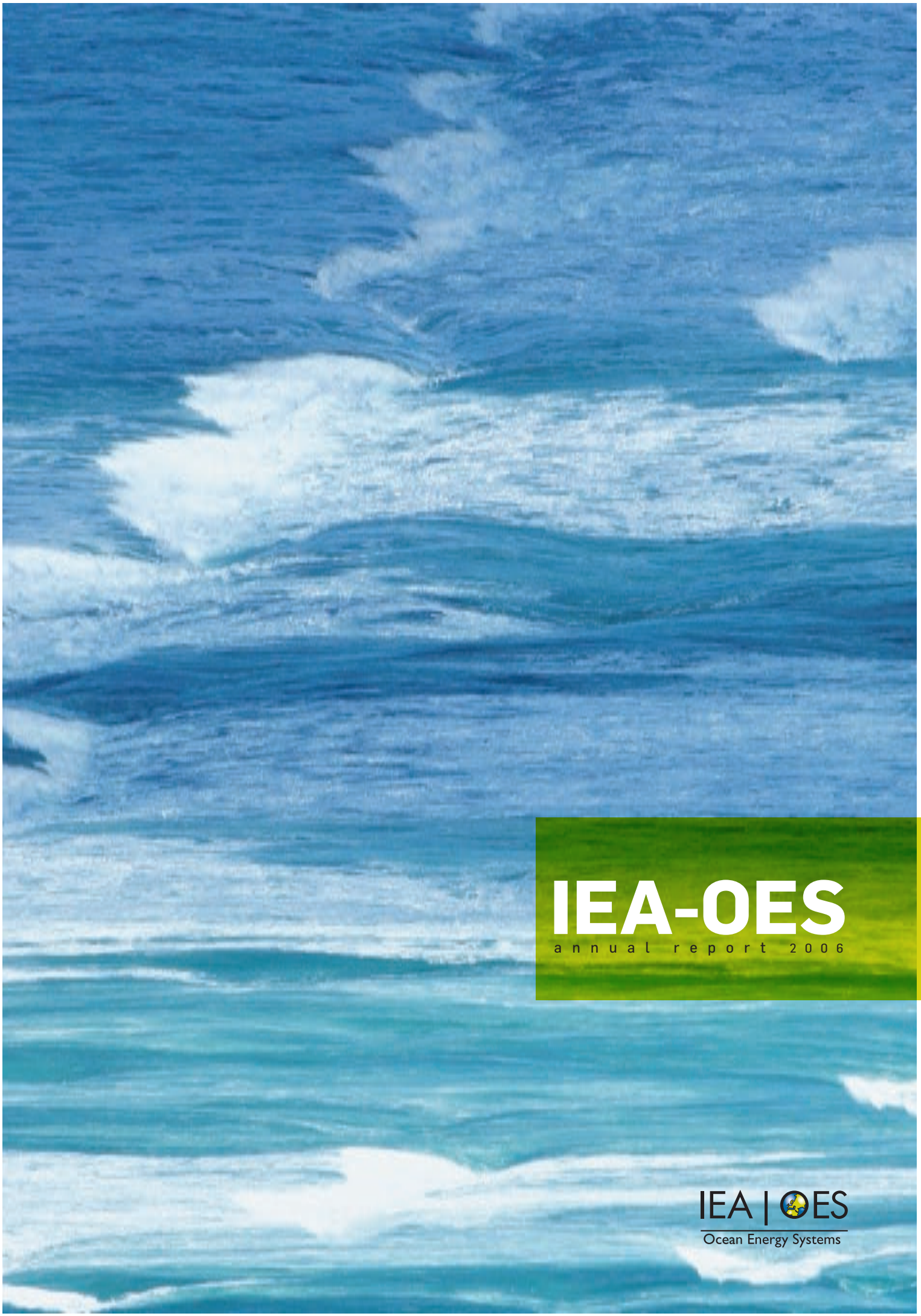
IEA-OES

annual report 2006



IEA-OES

annual report 2006

IEA | OES

Ocean Energy Systems

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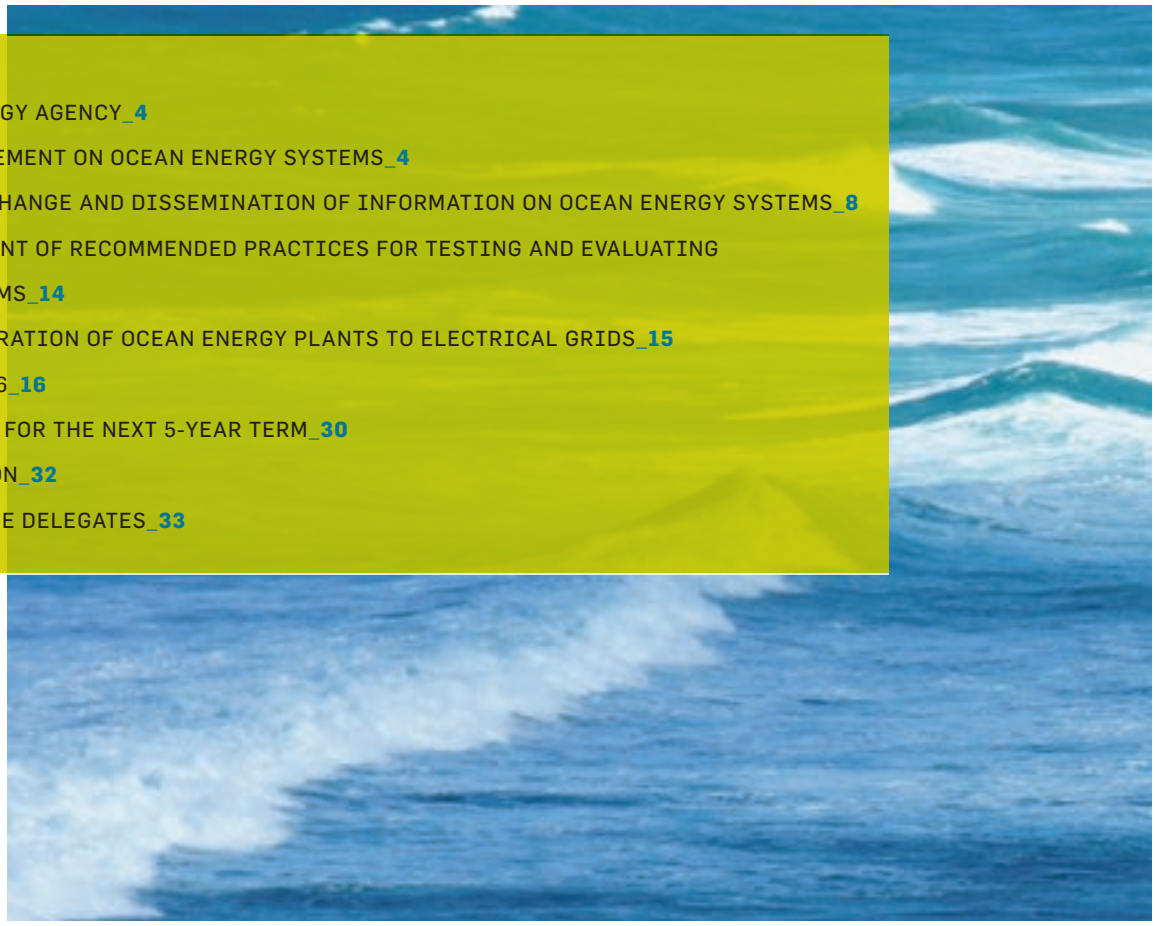

PUBLISHED BY
IEA-OES
EXECUTIVE COMMITTEE
ACTING EDITOR IEA-OES
DESIGNED BY
P-06 ATELIER
CIRCULATION
1.000 EXEMPLARS
PRINTED BY
TEXTYPE

FORWORD

by Katrina Polaski
2006 Chair of the IEA-OES

2006 was another significant year in Ocean energy development, both from the perspective of device and project development, and from that of the IEA Ocean Energy Systems Implementing Agreement.

From an industry perspective, another five devices have been tested in open seas: the Wavestar (Denmark), the Wavebob (Ireland), the Chinese Academy of Science's onshore oscillating buoy (China) the Verdant Power tidal project (USA), the Race Rocks tidal project (Canada) and the Ocean Energy Limited OE Buoy (Ireland), which was moored at the test site on the 29th of December. The Pico Plant in Portugal was re-commissioned and is providing grid-connected electricity. A number of devices that have been tested are in the process of planning and building full scale and multi-device projects, including the three device Pelamis project in Portugal funded by Enersis which was undergoing final assembly during the year. Additionally, policy makers are taking a greater interest in ocean energy with a number of countries developing specific policies for ocean energy including New Zealand, Canada, and Korea.

All of this interest and activity provided the background for a fruitful year for the IEA OES. Our meetings rooms were larger, to accommodate the growing number of member and observer countries attending, and our side trips were more interesting, as they provided opportunities to see tangible evidence of ocean energy development. Our meetings were also productive as we successfully agreed two new co-operative work programmes: the extension of Annex II to consider open sea testing, and Annex III to investigate grid integration issues for ocean energy systems. We were also very pleased to receive a positive response from both the IEA Renewable Energy Working Party and the IEA Committee on Energy Research and Technology to our End of Term Report, reviewing the first five year term of the IEA OES, and our Strategy for 2007 – 2011. Both groups approved the extension of the IEA OES for another five years.

On a personal note, serving as chair of the Executive Committee over the past two years was challenging and extremely rewarding. I look forward to 2007 with enthusiasm, and in particular to working with the new Chair, Dr. Gouri Bhuyan.

International Energy Agency

The International Energy Agency (IEA) was established as an autonomous body within the Organisation for Economic Co-operation and Development (OECD) in 1974 to implement an international energy programme.
The IEA provides a structure for international co-operation in energy technology research, development and deployment. Its purpose is to bring together experts in specific technologies who wish to address common challenges jointly and share the fruit of their efforts. The IEA's programme of International Energy Technology Co-operation includes a mechanisms called an "Implementing Agreement" (IA). There are more than 40 Agreements grouped in four branches, one of which is Renewable Energies and Hydrogen. Ocean Energy Systems is one of ten IEA Implementing Agreements within the Renewable Energy domain; the others being Bioenergy, Geothermal, Hydrogen, Hydropower, Photovoltaic Power Systems and Solar Heating and Cooling, Solar PACES, Wind Energy, and Renewable Energy Technology Deployment.

International Energy Agency
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75739 Paris CEDEX 15, France
URL: http://www.iea.org/

IEA-OES

Implementing Agreement on Ocean Energy Systems

Vision, Mission and Strategic objectives

Vision

To realise, by 2020, the use of cost-competitive, environmentally sound ocean energy on a sustainable basis to provide a significant contribution to meeting future energy demands.

Mission

To facilitate and co-ordinate ocean energy research, development and demonstration through international co-operation and information exchange, leading to the deployment and commercialisation of sustainable, efficient, reliable, cost-competitive and environmentally sound ocean energy technologies.

Strategic Objectives

To actively encourage and support the development of networks of participants involved in R,D&D, prototype testing and deployment, policy development, and deployment, and facilitate networking opportunities.
To become a trusted source of objective information and be effective in disseminating such information to ocean energy stakeholders, policymakers and the public.
To promote and facilitate collaborative research, development, and demonstration to identify and address barriers to, and opportunities for, the development and deployment of ocean energy technologies
To promote policies and procedures consistent with sustainable development.
To promote the harmonization of standards, methodologies, terminologies, and procedures where such harmonization will facilitate the development of ocean energy.

2001-2006

First 5-Year Term Program Achievement

The Implementing Agreement on Ocean Energy Systems (IEA-OES) completed its first 5-year term (2001-2006); a period during which it focused its activities on ocean wave and marine current energy.
An End of Term Report was prepared during 2006 and presented, along with the strategy for an additional five year term, at the 50th Renewable Energy Working Party (REWP) meeting, October 2006, and to the Committee on Energy Research and Technology also in October. A further five year term was approved (details of the report are available in the www.iea-oceans.org/publications).

