing facility off the Cornish coast. The management of the site will be undertaken by a partnership between FHC and the University of Exeter.

The Government published its conclusions and evidence from its Severn Tidal Power feasibility study in October 2010, i.e. the Government does not see a strategic case for public investment in a tidal scheme in the Severn at the present time, and has not carried out further work in this area since then. However, several private sector consortia are still interested in developing a tidal scheme in the Severn, and a group known as Corlan Hafren (Severn Holdings), led by Halcrow and Arup, have been the most active. They submitted a business case to the Government in November 2011, based on a very low head barrage with innovative contra-rotating turbines, and this is currently being discussed with the Government.
Feasibility studies have recently been carried out into the potential for tidal range schemes in a number of other estuaries and bays around the UK. In June 2010, Peel Energy published its final report into Mersey Tidal Power, and concluded that the cost of energy was too high to take forward in the short term, considering current Government support mechanisms. Solway Energy Gateway has also been taking forward its plans for a tidal energy scheme in the Solway Firth with an innovative hybrid technology developed by Verderg under the Severn Energy Technologies Scheme (SETS). There are also plans for a pilot coastally attached tidal lagoon near Llandudno in North Wales, and for a small offshore lagoon in Swansea Bay. Other estuaries, which developers are still actively looking at, are the Wyre and the Duddon in the North West of England and the Loughor in South Wales.

SCOTLAND

The 10MW Islay tidal array project, being taken forward by Scottish Power Renewables and Hammerfest Strom, secured its consent during 2011 – the process was completed by Marine Scotland within 9 months.

WALES

Recently, the Welsh Assembly & the Department of Energy and Climate Change (DECC) have announced the granting of the necessary consents for a 1.2MW tidal demonstrator device in Ramsey Sound off Pembrokeshire. This will be the first deployment of a marine device in Wales and the first in the UK to operate on a 'deploy and monitor' approach, allowing the device to operate around the clock. The evidence collated from the demonstration will provide the much needed field data and will be released into the public domain to move the industry forward.

NORTHERN IRELAND

The Swedish company Minesto announced in September 2011 that it would be testing a scale prototype of its tidal device in Strangford Lough in NI waters. Supported by The Carbon Trust, the innovative device is described as a "moving kite "rather than an underwater wind turbine.

JAPAN

Yasuyuki Ikegami, Institute of Ocean Energy, Saga University

INTRODUCTION

Solar and wind energy have received considerable interest from the Japanese government while less emphasis has been placed on the other renewable energy resources, such as ocean energy. However, in recent years, ocean energy has begun to receive increasing interest and several projects have been established for the promotion of ocean energy resources. The Japanese islands are surrounded by the ocean; hence Japan has higher potential for utilizing the various sources of ocean energy, such as waves, tidal range and tidal currents, ocean thermal energy, etc. Many research projects on the development and optimization of various ocean energy systems have been conducted, although most of these were conducted, using a laboratory scale experimental setups. Therefore, new initiatives are required to implementation of these research results in full-scale plants and real sea conditions to obtain more realistic results that pave the way towards the commercialization of the ocean energy systems.

For this purpose, a plan called "Ocean Energy Technological Development Research" was established in 2011. The plan lasts for 5 years and aims to promote ocean renewable energy research projects in Japan.

OCEAN ENERGY POLICY

Strategy and National Targets

According to the "Basic Plan on Ocean Policy" which complies with the law of "Basic Act on Ocean Policy" enforced in July 2007, promotion of research on ocean energy will be focused on feasibility studies, performance and economic improvement of the technologies used in exploiting the various types of ocean energy. Similarly, a project under the title "Ocean Energy Technological Research And Development" was started in 2011. This project is part of the "Basic Energy Plan", which comes in accordance with the law of "Basic Act on Energy Policy".

Relevant Legislation and Regulation

- Basic Act on Energy Policy, including the Basic Energy Plan approved by the Cabinet, June 2010
- Basic Act on Ocean Policy, Basic Plan on Ocean Policy approved by the Cabinet, March 2008
- New Growth Strategy approved by the Cabinet, June 2010.

Relevant documents released

- Awareness of the ocean energy potential (2010)
- NEDO renewable energy technology white paper (2010)

RESEARCH & DEVELOPMENT

Government-Funded R&D

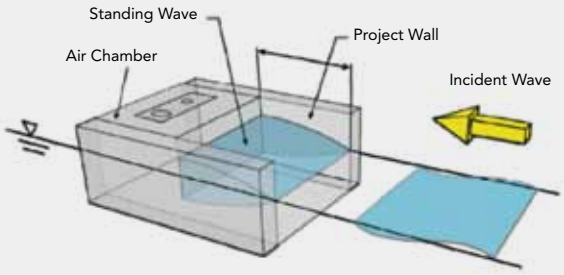
The "**Ocean energy technological research and development**" has a total budget of approximately 7.8 billion yen for the years 2011 - 2015.

One Billion yen research project was established at NEDO in 2011 under the Ministry of Economy, Trade and Industry, to promote the actual use and commercialization of each ocean energy exploitation system, particularly focusing on wave power, tidal power and ocean thermal energy conversion; in addition to fundamental research on ocean energy utilization systems.

TECHNOLOGY DEMONSTRATION

New Developments

Multi-resonant OWC: JAMSTEC (Japan Agency for Marine-earth Science and Technology) is developing a multi-resonant oscillating water column (OWC) that uses a Project Wall to improve power generation efficiency. This equipment does not have machinery underwater.



AMSTEC (Japan Agency for Marine-earth Science and Technology) is developing a multi-resonant oscillating water column (OWC) that uses a Project Wall to improve power generation efficiency.

Concept of Multi-resonant OWC wave energy converter

Power Buoy: Mitsui Engineering & Shipbuilding CO., LTD. and Akishima Laboratory (Mitsui Zosen) Inc. are developing Japanese Power Buoy in co-operation with Ocean Power Technologies Inc.

Tank Test of Power Buoys

Gyroscopic wave power generation system (Gyrodynamics Corporation): The gyroscopic wave power generation system is a pure rotational mechanical system that does not use conventional air turbines and is housed on a unique floating platform ("float"). Its outstanding feature is that it utilizes the gyroscopic (spinning) effect. Sea trials of a 45-kW class prototype have been held offshore from the town of Susami in Wakayama Prefecture, where it generated 40 kW in 2.5 m wave height and 4.0 sec wave period condition.

Experimental wave power generation system offshore from the town of Susami in Wakayama Prefecture

Tidal Current

Tidal current projects are being conducted by:

- Kawasaki Heavy Industries, Ltd
- University of Tokyo, IHI Corporation, Toshiba Corporation and Mitsui Global Strategic Studies Institute
- West Japan Fluid Engineering Laboratory Co. Ltd. and Kyushu University
- Kitakyushu city administrative department and Kyushu Institute of Technology in Kanmon Straits
- Imabari city administrative department and Ehime University in Kurushima Straits.
- Kitami Institute of Technology in Saroma Lake.

Ocean Thermal Energy Conversion

A study of ocean thermal energy conversion is being conducted, using 30kW experimental plant at Saga University. In Kume Island of Okinawa, feasibility studies on the compound use of 1MW ocean thermal energy conversion were performed in 2011.
The Okinawa administrative department announced a plan to install a 24h/365day-running 100 kW ocean thermal energy conversion experimental plant in Kume Island in 2012.

Salinity Gradient

Research and development on osmotic power is being carried out mainly at the Tokyo Institute of Technology. Research is being carried out to develop new efficient membranes.

IRELAND

Eoin Sweeney, Sustainable Energy Authority of Ireland

INTRODUCTION

Transformational changes are taking place in the energy sector in Europe and the world. In the context of a very large-scale shift to the use of renewable energy technologies, Ireland has one of the most energetic offshore wind and wave resources in the world, which will yield higher power levels than other European neighbours.

It was in this context that the Ocean Energy Strategy was initiated in 2006, aimed at developing the wave and tidal sector. Since then, there has been ongoing work to create a supportive policy framework, develop infrastructure and build research capacity to create a favourable developmental environment. To this end, the Ocean Energy Development Unit (OEDU) was set up in the Sustainable Energy Authority of Ireland (SEAI) in 2008 to take the sector forward.

OCEAN ENERGY POLICY

Strategy and National Targets

Ireland's Offshore Renewable Energy Development Plan (OREDP) is currently being developed by the Department of Communications, Energy & Natural Resources. The draft OREDP is publicly available on the Department's and SEAI's websites. The draft OREDP describes the current state of play in Ireland on offshore wind, wave and tidal energy. It explains how policy is in development in this sector and some of the factors that are likely to affect policy as it develops.

The draft plan notes Ireland's involvement in many initiatives and its openness at a strategic level to considering the possibilities and opportunities offered by offshore renewable energy. The draft OREDP considers low, medium and high scenarios for the development of offshore wind, wave and tidal energy in the period to 2030. The Strategic Environmental Assessment has been undertaken on these three scenarios, which include up to 4,500MW of offshore wind and 1,500MW of wave and tidal energy in the period up to 2030.

Ireland has been set a binding renewable energy target under Directive 2009/28/EC and has published a National Renewable Energy Action Plan (NREAP) setting out how the target for 2020 is to be achieved. In the NREAP, Ireland states in its modelled electricity scenario that it expects 555MW of offshore wind to be contributing to its 2020 target as well as 75MW of wave and tidal generated power.

Noting that the Renewable Energy Directive provides co-operation mechanisms for Member States to trade renewable energy in the period to 2020, if they are able to exceed their national target, a study on the cost benefits of Ireland engaging in the co-operation mechanisms under the Directive was commissioned in 2011, for completion in the first quarter of 2012.

An **Ocean Energy Roadmap**, formulated by SEAI, was published in 2010. It is designed to initiate a debate about the pathway to 2050 for ocean energy in Ireland. Its analysis is based on programme experience, analysis and modelling, and a number of commissioned studies. Looking at two boundary scenarios, the Roadmap gives an indication of the resource potential and quantifies the opportunities for CO2 abatement. The pathways are also analysed in terms of economic competitiveness, employment opportunities and energy security. The key features of the Roadmap are:

- The Strategic Environmental Assessment reports that, potentially, 29GW of ocean energy capacity can be installed without likely significant adverse effects on the environment.
- Employment opportunities of up to 70,000.
- Cumulative economic benefit up to €12 billion by 2030 and up to €120 billion by 2050 from factors such as electricity generated, emissions reductions, security of supply, regional development
- & knowledge created.
- National energy security is significantly enhanced.

The assumptions and projections in SEAI's Roadmap need to be rigorously tested.

Support Initiatives and Market Stimulation Incentives

In 2009, the Government announced a refit (renewable energy feed-in) tariff of €220/MWh for wave and tidal energy. This has not yet been activated and the Industry association has proposed a more precisely structured mechanism to support the sector in its growth phase.

Main Public Funding Mechanisms

The principal funding mechanism for the ocean energy (OE) sector is the Prototype Development fund, administered by the Ocean Energy Development Unit. This supports industry-led projects for the following types of activities:

- Projects to develop and test wave and tidal energy capture devices and systems;
- Independent monitoring of projects/technologies;
- R&D aimed at the integration of ocean energy into the electricity market and the national electricity grid (and network);
- Data monitoring, forecasting, communications and control of OE systems;
- Specific industry-led research projects, which will be carried out by research centres.

Relevant Legislation and Regulation

Offshore marine renewable energy projects currently fall within the jurisdiction of the Foreshore Acts 1933 to 2009. The Foreshore Acts apply to the seabed and shore below the line of high water of ordinary or medium tides and outwards to the 12 nautical miles limit of the territorial seas.

Since 2010, the Department of Environment, Community and Local Government (DECLG) has been working on the streamlining and modernising of the consent process for foreshore developments, with particular emphasis on renewable energy projects. It is intended that the reforms will deliver a plan-led policy framework for the approval of activities and developments in the marine environment, a single consent process for project approval as well as greater certainty of timeframes. Mandatory pre-application consultations, transparent assessment of environmental impacts and full public participation are also planned. A new legislative Bill is expected in 2012.

The Department of Communities and Local Government (DECLG) is also working with other relevant departments and agencies on the development of a marine spatial planning framework, providing for the strategic development of the foreshore while managing competing and often conflicting sectoral demands. DECLG is supportive of awarding offshore renewable energy rights through a system of future competitive leasing rounds. The Department is of the view that optimal use can be made of the renewable resource through targeted development opportunities, identified and agreed by the various stakeholders involved in energy policy, grid connection and regulation of the marine and coastal zones.

Relevant documents released

A full list of publications relevant to the OE sector is available at:
http://www.seai.ie/Renewables/Ocean_Energy/Ocean_Energy_Information_Research/Ocean_Energy_Publications/

In 2011, two new documents were released:

- Assessment of Ports and Shipping Requirements for the Marine Renewable Industry Sector
- Industrial Development Potential of Offshore Wind in Ireland (listed because of supply chain relevance)

RESEARCH & DEVELOPMENT

Government Funded R&D

SEAI, in partnership with the Marine Institute, continued to operate the wave energy ¼ scale test site in **Galway Bay**. Work commenced, aimed at enhancing the facility by providing power and bandwidth to the site, in conjunction with the SmartBay initiative, for completion in 2012.

The OEDU is continuing work on the establishment of a full-scale grid connected wave energy test facility off County Mayo. A foreshore licence was awarded in late 2009 to support the Site Investigation works at the proposed test site location off Annagh Head, Belmullet, County Mayo. This project involves a phased development, from Site Investigation with a Foreshore Licence, to Design and Grid Application, to Planning and Foreshore Lease and finally procurement and construction. It will be connected to the national electricity grid and will provide facilities for the testing of full-scale devices in development by Irish and multi-national companies and will be able to accommodate up to 3 devices at any one time. A grid offer is in place and the lease application has been made.

Full-scale grid connected wave energy test facility off County Mayo

The **SmartBay Pilot Project in Galway Bay**, which is supported by the Marine Institute and the Environmental Protection Agency (EPA), is designed to be a research, test and demonstration platform and innovation test bed for new ocean technologies developed by research institutes and companies, e.g. communications, informatics, instrumentation and sensors. The core infrastructure comprises a suite of commercially available technology. This includes a network of buoys, sensor hardware and communications systems against which prototype products or services can be validated. SmartBay embraces the ¼ scale wave test site creating a facility for the coordinated development of OE technology and associated information and communication technology (ICT) capabilities.

Hydraulics and Maritime Research Centre in University College Cork is a key ocean energy research facility in Ireland with special interest in ocean energy research and coastal engineering. The group expanded its staff size in 2007 following the allocation of long-term funding of research personnel from the Parson Energy Research awards, administered by Science Foundation Ireland. It is currently upgrading its equipment and facilities with financial support from the OEDU and further major enhancement of the

facility as the National Ocean Test Facility is planned, with financial support from the Higher Education Authority, industry and the OEDU.

University of Limerick has been actively pursuing the development of air turbines for use with oscillating water column devices.

The Electricity Research Centre in University College Dublin has had significant involvement in the integration and the study of management issues for intermittent renewable generators such as wind power systems operating on the national grid. Their interests include modelling of dynamic response of electrical generators and tidal energy systems.

The Department of Electronic Engineering in the **National University of Ireland, Maynooth**, has a dedicated group working in the areas of hydrodynamic modelling, PTO modelling, impact of wave directionality on WECs, device optimisation, control system design for WECs and resource assessment.
is funding two projects through the Commercialisation Fund Programme: grid integration software and services of ocean energy (SEAGRID) and in economic assessment of ocean energy systems, farms and projects (NAVITAS).

Participation in Collaborative International Projects

MaRINET – Marine Renewables Infrastructure Network for Energy Technologies - UCC Coordinated FP7 EU Infrastructures project (28 Partners; €9 million). SEAI, UCC QUB are the Irish Participants. MARINET is a new network of research centres, which aims to accelerate the development of marine renewable energy (wave, tidal & offshore wind), by bringing together world-class testing facilities to offer EU-funded testing and to co-ordinate focussed R&D.
The aim of MARINET is to facilitate testing and to coordinate and advance marine renewables R&D at all scales - from small models and laboratory tests through to prototype scales and open sea tests. Through this EC funding, MARINET offers periods of access, at no cost to users, to test facilities, which are located outside the country where those users work. Users can avail of this access to test and develop their devices and concepts. This enables users to access facilities, which are not available in their home country and may be too expensive to access normally, or are simply inaccessible under national renewables support funding as the desired facilities are located outside the state providing that funding. Access is available to 42 facilities from 28 network partners spread across 11 European Union (EU) countries and 1 international co-operation partner country (Brazil). The initiative runs for four years until 2015, with at least four calls for access applications. For further information see: www.fp7-marinet.eu.

Other international collaborative projects:

CORES - New Components for Ocean Renewable Energy Systems – UCC Coordinated 13 Partners €3.5 million. Demonstrating at sea new systems, components and methods for ocean energy.

MARINA - Combined wind and wave energy systems. FP7 EU 17 Partners €10 million. UCC Partners.

ORECCA - Off-shore Renewable Energy Conversion platforms – Coordination Action. EU FP7 UCC Partner.

SOWFIA - Streamlining Ocean Wave Farms Impact Assessment – Multi-disciplinary multi- partner EU EACI IEE project with objective to develop and improve tools and methods for environmental and social impact assessment of wave farms.

EQUIMAR - Equitable Testing of Marine Renewables. EU FP7, UC Partner. Developing standards, guidelines and protocols for the sector. This work directly feeds IEA OES work and IEC TC114.

IEC TC114 - Ireland has a mirror committee and contributes experts to TC114's development of standards and guidelines in ocean energy.

International Smart Ocean Graduate Education Initiative – Ireland has a graduate programme co-funded by members of the SmartOcean group, which has a mix of Irish and International entities. First round of PhDs starting.

TECHNOLOGY DEMONSTRATION

Operational Ocean Energy Projects

Ocean Energy Ltd deployed their ¼ scale device (OE Buoy) for a 6-month period at the Galway Bay Quarter – scale Test Site, as part of the EU-funded CORES project. This project set out to address particular issues resulting from the development of Oscillating Water Column Wave Energy Converters (OWC WECs). The Hydraulics & Maritime Research Centre (HMRC) coordinated this 13-partner European project. The system was tested successfully at sea in Galway Bay for three months in 2011. This enabled the integration of the resulting real, validated and verified results into a holistic system model, a "Toolbox" for wave-to-wire simulations of complete WEC systems.

OE Ltd ¼ scale device at the Galway Bay Quarter-scale Test Site

The system was tested successfully at sea in Galway Bay for three months in 2011. This enabled the integration of the resulting real, validated and verified results into a holistic system model, a "Toolbox" for wave-to-wire simulations of complete WEC systems.

New Developments

UCC Beaufort and IMERC: DCENR, IDA, PRTLI SEAIOEDU, UCC and Bord Gais are funding a new building to house the National Ocean Test Facility. This is a €16.5 million cornerstone and flagship facility housed within the Irish Maritime and Energy Research Cluster. IMERC is a joint venture between UCC, the National Maritime College and the Irish Naval Service.

5 MW Demonstration Project: The WestWave project aims to develop the first wave energy project in Ireland by 2015 by generating 5 MW of electricity from the plentiful wave energy resource off the west coast of Ireland. WestWave is a collaborative project being led by ESB International (ESBI) in conjunction with a number of wave energy technology partners including Irish technology developers Wavebob and Ocean Energy and Scottish technology developers Aquamarine Power and Pelamis Wave Power. ESB, with support from the Sustainable Authority of Ireland (SEAI), is building upon previous supply chain analyses of marine energy to focus specifically upon the requirements of the WestWave Project. Within this supply chain study, the WestWave project team has assessed, along with four leading technology developers, the requirements to deliver the WestWave project within the timeframe required.

CANADA

Tracey Kutney, CanmetENERGY, Natural Resources Canada
Chris Campbell, Ocean Renewable Energy Group
Jonathan Brady, Natural Resources Canada

INTRODUCTION

One hundred sector participants representing technology developers, utilities, research, technical services, project development and Government released the Marine Renewable Energy Technology Roadmap report to advance the commercialization of marine energy in Canada. This Roadmap builds on the initiatives and actions of some of the coastal provinces and industry in recent years. In 2011, the Federal Government launched the $97 million (CAD) ecoENERGY Innovation Initiative programme to support research, development and demonstration (RD&D) projects, including marine renewable technologies. On the policy front, the Federal Government announced the $4 million (CAD) Marine Renewable Energy Enabling Measures programme to work towards the development of a policy framework for administering renewable energy activity in the federal offshore.

2011 was the year in which the concept of the Fundy Ocean Research Centre for Energy (FORCE), in Nova Scotia, was recognised as a model for incubation of this industry, its collaborative agreement with the European Marine Energy Centre being one part of this.

2011 also saw emergence of the Canadian strength in river-current energy development with the RER TREK demonstration in Montreal and prototype testing by Clean Current, MAVI and Sabella Energie. There are plans for new pilot projects in Quebec, Manitoba and British Columbia, and internationally, New Energy Corp. is involved in a project development in India.

OCEAN ENERGY POLICY

The Renewable Electricity Plan in Nova Scotia, the Plan Nord in Quebec, the Green Energy Act in Ontario and the Clean Energy Act in British Columbia have all adopted aggressive renewable electricity targets.

The Government of Canada is committed to reducing Canada's total greenhouse gas emissions by 17 % from 2005 levels by 2020 – a target that is inscribed in the Copenhagen Accord and aligned with the United States. To meet this commitment, the Federal Government has been implementing regulations to reduce greenhouse gas emissions in the transportation sector, has introduced new regulations on coal-fired electricity generation and announced funding in the 2011 budget to advance clean energy technology research, development and demonstrations.

Strategy and National Targets

With the development of the Canadian Marine Renewable Energy Technology Roadmap, the sector set targets of 75 MW by 2016, 250 MW by 2020 and 2 GW by 2030 for installed in-stream tidal, river-current and wave energy generation. The Nova Scotia Government is undertaking the development of a sector strategy to "create the winning conditions" for a tidal energy industry with initial discussions of development targets of 65 MW by 2015 and 300 MW to follow in 5-10 years. The Government of Quebec launched the Plan Nord in 2011 and identified a 200 MW development target for non-traditional renewables, such as tidal and river-current energy.

Support Initiatives and Market Stimulation Incentives

Over the last five years, Canada has contributed an estimated $75 million (CAD) in federal and provincial support to marine energy development projects.

At the provincial level, the Government of Nova Scotia launched a community-based feed-in tariff (COMFIT) programme, in September 2011, to encourage the development of local renewable energy projects by

municipalities, First Nations, cooperatives, universities, local economic development corporations and non-profit groups. Under the COMFIT programme, Nova Scotia will allow local community groups to connect small-scale in-stream tidal arrays (under 500 kW) to the electrical grid at the distribution level at a feed-in tariff price of 65.2 c/kWh, (CAD) over a 20-year contract. Nova Scotia's COMFIT programme is believed to be the first in North America to pay for community-owned tidal power projects.

Quebec's Plan Nord is an economic development strategy for northern Quebec. Clean energy development is fundamental to any industrial (mostly mining) proposals that will be generated and major electricity development targets include 200 MW of non-wind, non-hydro and likely hydrokinetic generation developments.

British Columbia's Clean Energy Act enabled emerging energy feed-in tariffs for six resources including wave, tidal and river current. Work on regulations and implementation plans await a launch signal, which may be seen as early as 2012.

Main Public Funding Mechanisms

To date, Canada's main public funding programmes supporting national research, development, and demonstrations are the Clean Energy Fund (CEF), the Programme for Energy Research and Development (PERD), the ecoENERGY Innovation Initiative (ecoEII), which are all administered through the Office of Energy Research and Development (OERD) at NRCan. While none of these programmes have been specific to marine energy, it is estimated that over $28 million (CAD) has been committed to marine renewable energy RD&D. In addition, Sustainable Development Technology Canada, an arm's length foundation created by the Government of Canada, has committed approximately $20 million (CAD) to develop and demonstrate projects that include tidal, wave and low head hydro technologies.

The CEF was critical to the FORCE cabling infrastructure, providing $20 million (CAD) to support cabling infrastructure and related R&D. Cable procurement occurred in 2011 with installation expected in 2012. The National Research Council Industrial Research Assistance Programme has supported many early technology assessment and physical and numerical modelling trials. Most projects have benefitted from the refundable tax credit for Scientific Research and Experimental Development. Many projects have also received support from provincial economic development agencies.

Nova Scotia has directly invested in the FORCE development initiative and, through the Offshore Energy Environmental Research Association, supported a Strategic Environmental Assessment and two thirds of the funding for 22 strategic research projects in marine energy (estimated to be approximately $8 million (CAD)). In addition, provincial economic development agencies and funds (in Nova Scotia, Quebec, Ontario and British Columbia (BC)) have provided at least $10 million (CAD) to support projects.

The Ocean Renewable Energy Group (OREG) estimates that more than $75 million (CAD) has been committed, leveraging a further 1 ½ times as much from other funders or private investments.

Relevant Legislation and Regulation

In Canada, provincial Governments have exclusive jurisdiction over the development and management of sites and facilities for the generation of electrical power within the boundaries of their respective provinces. As a consequence, decisions regarding the generation of electricity from marine renewable energy resources, including the allocation of land and rights, are made by each province.

A number of provinces are working towards comprehensive policy or regulatory frameworks for marine renewable energy development within their boundaries. Nova Scotia has issued "Guidelines for Permitting of a Pre-Commercial Demonstration Phase for Offshore Renewable Energy Devices" and is working towards a marine renewable energy legislative framework, which is expected in 2012. New Brunswick has designed a comprehensive policy for the "Allocation of Crown Lands for Tidal In-Stream Energy Conversion Projects". Details on implementation of Quebec's Plan Nord are expected early in 2012. An amendment to the BC Clean Energy Act is expected in 2012 with the feed-in tariff unchanged, although its implementation may be delayed. British Columbia has issued an Interim Policy Directive and Land Use Operational Policy for ocean energy projects. There is the potential for many renewable energy projects to be situated in areas outside of the boundaries of a province, in marine areas under federal jurisdiction. In these circumstances, the Federal Government is responsible for making decisions regarding marine renewable energy development, including the allocation of land and rights.

However, regardless of where a marine renewable energy project is situated, the Federal Government's responsibilities include, but are not limited to, the following acts: Fisheries Act, Navigable Waters Protection

Act, Canadian Environmental Protection Act and Canadian Environmental Assessment Act. In 2011, the Government of Canada announced the $4 million (CAD) Marine Renewable Energy Enabling Measures programme to enable Natural Resources Canada work towards the development of a policy framework for administering renewable energy activity in the federal offshore. Ongoing collaboration between provincial Governments and the Government of Canada is anticipated as Governments continue to develop efficient and effective regulatory frameworks for administrating renewable energy developments.

Relevant documents released

- Canada's Marine Renewable Energy Technology Roadmap was released in November at the OREG 2011 conference in Montreal. This document is the result of a year of contributions by about 100 sector members: www.oreg.ca/index.php?p=1_58_Marine-Energy-TRM
- In July, CanmetENERGY released the Marine Energy Sector Profile and Early-Stage Supply Chain reports. OREG's discussion paper "The Role of Feed-in Tariffs: Moving Ocean Energy Ahead in Canada" has been an input to the feed-in tariff (FIT) development processes: www.oreg.ca/web_documents/oreg_the_role_of_fits.pdf
- In 2011, the Nova Scotia Government reported on consultations toward legislation actions to support the development of the marine renewable energy sector: www.gov.ns.ca/energy/resources/spps/public-consultation/marine-renewable-energy/Fournier-Report-English.pdf
- In a significant step toward an industry development plan, Nova Scotia also released the Marine Renewable Energy Infrastructure Assessment Report looking at the capacity to support development: www.gov.ns.ca/energy/renewables/explore-invest/recent-reports.asp
- The Fundy Ocean Research Centre for Energy (FORCE) released its first environmental assessment and monitoring reports in October 2011: fundyforce.ca/assessment, fundyforce.ca/monitoring

RESEARCH & DEVELOPMENT

Government Funded R&D

FORCE, Offshore Energy Environmental Research (OEER) and the Fundy Energy Research Network (FERN) in Nova Scotia have launched a suite of strategic research and monitoring initiatives. Research activities to date can be found at www.offshoreenergyresearch.ca/Home/TidalEnergyResearch/tabid/386/Default.aspx
In the last couple of years, marine energy research has been conducted at the University of Victoria, University of Winnipeg, Acadia University, Dalhousie University, and College of the North Atlantic. Marine energy research activities at universities have been growing with around 12 graduate students and focused research grants of approximately $5 million (CAD) in place.
The Marine Energy Technology team at CanmetENERGY (an NRCan laboratory) is supporting and conducting technology-focused research, and is the only Federal Government team that is focused on marine energy. The CanmetENERGY Marine Energy Team is currently engaged in marine energy research to support the development of standards, technology advancement, resource characterization, and monitoring equipment. CanmetENERGY is also supporting the Canadian effort for developing international standards for this sector and has supported the development of the industry-lead Marine Renewable Energy Technology Roadmap. The Geological Survey of Canada, another area within NRCan, has projects focusing on understanding sea floor geomorphology and dynamics and potential impacts to marine energy project siting.
The Department of Fisheries and Oceans (DFO) is the Federal Government department leading the efforts on environmental impacts research. DFO is currently working on a project that develops pathways of effects (PoEs) models for each major form of offshore renewable energy technology. The next stages will include the assignment of levels of risk and identification of major regulatory decision points with the intent to produce a development of environmental regulatory guidance document in 2012.

Participation in Collaborative International Projects

The Clean Energy Dialogue was established between Canada and the United States in February 2009 to enhance joint collaboration on the development of clean energy science and technologies to reduce greenhouse gases and combat climate change.
In September 2011, Canada and the United Kingdom signed a joint declaration to ensure a stronger

partnership for the 21st century. One of the topics pointed to in the declaration states "We will encourage the development of technology systems necessary for commercial-scale electricity production from marine energy. We plan to lead the world in moving forward from pilot wave and tidal energy devices to exploring actual power generation stations connected to our respective electricity grids".
FORCE and the European Marine Energy Centre (EMEC) joined in a strategic relationship in 2011 with the signing of a Memorandum of Understanding. Collaborative activities under this relationship may include, but are not limited to, activities in the scientific and technical areas of mutual interest.
In June 2011 Canada relinquished the chair of the IEC TC114 committee but the Canadian contribution to the standards initiative continues with experts participating in all 8 active project teams.
New Energy continues to work with resellers in India and Alaska in pilot in-stream project development. Sabella Energie Inc. continues the development of river and marine current technologies in collaboration with French project partners. Clean Current Power Systems has completed its work with Alstom in support of the commercial-scale version of their tidal generator, and is now developing and testing its new river-current device. Powertech Labs and Triton Consultants have provided feasibility assessment advice to Korean utility projects. SMRU Ltd (Canada) is collaborating with Northwest National Marine Renewable Energy Centre and Pacific Northwest National Laboratory on US Department of Energy (DOE) funded project investigating impact of noise on the marine environment from tidal in-stream energy converters (Snohomish Public Utility District project focus).

TECHNOLOGY DEMONSTRATION

Operational Ocean Energy Projects

Open Hydro, the first deployment at the FORCE test centre in Nova Scotia, recovered their turbine from the site in December 2010. The device was still on station and the retrieval was successful. Blade failures had occurred and data analysis determined that the failures occurred during exposure to the second spring tides.

RER - Renewable Energy Research deployed the TREK turbine in Montreal Harbour in the second half of 2010. The operator reports 10,000 hours of energy production.

The original **Clean Current Power Systems** generator has been recovered from the Race Rocks demonstration site after five years of deployment for analysis of fouling and corrosion. As North America's first prototype large-scale tidal generator, it will be exhibited in Canada's Science and Technology Museum in Ottawa.

