An International Network on Offshore Renewable Energy

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The International Network on Offshore Renewable Energy (INORE) is a network of PhD students, early stage researchers and those at a similar stage in industry or government. The members work in all aspects of research or development for offshore renewable energy, from social policy to technical engineering, and on many different technology concepts. INORE provides a forum for knowledge exchange between these various people, and between these people and those who are more established in this sector. INORE achieves this by holding symposia, events and workshops, as well as by providing small grants to be put towards collaborative projects, and by hosting a website where news and documents can be exchanged. This paper will summarize INORE's role in supporting the sector by presenting the solutions that the groups put forth during the 2012 INORE symposia when posed questions of vital relevance for the sector.

1. Introduction

INORE is a network for researchers working with issues related to offshore renewable energy: wave, tidal or offshore wind energy. We are for, and run by, PhD students and Post Docs. In order to advance the development of the sector, we bring together researchers from around the world to meet, collaborate, and share knowledge through our website (www.inore.org) and through events run independently and alongside other conferences.

INORE will hold two symposia in 2013: one in May in Wales and one in June in Nova Scotia.

INORE enhances the development of young researchers within offshore renewable energy by creating opportunities for early-stage researchers to meet and collaborate, regardless of different backgrounds and nationalities. INORE's primary target is to create and sustain a truly international, interdisciplinary and active network of young researchers who work on issues related to offshore renewable energy. We strive to have members from all continents and relevant areas of research.

Furthermore, INORE endeavors to maintain ties with the whole spectrum of stakeholders in offshore renewable energy. This includes stakeholders from industry, academia and government.

For those working in industry, collaboration with INORE allows an opportunity to expose their company to the current level of academic research and a forum for aligning the direction of academic work with their needs to help accelerate development, as well as providing an opportunity to associate their company with a large and international community of potential employees and clients.

INORE can provide government bodies with the definitive representative body of early stage researchers in offshore renewable energy. It can also be an agent for creating, disseminating and aligning research within the offshore renewable energy sector.

To the academic world, INORE directly gives a sounding board for posters, presentations and publications, as well as incentives and support for collaboration between diverse institutions. It also showcases the members' research to representatives from the marine energy sector.

Working together with these stakeholders, as well as with others at a similar career stage, means that early-stage researchers have a platform to present work to their peers in an open and engaging atmosphere. It also provides the opportunity to gain useful information and feedback about research and is a support mechanism for collaborative research.

2. Knowledge exchange channels

2.1 Symposia

The largest single events in the INORE calendar are its symposia. An INORE Symposium is an international event for early stage researchers to discuss their work and learn through each other's experience. This event helps the launch of future collaborative research between the different participants. A symposium includes descriptions of their research from each participant and inspiring sessions with keynote speakers including industry leaders, leading researchers and government representatives. The Symposium is not only an academic arena. In order to facilitate networking and learning, the symposium also includes social activities.

During 2012, INORE held two symposia: one in Denmark in May, and in June, the first North American Symposium was held in Boston, USA. Table 1 shows the number of INOREans attending each symposium. An INOREan is an early stage research or development professional who is part of the INORE network.

Table 1 Numbers of INOREans in attendance

Symposium	Number of INOREans
Denmark, 2012	45
USA, 2012	26

2.2 Workshops

In conjunction with other events, for example conferences such as ICOE or EWTEC, INORE runs workshops. This enables a wider group of young research and development professionals to network, to hear from people further on in their careers. The group is wider because more people working in industry can take a single day out of their normal working patterns at a conference, rather than investing a whole week, as would be the case for a symposium.

2.3 Website

As well as these special events, INORE has a website for the sharing of information on issues related to offshore renewable energy, which can be found at www.inore.org. The website is fully driven by the members who all have the opportunity to add news, events and jobs, update their profiles, contribute on the forums and upload documents to wiki database. INORE wants to communicate with the world at large; therefore anybody can register as user of the INORE website. Registered users may receive news, use the discussion forums, comment on news and update their profile.