The work of the IEA-OES during the initial term was carried out under the operation of two Annexes:

> Annex I: Review, Exchange and Dissemination of Information on OES
> Annex II: Development of Recommended Practices for Testing and Evaluating OES

The objective of Annex I is to collate, review and facilitate the exchange and dissemination of information on the technical, economic, environmental and social aspects of ocean energy systems. Specific activities during this 5-year term included:

> Publication of 2 reports:
Wave and Marine Current Energy – Status and Research and Development Priorities, 2003
Review and Analysis of Ocean Energy Systems Development and Supporting Policies, 2006
> Launch and publication of a semi-annual newsletter,
> Development of a website (www.iea-oceans.org),
> Collection of information on policy, institutional research and industry activities through standard surveys collected annually from Contracting Parties and Observers,
> Development of an *On-line Reference Library* containing information on published documents on Ocean Energy Conversion,
> Establishment of a *Wave Data Catalogue*, containing information on the wave data appropriate for wave energy resource assessment and characterization available in Member countries,
> Plans for the production of an informational DVD on ocean energy.

The objective of Annex II is to develop recommended practices for testing and evaluating ocean wave and marine current systems and, in this way, to improve the comparability of experimental results. The report *Development of Recommended Practices for Testing and Evaluating Ocean Energy Systems* was published in 2003 under this Annex. Focusing in tank testing of scale models, the report provides an overview of testing facilities in IEA-OES member countries and guidelines for testing, preliminary cost assessment and presentation of results. The Work program of Annex II, initially established to address scale models, was recently extended to cover prototype testing.

During this initial term the following other topics were discussed by the Executive Committee:

> Market Facilitation for Ocean Energy Systems – a proposal for a new annex addressing this topic was developed, however in 2004 the Executive Committee decided to cooperate with the new Implementing Agreement on Renewable Energy Technology Deployment (www.iea-retd.org) to address this area. A cooperative work programme will be developed for the second term.
> Integration of Ocean Energy Plants to Electrical Grids – two expert group meetings were held and a draft proposal for a new annex (Annex III) was discussed and approved in 2006.
> Resource, Infrastructure and Environmental Assessment – this topic is considered appropriate for a new Annex and the Executive Committee intends to discuss specific details of a work plan for the forthcoming term.

Membership

In 2006 Belgium joined the IEA-OES. The Federal Public Service Economy was designated by the government of Belgium to be the contracting party to this Agreement.
Representatives from China, Korea, Mexico, New Zealand, and Spain participated in meetings of the Executive Committee for the first time in 2006.
In November 2006 Germany, Mexico, & Norway were officially invited by the IEA-OES Executive Committee to become Members. The ExCo also formally made a decision in 2006 to invite Korea.
The IEA-OES continues making efforts to extend invitations to other countries to consider joining.

Year	Country	Contracting party
2001	Denmark	Ministry of Transport and Energy, Danish Energy Authority
	Portugal	Instituto Nacional de Engenharia Tecnologia e Inovação (INETI)
	United Kingdom	Department of Trade and Industry (DTI)
2002	Ireland	Sustainable Energy Ireland (SEI)
	Japan	Saga University
2003	Canada	Powertech Labs Inc.
	European Commission	Commission of European Communities
2005	United States of America	United States Department of Energy (DOE)
2006	Belgium	Federal Public Service Economy

Table 1. Contracting Parties to the IEA-OES (status: end 2006)

Executive Committee

The work program within the Implementing Agreement is co-ordinated by an Executive Committee (ExCo) consisting of a Member and an Alternate Member from each Member-Country. The ExCo meets twice every year to exchange information on ocean energy activities, to review ongoing tasks under the Agreement, to discuss new Annexes proposed by participants and to approve the budget to administer the Agreement. Each individual project carried out is called an "Annex" (or also "Task"), and is managed by an "Operating Agent".
During 2006, Ms. Katrina Polaski (Ireland) was the Chair of this ExCo and Dr. Gouri Bhuyan (Canada) and Dr. Teresa Pontes (Portugal) were Vice-Chairs. In the last 2006 ExCo meeting Dr. Gouri Bhuyan was elected Chair for 2007-08, Mr. Gary Shanahan (UK) was elected Vice-Chair and Ms. Katrina Polaski was elected second Vice-Chair for the same period.
The ExCo secretariat is run by Dr. Ana Brito Melo (ana@wave-energy-centre.org) and is based in the Wave Energy Centre, a non-profit organization in Portugal dedicated to the development and promotion of Wave Energy.

The 2006 ExCo meetings were held in Vancouver, Canada (1-2 May) and Lisbon, Portugal (14-15 November).

10th ExCo meeting
1-2 May 2006, Vancouver, British Columbia, Canada

This meeting was held at the University of British Columbia and was hosted by the British Columbia Ministry of Energy, Mines, and Petroleum Resources. The meeting corresponded with a two-day international symposium "Canada and the World of Ocean Renewable Energy" in Victoria, British Columbia, hosted by OREG (Ocean Renewable Energy Group).

The first day of the symposium was devoted to presentations by the IEA member and observer countries; Korea, China, Mexico, Germany and New Zealand, and the second day was devoted to presentations by Canadian organizations involved in ocean energy activities.
Following the ExCo meeting, a visit to a 65 kW tidal current demonstration project (The Pearson College-EnCana-Clean Current) at Race Rocks in Vancouver Islands was organized.

Members and Observers at the 10th IEA-OES ExCo meeting in Canada

11th ExCo meeting
14-15 November 2006, Lisbon, Portugal

This meeting, hosted by INETI, was held in correspondence with a two-day Workshop "Performance Monitoring of Ocean Energy Systems" (http://pmoes.ineti.pt) organized by INETI in the context of the Coordinated Action on Ocean Energy (CA-OE). Participants at the ExCo had the opportunity to attend the CA-OE workshop. This EC-funded project, initiated in 2004 with 42 partners, holds bi-annual workshops on relevant ocean-energy topics.
Following this event a site visit at the Peniche shipyard, where the Pelamis offshore wave energy converter is being prepared for installation in Northern Portugal, was organized for the IEA-OES group and CA-OE participants. This installation is being built by Ocean Power Delivery for Enersis, Portugal's largest developer of renewable energy projects. Phase I consists of three Pelamis 750 kW machines installed 5 km off the coast of Portugal in 50 m water depth.

Site visit at the Peniche shipyard where the three Pelamis wave energy machines are being prepared (Nov. 2006)

Members and Observers at the 11th IEA-OES ExCo meeting in Portugal

highlights

2006 work program highlights

The milestones of the 2006 work programme can be summarised as follows:
> Information exchange – development of the **IEA-OES On-line Reference Library** where authoritative research would be made available electronically to those interested in the area, thus promoting information exchange between leading academics and commercial researchers in the field; development of the **IEA-OES Wave Data Catalogue** compiling country-by-country review of wave data in the IEA-OES member countries; and preparing for the production of an **informational DVD**.
> Publication of the report **"Review and analysis of ocean energy systems development and supporting policies, 2006"**, which reviews current policy and device development trends in the Member countries and various Observer states to the IEA-OES, and the target "Plus 5" nations (Brazil, China, India, Mexico, and South Africa).
> Development and agreement to proceed with an **extension of the Annex II work program** to cover prototype testing in ocean based test sites, guidelines for performance measurements, and recommended testing procedures for the development cycle of ocean energy wave and marine current devices.
> Development and agreement to proceed with a work program for a **new Annex on grid integration** issues for ocean energy.

06 Programme achievements 2006

ANNEX I
REVIEW, EXCHANGE AND DISSEMINATION OF INFORMATION ON OCEAN ENERGY SYSTEMS

Operating Agent: **Instituto Nacional de Engenharia e Tecnologia e Inovação (INETI) – Portugal**

Annex I was initially established with a five year term, however during 2006 the Executive Committee voted to extend the Annex indefinitely and to make participation in this Annex compulsory for all Contracting Parties to the Implementing Agreement.
During 2006 the following dissemination activities were developed:

A. IEA-OES On-line Reference Library
B. IEA-OES Wave Data Catalogue
C. Policies and Development Trends Report
D. Development of an informational DVD
E. Participation and presentation of the IEA-OES in ocean energy related events
F. Publication and dissemination of 2 issues of the IEA-OES newsletter
G. Maintenance of the IEA-OES website

A. IEA-OES On-line Reference Library

Result of a title search on the IEA-OES On-line Reference Library

An additional activity approved under Annex I in the last ExCo meeting was the development of this reference library by INETI. The *Ocean Energy On-line Reference Library* is a virtual library containing authoritative information on Ocean Energy Conversion, in particular that which cannot be easily found using the most common search engines, namely conference proceedings and reports. The on-line library will promote the exchange of information between leading academics and commercial researchers in the field. The library will be an extension of the current website of the Implementing Agreement on Ocean Energy Systems.
Using state-of-the-art web search techniques, this ocean energy references dataset and the accompanying software provide a straightforward way to find documents using various search criteria, namely title, type (proceedings paper, journal paper, report, book), author(s), topic, keywords and new additions (the 10 most recent uploaded references). Each search can be made using multiple cumulative criteria. In the November ExCo meeting the structure and contents of this Library was presented.

programme a

B. IEA-OES Wave Data Catalogue

The main objective of the IEA-OES Wave Data Catalogue is to provide an overview of the wave data appropriate for wave energy resource assessment and characterization available in the IEA-OES member-countries. In addition to collating such information in a single document, it will serve to inform discussion on whether a new Annex on resource assessment should be pursued at this time.

The catalogue is based on existing wave data collected via a questionnaire provided to each member country, observers and targeted observers, and complemented by a web search. T. Pontes presented an overview of the work done, including data collected from the following countries – Belgium, Canada, Ireland, Portugal, Ireland, UK and USA. A report presenting the results of the first phase of this activity is being prepared.

The report begins with an overview of the various wave data sources which include in-situ and remote sensed measurements, and results of wind-wave mathematical models that compute wave conditions starting from the wind-fields over the ocean. Most of the in-situ wave measuring systems are briefly presented in the appendix. Remote sensed data are mostly obtained from radar altimeter and Synthetic Aperture Radars (SAR) on board satellites. A review of the various satellite missions and their characteristics is included. The most relevant wind-wave models that are implemented in the routine operation of institutes and centres worldwide are presented. Details of the availability of wave results produced by the models implemented globally or regionally are described and the most common uses of the various data types are analyzed. Finally, a review of the wave and wave energy resource atlases and databases is included.

A country-by-country review of wave data, namely the national in-situ measurement programmes and the available wind-wave model results is presented. A detailed analysis including the identification of the measuring devices, their location and water-depth, data type and availability is made, showing the significant differences among country programmes and data distribution policies.

C. Policies and Development Trends Report

A report entitled “Review and analysis of ocean energy systems development and supporting policies” was prepared for the IEA-OES in 2006 by AEA Energy & Environment on behalf of Sustainable Energy Ireland. The study was focused on the IEA-OES member countries, however other IEA and non-IEA member countries, where ocean energy systems are being developed, were also analysed.

The source data used was the information gathered from the initial Annex I 2003 report “Wave and Marine Current Energy – Status and Research and Development Priorities”, the Roundtable Country Review at the November 2005 ExCo meeting and the review of questionnaires sent to all Members and Observers in early 2006. Further information was provided by IEA publications and interviews with key organisations and device developers. The report assesses ocean wave and tidal current technologies and briefly covers the Ocean thermal energy conversion (OTEC) and salinity gradient technologies. The report analyses the research, development and demonstration (RD&D) of ocean energy systems in terms of the four aspects:

> Current status of ocean energy systems RD&D.
> Policies and support mechanisms which impact on development.
> Services and facilities which provide practical support for RD&D.
> Common barriers to progress and possible solutions.

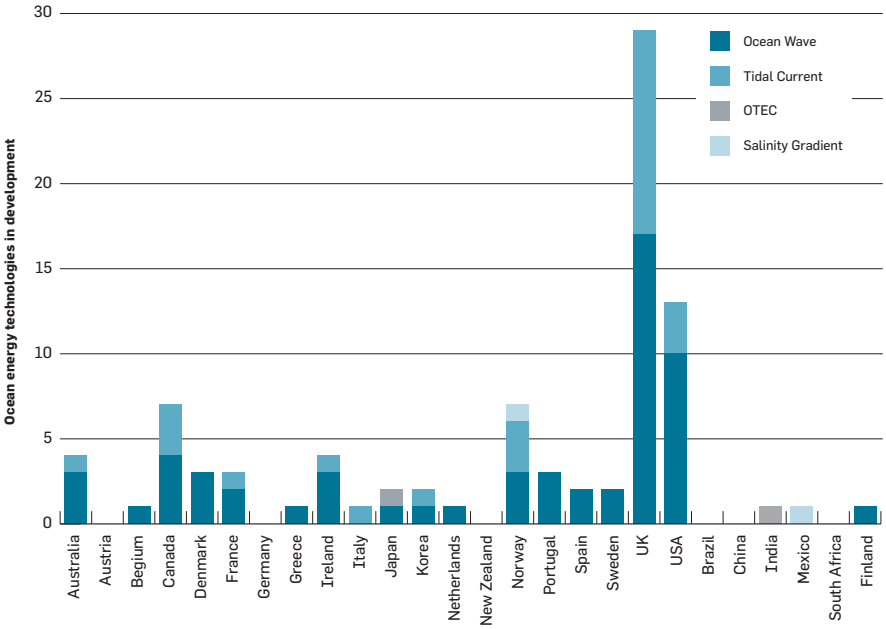
achievements

Review and Analysis of Ocean Energy System Developments and Supporting Policies, Future Energy Solutions, IEA-OES Report 2006.