New Developments

There was ongoing marine energy converter technology development in 2011 by **Clean Current Power Technology, Grey Island Energy, Mavi Innovations, New Energy Technology, RER, Sabella Energie and Seawood Designs**. Six technology developers used the National Research Council's Institute for Ocean Technology (NRC-IOT) as a testing facility for model validations and tow tank work. Powertech Labs completed work to help improve river-current and wave energy device designs. Triton Consultants has been working on advancing regional and site-scale resource modelling for wave and tidal energy.
Alstom Hydro has been finalising design and building a full commercial-scale prototype of the device originally developed by Clean Current Power Systems.
After a slow-down in the permitting process, the Canoe Pass project to deploy 2 x 250kW **New Energy EnCurrent** generators is on track for 2012 deployment.
The cabling to allow a 65MW capacity installation at FORCE has been delivered for a 2012 installation.
Atlantis Marine Resources and its partners Lockheed Martin and JD Irving have been selected as the fourth berthholder for deployment at FORCE. They join the three other berth holders: Alstom, MCT / Minas Basin Pulp and Power, and Open Hydro / Nova Scotia Power.
A first deployment of the **Sabella** river generator is planned for 2012 in Montreal Harbour.
A new river-current testing and development site is being identified by Manitoba Hydro and the University of Manitoba.
Emera has indicated that it is assembling partners to begin planning a 40MW tidal development for Nova Scotia, with the aim of contributing to the first Marine Renewable Energy Technologies Roadmap target for 2016.

UNITED STATES OF AMERICA

Michael C. Reed, U.S. Department of Energy

INTRODUCTION

This past year included notable achievements for ocean energy research, development and deployment in the U.S., including open-water tests of wave and current energy devices. Environmental research for ocean energy systems began to show results as resource assessments are reaching completion and databases are being launched. Significant progress was also made in technology research as the first set of Department of Energy (DOE) Reference Models near completion and an Annex to the International Energy Agency's Ocean Energy Systems – Implementing Agreement (OES) was approved. Scientific programmes continue to develop at multiple universities and national laboratories and several wave and tidal energy projects were deployed with more expected in 2012. The outlook for 2012 is optimistic, with indications that Government support will continue and results from additional demonstration projects will be available.

Two projects succeeded in deploying their devices in a relevant environment, while a number of other projects are expected to enter the water in early 2012. 2011 also marked the submission of a Federal Energy Regulatory Commission (FERC) Federal Pilot License application for a tidal turbine project in Maine and DOE's adoption of FERC's environmental assessment and issuance of a Finding of No Significant Impact for a single wave buoy project in Oregon.

OCEAN ENERGY POLICY

Strategy and National Targets

The mission of the Water Power Program is to research, test, evaluate, develop and demonstrate deployment of innovative technologies capable of generating renewable, environmentally responsible and cost-effective electricity from water resources. Pursuant to that mission, the Programme is currently undertaking the necessary analysis to assess the opportunities associated with tapping ocean energy resources. The results of this analysis will effectively inform DOE's strategy going forward, which will include the establishment of aggressive national goals for deployment of marine and hydrokinetics (MHK) technology in the United States.

Water Power Vision

The vision of the Water Power Program is that effective and efficient investments of DOE resources in support of advanced water power technologies will enable the development of a robust and competitive MHK industry in the United States that capably contributes to our Nation's energy portfolio.

In order to achieve this vision, the Programme is focusing its near-term research and development efforts in the following areas:

- Determine extractable resource potential;
- Address environmental challenges;
- Validate Levelized Cost of Energy (LCOE) and opportunities for cost reduction by identifying key cost drivers;
- Demonstrate performance viability and identify technology leaders.

The current MHK portfolio consists of 73 projects and represents a total programme investment of $87.2 million, including mortgages. Most of the MHK funding is directed toward technology development activities. Currently, technology development accounts for 87% of funding.

Support Initiatives and Market Stimulation Incentives

Incentive programmes are a key component vital to the successful advancement of the marine and hydrokinetic technology industry. The success of the wind industry in the United States is largely due to incentive programmes. Similarly, the success of Europe's renewable energy industry, particularly Germany's wind industry, is largely due to successful feed-in tariffs. There are a number of federal incentives that can be leveraged to further MHK in the U.S.

Federal Renewable Energy Financial Incentives:

- Clean Renewable Energy Bonds (CREBs);
- Qualified Energy Conservation Bonds (QECBs);
- Renewable Electricity Production Tax Credit (PTC);
- Renewable Energy Production Incentive (REPI);
- U.S. Department of Energy - Loan Guarantee Program;
- U.S. Department of Treasury - Renewable Energy Grants;
- USDA - Rural Energy for America Program (REAP) Grants;
- USDA - Rural Energy for America Program (REAP) Loan Guarantees.

DOE maintains a database of state incentives for renewables and efficiency which can be found on the following website: http://www.dsireusa.org/

Government support for MHK technologies has continued, mainly through the Department of Energy (DOE), though at a lower level than previous years, partly due to budgetary and legislative uncertainties. The upcoming Presidential election in November 2012 also reduces the likelihood that any significant piece of renewable energy or climate change legislation will be considered by Congress.

Main Public Funding Mechanisms

Funding opportunity announcements (FOA's) provide a means for distribution of appropriated funds through grants and cooperative agreements. In 2011, no FOA's were released for MHK technologies, however out year funding continued on previously awarded projects.

Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) are U.S. Government programmes, in which Federal agencies with large research and development budgets set aside a small fraction of their funding for competitions among small businesses only. Small businesses that win awards in these programmes keep the rights to any technology developed and are encouraged to commercialize the technology. In 2011, the Department of Energy SBIR/STTR programme made a Phase I Advanced Water Power Technology Development award to Oscilla Power in support of their wave energy harvester. Seven Phase II SBIR/STTR MHK projects entered their second year of funding and continued their analysis, design and commercialization efforts.

Relevant Legislation and Regulation

In 2010, President Obama signed an Executive Order establishing a National Ocean Council and adopting a national ocean policy. In 2011, the National Ocean Council began implementation of a national Coastal and Marine Spatial Planning (CMSP) effort by hosting a national CMSP workshop. The council is working to draft strategic action plans for each of the nine ocean policy priority objectives, including CMSP, which will serve as guidance and roadmaps for the implementation of the new national ocean policy.

The final stage of the reorganization of the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) became effective on 1 October 2011, when it split into two independent entities: the Bureau of Ocean Energy Management (BOEM) and the Bureau of Safety and Environmental Enforcement (BSEE). Currently, BSEE will only address oil and gas and all renewable energy functions will be housed under

BOEM. BOEM is responsible for all renewable energy function and for managing development of the Nation's offshore resources in an environmentally and economically responsible way. Functions include: leasing, plan administration, environmental studies, National Environmental Policy Act (NEPA) analysis, resource evaluation, economic analysis and renewable energy. BSEE enforces safety and environmental regulations. Functions include: all field operations including permitting and research, inspections, offshore regulatory programmes, oil spill response, and newly formed training and environmental compliance functions.
BOEM has seen very strong interest in offshore renewable energy projects on the Outer Continental Shelf (OCS). BOEM is working closely with several states regarding offshore energy development and is in the process of coordinating federal-state task forces in 17 coastal states.

Relevant documents released

The DOE has completed wave and tidal energy resource assessments of US coastal waters this year. The projects include publicly available Geographical Information Systems (GIS)-based maps of the power densities, energy fluxes, and bathymetry as well as final reports that detail the methodology used to carry out each assessment. Independent validation of the results is an integral part of each project: a national lab carried out an independent validation of both projects and the National Academy of Sciences is conducting a peer review of the methodology.

- Tidal energy resource assessment report: http://www1.eere.energy.gov/water/pdfs/1023527.pdf
- Tidal energy map: http://www.tidalstreampower.gatech.edu
- Wave resource assessment report: http://my.epri.com
- Wave energy map: http://maps.nrel.gov/mhk_atlas

DOE conducted an Advanced Marine Renewable Energy Instrumentation Experts Workshop on 5-7 April, 2011. The report can be found at: http://www.nrel.gov.
DOE conducted the 2011 Marine Hydrokinetic Device Modeling Workshop on 11 March 2011. The report can be found at: http://www.nrel.gov.

RESEARCH & DEVELOPMENT

Government Funded R&D

The primary focus of Federal-level activity remains to improve performance, reduce costs and accelerate deployment of innovative water power technologies. This is accomplished via provision of grant support to companies and institutions active in ocean energy R&D in the United States – much of which is funded through the DOE Wind & Water Power Program. Targeted investments are focused the elements that will deliver the Water Power Vision (see above).
DOE continues to use Technology Readiness Levels (TRLs) as an organizing principle to reduce risk within DOE's investment portfolio and allow tracking of progress towards technology maturity. Technology Readiness Levels (TRLs) are used by numerous Federal agencies, including the Department of Defense and National Aeronautics and Space Administration and many private sector companies, as a measure (or metric) to assess the maturity of evolving technologies. TRLs 1-4 are focused largely on Research and Development (Innovations and Emerging Technologies) and TRLs 5-8 involve Technology Demonstration (latter stages of Emerging Technology through Systems Integration).
The US DOE has launched an effort to develop "Reference Models" for marine and hydrokinetic devices. These are technology and cost models with scaled model validation tests that provide a technical, economic and environmental benchmark against which new MHK designs can be measured. The first 3 baseline models (1 wave, 1 tidal and 1 river current device) have been under development for over a year, and two of these are nearly at a stage to be released for public dissemination and use. The third (a wave device) requires additional work before its release in 2012. The next 3 models, consisting of 2 wave energy converters and 1 ocean current device, have been selected and development has begun.
The reference models investigate characteristics affecting the overall cost of electricity of MHK device types, which includes energy conversion performance, environmental compliance and mitigation, and life

cycle cost. The baseline models assess the current state-of-the-art performance of marine energy devices, using scaled testing to validate analytic and empirical design assumptions and technical approach. The cost analysis of these models is parameterized so that the influence of array scale, resource intensity, and other variables can be evaluated. The reference models will lead to understanding the key cost drivers of the devices, so that future device research and development can focus on modifications that are critical to COE reduction.

The Department of Energy is actively working to research, monitor and mitigate the potential environmental effects of marine renewable technologies. During 2011, DOE completed the initial development of a publicly accessible environmental research database that will house both domestic data and information gathered through an international environmental data sharing agreement.
The Department has also conducted a well-attended series of webinars aimed at increasing awareness of environmental research surrounding marine and hydrokinetic technologies. Topics included 1) data management, cumulative impact modelling, and risk assessments 2) interactions between aquatic animals and MHK devices 3) monitoring technologies and strategies 4) research on the potential acoustic effects of marine and hydrokinetic technologies.
The programme supports the development and testing of a wide variety of marine and hydrokinetic systems and components from the earliest-stage proof-of-concept studies through full-scale demonstration projects. The funding mechanism for this support is the provision of federal grants, which typically have a cost share requirement. To meet the cost share requirement, awardees must provide matching funds, typically on the order of 20 - 50% of the federal award. FY11 federal investments correspond to $17 million of non-federal investment in MHK technologies through cost share requirements. Over their entire period of performance, these projects will total approximately $57 million of non-federal cost share. Of these projects, 31% are TRL 1 - 3, 25% are TRL 4, 33% are TRL 5 - 6 and 11% are TRL 7 - 8.
There are over 100 US based MHK companies who are actively engaged in developing MHK devices across all technology readiness levels. Current global economic conditions have created a challenging environment for raising venture capital; therefore investment in MHK R&D is largely based on state and federal grants, "angel" investors and other forms of private investment.

Participation in Collaborative International Projects

The Department of Energy proposed an Annex to the International Energy Agency's Ocean Energy Systems - Implementing Agreement (OES) entitled "**Exchange and Assessment of Ocean Energy Device Project Information and Experience**". The OES Executive Committee approved the Annex during their meeting on 13 - 14 September, 2011 in Madeira, Portugal (See chapter 3).
A wide range of different ocean energy technologies and devices are currently in development around the world. However, the data that exist on the possible environmental impacts of these technologies are often scarce, expensive to collect, and widely dispersed amongst different countries and developers. These environmental data are a critical component to the permitting and siting of MHK projects and are required for the successful advancement of the MHK industry. The DOE, in collaboration with the BOEMRE, and the Federal Energy Regulatory Commission (FERC) lead an international data sharing effort on the environmental effects of MHK technologies to create Annex IV (See chapter 3).
The DOE Office of Science (SC) is supporting an MHK Irish Fellowship programme. This programme supports research to advance the development and testing of MHK technologies. This fellowship programme will competitively select and send U.S. postgraduate students, engineers, and/or scientists to participate in research projects at selected European marine energy test sites and research institutions that have partnered with the U.S. Department of Energy.
DOE has been in communication with the Canadian Department of Fisheries and Oceans (DFO) to gauge common interests and activities, in which both countries are currently involved. Specifically, the U.S. DOE has been in contact with a representative of DFO Canada regarding their Pathways and Effects model to determine and prioritize the potential and environmental impacts of offshore renewables.

TECHNOLOGY DEMONSTRATION

Operational Ocean Energy Projects

The Ocean Energy industry in the US is largely comprised of pre-commercial stage projects and in 2011, Research and Development work continued at all Technology Readiness Levels. DOE continued support for industry demonstration projects through its Technology Readiness Advancement Initiative as well as Advanced Water Power grants. Two of the projects succeeded in deploying their devices in a relevant environment:

Free Flow Power (http://free-flow-power.com)

> *The Ocean Energy industry in the US is largely comprised of pre-commercial stage projects and in 2011, Research and Development work continued at all Technology Readiness Levels.*

Free Flow Power deployed an in-stream hydrokinetic turbine in the Mississippi River on 20 June 2011, near Baton Rouge, LA. Operational data is being collected to evaluate technical and environmental performance (http://free-flow-power.com).

Columbia Power Technologies' SeaRay prototype wave energy converter was deployed on 15 February 2011, in Puget Sound, WA and continues operating to date, controlled remotely from Corvallis, OR (http://www.columbiapwr.com).

The two projects mentioned above are actively conducting R&D and it should be noted that while sustained deployment data is of interest to both developers, the devices are being deployed and recovered as necessary to support their research and testing needs. Device developers continued to make strides in advancing their technologies down the commercialisation pathway in 2011. In order to support the emerging industry and numbers of devices that will require testing, US DOE investment in testing infrastructure continues. Test facilities are intended to offer a wide range of testing services that address both technical and nontechnical barriers of MHK systems. By spearheading the development of a testing infrastructure, DOE ensures that many more prototypes from a diverse set of technology developers can be tested than if each had to carry the cost of developing, permitting, and installing their own test facility. In this way, superior technology performance and design will determine which technologies will succeed, rather than those with more funding. Over 25% of MHK federal investment is dedicated towards advancing testing capabilities.

Northwest National Marine Renewable Energy Center (NNMREC)
Wave and Tidal Test Facility

The Northwest National Marine Renewable Energy Center (NNMREC) is a partnership between Oregon State University (OSU) and the University of Washington (UW). While serving as a standardized test facility for wave and tidal energy developers, the Center also focuses on research, education, outreach, and engagement. In the area of advanced wave forecasting, NNMREC has established a wave prediction scheme for the entire state of Oregon. The final site for the Newport wave energy test site was selected and background data collection continues to characterize the site. Field measurements continued at the

Snohomish PUD site in Admiralty Inlet; this continuous dataset is now over two years long and represents the best characterized tidal site in the US. Work has continued on a developing baseline acoustic database and various contributions from multiple existing sources (http://nnmrec.oregonstate.edu).

Southeast National Marine Renewable Energy Center (SNMREC)
Ocean Current Test Facility
SNMREC is working towards the implementation of a full-scale, at-sea testing infrastructure for open-ocean current energy conversion prototypes. Site characterization and environmental studies continued off the coast of Florida in support of Florida Atlantic University's effort to complete the permitting process for the test facility. Monthly aerial surveys continued to assess sea turtle individual and species distribution. To date, six surveys have been completed (http://snmrec.fau.edu).

Hawaii National Marine Renewable Energy Center (HINMREC)
Wave and OTEC Test Facility
HINMREC's mission is to facilitate the development and commercialization of wave energy conversion (WEC) devices and ocean thermal energy conversion (OTEC) systems. The University of Hawaii began site surveys at the Navy's Kaneohe Bay Test Site and initiated preliminary environmental analysis for possibly expanding the current test site (http://hinmrec.hnei.hawaii.edu).

New Developments

In conjunction with the DOE funded Reedsport PB150 Deployment and Ocean Test Project, New Jersey based Ocean Power Technologies (OPT) will deploy a 150 kW WEC device in 2012 to collect detailed operational data during two years of operations. This deployment is the first device deployment for a planned 1.5 MW wave farm in the Oregon Territorial Sea. On 15 April 2011, OPT successfully deployed a PB150 PowerBuoy at sea near Invergordon, Scotland. Sea trials were used to perform functional testing, examining the response of the PowerBuoy's structure and mooring system to the waves and the power produced by the on-board generator (http://www.oceanpowertechnologies.com).

Ocean Renewable Power Company (ORPC) is developing a 5 unit, grid-connected array of cross-flow tidal turbines near Eastport, ME. During 2011, significant progress was realized in both permitting and refinement of the device design. ORPC anticipates initial installation activities for the first unit to begin in March 2012 (http://www.oceanrenewablepower.com).

Public Utility District No.1 of Snohomish County (Everett, Washington) will continue to develop its efforts to deploy, operate, monitor, and evaluate two open-centre turbines, developed and manufactured by OpenHydro Group Ltd., in Puget Sound's Admiralty Inlet. Significant field measurements have already been performed, making this the best characterized tidal site in the US. Additional environmental monitoring will be taking place over the next 12 months and a deployment date will be set in Fiscal Year 12 (http://www.snopud.com).

BELGIUM

Pieter Mathys, Julien De Rouck, Ghent University
Gabriel Michaux, Federal Department of Economy

OCEAN ENERGY POLICY

Strategy and National Targets

Belgium has to increase its share or renewable in the gross final energy consumption to 13% by 2020. According to Eurostat, this share was 4.6% in 2009. The burden sharing between the Federal and regional states is still a point of discussion. On the Federal level, a strong increase is observed in 2010/2011 and will continue in the next years, mainly due to the developments for offshore wind (target set at 2 GW, currently 195 MW installed offshore). No specific targets have yet been set for wave or tidal current energy.

Support Initiatives and Market Stimulation Incentives

Belgium has implemented the system of Tradable Green Certificates (TGC) to support energy production from renewables. The regional Government of Flanders has approved a TGC for wave and tidal current energy of €90/MWh, guaranteed for 10 years, but it is to date unclear if this TGC could be applied since the sea area from the low water mark is under Federal, and not regional, jurisdiction. On the other hand, the Federal Government has approved a TGC for 'hydroenergy' for €50/MWh (10 years) but to date it is unclear if 'hydroenergy' also encompasses wave or tidal current energy, since hydroenergy is not defined as such in the Federal law. If wave and tidal current energy were excluded from 'hydroenergy', support would have to fall back on the lowest TGC available, which is €20/MWh.
Hence, there is significant uncertainty about the exact level of support. The Federal Department of Economy started up an evaluation in conjunction with the stakeholders to adapt this support system and to provide clarity and certainty about the exact support tariff.

Main Public Funding Mechanisms

The Flemish Agency for Innovation by Science and Technology (www.iwt.be) has co-funded the FlanSea project for €2.4 million (with €1.3 million funded by the private partners). The Federal Belgian Science policy has funded the BOREAS project (Belgian Ocean Energy Assessment, €180,000).

Relevant Legislation and Regulation

The Federal Government slightly modified the Northern and Southern boundaries of the zone for the 'exploitation for offshore wind, wave and tidal energy' in February 2011. This was mainly due to shipping lanes and navigation, but the total area did not change. The main focus for this zone is offshore wind, but it is explicitly open for wave and tidal current energy applications as well.

Relevant documents released

The BOREAS final report was released by the end of 2011 on the Belgian Science Policy website (www.belspo.be).

RESEARCH & DEVELOPMENT

Government Funded R&D

The FlanSea project, which aims at constructing a wave energy buoy for the low wave energy on the Belgian Part of the North Sea and the moderate wave climates further in the North Sea, entered its second year of development. The project partners are DEME Blue Energy, Cloostermans, Harbour of Ostend, Electrawinds, Spiromatic, CONTEC and 4 research groups from Ghent University. The BOREAS (Belgian Ocean Energy Assessment) project was finalised in 2011 and the report is available at www.belspo.be.

Participation in Collaborative International Projects

Ghent University participates in the WECWakes project, funded by Hydralab in order to assess wave energy convertor farm interactions in a physical wave flume (€225 thousands).

GERMANY

Jochen Bard, Fraunhofer IWES

OCEAN ENERGY POLICY

Strategy and National Targets

Germany's Federal Government committed itself to cut its greenhouse gas emission by 40 % compared to the 1990 baseline levels by 2020, if the European Union Member States agree to a 30 % reduction of European emissions over the same period of time. A comprehensive National "Integrated Energy and Climate Programme" has the potential to bring Germany very close to this goal by achieving a reduction of at least 36 % according to independent studies. Key elements of this programme are, amongst others:

- Renewable Energy Sources Act with the goal to increase the share of renewables in the electricity sector from the current level of at least 14% to 25-30% in 2020;
- Amendment to the Combined Heat and Power Act with the goal to double the share of high-efficiency Combined Heat and Power (CHP) plants in electricity production by 2020 from the current level of around 12% to around 25%;
- Renewable Energies Heat Act with the goal to increase the share of renewable energies in heat provision to 14% by 2020;
- Actions for grid expansion in a package of measures to improve the integration of renewables into the grid. The Energy Grid Expansion Act includes a bundled approval procedure for undersea cables connecting offshore wind turbines when new grid construction is undertaken. (IECP Action 2);
- Several actions towards energy saving in the transport and building sectors.

In context with the amendment of the Renewable Energy Sources Act, a new regulation on the demarcation of areas for specific uses at sea within the German Exclusive Economic Zone (EEZ) of the North and Baltic sea, in particular offshore wind energy, came into force in 2009. This reflects the Government strategy for offshore wind energy, which aims for the installation of wind turbines with a combined capacity of up to 25,000 MW by 2030. Spatial planning includes the designation of priority areas. The legal impact of this status is that any other uses that are not compatible with the designated priority must be disallowed or denied authorisation, thereby ring-fencing potential locations for offshore wind farms. To permit a flexible response to research that remains to be conducted on offshore wind energy use, these demarcations will initially only secure locations for a first tranche (with a total capacity of approx. 10,000 MW). A decision will have to be taken in the medium term as to whether any further priority areas are to be designated and, if so, where, on the basis of an amended or new plan, so that the Government's target of 25,000 MW can be assigned within the appropriate corridor.

Currently, there are no explicit plans to include wave energy into spatial planning but a study launched by the National Government identified no issues in the legislation, which would prevent wave energy projects from receiving approval.

A feed-in tariff for electricity from wave and tidal energy similar to the tariff for small hydropower has been available under the Renewable Energy Act since 2005. These figures were raised in 2009 to €11.67/kWh for power plants below 500 kW and € 0.0865/kWh up to 5 MW.

PUBLIC AND PRIVATE R&D

In the ocean energy sector, around 15 R&D institutes and universities are involved into developing wave, tidal current and osmotic power mainly in the framework of European research projects. The National funding in the framework of the national energy research programme for renewable energies was approximately €150 million in 2008. This programme is open to ocean energy research but not many proposals have been funded

yet. Up to now, three technology projects related to the development of components and concepts for tidal turbines have been funded for a total amount of €5.4 million.
The first projects were related to the development of a tidal turbine concept and component. Fraunhofer IWES (former ISET) and LTI Power Systems developed a pitch system, the dynamic simulation, control engineering and new drive train concepts for marine current turbines, such as the British Seagen concept, which was successfully installed in 2008. In the year 2011, Siemens became the main shareholder of Marine Current Turbines with a share of 45% through an investment coming from the new division Solar & Hydro within the Siemens-Energy sector. With this, tidal turbines have become a part of the Siemens energy technology portfolio. There are great expectation about the realisation of the first two farm projects, namely the 8 MW project at Kyle Rhea in Scotland and the 10 MW farm at the Skerries off the island of Anglesey, North Wales. The Crown Estate has leased these sites.

In 2009 Voith Hydro launched another project, in co-operation with Loher, a drive system manufacturer, for the development of a tidal turbine concept. It is based on a fully submerged horizontal turbine equipped with a variable speed direct drive permanent magnet generator and symmetrically shaped fixed blades, which allow the operation in two opposite flow directions. A first 110 kW pilot installation was installed during 2011 at a site off the coast of South Korea. Commissioning and testing is ongoing. A second device with 1 MW capacity will be installed at the European Marine Energy Centre (EMEC) for testing with funding from the UK Marine Renewables Proving Fund (MRPF). In February 2009 Voith Hydro, together with the German utility RWE Innogy, founded a joint venture named "Voith Hydro Ocean Current Technologies". In the framework of its venture capital activities, RWE holds 20% of the shares. The total investment expected in the coming years to commercialise the turbine technologies is €30 million.
The German marine propulsion specialist Schottel placed an investment into the UK tidal-power technology developer TidalStream in 2011. For Schottel, renewable energy is an interesting and forward-looking addition to the traditional product range portfolio. The Triton platform technology comprised of a semi-submerged turbine-carrying catamaran structure is expected to enable efficient installation of large power arrays and provides easy maintenance access. The Triton S concept is tailored to operate totally submerged for "non-surface piercing" applications by using a rigid swing-arm tether foundation, designed to be towed to site, mated with turbines and deployed into operating position via water-ballasting. After completing the ongoing 1:10 scale field test, up-scaling of the technology is ongoing with the Triton 3 for intermediate water depths with the capacity to generate up to 3MW from a single installation followed by the Triton 6 designed for deep water sites to accommodate turbines of up to 10MW capacity.
In 2005, Voith Hydro acquired the Scottish company Wavegen. Under the leadership of Voith, Wavegen's Wells-turbine technology has been developed further. In 2011, the Mutriku breakwater power plant applying this technology in a first commercial project under EU und EVE funding came into operation (see Spanish country report for further details). Another commercial breakwater installation based on up-scaled Wells turbines with a total capacity of 4 MW is planned on the Isle of Lewis, known as the Siadar Wave Power Station.

Other German suppliers such as Siemens, Bosch Rexroth, Schaeffler, Contitech, Thyssen Krupp, Hunger Hydraulik and Hydac deliver components and parts for a number of ocean energy devices – for wave as well as tidal turbine technologies mainly in Europe. Certification companies and consultants are contributing to the technology and project development in the sector. This international collaboration demonstrates the technology export opportunities, which exist in the ocean energy for the German industry.
A national Master Plan for Maritime Technologies is being prepared under the coordination of the Ministry of Economics and Technology to support the development of the maritime technology industry in the coming years. The goal is to develop recommendations for a future coordinated maritime technology policy, at federal and state level, and the clustering of the core competencies of industry and science through enhanced networking and clustering. It is anticipated that ocean energy technologies will play a role in the plan.

TECHNOLOGY DEMONSTRATION

In addition to the projects mentioned above, major German utilities such as E.ON and RWE are active in the ocean energy sector with test installations and prototypes around Europe. There is no ocean energy installation realised in Germany yet and no plans for installations have been published this year.

NORWAY

Harald Rikheim, Statkraft AS

INTRODUCTION

Due to the good energy resource and pragmatic consenting process for small-scale test installations in the sea, several developers continue their development work in Norwegian waters. Academic R&D activity also remains strong in all aspects of ocean energy. Governmental support and encouragement for R&D is increasing, especially for research. Some prototypes and demonstration units have received public support, but it is still difficult for small developers to achieve financial support. The common green certificate, agreed with Sweden from 2012, provides no extra certificates for ocean energy. A total price (el-spot + certificate) of approximately €75/MWh will most likely not alone, initiate any wave or tidal projects.

OCEAN ENERGY POLICY

Strategy and National Targets

An updated governmental strategy for energy is expected in 2012.

Norway has no special policy for ocean energy but ocean energy is included in more general renewable energy policies and programmes. An updated governmental strategy for ocean energy is expected in 2012.

Support Initiatives and Market Stimulation Incentives

In 2011 Norway and Sweden signed an agreement for a joint green certificate market. From 2012 on, one certificate per MWh will be given to all new renewable energy generation for 15 years, independent of the technology. The price per certificate is driven by the market with a common electricity production target of 26.4 TWh by the end of 2020. No extra certificates will be given for ocean energy generation and a likely certificate and a power price in the joint market are approximately €25/MWh and €50/MWh, respectively.

A total income of €75/MWh is almost certainly not enough for wave and tidal projects in the next decade, but governmental support programmes for research and development are intended to drive the development.

Main Public Funding Mechanisms

The Norwegian Energy Agency, ENOVA, offers capital grants for full-scale demonstration projects of marine renewables. While up to 50% of eligible costs can be covered, ENOVA's funding - measured in absolute figures - is limited. In addition, ENOVA has a programme that supports demonstrations of new energy technology. In 2010, Innovation Norway launched a programme supporting prototypes within "Environmental friendly technology". Ocean energy is included in this definition. Projects are supported with up to 45% of eligible costs.

The Research Council of Norway has an energy research programme called RENERGI. This programme supports R&D within all renewable energy technologies.

In 2011, these three institutions had a combined budget of approximately €110 million.

Relevant Legislation and Regulation

The Ocean Energy Bill, which regulates renewable offshore energy production entered into force on 1 July 2010. According to this new legislation, licences to build offshore wind, wave and tidal farms in certain far-shore geographical areas cannot be given without a prior governmental process, where suitable areas are identified, made subject to consequence assessments and made available for leasing. This legal framework is very much inspired by similar legislation in the Norwegian Petroleum Sector.

As a follow up on the Ocean Energy Bill, a group of relevant governmental bodies has identified 15 areas that could be suitable for large-scale offshore wind power. More detailed "strategic consequence assessments" will be finalized in 2012.
Meanwhile, the licensing body NVE has continued to prioritize small scale demonstration projects located nearshore according to the existing Energy Bill. The licensing process is efficient and pragmatic.

RESEARCH & DEVELOPMENT

In Norway, ocean energy is included in more general renewable energy support programmes. The overall funding for renewable energy R&D made available through the Norwegian Research Council, Innovation Norway and ENOVA has increased significantly over the last years. This has also resulted in increased funding for ocean energy projects as well, from research to prototypes and demonstration.
The research cluster in Trondheim, comprising of NTNU and SINTEF/MARINTEK, is active in ocean energy research. Some of the activities are technology screening and verification, control systems, mooring, marine structures, safety, optimal design of devices and load modelling. MARINTEK's model tank is also used to test ocean energy devices.

Runde Environmental Centre (REC) is located on the island Runde, off the Norwegian west coast. REC conducts research into marine biology, oceanography and ocean energy. REC has developed leading in-house competence on environmental monitoring, and offers Remotely Operated Vehicles (ROV) survey, field sampling and laboratory facilities to investigate environmental impacts of the tested devices. The test site is being developed in co-operation with the local marine industry to ensure customers find world-class services for all other necessary disciplines, making it an ideal location to perform extended product development, survivability and endurance tests, as well as technology qualification testing prior to field development.

The Stadt Towing Tank (STT) was founded in 2007 to deliver test and research services to the marine industry. The main market for STT has been ship designers in the maritime cluster of north-western Norway, but projects related to renewable energy were the main market in 2011, as new concepts are being developed and in need of testing and verification.

TECHNOLOGY DEMONSTRATION

Operational Ocean Energy Projects

Hammerfest Strøm
Hammerfest Strøm is among the leading technology developers in the world and is now taking the step into commercial delivery. The company has unrivalled commercial operation experience, by having developed and installed the world's first grid connected tidal turbine – the HS300. The technology has been tested and operated for more than 6 years, and has a track record over 17500 hours production time.
Based on this technology and experience, the company has developed a 1 MW tidal turbine, named HS1000™, and the company has received Carbon Trust funding for the HS1000 turbine development. The installation of the pre-commercial unit HS1000 was completed in the first part of December this year at the European Marine Energy Centre (EMEC) and commissioning will be in January 2012, after a test period.
Hammerfest Strøm is working closely together with its industrial shareholders, Andritz Hydro, Statoil and Iberdrola, and in co-operation with R&D institutions and sub-suppliers.

1.5 MW prototype Morild II in Lofoten, Norway
(Photo by Eric Fokke, www.lofotenbilder.no)

Hydra Tidal

Hydra Tidal´s floating concept idea for Morild I was registered in 2001 - and subsequently developed and laboratory tested through to 2008. The focus has since been directed towards designing, building and commissioning the full-scale 1.5 MW prototype Morild II in Lofoten, Norway. Since the official opening in November 2010, the plant has been grid-connected and pre-tested for performance, and has made several successful trial-feeds to the grid. Following a current modification and upgrade of the tidal power device, it will be re-connected to the grid, and tested further for performance, leading towards a complete verification and evaluation of the technology. In June 2010, Hydra Tidal was awarded the Schweighofer Prize for using turbine blades machined from pine timber. In 2011, the company became part of major Norwegian industrial group, and is currently seeking collaboration for tidal lease opportunities in strategic territories in the UK, North-America, the Far East, as well as in the Norwegian waters. Hydra Tidal is part of Straum, a Norwegian based technology developer and turn-key provider of marine renewable power plants (see www.straumgroup.com and www.hydratidal.com for more information).