In the past 3 years we have had 50,000 visits to the site originating from countries all over the world as displayed in the map in figure 1. The top 10 countries these visitors originated from are the UK (20%), Spain (19%), United States (13%), Ireland (8%), Portugal (6%), France (6%), Denmark (3%), Norway (3%), Germany (2%) and India (2%), with an additional 15 other countries recording at least one visit per week and a total of 48 countries averaging more than one visit per month. In the past 12 months the number of unique visitors to the site has more than doubled compared to the same period two years ago. The average user peruses 4 pages per visit. Most of this usage is in Europe and North America, but INORE hopes to expand with the sector to include more participation in Asia.

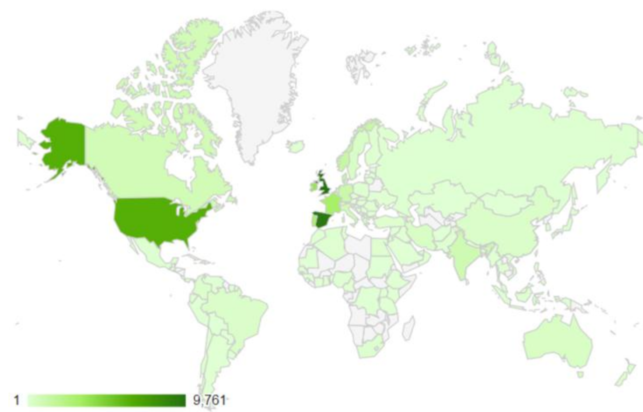

Fig. 1 INORE website use by country [Source: Google analytics]

2.4 Floating Wind Turbine Challenge

In September 2011, INORE and MARIN jointly held an event called the Floating Wind Turbine Challenge, the results of which have been presented in more detail elsewhere [1]. The idea was to gather together young researchers in offshore energy and enable them to trial designs for the floater section of a floating offshore wind turbine in MARIN's large tank in the Netherlands. Six small groups came together from all over the world and had twenty four hours to design and test their structures. The aim was to have as little movement of the nacelle for the smallest weight of materials.

2.5 The International Collaboration Incentive Scheme (ICIS)

The ICIS grants are designed to enable researchers who are just starting out to have the opportunity to work with people from other organizations on collaborative projects. Small awards of money are made available to facilitate this (usually by funding transportation costs). It should be noted that these grants are not only available to provide an incentive for collaboration between research institutions, but may also be used by people undertaking research in a governmental or industrial context.

Announced in 2009, INORE offered 5 pairs of INOREans funding of €200 per pair to assist their travel and accommodation, should they wish to produce a joint paper. Although €200 was not enough to pay for the entirely of the costs involved in collaboration, its function as a "springboard" for funding meant that three of these collaborative papers were published and presented at ICOE2010. Following on from this highly effective form of collaborative support leverage, the fund was increased in 2010-2011 to a maximum of €500 per pair.

Two researchers from Queen's University Belfast and one from the University of Strathclyde together looked into a number of experimental techniques in order to measure the velocity and turbulence characteristics of downstream wake of horizontal axis tidal turbine models at various scales.

A researcher from the Norwegian University of Science and Technology, Trondheim, Norway, was able to visit a researcher at the Politecnico di Torino, Italy, to explore the possibility of extending some control techniques already proposed for point absorbers devices to the ISWEC (Inertial Sea Wave Energy Converter).

Ph.D. students from the University of Southampton and Trinity College Dublin implemented a frequency domain model for an array of Oscillating Water Columns (OWC) using WAMIT. The model was validated against experimental data obtained from laboratory testing of an array of three OWC devices at a 1:50 scale. The collaboration is intended to develop a knowledge exchange of the numerical and physical modeling techniques. This work was presented to the wider community at EWTEC 2012 [2].

Experimental trials on an instrumented scale model tidal turbine, where the blade root bending moment response was measured under a range of unsteady onset flow conditions were done by a PhD student at the University of Auckland, New Zealand. Through the ICIS grant scheme, a student at Imperial College, London compared these experimental readings with two numerical models in which the added mass and dynamic inflow effect were treated differently.