Examples of key findings of the report

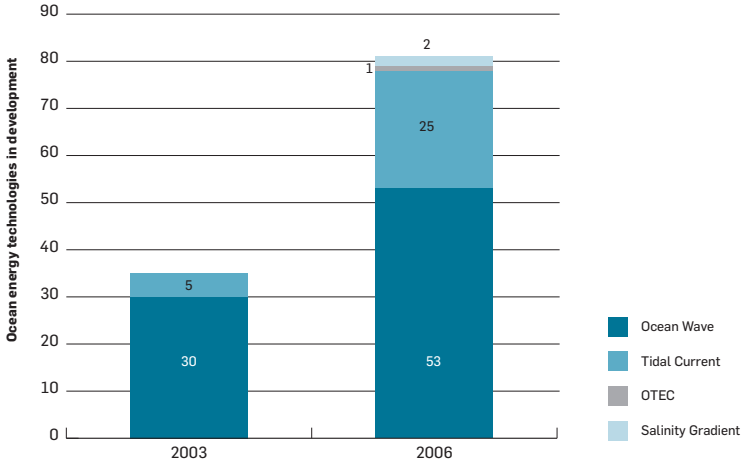
The study has identified that Ocean energy RD&D projects are in progress worldwide, but their distribution is concentrated in certain countries and continents (as shown in Fig. 1).

Fig1. The ocean energy technology RD&D projects in March 2006[1]



The current development status of ocean energy technologies was evaluated in this study. Fig. 2 shows that the technologies currently in development are at various stages of RD&D. There are still several relatively new devices at the concept stage (22 concepts), indicating that the total number being developed is still growing. Several concepts have advanced to detailed designs (10 designs). Many device developers have constructed more advanced models and are performing simulated testing of part-scale models in wave, flume or tow tanks (12 concepts). Twelve ocean energy developers claim to be at the full-scale demonstration phase. No device developer has yet completed a demonstration of multiple full-scale devices in an array or pre-commercial farm. One wave farm project is underway: Ocean Power Delivery Ltd (United Kingdom) has manufactured and delivered three full-scale prototypes for the Aguçadoura wave farm demonstration project to be installed in Portugal in Summer 2007.

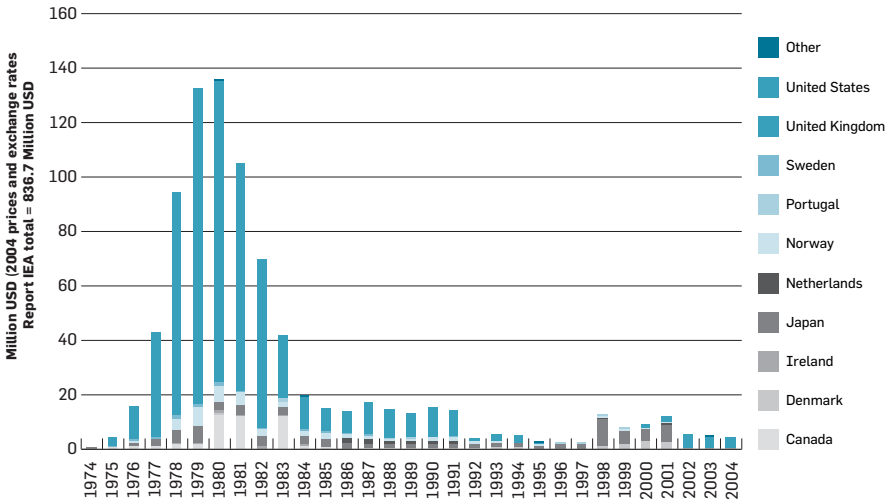
Fig2. Overall current development status of ocean energy technologies[1]



[1] *Review and Analysis of Ocean Energy System Developments and Supporting Policies*, Future Energy Solutions for IEA-OES, 2006

Fig 3 shows the increase in government expenditure on ocean energy in the aftermath of the oil price rises in the 1970s. In particular, the US, the UK, Japan, Norway and Canada were prevalent in the period from 1974 to 1984. RD&D peaked in 1980 and rapidly decreased by the mid-1980s owing mainly to the US withdrawing public support for OTEC RD&D. After an initial boom of government RD&D support from 1974 to 1984, the UK became the largest contributor between 1986 and 1991. Global funding was at its lowest from 1992 to 1997, before Japan began to invest heavily between 1998 and 2001 (resulting in the demonstration of the Mighty Whale OWC prototype). Notably, Denmark and Portugal also increased public spending between 1996 and 2001 (resulting in the demonstration of several ocean wave devices). Since 2001, renewed interest in ocean wave and tidal current RD&D in the UK has resulted in increased public spending. Consequently, several full-scale (or near full-scale) prototypes are nearing demonstration at sea.

Fig3. Reported government ocean energy RD&D budgets in IEA member states 1974-2004[1]



D. Development of an Informative DVD

During 2006 plans were discussed for production of a DVD on Ocean Energy with the objective to promote ocean energy as a viable energy resource, and educate decision makers as well as the public about what ocean energy is, and how it can contribute to sustainable energy production. A general plan and contents of the Video was presented and approved at the last ExCo meeting and production will begin in 2007.

E. Dissemination in Relevant Ocean Energy Related Events

The IEA-OES Programme, under the Annex I, continued to strengthen its dissemination activities through conference presentations in events relevant to Ocean Energy. Members regularly participate at international conferences and present the activities of the IEA-OES whenever it is appropriate.

OREG Symposium "Canada & the World of Ocean Renewable Energy"
Victoria, May 4-5, 2006

This symposium was organized by the Ocean Renewable Energy Group (OREG), a Canadian national organization headquartered in British Columbia. The event, scheduled around the 10th IEA-OES ExCo meeting, highlighted the ocean energy activities of the IEA-OES member countries and prospective member countries. The following presentations are available at the OREG website (http://www.oreg.ca):

> *The IEA Ocean Energy Systems Implementing Agreement: Status and Future Prospects, by Katrina Polaski* (IEA-OES Chair)
> *Ocean Energy in Ireland: National Policies and Strategies for RD&D and Commercialisation of Ocean Energy*, by Katrina Polaski
> *Development of Ocean Energy in Denmark*, by Kim Nielsen (Denmark delegate)
> *Keeping the UK on the Crest of the Wave*, by Gary Shanahan (UK delegate)
> *Wave Energy Utilization in Portugal*, by Teresa Pontes (Portugal delegate)
> *Activity, Strategies and Future on Ocean Energy in Japan*, by Yasuyuki Ikegami (Japan delegate)
> *US Ocean Energy RD&D Status*, by Michael Robinson, (USA delegate)
> *Tidal and Tidal Current Power Study in Korea*, by Kwang Soo Lee (representative from Korea)
> *National Policies and Strategies in Germany*, by Jochen Bard (representative from Germany)
> *Relevant Ocean Energy Activities in China*, by Zhang Liang (representative from China)
> *Sea and brackish water desalination with renewable energies Mexico*, by Gerardo Hiriart (representative from Mexico)
> *Oceans of Opportunities: Harnessing New Zealand's Marine Energy*, by John Huckerby (representative from New Zealand)
> *European Networks and Research Infrastructure: Review and the Need for International Collaboration*, by Tony Lewis (Ireland delegate)

World Renewable Energy Congress IX and Exhibition
Florence, Italy, 19-25 August 2006

The paper *The International Collaborative R&D Programme on Ocean Energy* by Teresa Pontes, delegate from Portugal and Vice-Chair, was presented in this prestigious event on Renewable Energy and is included in the proceedings.

International Conference on Ocean Energy
Bremerhaven, Germany, October 23-24, 2006

This new conference event brought together research and development, industries, project developers, utilities, policy makers and organisations involved in ocean energy.

The Chair, Katrina Polaski, gave a presentation focusing on the IEA-OES future strategy. The following paper was published in the proceedings of the conference: "*5-Year Activity Review of the IEA Ocean Energy Systems Implementing Agreement*", by K. Polaski and A. Brito-Melo, 2006.

Renewable Energy 2006 International Conference and Exhibition
Chiba, Japan, 9-13 October 2006

In the session "Energy Vision for Future" Teresa Pontes made a presentation on *Wave and Tidal Energy: Status and Perspectives* in which the IEA-OES was highlighted. Annual reports and newsletters were distributed at the IEA stand where clear interest was registered.

OREG Fall Symposium 2006
Enabling Wave and Tidal Energy: Technical Challenges and Technology Transfer Opportunities
Halifax, Nova Scotia, November 30 and December 1, 2006

The Canadian Delegate Gouri Bhuyan gave an invited presentation on the activities of the implementing agreement in this two day symposium, which was a successful event including delegates from local utilities, system operators, provincial and federal governments.

F. IEA-OES Newsletter

A printed newsletter is prepared and distributed by post and also via the website each six months. It has been widely distributed both within the Member Countries and at major conferences and seminars.

Members provide material of interest on planned and ongoing activities and programmes on ocean energy and ensure that the newsletter reaches its target audience in the respective countries. The last page of the Newsletter is dedicated to information on relevant events on ocean energy and includes the Member's contact details.

The 2006 February issue includes a summary about the contribution of the IEA-OES to the IEA report "R&D Priorities for Renewable Energy" launched in end 2005, an article with recent activities in ocean energy in Ireland and an article on a new project in the United States, the Roosevelt Island Tidal Energy Project.

The 2006 December issue includes articles from Mexico and New Zealand, countries with increasing interest in ocean energy exploration, and an article about the European Ocean Energy Association highlighting the benefits of cooperation amongst stakeholders in ocean energy.

G. Website

The website **www.iea-oceans.org** continues to be the first source of information about the activities of the IEA-OES. It provides easy access to all major IEA-OES documents: Annex descriptions, reports, newsletter, membership information as well as notification of upcoming events.

Extension of the work program

ANNEX II
DEVELOPMENT OF RECOMMENDED PRACTICES FOR TESTING AND EVALUATING OCEAN ENERGY SYSTEMS

Operating Agent: **The Ministry of Environment and Energy, Danish Energy Agency (acting through RAMBØLL) – Denmark**

During the first 5-year term, a document "Development of Recommended Practices for Testing and Evaluating Ocean Energy Systems, 2003" was produced by the IEA-OES addressing guidelines for tank testing of scale models.
In 2006, the ExCo has approved the extension of this Annex to develop practices for evaluating prototypes, and a draft work program was approved at the November ExCo meeting. The overall objective of the new work program is to provide the necessary basis in order to present the performance of different Ocean Energy Systems in a comparable format. The new work program has the following specific tasks and deliverables:

WP 1 Generic and specific wave and tidal data
Task 1.1 Generic and site related Wave Data – compilation of four generic Scatter diagrams that reflect typical wave conditions at different member states' coast lines ranging from 10 kW/m to 50 kW/m
Task 1.2 Generic and site related Marine Current Data – compilation of four generic diagrams that reflects typical tidal flow conditions at different member states' coast lines ranging from 0,5 kW/m2 to 2 kW/m^2

WP 2 Development And Evaluation Protocol For Ocean Energy Systems
Task 2.1 Development Protocol – development of a protocol in a common language explaining the steps needed in the development of Ocean Energy Systems, for developers and supporting bodies.

WP 3: Guidelines For Open Sea Testing And Evaluation Of Ocean Energy Systems
Task 3.1 Monitoring and data acquisition – compilation of guidelines regarding monitoring and data acquisition of different types of Ocean energy systems based on best practice and experience from the Ocean Energy community.
Task 3.2 Data preparation and presentation of results – compilation of guidelines regarding preparation and presentation of data that will be compiled based on best practice and experience from the Ocean Energy community. The guidelines will describe how the results from the test-site can be transformed to the generic ocean conditions of task 1.1 & 1.2.
Task 3.3 Guidelines on Design, Safety and Installation procedures – compilation of guidelines regarding the design of the Ocean energy system based on best practice and experience from the Ocean Energy community. Production of two documents: Development and assessment protocol for ocean energy systems and Guidelines for open sea testing.
In March 2006, the operating agent organized a Workshop in Amsterdam, Netherlands. This workshop was attended by 20 participants, among them technology developers, experts from universities developing activities on wave energy, and the New and Renewable Energy Centre (NaREC).
During the 11th Exco meeting, Det Norske Veritas BV (DNV) was invited to provide an overview to the ExCo on their proposed "OSS-312 Certification of Tidal and Wave Energy Converters" document.
The ExCo has decided to hold a kick off meeting in early 2007 to launch the extension of the work program. Most Member Countries have indicated their intent to participate in this extension.