Fred Olsen

In 2009 Fred Olsen Ltd. deployed the wave energy buoy, called "BOLT", their first full-scale prototype wave energy buoy with electricity production. The point absorber unit, which has a 45 kW installed capacity, is located on the south-east coast of Norway, close to the town of Risør. The system is not grid connected. As of mid-December 2010, BOLT has endured 18 months of sea operations with electricity production. The buoy will now be moved to a harsher environment further offshore in order to test max operating capabilities and production performance. The successful development of BOLT has also resulted in Fred Olsen Ltd being awarded a significant grant from the Technology Strategy Board in the UK and a pre-commercial full-scale BOLT unit was developed and deployed in the UK during 2011.

Seahorse

Seahorse is a single point absorber concept developed by the utility E-CO Energi. A main buoy on the surface and a submerged torpedo buoy are connected to the submerged generator unit by separate cords. The wave motion will move the surface buoy up and down, while the torpedo buoy will move in the opposite direction. This rotates the permanent magnet generator and produces electricity. The cords and the generator can be described as a two-drum/two-cord system. In this way, two drums have different sizes for the two cords to get correct speeds and force. A 3 kW prototype of the Seahorse concept has been tested at the Runde Environmental Centre (REC) in 2011.

Statkraft's Osmotic Power Prototype

Statkraft opened the world's first osmotic power plant in 2009 in Norway. The operation of the plant proves that power from salinity gradients can supply a stable base load of renewable energy, with a minimal ecological footprint. The next big milestone is the decision to build a 2 MW pilot plant. Investment decision is planned for 2013. Furthermore, the goal is to build a full-scale demonstration plant by 2020. Statkraft and Nitto Denko/Hydranautics have entered into an agreement for the development and supply of membranes for osmotic power. This co-operation will accelerate the development of membranes specifically designed for the use in large scale osmotic power plants.

Statkraft believes that osmotic power is one of the technologies that can provide clean energy towards 2050, and will continue to work with industry experts and technology suppliers globally to create real industrial progress and help realize the potential of salinity gradients.

New Developments

Havkraft AS

Havkraft is a Norwegian 'green technology' company specializing in offshore installations for the utilization of wave energy for power production. The company's shareholders are founder Geir Arne Solheim and Fjord Invest. Tests conducted in 2011 show promising results. H-WEC (Havkraft Wave Energy Converter) combines high efficiency and simple construction - with no movable parts in contact with sea - in an improved and patented OWC device (PCT pending). A large scale test programme will be started in 2012 with support from Innovation Norway and co-investors.

Langlee Wave Power

The Norwegian company Langlee Wave Power has developed an offshore floating wave energy converter with the innovative flap/wing system designed for the horizontal movements of the wave. The semi-submersible design for 50-150 m water depths is based on Norwegian offshore engineering and in 2010 Aker Solutions executed analysis and structural engineering for Langlee. The second round of extensive testing at Aalborg University, Denmark, was successful. Recently, Langlee has announced the development of a new mooring system based on proven fish farm technology to drive down supply chain costs.
In the summer of 2012, Langlee will deploy its own demo unit outside Egersund, Norway, for testing and verification. The Turkish company Ünmaksan has also a co-operation agreement with Langlee for a customer pilot in 2013. Projects for Island States, South America and Spain/Gran Canaria are in progress. Langlee has signed a Letter of Intent with Tangaroa Energy in New Zealand to launch a demonstration project off Steward Island, South Island, New Zealand. The project has just secured NZ$ 312,000 of funding from the New Zealand Government. Deployment is planned in 2012.

Intentium

Intentium AS is a Norwegian-based wave power developing company. Founded in 2007, the company's main goal has been to contribute to a sustainable energy production, through developing a wave energy system, called Intentium Offshore Wave Energy Project - iowep. Since start-up, the company has conducted internal model tank testing, carried out some external feasibility studies and gained patent NO329737B1 (international patent pending). The major news in the innovation is a focus on the dominant wave direction and wave crest length, the use of a double-acting pump, a buoyancy-controlled water anchor and a power take-off (PTO) consisting of an accumulator, water turbine and generator.

OWC Power

The Norwegian company OWC Power AS develops a wave power device based on the Oscillating Water Column (OWC) principle. Both the offshore engineering and fabrication specialist NLI and hydropower turbine supplier, Rainpower, are involved in the development project. This project is partly funded by the Norwegian Research Council. In the second half of 2011 tests of a small scale OWC device in wave tank and small scale air turbine in a turbine lab were carried out. The technology is expected to be applicable both in shoreline based and offshore based installations. The first prototype is expected to be a shoreline based installation. For further information about OWC Power AS, please visit their web pages at:
www.owcpower.com

MEXICO

Gerardo Hiriart L, ENAL, Energías Alternas, Estudios y Proyectos

INTRODUCTION

The Mexican Government has introduced significant changes to the energy sector in recent years. Mexico has large quantities of natural resources but the most important energy sources used nowadays are fossil fuels. Oil has been a key component of Mexico's economy, therefore for several years all activities in the sector were focused on traditional technologies based on petroleum products and renewable energy was not a priority. However, there is a strong political will to strengthen the energy policy with the main objective of promoting a transition to a low carbon economy. This new energy policy seeks to achieve a sustainable development and to address new challenges that the country is facing: energy security, climate change and competitiveness. One of the most important tools that the Government is encouraging to address these concerns is the diversification of primary energy sources.

Even if there is not a specific policy for ocean energy systems, renewable energy has had a significant strengthening under President Felipe Calderón administration. Several actions have been implemented in order to reduce the environmental footprint of the energy sector and to increase the use and development of clean technologies. For example, renewable energies now have a specific legal and regulatory framework to foster its development and give certainty to private investments. The Ministry of Energy has the duty to develop a National Strategy for Energy Transition and for the Sustainable Use of Energy that must be reviewed in a yearly basis and a Special Programme for the Development of Renewable Energy that includes targets and goals related to the participation of renewable sources in the domestic energy matrix.

Besides the energy sector, there is also a more active participation of other Government agencies and actors in the promotion of this industry and the conscience and interest in environmental issues is growing among society.

The Ministry of Economy is also involved and is looking to strengthen the supply chains to have local production of components and equipments. Economic and fiscal incentives have been applied to increase the interest of private industry to invest in this field.

Multiple research centres, universities and educational institutions are integrating capacity building programmes for renewable energy and the National Science and Technology Council has integrated new funding mechanisms and programmes specially oriented to sustainable energy systems.

The proposal of a new Innovation Centre for Ocean Energy is being analysed and is expected to be approved early 2012.

OCEAN ENERGY POLICY

Strategy and National Targets

- National Energy Strategy (2009-2024) - Installed capacity for power generation with clean technologies (renewable energy, hydro and nuclear) of 35%.
- Energy Sectoral Programme (2007-2012) - Participation of renewable energy (including hydro) in the energy matrix increase from 23 to 26%.
- Special Programme for the Development of Renewable Energy (2009-2012) - Installed capacity of 7.6% and power generation between 4.5 and 6.6% from the total national generation from renewable sources (not considering large hydro).

Support Initiatives and Market Stimulation Incentives

- National Income Tax Law (Article 40, fraction XII): This law establishes an accelerated depreciation of 100% on investments for renewable electricity generation equipment and machinery as an incentive for taxpayers who make investments in this field. The qualifying equipment includes all items involved in energy production from sun, wind, water, oceans and geothermal resources as well as biomass.
- Zero Tax for Imports and Exports: The pollution control equipment and parts, machinery, equipment, tools, materials, and other articles for research or technological developments are exempt from payment of general import or export tax.
- Interconnection Contract Model for Self Supply from Intermittent Sources of Energy: This contract model incorporates a methodology for self-suppliers to estimate and credit the capacity contribution of renewable energy sources to the national electric system.

Main Public Funding Mechanisms

- Fund for Energy Transition and the Sustainable Use of Energy: This fund was created under the Law for the Development of Renewable Energy and Energy Transition Financing. In the federal budget approved for the fiscal year 2010, 3,000 million pesos (US$200 million) fund was included for the promotion of the use of renewable energy.
- Federal Power Commission (CFE)-CONACYT Fund: This programme was directed for seven types of projects on specific categories, including the creation of energy from sea waves, ocean currents, hydraulic equipment, and nuclear energy, and for measuring gas emissions.
- SENER-CONACYT Sector Fund for Energy Sustainability: The main objective of this fund is to promote scientific research and applied technology as well as adoption, innovation, assimilation and technology development in four areas: i) Renewable energy sources, II) Energy efficiency, III) Use of clean technologies and IV) Diversification of primary energy sources. Resources for this fund will come from a fee equivalent to 0.13% of the value of crude oil and natural gas extracted by PEMEX.

Relevant Legislation and Regulation

The energy reform approved in 2008 enacts the Law for the Development of Renewable Energy and Energy Transition Financing (Ley para el Aprovechamiento de Energías Renovables y el Financiamiento de la Transición Energética). The main objective of this Law is to regulate the use of renewable energy as well as to establish a national strategy and financing instruments to allow Mexico to scale up electricity generation based on renewable energy sources.

The law created the Consultative Council for the Renewable Energy (Consejo Consultivo de las Energías Renovables) to incorporate all the sectors with the Government in the design of public policy. This legal framework set Mexico's strategy to support policies, programmes, actions and projects that were oriented toward increased usage of renewable energy sources and clean technologies, that promoted energy efficiency and sustainability, and that decreased oil dependency as the main source of energy.

Relevant documents released

Renewable energy is a constant in all the programmes and policies of the Calderon Administration. Some of the relevant documents released in the current administration and related to renewable energy are the following:

- National Development Plan;
- National Infrastructure Programme;
- Energy Sectorial Programme;
- Special Programme for Climate Change;
- National Strategy for Energy Transition and for the Sustainable Use of Energy;
- Special Programme for Renewable Energy Development.

RESEARCH & DEVELOPMENT

Government Funded R&D

Several R&D funded projects were running during 2011:

Hydrogenerator QK: The National University of Mexico (UNAM) through its IMPULSA Project (Multidisciplinary Research of University Projects for Leadership and Academic Progress) is improving a private design of a floating hydrogenerator named QK. This device transforms the kinetic energy of flowing water into electricity and has been tested in simple channels.
Investment: US$ 370,000 (Second phase)

SIBEO: The National University (UNAM) through the Institute of Marine Sciences and Limnology is conducting a project consisting of a pumping system activated by the resonance of the waves, using the OWC technology.
Investment: US$ 370,000

Oceanographic review off the coast of Mexico: The National University (UNAM) through the Institute of Marine Sciences and Limnology presented a proposal to develop an Oceanographic review of the coasts of Mexico to assess the potential of the thermal gradient in some regions for its use into air conditioning systems in hotels.
Investment: US$148,000

Network of Observations and Predictions of ocean variables (ROPVO) on the coasts and ports of the Gulf of Mexico: Since 2005, the National Polytechnic Institute (IPN) trough the Research Centre for Applied Science and Advanced Technology (CICATA) has been operating four oceanographic stations capable of detecting and monitoring changes in the sea level. The objective of the project is to establish a monitoring system that can led to a prediction method and an assessment of energy potential across the coast and ports of the Southeast of the Gulf.
Investment: US$370, 000

Information Recovery and Analysis of wave behaviour: In this project, data analysis of wave behaviour is made with information from several sources (remote and in situ sensors, numerical simulations). Numerical models are also used to simulate and predict the directional wave spectrum. The project focuses on information acquisition and processing techniques.
Investment: US$370,000

Wave Energy Potential Assessment in the Baja California Peninsula: This project uses numerical models to simulate waves in different geographical scales with several resolutions in the west coast of Baja California in order to assess the potential of power production in the Peninsula. The results will be used to propose a regionalization of the territory as a function of the wave behaviour and the associated energy potential. The project also includes an analysis of devices to convert wave energy into electricity.
Investment: US$148,000

Oceanlinx: Since 2006, the Federal Power Commission (CFE) has been developing with Oceanlinx, a private company of Australia, a joint test of the wave energy converter MK3 in Rosarito, Baja California. Currently, different technologies are being analysed in order to present a proposal for a 500 kW project.
Investment: US$148,000

Feasibility analysis of a wave energy power plant in Baja California Sur (BCS): CFE is trying to identify suitable sites to develop wave energy projects in the future. In Cabo Falso, BCS studies such as maritime climate and bathymetry, have been conducted.
Investment: US$ 74,000

Wave Energy in the Gulf of California: CFE has been developing oceanographic studies, mathematical

modelling, geophysics, tectonics and soil mechanics near the Montague Island and Adair Bay to assess the feasibility of a pilot wave energy power plant in the Gulf of California.
Investment: US$ 148,000

Forecasting System: The project includes the development of a numerical forecasting system of waves and tides under normal conditions, storms and heavy seas in Mexico.
Investment: US$74,000

Atmospheric characterization: The project consists of the characterization of the atmospheric boundary layer in the coastal zone of the Yucatan Peninsula to assess the offshore wind potential.
Investment: US$74,000

Oceanographic buoy: Development of a multisensory oceanographic buoy network to measure several marine and climate variables in order to have a data base and a possible potential assessment.
Investment: US$ 74,000
Participation in Collaborative International Projects

THESEUS (Innovative technologies for safer European coasts in a changing climate) is the largest integrated project within coastal risk assessment and mitigation funded by the European Commission and consists of 31 partner institutes from different countries. Mexico participates through the National University (UNAM).The scope of the work is to verify whether there are any possibilities of combining wave energy conversion with coastal protection. The impacts of the project will be focused on reducing technical and non-technical risk in the marine environment as well as reducing the cost per kWh of generated energy, through multipurpose structures designed not only for electricity generation but also for coastal protection.
Investment: US$ 10 million

TECHNOLOGY DEMONSTRATION

New Developments

UFCAP: The private company RDZ Renewables has been testing a prototype of a Unidirectional Flow Collective Air Pump and is trying to develop a commercial device based on their own patent.
Investment: US$ 74,000

Sexto Sol: Development of a wave energy converter prototype based on sequential modules of wave capture. This project seeks to reach a unique system that can be adapted to any coast of the world and to deep water as well.
Investment: US$ 74,000

SPAIN

Jose Luis Villate, TECNALIA [2]

INTRODUCTION

The main milestone of ocean energy in Spain in 2011 was the final deployment of the first grid connected wave power plant, promoted by EVE - Ente Vasco de la Energia (the Basque energy agency). Voith Hydro Wavegen handed over the Mutriku OWC plant to EVE in November 2011, resulting in the first wave power plant to be sold on a commercial basis, with standard guarantees for performance and availability. The 300kW wave power plant, consisting of 16 turbines, is housed within a breakwater at the port of Mutriku. It has been designed for a 25 year operational life and will provide electricity for 250 homes. During commissioning and acceptance testing the plant has produced 100MWh. This major achievement together with the official inclusion of ocean energy in the Spanish renewable energy plan 2011-2020 and some other industrial projects put Spain at the forefront of ocean energy development.

Turbines of the Mutriku OWC plant

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OCEAN ENERGY POLICY

Strategy and National Targets

The Spanish Government officially approved the "Renewable Energy Plan 2011-2020" in November 2011. This plan includes targets for ocean energy for the first time:

- The first 10 MW of installed ocean power are expected by 2016;
- An annual growth rate of 20 - 25 MW between 2016 and 2020 is expected to accumulate to 100 MW by 2020; The average electricity production in the period 2011 - 2020 will be approximately 50GWh/annum with a peak in 2020 of 220 GWh/annum.

The plan foresees an important growth of ocean energy after 2020 with the following phases:

- Reliability confirmation (2010 - 2015): simulation, modelling and prototypes will be key aspects. Cost of the electricity is not a major issue during this phase;

2 ACKNOWLEDGEMENT: This report has been prepared with the collaboration of APPA-Marina, the ocean energy section of the Spanish Renewable Energy Association. APPA-Marina represents the voice of the Spanish ocean energy industry with two main objectives: to promote an appropriate legal framework and to facilitate a successful technology development, both with the final goal of putting ocean

- Technology development (2016 - 2020): demonstration of full-scale prototypes with generation costs between €21 and €33 per MWh;
- Technology consolidation (2021-2030): commercial deployment of ocean power plants with a cost reduction of the electricity down to €7- €15 per MWh;

Support Initiatives and Market Stimulation Incentives

The Spanish Renewable Energy Plan 2011 - 2020 includes some strategic actions to facilitate the achievement of its targets. Regarding ocean energy the following actions are proposed:

Technology strategy actions

- An intensive R&D programme focused on new designs and components clearly aimed at reducing costs and improving the survivability of the devices;
- A demonstration programme aimed at developing and testing small scale prototypes;
  Support of experimental testing infrastructures to validate the performance of the devices during the full life cycle. This includes a specific and simplified consenting process for experimental platforms;
- Collaboration with other European countries by means of an initiative of the European Union focused on improving the reliability and new installation techniques.

Non-technology strategy actions

- Definition of a specific regulatory framework for ocean energy projects, with simplified licensing processes;
- Modification of the feed-in tariff system to create a different group for ocean energy more appropriate for its stage of development;
- Planning of grid infrastructures to facilitate ocean energy integration;
- General dissemination and promotion campaigns amongst different stakeholders to improve social acceptance and to facilitate a new market.
- There is a feed-in tariff system for the support of renewable energy sources in Spain but this system is not very attractive for ocean energy. It is possible to negotiate a specific tariff for every individual project, depending on the investment cost. However, a comprehensive description of the project is required and no references are available so far.

Relevant Legislation and Regulation

There are no additional changes in the current Spanish legislation regarding ocean energy, which is defined by means of two Royal Decrees from 2007. The first establishes the administrative procedure to apply for an authorisation for electricity generation installations at sea. The second sets the feed-in tariff mechanisms.
As mentioned before, the legal situation of ocean energy in Spain needs important improvements, which should cover the following aspects, according to the Renewable Energy Plan 2011-2020:

- Simplification of administrative procedures;
- R&D subsidies for technology development, including prototypes, resource assessment and experimental platforms;
- Investment grants for demonstration and pre-commercial projects;
- Specific and more attractive feed-in tariff system for ocean energy projects.

Relevant documents released

The Renewable Energy Plan 2011-2020 is available in Spanish at www.idae.es. It includes some technical support documents, such as a detailed evaluation of the Spanish wave energy resource.

RESEARCH & DEVELOPMENT

Government and Industry Funded R&D

The most important R&D project has been running since 2009 partially funded by the Ministry of Science and Innovation within its CENIT programme. OceanLider, led by "Iberdrola Ingeniería y Construcción", includes several R&D activities with a holistic perspective, covering the following research lines:

- Identification and characterisation of suitable sites and optimum resource assessment;
- Technology development of wave and tidal devices, including hybrid systems with offshore wind;
- Distribution, transportation, transformation and quality of electricity;
- Management, maintenance and intelligent communication systems;
- Technologies and systems for the operation and safety;
- Preservation of resources, environmental management and climate change.

The project has a budget of €30 million (€15 million public funding) a duration of 40 months and the participation of 20 industrial partners and 24 research centres.
Within the OceanLider project, Norvento Enerxía is developing its own concept of a wave energy converter. The system is between a point absorber and an outline tracker. The prototype is made up of collecting-converter floating units which capture the power in all directions. Nowadays, the design and manufacture of a scale prototype is being carried out to test in real conditions on the Atlantic coast. Such trials will allow validation and optimization of the designs and systems for the subsequent full-scale application. Norvento is also developing other projects in the ocean renewable energy field in order to promote the sector, for example, Operation and Maintenance in Ocean Renewable Energy Installations, Swell Resource Assessment on the Atlantic Coast, and Environmental Studies in Ocean Renewable Energy Installations.

Participation in Collaborative International Projects

Coordination of European Ocean Energy Research

Within the context of the European Strategic Energy Technology Plan (SET-plan), fifteen leading European Research Institutes have taken up the challenge to found a European Energy Research Alliance (EERA). The key objective of the EERA is to accelerate the development of new energy technologies by conceiving and implementing Joint Research Programmes in support of the SET-plan pool and integrate activities and resources, combining national and Community sources of funding and maximising complementarities and synergies.
In 2011, a Joint Research Programme (JP) on ocean energy was launched with the active participation of Spain through the involvement of TECNALIA. The EERA Ocean Energy JP is based around six key research themes. These themes have been developed, based on existing research roadmaps, which identify the critical areas of research required for the successful growth of the industry. The 6 research themes are Resource, Devices and Technology, Deployment and Operations, Environmental Impact, Socio-economic Impact and Research Infrastructure, Education and Training. Spain is participating in all of the research themes and TECNALIA is leading the "Deployment and Operation" theme together with the German centre Fraunhofer IWES.

MaRINET - Marine Renewables Infrastructure Network

The Spanish marine renewable energy sector is set to benefit from a new €9 million EU-funded initiative to provide access to test facilities in specialist marine renewable energy centres across Europe. 'MaRINET' (Marine Renewables Infrastructure Network) offers periods of marine renewable energy testing at these centres at no cost to participants through funding from the European Commission. The initiative, with at least four calls for applications, runs until 2015 and the first call for applications started in December 2011. In Spain, EVE and TECNALIA are key partners in this initiative: TECNALIA is offering its Electrical PTO lab testing facilities, and EVE is offering its Mutriku OWC plant and BIMEP testing facilities. A significant number of European companies and research groups are expected to apply to use these facilities. Further information can be found at www.fp7-marinet.eu

Spanish leadership in offshore multi-purpose platforms

With the leadership of the Spanish company Acciona Energia, the European MARINA-Platform project will

establish a set of equitable and transparent criteria for the evaluation of multi-purpose platforms for marine renewable energy. Using these criteria, the project will produce a novel, whole-system set of design and optimisation tools addressing, inter alia, new platform design, component engineering, risk assessment, spatial planning, platform-related grid connection concepts, all focused on system integration and reducing costs. These tools will be used, incorporating into the evaluation all presently known proposed designs including (but not limited to) concepts originated by the project partners, to produce two or three realisations of multi-purpose renewable energy platforms. The MARINA-Platform project started in January 2010 with the support of the European Commission through the seventh framework programme and will run during 54 months. More information at www.marina-platform.info

PLOCAN

The Oceanic Platform of the Canary Islands (PLOCAN), is leading another European Project (TROPOS) recently funded under the call "the Ocean of Tomorrow". The objective of this project is to design multi-use offshore platforms where ocean energy plays a key role.

TECHNOLOGY DEMONSTRATION

Operational Ocean Energy Projects

The Biscay Marine Energy Platform – bimep – provides wave energy device manufacturers with facilities to validate their designs and to test their technical and economic feasibility. The Basque coast, and specifically the location of bimep off the coast of Armintza (Bizkaia), offers suitable wave conditions for device testing and a relatively low exposure to extreme waves that could damage the prototypes. Bimep occupies a 5.3 km^2 marked area excluded for navigation and maritime traffic, and located at a minimum distance of 1,700 m from shore, close enough for fast access to deployed devices. The total power of 20 MW is distributed over four offshore connection points of 5 MW each at 50-90 m water depths.

Once authorisation has been granted for the installation of facilities and contracts awarded for the supply and installation of submarine power lines and ground cables, which will transfer power from the offshore sites to land, bimep is expected to commence operations in the last quarter of 2012.

Aerial view of the bimep area

> *Once authorisation has been granted for the installation of facilities and contracts awarded for the supply and installation of submarine power lines and ground cables, which will transfer power from the offshore sites to land, bimep is expected to commence operations in the last quarter of 2012.*

The **Oceanic Platform of the Canary Islands (PLOCAN)** is a public consortium aimed to build and operate an offshore infrastructure to facilitate and accelerate the development of new oceanic technologies. The Spanish Government (50%) and the Regional Government of the Canary Islands (50%) govern PLOCAN. This Consortium is located on the island of Gran Canaria. PLOCAN offers a marine test site for ocean energy converters prototypes. The submarine electrical infrastructure is being designed (expected by the end 2013) offering the required grid connection. The initial capacity is set in 10 MW with a future extension planned up to 50 MW by 2020. Main technologies on testing will be related with waves and offshore wind conversion. The PLOCAN marine test site is currently involved in several projects related with wave energy conversion:

WELCOME project and PIPO Systems: The WELCOME Project was funded by the Spanish Ministry of Science and Innovation and led by the Spanish company PIPO Systems. The project aimed to design, build and deploy a 1:5 scale wave energy converter prototype (called APC-PISYS and patented by PIPO Systems). The deployment of the small-scale prototype was completed in March 2011 and the company is now working on a new project funded again by the Spanish Ministry of Science and Innovation with the objective of extending the concept of APC-PISYS technology looking for new applications. The deployment is expected by the end of 2012.

UNDIGEN project and Wedge: Wedge is currently leading an Ocean Demonstration Project based on its innovative electrical power take-off (PTO) to be deployed offshore at the Canary Islands' hub by 2012. This project has been awarded as unique & sole marine project within the 2011 INNPACTO Programme granted by the Spanish Ministry of Science and Innovation. The UNDIGEN Project is formed by FCC (Final User), CIEMAT (R&D Institute), PLOCAN (Site) and WEDGE (Tech Company), and is aimed to test the cutting-edge electrical solution (switched reluctance) into a standard floating body (WEC) with no grid connection in 2012.

New Developments

Abencis Seapower installed its prototype of a "marine pump" at ¼-scale during 2011. The ultimate goal is the design and construction of a plant to convert wave energy into electricity, in a sustainable and efficient way. The prototype consists of a float-arm structure with a hydraulic system that allows the simulation of any kind of load. Tests are taking place in the Mediterranean Sea and the data collected are being used to optimize the control strategies. The results from the ¼-scale prototype will be used to design a demonstration power plant in the Atlantic Ocean during 2012.

¼ scale Abencis Seapower prototype installed in Sant Feliu de Guíxols (Mediterranean Sea)

OPT Powerbuoy 150kW

OPT and the WAVEPORT project

WavePort is a EU funded project lead by Ocean Power Technologies (OPT) who are collaborating in a consortium with Degima SA, University of Exeter, the UK Intelligent Systems Research Institute, Fugro Oceanor, and the Wave Energy Centre (WavEC). WAVEPORT project aims to expedite the development of alternative devices by installing in Santoña site in Spain a ten port "open platform" 1.5 MW-rated underwater substation pod for the validation of future wave energy converters. To address the need for improved efficiency, a novel Real-Time Wave-by-Wave tuning system is being developed.

ITALY

Gerardo Montanino, GSE

OCEAN ENERGY POLICY

Italy's major policy to support the deployment of renewable energies is based on a quota system combined with a green certificate trading scheme that became operational in 2001 (introduced by Legislative Decree 79/99). Italian energy producers and importers, producing or importing more than 100 GWh per year, are obliged to ensure that a percentage of their annual electricity supply comes from entitled renewable energy plants (i.e. plants commissioned after 30.4.1999). The renewable obligation has been set for 2011 at 6.05%, and 6.80% for 2012.

During 2009, Law 244/07 came into force. This law principally revised the Green Certificates (GC) System and introduced a feed-in tariff mechanism.
Renewable energy power plants receive GCs for 15 years. The total amount of GCs is differentiated by energy source in reason of the technology maturity, so wave and tidal energy receives the highest support. The bid price of GCs owned by GSE (Gestore dei Servizi Elettrici), which can be seen as a market cap, in 2011, was set at €113.1/MWh (VAT not included). GSE also withdraws GCs, providing a kind of market floor; in 2011, the withdrawal price was set at €87.38/MWh (VAT not included).
Law 244/07 introduced also the option (for small plants < 1 MW), to choose the feed-in tariff system as an alternative to the GCs mechanism. The feed-in tariff grants guaranteed prices per kWh, differentiated by source, over a 15 - year period.

For wave and tidal energy projects:

- 1.80 GC/MWh, or
- €0.34/kWh choosing the feed-in tariff.

For offshore wind farms:

- 1.10 GC/MWh (1.50 GC/MWh only for production after 15.08.2009 and from plants in operation after 31.12.2009)
- €0.30/kWh choosing the feed-in tariff (< 200KW).

The average market power price for 2010 was about €64 /MWh.

Green Certificates are going to be phased out in a pending reform of RES subsidies: the basic principles of the reform (currently on draft) are expected to be the following.
Starting from 2013, all RES operators (except photovoltaic operators) will be subsidised through a new system:

- Operators with an installed capacity between 1kW and 1 MW will be subsidised through a feed-in tariff (GSE will manage the sale on behalf of the producers), based on electricity fed into the grid;
- Operators with an installed capacity over 1 MW will be subsidised through a sliding feed-in premium, rewarding produced electricity; operators will be responsible for selling the electricity produced. The subsidy will be calculated as the difference between a payment cap (determined in relation to the cost of generation, differentiated on technology, fuel type and power plant size) and the hourly regional market price. For operators with power exceeding 5 MW (this value could be got up), the value of the incentives will be awarded on the basis of a tender procedure.

Eligibility period and tariff amounts will be set by decree.

RESEARCH & DEVELOPMENT

Key players involved in research regarding the exploitation of marine tidal and river current to produce energy are universities. Among these, the University of Naples "Federico II" is distinguished for its GEM project. In fact, the ADAG research group of Department of Aerospace Engineering (DIAS)[3], in collaboration with Eolpower Group[2] Srl and Eng. Nicola Morrone, developed one of the most attractive projects of the last period in the field of renewable energy production using marine source, named GEM.

GEM project

The patented concept consists of a submerged floating body linked to the seabed by means of a tether. This hull houses electrical generators and auxiliary systems. Two turbines are installed outside the floating body and are exposed to the external currents.

Due to a relatively safe and easy self-orienting behaviour, GEM is a good candidate to solve some problems involved with oscillating and reversing streams, typical of tidal current. An additional advantage of its configuration is related to the possibility of avoiding the use of expensive submarine foundations on seabed, because these are replaced with a flexible anchorage. Releasing the anchorage cable allows the system to pop-up for easy maintenance. A special diffuser has been designed to increase the output power for very low speed currents.

After several numerical investigations, a series of experimental tests has been carried out in the towing tank of the Department of Naval Engineering at the University of Naples. The real scale prototype system of 100 kW with 3.5 knots water current has been built and it will be deployed in January 2012 nearby Venice in a very slow speed current.

TECHNOLOGY DEMONSTRATION

Actually, there are other two different projects which involve the ADAG research of the Department of Aerospace Engineering of the "Federico II" University. They are:

- The FRI – EL SEA POWER System
- The KOBOLD Turbine

FRI – EL Sea Power System

Sea Power is a new groundbreaking project, which consists of a vessel or pontoon, moored to seabed, to which several lines of horizontal axis hydro turbines are attached. The same pipes, connecting the turbines through cardanic joints providing the necessary flexibility to the system, transfer the power captured from the water on board of the pontoon. Pipes are here connected to electrical permanent magnet generators (PMG) that are kept out of the water in order to simplify and diminish their maintenance. The electric generators transform the power carried by the transmission lines into electrical energy, which can be directly fed into the grid through an undersea cable, connecting the individual floating structures to a submarine hub, which in turn is connected to the shore by a single submarine cable. Alternatively, the systems can be installed offshore far away from the coasts and hydrogen can be produced with the electricity generated by the turbines.

After several numerical simulations, a first validation of the studies has been made by testing a prototype of the system in the water towing tank of the Naval Engineering Department of the University of Naples "Federico II". Soon after the controlled tests, a series of open water prototypes tests has been carried out in the Strait of Messina in order to check the system well working in real conditions.

3 www.dias.unina.it/adag/

2 www.eolpowergroup.com

In July 2008, a reduced scale of Sea Power prototype (6 kW - 2.5 m/s) was launched and in 2009 later another bigger prototype (20 kW - 2.5 m/s) was tested in the same waters.
The final system has been designed to be installed in the Strait of Messina and it is conceived to produce up to 500 KW with a nominal flow speed of 2.5 m/s.The real scale prototype has not yet been built but several theoretical analysis, numerical predictions, tests in towing tank and real conditions on a scaled prototype have been already carried out. Permits to deploy the final system are expected for the middle of 2012. To this aim, the new SEAPOWER public/private consortium has been already constituted by Frie-Sea Power Company and University of Naples "Federico II". The consortium will develop not only the FRI-EL Sea Power system but it will also set up and manage a real field laboratory in the Strait of Messina opened to Italian and to foreign companies that want to test prototypes in the Strait of Messina. The laboratory will provide assistance in deploying the devices, data handling and certification for the prototypes installed and tested in the area available to the consortium.