The final ICIS grant of 2010-2011 allowed a PhD student at the University of Plymouth, UK and another at the University of Washington, Seattle, U.S.A to work together to test an assessment tool for tidal turbine placement on a regional scale.

For the period 2011-2012, students from Aalborg University, Denmark, and the University of Victoria, British Columbia, investigated buoy motions in the laboratories at Aalborg.

3. Group tasks

The main forums for knowledge exchange run by INORE are its symposia. At the two symposia in 2012, as in previous years, group tasks were investigated: nine during the symposium in Denmark and three during the symposium in Massachusetts.

The group size at the symposium in Denmark, where there were more people familiar with the setup, was 4-5, while in the USA there were around 8 people working on each task. The INOREans chose which task they wanted to tackle on a first come, first served basis. The idea was that people could work on a task that was not the same as their research topic, but where ideas could cross over from one technology or discipline to another.

The groups had around five hours to work together on their tasks, at the end of which, they presented their ideas to the rest of the symposium, including to representatives from the organizations that had suggested the questions. The tasks and the findings of the small groups are described in the rest of the section.

3.1 Standards to increase survivability and reduce risk

Because a major factor in the riskiness of an offshore project is whether the equipment can survive in an extreme environment, standards which quantify this risk can help in the design stages and when developing a project. With some feeling for the levels of risk in a project, financial backing can be easier to secure. As such, one group of INOREans was asked to consider survivability standards in numerical modeling and small-scale testing, and for characterization of the resource (without which no determination of what has to be survived can be made).

As well as gathering together the existing standards, the group analyzed the similarities and differences between how these standards are applied and the needs of ocean energy. They also made some recommendations: as ever, an open collaboration between research facilities and industry was encouraged. Multidisciplinary collaboration was also suggested, as was directed research so that there was a roadmap towards successful devices including standards. The group suggested that standards for testing facilities would make a large impact so that the similarities and differences between facilities and thus the observations made at them were clear. Finally, the group recommended that WECs and hydrokinetic plants should be continuously monitored while in operation to give an indication of what conditions are being survived in the real environment.

3.2 Requirements for physical tests of a floating oscillating water column (OWC)

OWC systems may be considered one of the most reliable WEC technologies. The interaction between the incident waves, the air in the chamber and the damping caused by the turbine is not straightforward. This is further complicated by having a floating OWC-WEC. The group of INOREans was thus asked what the requirements for testing a floating OWC in a basin would be.

The group came up with a test program for a 1/50 scale model. It should be noted that the group thought that working together on the physical testing and numerical modeling was crucial in comparison to working on these tasks in isolation.

3.3 Enabling technologies

Thus far, most of the work done in the offshore renewable energy industry has been on the energy extraction technologies. However, for operation and maintenance, a number of enabling technologies will need to be developed. The group was asked to compare several such technologies according to cost, scale, possibilities for evolution of the technology and applicability to wind, wave and tidal energy.

The group who worked on this problem in Denmark considered specialized boats for upkeep and deployment, monitoring via satellite, development of new software-hardware schemes for optimizing product life cycle; an iPhone app, the standardization of transmission systems, helicopters specifically designed for the transport and extraction of both people and hardware from the offshore site, the standardization of components, the development and deployment of intelligent materials, the development and use of robots for various tasks, and focused on the possibilities for autonomous maintenance vehicles which would enable maintenance even during conditions which are unsafe for human operation.

This task was also tackled at the symposium in the USA. Here the group decided that specialized boats for installation and maintenance would be the best enabling technology to provide a return on investment.

3.4 From sea to tank

Spectral models of waves do not generate a realistic approximation to excitation by the real sea. The question put to the group was, "What would?" The INOREans felt that the best way to approximate a real sea would be to discretize data from a buoy into 30 min bins, with one year being the minimum length of time for the data to be deemed complete. A spectrum would then be created and the H_s and T_p extracted. The "groupiness factor" would also be extracted. This is a new measure, which describes how often the waves form into smooth groups that are the ideal operational conditions for a resonant WEC. The JONSWAP peakiness factor would also be measured.