Launch of the Annex III

NEW ANNEX ON INTEGRATION OF OCEAN ENERGY PLANTS TO ELECTRICAL GRIDS

Operating Agent: **Powertech Labs Inc. – Canada**

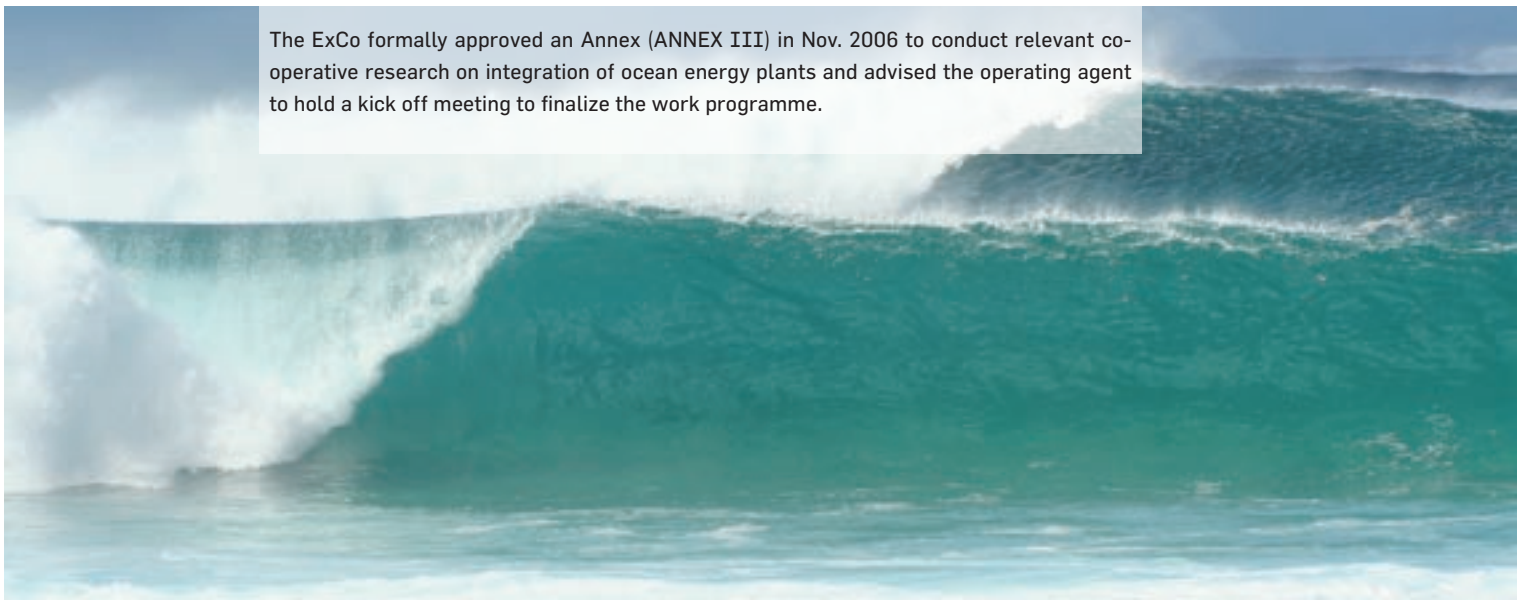
The IEA-OES Executive Committee has held several discussions and expert meetings since 2004 to consider the need for cooperative research related to integration of ocean energy plants within electricity supply systems and establish an international forum for exchange of relevant knowledge, ideas, and experience,. Following on from an Expert meeting on the subject during the November 2004 ExCo meeting, and subsequent discussions during 2005, the Canadian Delegate circulated a draft work program among the IEA-OES members in 2006.

On April 28, 2006, an expert meeting was held in Vancouver to further define the scope of the work program. This meeting was attended by representatives from the UK, Ireland, USA, Japan, and Canada. The following specific issues were identified for consideration for an IEA-OES Co-operative initiative:

> In-depth review of critical voltage quality and grid integration issue arising from the wind industry and how these challenges have been addressed
> Ocean Energy Device characterization
> Power performance testing of conversion system
> Network Modelling methodologies
> Island grid integration
> Offshore connection design
> Power oscillations (flicker)
> Integration with other energy sources
> Examine how related tidal current and wave energy power sites could increase reliability factors

Based on the inputs from a task group, consisting of members from Canada, UK, US and Ireland, the draft work program was revised and presented to the ExCo members and observers at the November 2006 meeting. Powertech Labs was proposed as the Operating Agent for this new Annex. Dr Ana Estanqueiro, Vice-Chair of the Wind Implementing Agreement also gave an overview on how grid integration issues are being addressed by the Wind Implementing Agreement.

The ExCo formally approved an Annex (ANNEX III) in Nov. 2006 to conduct relevant co-operative research on integration of ocean energy plants and advised the operating agent to hold a kick off meeting to finalize the work programme.



Country Review 2006

During the 11th ExCo meeting in Lisbon (14-15 November 2006) the contracting party country representatives and observers were invited to present their countries' national activities in the ocean energy field. These presentations are available at the website www.iea-oceans.org/presentations. Further, members and observers provided a summary document about the current state of ocean energy in their countries.

BELGIUM

By Julien De Rouck, ExCo Alternate from Belgium

The SEEWEC project presents a robust floating wave energy converter: the FO^3, meant to be installed near shore and intended to lead to competitive and economically effective exploitation of wave energy along (European) coasts. The concept of the FO^3 device combines experience from the offshore industry with knowledge of energy conversion from waves by use of point absorbers. The long term objective is to be able to produce electricity at a competitive cost to electricity from other renewable sources. The first step is to become competitive to offshore wind.

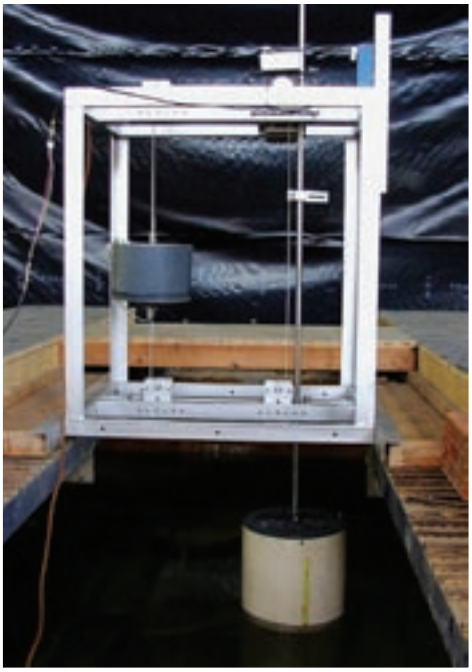
The concept is being tested in the sea. In January 2005 the FO^3 1:3 platform, the so-called laboratory rig, was launched off the Norwegian coast.

The main topics which are investigated within SEEWEC are materials, platform, farm and power generation.

Results of this research, together with monitoring results of the 1:3 laboratory rig are the basis of the 2nd generation FO^3 wave energy converter.

The SEEWEC project is financially supported by the European Community under the 6th Framework Programme.

An investigation on the possibilities for wave energy on the Belgian Continental Shelf will start early 2007. Apart from "available" wave energy also the use of the Continental Shelf for other purposes will be considered.



Point absorber model tests by Ghent University at Flanders Hydraulics Research, Flemish Authorities, Antwerp

CANADA

By Gouri Bhuyan and Melanie Nadeau, ExCo Member & Alternate from Canada

It has been recognized within the federal government that ocean energy represents a potential opportunity to provide clean energy to meet growing energy demands and replace increasingly expensive fossil fuels. In response to this interest, a Federal Ocean Energy Working Group (FOEWG) was established in 2005. This interdepartmental group is composed of representatives from eight federal departments and agencies across Canada. The objective of the group is to assess the potential contribution of ocean energy conversion technologies, both national and international, to the Canadian renewable supply, and develop a framework for increasing Canada's renewable ocean energy contribution to the country's energy supply.

In early 2006, the FOEWG commissioned a preliminary resource assessment entitled *The Inventory of Canada's Marine Energy Resources*. The study focused mainly on wave and tidal kinetic resources estimating a total power potential of approximately 226 GW. It must be noted, however, that not all of the energy from these resources can be captured and converted into wave and tidal power. This inventory of wave and tidal stream energy resources represents the best possible pan-Canadian assessment at this time and constitutes the first phase of a multi-year project aimed at creating a digital atlas of Canadian renewable marine energy resources.

In parallel, a multi-dimensional analysis of the ocean energy sector was commissioned in late 2005. The study examined Canada's industrial capacity to compete in ocean energy development. The preliminary findings have shown that Canada has world-class testing facilities, extensive capacity to undertake feasibility studies, transferable experience from the offshore oil and gas industry, and extensive capacity in marine engineering, design, systems integration, installation and construction. It was found, however, that there was a lack of awareness among organizations of the potential for ocean energy development in Canada and elsewhere.

ers

At the provincial level, several provinces are actively identifying potential ocean energy opportunities. The province of New Brunswick and Nova Scotia commissioned a tidal current resource assessment and are in the process of developing a framework to streamline the permitting process for ocean energy developments. The province of British Columbia will soon be releasing a new energy plan that will likely include mechanisms to aid ocean energy development. Similarly, BC is aiming to streamline permitting and has put forward an Ocean Energy Project Application Directive.
Both provincial and federal governments are committed towards working together in a collaborative approach to increase Canada's ocean renewable energy capacity.
In 2006, Sustainable Development Technology Canada (SDTC) awarded over 2M dollars to two tidal current projects in western Canada. In the fall, the project at Race Rocks, British Columbia was launched demonstrating the Clean Current generation technology (65kW) and thus, reducing emissions by displacing diesel fuel on the island. The second project located near Campbell River, British Columbia will consist of a 500kW tidal current demonstration using New Energy Corporation technology.
In partnership with the University of Victoria, Syncwave Energy Device is performing research and development on their wave energy conversion device technology aiming to provide a hybrid solution to serve capacity constrained and off-grid customers. Blue Energy Canada, in collaboration with the University of British Columbia, continues their efforts in advancing the development of their tidal current technology. In addition, testing of other wave energy technologies has taken place over the year at the National Research Council's Institute for Ocean Technology.
Earlier in the year, the Ocean Renewable Energy Group (OREG) released **The Path Forward – A plan for Canada in the World of Ocean Energy** which proposed actions to ensure a strong and sustainable ocean energy industry in Canada. In May 2006, OREG held an international symposium in Victoria, British Columbia in conjunction with the 10th EXCO meeting. A fall symposium followed shortly after in Halifax, Nova Scotia. Both events were well attended and proved to be a success for all ocean energy stakeholders.


Clean Current Demonstration Project at Race Rocks, BC, Canada

DENMARK

By Kim Nielsen, Alternate Member from Denmark

The wave energy activities in Denmark are at the moment focused on two main projects supported by public Danish funding the Wave Star and the Wavedragon project. Aalborg University is assisting both projects as well as two Norwegian projects and other projects. Other developers are also active in Denmark such as Waveplane, Poseidons Organ and Ramboll and the Danish Wave Energy Association have two open meetings.


website: www.wavestarenergy.com

Wave Star Energy Project scale 1:10
The 1:10 scale model is 24 metres long placed on 2-meter deep water. The 40 floats are one metre in diameter, 20 on either side of the machine. The machine generates electricity from waves of a height of just 10 centimetres. The future 3 megawatt full scale machine will be 240 meter long.
The test machine can produce up to 5.5 kilowatt electric power. The plan is that it will remain in Nissum Bredning for three years. Wave Star Energy has already started work on the construction of a 1:2 model of the full scale.


website: www.wavedragon.net

Wave Dragon scale 1:4,5 tested in Nissum Bredning
Wave Dragon is a floating, slack-moored energy converter of the overtopping type. The first prototype connected to the grid is currently deployed in Nissum Bredning, Denmark. Long term testing is carried out to determine system performance; i.e. availability and power production in different sea states. The energy absorption performance has been independently verified and focus will now be on power production optimisation. These tests will lead to a multi-MW deployment in 2007.