Kobold Turbine
The "Kobold Turbine" is conducted in collaboration with "Ponte di Archimede international Spa", a company that works in the field of research and development into alternative and renewable energy sources, specialising in the environmental aspects of this work.
The Kobold consists of a submerged vertical-axis turbine for exploitation of marine currents installed in the Strait of Messina, 150 metres off the coast of Ganzirri, since 2002. The realization of the Enermar prototype has been financed by Ponte di Archimede International, together with a 50% fund paid by the Sicilian Region Administration (Regione Siciliana), in the framework of European Union Structural Funds. This project has been disseminated among the developing countries, in which the United Nations Industrial Development Organization (UNIDO) operates, and three first countries that expressed interest were the People's Republic of China, the Philippines, and Indonesia. A joint-venture was created, under the auspices of UNIDO, between "Ponte di Archimede" and the Indonesian Walinusa Energy Corporation.

A prototype is being built and it will be placed on the Lombok island (the island immediately east of Bali), where it could feed energy to a small village. The Indonesian plant will have blades length 7 m (chord 0,4 m) and diameter 5 m (intercepted area 35 m^2). The power could be about 120-150 kW in a current 3m/s speed. Ponte di Archimede International has signed an agreement with the Dutch company Bluewater to develop the Bluetec plant with the scientific and technological support of ADAG Group from University of Naples "Federico II". This floating device, to be anchored at the European Marine Energy Centre (EMEC) facilities on Orkney Islands, will hold four Kobold turbines for a total power of about 1 MW and will represent a single unit of a possible farm made by several Bluetec systems. Towing tank experiments have been carried out both at the Wageningen facilities and at the University of Naples.

NEW ZEALAND

John Huckerby, AWATEA

OCEAN ENERGY POLICY

Strategy and National Targets

The NZ Coalition Government published a new New Zealand Energy Strategy in mid-August 2011. The Strategy is a high-level document with limited references to marine energy and few action items have been articulated. The overarching aspirational target of achieving 90% of electricity generation from renewable sources by 2025 has been retained. NZ's current renewable electricity percentage rose to 79% in the quarter to June 2011.

The Ministry for the Environment manages the Emissions Trading Scheme, a cap-and-trade scheme, including stationary energy (i.e., electricity generation) since 1 January 2010.

The Marine and Coastal Area Act 2011 was enacted, which effectively makes the coastal marine area (out to 12 nm) common land, which cannot be owned by the Crown or individuals, but over which public access is guaranteed.

A loose syndicate of organizations has developed a proposal for a New Zealand Marine Energy Centre, which was delivered to the Ministry of Science and Innovation in August 2011. The proposal, which would be co-funded by industry and Government, is still under consideration.

Support Initiatives and Market Stimulation Incentives

There are no specific support initiatives or incentives for marine energy or renewable energy, although the National Policy Statement on Renewable Electricity Generation provides guidance to the courts and regional authorities on the national importance of renewable electricity generation.

Main Public Funding Mechanisms

There are three principal public funding mechanisms for marine energy:

- A dedicated fund called the Marine Energy Deployment Fund (MEDF), which was enacted in 2008 for 4 years. The MEDF was a competitive application funding mechanism with an expert review panel recommending projects for funding. The 4th and final Round of the MEDF led to the distribution of $880,000 to 3 projects with two other projects still being funded. The new National-led Coalition Government (elected 26 November 2011) has given no indications that it will continue, rejuvenate or replace the Fund.
- Technology New Zealand funding. A fund of unspecified size to support companies to develop or advance technologies. TechNZ funding is continuously available, although grants are rarely made public.
- R&D funding: see below

Relevant Legislation and Regulation

Planning or resource consents for all marine energy deployments and developments are judged and approved by regional councils (coastal permits – for offshore and shore-crossing activities) and district/city councils (land use permits – for onshore activities).

If a project is deemed to be of national significance, there is an alternative process managed by the Environmental Protection Authority (which operates under the Ministry for the Environment).

The Government introduced new environmental legislation to regulate development activities in the Exclusive Economic Zone (between 12 and 200 nautical miles) and Extended Continental Shelf (areas beyond the EEZ, which are underlain by contiguous continental shelf). The Exclusive Economic Zone and Continental Shelf (Environmental Effects) Bill passed its First Reading on 13 September 2011

and has been referred to select committee. The Bill, once passed, will set up a consenting regime and manage the environmental effects of activities – like petroleum exploration, seabed mining, and marine energy generation – in New Zealand's Exclusive Economic Zone and Continental Shelf.

Relevant documents released

- New Zealand Energy Strategy and New Zealand Energy Efficiency and Conservation Authority
- Marine and Coastal Area Act 2011

RESEARCH & DEVELOPMENT

Government Funded R&D

The Government presently funds 3 research projects:

- Wave Energy Technology – New Zealand (WET-NZ): a 6-year project to develop a wave energy converter. The project reached the halfway point on 30 September 2011.
- Optimizing Tidal Energy: this 3-year project, being undertaken by the National Institute of Water and Atmospheric Research, is due for completion in September 2012.
- Extreme Waves and Storm Surges: this 3-year project is really a natural hazards project but may provide useful information for project developers. Due to be completed in September 2012.

In December 2011, the NZ Ministry of Science and Innovation announced a forthcoming Request for Proposals for Energy and Minerals R&D, with funded projects due to begin in October 2012.
There are also a small number of Ph.D. students at a number of universities, undertaking research on wave and tidal energy topics.

Participation in Collaborative International Projects

Through involvement in OES, New Zealand participates in two Annex activities. It is an active member of Annex IV on Environmental Impacts and a proposal to join Annex V is under discussion.

TECHNOLOGY DEMONSTRATION

Operational Ocean Energy Projects

As noted above, WET-NZ has tested three point absorber wave energy converters. The first was a 2 kW 1:5-scale proof-of-concept device tested in Taylor's Mistake Bay from December 2006 to November 2008. The second 2 kW 1:4-scale device was tested intermittently at the same site from mid-2009 to June 2011.

New Developments

WET-NZ recently tested a 20 kW 1:2-scale device off Akaroa Heads, near Christchurch, from 9 September to 3 December 2011. It has since been towed to Wellington, where it will be refurbished before a 2+ year deployment at a consented site south of Wellington in the first quarter of 2012.

Figure 1: a) WET-NZ's 1:5-scale 2 kW proof-of-concept device (2006-2008)
Figure 1: b) WET-NZ's 1:4-scale 2 kW PSAF device (2009 – 2011)
Figure 1: c) WET-NZ's 1:2-scale 20 kW MEDF device (deployed 9 September 2011)

SWEDEN

Maja Wänström, Swedish Energy Agency (SEA)

INTRODUCTION

During 2011, ocean energy research and technology development and demonstration continued and progressed in Sweden. Highlighted events include:

- The 10 MW demonstration park project based on the point absorber linear generator technology of Seabased and funded by the Swedish Energy Agency commenced during 2011;
- A tidal stream prototype development and ocean testing project of the technology developedl by Minesto was awarded funding from the Swedish Energy Agency and was initiated during 2011.

Ocean Energy Centre (OEC)[4], a new developers' initiative connected to Chalmers University at the west coast city of Göteborg, was formed during 2011. The purpose of OEC is to develop into a public-private sector platform that is able to support the applied research of the growing number of developer companies in the region. OEC is currently supported by a regional grant.
A marine spatial planning process of the Swedish territorial coastal waters is planned to commence in 2012. Areas with potential for energy conversion by wave power plants, if applicable, will be identified during this process.

OCEAN ENERGY POLICY

Currently, Sweden has no specific strategy or national targets for ocean energy. However, the general electricity certificate system applies to power produced by renewable energy sources, including wave power. Renewable energy policy in Sweden is based on the electricity certificate system, which addresses production of electricity from renewable energy sources in general. Therefore, no particular policy applies specifically to ocean energy. The electricity certificate system is a market-based support system for expansion of electricity production in Sweden from renewable energy sources and from peat that came into force in 2003. The objective is to increase, by 2020, the production of electricity from such sources by 25 TWh relative to production in 2002. The certificate system, which will run until the end of 2035, is intended to help Sweden achieve a more ecologically sustainable energy system. Certificates are currently granted to producers of wave power electricity, but no other ocean energy sources.
In 2011, a binding agreement on a joint Swedish-Norwegian electricity certificate market was signed. The market is planned to start on 1 January 2012, with the agreement running until 2036. The objective of the joint market is to increase the production of renewable electricity by over 26 TWh between 2012 and 2020, with both countries having equal ambition levels.
The main public funding mechanisms include state funding from public sector agencies, predominantly the Swedish Energy Agency (SEA), but also public agencies targeting innovation development like Swedish Governmental Agency for Innovation Systems, VINNOVA. Regional funding for research and development is also available.

Relevant Legislation and Regulation

In order to establish field-testing, demonstration or commercial parks in Swedish marine environments, permits must be obtained from the local County Administration Board. The permits are granted after an extensive environmental impact assessment court procedure, which involves all relevant governmental and regional agencies.

4 http://www.oceanenergycentre.org/

State funding in Sweden is regulated by national legislation that complies with the legislation regulating state funding in the European Community.

Relevant Documents Released

The Electricity Certificate System 2011, ET2011:52; Available at the webpage of the Swedish Energy Agency at www.energimyndigheten.se.

RESEARCH & DEVELOPMENT

Government Funded R&D

- Centre for renewable electricity conversion (Uppsala University). The project runs until 2013.
- The Lysekil project - Wave power at Lysekil (Uppsala University). The project was concluded during 2011. Uppsala University continues to be very active in research related to linear generator wave power and low speed marine current technology. Wave energy activities are focused on ocean tests, generator and buoy design, and model development. Testing activities are performed at the 10-unit field research site at Lysekil, which includes a submarine switchgear and sea cable connection to load. The research site has been in active use since 2006. Marine currents research activities are focused on establishing a test site in a riverbed environment. Both efforts are supported by public research grants from the Swedish Energy Agency and a number of private sector contributions. For further details please visit http://www.el.angstrom.uu.se/Meny/Eng/index_E.html.
- Performance test of wave power converters (Seabased); Concluded during 2011. Seabased is a spin-off company from the research activities at Uppsala University (www.seabased.se).
- Prototype testing of tidal stream technology (Minesto); Initiated in 2011.

A tidal stream prototype development and testing project of the technology developed by Minesto started in 2011. The project includes ocean testing at a site in Strangford Lough, Northern Ireland, and is supported by a grant from the Swedish Energy Agency.

Industry Funded R&D

The utility Vattenfall AB funds a number of development projects in Scotland, UK. The SEA does not currently know the extent of Vattenfall funding.
The utility Fortum funds the 10 MW demonstration park.

Participation in Collaborative International Projects

Collaboration between Uppsala University and Portuguese wave energy research is planned within the European InnoEnergy framework.

TECHNOLOGY DEMONSTRATION

Operational Ocean Energy Projects

Plant for demonstration of renewable energy conversion from ocean waves **(Seabased)**:
In 2008, the Swedish Energy Agency announced a call for demonstration projects for renewable energy sources. In 2009, funding was granted to a 10 MW wave power demonstration park project based on the linear generator point absorber technology developed at Uppsala University and the spin-off company Seabased. The project is financed by state funding from the Swedish Energy Agency and the private sector utility company Fortum Wave Power and aims at verifying the technology ability to generate 25 GWh/year electricity from the mild wave climate off the west coast of Sweden. The grant was awarded on condition of approval of the state funding and competition evaluation of the European Commission.
During 2011 the European Commission decided not to object to the proposed state funding and the demonstration project commenced.

AUSTRALIA

Jim Smitham and John Wright (CSIRO)

INTRODUCTION

The ocean energy arena is very active in Australia, with a number of projects moving from R&D, through demonstration and towards commercialisation, including internationally outside Australia. Australia's very large potential ocean energy resources were confirmed in a 2011 study conducted by CSIRO and syndicated with industry and Government. Capitalising on those resources will require overcoming problems, such as distance to existing electricity grids/networks from the resource centres, competition with other low emission technologies on initial and lifetime cost, meeting the investment criteria of the financial sector and demonstrating the environmental credentials of ocean energy.

OCEAN ENERGY POLICY

Strategy and National Targets

The Federal Government has specified a renewable electricity target of 20% by 2020. This has broken into large-scale devices and small-scale systems, focused on rooftop PV's. The large and small-scale systems attract renewable energy certificates, which can be traded to retailers, whom have to purchase the renewable energy[5]. There is no 'carve-out' of allocations for different technologies within the 20% target, and the large-scale systems are currently dominated by wind.

In 2011, the Federal Government introduced the legislation for an initial carbon tax of A$ 23/tonne of CO2 on the top 500 polluters from July 2012, transitioning later to a carbon-trading scheme. In theory, and with time, this may assist the economic case for ocean energy in Australia.

The Federal and State Governments recognise that the Australian electricity system may require as much as A$ 240 billion of investment by 2030 in the domestic electricity and gas sectors, including not just generation but transmission and distribution as well. Pathways and technologies that can reduce this level of investment are earnestly being sought as part of the Draft Energy White Paper, released for comment on 13 December 2011[6]. The focus is on creating efficient market solutions for low cost solutions.

Support Initiatives and Market Stimulation Incentives

The Federal Government has established a new body, the Australian Renewable Energy Agency (ARENA) to bring together a number of previous renewable energy schemes and create new renewable energy investment[7] totalling A$ 3.2 billion.
This will provide an opportunity for research, development, demonstration and commercialisation to be integrated and will provide greater continuity of support for technologies such as ocean energy in the future.

5 http://www.orer.gov.au/Certificates/certificates6
6 http://www.ret.gov.au/ENERGY/FACTS/WHITE_PAPER/Pages/energy_white_paper.aspx
7 http://www.ret.gov.au/Department/Documents/clean-energy-future/ARENA-FACTSHEET.pdf

RESEARCH & DEVELOPMENT

Government Funded R&D

A small number of universities are involved in ocean energy research. These include the University of Tasmania's Australian Maritime College, The University of Wollongong, the University of New South Wales Water Research Laboratory, the University of Sydney and spin-off companies from the University of Queensland. The work is focused on a wide range of topics of general interest in the ocean energy domain.

CSIRO's research has been focused on Australia's ocean energy resource base and the economics of inclusion of ocean energy in the technology suite in Australia to 2050, while the development of ocean energy extraction devices has not been a priority for the organisation.

Industry Funded R&D

A new industry association, Ocean Energy Industry Australia (OEIA) is in formation and expects to be operational in 1st quarter of 2012. OEIA's members will include wave and tidal energy developers as well as other individuals or businesses, which support ocean energy development in Australia. OEIA's principal purpose is *"to support exploration of various methods of harnessing energy from the ocean, producing mechanical power and/or clean electricity with no emissions, leading to reduced carbon pollution in Australia"*. OEIA aims to progress in three initial areas, namely a public education initiative, the preparation of a sectoral ocean energy development strategy and building best practice for ocean energy governance in Australia.

There are about 12 companies active in Australia, varying in scale from concept development to demonstration to commercial deployment. The industry sums invested are commensurate with the scale of achievement and those companies, which have been successful in securing Government grants, have had to invest at significant scale.

REPUBLIC OF KOREA

Keyyong Hong, Korea Ocean Research and Development Institute (KORDI)

INTRODUCTION

Ocean energy development made significant progress in 2011 when the construction of the Sihwa tidal barrage power plant (TBPP) was completed. With a capacity of 254 MW, it finally started its operation in August. Other ocean energy activities and their budgets continued to grow in Korea in 2011.

The number of ocean energy projects increased with technologies diverse in both design principles and target sites. The renewable energy policy, including ocean energy, will change in Korea from 2012 on, when the new RPS (Renewable Portfolio Standard) replaces the existing FIT (Feed-In Tariff) as a primary promotion tool for renewable energy. Interest on seaside test beds for performance evaluation of ocean energy harvesting devices is increasing in Korea and the possibility of renovating existing demonstration plants into test facilities is being discussed.

OCEAN ENERGY POLICY

Strategy and National Targets

The Strategic Plan for ocean energy development in Korea is divided into 3 phases. In the first phase until 2012, ocean energy RD&D (Research, Development and Demonstration) is mainly funded by the Government and it focuses on the development of core technologies that are suitable to coastal areas. In the second phase, from 2013 to 2020, the role of industries will gradually increase in both funding and RD&D and the technologies that are applicable in open sea will be exploited. In the third phase, from 2021 to 2030, the industries will lead commercial development for ocean energy resources and the hybrid utilization of technologies combining multiple ocean energy resources will be activated.

Korea targets to supply 11% of the national energy demand from new and renewable energy by 2030, of which ocean energy will contribute 4.7% to total new and renewable energy supply, which amounts to 1,540 kTOE.

Support Initiatives and Market Stimulation Incentives

The original FIT policy was initiated in 2002. The FIT for ocean energy promotion is currently applied only to tidal barrage power. The first FIT for ocean energy was applied at the Sihwa TBPP, which is allocated to a category of tidal barrage power plant in capacity more than 50MW without a tide embankment. The FIT standard price is 62.81 Korean Won. The Government has announced that the RPS policy will be enforced to utility companies from 2012. The RPS policy requires the supply of 2% of the total electricity by renewable energy in 2012 and to increase its portion to 10% in 2022.

Main Public Funding Mechanisms

The public funding for renewable ocean energy is limited to RD&D since its technologies are not mature enough for commercial use yet. The two ministries MLTM (Ministry of Land, Transport and Maritime Affairs) and MKE (Ministry of Knowledge Economy) lead the national promotion of ocean energy RD&D. MLTM supports mainly demonstration projects under the "Practical Ocean Energy Technology Development Programme". MKE funds mostly fundamental R&D projects under the "New and Renewable Technology Development Programme". Though the Government funding supports both fundamental researches and

demonstration projects, the latter usually requires industrial matching fund, which amounts at least 25% of the total budget for small and medium companies and 50% for large companies.

Relevant Documents Released

There are two extensive documents concerning the strategy and roadmap for renewable ocean energy development. The MKE released "RD&D Strategy 2030 for New and Renewable Energy – Ocean" in 2008 and the MLTM published "Development of Activity Plan on Ocean Energy R&D Programme" in 2009. Also, MKE issued the "White Paper on New and Renewable Energy", which includes national policy and statistics on new and renewable energy.

RESEARCH & DEVELOPMENT

Tidal Energy R&D Projects

PROJECT (CHARGED BY, FUNDED BY)	TYPE OF CONVERTER	STRUCTURE	POWER CAPACITY	PROJECT PERIOD	REMARKS
Sihwa Tidal Barrage Power Plant (K-Water, K-Water)	Horizontal Axial Bulb	Concrete Dam	10x25.4MW	2004~2011	Operation in 2011
Uldolmok Tidal Current Pilot Plant (KORDI, MLTM)	Helical Turbine (VAT)	Jacket	2x500kW	2001~2011	Completed in 2009
Site Evaluation for Tidal Barrage (KORDI, MLTM)	Feasibility Study			2001~2011	Incheon Bay et al.
Tidal Current Energy RC (KMU, MKE)	(Turbine Design)	(Underwater design)	(Resource Assessment)	2009~2014	Joint Research Centre
Standard Turbine Design S/W (KMU, MKE)	(HAT/VAT)	(Performance Chart)	(GUI System)	2009~2012	Based on CFD
VIVEED (KORDI, MKE)	VIV Cylinder	Pile	2009~2012	2009~2012	
In-stream Hydro System (Ecocean Ltd., MKE)	Helical Turbine (VAT)	Jacket	50kW	2010~2012	Discharge Channel of Power Plant
MW Class Tidal Current Device (HHI, MKE)	Pitch Control	Pile	>500kW	2010~2015	Sea Test in 2014
Hydraulic Turbine for Tidal Barrage (HHI, MKE)	Bulb		7MW, 30MW	2011~2014	Applicable to Hydraulic Dam
Flexible Turbine for Tidal Current (KORDI, MKE)	Flexible Flap		10kW	2011~2014	Efficiency > 26%

Notes: KORDI: Korea Ocean Research and Development Institute | KMU: Korea Maritime University | HHI: Hyundai Heavy Industries Co., Ltd.

Wave Energy R&D Projects

PROJECT (CHARGED BY, FUNDED BY)	TYPE OF CONVERTER	STRUCTURE	POWER CAPACITY	PROJECT PERIOD	REMARKS
Yongsoo OWC (KORDI, MLTM)	OWC	Caisson	500kW	2003~2013	Pilot Plant in 2012
Variable Liquid Column Oscillator (KEPRI, MKE)	Attenuator	Cylinder	300kW	2009~2011	Prototype Test in 2011
Pendulum WEC (KORDI, MLTM)	Oscillating Surge	Barge	300kW	2010~2016	Korea-Japan Collaboration
AWS with Linear Generator (Yonsei Univ., MKE)	Point Absorber	Buoy		2010~2013	4-sided Linear Generator
Resonant Vertical Oscillator (Gyeongju Univ., MKE)	Point Absorber	Buoy		2010~2013	Prototype Test in 2013
Cross-Flow Hydraulic Turbine (KMU, MKE)	Wave Overtopping	Caisson		2011~2014	Converting Wave Energy to Current Energy

Note: KEPRI - Korea Electric Power Research Institute

Ocean Thermal Energy and Salinity Gradient Energy R&D Projects

Three OTEC (ocean thermal energy conversion) projects have recently been launched in Korea as follows:

1. The project charged by KORDI and supported by MLTM is to utilize the deep ocean water for air
2. cooling and heating as well as power generation
3. A project carried out by KEPRI and funded by MKE, which uses the cooling water discharged from power plant
4. A fundamental research project on working fluids used for OTEC.

There is one on-going project on the salinity gradient energy, which is conducted by Hongik University and supported by MKE. It develops key technologies that utilise the large salinity difference between sea and fresh waters at estuaries.

TECHNOLOGY DEMONSTRATION

Operational Ocean Energy Projects

The construction of the 254 MW **Sihwa tidal barrage power plant** was completed and it began operations in August 2011. The plant is expected to produce 552 GWh/year, once it begins to operate fully. Sihwa TBPP operates only on flood tide generation, which produces electrical power during the flood tide; the water is discharged back from basin to sea during ebb tide. Sihwa Lake was originally planned to be a fresh water lake. However, it was changed into a seawater reservoir to improve the water quality by allowing sea water exchange. Since the operation of tidal barrage power plant facilitates water exchange between the sea and Sihwa Lake, dramatic improvement of water quality is expected.

254 MW Sihwa tidal barrage power plant

New Developments

The 500 kW Yongsoo wave power plant, of the OWC (oscillating water column) type, which has been developed by KORDI and funded by MLTM, is going to be constructed at Yongsoo, Jeju of Korea in 2012. A couple of turbines and generators with a capacity of 250kW were manufactured in 2010 and an integrated system of generator and power control module was extensively tested in the laboratory of Korea Electrotechnology Research Institute in 2011. A caisson structure of 15,000 ton is being constructed at a test site, which is 1km off the coastline of Yongsoo. An underwater cable line between the caisson structure and a powerhouse on land will be installed for grid connection. It was expected to start test operation in October of 2011.

500 kW Yongsoo wave power plant

SOUTH AFRICA

Thembakazi Mali, SANERI

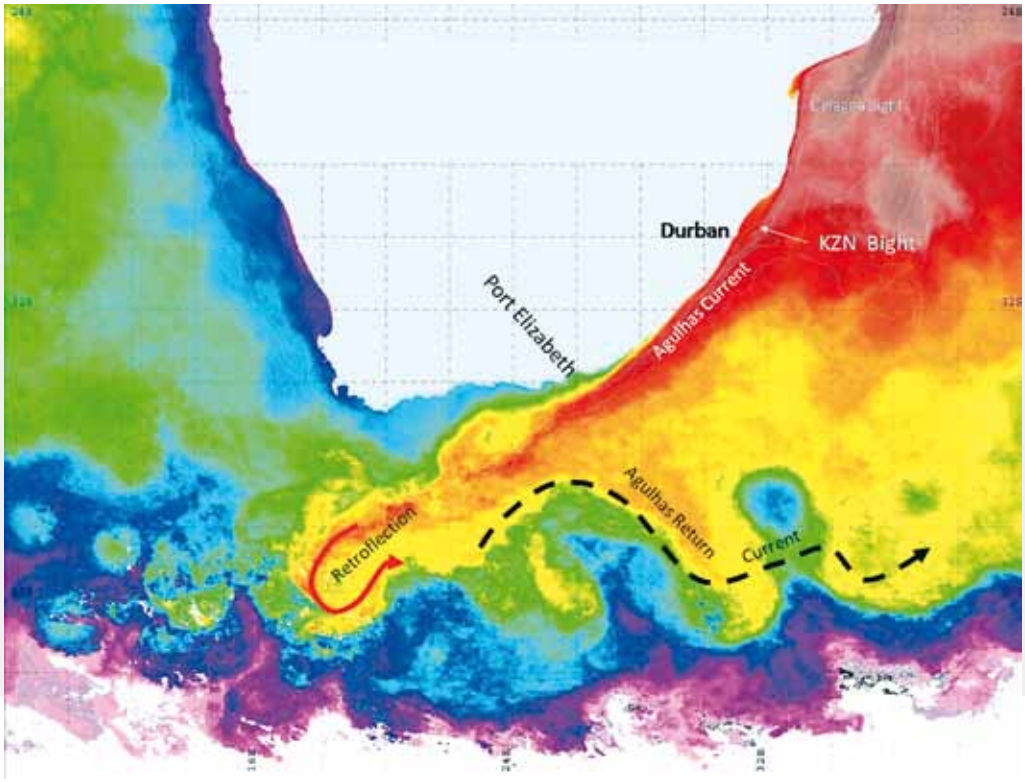
South Africa has a significant wave energy resource, in the order of 40-50 kW/m, and the Agulhas current is estimated to flow between 1-2 m/s in some places.

The major barrier to exploiting ocean energy is the lack of regulations in South Africa to facilitate the development of ocean energy projects.

National research programmes in renewable energy, including ocean energy, have been conducted, with limited support by the South African National Energy Research Institute (SANERI) for ocean energy.

Eskom, the SA national power utility, has been investigating the possibility of using ocean energy technologies as part of the Eskom generation mix since 2003. To date, resource assessments have been completed for wave and ocean currents energy and progress on international developments has been assessed.
At Stellenbosch University there is a research group active, which was formed in the eighties as part of the Ocean Engineering Research Group[8] to investigate ocean energy. Other key institution is the Department of Oceanography at the University of Cape Town[9], conducting research into ocean currents and temperature and its effect on Climate Change.

There are no demonstration projects yet in South Africa.



The Agulhas current stream off the eastern coast of South Africa

8 www.sun.ac.crses
9 www.sea.uct.ac.za

CHINA

Dengwen Xia, National Ocean Technology Centre

INTRODUCTION

In 2011, the "Twelfth Five-Year" Plan of Renewable Energy in China was basically formulated and submitted to public consultation. The Special Plan of Twelfth Five-Year for Marine Renewable Energy in China is still under progress, which has been released by the end of this year.

The State Oceanic Administration (SOA) established the Administrative Centre for Marine Renewable Energy (ACMRE) to co-ordinate and manage the development and utilization of marine renewable energy in China. As the first survey of marine renewable energy resources, the project of "National survey and utilization evaluation of offshore ocean energy in China" was successfully completed.

The national project of a pilot zone and testing sites construction, which will serve for the sea trial of wave and tidal current devices, has been initiated. A hybrid power system of 100 kW with wind, solar and wave energy has been constructed and operated by National Ocean Technology Centre.

The largest national special funding programme for marine renewable energy in China started in 2010. Under the support of the special funds, more research, development and demonstration projects have been proposed. Recently, the first round of national special funding has been fully implemented and projects for the second round of special funding programme has been confirmed.

OCEAN ENERGY POLICY

Strategy and National Targets

In 2011, the "Twelfth Five-Year" Plan of Renewable Energy in China was basically formulated and submitted for public consultation. During the next five years, the "Twelfth Five-Year" Plan of Renewable Energy will be fully implemented, when there will be more and more opportunities and challenges compared with the Eleven Five-Year. The new plan explicitly sets out the targets and directions in the next five years for marine renewable energy in China, highlighting the demonstration and utilization of isolated hybrid power system on remote islands. Furthermore, the draft of "Twelfth Five-Year" Plan of Renewable Energy is still under progress by the State Oceanic Administration (SOA) and the National Energy Administration (NEA).

The National Ocean Technology Centre (NOTC) is drawing up the "Strategic report for the development and utilization of marine renewable energy in China", which outlines the overall goals and different stages of marine renewable energy till 2030. It finally gives the solution for strategic development of marine renewable energy in China.

Support, Incentives and Market Initiatives

To promote the development and utilization of ocean energy, the Chinese Government has established the largest special funding programme for marine renewable energy with the highest amount of funds under the leadership of the Ministry of Finance and SOA. It mainly focuses on the construction of isolated island power generation systems and grid-connected power stations, industrialization for key technology, research and development for new technology and the public service system.

In 2010, special funds of RMB 200 million had been invested to support 26 projects in the first funding round, of which more than RMB 110 million was used for technical demonstration projects, accounting for 55% of the total sponsored amount in 2010. In 2011, the establishment of a special fund project was basically completed with total sponsored amount of RMB 200 million. A total of 39 projects passed the review for project establishment. In 2011, the support direction of the special fund is mainly in technical research and

test of development and utilization for marine energy, and 30 technical research projects passed the review for the project establishment, accounting for 77% of the total projects. For the demonstration projects, except that continuous support will be provided for the demonstration projects established in 2010, support has been provided for several islands of rich marine energy and outstanding demand for marine energy, and there are up to 10 technical demonstration projects being supported by the special funds. In addition, "863 Programme", "National Key Technology Research and Development Programme" and "National Natural Science Foundation of China (NSFC)" shall also provide relevant support for Technology R&D and demonstration about the development and utilization of marine renewable energy.

Relevant Legislation and Regulation

In April 2010, the "Renewable Energy Law of the People's Republic of China (Amendment)" was formally implemented. Since the formal implementation of "Renewable Energy Law of the People's Republic of China" in January 2006, it has played a very important role in accelerating and promoting the development and utilization of renewable energy in China. But with the rapid development of the renewable energy industry in China, some problems during the implementation of renewable energy law have been gradually exposed. For this reason, the "Renewable Energy Law of the People's Republic of China (Amendment)", passed by the decision of the 12th Meeting of the Standing Committee of the 11th National People's Congress of the People's Republic of China on 26 December 2009, modified some articles in "Renewable Energy Law of the People's Republic of China" and further defined some details of its original contents.

Main Public Funding Mechanisms

To strengthen the management on the development and utilization of marine energy in China, the Administrative Centre for Marine Renewable Energy (ACMRE) was established by State Oceanic Administration (SOA) on 24 November 2010. As the authoritative supervision organization of the special funds, ACMRE, is responsible for the supervision and management of the special funding programme and the projects in China. ACMRE ensures the implementation of the projects on schedule by technical review of the project implementation proposals as well as special inspection on the fund utilization and implementation progress of the projects. Now ACMRE has completed the technical review on the implementation proposals of special fund projects for marine renewable energy in 2011, and all the projects will step into the practical phase very soon.

RESEARCH & DEVELOPMENT

Government Funded R&D

Technology R&D for the development and utilization of marine renewable energy in China is mainly supported by the Government, and funding comes from the public finance.

Tidal energy

Relatively mature tidal power generation technology has been mastered in China. Jiangxia Tidal Power Station operates well with only several major technology modifications and never caused any significant environmental problem. In 2009 its power generation reached the highest level in its history, and it provided a large amount of electricity power to grids. It has been proven that reasonable choice of the power station site can reduce the environmental impact to an acceptable level; and with the support of an incentive policy, that tidal power stations of a certain scale can survive in the market.

Wave energy

National Ocean Technology Centre (NOTC): To meet the basic demand of power supply for daily life of the inhabitants of remote islands without power supply and to improve their quality of life, the National Ocean Technology Centre (NOTC) carried out the study of a bottom-mounted pendulum wavepower generation system, based on the R&D of surging-swing wave power device. At present, this project has completed the modelling test for the small-scale physical model (1:20) in a flume tank and a sea trial is expected to be carried out in 2012.