The data would then be binned according to H_s and T_p to form a scatter diagram and, for each bin, the groupiness distribution would be calculated. Then a choice of the number of sea states required to represent the sea to determine the behavior of a device is needed. Representative time series of each sea state would then be found from within the real data itself, based on how well that data matches the desired H_s, T_p, groupiness and peakiness.

3.5 How can the offshore renewable energy industry improve its credibility?

In order to attract investment, spark political will and get through the consenting process, the offshore renewable energy sector needs to have credibility. This group of INOREans looked at the difference in public perception between the UK and Denmark. In Denmark, where renewable developments are largely undertaken by Danish-owned companies, public trust is high. It was felt that pushing for UK-based companies in the supply chains of renewables projects could help with this.

Another major block to credibility was a lack of transparent troubleshooting. The group thought that failures should be accepted and lessons learned from them, with these lessons shared throughout the industry.

Finally, before speculating about the potential profitability of offshore renewables technologies, the reliability of their energy supply should be more secure. This way, the home-produced nature of the energy could appeal to the public, and investors would not be put off by returns which are always below the stated expected values.

3.6 The design and analysis of a global solution for floating platforms for wind turbines

As the deployment of wind turbines moves into deeper waters, the foundations of such turbines will need to be floating platforms rather than fixed piles. These floating platforms must keep the turbines stable and must be moored securely into position.

The INOREans wanted to measure acceleration in each degree of freedom as a measure of stability, displaced volume as a measure of materials costs and to quantify the complexity of the structure so as to have a measure of the difficulty (cost) of installation, operation and maintenance.

After brainstorming their ideas, the group's leading design was the "floating stool" concept. This had a floating tripod structure with its legs below the water. Each leg was then attached to a single central mass below the tripod. The mass was then moored to the sea floor using a standard three-point mooring.

It was felt that the design achieved the required stability criteria for wave loading whilst being simple to manufacture. However, installation would not be so straightforward and there was a risk of snap loading on the submerged cables.

The group also drew up an iterative scheme for the development of their structure.

3.7 Synergies between wind and wave

This group was asked to look at synergies in offshore wind and wave projects in terms of sharing costs in cabling, transformers, installation, maintenance consenting and also by using the WEC shadowing effect to increase the number and length of weather windows for maintenance and to shelter the foundations of the wind turbines.

Five positive synergy effects were identified: shared site costs, weather shielding, shared structure costs, investor confidence for wave industry, wave energy smoothing wind energy output.

Most of the risks identified for such synergistic projects were due to the uncertainties still associated with wave energy projects. Thus, the greatest risk to such a co-location project was due to financial uncertainty.

The INOREans looked at three case studies for co-location designs. The first involved placing WECs between the turbines in the first row and column of the array (as viewed from the prevailing wind and wave direction). The second case had the first row and column as hybrids with the wind turbine and the WEC fixed to the same foundation. The third case featured hybrids in the first row and column, with large WECs taking the place of every other turbine. In the columns and rows behind the first, the gaps between the standard wind turbines had small WECs placed in the gaps between them.

The group thought that the uncertainty of the first case was smallest and thus it was the least risky, while the second case was likely to result in the most savings due to the co-location of the devices.

3.8 Industrial partnership for wave energy development

There are many challenges in the offshore renewable energy sector that all projects will face. These come in the form of moorings issues, subsea electrical connections, power chain efficiency and materials selection.

Rather than each offshore technology project face each of these alone, it seems reasonable to forma partnerships to pool knowledge and resources to solve these challenges collaboratively. This approach has the potential to make better use of the R&D funding in the sector.

The group undertook a SWOT analysis (Strengths, Weaknesses, Opportunities and Threats) to identify the differences between forming a partnership to solve these challenges and going it alone. The main differences between working in a partnership and working alone were that the risks are larger, but the rewards can be bigger when you have no partners. This can be good for the individual “winning” organization, but does not advance the sector most effectively, and without a group of organizations combining thorough R&D and a strong supply chain, an industry may not appear.