AquaBuOY scale 1:10 under construction, to be tested in the spring 2007
The AquaBuOY is a slack moored point absorber. In full scale the diameter of the point absorber is 7 meter and it will produce up to about 250 kW. The scale model AquaBuOY will be tested in Nissum Bredning next to Wave dragon during the spring of 2007. The project is financial supported by Energinet.dk, AquaEnergy Group Ltd and Ramboll.

IRELAND

By Katrina Polaski, ExCo Member from Ireland

Ocean energy activities in Ireland increased substantially during 2006, with the efforts of many years preparation in both the device development and policy development areas bearing fruit during the year.

Ocean Energy Buoy (OEBuoy), Galway Bay Test Site

Statistics

The number of active device developers with some presence in Ireland has increased to five during the year, including:

> Ocean Energy Limited
> Wavebob Limited
> Hydam (McCabe WavePump)
> Open Hydro
> Finavera (Aquabouy)

A number of these developers also have participation or operations in other countries.
To date, there are four devices that have been tested at large scale in the open sea.
In 2006 the Irish government spent (k€385 SEI, k€510 Marine Institute) and committed another €1.5 M in direct funding for device developers and research going forward.

Policy

In 2006, Ireland's Department of Communications, Marine and Natural Resources (DCMNR) adopted and launched *Ocean Energy in Ireland*, a document laying out Ireland's strategy to advance the speed at which ocean energy can contribute towards Ireland meeting its renewable electricity generation targets. The strategy, proposed to the DCMNR by Sustainable Energy Ireland and the Marine Institute in October 2005, was detailed in the 2006 Annual Report. It is a four phase strategy incorporating the following elements:
Phase 1 – support for Irish device developers testing at $^1/_4$ scale; support for research facilities; development of a $^1/_4$ scale test site;
Phase 2 – support for Irish device developers testing full scale prototypes; support for research facilities; development of a grid connected open sea test site; price support for electricity generated by ocean energy;
Phase 3 – support for Irish device developers testing an array; support for research facilities; multi-device grid connected open sea test site; price support for electricity generated by ocean energy;
Phase 4 – price support for electricity generated by ocean energy.

The DCMNR also announced a major support initiative for research in the energy sector, launching the Charles Parsons Awards to support post-doctoral research positions, PhDs and undergraduate summer student placements. The awards are aimed a increasing the research capacity in Ireland for chosen areas of energy related research. An estimated €3 – 4 million was awarded for research in ocean energy under the programme. The positions will attract funding over a seven year period.

Activities

Ireland's $^1/_4$ scale open sea test site, off Spiddal in Galway Bay in the west of Ireland, was officially launched in March 2006. The site is does not include a grid connection, however the Marine Institute have deployed a WaveRider buoy to provide wave measurements at the site. The Marine Institute and Sustainable Energy Ireland provided the funding for the site.
The Wavebob Limited wave energy device, the Wavebob, was launched at $^1/_4$ scale in the Galway Bay test site in March 2006. The device was tested for a number of months before being removed for further development.
In December 2006, the Ocean Energy Limited's OE Bouy was launched at the $^1/_4$ scale test site. It has since survived 8 meter waves at the site in January storms.
Work was ongoing throughout 2006 on construction of a part-scale model open centre turbine tidal energy device by Open Hydro. The device was to be installed in 2007 at the European Marine Energy Centre in Orkney.
All three of the $^1/_4$ scale model device projects wer e supported by Sustainable Energy Ireland.

Research

Under the joint University College Cork – Marine Institute Blue Power Initiative, a number of post-doctoral projects were initiated in 2006.
Dr. Garth Bryans completed a PhD on tidal stream energy considering integration of tidal stream devices to electricity grid systems.
The Wave Energy Atlas, initially a SEI-Marine Institute jointly commissioned research project undertaken by ESBI, has been extended in conjunction with the All-Island Renewable Grid Study for the island of Ireland. Results from Work Stream 1, prepared by ESBI, and in which the extended work on the wave atlas is incorporated, will be available in the third quarter of 2007.

JAPAN

By Yasuyuki Ikegami, ExCo Member from Japan

30kW OTEC experimental apparatus

Demonstration test of OWC type wave energy converter in Niigata

OTEC

In the Institute of Ocean Energy, Saga University(IOES), the OTEC Project have been progressed by the 21st COE Program of "Advanced Science and Technology for Utilization of Ocean Energy " as the center of excellent in Japan, which supported by Japan's Ministry of Education, Culture, Sports, Science and Technology from 2002. By the program, it is proved experimentally that an OTEC system (30kW) using ammonia/water mixtures as working fluid has been taken the net power thermally in 2006. IOES have been supported by the Japanese Government over USD40 million of public funding for OTEC in 2001. In Japan, there are some discussions on further OTEC RD&D to realize the project. Especially it is a joint project a floating ocean nutrient enhancer, 'TAKUMI' using OTEC as power source.

Wave Energy

Research group of Professor Takao has started the demonstration test of OWC type wave energy converter with Setoguchi impulse turbine in Niigata since 2005. Research group in Saga University is studying about Backward Bent Duct Buoy (BBDB) which is a wave energy converter invented by Mr. Masuda numerically and experimentally.

Tidal Energy

Research group of Professor Shimada is carrying out the sea test in Kyushu. Research group in Nihon University is executing the sea test of navigation buoy with Darrieus type turbine in Akashi straight.

Sea test in Kyushu

Navigation Buoy with Darrieus Turbine

PORTUGAL

Teresa Pontes, ExCo Member from Portugal

Portugal enjoys a very favourable mix of renewable energy sources including hydro, solar, wind, waves and biomass. In accordance with the policy of the European Union, the Portuguese government is establishing mechanisms to increase the penetration of renewables in the country. The recent update of the 2010 target from 39% to 45% for green electricity consumption is a clear step in this direction.

Specifically for wave energy, the most relevant measures are the high feed-in tariff that is presently being awarded (circa 24c /kWh) although on a case-by-case basis, and the announcement for a Pilot Zone off the central west coast where licensing will be eased and some infrastructures for grid connection and plant monitoring are expected to be in place. The total planned capacity is 250 MW.

400 kW OWC Pico Power Plant, Azores

THE FOLLOWING WAVE ENERGY PROJECTS HAVE BEEN UNDERWAY:

1. Pico Plant

The European Wave Energy Pilot Plant in the island of Pico, in the Azores archipelago, was connected to the electrical grid in late 1999. This is an OWC shoreline plant rated 400 kW equipped with an air turbine of the Wells type and an asynchronous generator. Funding was provided by the Azores and mainland utilities EDA and EDP, in addition to several EC contracts coordinated by Instituto Superior Técnico (IST). After the start up reaching 200 kW electricity production, problems in the turbine were apparent (vibrations of stator blades and lubrication). Despite the repairs in 2000-2003, the plant did not operate regularly which caused the degradation of part of the electrical, control and ancillary equipment due to the aggressive humid salty environment. The Ministry of Economy and Innovation PRIME/DEMTEC Programme, in addition to private funding enabled to start the refurbishment in 2005, the Wave Energy Centre being the coordinator. Although not all the difficulties have been overcome, it was possible in 2006 to test the plant in various sea conditions. These tests showed good performance of the power take-off equipment, in accordance to the theoretical time-domain modelling.

2. OWC Power Plant at the mouth of Douro River, Porto.

A new wave energy power plant of the OWC type is planned to be incorporated in the breakwater under construction at the mouth of Douro River in Porto. The plant will incorporate two chambers imbedded in the breakwater head-caissons with vertical air turbines of the Wells type, the total rated capacity being 750 kW. The plant will be jointly owned by the EDP and IPTM (Harbour and Maritime Transportation Institute). An EC contract that will co-fund the construction has been approved.

The feasibility studies were carried out by IST, INETI, WEC, and various companies including the coastal engineering company Consulmar and the equipment supplier Kymaner. The call for tenders for the supply of the equipment was launched in late 2006. It is planned that the plant will start running in late 2008.

4. Pelamis Wave Farm

A wave farm consisting of three 750 kW Pelamis devices is to be deployed off Póvoa do Varzim, north of Porto. It is owned by the renewable electricity company ENERSIS one of largest in the country that owns small hydro plants and wind farms. The machines assembly started in 2006 at the Peniche shipyard, 100 km north of Lisbon. The deployment of the devices is planned for 2007.

5. MARTIFER ENERGIA

The company Martifer Energia, part of the Martifer holding, has diversified its activity into various renewable energy technologies, including wind, wave, biofuels and solar. The company is developing in-house an offshore wave energy power device, with the contribution of R&D institutions. There are plans for deploying in 2008 a device in real sea.

6. Aquabuoy

An EC STREP proposal will provide funding for the construction and deployment of two 250 kW Aquabuoy units off Portugal west coast. EDP, Mondego Shipyard, IST, INETI and Kymaner are the Portuguese partners of this project. The deployment is planned for 2008.

POLICY & PLANNING

A major review of UK energy policy was carried out in 2006[i] which focused on ensuring that the UK remains on course for achieving its key energy goals of climate and energy security. Amongst other things, the review set out proposals to improve the Renewables Obligation (RO), the key support mechanism for renewable energy in the UK. Specifically, to increase the requirement placed on electricity suppliers to meet a growing proportion of their generation from renewable sources from the current 15% in 2015 up to 20% when justified and to adapt the RO to provide greater support to emerging technologies. Formal detailed proposals on how the RO may be used to assist emerging technologies will form part of an Energy White Paper expected to be published in Spring 2007.

Separately, the Scottish Executive published proposals in September 2006 that will amend the Scottish Renewables Obligation so as to provide greater support for wave and tidal-stream technologies. The proposed initial phase of support is for up to 75MW giving support levels of £175/MWh for wave and £105/MWh for tidal-stream. The new legislation is planned to come into force in Scotland in April 2007.

Aquamarine Power Ltd – Oyster wave surge converter

In November 2005 the Department of Trade and Industry (DTI) published guidance[ii] on consenting arrangements in England & Wales for a pre-commercial demonstration phase that leading wave and tidal-stream (marine) energy technologies are shortly expected to enter. The purpose of the guidance is to provide clarity on how existing regulations will be interpreted and applied across government when considering consent applications for marine energy device demonstrations. The guidance will provide certainty for the duration of the demonstration phase, but introduces no new regulation.

In September 2006 the Welsh Assembly Government announced a £1 million 3-year project to develop a Welsh Marine Renewable Energy Strategic Framework (MRESF) that will ensure the sustainable development of the marine renewable energy resource contained within the Welsh Seas.

RESEARCH, DEVELOPMENT AND DEMONSTRATION

In 2006 government continued to support research and development of marine energy technologies primarily through the DTI's Technology Programme. The objectives of the programme and related demonstration initiatives are to stimulate innovation, develop industrial capability and to gain an understanding of the long-term commercial prospects for low-carbon energy technologies. Under the programme a further 7 new research and development projects were supported, with levels of assistance totalling £2.75 million and typically at 50% of project cost. These new projects brought the total number of ongoing marine energy technology r&d projects supported by the DTI to 16 with grant support totalling £17.3 million.

Two of the new projects, a floating tidal turbine by SRTT and a nearshore wave energy converter by Aquamarine Power Ltd are illustrated below.

[i] UK Energy Review – www.dti.gov.uk/energy/review/page31995.html
[ii] Guidance on Consenting Arrangements in England and Wales for a Pre-Commercial Demonstration Phase for Wave and Tidal Stream Energy Devices – www.dti.gov.uk/files/file15470.pdf

SRTT design and operation.
Scotrenewables (Marine Power) Ltd. 2007

MCT SeaGen device – Pile and Collar

Within the R&D activities in the UK a number of full-scale prototypes are expected to be deployed and demonstrated during 2007. Amongst these is the SeaGen project led by Marine Current Turbines Ltd. The company expect to install their 1MW twin rotor tidal-stream device in Stangford Lough, Northern Ireland.

In October the Carbon Trust announced a major new £3.5 million initiative in marine renewable energy called the Marine Energy Accelerator (MEA). The programme aims to accelerate progress in cost reduction of marine energy technologies, to bring forward the time when marine energy becomes cost-competitive. The individual projects will involve device developers and component technology manufacturers working with engineering consultants, contractors and academic research groups. The projects are expected to start in Spring 2007. This follows-on from the Trusts' Marine Energy Challenge (a summary of which is contained in the Strategic Plan Chapter of this Annual Report).