Installation of the 10kW prototype testing

At present, this project has completed the modelling test for the small-scale physical model (1:20) in a flume tank and a sea trial is expected to be carried out in 2012.

Guangdong Zhongda Marine Biotechnology Centre of South China Sea Co., Ltd.: Guangdong Zhongda Marine Biotechnology Centre of South China Sea Co., Ltd. has been researching a 10 kW new high-efficiency wave energy device. The company has manufactured the 100 W small-scale model. The sea trial of the prototype will be carried out in the area near Yangjiang – Zhapo East Island, Guangdong Province.

Guangzhou Institute of Energy Conversion (GIEC) of Chinese Academy of Sciences (CAS): The 20 kW power base station of oceanographic instrument wave energy developed by Guangzhou Institute of Energy Conversion (GIEC) of Chinese Academy of Sciences (CAS) is an absorptive floating-point power base station for oceanographic observation instrument of wave energy applicable for modular manufacturing, with the installed capacity of 20 kW, capable of providing electric energy for oceanographic observation instrument. A 10 kW device has been deployed.

Installation of the 10kW prototype testing (GIEC of Chinese Academy of Sciences)

Tidal current energy

Harbin Engineering University: Harbin Engineering University has carried out some small-scale tests and demonstration with tidal current energy devices. In September 2011, a 10 kW horizontal-axis tidal current prototype was deployed in Daishan of Zhejiang Province. The power is used to provide electricity to the lighthouse.

10 kW horizontal-axis tidal current prototype

Zhejiang University: Based on the sample machine of 25 kW power generation device with tidal current energy in the initial phase, Zhejiang University carried out research and manufacturing of the engineering sample machine for a 60kW power generation device of semi-direct drive type horizontal axis with tidal current energy.

Northeast Normal University: The 5 kW tidal current energy device of modular power technology, which can supply power for oceanographic observation platform, was developed by Northeast Normal University. It can provide the power supply for an anchor-type oceanographic observation instrument.

Ocean University of China: A 20 kW axial-flow tidal current power generation device has been developed by Ocean University of China. Its total installed capacity is no less than 20 kW. The work carried out included the testing of its hydrodynamic performance and sea site survey.

25kW prototype testing

5kW prototype testing

Prototype device laboratory testing

Ocean thermal energy

The First Institute of Oceanography of State Oceanic Administration (SOA)

The First Institute of Oceanography of State Oceanic Administration (SOA) has been undertaking a project with a 15 kW closed power station using ocean thermal energy. The plant is under installation and commissioning in Qingdao Power Generation Co., Ltd. of China Huadian Corporation.

Participation in Collaborative International Projects

Guangzhou Institute of Energy Conversion (GIEC) of Chinese Academy of Sciences (CAS) cooperates with Blum Company to explore the problem of typhoon resistance and anchoring system of the Blum power generation device with wave energy, and carry out the hydrodynamic calculation, structural and anchoring optimization design, and the optimization design on water turbine and power generation system; the underwater appendage technology is used on the Blum power generation device with wave energy to increase the wave energy capturing efficiency and typhoon resistance of this device.

China is co-operating with Korea in a study and optimization of an Oscillating Water Column (OWC) device. This project is being undertaken by Ocean University of China and is sponsored by the "National Natural Science Foundation of China (NSFC)".

Under the support of national and international science and technology co-operation plans, Ocean University of China co-operates with the European Marine Energy Centre (EMEC) in the R&D of intelligent power supply system applicable for the device characteristics of ocean energy in China from January 2011 to December 2013, with the objective to fulfil the making of model sample machine for general design and key components of the system, achieve multiple inputs and stable output, and to propose the evaluation method of the device with ocean energy.

TECHNOLOGY DEMONSTRATION

Operational Ocean Energy Projects

Jiangxia Tidal Power Station: In 2007 No. 6 generator unit was put into power production. There are 6 bulb turbine generator units, operating in both ebb and flood tides with a total installed capacity up to 3.9 MW, producing an annual power output of 7.2 million kWh. The power station has 79 employees. In 2002, with the implementation of power system reform, the Jiangxia power station was acquired by China Guodian Corporation and managed by China Longyuan Power Group Corporation Limited.

Jiangxia Tidal Power Station

Isolated hybrid power system in Daguan Island: Under the support of the "National Key Technology Research and Development Programme" in "Eleventh Five-Year Plan" Period and the "908" Special Programme, the National Ocean Technology Centre (NOTC) has increased the installed capacity of the hybrid power system from 100 kW to 200 kW on Daguan Island, Jimo City, Shandong Province, based on the existing 30 kW pendulum onshore wave power station. The new power system includes a 130 kW wave energy device, 60 kW small wind turbines and 10 kW solar cells. The power system has passed the project acceptance and was put into operation in June 2011. Phase II works of this demonstration power station 100 kW offshore wave power generation system is under development and will be put into operation in 2012.

New Demonstration Projects

Isolated power system on the islands of South China Sea: Guangzhou Institute of Energy Conversion (GIEC) of Chinese Academy of Sciences (CAS) plans to build an isolated power system with renewable energy on Dawanshan Island, Guangdong Province before August 2012, with total installed capacity of 500kW, including 300kW from wave energy device and 200kW from wind turbine. The design of 100kW floating duck-type device, charging process and special transporting boat has been completed, and the ½-scale prototype is testing.

½-scale prototype under construction

The design of 100kW floating duck-type device, charging process and special transporting boat has been completed, and the ½-scale prototype is testing.

500kW Isolated power system with ocean energy: The Research Centre of China National Offshore Oil Corporation (CNOOC) plans to build an isolated power system with total installed capacity not less than 500kW on Zhaitang Island, Jiaonan City, Shandong Province, including 300kW total installed capacity from tidal current energy, 150kW total installed capacity from wind power and 50kW total installed capacity from solar energy. Multiple research works, such as "General proposal design report for "500kW demonstration project of isolated power system with ocean energy"" and "Study report on site selection and argumentation of "500kW demonstration project of isolated power system with ocean energy"" have been completed.

Grid-networked power system with tidal current energy: Shandong Branch of China Datang Corporation plans to build a 4×300kW grid-networked power system with sea current energy in the sea area near Longxu Island, Rongcheng City, Shandong Province. Multiple research works have been completed, including "Study on the design and performance prediction method of horizontal-axis turbine with tidal current energy", "Study on the design of grid-networked inverter in the power generation system with tidal current energy", and "Study on power conversion system with tidal current energy".

Grid-networked power system with ocean energy in Daishan Sea Area, Zhoushan City, Zhejiang Province: China Energy Conservation and Environmental Protection Group plans to build a power generation station with tidal current energy with total installed capacity of 1 MW in Daishan Sea Area, Zhoushan City, Zhejiang Province, which will be networked with power grid of State Grid via 10 kV transmission line. This project is sponsored with RMB 30 million from the Special Fund. The first part of this project for marine surveying engineering has been completed.

Schematic diagram for demonstration project of grid-networked power system with ocean energy in Daishan Sea Area, Zhoushan City, Zhejiang Province

4.2 Observer Countries

FRANCE

Michel Paillard, Ifremer [10]

OCEAN ENERGY POLICY

Ministry of Ecology and Sustainable Development

Through the "Grenelle Law" France has set a target to increase the share of renewable energy to 23% of its total energy consumption, by 2020. France expects to leverage this effort by generating benefits in terms of economic development and employment, while keeping overall costs for electricity consumers under control. France has a huge potential for exploiting marine renewable energy. This market reality is coupled with strong R&D and industrial competences to develop these technologies and take them to market. In addition, France requires that these ambitious targets are achieved with strong environmental performance of these technologies as well as a solid acceptance of different stakeholders of marine resources.
In late 2011, the Ministry of Ecology and Sustainable Development in alignment with the Ministry in charge of industry established the creation of a working group to work on all these levers. This working group brings together the major international industrial players, energy companies, developers, and research organisms. Support for R&D initiatives has been very strong since 2010 and several examples can be cited:

- the construction of 5 demonstrators being co-financed by the "Investissements d'Avenir", under ADEME's management;
- the creation of the Institute "France Energies Marines" expected for 2012, with R&D and demonstration objectives such as the creation and management of shared test sites;
- support to small and medium enterprises (SME) and innovative start ups granted as well through other public mechanisms with the support of "Competitivity Clusters" like Pôle Mer Bretagne and Pôle Mer PACA;
- leveraging European R&D support mechanisms, France participates in FP7 programmes and has presented 3 marine technology projects (out of 5) at the NER 300 European call.

RESEARCH & DEVELOPMENT

The implementation of the French Government policy on renewable energy involves a number of actors that provide a continuous support to R&D activities in Marine Renewable Energy (MRE). These actors provide support ranging from management of state funding schemes to facilitating the development of R&D projects. A new research institute dedicated to MRE is also being set up to accelerate the development and the cost reduction of the technologies.

ADEME is the French agency for the energy and the environment. ADEME has been supporting several initiatives: the studies conducted by Ifremer to find a test centre for floating wind turbines in France, the R&D actions of the EDF tidal project at Paimpol Bréhat, the development of a storage system integrated in Pelamis technoloy, and the development of a French expertise in OTEC fields. ADEME has launched

10 **Contributions:** Ministry of Ecology and Sustainable Development, ADEME, Pôles Mer, France Energies Marines, Ifremer, École Centrale de Nantes, IFP Energies Nouvelles, SATIE, École Navale, Alstom, EDF R&D, EDF EN, TECHNIP, NENUPHAR, Nass&Wind, DCNS, D2M, SABELLA SAS, HydroQuest, Le Gaz Integral, Energie de la Lune, GERRI, Arer, GDF SUEZ, SEDEP, EDF DIPH, Ecocinetic, Hydro-Gen, ODEWA.

a national call for R&D projects dealing with non technological barriers of renewables (including ocean energy) and also on the ocean energy resources (call closes in March 2012).

In 2011, two floating wind turbine projectos and three demonstration ocean energy projects in the "Investissements d'Avenir" framework were selected by ADEME:

- the tidal project SABELLA D10 in the straights of Ouessant;
- the tidal project ORCA at Paimpol Bréhat;
- the wave energy converter S3 at Le Croisic (SEM-REV).

Pôle Mer Bretagne and Pôle Mer Provence Alpes Côte d'Azur are economic development and competitiveness clusters set up by the French Government in 2005. Covering a specific geographical area (in this case, Brittany and Provence Alpes Côte d'Azur), the two clusters (650 members) combine companies, training centres and public/private research centres engaged in partnership initiatives designed to draw out synergies from joint, innovative projects, with economic development as the ultimate goal. Since 2005, these clusters have been involved in several marine renewable energy projects.

FRANCE ENERGIES MARINES: In 2011 a call for tenders dedicated to "institutes in carbon-free energies" gave the key-players of the French marine renewable energy (MRE) branch the opportunity to set up the long running project of an institute devoted to MRE. In the scope of this new institute, five test sites are being set up and will be operational by 2012/2013, including a tidal energy test site in Paimpol-Bréhat, an estuarine tidal test site in Bordeaux (SEENEOH), a wave energy test site in Le Croisic (SEMREV), and two floating offshore wind test sites, one in Fos sur Mer (Mediterranean sea) and one in Groix (Atlantic ocean). No less than 55 stakeholders constitute the public-private partnership, with 33 private structures (including 9 large corporate groups). Over the 10 year period of the original project, the team will comprise 70 researchers, engineers and technicians, and the overall budget should reach €142 million with the expected 30% state funding.

The five test sites locations

> *In the scope of this new institute, five test sites are being set up and will be operational by 2012/2013, including a tidal energy test site in Paimpol-Bréhat, an estuarine tidal test site in Bordeaux (SEENEOH), a wave energy test site in Le Croisic (SEMREV), and two floating offshore wind test sites, one in Fos sur Mer (Mediterranean sea) and one in Groix (Atlantic ocean).*

R&D Activities in the Public Sector

Ifremer

The Hydrodynamics and Metocean group has been working on the resource assessment, theoretical and experimental modelling of hydrodynamics, experimental methods and experimental tests in the framework of industrial partnerships.

The Materials and Structures group has been working on the long term durability of composite materials for marine structures for over 20 years. Over the last 5 years this activity has focused on the long term behaviour of composite tidal turbine blades.

Several atolls of French Polynesia consist of large lagoons opened on the Pacific Ocean by one or more passes of limited size with strong currents. People in these remote atolls are scarce, isolated, with electric power essentially dependent on gasoil generators. These characteristics are the basis of the potential value of marine current power development in these atolls. In this context, a first pilot study was successfully conducted from June 2010 to July 2011 (http://wwz.ifremer.fr/cop/Energie-marine).
Ifremer is member of the WINFLO project (floating offshore wind turbine) and of the ORCA project (development of a current turbine) and has further an important position in the FP7 funded European project MARINET by managing the transnational access.

École Centrale de Nantes
In 2011, the SEM-REV French wave energy test site construction made a step forward. The final consents and authorizations have been secured and the site was fully marked at sea to ensure the navigation restrictions. The high voltage submarine cable has been ordered and the contract for the maritime shore works and offshore cable burial has been awarded. All works are now planned to start in February 2012 and to end before September 2012, where full electrical connection will be ensured. The final power capacity for the SEM-REV test site is 8 MVA. Wave energy converters can be installed within the consented area and 4 subsea cables derive the initial static cable to 4 slots, where each converter can be installed. Oceanographic instrumentation, including wave monitoring buoys, acoustic current profilers and wind and atmospheric buoys have been fully commissioned on the test area. Wave height records were recorded in December 2011 with measurements that started in May 2009.
The SEM-REV onshore facilities were achieved by the end of 2011. Offices and technical facilities will be equipped in early 2012 and staff will start working full time at Le Croisic town, which is the test site's land base. A first contract has been signed with the company SBM, which has publicly announced its funding from the French renewable energy organization ADEME.

SATIE Laboratory (CNRS - ENS Cachan Britain)
SATIE (Systèmes et Technologies de l'Information et de l'énergie) laboratory has been carried out research on electric energy conversion and storage systems issues for direct wave energy converters (DWEC), in collaboration with the LMF (Laboratoire de Mécanique des Fluides) laboratory. These studies concern methodologies of sizing optimization of the electrical conversion chain of DWEC systems including the damping control strategy.

École Navale (Brest - Britanny)
The Research Institute of Naval Academy (RINA) is working on modelling and design of marine energy systems, mainly on the topic of marine current turbines. Three main projects are carried out in RINA:
"Rim-Driven Project" - methodologies for modelling and design of non conventional structures of turbines;
"SHIVA Project" – development and study of a new concept of a vertical axis turbine;
"Virtual Hydrole" - to develop, in collaboration with the University of Brest (LBMS Laboratory), a global simulation tool to predict the behaviour and the performance of different technologies of marine current turbines.

IFP Energies Nouvelles
IFP Energies Nouvelles is currently focusing its effort on the development of innovative solutions for floating wind turbines. A prototype version has been developed and the R&D joint Industry Project ISIFLOAT is being launched with Principia. In parallel, conceptual studies on floaters, mooring and wind turbine designs, including innovative control strategies, are being performed to identify optimal technical and economic solutions.

R&D Activities in the private sector

Alstom
In April 2009, Alstom Power Hydro signed with Clean Current Power Systems, Vancouver, British Columbia, Canada, a worldwide exclusive license agreement for the development of its Tidal In Stream Energy

Converter (TISEC) technology

Alstom has installed its ocean energy expertise centre in Nantes in the west of France and has deployed a fully dedicated team of 40 elements to further develop, industrialise and commercialise the tidal technology. With a capacity of 1MW and a 13m turbine inlet diameter, BELUGA 9 will be the first commercial scale demonstrator to be tested in 2012 in the Bay of Fundy, Nova Scotia, Canada. A second demonstrator with a bigger diameter, ORCA, is being developed, planned to be tested in 2013 in the French tidal test site of Paimpol-Bréhat.

In June 2011, Alstom broadened its marine energy portfolio by taking a 40% stake of the Scottish company AWS Ocean Energy. Following tests with a 1:9 scale model in 2010, AWS is now working towards a full-scale 2.5 MW prototype of the AWS – III (a floating platform equipped with flexible membranes).

EDF R&D and EDF EN

The EDF group, through its subsidiary EDF Energies Nouvelles, is running a wave energy demonstration project, based on the CETO technology, off the coast of Reunion Island in the Indian Ocean. The company responded to the NER300 call for tenders with a proposal for a 17MW tidal turbine farm, known as Normandie Hydro, and a 26 MW floating offshore wind farm, known as Provence Grand Large, both of them to be developed off the French coast.

To assess the potential operating performance of tidal array systems, the R&D division of EDF group builds on existing knowledge relating to the physics of the flow around tidal turbines in order to account for the presence of a tidal farm in its numerical models.

DCNS

The DCNS group, a world leader in naval systems is expanding to ocean renewable energies and is developing projects in floating wind turbines (WINFLO project), tidal turbines (with Irish company Openhydro), wave energy and OTEC. Since 2008, DCNS has a dedicated OTEC team, which is very active in the OTEC field. DCNS has conducted several feasibility studies since 2008. In 2011 DCNS submitted to NER300 European funding programme a 10 MW project for the French region Martinique

DCNS – OTEC project

SABELLA SAS

SABELLA is fully dedicated to the development of tidal turbine technology. In March 2008 with a successful pioneering deployment in Brittany's waters of its demonstrative pilot "Sabella D03" (scale 1/3) of submarine tidal stream turbine, SABELLA SAS was founded the same year.

SABELLA is pursuing with the implementation of its "Sabella D10" head of series "scale 1", a collaborative approach with three major referent actors (IFREMER, VEOLIA environment, BUREAU VERITAS), and was elected in 2010 to a public support from "Investissements d'Avenir". "D10" is the first step of an ambitious "EUSSABELLA" programme of a "showcase" tidal farm (about 2 MW in the Fromveur, grid linked to Ouessant Island). Otherwise, the Breton company jointly develops a river turbine technology through its Canadian subsidiary "SABELLA ENERGY Inc.". The "SR-01" pilot of this new innovation will be immersed in the summer of 2012 in Montreal in St. Lawrence River.

HYDROQUEST

HydroQuest, a French company created in 2010, designs, manufactures and supplies complete water turbine farms for rivers, estuaries, man-made channels and the ocean. The first machines are being installed through a cooperation programme with EDF, the major European electricity producer.

LE GAZ INTEGRAL (LGI) - "BluStream® project

LGI has been developing the project BluStream® which is now ready for sea installation. In 2011 the company obtained the label "Pôle Mer Bretagne" from the French authorities opening the door to financial support and received from OSEO (public fundings) a grant of €2.5 million for development and engineering phase.

ENERGIE DE LA LUNE

Energie de La Lune is a research department specialised in tidal energy. The project SEENEOH Bordeaux, located in the Garonne river (Gironde estuary), offers a step in the estuarine environment to develop the tidal devices sector. Studies made on the test site will focus on validation studies, impact monitoring, power generation monitoring, estimating the performance of the converter in real conditions, maintenance constraints and conflict of users.

D2M – Bilboquet project

After a joint certification by the Pôles Mer PACA et Bretagne as well as by the Pôle Tenerrdis in 2011, the Bilboquet project has been awarded a 3 year public funding, contributing to cover the design studies and the development of a wave energy demonstrator (point absorber).

FRENCH OVERSEAS COUNTRIES CONTEXT

Reunion Island

The GERRI (Green Energy Revolution - Reunion Island) public interest group is currently in charge of monitoring ten ocean energy projects, of which seven have already a maturity or relatively advanced formulation. The Regional Agency for Energy on Reunion Island (ARER) was created in 2000 by the Regional Council in order to expand the renewable energies for the electricity production and the rational use of energy for sustainable building, country planning and transport. Therefore, ARER participates in GERRI project, which aims to reach energy self-sufficiency of the island by 2030.
Reunion Island has become a laboratory in natural environment, with eight marine energy projects in progress (see box).

Wave Energy:

- Offshore SEAWATT project - based on PELAMIS technology with the novelty, essential for an island, of a storage capacity by an oleo pneumatic system. Four machines (about 3 MW) are planned to be installed in 2014, off Saint-Pierre.
- Nearshore EDF EN project based on the CETO technology - a prototype, not grid connected, is being developed to be launched off Saint-Pierre in order to study the system efficiency and the environmental impacts.
- Onshore wave energy converter – considering to be set in Saint-Philippe as part of a seawall construction.

Thermal Energy:

- SWAC project – led by GDF Suez consisting in air-conditioning using deep cold water (1000 m deep).
- OTEC land based prototype - designed by DCNS to be installed in 2012 at the University campus, a research tool aiming to validate numerical models and test key components.
- OTEC plant off Le Port - feasibility study done by DCNS indicated that a 20 MW OTEC plant could be build off Le Port by 2020.

Osmotic Energy: An opportunity study showed that a huge potential of osmotic energy exists in Sainte-Rose. Indeed, the hydroelectric power station discharges a lot of fresh water, with a significant flow (up to 10m3/s), in the salt water of marina. According to that and the available surface area near the marina, an osmotic power station of about 4 MW could be built.

Microalgae project: The ALBIUS project led by Bioalgostral aims to develop an industrial biofuel production unit in Europe using marine microalgae.

French Polynesia

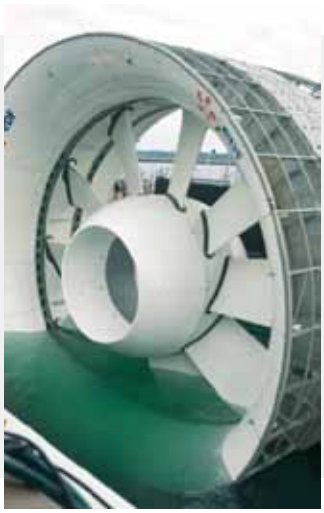
OWC pilot plant: In a partnership with WAVEGEN (VOITH SIEMENS), SEDEP with DORIS ENGENEERING has designed an OWC pilot plant for the island of Tahiti. The pilot plant will be commissioned by the private company ITO ARE (wave energy in Tahitian language), which has already the administrative permits for a site. The new Polynesian law organizing the field of renewable energies should come into force in 2012 and will enable the commissioning, scheduled for 2014.

Renewable marine cooling (SWAC system): In July 2011, the privately owned Tahitian company ITO ARE MOANA signed a 30 years agreement with the Polynesian Government to install a pumping station and a deep sea intake to deliver renewable cooling to a part of the town of Pirae (suburb of Papeete). The project will avoid 5 MW of electricity generated by fossil fuel and 25 GWh per year.

TECHNOLOGY DEMONSTRATION

EDF DPIH: The EDF Paimpol-Bréhat pilot tidal current farm

At the end of 2008, EDF took the decision to launch a pilot tidal current farm. Located in Brittany, 15 km north of the Bréhat Island, the project consists in 4 OpenHydro hydrokinetic turbines at a 35m depth. The first turbine, 16m in diameter and weighting 850t, has successfully been deployed on site on 22 October 2011 for a 3 months test period. The €40 million EDF Paimpol-Bréhat project has gained financial support from the Brittany local Authority (Conseil Régional de Bretagne), the French state (ADEME) and the EU (FEDER).



The turbine on its barge leaving Brest Harbour to Paimpol-Bréhat (crédit photo EDF / Agence TOMA)

HYDRO-GEN: The Hydro-Gen project

Hydro-Gen™ is a technology of floating current converters successfully developed for 6 years appropriate for middle range power needs for remote communities and isolated areas, particularly along rivers or estuaries. Three projects of 50 kW are currently underway at sea, river or estuary: in France, in République Démocratique du Congo and French Guyana.

ECOCINETIC

ECOCINETIC (r) develops and comercialises cross flow marine and fluvial turbines, named "Hydroomel (r)", composed of little modules that perfectly fits into natural and urban environments and on existing structures where it could be located.

Ecocinetic turbine

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ODEWA - Sea Water Air Conditioning (SWAC)

As a marine renewable energy, the SWAC system has first been implemented in French Polynesia on a commercial scale in 2006 by Pacific Beachcomber group (PBSC) and has successfully proved its technical feasibility, potential and financial viability since then. The InterContinental Bora Bora Resort and Thalasso Spa is the first private entity in the world to be fully air-conditioned with a SWAC. The system consists of a 2.3km HDPE pipeline pumping seawater at a 915m depth and has a cooling capacity of 1.6MWf.
A second SWAC with a higher cooling power (2.4MWf) is currently under construction by PBSC (projected completion in March 2012) on the island of Tetiaroa for the future luxury eco-resort "The Brando", which will be the first resort in the world fully relying on renewable energy.

France is very active on floating offshore wind. This Annual Report does not cover offshore wind, however due to synergies with the ocean energy, two recent developments are briefly mentioned:

The Vertiwind project (NENUPHAR) - a floating wind turbine prototype using a vertical axis wind turbines (VAWT), developed by Nenuphar. The project is supported by Bureau Veritas, the École des Arts et Metiers ParisTech, EDF and Technip (leader of the prohect), and has recently received €3 million of investment from the private equity company Idinvest Partners. A 35kW VAWT prototype is being tested onshore at Boulogne-sur-Mer and 2MW machine is being built.

The WINFLO project (NASS & WIND): aims to develop an innovative semi-submersible free floating platform combined with a dedicated multi-megawatt turbine. Initiated in 2008, it is developed through a consortium coordinated by Nass&Wind Industry, major player in wind sector, in close partnership with DCNS, international industrial player in ship building and marine renewables, and Vergnet, experienced in turbine engineering and manufacturing for harsh environments. The first step of the programme, covered by a joint investment of more than €35 million, leads to a demonstration phase beginning in 2013.

05

MARINE SPATIAL PLANNING AND OCEAN ENERGY

INVITED PAPERS

MARINE SPATIAL PLANNING: AN IDEA WHOSE TIME HAS COME

Charles N. Ehler, President[11]
Ocean Visions Consulting
Paris, France

Before the last century, the oceans were used mainly for two purposes: marine transportation and fishing. Conflicts between uses were few and far between, except around some ports. Fisheries were managed separately from oil and gas development, which in turn was managed separately from marine navigation, despite real conflicts between and among these uses.

Single-sector management has often failed to resolve conflicts among users of marine space, rarely dealing explicitly with trade-offs among uses, and even more rarely dealing with conflicts between the cumulative effects of multiple uses and the marine environment. New uses of marine areas, including wind energy, ocean energy, offshore aquaculture, and marine tourism, as well as the demand for new marine protected areas, have only exacerbated the situation. Single-sector management has also tended to reduce and dissipate the effect of enforcement at sea because of the scope and geographic coverage involved and the environmental conditions, in which monitoring and enforcement have to operate. In sharp contrast to the land, little "public policing" of human activities takes place at sea.

As a consequence, marine ecosystems around the world are in trouble. Both the severity and scale of impact on marine ecosystems from overfishing, habitat loss and fragmentation, pollution, invasive species and climate change are increasing, with virtually no corner of the world left untouched.

Awareness is growing that the ongoing degradation in marine ecosystems is, in large part, a failure of governance. Many scientists and policy analysts have advocated reforms centred on the idea of "ecosystem-based management" (EBM). To date, however, a practical method for translating this concept into operational management practice has not emerged. One step in that direction is the increasing worldwide interest in "marine spatial planning".

What Is Marine Spatial Planning?

Marine spatial planning (known as maritime spatial planning, in Europe), or MSP, is a practical way to create and establish a more rational organization of the use of marine space and the interactions between its uses, to balance demands for development with the need to protect marine ecosystems, and to achieve social and economic objectives for marine regions in an open and planned way.

MSP is a public process of analyzing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic and social goals and objectives that are usually specified through a political process.

Its characteristics include:

- **integrated** across economic sectors and governmental agencies, and among levels of government;
- **strategic** and **future-oriented**, focused on the long-term;
- **participatory**, including stakeholders actively in the entire process;

11 Charles Ehler is a consultant to the Marine Spatial Planning Initiative of UNESCO's Intergovernmental Oceanographic Commission. Information on this initiative is available at: http://www.unesco-ioc-marinesp.be/, including the UNESCO publication, *Marine Spatial Planning: a step-by-step approach toward ecosystem-based management.*

- **adaptive**, capable of learning by doing;
- **ecosystem-based**, balancing ecological, economic, social, and cultural goals and objectives toward sustainable development and the maintenance of ecosystem services; and
- **place-based or area-based**, i.e., integrated management of all human activities within a spatially defined area identified through ecological, socio-economic, and jurisdictional considerations.

It is important to remember that we can only plan and manage human activities in marine areas, not marine ecosystems or components of ecosystems. We can allocate human activities to specific marine areas by objective, e.g., development or preservation areas, or by specific uses, e.g., offshore energy, offshore aquaculture, or sand and gravel mining.

Why Is Marine Spatial Planning Needed?

Most countries already designate or zone marine space for a number of human activities, such as maritime transportation, oil and gas development, offshore energy, offshore aquaculture and waste disposal. However, the problem is that usually this is done on a sector-by-sector, case-by-case basis without much consideration of effects either on other human activities or the marine environment. Consequently, this situation has led to two major types of conflict:

- Conflicts among human uses (user-user conflicts); and
- Conflicts between human uses and the marine environment (user-nature conflicts).

These conflicts weaken the ability of the ocean to provide the necessary ecosystem services upon which humans and all other life on Earth depend. Furthermore, decision makers in this situation usually end up only being able to react to events, often when it is already too late, rather than having the choice to plan and shape actions that could lead to a more desirable future of the marine environment.
By contrast, marine spatial planning is a future-oriented process. It offers a way to address both these types of conflict and select appropriate management measures to maintain and safeguard necessary ecosystem services. MSP focuses on the human use of marine spaces and places. It is the missing piece that can lead to truly integrated planning from coastal watersheds to marine ecosystems.

When effectively put into practice, MSP can be used to:

- Set priorities - to enable significant inroads to be made into meeting the development objectives of marine areas in an equitable way, it is necessary to provide a rational basis for setting priorities, and to manage and direct resources to where and when they are most needed;
- Create and stimulate opportunities for new users of marine areas, including ocean energy;
- Co-ordinate actions and investments in space and time to ensure positive returns from those investments, both public and private, and to facilitate complementarity among jurisdictions and institutions;
- Provide a vision and consistent direction, not only of what is desirable, but what is possible in marine areas;
- Protect nature, which has its own requirements that should be respected if long-term sustainable development is to be achieved and if large-scale environmental degradation is to be avoided or minimized;
- Reduce fragmentation of marine habitats, i.e., when ecosystems are split up due to human activities and therefore prevented from functioning properly;
- Avoid duplication of effort by different public agencies and levels of government in MSP-related activities, including planning, monitoring and permitting; and
- Achieve higher quality of service at all levels of government, e.g., by ensuring that permitting of human activities is streamlined when proposed development is consistent with a comprehensive spatial plan for the marine area.

Why Is Space and Time Important?

Some areas of the ocean are more important than others — both ecologically and economically. Species, habitats, populations of animals, oil and gas deposits, sand and gravel deposits, and sustained winds or waves — are all distributed in various places and at various times. Successful marine management needs

planners and managers that understand how to work with the spatial and temporal diversity of the sea. Understanding these spatial and temporal distributions and mapping them is an important aspect of MSP. Managing human activities to enhance compatible uses and reduce conflicts among uses, as well as to reduce conflicts between human activities and nature, are important outcomes of MSP. Examining how these distributions might change due to climate change and other long-term pressures, e.g., overfishing, on marine systems is another important step of MSP.

What Have Been the Principal "Drivers" of MSP?