The group also suggested a prize for long-term connected wave energy that required partnerships to win the money.

3.9 How to channel funding to advance the sector most effectively

One of the difficulties for the wave industry in particular is that no leading technology has emerged. This means that it is hard to channel resources towards the best technologies and R&D funding can seem to be wasted.

The INOREans who looked at this problem thought that the main way around this would be to have a series of test centers which would represent different climactic possibilities in a standardized way. Thus, each wave energy extraction method could be judged on the same footing, allowing investors to compare like with like. Rather than supporting individual projects, national and international funding could support the test centers and the test campaigns for each device.

3.10 Marine spatial planning

It is often thought by marine energy developers that the areas of the coastline and ocean that will provide the best energy yield should naturally be put to their use, as this will provide the most benefit to the general population. However, as has clearly been seen in the case of onshore wind, different stakeholders use different areas of the land, and have good reason to want to continue to do so. Marine spatial planning (MSP) is a way of categorizing which activities are given priority in different areas.

The group of INOREans was given an imaginary scenario in which different marine activities were overlapping and could potentially lead to conflicts. There was an added level of complexity due to the different jurisdictions that these activities came under: various coastal states, tribal lands and military activities.

The group thus came up with a list of importance for a generic scenario and then proceeded to apply this to the particular scenario. The major messages to note were firstly that environmental considerations would generally outweigh other factors, although where these were only important during certain times of the year (as is the case for whale migration), other activities may use the same sea area for the rest of the time. Secondly, marine energy developments that could affect those at the shoreline by being in the viewshed should seek ways of bringing that community on board by them holding a financial stake in the project. Finally, in any MSP activity monitoring and future research should be included in the ongoing plan so as to ensure that the balancing of activities is based on true measures of biodiversity, mineral location and fish stocks.

4. Supporting the sector

In the widest sense, the knowledge exchange opportunities provided through INORE enable industry and academia to see what the other is doing. It allows researchers and developers to see what the challenges are for offshore renewable energy and who is trying to tackle similar problems. This is very good for collaboration and partnership and for not having to reinvent the wheel.

The specific example of the collaborative tasks worked on during the INORE symposia described herein allows industrial and governmental organizations to put forward the next challenges that they are facing. This means that the next generation of research and development professionals is already aware of these factors. This can be helpful to both the offshore renewable energy industry and to the individuals concerned in that these challenges may be included in their current research. They might also appear as future projects by these researchers or their teams. In an industrial context, this awareness of the next challenges, how to solve them or who is solving them is an advantage to future employers, be they governmental, industrial or academic.

For the bodies that set the tasks, new ideas may be generated and they are certainly made aware of those people with an interest in being the people to solve their specific challenges. As the responses are available to the whole sector through the INORE website, this information can also be shared across national borders.

In terms of recruiting into the industrial sector, this knowledge exchange is of particular use. Not only can the industry find out who has the knowledge and skills base that would be most helpful to their organization, but the early stage researchers are able to find out more about the company before they sign up, which has the potential to increase retention.

It is positive to see that in all of these group tasks, the INOREans saw the possibilities for development. Whether this was in terms of specific research approaches as in the tank test tasks or the wind-wind synergies, or whether this was in the wider context of building credibility, standards and consensus around marine spatial planning, this positivity about upcoming opportunities for development bodes well for the future.

5. Conclusions

The International Network on Offshore Renewable Energy (INORE) is a network of PhD students, early stage researchers and those at a similar stage in industry or government. INORE provides a forum for knowledge exchange between these researchers, and between these researchers and those who are more established in the sector. INORE achieves this by holding symposia, events and workshops, as well as by providing small grants to be put towards collaborative projects, and by hosting a website where news and documents can be exchanged.

One example of INORE supporting the sector is its use of collaborative tasks at its symposia whose questions are posed by industry and by governmental organizations. This provides an opportunity to familiarize the INOREans with the upcoming challenges for the industry and to enable the INOREans to work on and put forward innovative ideas.

Currently INORE mainly operates in Europe and North America, but in the future, this could expand geographically.

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