Also in October the Scottish Executive launched a 'Wave and Tidal Energy Support Scheme' that has total funding of £8 million. The aim of the Scheme is to provide grants to businesses to support the installation and commissioning/deployment of pre-commercial wave and tidal devices at EMEC. The scheme will also support components of projects requiring testing at EMEC e.g. mooring systems, foundation installation systems etc. that will lead to reduced project cost and/or improved operation and maintenance for the industry.

A new DTI Scheme to support the first larger-scale multi-device grid connected pre-commercial demonstrations was launched in February. The DTI "Wave and Tidal-stream Energy Demonstration Scheme"[iii] makes available a total of £42 million, with up to £9 million for individual projects. The funding is delivered through a combination of capital grant (up to 25% towards eligible costs) and revenue support (£100/MWh for up to 7-years). In addition to the capital and revenue support received under the Scheme projects may also receive revenue from the sale of electricity and greens certificates under the existing market.

The Scheme is part of a package of measures under the DTI's £50 million Marine Renewables Deployment Fund. Other measures include support for infrastructure projects and a marine environmental research programme that are discussed below.

The proposed 'Wave Hub[iv]' infrastructure project is an electrical grid connection point 15 km offshore into which wave energy devices can be connected. The chosen site is off the North Cornwall coast. The 'Wave Hub' approach is expected to bring a number of benefits to developers, including a well defined and monitored site with electrical connection to the onshore electricity grid and a simplified and shortened consents process, reducing the risk for developers of the first pre-commercial wave arrays.

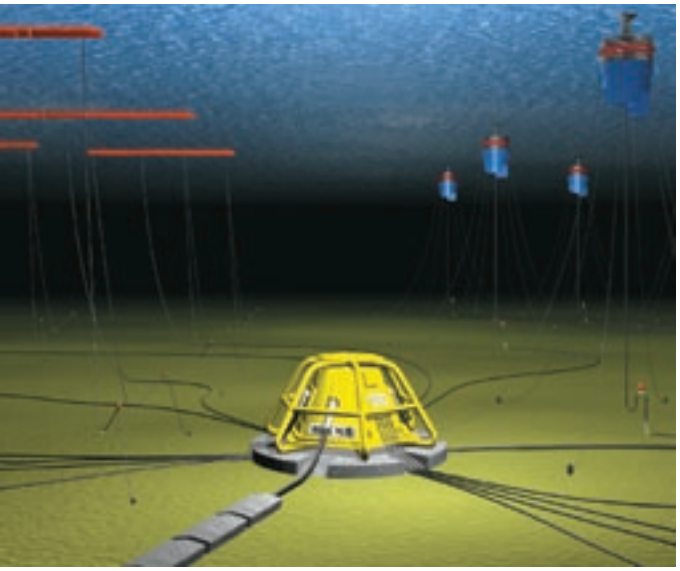
The total project cost is estimated at £20 million for 20MW capacity and DTI in August announced support of up to £4.5m towards the cost of the project. If the project receives the necessary support from the industry, then it could be commissioned as early as Summer 2008.

SWRDA Wave Hub

In 2006 the European Marine Energy Centre (EMEC) in Orkney completed a £7.2 million project to extend the current facilities to include tidal-stream testing berths. The new berths are grid connected having a total capacity of 20MW. As well as providing world leading test facilities, the measurement and independent verification of the performance of marine devices will form part of the services provided by EMEC. In April DTI and the Scottish Executive provided up to £250k funding to assist EMEC develop methodologies for the measurement and reporting of performance of marine energy devices.

Gaining an understanding of the environmental impacts of new marine technologies has been identified as a priority area. The UK Research Advisory Group (RAG) was created by the DTI as a pan-government body to facilitate a co-ordinated approach among the regulatory and funding bodies to address the key impact issues of offshore renewables. The remit of RAG has now been extended to gain further understanding on the potential impacts of wave & tidal-stream energy generation and a total of £2 million has been allocated under the MRDF to a marine energy technologies research and monitoring programme. In 2006 a number of projects were commissioned including environmental monitoring of the SeaGen Strangford Lough demonstration project. The results from the programme are to be published and will inform decisions makers both at a project and strategic level.

[iii] DTI Wave and Tidal-stream Energy Demonstration Scheme – www.dti.gov.uk/energy/sources/renewables/business-investment/funding/marine/page19419.html
[iv] South West Regional Development Agency Wave Hub Project – www.wavehub.co.uk



SWRDA Wave Hub

Along with the industry-led activities and initiatives in the UK, a new £6 million 4 year programme of fundamental marine energy research involving a number of UK universities and known as Supergen Marine Consortium[v] was approved by the Research Councils.

This new programme builds upon research carried out under the previous Supergen Marine I research programme. Notably it seeks to better understand *device-sea interactions* and so should complement work that is ongoing under many of the other initiatives discussed above.

In July a major £400k study on tidal power in the UK was commissioned by government. The study will consider the UK tidal resource and the technologies to harness tidal energy including tidal barrages. In particular the study looks at the potential for tidal power developments in the Severn Estuary and related issues in depth. The study is planned to report in Summer 2007.

It is clear that a unique opportunity now presents itself for greater collaboration between government, industry and the research community so as to better understand the long-term prospects for marine energy as a contributor to the achievement of the government's energy goals.

UNITED STATES OF AMERICA

By Walt Musial, ExCo Alternate Member from USA

The U.S. wave energy resource potential that could be harnessed is estimated to be about 260 TWh/yr, which is roughly equivalent to the total energy generation of conventional U.S. hydro power (about 6.5% of total supply). The U.S. energy potential of tidal, ocean and river currents has not been fully evaluated; however, a review of the literature estimates a potential of about another 130 TWh/yr.

The development of ocean wave, ocean current, tidal and river in-stream energy devices in the United States has lagged behind other renewables energy sources but interest is growing rapidly. Several privately-funded companies have developed prototype devices and are poised for full-scale deployment but only a few have reached the stage of open water testing. Some of the early projects underway in the United States are:

> Hawaii – Ocean Power Technology (PowerBuoyTM) received a license which was expedited by the U.S. Navy. The 40 kW project was installed in June 2005 and has logged about 8 months of operational experience.

> Makah Bay, Washington State -AquaEnergy submitted a full license application to Federal Energy Regulatory Commission (FERC) – the agency that regulates interstate transmission of electricity and licenses hydroelectric projects in nonfederal waters – for a 1-MW wave point absorber project consisting of 4-250 kW units in November, 2006. The project is currently awaiting a permit to install.

> FERC has received preliminary permits for the following ocean wave projects:

- > Reedsport, Newport and Coos Bay, Oregon – Ocean Power Technology
- > Lincoln County, Oregon – multiple plants
- > Douglas County, Oregon – multiple plants
- > Bandon, Oregon – Finavera Oceanenergy
- > Eureka, California – Finavera Oceanenergy

> New York, NY – Verdant Power was allowed by FERC to deploy 6 turbines to support their license application for the Roosevelt Island Tidal Energy (RITE) Project in the East River. The demonstration is supported by permits from the New York State Department of Environmental Conservation and U.S. Army Corps of Engineers. The New York State Energy Research and Development Authority has partnered with Verdant on the project. Investing over US$2,000,000 to date.

> San Francisco Bay – Oceana / Golden Gate Energy was granted a preliminary permit investigate a current turbine project in San Francisco Bay.

> Washington State – Tacoma Power was granted a preliminary permit to investigate a current turbine project in the Tacoma Narrows.
> 32 additional preliminary permit applications are pending at FERC.
> The pace of development of the industry can be seen in the increasing role of the investment community in the technology. For example, in August Verdant Power closed a US$15,000,000 institutional investment. Ocean Power Technologies has filed a statement with the Securities Exchange Commission (SEC) to raise approximately US$100,000,000 through an initial public offering. These developments are a very positive sign for the growth of this technology.

In 2005, the U.S. Congress passed the Energy Policy Act of 2005 (EPAct 2005). Section 931 of EPAct 2005 authorizes the Department of Energy (DOE) to conduct research, development, demonstration, and commercial application programs for ocean energy, wave energy and kinetic hydro turbines, but no funding was appropriated. During the most recent budget cycle, the U.S. Senate proposed a federal budget of US$4M for the 2007 fiscal year; however, due to shifting political directions in the United States it is not likely that this budget will be adopted. This activity does suggest, however, a positive attitude toward a future Ocean, Tidal and In-stream Renewables Program within the DOE.
Ocean projects in the United States have proceeded in the absence of a clear and efficient regulatory process. The regulatory process being applied today was designed for conventional hydroelectric plants and does not fit the characteristics of today's wave and tidal in-stream energy conversion technology. Because extensive regulation applies to even small pilot projects, whose purpose is to investigate the interactions between the energy conversion devices and the environment in which they operate, the regulations are lengthening the time for demonstration projects to get off-the-ground and into the water. The lack of an appropriate approval process is one the largest obstacles to development of ocean, tidal and in-stream energy technology in the United States. The regulatory process was further confused when Congress authorized the Minerals Management Service (MMS), the agency in charge of regulating offshore oil and gas, to regulate alternative use activities, including ocean renewables, on the outer continental shelf (federal waters outside of 3-nautical miles) in EPAct 2005. MMS is in the process of developing rules and leasing protocol for projects within this jurisdiction. Projects located inside of the 3-nm limit are likely to be regulated and permitted by FERC. The potential for a jurisdictional conflict is significant between MMS and FERC which could further hinder the approval process.

EUROPEAN COMMISSION
European Commission, DG RTD

In 2006, the last calls for proposals of the sixth RTD Framework Programme were launched and the resulting proposals were selected and negotiated. The seventh RTD Framework Programme has also been approved and launched. Finally, an important policy consultation was launched on maritime policies.
With the closing of the last calls of the sixth RTD Framework Programme, the ocean energy sector can look back on the remarkable success of ocean energy projects. Eleven projects were selected and negotiated for a cumulated EC contribution of 17.3M , representing 52.4% of the total EC support since the first RTD Framework Programme. This success is the outcome of continuous efforts at European and national level to secure successful technical demonstrators of ocean energy systems. Within the RTD Framework Programmes, such demonstrators include the Seaflow current turbine, the Limpet and Pico OWC prototypes, and the overtopping floating device WaveDragon. Looking ahead, the new WaveDragon MW, SEEWEC, WAVESSG, ALDA, AquaBuOY, Archimedes Wave Swing MkII, BREAKWAVE, NEREIDA MOWC and WAVESTAR projects need to achieve new successes to push ocean energy systems closer to the market.
In the seventh RTD Framework Programme, renewable energy sources such as biomass, hydro, geothermal, wind, ocean and solar energies, are at the heart of the Energy theme. There are three activities dedicated to renewables: renewable electricity generation, renewable fuel production, and renewables for heat and cooling. The objectives are to achieve the policy goals of 21% of green electricity, 12% of energy consumption and 5.75% of fuel consumption from renewable sources by 2010. Ocean energy is one five energy areas where the Research Infrastructure programme has recognised the potential to bring together existing test facilities for increased efficiency and integration of research.
The European Commission published a Green Paper in June 2006 on a future common European Maritime Policy (http://ec.europa.eu/maritimeaffairs/). The Green Paper is the result of over a year of consulting with stakeholders, identifying gaps between sea-related sectorial policy areas and attempting to adopt best practice and learn from obstacles and challenges. The mandate has been to examine all economic activities of Europeans which are linked to or impact on the oceans and seas, as well as all the policies dealing with them, with a view to finding the best way to extract more benefit from the oceans in a sustainable manner. This Green Paper will be a success if it forges a consensus among stakeholders that the EU needs to look at the oceans and seas in an integrated manner if Europe is to maintain its resource base and to continue being competitive in maritime affairs. Opinions on the Green Paper and ideas can be expressed till 30th June 2007. All contributions to this important consultation will lead to a Communication to the European Parliament proposing the way forward to achieve this holistic approach.

observers

CHINA

By Liang Zhang, Observer from China

There are about 7000 islands in China and shore line is about 18,000 km. from 2003 to 2006, China's activities on RD&D of the tidal current energy conversion have been carrying out by the researchers of the ocean energy group of Harbin Engineering University (HEU) and the wave energy conversion by Guangzhou Institute of Energy Conversion, Chinese Academy of Sciences. The projects are supported by the national or provincial government. The issue of the "RE Law of China" has been in active in January 2006.