Pressures from human activities have often led to initiatives to better manage marine areas. For example, in the 1970s, the threat of offshore oil and gas development and phosphate mining led to efforts to protect the Great Barrier Reef. More recently, particularly in Western Europe, MSP has been driven by national policies to develop offshore wind energy in Belgium, the Netherlands, and Germany (all of whom have developed and implemented marine plans), and the United Kingdom (England has only just begun development of marine spatial plans for two sub-regions of its marine area). There is also a requirement to designate more marine protected areas under directives of the European Commission. These "new" uses have had to compete with traditional users for scarce ocean space. Offshore wind energy has also been a driver for MSP in the states of Massachusetts and Rhode Island in the United States of America (USA), both of which have completed plans for their state waters that identify "appropriate" areas for wind energy development. Since ocean energy remains in the R&D stage today, it has not been a principal driver of MSP in any country, to date. While interests in the development of an ocean energy sector are high, large-scale commercial development and economic viability appear to still lie in the future. In 2009, Marine Scotland published a consultation document on a framework for MSP and a guidance document for marine renewable energy for the Pentland Firth and Orkney waters (0-12 nm) - an area long recognized for its ocean energy potential.
In the USA, the State of Oregon is completing a plan for its marine waters that is considering the potential of ocean energy. Oregon has an ideal combination of high-energy waves and available infrastructure that has led many companies to try to stake a claim to the State's potentially lucrative waters. The Oregon State government reached an agreement in 2008 with the federal agency responsible for issuing ocean energy permits to suspend issuing wave energy permits while the State updated its Territorial Sea Plan to deal with the new use of the ocean. The Federal Government has to work with the State in permitting sites inside state waters (0 - 3 nm) and as far out as the outer continental shelf. Oregon's Ocean Policy Advisory Committee has been gathering data to identify possible wave energy sites, including key fishing grounds, important wildlife areas, and to other competing uses. The plan should be completed in 2012.

What Are the Key Elements of Marine Spatial Planning?

The development and implementation of MSP involves a number of steps, including:

1. Identifying need and establishing authority;
2. Obtaining financial support;
3. Organizing the process through pre-planning;
4. Organizing stakeholder participation;
5. Defining and analyzing existing conditions;
6. Defining and analyzing future conditions;
7. Preparing and approving the spatial management plan;
8. Implementing and enforcing the spatial management plan;
9. Monitoring and evaluating performance; and
10. Adapting the marine spatial management process.

These 10 steps are not simply a linear process that moves sequentially from step to step. Many feedback loops should be built into the process. For example, goals and objectives identified early in the planning process are likely to be modified as costs and benefits of different management measures are identified later in the planning process. Analyses of existing and future conditions will change as new information is identified and incorporated in the planning process. Stakeholder participation will change the planning

process, as it develops over time. Planning is a dynamic process and planners and stakeholders have to be open to accommodating changes as the process evolves over time.
Comprehensive MSP provides an integrated framework for management that provides a guide for, but does not replace, single- sector management. For example, MSP can provide important contextual information for guiding marine protected area management or for fisheries management, but does not replace it.

MSP answers four simple questions:

- **Where are we today?** What are the baseline conditions?
- **Where do we want to be?** What are the alternative spatial scenarios of the future? What is the desired vision?
- **How do we get there?** What spatial management measures move us toward the desired future?
- **What have we accomplished?** Have the spatial management measures moved us in the direction of the desired vision? If not, how should they be adapted in the next round of planning?

What Are the Outputs of Marine Spatial Planning?

The principal output of MSP is a comprehensive spatial management plan for a marine area or ecosystem. The plan moves the whole system toward a "vision for the future". It sets out priorities for the area and—more importantly - defines what these priorities mean in time and space. Typically, a comprehensive spatial management plan has a 10- to 20-year horizon and reflects political and social priorities for the area. The comprehensive marine spatial plan is usually implemented through a zoning map, zoning regulations, and/or a permit system similar to a comprehensive regional plan on land. Individual permit decisions made within individual sectors (for example, the fisheries, or oil and gas, or tourism sectors) should then be based on the zoning maps and regulations.
MSP does not replace single-sector planning and decision making. Instead, it aims to provide guidance for a range of decision makers responsible for particular sectors, activities, or concerns, so that they have the means to make decisions confidently in a more comprehensive, integrated and complementary way.

Why Is Stakeholder Participation Critical to Marine Spatial Planning?

Involving key stakeholders, including those in the ocean energy sector, in the development of MSP is essential for a number of reasons. Of these, the most important is that MSP aims to achieve multiple objectives (social, economic and ecological) and should therefore reflect as many expectations, opportunities or conflicts that are occurring in the MSP area, as possible. The scope and extent of stakeholder involvement differs greatly from country to country and is often culturally influenced. The level of stakeholder involvement will largely depend on the legal or cultural requirements for participation that often exist in each country.
Generally speaking, all individuals, groups and organizations, which are, in one way or another affected, involved or interested in MSP, can be considered stakeholders. However, involving too many stakeholders at the wrong moment or in the wrong form can be very time consuming and can distract resources from the expected or anticipated result. To involve stakeholders effectively (e.g., leading toward expected results) and efficiently (e.g., producing expected results at least-cost), three questions should be asked:

- Who should be involved?
- When should stakeholders be involved?
- How should stakeholders be involved?

Where no legal obligations exist, it is important to define what type of stakeholder participation will be most suitable for a successful result. For instance, involving indigenous people in MSP efforts may not be a legal requirement, but they could however be greatly affected (positively or negatively) by MSP management measures, and should therefore participate.

Wide-ranging and innovative approaches to stakeholder participation and proactive empowerment should be used in the MSP process. Stakeholder participation and involvement in the process should be early, often, and sustained throughout the process. Stakeholder participation and involvement encourages "ownership" of the plan and can engender trust among the various stakeholders. Different types of stakeholder participation

should be encouraged at various stages of the MSP process. The key stages at which stakeholders should be involved in the process include:

- **The planning phase:** Stakeholders need to be involved and contribute to the setting of goals and objectives of MSP. They also need to be involved in the evaluation and choice of specific management measure options and the consequences of these choices on their areas of interest;
- **The implementation phase:** Stakeholders should be involved in the actual implementation of MSP and its management measures. For example, an approach to enforcement may be identified and that would involve local communities in the regulatory and enforcement process. When the local communities understand the problems and benefits of taking action—and agree upon the management measures to be taken—they will be part of the enforcement process, at least to the extent of encouraging compliance; and
- **The monitoring and evaluation (post-implementation) phase:** Stakeholders should be involved in the evaluation of the overall effectiveness of MSP in achieving goals and objectives. The post-evaluation effort should involve all stakeholders in a discussion to identify plan results, evaluate results against objectives, and prepare the next round of planning.

CONCLUSION

While ocean energy has not been a principal driver of MSP so far, the situation is likely to change over the next two decades. Since ocean energy projects may take up significant areas of local ocean space, it is likely to compete with other purposes for the same space, including other human uses and areas reserved for nature conservation. The possible impacts of ocean energy on other uses, such as marine transport, offshore aquaculture, fishing, and recreation, will depend on the location of ocean energy infrastructure. Certainly over the next decade, MSP will be up and running in the marine areas of most countries. Early and continuing engagement with these emergent MSP processes will certainly benefit the ocean energy sector.

MARINE SPATIAL PLANNING (MSP) IN THE EUROPEAN UNION AND ITS APPLICATION TO MARINE RENEWABLE ENERGY

Anne Marie O'Hagan
Charles Parsons Research Fellow
Hydraulics & Maritime Research Centre (HMRC), University College Cork, Ireland

Introduction

Maritime Spatial Planning (MSP) is an essential tool for the sustainable development of maritime regions. It is intended to promote rational use of the sea by providing a stable and transparent planning system for maritime activities and users. Numerous definitions of MSP exist: in the European Union (EU) it is defined as a process that relates to planning and regulation of all human uses of the sea while protecting marine ecosystems. It is accepted in the EU that MSP focuses on marine waters under national jurisdiction. However, the geographic coverage of any MSP system will vary according to regional conditions. In principle, from an EU perspective, the MSP process does not include coastal management or planning of the land-sea interface, which is to be addressed through the implementation of Integrated Coastal Zone Management (ICZM). Different terms tend to be used synonymously in current practice, for example, marine planning, ocean planning, and marine spatial planning. In the EU 'Maritime' Spatial Planning is preferred, as it is thought to capture the holistic, cross-sectoral approach of the process (COM(2008) 791 final). For this reason, the term *Maritime* Spatial Planning is used throughout this article.

This article initially outlines the policy basis for MSP in the EU, the principles for a common European approach and the status of MSP in individual Member States. The status is reviewed according to extant legislation, coordination of MSP and existing programmes, plans and projects that endeavour to implement MSP. While it is impossible to include a review of all national initiatives in this article, the approaches adopted by a selection of EU Member States are discussed and examples from key projects that focus on MSP, or aspects of it, are highlighted. To reflect the importance of MSP for marine renewable energy development, the article focuses on the application of MSP to marine renewable energy across Europe and, more specifically, how industry requirements are incorporated (or not) in existing MSP systems. The ocean energy sector is still developing and, as such, may have differing requirements to other sectors. The final section of the article considers other policy developments that are likely to influence the future development and functioning of MSP. As MSP is inextricably linked to Integrated Coastal Zone Management, the position of this in EU Member States is included.

Principles of Maritime Spatial Planning in the European Union

An Integrated Maritime Policy (IMP) for the European Union was published by the European Commission in 2007 (COM(2007) 575 final). This acknowledged that there was increasing competition for marine space and that this was leading to both conflicts between existing users and deterioration of the marine environment. The IMP clearly recognised that everything relating to Europe's oceans and seas is interlinked and, consequently, there is a need for an integrated approach to maritime governance and new tools to deliver this type of approach. Traditionally, management of marine resources and associated uses occurs on a sectoral basis with the existence of a management authority for almost every maritime activity. From previous experiences in resource management, it is known and accepted that such fragmented decision-making invariably results in conflicts of use, inconsistencies between sectors and inefficiencies. The Commission, through the IMP, therefore, sought to address this by applying the integrated management approach at every level, through the utilisation of both horizontal and cross-cutting policy tools. In this context, the IMP put forward maritime

surveillance, Maritime Spatial Planning and [additional] data and information as three essential tools for integrated management.

Given the strong advocacy of MSP as the desired planning tool to be used for sustainable decision-making, the Commission felt it necessary to put forward a set of common principles to "facilitate the process in a flexible manner and to ensure that regional marine ecosystems that transcend national maritime boundaries are respected" (COM(2007) 575 final, p.6). A common approach was deemed necessary to ensure consistency. Competency for the design and implementation of MSP resides with individual Member States and not with the EU per se. This also explains why progress varies between Member States (see below). The Commission published their common principles in 2008 in a Communication entitled "Roadmap for Maritime Spatial Planning: Achieving Common Principles in the EU" (COM(2008) 791 final). In this Communication, the Commission put forward their rationale for the benefits of a European approach stating that, ultimately, the use and implementation of MSP will "enhance the competitiveness of the EU's maritime economy, promoting growth and jobs in line with the Lisbon agenda… in line with ecosystem requirements" (p.3). The over-arching principle for MSP is the ecosystem approach, whereby human activities affecting the marine environment are managed in an integrated manner promoting conservation and sustainable use, in an equitable way, of oceans and seas (COM(2005) 504 final, p.5). This is complemented by ten supporting principles, presented in Box 1.

- Using MSP according to area and type of activity;
- Defining objectives to guide MSP;
- Developing MSP in a transparent manner;
- Stakeholder participation;
- Coordination within Member States - Simplifying decision processes;
- Ensuring the legal effect of national MSP;
- Cross-border cooperation and consultation;
- Incorporating monitoring and evaluation in the planning process;
- Achieving coherence between terrestrial and maritime spatial planning; and
- A strong data and knowledge base.

Box 1: European Union Principles for MSP (COM(2008) 791 final)

These principles were derived from existing approaches to MSP in Member States and other international examples that included research projects. Other legal instruments informed the creation of these principles. These include the United Nations (UN) Law of the Sea Convention, Regional Seas Conventions (e.g. OSPAR, HELCOM) and numerous EU legal instruments (e.g. Common Fisheries Policy, Water Framework Directive, Marine Strategy Framework Directive etc.). The Roadmap containing these principles is seen as "the first steps towards a common approach on MSP" (COM(2008) 791 final, p.11).

Status of MSP in EU Member States

Notwithstanding the strong policy base for MSP, implementation is taking place on a predominantly ad hoc basis. The EU member nations of the Ocean Energy Systems Implementing Agreement have implemented MSP differently (Table 1). Whilst few Member States have dedicated MSP legislation or an over-arching coordination authority, most have some form of programme or plan on MSP, a necessary first step in the MSP process. While such programmes and plans take a sectoral perspective, they have enabled initial debate on coexistence of maritime uses, conflicts between uses and problems with existing spatial management tools. This can inform the development of an appropriate MSP system, in line with the common principles above. Each Member State faces different challenges in developing an MSP system and it should be recognised at the outset that there is no single, correct approach to MSP. The approach taken will vary according to the size and nature of the maritime space, the types of activity and uses going on there, as well as the pertinent legal and institutional arrangements (MRAG/European Commission, 2008). As a result, a variety of

mechanisms can be used to implement MSP, including specific regulations and zoning of sea areas. It is also important to stress that MSP is just one element of broader ocean management and should be viewed as a 'strategic vision' for a maritime area that is supported by a range of other policies, including sector specific policies (Ehler and Douvere, 2009).

Member State	Legislation	Programmes	Coordination	ICZM
Belgium				Equivalent measures
Denmark				Sectoral tools
Germany				National strategy
Ireland				Sectoral tools
Italy				Strategy in preparation
Portugal				National strategy
Spain				Strategy in preparation
Sweden				Equivalent measures
United Kingdom				National strategy

Table 1: Status of MSP in EU Member States that are Members of the OES

Note: With respect to legislation for, programmes on, and coordination of MSP dark green indicates that the Member State has sectoral elements in place. Bright green indicates that fully integrated elements are in place. Grey indicates that the status is unknown and red indicates that the element is not yet in place. The information presented in this table is adapted from Thetis, 2011.

Many States across Europe are just beginning to formulate an appropriate legal framework for MSP. This is complicated by competencies across governance levels in many EU Member States. In the case of **Germany**, for example, responsibility for MSP in the Territorial Sea (i.e. to the 12 nm limit) rests with the federal states (*Länder)* as part of their regional planning functions. Beyond the Territorial Sea, in the Exclusive Economic Zone (EEZ) (to 200 nm), MSP is the responsibility of the German Federal government. Specific legislation was enacted for spatial planning in the German EEZs of both the North Sea and the Baltic Sea in 2009. In **Sweden**, a Marine Environment Inquiry was appointed by the Government, in 2006, to explore ways in which their marine management could be improved. The report of the inquiry was released in June 2008 and found that it was time for a "third-generation environmental policy" that "must entail a holistic approach and full integration of environmental issues into all policy areas, stronger political leadership and, to a much greater extent, an international focus" (Ministry of the Environment, 2008). Despite this, no formal and integrated legal framework for MSP exists. Legislation for spatial planning of land, however, extends to the limit of the Territorial Sea. **Belgium** was among the first EU Member States to start implementing an operational, multiple-use planning system in its Territorial Sea and EEZ, through associated legislation, namely the EEZ Act of 1999 and the Marine Protection Act of 1999. In practice, these effectively provide for a zoning approach to regulate activities at sea rather than for a broader MSP process.

In contrast, the UK has adopted a new policy to deliver the provisions of the Marine Strategy Framework Directive (MSFD) in the **United Kingdom**[12] through the enactment of the Marine and Coastal Access Act 2009.[13] This Act also establishes an integrated planning system for managing seas, coasts and estuaries, a new legal framework for decision-making as well as streamlined regulation and enforcement. The new

12 The UK, in this context, refers only to England and Wales. The Marine (Scotland) Act 2010 and proposed legislation in Northern Ireland will introduce new marine planning systems in those jurisdictions.

13 Formerly known as the Marine Bill.

marine planning system has three components: the Marine Policy Statement, Marine Plans and Marine Licensing. The Marine Policy Statement sets the general environmental, social and economic considerations that need to be taken into account in marine planning (Part 3, Chapter 1, sections 44 - 48). This Statement applies to all UK waters. Marine Plans must be consistent with the Marine Policy Statement and, ultimately, will indicate to developers the locations where (1) they can conduct their activities; (2) they can conduct their activities under certain restrictions or (3) their activities are unlikely to be considered appropriate (Part 3, Chapter 2, sections 49 - 54). Following the adoption of a marine plan, public authorities taking consenting or enforcement decisions must do so in accordance with those Marine Plans and the over-arching Marine Policy Statement unless they can provide justification for doing otherwise (Part 3, Chapter 4, sections 58 - 60).

Portugal has also been relatively progressive in implementing a legal framework for MSP. This stems from the publication of a National Ocean Strategy in 2006, which sought to integrate sectoral policies and define principles for both MSP and ICZM (Government of Portugal, 2006). As a response to this, work on the Plano de Ordenamento do Espaço Marítimo (POEM), a Portuguese maritime spatial plan, began in 2008. The development of this plan consists of four stages, (1) characterisation studies and assessment; (2) provisional maritime spatial plan; (3) zoning plan and implementation programme; and (4) public consultation. The public consultation stage has recently ended and the final version of the plan is due for publication in the near future. In Denmark, Ireland, Italy and Spain work on the development of an appropriate MSP system is just beginning. In **Denmark**, for example, this has involved the creation of a working group, consisting of the relevant Danish authorities, which is tasked with presenting proposals for future practice in terms of MSP in Denmark (Danish Government, 2010). A number of pilot projects on MSP in Denmark also exist. **Ireland** is in the process of reforming its foreshore management regime and it is hoped that this will reflect the EU's MSP principles (O'Hagan and Lewis, 2011). In **Italy** and **Spain** there is no integrated approach to MSP as yet, though there are some active projects which seek to apply MSP in specific locations.

Coordination of MSP systems also varies according to Member State. In some countries, there is a dedicated single management entity responsible for implementation of MSP. In the **UK**, for example, Part 1 of the Marine and Coastal Access Act 2009 provided for the establishment of the Marine Management Organisation, which is tasked with implementing the new MSP system, the associated licensing regime, management of fishing fleet capacity and designation of Marine Protected Areas. In **Portugal**, any amendments to the POEM will require approval by a multi-disciplinary team, consisting of representatives from the relevant government ministries, Instituto Nacional da Água (INAG; Portuguese Water Institute) and four external consultants, including some university representatives (Calado et al., 2010). Generally, the constitutional system in each Member State will dictate their governance structure. Consequently, in States with complex governance structures, such as **Belgium**, **Germany** and the **UK**, the constitutional system will determine both the entity that has legislative capacity for elements of MSP and the level of government that has primary competency over internal waters, the Territorial Sea, EEZ etc. (MRAG/European Commission, 2008). Despite the governance model that exists, what is essential is that there is a framework to support MSP and facilitate integration amongst sectors. As a tool for improved decision-making, MSP must ensure that all stakeholders are included and can get involved in the process.

Plans, Programmes and Projects on MSP

From the brief outline above, it is clear that progress on MSP across the European Union varies significantly with few fully integrated and developed MSP systems. One way in which this is being addressed, both at EU and individual Member State level, is to begin the MSP process with a dedicated MSP programme, or pilot demonstration, at specific locations, often where a range of maritime uses exist. Such initiatives can be instigated solely at national level but more commonly take a regional or pan-European approach, reflective of the approach suggested in the IMP, and as such can be funded under various EU research programmes such as FP7, Intelligent Energy Europe and INTERREG. Table 2 presents a selected sample of such projects, paying particular attention to those that have a marine renewable energy focus.

NAME	AIMS AND OBJECTIVES	WEBSITE
INTERREG III BALANCE: Baltic Sea Management: Nature Conservation and Sustainable Development of the Ecosystem through Spatial Planning	The project aims to develop transnational MSP tools and an agreed template for marine management planning and decision-making. It is based on 4 transnational pilot areas demonstrating the economic and environmental value of habitat maps and MSP (through 2 zoning plans). The tools and zoning plans integrate biological, geological and oceanographic data with local stakeholder knowledge	http://www.balance-eu.org/
INTERREG IV BaltSeaPlan: Towards a Spatial Structure Plan for Sustainable Management of the Sea	With a learning-by-doing approach, BaltSeaPlan will attempt to overcome the lack of relevant legislation in most Baltic Sea Region countries for MSP. The project developed pilot plans for 8 demonstration areas around the Baltic Sea and has also advanced methods, instruments and tools and data exchange necessary for effective maritime spatial planning.	http://www.baltseaplan.eu/
FP7 COEXIST: Interaction in Coastal Waters: A Roadmap to Sustainable Integration of Aquaculture and Fisheries	COEXIST is a broad, multidisciplinary project which will evaluate competing activities and interactions in European coastal areas. The ultimate goal is to provide a roadmap to better integration, sustainability and synergies among different activities in the coastal zone. Six case study areas are included in the project.	http://www.coexistproject.eu/
INTERREG III GAUFRE: Towards a Spatial Structure Plan for Sustainable Management of the Sea	The main aim of the project is the delivery and the synthesis of scientific knowledge on the use and possible impacts of use functions. Consequently, a first proposal of possible optimal allocations of all relevant use functions in the Belgian part of the North Sea (BPNS) will be formulated.	http://www.vliz.be/projects/gaufre/index.php
FP7 KnowSeas: Knowledge-based Sustainable Management for Europe's Seas	The overall objective of the project is to provide a comprehensive scientific knowledge base and practical guidance for the application of the Ecosystem Approach to the sustainable development of Europe's regional seas. It will be delivered through a series of specific sub-objectives that lead to a scientifically-based suite of tools to assist policy makers and regulators with the practical application of the Ecosystem Approach to various sectors.	http://www.knowseas.com/
EU Preparatory Action (IMP) MASPNOSE	The project will explore the possibilities for cross-border collaboration in maritime spatial planning in the North Sea and will build on other projects and initiatives that are already looking at integrating spatial information and planning.	https://www.surfgroepen.nl/sites/CMP/maspnose/default.aspx
FP7 MESMA: Monitoring and Evaluation of Spatially Managed Areas	This project aims to produce integrated management tools (concepts, models and guidelines) for monitoring, evaluation and implementation of Spatially Managed Areas (SMAs). The project results will support integrated management plans for designated or proposed sites with assessment methods based on European collaboration.	http://www.mesma.org/
FP7 ODEMM: Options for Delivering Ecosystem-Based Marine Management	The aim is to develop a set of fully-costed ecosystem management options that would deliver the objectives of the MSFD, the Habitats Directive and the IMP. The key objective is to produce scientifically-based operational procedures that allow for a step by step transition from the current fragmented system to fully integrated management.	http://www.liv.ac.uk/odemm/
EU Preparatory Action (IMP) PlanBothnia	The project, coordinated by the HELCOM Secretariat, will test MSP in the Bothnian Sea area as a transboundary case between Sweden and Finland. Partners provide background material on relevant human activities and natural features as well as draft material for plans for the Bothnian Sea region. This material will be considered in five dedicated transboundary planning meetings.	http://planbothnia.org/
INTERREG III PLANCOAST	The aim is to develop the tools and capacities for effective integrated planning in coastal zones and maritime areas in the Baltic, Adriatic and Black Sea regions. PlanCoast pilot projects formed the basis for recommendations at local and national level on how to implement, adapt and further develop the ICZM and MSP in each partner country.	http://www.plancoast.eu/
INTERREG III POWER: Pushing Offshore Wind Energy Regions	The central aim of POWER is to unify North Sea regions, to learn from each other, to set up common strategies overcoming economic changes, to respond to new educational needs and thereby give a positive impetus to continuing sustainable development of the region.	http://www.offshore-power.net/
EACI/IEE SEAENERGY 2020	The project will formulate concrete policy recommendations on how best to deal with MSP and remove MSP obstacles that hinder the deployment of offshore renewable energy. It will provide policy recommendations for a more coordinated approach to MSP and larger deployment of marine renewables (wind, wave, tidal).	http://www.seanergy2020.eu/
EACI/IEE WINDSPEED: Spatial Deployment of Offshore Wind Energy in Europe	Windspeed aims to assist in overcoming existing obstacles to deployment by developing a roadmap defining a realistic target and development pathway up to 2030 for offshore wind energy in the Central and Southern North Sea. This includes delivering a decision support system (DSS) tool using geographical information system (GIS) software. This will also facilitate the quantification of trade-offs between electricity generation costs from offshore wind and constraints due to non-wind sea functions and nature conservation, thereby assisting policy makers in terms of allocating space for the development of offshore wind the Central and Southern North Sea.	http://www.windspeed.eu/

Table 2: Current and Completed MSP Projects of Relevance to Marine Renewable Energy Projects

The deliverables from many of the above mentioned projects will assist in the development of more effective national and regional MSP systems. This is particularly true of projects that have a specific sectoral or industry focus, such as renewable energy, or projects that consider the potential for conflict between actors, for example, fisheries and offshore wind energy.

Application of MSP to Marine Renewable Energy

Inclusion of marine renewable energy requirements in MSP systems varies not only according to location but also according to the status of the industry in that country. In **Germany**, for example, dedicated work on MSP was triggered by the economic interest in developing offshore wind energy, which was necessary to achieve the Government's emission targets (MRAG/European Commission, 2008). To secure the scale of investment needed for such large scale projects, a stable and predictable planning framework was required. MSP was viewed as the process which could help identify and allocate areas to certain activities and thus contribute to expediting the decision making process. Priority areas for offshore wind energy development in the German EEZs of both the North Sea and the Baltic Sea were subsequently zoned (Figure 1). **Belgium** has taken a similar 'zoning' approach and legally designated a 270 km² area for offshore wind projects (total capacity of 2,000 MW).[14] Whilst **Denmark** does not have an established MSP system in place, 23 sites were pre-selected for offshore wind energy development as far back as 2007 (Danish Energy Authority, 2007).

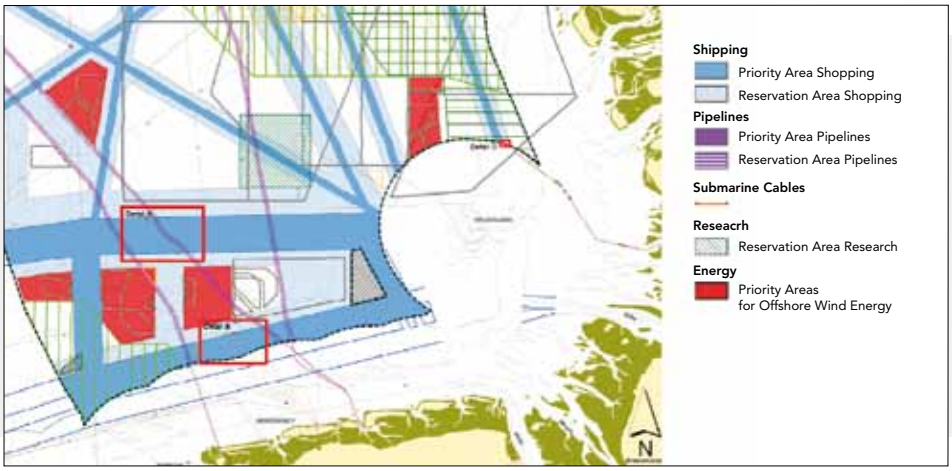

Figure 1: Extract from Spatial Plan Map for the German EEZ of the North Sea (BMVBS, 2009)

It should be emphasised here that zoning of activities/areas is one of a number of management mechanisms which may be introduced in a Marine Spatial Plan to help achieve the overall objectives of the MSP system. Technically, zoning can be described as a management tool for spatial control of activities with defined activities, permitted or prohibited from specified geographic locations (Gubbay, 2005). Zoning can separate conflicting activities or indeed give a particular sectoral interest exclusive use of an area of sea, as is the case in the above mentioned examples for offshore wind energy development. Generally, if an area is zoned for a particular use, that use will require the granting of a consent or licence[15] so that a dedicated space can be allocated. A consent or licence, therefore, is the mechanism by which the overall objectives of MSP are translated into the rights and responsibilities of individual users. Obviously, it is also essential that an MSP system is sufficiently flexible to take new information and, in the context of ocean energy, new technology types into account. An overly-prescriptive MSP system, for example, could restrict future developments and

14 Royal Decree of 17 May 2004

15 Different jurisdictions use different terms for this, e.g., consent, permission, licence, lease, permit etc. The term to be used will be defined by the applicable legislation. In Ireland, for example, under foreshore legislation, a licence is granted for short-term, non-exclusive use/occupation, whereas a lease is granted for long-term, sole use/occupation.

innovation. For this reason, an adaptive management approach is inherent in many MSP systems and any supporting Plan will set an explicit timeframe for review. The incorporation of adaptive management principles into MSP also allows the potential for coexistence of industries to be explored. It may be possible for certain fishing activities to co-exist with marine renewables developments, for example, fishing involving potting techniques.

Given the current status of ocean energy development in the European Union, very few existing maritime spatial plans currently include a dedicated area for ocean energy development. One exception to this is in **Scotland** and relates to the Pentland Firth and Orkney Waters and the MSP approach taken by Marine Scotland. This area has significant ocean energy resources and is also of high environmental quality. The area is host to a range of other uses and sectors such as fishing and shipping. Consequently, there was a need to examine how future ocean energy development could progress in a manner that avoided conflict with those users. MSP was the obvious solution of choice, but the legislative framework setting out the requirements and content of regional marine plans was not yet in place. A de facto Marine Spatial Plan Framework (MSPF) was put in place, which sets out a process for the development of future plans, covering the areas from the mean high water mark out to the limit of the Territorial Sea (12 nm) (Scottish Government/Marine Scotland, 2010). This Framework consists of a document that contains information on different uses of the seas, how these uses may impact on each other and ultimately aims to set out the process for developing the future, over-arching MSP System. The Framework document is complemented by a Regional Locational Guidance document, which provides guidance and advice to marine renewable energy developers and other stakeholders on the siting of wave and tidal developments in the Pentland Firth and Orkney Waters (Scottish Government/Marine Scotland, 2010).

Elsewhere, test sites and pilot demonstration zones are usually close to shore in the coastal zone, which is often outside the geographic scope of any existing MSP system. As yet, the latter applies primarily to territorial seas and EEZs, with nearshore coastal planning being the responsibility of the adjoining local authority or regional government. This boundary varies according to jurisdiction. In Britain and Ireland, for example, planning powers end at the low water mark and high water mark, respectively. In the Scandinavian countries, local governments have planning powers extending up to three miles offshore. This is of relevance to ocean energy development, as developments have the potential to straddle a number of maritime jurisdictional zones. A probable implication of this is that a number of regulatory bodies will be involved in the consenting process. MSP should, therefore, address this issue by providing an integrated planning framework.
More established maritime sectors and uses are subject to more mature management regimes and, as their needs are well known and documented, it is arguably easier to reflect their needs in a MSP system. Newer industries, such as ocean energy, have not reached this stage yet but still require the predictable and transparent planning system that MSP seeks to deliver. For this reason, it is essential that the needs of the industry are made known to those tasked with developing MSP in their region.

Key considerations include:

- Strategic development zones so as to ensure room for growth. Such zones also need to take existing support infrastructure into account (e.g. proximity to grid connections, ports, suppliers);
  Strategic development zones need to be tailored to device type/depth. MSP should operate on three dimensions (on the sea bed; in the water column; and on the surface) as it is probable that other maritime activities will therefore be able to co-exist with ocean energy developments;
- While still developing, the ocean energy sector should be considered in parallel with other, more established, maritime activities;
- The MSP system should be adaptive and flexible so as to include a range of possible deployment areas and enable new technological developments and scientific knowledge to be taken into account;

- From a practical perspective, 'zoned' rectangles are not wholly appropriate to ocean energy development and also present difficulties from an enforcement and compliance point of view;
- Ocean energy developments will straddle a number of maritime jurisdictional zones such as internal waters, the Territorial Sea and potentially the EEZ. Land based elements of such developments, for example, electrical sub-stations, must be considered as part of the total project. For this reason, there is a requirement for coherence and coordination between maritime and terrestrial planning systems;
- The terminology used in Maritime Spatial Planning needs to be clear and consistent. Terms like pilot, demonstration, temporary, and commercial can mean different things to different people and lead to conflict at a later stage.

Other Policy Developments with Implications for MSP Implementation

The Marine Strategy Framework Directive (2008/56/EC) was adopted by the European Commission in June 2008. This aims to achieve 'Good Environmental Status' (GES) of the EU's marine waters by 2020 and to protect the resource base upon which marine-related economic and social activities depend. This Directive therefore enshrines the ecosystem approach in a legislative instrument. Accordingly, the MSFD will deliver the environmental pillar of the IMP. Under the Directive, Member States must develop a strategy for their marine waters. This strategy must contain a detailed assessment of the state of the environment, a definition of 'GES' at regional seas level and the establishment of clear environmental targets and monitoring programmes. Member States must determine a set of characteristics for GES on the basis of eleven qualitative descriptors listed in Annex I of the Directive. These descriptors are presented in Box 2.