Tidal current Energy

1. "Wanxiang-II" 40kW tidal current prototype plant

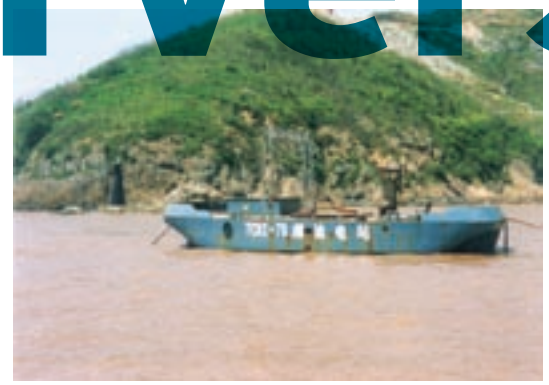
A 40kW tidal-stream power plant has been constructed in the end of 2005 by HEU. The prototype, named as Wanxiang-II, is under water and seats on sea-bed of a strait of Daishan, Zhejiang province. It is the second one after a 70kW floating on-grid tidal-stream power plant (1996-2002), named as Wanxiang-I, in china. The Wanxiang-II is a off-grid station with intensifier, two vertical axis variable-pitch 2*3 straight blades rotors, and with capacity of 40kW, size of 7.6*7.6*5 m and weight in air of 60 ton. The output electric power is used for a light tower near a bridge.

2. First international joint venture company for tidal current energy exploration has been established in China in November, 2006. The JV company will implement a project supported by UNIDO. Both sides of cooperation are Ponte di Archimede, PdA, Italy and Daishan Gaoting Shipyard, DSS, China.

3. A pre-design tool for the performance analysis of vertical axis variable-pitched tidal stream hydro turbine, VAPHT, has been presented up to 2006 by HEU. Its code is based on the modified stream tube models and the vortex-panel model and still in validation through the model test and prototype machine.

Wave Energy

On April 2006, Guangzhou Institute of Energy Conversion, Chinese Academy of Sciences had finished the construction of a 50 kW onshore oscillating buoy wave power device in Shanwei City, Guangdong Province, China. The device has a buoy capturing wave power. Three pumps with capacities of 10kW, 20kW and 40kW are driven by the buoy to convert the captured energy to hydraulic energy. The hydraulic energy is used to drive two hydraulic motors which are connected with one 20kW and one 30kW generators respectively. An energy buffer with capacity of 10 MJ is used to smoothen the pressure in the hydraulic system. The system can work independently, without aid of any power system, output high quality A.C. electricity which can be used directly for illumination, computers, air condition and other electrical devices. The total efficiency from captured energy to electricity is 45%~65%. The maximum instant captured power is 280kW.



Wanxiang-I *Power Plant* (HEU, China)

Wanxiang-II *Power Plant* (HEU, China)

Energy buffer of 10 MJ in capacity

50 kW onshore oscillating buoy wave power device

GERMANY

By Jochen Bard, Observer from Germany

With respect to available resources in the range of about 2% of the electricity consumption a continuing high interested in ocean energy can be found in Germany in the public as well as in research and industry. Currently around 10 R&D institutions are involved into developing wave, tidal current and osmosis power in the framework of mainly European research projects. In addition, there are around 20 companies involved into system and component development and supply to different technologies mainly in Europe. There is no installation realised yet, but a first Limpet type wave power plant of 250 kW has been announced to be installed at the North Sea Cost. The joined project of Wavegen – a Voith Siemens Hydro Company and EnBW, a regional utility, is planned to be installed between 2008 and 2010 into a civil structure to be built. Site surveys are not yet completed. In addition, Voith Siemens Hydro has announced the development of a tidal turbine for installation in Korea. A memorandum of understanding has been signed with a Korean consortium to develop a project with a final implementation of 600 MW in a tidal energy park. The public funding in the framework of the National energy research programme is currently limited to tidal turbine concept and component development. The total amount of funding between 2001 and 2007 is around 1.4 Mio Euros. A feed in tariff for electricity from wave and tidal energy similar to the tariff for small hydropower (around 7 to 10 cent) is available under the renewable energy act of 2005. A first international conference on Ocean Energy was held in Bremerhaven in October 2006. Germany will become a member of the IEA-OES in 2007.

INDIA

By Phanikumar Sistla, National Institute of Ocean Technology

Energy and fresh water are two of the major thrust areas for India because of the ever-increasing demand. Consequently, harnessing fresh water from the sea and renewable energies from waves, tides and thermal gradient in the ocean are major activities of the Institute. In the process of developing the related technology, NIOT has crossed many milestones, a few of which are detailed below.

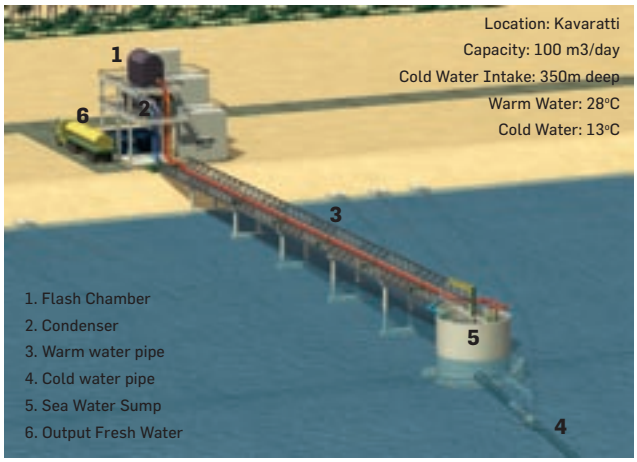
Desalination

The low temperature thermal desalination (LTTD) process depends on evaporating the warm surface seawater at low pressure and condensing the resulting pure vapour using the cold, deep seawater. The advantage of the eco-friendly process is the absence of any non-biodegradable bye-products, the possible use of nutrient rich cold water for aquaculture and future expansion of the process to include a power cycle. NIOT has successfully developed a 5m^3/day plant model to its current scaled up plants by wading through various stages.

> Demonstration of 100m^3/day barge mounted desalination plant off the coast of Tuticorin.

> **Establishment and continuous operation of 100m^3/day land based desalination plant at Kavaratti island**: A 600m long, 650 mm diameter high density polyethylene (HDPE) pipe was welded at island shore and deployed to draw cold water at 12°C from 350m water depth. The desalination plant, commissioned in July 2005 has been operational ever since and the water is being distributed to local people. The plant has since been fine-tuned to enhance the capacity to 140m^3/day. Efforts are currently underway to establish similar plants of 300m^3/day and 150 m^3/day capacities in the other islands of the region.

> **Successful demonstration of 1000m^3/day barge mounted desalination plant off the coast of Chennai**: As an intermediate step towards fulfilling the water requirements of the mainland, a barge mounted 1000 m^3/day desalination plant was undertaken. The plant, completely indigenous, generated water for two weeks for the first time. A 1m diameter, 700m long HDPE pipe was deployed to draw cold water at 10°C from a 600m water depth. The barge was anchored at 1200m water depth using an indigenous single point mooring, the deepest of its kind in Asia. Efforts are underway to establish scaled up models of barge mounted operational plants in the near future.



A typical land based LTTD plant

Floating Barge Mounted Plant and its mooring

Wave Energy

NIOT has also commissioned the first ever wave powered desalination plant at Vizhinjam, India. The wave energy plant is one of the very few working wave energy plants in the world. The energy produced from this plant is being used to run a reverse osmosis based 10m^3/day desalination plant to cater to the needs of the local fishing community. The current working version that has been operational for the past decade has an impulse turbine driven by an oscillating water column.
The institute has earlier experimented firstly with a constant chord Wells turbine model and secondly with variable chord Wells turbine. Large caisson based wave powered devices are not very economical in the seas around India, because of the low average wave power. NIOT is focusing on floating wave powered devices with potential applications in remote islands. One such device, a Backward Bent Ducted Buoy is currently being installed and tested at NIOT.

A schematic of the proposed project near Khambat

Future Programs in Related Areas

A large dam is being built across the gulf of Khambat to harness the tidal power as a part of the Kalpasar project. NIOT has been an active participant in the project with key roles ranging from feasibility studies to field surveys.
Ocean thermal energy conversion (OTEC) is also one of the areas being studied at NIOT. The new LTTD plants that are currently being established are proposed to be made self-sustaining by using the thermal gradient between the cold and warm streams to produce just enough power to run the plants.

ITALY

By Antonio Fiorentino, Observer from Italy

The activity in Italy concerning Ocean Energy is still confined to the initiatives undertaken by Ponte di Archimede Company. This activity is being developed in two directions:


Enermar system, Sea testing in the Strait of Messina

Improvement of the instrumentation onboard the existing prototype moored in the Strait of Messina.

An automatic data logger is being fitted onboard the Messina prototype. The campaign of data collecting will last some months and at the end a complete map of the systems performances will be available. The map will show the power output for any current velocity and any number of revolutions of the turbine. From this map a second step will be started, the power optimization: a controller will read the current velocity and adjust the generator load accordingly, in order to keep the turbine revolutions in correspondence of the maximum efficiency. This setting will be varied at any variation of current velocity.

Cooperation with UNIDO for three more prototypes to be launched in the East Asia

The cooperation with UNIDO (United Nations Industrial Development Organization) is going on.
Two prototype plants have been designed to be moored in the waters of two Eastern Countries: Indonesia and P.R. of China. For the first one, already some tenders have been collected and the preparation is going ahead. For the second one, an agreement has been signed in Rome last November, between Ponte di Archimede and the Harbin University. From the Chinese side, the document has been signed by professor Liang Zhang (who also attended the Ex-Co in Lisbon) and the prototype shall be built by the Daishan County Gao Ting Shipyard.
A third prototype to be fitted in Philippines waters is still in discussion and in these days an Italian delegation is accompanying dr. Vento of UNIDO to Manila in order to define further details. The sites already selected for the first two plants are the channel between the islands of Salajar and Celebes in Indonesia and in the Zhoushan Archipelago in China.

MEXICO

By Gerardo Hiriart, Observer from Mexico

Tidal Storage

A theoretical evaluation of the potential to use “Storage Tidal Energy” in the Gulf of California was completed in his first part. An enormous potential was theoretically determined (over 40 GW), but impossible to build because of his cost and environmental impact. Further calculations were made for smaller, two reservoirs, tidal storage and found that this is a very good scheme as long as one finds the appropriate geometry (a narrow entrance to a two arms reservoir). A couple of sites where located with this characteristics. Economics is not too bad, but ecology might be a big problem. We continue working to find the appropriate site.

Tidal currents

Tidal velocity was measured in the Infiernillo channel. Combination of this short time measurement with a theoretical model indicates that the peak velocities are over 3 meters per second. A more intensive campaign will be performed during 2007.

Tidal currents turbine

A new turbine to be used in a floating device to produce electricity was invented and in process to be patented. The new design, called IMPULSA turbine, is under testing at the labs of the University. Results are expected to be presented at the workshop in Mexico City march 22 and 23. Gerardo Hiriart and collaborators are working on this design.

Wave pump

A Wave pump developed by Steve Czitrom was improved. Several due diligences were made to obtain the funds to install one real, full scale pump, in the coast of Cancun in Mexico.

Salinity and Temperature

Several surveys were done in the coast of the Baja California Peninsula to measure anomalous temperatures and salinities. Extremely high salinity (48 000 ppm) was found in the upper part of the Cortez Sea and several high temperature sea water spots were identified, being the highest 84ºC in Los Cabos. During 2007 a more precise survey will be done in the Puma Oceanographic Ship of the University.

NEW ZEELAND

By John Huckerby, Executive Officer of AWATEA, Observer from New Zealand

Formation of AWATEA

A major step forward for marine energy in New Zealand occurred on 10 February 2006 when the Aotearoa Wave and Tidal Energy Association (AWATEA) first met.

AWATEA will be an industry promotion body and lobbying organization (www.awatea.org.nz). Its members are drawn from electricity generators, marine research organizations, energy industry and marine industry consultancies, Government agencies and private individuals with interests in marine energy in New Zealand.

To date AWATEA's Executive has met ten times. It organized a very successful 'miniconference' in September 2006 and Executive members have made a number of presentations both in New Zealand and at international conferences.

AWATEA's Executive has also had a number of meetings with Government officials, including the Minister of Energy, to raise awareness and promote Government interest in and support for marine energy.

At the time of writing AWATEA is planning to hold its first annual marine energy conference: "Blue Energy: Taking the Plunge" on 15 March 2007 in Wellington.

IEA Ocean Energy Systems

AWATEA's founder and Executive Officer, Dr. John Huckerby, attended the two IEA:Ocean Energy Systems Executive meetings and presented papers on marine energy in New Zealand at the OREG Symposium in Victoria (May 2006) and the OTT conference in Bremerhaven (October 2006). AWATEA has also published articles in the IEA-OES newsletter and various New Zealand publications.