- Descriptor 1: Biological diversity;
- Descriptor 2: Non-indigenous species;
- Descriptor 3: Population of commercial fish/shell fish;
- Descriptor 4: Elements of marine food webs;
- Descriptor 5: Eutrophication;
- Descriptor 6: Sea floor integrity;
- Descriptor 7: Alteration of hydrographical conditions;
- Descriptor 8: Contaminants;
- Descriptor 9: Contaminants in fish and seafood for human consumption;
- Descriptor 10: Marine litter; and
- Descriptor 11: Introduction of energy, including underwater noise.

Box 2: Qualitative Descriptors for Determining 'Good Environmental Status' (Annex I, MSFD)

A number of these descriptors could have significant implications for future marine renewable energy developments. Following an initial characterisation, Member States are required to identify the measures which need to be taken in order to achieve or maintain GES in their marine waters. According to Annex VI of the Directive, programmes of measures can include, amongst others, spatial and temporal distribution controls: management measures that influence where and when an activity is allowed to occur. Theoretically, therefore, the MSFD could contribute to the implementation of MSP at Member State level.

To a certain extent, this has been the experience in Spain, for example, where the legislation transposing the requirements of the MSFD into national law specifically lists MSP as one of the measures that can be adopted to achieve or maintain GES (Suárez de Vivero and Rodríguez Mateos, 2012).

MSP is inextricably linked to Integrated Coastal Zone Management (ICZM). A review of the need for a new or revised instrument on ICZM in the EU is currently underway. Given these linkages, the review is being carried out in conjunction with an assessment of possible future action on MSP. The Commission will put forward a range of proposals as a follow-up to the EU ICZM Recommendation, in conjunction with an assessment of possible future action on Maritime Spatial Planning, as appropriate, by the end of 2011.

While it is not certain at this time what format the proposals will take, a new Directive on MSP may be one of the proposals. This would provide a common framework for MSP in Member States of the EU, making MSP mandatory, while simultaneously leaving Member States free to decide on how to implement the process. If there is a Directive on MSP, there may also be a separate, but related, Directive on ICZM.

CONCLUSION

Maritime Spatial Planning will have significant implications for the development of marine renewables generally and the ocean energy sector in particular. Economic development and marine environmental protection have an equal weighting in the EU's Integrated Maritime Policy and both elements are either already specifically addressed in legislation or will be in the near future. This means that it is essential for the ocean energy industry to engage fully in the Maritime Spatial Planning process to ensure that conflicts are minimised and that the industry can progress in a sustainable manner. From an industry perspective, it is essential that research is undertaken to understand the extent to which ocean energy developments can be deployed and co-located with other users of the sea. This could help lessen the need for 'exclusion zones' within MSP systems.

As a key player in the advancement of ocean energy, the Ocean Energy Systems Implementing Agreement (OES) is in a unique position to encourage device and project developers to involve themselves in the debates and processes surrounding development of Maritime Spatial Planning systems in different jurisdictions. The European Commission recognized that stakeholder participation will significantly raise the quality of MSP (COM(2008) 791 final). Developers already have a wealth of tacit knowledge from their experiences of deploying devices. They know what has worked well and where. This type of knowledge will help inform the creation of an MSP system that is both fully reflective of the needs of the industry and will also enlighten other industries as to the specific requirements of the ocean energy sector. The OES should promote this active involvement of the sector, as it is an essential criterion for progress and acceptance of MSP.

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SITING WAVE ENERGY ON THE OREGON COAST: THE OREGON TERRITORIAL SEA PLAN AND SITING ANALYSIS TOOLS

Simon Geerlofs, Pacific Northwest National Laboratory
Rebecca Sherman O'Neil, Oregon Department of Energy
Luke Hanna, Pacific Northwest National Laboratory
Hoyt Battey, U.S. Department of Energy

Summary

Oregon's powerful waves, steady winds and strong renewable energy policies make the state a natural place for wave energy business. Healthy marine ecosystems, commercial and recreational fishing, marine transportation, tourism and the scenic beauty of the ocean are also important values to coastal communities. Encouraging development of a sustainable wave energy industry, while protecting existing coastal values presents a management challenge for the State of Oregon. It also presents an opportunity for a science-based discussion around how the ocean is currently used and how it can be used in the future to maximize public benefit.

Over the last four years, the State of Oregon, led by the Department of Land Conservation and Development (DLCD), has worked to address this management challenge by updating its existing Territorial Sea Plan (TSP) to include wave energy siting considerations. The process has provided an important opportunity for a full accounting of existing uses within the territorial sea (state marine waters from 0-3 miles offshore). However, due to planning constraints of the TSP and Oregon's existing Statewide Planning Goal 19 (which serves to protect existing ocean uses and resources), the update process has not provided an opportunity for a full discussion of present and future marine renewable energy values, opportunities and industry needs.

Through interviews with Oregon's planning and wave energy leadership, this article describes the Oregon TSP update process and discusses how that process has considered marine renewable energy (primarily wave energy), a new use of space in an already crowded sea. It also describes information products being used to map Oregon's coastal resources, as well as other tools under development in Oregon to support siting decisions.

The Oregon Wave Energy Opportunity and Energy Policy

With more than 300 miles of coastline and a wave climate well suited to power production, Oregon has long been considered a prime U.S. location for wave energy development. The presence of deepwater ports, manufacturing industries and diffuse coastal electricity demand offer developers excellent siting opportunities.

Recognizing the opportunity to be a leader in an emerging international industry focusing on marine renewable energy, Oregon has adopted policies to encourage wave energy developers to test, construct and locate devices in Oregon waters. In 2007, the Oregon Innovation Council began to fund the Oregon Wave Energy Trust (OWET), a public-private partnership that connects stakeholders and carries out research in support of wave energy development. In the same year, the state enacted a Renewable Portfolio Standard that required 25% of power consumed in Oregon to be sourced from renewable resources and identified a preference for marine renewable energy development including wave energy.[16]

16 Oregon Revised Statutes 469A.210, as amended by HB 3633 (2010). "The Legislative Assembly finds that community-based renewable energy projects, **including but not limited to marine renewable energy resources that are either developed in accordance with the Territorial Sea Plan adopted pursuant to ORS 196.471 or located on structures adjacent to the coastal shorelands**, are an essential element of Oregon's energy future, and declares that it is the goal of the State of Oregon that by 2025 at least eight percent of Oregon's retail electrical load comes from small-scale renewable energy projects with a generating capacity of 20 megawatts or less."

In 2008, Oregon State University established the wave energy division of the Northwest National Marine Renewable Energy Centre, one of three US Department of Energy-sponsored research institutions that helps facilitate commercialization of wave energy devices.

The Oregon Territorial Sea Plan Part 5 and Statewide Planning Goal 19

The state's policy actions encouraging marine renewable energy created early enthusiasm for development on the part of the wave energy industry. As developers began to explore sites and engage in permitting processes, concern started to grow in coastal communities about the size of wave energy installations and how fast development could occur. In response, Oregon signed a Memorandum of Understanding (MoU) with the Federal Energy Regulatory Commission (FERC) - the federal agency that licenses grid-connected pilot and commercial wave energy projects - in March 2008, to agree that all proposed wave energy projects are responsive to State environmental, economic and cultural concerns.[17] The Governor then directed that Oregon's existing TSP should be amended to guide the siting of ocean renewable energy facilities.[18]

The Oregon TSP, created in 199419, guides ocean policy in state marine waters and provides important context and constraints for Oregon's current marine renewable energy planning activities. In 2009, a new Part 5 of the TSP was approved to establish state governance of marine renewable energy projects.[20] Part 5 describes the policies, standards and procedures that state agencies will use to approve new alternative energy developments within the territorial sea. These processes and procedures are additional to the existing FERC licensing process.[21]

A second and final phase of Part 5 is ongoing and expected to be completed by mid-2012. The second phase provides an inventory of existing resources, which are then used to create a master map of the Territorial Sea. The State hopes that the map will identify where development of ocean energy may occur without interfering with existing marine resources and other uses. Until both phases are complete, no new commercial-scale wave energy permits will be issued in Oregon waters.

The development of Part 5 of the Territorial Sea Plan is framed by Oregon Statewide Planning Goal 19,[22] (referred to as Goal 19), which guides all planning activities that could affect ocean resources. Paul Klarin is Oregon's Department of Land Conservation and Development's (DLCD) Marine Affairs Coordinator and staff lead for the TSP update process. According to Klarin, Goal 19 "provides three planning pillars that need to be addressed during the TSP update; broadly speaking, these are to protect 1) marine ecosystems, 2) areas important to fisheries, and 3) existing uses of the territorial sea."

Mapping the Oregon Coast

The DLCD is using Goal 19 to drive the TSP mapping process, setting out to identify Goal 19 resources in the territorial sea and creating a map layer for each of the three planning pillars described above. "Those three sets of maps are combined to give us an understanding of the total areas that need to be protected from new development," said Klarin.

Goal 19 does not provide specific guidance on measures necessary to "maintain and protect" ecosystems, fisheries and existing uses. The DLCD has indicated that it will take a conservative planning approach to identify Goal 19 resources first and then buffer them against marine renewable energy installations. At this point, planning options exclude marine renewable energy from Goal 19 protection areas.

The DLCD is using a web-based interactive mapping tool called MarineMap[23] to assemble spatial data,

17 http://www.ferc.gov/legal/maj-ord-reg/mou/mou-or-final.pdf

18 Executive Order 08-07: Directing State Agencies to Protect Coastal Communities in Siting Marine Reserves and Wave Energy Projects. http://www.oregon.gov/Gov/docs/executive_orders/eo0807.pdf

19 By the Ocean Policy Advisory Council (OPAC) http://www.oregon.gov/LCD/OPAC/

20 http://www.oregon.gov/LCD/OCMP/docs/Ocean/otsp_5.pdf

21 The Bureau of Ocean Energy Management (BOEM) has jurisdiction for siting in federal waters greater than 3 miles offshore. BOEM and FERC coordinate on the project licensing process in federal waters; though the state also has a say in these projects through Coastal Zone Management Act consistency review.

22 http://www.oregon.gov/LCD/docs/goals/goal19.pdf

show the location of existing Goal 19 resources and to inform stakeholder dialog around planning options. MarineMap does not describe potential compatibility of new uses with those that currently exist, or tradeoffs, if uses were co-located.

The Goal 19 data layers within MarineMap portray one side of the energy siting story: potential constraints to wave energy development. Energy opportunities, to date, have not been incorporated into the spatial analysis. The assumption of the DLCD is that once Goal 19 resources are identified, the space that remains could be considered for marine renewable energy development. In this way, the planning process will "back into" energy opportunities.

Marine renewable energy experts are concerned by this approach. According to Jason Busch, Executive Director of OWET: "The fact is wave energy can't just go anywhere. Minimizing distance from deepwater ports, nearby transmission infrastructure, suitable bathymetry, an adequate wave climate and other factors make the difference between a viable site and one that is not feasible."

The concern is that the space remaining after Goal 19 resources are identified and buffered will be minimal and may not be suitable for marine renewable energy. And while it is possible for some developers to move further offshore into federal waters, siting in the Territorial Sea to keep costs low is likely to be desirable for the first generation of projects. Furthermore, some wave devices are designed exclusively for nearshore and shallow depths; these devices do not have the option of moving offshore.

So, the question is: how does the State meet its obligation to protect Goal 19 resources, while ensuring adequate space in the right places to support marine renewable energy?

Consideration of Energy in the Planning Process

All parties acknowledge that it is difficult to plan for an industry that is brand new. Without considering a specific device in a specific location, the Oregon Wave Energy Trust has attempted to define compatibilities and what the industry needs most. "OWET has already mapped high priority areas and vetted the parameters with industry," said Busch. He believes that planning for marine renewable energy should "begin with these high priority areas with a thought toward commercial development and try to find sites that strike a balance."

While broadly supportive of wave energy development, the State's existing directives are not explicit about how to strike that balance between uses. "What we lack," said Klarin, "is any kind of decisive policy on the part of the State and Federal Government about how to site renewable energy in the ocean specifically and how to weigh it against other uses."

Most energy facilities in Oregon are sited on a project-by-project basis, typically at the local (county) level. Very large wind generators, gas facilities, transmission lines and other major energy infrastructure trigger jurisdiction under the State's Energy Facility Siting Council. This body issues a site certificate for an energy facility, if it can meet a series of standards that protect natural resources and public health and safety. If the facility does not meet one or more of the standards, the Council cannot issue a site certificate, unless the applicant can show that the overall public benefits of the facility outweigh potential damage to resources. This type of balancing requires an understanding of the benefits of all uses involved. Fishing, marine ecosystems and tourism provide benefits to the State and citizens of Oregon. Marine renewable energy has benefits in high technology job creation and new carbon free power that could displace other more polluting forms of energy. But current planning goals in Oregon do not provide the ability to consider carbon mitigation, economic development and other benefits of a marine renewable energy installation and weigh those against protection of existing uses and Goal 19 planning goals.

23 http://marinemap.org/

"A good MHK [marine hydrokinetic] test site is tremendously valuable for the State and it's frustrating that we're not able to weigh that value in the planning process and fully consider how it compares to other existing uses," said Busch.

Other states and countries have also wrestled with the uncertain benefits and impacts of marine renewable energy in their own coastal and marine spatial planning processes. On the U.S. East Coast in Massachusetts, Rhode Island and Maine, state plans have recognized that uncertainty requires some level of flexibility. For example, preserving ample space for multiple uses, where energy project applications could be considered on a site-by-site basis under existing law. Klarin and Busch both recognize this need for flexibility in the Oregon plan.

Busch would like to see consideration of the appropriate level of protection for Goal 19 resources, so that in some cases co-location with energy facilities could be an option. "What does it mean to protect Goal 19 resources?" he asks. "There are obvious no-go zones -MPAs [marine protected areas], previously permitted sites and cables, for example - but are there other Goal 19 areas that are a little more flexible where multiple uses might work and existing uses could be maintained? No one has actually analyzed what the impacts of renewable energy might be in some of these areas. The question is: are you willing to make a decision today about categorical exclusion of those sites?"

Klarin argues that multiple use zones where energy could be allowed make sense where Goal 19 resources are not as significant, but concedes that a "very large percentage of the territorial sea is going to be off-limits for marine renewable energy for one or more reasons." And according to Klarin, many of the areas with overlapping Goal 19 resources are likely to be around deepwater port facilities that the marine renewable industry sees as prime locations for the first generation of projects. Recognizing the impact this could have on early industry adopters, Klarin sees "temporary use areas" as a potential option in certain Goal 19 areas. He explained that "temporary use areas could allow testing or deployment for sites with a small footprint, limited duration and an understanding that, after testing, equipment would be removed and commercial development would occur outside of the Goal 19 area."

According to Busch, "temporary use areas might work but the details are important. If we could work out an arrangement where after demonstration, the developer could keep some critical infrastructure in place, like cables, and then move beyond the three mile line or to a site nearby for a larger build out, it could be acceptable."

The TSP process is moving into a public phase in the beginning of 2012, with increased opportunity for discussion and participation from the renewable energy industry as well as other interested stakeholders. Workable solutions that meet both Goal 19 and state renewable energy targets will require the transparency of public process, as well as a better understanding of both the potential impacts and benefits of renewable energy technologies. As planning details are worked out over the next 10 months of public process and in the period following adoption of the updated TSP, the State and stakeholders will have a growing data set and tools available to support transparent decision making.

Decision Support Tools to Guide Planning and Siting in Oregon

In addition to providing spatial representation of uses and resources in the Territorial Sea to inform the planning process, the DLCD has selected MarineMap as its decision support tool for considering new energy permits. MarineMap contains dozens of spatial layers for Goal 19-eligible resources and uses. A one-square mile grid is applied to the Territorial Sea so that those varied spatial data layers are combined to provide a coarse filter representing the presence of all relevant Goal 19 resources and uses.

Virtually all spatial planning analyses today are built around the power of existing geographic information systems (GIS) applications. This is popular because these systems already exist and adapting them for planning tasks is straightforward. They are widely available and there is a large user base familiar with GIS systems. However, most available GIS systems do not handle multi-dimensional or incompatible data well;

they do not account for uncertainties in the data; they do not handle temporal data well or at all and they do not help the user make value-balancing decisions.

Therefore, the scientific focus of marine renewable energy siting tools currently under development is to add to the spatial power of GIS with a processing engine that can handle the three missing components: complexity, uncertainty and time. In addition, the tools should support decision making once the scientific analysis is complete.

To address these issues, three federal agencies, U.S. Department of Energy, National Oceanic and Atmospheric Administration and the Bureau of Ocean Energy Management are providing funding to a team comprised of Parametrix, Oregon State University,[24] Robust Decisions and The Nature Conservancy to develop a tool using Bayesian logic, called a Bayesian Analysis of Spatial Siting, or BASS. BASS can integrate disparate data in a manner where the uncertainty of that data is known and the user can see risks associated with making decisions. The BASS tool is building on a previous OWET effort involving many of the same partners to assess cumulative effects, potential impacts and benefits of various marine renewable energy scenarios.

Klarin sees these analytical tools as particularly valuable post planning, to "zoom in on particular sites, do tradeoff analysis and inform adaptive management." Busch had envisioned the tools as useful in the broader planning context.

Parametrix acknowledges that the BASS project is in early development and will not be ready to apply to the Territorial Sea Planning process in the next few months. Because of the intensity of data inputs and complexity of the results, this tool is most applicable in small-scale or project-specific siting work, instead of territorial sea-wide planning.

Next Steps and Conclusions

After nearly four years of policy work, data collection, mapping and stakeholder meetings, Klarin sees the TSP update process as "in the home stretch." He predicts that the mapping process will take up most of the first half of 2012, culminating in a series of recommendations[25], which will eventually reach the Oregon Land Conservation and Development Commission. The Commission will then consider those recommendations, as well as additional stakeholder input, before making a final decision to adopt a plan, likely in third quarter of 2012.

Planning is a public process and Klarin and Busch both see a great deal of value in that process. "The TSP update invokes a public discourse that engages a wide range of stakeholders and members of the general public in an informed discussion they've never had before about a particular use," says Klarin. Busch agrees: "What's most important to me is at some level we have a rational, legitimate, scientifically based conversation about whether and how we move this industry forward in Oregon."

As an emergent coastal interest, Klarin sees benefits to the marine renewable energy industry for having participated in the TSP update: "Having gone through the planning process, we've built the bridge between developers and stakeholders and encouraged discussions before they walk through the regulatory door. If you clear impediments in advance, the regulatory process is accelerated. What makes the regulatory process slower is conflict."

Busch is cautiously optimistic about the outcome of the TSP process. The marine renewable energy industry, as the most recent industry in an already crowded sea, "will be held to the highest level of environmental scrutiny, as all user groups should be." He sees value in a planning process that allows full consideration of all current and future uses of the territorial sea. "If that process works, it means that we brought everyone to the table, we sorted through all of the available information and we made decisions to the benefit of the State. If we can do that, I think that ocean energy has a fighting chance."

24 http://nnmrec.oregonstate.edu/

25 To the Ocean Policy Advisory Council (OPAC) and the Territorial Sea Plan Advisory Committee (TSPAC)

MOUNTAINS OF "BLUETAPE"
BARRIERS TO UNITED STATES AND NEW ZEALAND MARINE RENEWABLE ENERGY PROJECTS

Ian Boisvert

Ian Boisvert was a 2011 Ian Axford Fellow in Public Policy through Fulbright New Zealand. Ian is now returned to San Francisco, California, where he practices renewable energy and environmental law.

Part One: *Introducing the Mountains of "Blue Tape"*

New Zealand and the United States share many characteristics. They each have Anglo-derived common law systems, English is the lingua franca, and both support liberalized, capital markets. For all these commonalities and more, they could not have more dissimilar regulatory regimes for permitting offshore renewable devices such as wave energy converters, tidal turbines and wind turbines.

To put a device in the ocean without being connected to the grid a developer in the United States may have to deal with three different governments (federal, state, and native sovereignty) each with multiple agencies who enforce a dizzying web of laws and regulations on different timeframes. A developer in New Zealand, on the other hand, has to deal with one central government, one authorizing body at the local level, and, for the most part, one statute.

The difference in the amount of "blue tape" standing between the developer in United States and the one in New Zealand can be measured in years and millions of dollars. And that is just for pilot project development. When a proposed development increases to a commercial scale that difference dissipates: both the New Zealand and United States developer faces the possibility of spending millions of dollars over years just to obtain permission to build. Still, for all the well-intentioned policies and Memoranda of Understanding (MOU) that United States agencies and states create to make pilot permitting more streamlined, the United States developer faces a longer, harder, more complex process than its New Zealand equivalent.

Part Two of this article explains the three United States permits suited to deploying pilot-scale ocean renewable devices. Part Three explains the New Zealand consent process for a similarly scaled project and contrasts that with the United States approach. Part Four examines, with two brief case studies, why neither the United States' nor New Zealand's permitting processes are equipped to handle commercial-scale ocean renewable development. Part Five concludes with lessons for regulators in both countries.

Part Two: *United States's Mountain Chains of Blue Tape*

Ocean renewable power developers in the United States intent on deploying a pilot-scale device must deal with federal and state agencies and laws. The Federal Energy Regulatory Commission (FERC) is arguably the most important of the federal agencies because under the Federal Power Act it has authority to regulate and license hydroelectric projects on navigable waters.[26] A developer must get FERC approval to operate the device, whether a pilot project will lie within an adjoining state's jurisdiction of three nautical miles from shore (ten miles for Texas and parts of Florida) or back into federal jurisdiction beyond the Outer Continental Shelf (OCS).

Over the decade since FERC first asserted jurisdiction over an ocean energy project in Makah Bay, Washington, three types of permits have emerged for pilot-scale projects.[27]

The three types are: preliminary permits, "Verdant Orders", and pilot project license policy.

26 16 USC sec. 817(1).

27 Prof. Rachael Salcido, Siting Offshore Hydrokinetic Energy Projects: A Comparative Look at Wave Energy Regulation in the Pacific Northwest, 5 Golden Gate University Environmental Law Journal 109, at 125 (2011).

A preliminary permit allows a potential developer to explore and investigate a site for up to three years.[28] The applicant applies through submitting a plan to conduct baseline studies for the preferred site.[29] In reaction to public comments FERC now reviews these applications on a "strict scrutiny" basis to avoid potential "site banking."30 FERC will take at minimum 60 days to process the application, but that could extend to years under certain conditions.[31] That is, whether the myriad other federal, state, or tribal agencies intervene.

The value of the preliminary permit for the prospective developer is to secure a site, study the site's viability for the proposed device(s), and to engage the site's other stakeholders in voluntary, early consultation. The obvious drawback is that the developer may not deploy or operate any device in the site with only the preliminary permit.

If the developer is prepared to move beyond mere site investigation and has an experimental device it would like to test, the Verdant Order is the appropriate permit to apply for. A Verdant Order arose from a FERC interpretation of the Federal Power Act as it applied to Verdant Power LLC's efforts to site its experimental tidal turbines in New York's East River.[32] To secure a Verdant Order the applicant must be seeking to conduct studies on an experimental technology only for a short time (undefined) and, critical to a successful application, any power generated does not displace and is not trasmitted to the national grid.[33] Importantly, under a Verdant Order the applicant-developer might still have to obtain all other necessary approvals such as the Clean Water Act Section 404 and 401 permits, Endangered Species Act Section 7 permit, as well as state, municipal, and, where applicable, tribal approvals.[34]

The value of the Verdant Order permit is that it allows the developer to avoid full-blown FERC commercial license procedures, which can be quite daunting, to test a few experimental devices for a short period of time. However, one drawback is the developer may still have to adhere to multiple other environmental permits that could, as in the case of Verdant, lead to years of permit hearings and studies. The other drawback is that the developer can only test the device for its operation in the water and not truly its ability to generate electricity because of the limitation against displacing power in the national grid.

If a device developer is interested in both testing pilot-scale devices and generating electricity that enters the grid then FERC's pilot project license is the relevant permit. The pilot project license is only a policy that flows from FERC's interpretation of 18 CFR § 5.18.[35] Because it is not law, FERC is not legally bound to follow it. The requirements for an application to be considered for the pilot project license are: (1) small scale (e.g., 5 MW or less); (2) must avoid "potentially" sensitive areas as described by the applicant, commented on by stakeholders, and determined by FERC; (3) devices can be shut down or removed on "short notice" if "unacceptable risks" arise—FERC defines neither term more explicitly; (4) applicant must seek either a multi-decade license or completely decommission site at end of pilot project license duration; and (5) the applicant initiates the permit through a draft application that offers sufficient information for environmental analysis.[36] The last point means the applicant must still get all other environmental approvals from other federal, state, and, where applicable, tribal agencies. These include Army Corps of Engineers-issued Clean Water Act Section 404 and 401 permits, National Marine Fisheries Service approvals for devices in "Essential Fish Habitat," as well as National Oceanic and Atmospheric Administration Marine Mammal Protection Act approvals.

If an applicant succeeds in securing all necessary approvals, the pilot project license permits the developer

28 16 USC sec. 797(f).

29 18 CFR 4.81

30 Prof. Rachael Salcido, Siting Offshore Hydrokinetic Energy Projects: A Comparative Look at Wave Energy Regulation in the Pacific Northwest, 5 Golden Gate University Environmental Law Journal at 131 (2011).

31 Pacific Energy Ventures, Siting Methodologies for Hydrokinetics: Navigating the Regulatory Framework, p. 14 (December 2009).

32 Verdant Power, LLC, 111 FERC 61,024 (2005), on reh'g, 112 FERC 61,143 (2005).

33 Pacific Energy Ventures, Siting Methodologies for Hydrokinetics: Navigating the Regulatory Framework, p. 14 (December 2009).

34 Stoel Rives LLP, The Law Of Marine And Hydrokinetic Energy, ch. 3, at 4 (4th ed. 2011).

35 Federal Energy Regulatory Commission, Licensing Hydrokinetic Pilot Projects White Paper (Apr. 14, 2008), available at www.ferc.gov/industries/hydropower/indusact/hydrokinetics/pdf/white_paper.pdf

36 Id.

to test its technology and transmit electricity into the national power grid, as well as pursue a standard license application following the pilot project license.[37] However, an application for a standard license must be initiated 5 years prior to generation. Paradoxically, the applicant must simultaneously apply for the pilot project license and standard license even though the applicant will not have yet collected the data to support the standard license.

Moreover, a wide array of stakeholders can comment on and make recommendations about the applicant's proposed plans, overall draft application and request for waivers, which further complicates and adds time to the application process. Even after FERC accepts the application, parties can still file interventions and comment on the application and monitoring and safeguard plan proposals. Any of these delays in processing time eats into the five-year timeframe for which the applicant has to test its devices.

The value of the pilot project license is, according to FERC, a streamlined permit process offering device developers an opportunity to test devices, collect *in situ* data, and build the case for commercial development. The drawbacks, though, are significant. The application approval process is likely to take over 12 months because of the additional authorizations and opportunity for public comment and intervention. That delay reduces possible operations within the 5 years the pilot project license runs. Moreover, if a developer wanted to pursue a commercial-length FERC lease, the pilot project license would be of little value, because the developer would need five years to complete the commercial lease process. The developer will not have that data until after the pilot project license ends. Consequently, no ocean renewable developer in the United States has secured a pilot project license in the three years since FERC made it available.

	UNITED STATES	NEW ZEALAND
Agencies Potentially Involved	FERC; BOEM; Army Corps; USWFS; NMFS; EPA; USCG…; State & Municipal Agencies	Regional Council; Dept. of Conservation
Laws Potentially Involved	FPA; NEPA; ESA; CWA; CZMA; MMPA; MSA; NHPA; CFRs…140 possible federal laws; State laws, too	Resource Managem't Act; Local Gov't Act
Jurisdictions Potentially Involved	Federal; State; Municipal; Native Sovereignties	Regional; National
Minimum Estimated Processing Time	2 months	4 weeks

Comparing United States and New Zealand Regulatory Regimes

Part Three: *New Zealand's Hills of Blue Tape*

New Zealand ocean renewable developers face a wholly different consenting regime than their United States counterparts. The New Zealand regime is governed by the Resource Management Act 1991 (RMA), which is the prevailing statute for any project that uses natural resources. Its overarching purpose is to guide "sustainable development" through an "effects-based" testing model that addresses the extent to which a proposed project affects the environment.[38]

The RMA's relevance to prospective ocean renewable energy developers is that it lays out the consent process by which regional government bodies approve developments. The RMA offers three tracks the developer can pursue: (1) limited- or non-notification; (2) public notification; and (3) call-in process. For

37 Id.

38 Resource Management Act (1991), Section 5, Paragraph 1.

a pilot or small-scale project, the most relevant and useful track is the limited/non-notified consent process. Although developers can request a particular track, regional government bodies ultimately make that decision.

Part 6 of the RMA lays out the process for securing resource consents. One of the first steps is that the consent authority determines whether the applied-for project should be publically notified or not. If the authority determines the proposal only needs limited notification then the consent authority must decide if there are any affected persons, customary rights group or customary marine title group in relation to the activity.[39] Under the RMA an "affected person" must have some nexus with a project such that the "activity's adverse effects on the person are minor or more than minor (but are not less than minor)" and determination made by consent authority.[40] Whether "adverse effects [are] likely to be more than minor" is determined by the consent authority.[41] However, a project applicant can limit the number of "affected persons" by getting written pre-approval from persons to undertake the proposed project.[42]

For limited- or non-notification consultation requirements only those people served with notification of the application have the right to make a submission (comment) on the application.[43] Moreover, they must also prove their submission shows they are likely to be directly affected by an adverse effect that the proposed project will have on environment.[44]

The value of proceeding with a non- or limited-notification resource consent hearing means the scope of input the developer needs to actively solicit, and therefore respond to, is much less than with a public notification hearing. Consequently, the developer can expect a relatively rapid hearing process as compared to if the developer were pursuing a US permit for a similarly scaled project. A regional council would be very unlikely to accept a non- or limited-notification resource consent for a large- or commercial-scale project. For example, Crest Energy Ltd. sought to deploy 200 x 1 MW tidal turbines in the narrow mouth of the Kaipara Harbour and had to follow a public notification process, which took over 6 years. In comparison, Chatham Islands Marine Energy Ltd. secured a non-notified resource consent in under 6 months for a single 220 kW oscillating water column device to be installed near Point Durham, Chatham Island, for up to 35 years.

In short, limited notification gives an applicant a much higher chance of gaining approval within a few months and reduces the chance of litigation. It is thus like FERC's Pilot Project Policy License without the regulatory and concomitant temporal uncertainty.

COMPANY	PROJECT DESCRIPTION	PUBLICLY NOTIFIED	LT'D/ NON-NOTIFIED	CONSENT PROCESSING	LOCATION
Crest Energy	200 x 1 MW tidal turbines; 35 years	YES		+6 years	Kaipara Harbour
Tangaroa Energy	1 x 20 kW device for 35 years	YES		Ongoing	Stewart Island
WET-NZ/PPL	3 devices (up to 20 kW each); up to 5 years		YES	<3 months	Various
Neptune Power	1 x 1 MW device; up to 10 years		YES	<6 months	Cook Strait
CHIME	1 x 220 kW device; 35 years		YES	<6 months	Chatham Island

New Zealand Limited/Non-Notification Vs. Public Notification

39 Resource Management Act (1991), Section 95E-F.
40 Resource Management Act (1991), Section 95E(1).
41 Resource Management Act (1991), Section 95D.
42 Resource Management Act (1991), Section 95E(3).
43 Resource Management Act (1991), Secs. 95(B) & 96(3).
44 Resource Management Act (1991), Sec. 308B.

Part Four: *Commercial Scaling - The Impassible Mountain of Blue Tape*

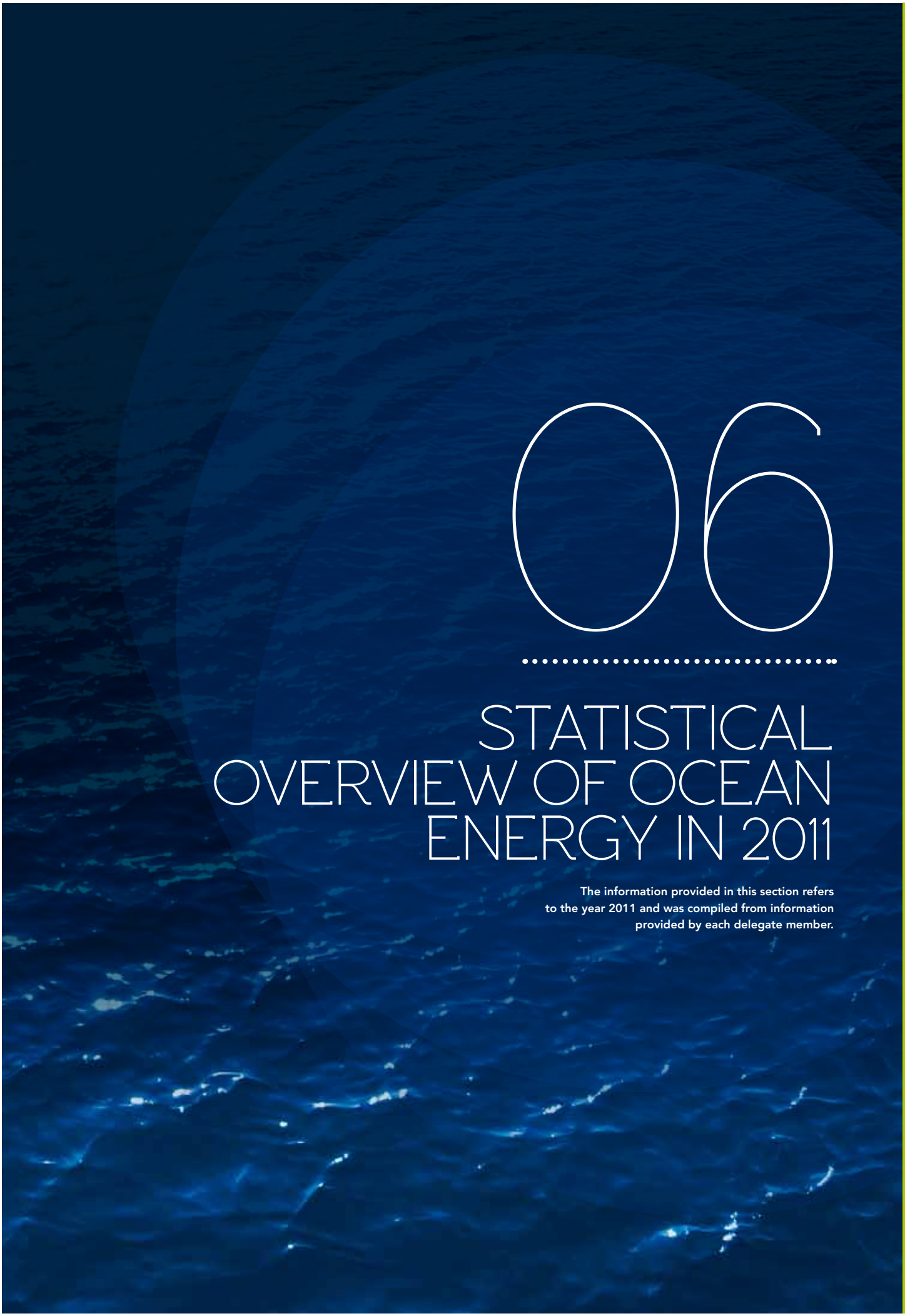
The New Zealand and United States governments proclaim supporting innovative, clean technology that mitigates climate change and promotes job creation. But marine renewable device innovators and project developers are experiencing respective regulatory regimes, which are not in synch with that broader message. As noted above, Crest Energy proposed a 200 tidal turbine array in 2006. Because of the scale of their project, Crest Energy had to follow the public notification process. Over the next 5 years the company faced public opposition, opposition from the Department of Conservation, and risk aversion from the resource consent authority, the Northland Regional Council, who was uncertain of what environmental effects the development might have. Accordingly, the first commercial-scale marine renewable project in New Zealand has so far cost Crest Energy hundreds of thousands of dollars and upwards of 5 years just to secure consent to develop. After Crest Energy achieved final consent approval, the conditions Northland Regional Council imposed on their development add further doubt as to whether Crest Energy will be able to fully develop their project before 2022.

In the United States, Energy Management Inc. (EMI) has been entangled in a similar experience over the development of Cape Wind. In the early 2000s EMI proposed an offshore wind farm of 130 wind turbine off the Massachusetts coast. The regulatory landscape alone has been daunting: seventeen Federal and State agencies are involved with overlapping jurisdictions, inconsistent timelines, and each enforcing numerous and different statutes and regulations. Additionally, EMI has had to face opposition - allowed because of the notion of "public attorneys general" written into many environmental laws - from local landowners, Indian Tribes, fishing interests, and environmental groups. The multi-dimensional scale of the regulatory hurdles makes commercial-scale marine renewable energy development in the United States a lawyer's dream but a developer's nightmare.

PERMIT TYPE	UNITED STATES	NEW ZEALAND	TARGET ACTIVITY	EST. PERMIT PROCESS TIME	PERMIT TERM
Preliminary Permit	√		Site selection and study	60 days min.	3 years
Verdant Order	√		Testing devices	Depends if EIS is required?	Short-term
Pilot Project Lic.	√		Proving devices	6 mo. min	5 years
Publicly Notified Resource Consent		√	Commercial-scale development	Months to years	Up to 35 years
Lt'd/Non-Notified Resource Consent		√	Testing, proving, small-scale	Weeks to months	Up to 35 years

Part Five: *A Suggestion to Regulators: Scale Back the Blue Tape*

New Zealand and the United States have both nationally proclaimed interest in promoting marine renewable energy development. Nonetheless, developers in both countries have faced, and continue to face, complex regulatory frameworks with multi-year timeframes for commercial-scale development. As such, it appears both countries have room to make meaningful changes to their regulatory regimes that could reduce a major obstacle to marine renewable energy development. Part of the change could be a shift in what appears to be institutional risk aversion, which marine renewable energy developers face, due to bureaucratic unfamiliarity with marine energy projects and their environmental effects. Whereas offshore oil development in the United States can secure permits in less than one year, marine renewable developers experience much longer timeframes although the greatest risk renewable development represents pales in comparison to that of offshore oil drilling platforms. In light of this, regulators could consider reducing institutional risk aversion to marine renewable energy development, streamline and coordinate their permit requirements and process schedules, and align regulatory regimes with national proclamations of support by designing one-stop permit processs for commercial-scale marine renewable energy development. Without reducing the amount of "blue tape," marine renewable energy developers may have a difficult time scaling their pilot projects to commercial scale developments.



06

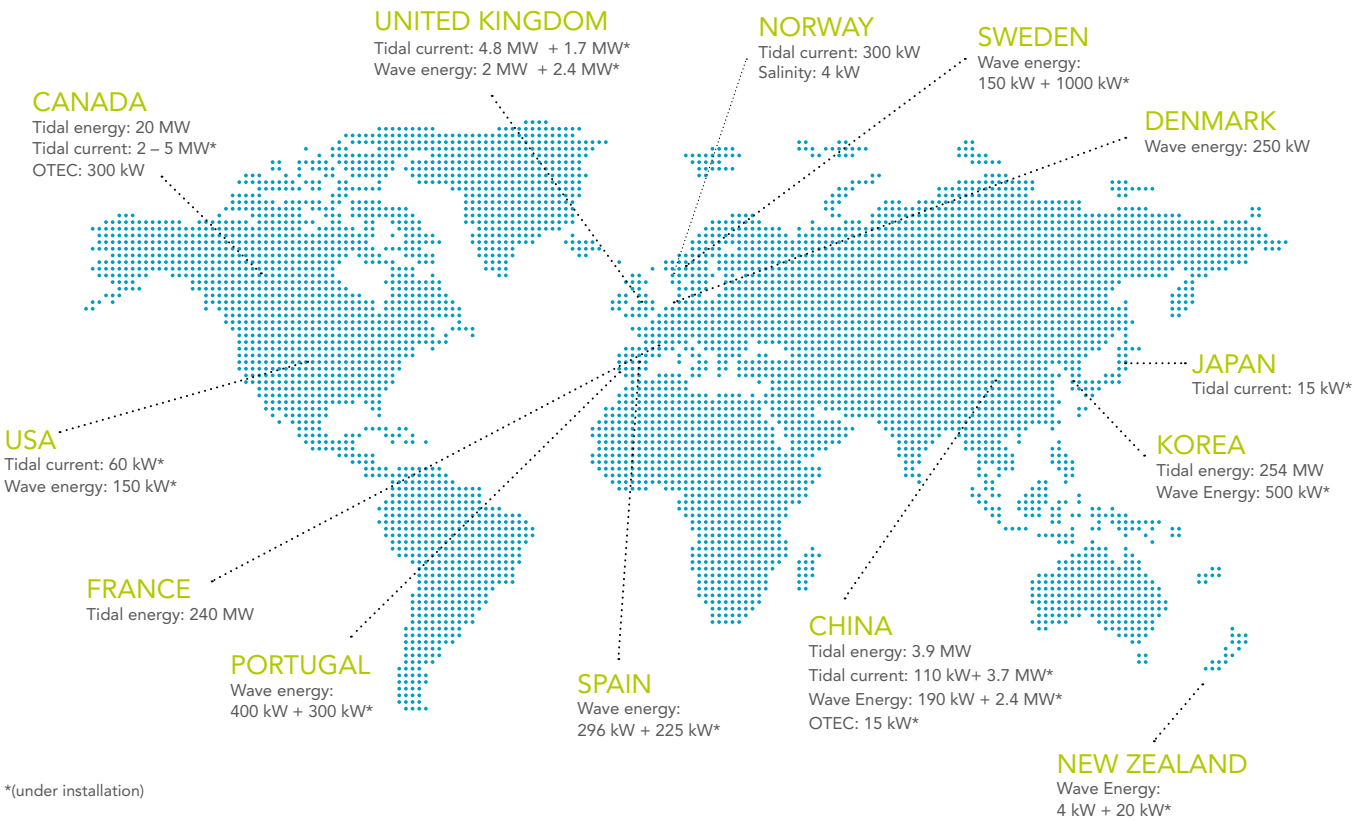
STATISTICAL OVERVIEW OF OCEAN ENERGY IN 2011

The information provided in this section refers to the year 2011 and was compiled from information provided by each delegate member.

6.1
LEVEL OF RESEARCH & DEVELOPMENT AND DEMONSTRATION INVESTMENT

	RESEARCH & DEMONSTRATION			TECHNOLOGY DEMONSTRATION		
	Investment			Investment		
	Public (M€)	Private (M€)	Observations	Public (M€)	Private (M€)	Observations
Australia	M-H	M-H		L	L	
Belgium	2.8	1.3	BOREAS, WecWakes and FlanSea			
Canada	>33.75	>18.75	Estimate of past; current and new proposals may exceed this	>22.5	>60.0	Estimate of past; current and new proposals may exceed this
China				3.8	1.6	Wave energy
				3.8	1.8	Tidal current energy
				1.3	0.2	Tidal energy
Denmark	Approx. 1.5	N/A				
Ireland	5.5	4.5				
Korea	5.5	0.8	Inclusion of educational promotion programs	10.5	4	Exclusion of commercial Sihwa TBPP
Mexico	1.8	0		0	0	
New Zeeland	0.9	Unknown	3 R&D programmes; private invest. must equal or exceed public investment	2.4	3.6	Estimate based upon grant awards and 60% matching fund requirements
Norway	2.0	3.2	Private investment is probably higher	0.5	4.7	Private investment is probably higher
Spain	4.5	8.0	Rough estimations	2.0		bimep
Sweden	1.5	2.0	Known to the Swedish Energy Agency	15.5	13.4	Known to the Swedish Energy Agency
USA	4.4*	2.2**	* DOE public funding in FY11. ** Approx. cost share requirements associated with DOE funding in FY11.	1.5*	10.4**	* DOE public funding in FY11. ** Approx. cost share requirements associated with DOE funding in FY11.

6.2
WORLDWIDE OCEAN POWER INSTALLED CAPACITY



*(under installation)

6.3
ELECTRICAL UTILITIES INVOLVED IN RESEARCH & DEVELOPMENT AND DEMONSTRATION

COUNTRY	ELECTRICAL UTILITY	TYPE OF INVOLVEMENT
UK	Scottish and Southern Energy	R&D, technology demonstration and project development
	Scottish Power Renewables	R&D, technology demonstration and project development
	EON	R&D, technology demonstration and project development
	ESBI	R&D, technology demonstration and project development
	Vattenfall	Project development
	IT Power	Project development
	RWE – nPower Renewables	Technology demonstration and project development
Korea	Korea Water Resources Corporation (K-water)	Operation of Shihwa tidal barrage power plant
	Korea East-West Power Co., Ltd.	Operation of Uldolmok tidal current pilot plant
	Korea Western Power Co., Ltd.	Feasibility study on Garorim tidal barrage power site
	Korea Hydro and Nuclear Power Co., Ltd.	Feasibility study on Incheonman tidal barrage power site
	Korea Midland Power Co., Ltd.	Feasibility study on Ganghwa tidal barrage power site
	Hyundai Heavy Industry Co., Ltd.	Full-scale demonstration of 1MW tidal current device
	Korea Electric Power Corporation	Prototype demonstration of attenuator with liquid column oscillator
Denmark	Dong	IEC-TC standards, ORECA EU project
	Thy mors	Technology demonstration
Ireland	Electricity Supply Board (ESB)	Through its subsidiary, ESBI, the ESB has an active programme designed to support OE into its generation mix and is lead partner in developing the Westwave 5MW demonstration project. ESBI is also an active partner in the AMETS open ocean test facility.
	Bord Gais Eireann (BGE)	BGE has invested in a number of wave energy technologies and is providing technical and engineering support to the entities involved.
Japan	The Okinawa Electric Power Company, Incorporated.	Project development
Canada	NALCOR – Newfoundland and Labrador	Technology development for microgrid management
	EMERA / Nova Scotia Power	Open Hydro investor, technology demonstrator, planning project development
	Hydro Quebec	Engagement with two technology demonstrations
	Ontario Power Authority	Waterpower Feed in Tariff for project development
	Manitoba Hydro	Access to site for R&D and technology demonstration
	BC Hydro	Standing offer amended to allow technology demonstration; site access for technology demonstration of river current
Belgium	Electrawinds	FlanSea project partner
Norway	Hafslund AS	Supports tidal energy concept
	Statkraft AS	Develops osmotic power
	Tussa Kraft AS	Supports wave energy concept SeaBased
	E-CO Energi AS	Develops wave energy concept Seahorse
	Hammerfest Energi AS	Part owner of Hammerfest Strøm AS
Spain	IBERDROLA	R&D, technology demonstration and project development.
	FCCE	Technology Demonstration
New Zealand	Todd Energy Limited	2011: Increased ownership of Crest Energy from 30% to 54% for project development (200 MW tidal current project in Kaipara Harbour)
Sweden	Vattenfall AB	R&D
	Fortum AB	Technology demonstration
	Statkraft AS	R&D
	Göteborg Energi AB	R&D
	Falkenberg Energi AB	R&D

APPENDIX 1

CONTRACTING PARTIES TO OES

YEAR OF SIGNATURE	COUNTRY	CONTRACTING PARTY
2001	Portugal	Laboratório Nacional de Energia e Geologia (LNEG)
	Denmark	Ministry of Transport and Energy, Danish Energy Authority
	United Kingdom	Department of Energy and Climate Change (DECC)
2002	Japan	Saga University
	Ireland	Sustainable Energy Authority of Ireland (SEAI)
2003	Canada	Natural Resources Canada
2005	United States of America	United States Department of Energy (DOE)
2006	Belgium	Federal Public Service Economy
2007	Germany	The Government of the Federal Republic of Germany
	Norway	The Research Council of Norway
	Mexico	The Government of Mexico
2008	Spain	TECNALIA
	Italy	Gestore dei Servizi Energetici (GSE)
	New Zealand	Aotearoa Wave and Tidal Energy Association (AWATEA)
	Sweden	Swedish Energy Agency
2009	Australia	Oceanlinx Pty Ltd
2010	Republic of Korea	Ministry of Land, Transport and Maritime Affairs
	South Africa	South African National Energy Institute (SANERI)
2011	China	National Ocean Technology Centre (NOTC)

Status at 31 December 2011

APPENDIX 2

MEMBERSHIP OF THE EXECUTIVE COMMITTEE

CHAIRMAN
Dr. John Huckerby
AWATEA
PO Box 25456, Panama Street
Wellington 6146
New Zealand
international@awatea.org.nz

VICE-CHAIR
Mr. Eoin Sweeney
Sustainable Energy
Authority of Ireland
Eoin.Sweeney@seai.ie

SECRETARY
Dr. Ana Brito e Melo
Wave Energy Centre
Av. Manuel da Maia, 36 – r/c dto
1000-201 Lisboa
Portugal
ana@wavec.org

VICE-CHAIR
Mr. Jose Luis Villate
TECNALIA, Energy Unit
Bizkaia
joseluis.villate@tecnalia.com

DELEGATES

AUSTRALIA

Member
Mr. Ali Baghaei
Oceanlinx
email: Ali.Baghaei@oceanlinx.com

BELGIUM

Member
Dr. Gabriel Michaux
Federal Public Service Economy
e-mail: gabriel.michaux@mineco.fgov.be

Alternate
Mr. Pieter Mathys
Ghent University
Civil Engineering Department
e-mail: pieter.mathys@UGent.be

CANADA

Member
Mrs. Tracey Kutney
Natural Resources Canada
e-mail: tkutney@nrcan.gc.ca

CHINA

Member
Mr. Xia Dengwen
National Ocean Technology Center, SOA
e-mail: xiadengwen@vip.163.com

Alternate
Mr. Lin Cui
National Ocean Technology Center, SOA
e-mail: mredumc@126.com

DENMARK

Member
Mrs. Hanne Thomassen
Energistyrelsen
e-mail: hth@ENS.DK

Alternate
Dr. Kim Nielsen
Ramboll
e-mail: kin@ramboll.dk

GERMANY

Member
Mr. Ullrich Bruchmann
Federal Ministry for the Environment,
Nature Conservation and Nuclear Safety
e-mail: ullrich.bruchmann@bmu.bund.de

Alternate
Mr. Jochen Bard
Fraunhofer Institute for Wind Energy and Energy System
Technology IWES
e-mail: jbard@iset.uni-kassel.de

IRELAND

Member
Mr. Eoin Sweeney
Sustainable Energy Authority of Ireland
e-mail: Eoin.Sweeney@seai.ie

Alternate
Dr. Tony Lewis
Hydraulics and Maritime Research Centre
University College Cork
e-mail: T.lewis@ucc.ie

ITALY

Member
Mr. Gerardo Montanino
Gestore dei Servizi Energetici (GSE)
e-mail: gerardo.montanino@gse.it

Alternate
Prof. António Fiorentino
Ponte di Archimede International
e-mail: antonio.fiorentino90@vodafone.it

JAPAN

Member
Dr. Yasuyuki Ikegami
Institute of Ocean Energy, Saga University
e-mail: ikegami@ioes.saga-u.ac.jp

Alternate
Dr. Shuichi Nagata
Institute of Ocean Energy, Saga University
e-mail: nagata@ioes.saga-u.ac.jp

KOREA

Member
Dr. Lae-Hyung Hong
Ministry of Land, Transport and Maritime Affairs
e-mail: honglaehyung@korea.kr

Alternate
Dr. Keyyong Hong
Korea Ocean Research and Development Institute
e-mail: kyhong@moeri.re.kr

MEXICO

Member
Dr. Sergio Alcocer
Instituto de Ingeniería UNAM
e-mail: salcocerm@ii.unam.mx

Alternate
Dr. Gerardo Hiriart
Energias Alternas, Estudios y Proyectos SA de CV
e-mail: ghiriart@enal.com.mx

NEW ZEALAND

Member
Dr. John Huckerby
AWATEA
e-mail: mail@awatea.org.nz

Alternate
Mr. Nick Eldred
AWATEA
e-mail: chairman@awatea.org.nz

NORWAY

Member
Mr. Harald Rikheim
Statkraft SF
e-mail: harald.rikheim@statkraft.com

Alternate
Mr. Tore Gulli
Fred Olsen Ltd
e-mail: tore.gulli@fredolsen.no

PORTUGAL

Member
Dr. Paulo Justino
Laboratorio Nacional de Energia e Geologia (LNEG)
e-mail: paulo.justino@ineti.pt

Alternate
Prof. António Falcão
Instituto Superior Técnico
e-mail: falcao@hidro1.ist.utl.pt

SOUTH AFRICA

Member
Dr Thembakazi Mali
SANERI
e-mail: thembakazim@saneri.org.za

Alternate
Mr. Terence Govender
Eskom Corporate Services Department
e-mail: terence.govender@eskom.co.za

SPAIN

Member
Mr. Angel Chamero Ferrer
Ministerio de Industria, Turismo y Comercio
e-mail: achamero@mityc.es

Alternate
Mr. José Luis Villate
TECNALIA
e-mail: joseluis.villate@tecnalia.com

SWEDEN

Member
Dr. Maja Wänström
Swedish Energy Agency
e-mail: Maja.Wanstrom@energimyndigheten.se

Alternate
Ms. Maria Danestig
Swedish Energy Agency
e-mail: maria.danestig@energimyndigheten.se

UNITED KINGDOM

Member
Mr. Trevor Raggatt
Department of Energy and Climate Change (DECC)
e-mail: Trevor.Raggatt@decc.gsi.gov.uk

Alternate
Mr. Henry Jeffrey
The University of Edinburgh
e-mail: henry.jeffrey@ed.ac.uk

UNITED STATES OF AMERICA

Member
Mr. Michael Reed
U.S. Department of Energy
e-mail: Michael.reed@ee.doe.gov

Alternate
Mr. Robert Thresher
National Wind Technology Center
e-mail: robert.thresher@nrel.gov

APPENDIX 3
EXECUTIVE COMMITTEE MEETINGS

PAST MEETINGS

MEETING	DATE	PLACE	
1	19 October 2001	IEA, Paris	France
2	21 - 22 March 2002	London	UK
3	31 October 2002	Brighton	UK
4	4 March 2003	Paris	France
5	15 - 16 September 2003	UCC, Cork	Ireland
6	26 - 27 February 2004	INETI, Lisbon	Portugal
7	4 - 5 November 2004	DEA, Copenhagen	Denmark
8	4 March 2005	IEA, Paris	France
9	16 - 17 November 2005	EC, Brussels	Belgium
10	1 - 3 May 2006	Vancouver, BC	Canada
11	14 - 15 November 2006	INETI, Lisbon	Portugal
12	20 - 21 March 2007	UNAM, Mexico City	Mexico
13	16 - 17 October 2007	Messina	Italy
14	15 - 16 April 2008	New York city	USA
15	13 - 14 October 2008	Ifremer, Brest	France
16	30 - 31 March 2009	Bilbao	Spain
17	4 - 5 September 2009	Statkraft, Oslo	Norway
18	22 - 23 April 2010	Wellington	New Zealand
19	30 Sep - 1 Oct 2010	Dublin	Ireland
20	26 - 27 April 2011	Washington DC	USA
21	13 - 14 September 2011	Madeira	Portugal

PLANNED MEETINGS

MEETING	DATE	PLACE	
22	17 – 18 May 2012	Daejeon	Korea
23	21-24 October	Aalborg	Denmark

APPENDIX 4

COMPLETED ANNEX PROJECTS

ANNEX	ANNEX II - DEVELOPMENT OF RECOMMENDED PRACTICES FOR TESTING AND EVALUATING OCEAN ENERGY SYSTEMS
Objective	The objective of this Annex was to develop recommended practices for testing and evaluating ocean energy systems (wave and marine currents). There are a number of different resource types within ocean energy systems (including waves, tidal range, tidal and ocean currents, salinity gradients, OTEC and hydrothermal vents) and several different approaches to extracting energy from each resource type. The present lack of technology convergence creates difficulty in comparing systems. Annex II attempted to address this issue by providing guidelines, with the intent of laying the groundwork for the future establishment of standards and protocols, for theoretical, model and prototype testing, preliminary cost assessments and the presentation of results.
Operating Agent	Dr. Kim Nielsen, Ramboll – Denmark
Duration	The Annex was set up in 2001 to address laboratory testing and, in 2006, the Executive Committee agreed to extend the Annex to address prototype testing. The Annex was concluded in March 2011.
Reports	***Development of Recommended Practices for Testing and Evaluating Ocean Energy Systems, Summary Report*** K. Nielsen (2010) ***Generic and Site-Specific Wave Data*** K. Nielsen and T. Pontes (2010) ***Guidelines for the Development & Testing of Wave Energy Systems*** B. Holmes (2010) ***Guidelines for the design Basis of Marine Energy Converters*** P. Davies (2009) ***Guidance for Assessing Tidal Current Energy Resources*** Cornett (2008) ***Tidal Energy Development Protocol*** S. Bahaj, L. Blunden and A. A. Anwar (2008) ***Preliminary Wave Energy Device Performance Protocol*** G. Smith and J. Taylor (2007) ***Preliminary Tidal-current Energy Device Performance Protocol*** S. J. Couch and H. Jeffrey (2007) All reports are available at www.ocean-energy-systems.org

ANNEX	ANNEX III - INTEGRATION OF OCEAN ENERGY PLANTS INTO DISTRIBUTION AND TRANSMISSION ELECTRICAL GRIDS
Objective	The overall aim of this Annex is to provide a forum for enabling co-operative research activities related to integration of wave and tidal current power plants into electrical grids.
Operating Agent	Dr. Gouri Bhuyan, Powertech Labs – Canada
Duration	This Annex was commissioned in 2008 and was concluded in March 2011
Reports	***Potential Opportunities and Differences Associated with Integration of Ocean Wave and Marine Current Energy Plants in Comparison to Wind Energy*** J. Khan, G. Bhuyan and A. Moshref (2009) ***Key Features and Identification of Needed Improvements to Existing Interconnection Guidelines for Facilitating Integration of Ocean Energy Pilot Projects*** J. Khan, G. Bhuyan, and A. Moshref (2009) ***Dynamic characteristics of wave and tidal energy converters & a recommended structure for development of a generic model for grid connection*** D. O' Sullivan, D. Mollaghan, A.Blavette and R.Alcorn (2010) ***Integrating Wave and Tidal Current Power: Case Studies through Modelling and Simulation*** M. S. Múgica, F. S. Fernandez , J. L. Mendia , J. Khan, D. Leon, S. Arabi, A. Moshref, G. Bhuyan, A. Blavette, D. O'Sullivan, R. Alcorn (2011) All reports are available at www.ocean-energy-systems.org

APPENDIX 5

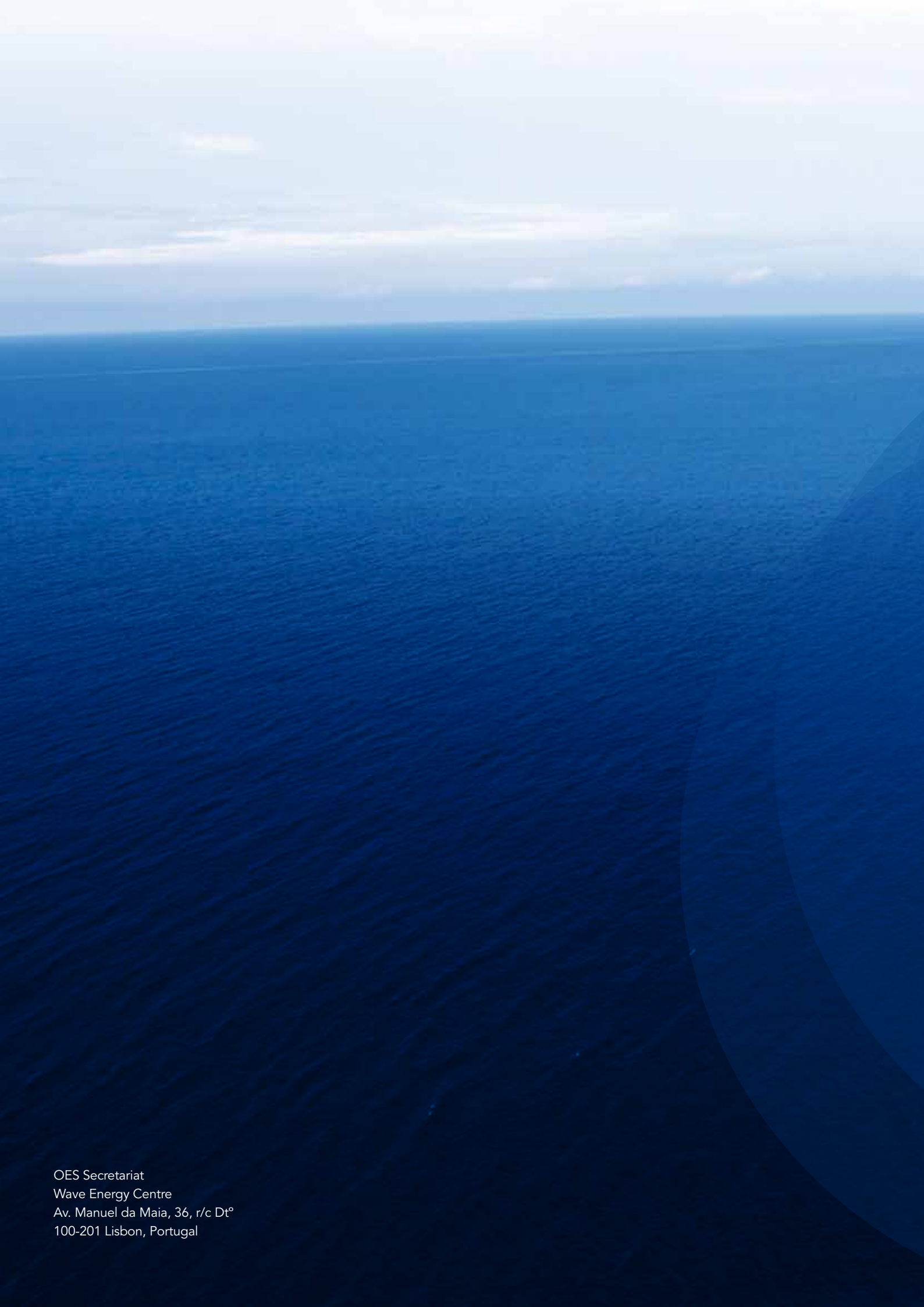
TERMINOLOGY FOR OES

TERM	DEFINITION
Annex	addendum to an Implementing Agreement (IA) and an integral part thereof, which sets forth the manner, including the financial undertakings and other means of support, by which the activities (sometimes called Tasks) of the Annex will be implemented by the Participants.
CERT	Committee on Energy Research and Technology is one of the IEA Standing Committees. Comprised of representatives from each IEA Member country and supported by the Secretariat, the CERT formulates and supervises the execution of the IEA's R&D programme, including national programme reviews, technology reviews, studies on strategic planning and oversees the IAs. The CERT is supported by four Working Parties on Renewable Energy, EndUse Efficiency, Fossil Fuels, and Fusion Power.
Common Fund	fund established by the Executive Committee into which the financial contributions of the Participants are placed.
Contracting Party (CP)	Signatory of an IA.
Executive Committee (ExCo)	the body, comprising representatives of all the Participants in an Implementing Agreement, which supervises the work of the IA and is the decisionmaking body of the IA.
ExCo representative	the individual designated by each Participant to be the Participant's representative on the Executive Committee.
Implementing Agreement (IA)	the contractual relationship established by at least two IEA Member countries and approved by the Governing Board to carry out programmes and projects on energy technology research, development and deployment.
Operating Agent (OA)	the legal entity designated in the IA text, or by the ExCo, or by the Participants in an Annex, to manage part or all of the Programme of Work of an IA and/or of its Annexes.
Programme of Work	the overall plan of activities determined by the Executive Committee to be implemented under the Implementing Agreement.
Task	particular collaborative R&D activity within the IA's Programme of Work in which some, but not all, Participants may choose to participate. The activity, and the means of participation in the activity, is described in an Annex to the IA.
Working Party (WP)	one of the current Working Parties mandated by the CERT to carry out specified work in energy technology and to initiate, evaluate and review IAs in its special field. At present, the Working Parties are: the Working Party on Energy EndUse Technologies (EUWP); the Working Party on Fossil Fuels (WPFF); the Working Party on Renewable Energy Technologies (REWP); and the Fusion Power Coordinating Committee (FPCC).

CONTACTS:

Wave Energy Centre
Av. Manuel da Maia, nº 36 – r/c dto
1000 - 201, Lisbon
PORTUGAL

www.ocean-energy-systems.org



OES Secretariat
Wave Energy Centre
Av. Manuel da Maia, 36, r/c Dtº
100-201 Lisbon, Portugal