Marine Energy Projects

Work undertaken by Power Projects Limited in 2005 for the Ministry of Economic Development identified twelve marine energy projects actively being developed in New Zealand. In 2006 at least two more projects have been proposed, although none has progressed to deployment. In June 2006 Neptune Power announced its proposal for a tidal energy scheme on the eastern side of Cook Strait. The scheme proposes to use the SMD Hydrovision TidEl technology. Resource consent applications are likely to be submitted in 2007.

In September 2006 CREST Energy announced their proposal for a tidal energy scheme in the outer part of the Kaipara Harbour (on the west coast of the North Island). This scheme proposes to use the Lunar Energy tidal turbine technology with a potential capacity of up to 200 MW. Resource consent applications were submitted in September 2006 and will be considered in early 2007.

In November and December, the Wave Energy Technology R & D programme (www.wavenergy.co.nz) tested its first prototype for a point absorber wave energy device. This was a milestone as the first trial of a marine energy device in New Zealand waters. Plans for a larger 'proof-of-concept' device are in development.

Government Strategies

Perhaps the most significant activity in 2006 has been the New Zealand Government's publication of a number of energy and climate-change-related strategy documents for consultation. The draft New Zealand Energy Strategy was published on 11 December 2006, by the Ministry of Economic Development (www.med.govt.nz), together with complementary documents outlining transitional measures for New Zealand to meet its own emissions reductions targets and establish greenhouse gas costs. The draft New Zealand Energy Efficiency and Conservation Strategy was also published by the Energy Efficiency and Conservation Authority (www.eeca.govt.nz) on 14 December 2006.

These two documents reflect the current Government's forward plans for energy and consider energy scenarios out to 2050. They reflect the Government's desire to develop a "reliable and resilient system delivering New Zealand sustainable, low emissions energy". This will be achieved by, amongst other initiatives, "maximizing the proportion of energy that comes from our abundant renewable energy resources", "reducing greenhouse gas emissions"...and "promoting environmentally sustainable technologies".
The draft Energy Strategy proposes a number of initiatives for marine energy, the most interesting being a "Marine Energy Deployment Fund" of NZ$ 8 million over four years to encourage small-scale deployments, near islands or coastal communities currently using diesel-fuelled generation. The Government has yet to determine criteria for funding and how the fund will be administered.
In addition the Ministry of Research, Science and Technology has produced an Energy Research Roadmap (www.morst.govt.nz/current-work/roadmaps/energy/), which recognizes the potential for marine energy and proposes some investment guidelines for marine energy research and development. The Roadmap focuses on resource assessments and R & D investment, together with evaluation of potentially commercial technologies, including off-grid, distributed applications. All the draft documents can be downloaded from the respective websites and interested parties are encouraged to make submissions via these websites. The Ministry of Economic Development is still considering joining the IEA: Ocean Energy Systems Implementing Agreement.

Summary

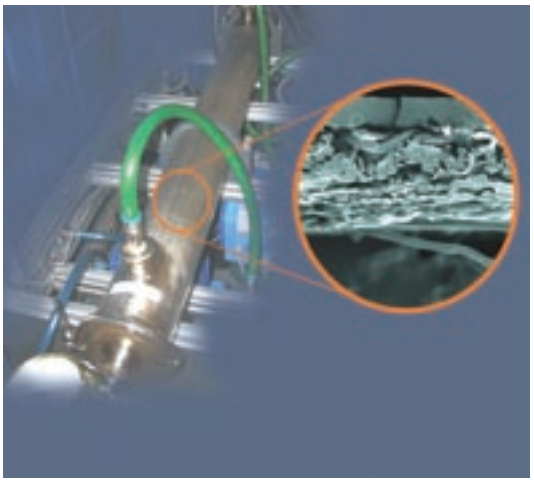
The year 2006 will be remembered as the year that marine energy first entered the public consciousness in New Zealand. The potential for marine energy in New Zealand is huge. Its growth will only be hampered by delays in development of commercial technologies, lack of investment in domestic-based projects and the consenting process. However, the Government's proposed focus on promoting renewable energy technologies and reducing emissions is likely to lead to material support for marine energy projects. Hopefully it won't be too long before the New Zealand takes its place beside some European, North American and Asian countries in being a leader in the development and uptake of marine energy.

NORWAY

By Peter Hersleth, Observer from Norway

There are approximately 15 initiatives on Ocean Energy that have received support from the Norwegian Government. The total support is approximately 15 MNOK (2 MEuro), and the total amount spent on ocean energy activities in 2006 is approximately 65 MNOK (8 MEuro).
> 60-70 % of the initiatives are on wave power, one project is on Osmotic/ Salinity power and the rest is on tidal power.
> 8-10 of the initiatives are technology development and small-scale prototype testing by small development companies.
> There are 3-4 larger R&D projects with several project partners.
> There are 2-3 ongoing large scale or full-scale prototype projects.
In addition Norwegian partners are involved in several projects that received support form EC FP6 program in 2006.

"Buldra" research platform: Wave-power plant on Karmøy, Norway.



Membrane samples and membrane modules tested for salinity/osmotic power.

New strategic plan for the Next 5-Year Term

The following is an excerpt from the IEA OES Strategy for 2007 – 2011. The full document is available on the IEA OES website (www.iea-oceans.org).

INTRODUCTION

The pace of development in ocean energy has continued to increase since the launch of the IEA-OES in 2001. A recent study for the IEA-OES shows that since 2003 the number of devices in development has doubled from approximately 35 to 76 in the countries studied, and the number of government programmes offering funding for ocean energy appears to be on the increase[2]. This is reflected in the increased interest in the IEA-OES which has expanded from the original three members (Denmark, Portugal and the United Kingdom) to eight over the past five years, including Japan, Ireland, the European Commission, Canada and the United States. We have also had a large number of observers participating in Executive Committee meetings from countries that have not yet joined the IEA-OES, including two of the "Plus Five" countries identified as targets for international cooperative programmes in energy technology in the Gleneagles G8 meeting.

Our previous Strategic Plan identified that the focus for the IEA-OES would be ocean wave and tidal current technologies. At least one of the member countries and a number of the observer countries have a significant programme in other types of ocean energy (Ocean Thermal Energy Conversion – OTEC and Salinity Power, for example) or are considering devices that use the energy extracted for purposes other than electricity generation (e.g. desalination).

To reflect the expanded scale and scope of activities in ocean energy research and development at present, it was decided that the IEA-OES would revisit the vision, mission and strategic objectives of the implementing agreement while preparing the next five year strategy. A subgroup of the members of the Executive Committee was tasked with considering the strategy, proposing updates to the wider strategic objectives of the group, and setting the strategic direction for the next five years.

A new strategic plan for the next 5 year term (2007-2011) with a modified Vision and Mission statement was prepared and presented to the IEA Renewable Energy Working Party (REWP) along with the End of the first 5-year term report. Based on the comments from the REWP on the proposed strategic plan, the Committee on Energy Research and Technology (CERT) of the International Energy Agency approved the extension of the IEA-OES for a next five year term. The ExCo formally approved the strategic plan for the period 2007 – 2011 at November 2006 meeting. The complete strategy document can be viewed at the IEA-OES web site www.iea-oceans.org.

[2] *Review and Analysis of Ocean Energy System Developments and Supporting Policies, Future Energy Solutions* for IEA-OES, 2006.

strategic pl

ACTIONS FOR THE NEXT 5-YEAR TERM

Despite the increased interest and research and development activity in the area over the past five years, ocean energy technologies remain high risk and at an early stage of development. The IEA-OES wishes to facilitate and accelerated pace of development of technologies to enable the cost effective and environmentally sound utilization of the ocean energy resource.

The strategy document has identified a number of actions that the IEA-OES will prioritize during its second five year term. These actions will address the current barriers facing ocean energy development in accordance with the strategic objectives of the IEA-OES. Following is the summary of the strategic actions for the next 5-year term:

Actions to increase networking opportunities:

> Actively promote expansion of the IEA-OES membership through a policy of inviting observers and targeting information on the IEA-OES to decision makers in countries who are potential future members.

> Intesify our efforts to encourage the Plus Five countries (Mexico, China, India, South Africa, and Brazil) to become members of the IEA-OES within the next three years. In this context, we plan to hold meetings of the ExCo in one of these countries in conjunction with other relevant international forum/conference taking place in those countries.

> Seek to expand the networking potential of the IEA-OES through the inclusion of industry groups participating in the IEA-OES as sponsors to Annexes.

> Take a leadership role on the formation of an International Society for Ocean Energy to foster international collaboration and networking for relevant R&D activities.

Actions to support collaboration in addressing barriers and opportunities:

> Hold expert group meetings on environmental impacts from ocean energy development and promote collaborative research in the area resulting in outcomes targeted to policy makers and agencies responsible for consents.

> Hold expert group meetings on the availability of finance at the different stages of ocean energy development to include device developers and sources of funds.

> Support collaborative research through a formal annex on grid integration issues for ocean energy, ensuring that the annex seeks cooperation with similar research on other renewable energy technologies.

> Support collaborative research through a formal annex on the integration of ocean energy with other renewables, combined with different storage options for remote coastal area.

> Hold technical issues group meetings where developers and researchers are invited to consider issues such as O&M techniques and costs, mooring techniques, power take off systems, etc.

Actions to encourage harmonization amongst international stakeholders in ocean energy:

> Hold expert group meetings on resource assessment techniques and promote collaborative research in the area.

> Support collaborative research through a formal annex on the development of common guidelines and practices for development, evaluation, and testing of performance, reliability and survivability.

> Add a terminology glossary to the IEA website to influence harmonization of terminology used in the area.

Actions to improve information dissemination:

> Further develop the information offering including the production of a video on ocean energy and possible use of the DVD format for targeted information campaigns to address various stakeholders including policy makers, planners, students, and the public.

> Feature articles on device demonstrations in the semi-annual newsletter.

Actions to encourage appropriate policies and procedures:

> Incorporate visits to device demonstration sites with ExCo and Annex meetings and invite stakeholders including policymakers and finance.

COLLABORATION WITH OTHER PROGRAMMES

The IEA-OES will continue to seek out appropriate collaboration with other programmes. The EC funded Coordinated Action on Ocean Energy provides an important collaboration partner in Europe. The Ocean Renewable Energy Group (OREG) in North America has also provided opportunities to expand the reach of the IEA-OES through collaborative events.
The IEA-OES will also seek to collaborate with other IEA Implementing Agreements, particularly in areas where common barriers are under investigation including grid integration issues and market deployment issues. Collaboration with initiatives lead by the REWP and the IEA secretariat will also provide important opportunities. The NEET (Networks of Expertise in Energy Technology) initiative for instance will provide opportunities for the IEA-OES to reach out to the "Plus Five" countries, many of whom are identified as having good ocean energy potential.

Fund Administration

IAs can be cost-shared when Participants contribute to a common fund to finance the work, task-shared when Participants assign specific resources and personnel to carry out the work; or a combination of these two forms of arrangements until 2006. The IEA-OES, like most IAs, has been a combination type, as though most of the work is task shared, with a common fund to provide secretariat and other services.
The common fund has been managed by INETI, Portugal. To date this fund has been mainly supporting the secretariat and the Annex I programme concerning dissemination activities such the IEA-OES Newsletter, maintenance of the website, edition of reports and expenses of the Chair/Vice-Chair representing the IEA-OES in relevant meetings.
Total funds assigned in 2006 amount to 61,000 Euros with annual contribution of 7,000 Euro by each of nine members (Belgium, Denmark, Portugal, UK, Ireland, Canada, Japan, USA and the European Commission). Total expenditures in 2006 were ca. 36,000 Euros.

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by Gouri Bhuyani
2007 Chair of the IEA-OES

Gouri S. Bhuyan, the Principal Advisor for Alternative Energy at Powertech Labs Inc. (a R&D Subsidiary of British Columbia Hydro, Canada), is the in-coming Chair of the Executive Committee of the IEA-OES for 2007-08. Gouri has been representing the Canadian Federal Government at the IEA-OES since 2002. He holds a Master and a Doctoral degree in Ocean Engineering from the Indian Institute of Technology, Chennai and the Memorial University of Newfoundland, respectively. He is a Fellow of the American Society of Mechanical Engineers (ASME) and is a member of the Association of Professional Engineers and Geoscientists of British Columbia. Since 1988, he has been with Powertech Labs.