MAREN Conference

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National University of Ireland, Galway

Abstracts

Dr. Stuart Anderson

Title: 'ENERGY ISLANDS & D-DAY 2014: time to launch a strategy to liberate coastal space for 21st C needs'

Public engagement in integrating new coastal defence infrastructure with urban and tourism regeneration is something North Wales is proud of having achieved during the present EU Convergence Programme. Colwyn Bay's Porth Eirias Watersports Centre and Rhyl's harbour scheme each add great value by being designed into the Coastal Cycle Route/Footpath. A proposed cross-County 'SEACS' (for Sustainable Engagement in the Adaptation of Coastal Spaces) programme now aims to use this success as a springboard from which studies of a proposed pilot tidal impoundment scheme at Llanddulas can be launched. Ultimately, one aim is for seven thematically linked visitor centres, each leading on distinct aspects of coastal sustainable energy and heritage. But the first step is a floating Coastal Engagement Centre at Conwy, to follow the outline dimensions of a WW2 Phoenix caisson only built from lightweight modern materials. Below the waterline this will serve as a tidal stream generator, allowing study of the ability of a counter-positioned, contra-rotating (CPCR) turbine format to allow safe passage for migratory fish. Opportunity has arisen to attract partnership from a Channel 4 programme team studying major wartime exploits and projects like The Bouncing Bomb, Great Escape, Colditz glider, Zeppelin airship etc. Support may greatly help MAREN partners elevate the profile and credibility of tidal range ideas within the EU Atlantic Arc programme. Meanwhile Conwy County BC is to consider issuing a 'Phoenix Declaration on Engagement in Coastal Sustainability' on the proposed completion date for the Phoenix Centre's design - Fri 6th June 2014.

Draft wording of Conwy's proposed Phoenix Declaration:

'To mitigate presently foreseen potential impacts of climate change, Conwy County Borough Council - representing the locality that hosted the first, secret prototyping of physically the single biggest technology used in the 20th Century liberation of Europe - requests and invites open engagement in the urgent market development of this technology to help sustain coastal habitats and habitability worldwide into and beyond the 21st Century''

Jacqueline Black

Title: Marine Renewable Energy and the Environment

Keywords – wave and tidal energy – environmental impacts – resource

In the past decade the Environmental Research Institute (ERI) which is located in the Highlands and Islands Region has built an enviable reputation as a dynamic centre of research expertise. The prime location of ERI with direct access to world class natural resources has enabled it to deliver acclaimed knowledge exchange; education and training; consultancy and commercial services. A prime focus of this has been on renewable energy with projects spanning marine renewables, biomass, peatlands research and climate change. The world class environments, unique habitats, living laboratory for research, and Pentland Firth offer unrivalled scientific opportunities.

The ERI started in the Castle Street premises in 2000 with 1 researcher, 1 PhD student and 0.5 FTE technician. It now boasts 2 research centres and over 40 staff. In January 2011 a new £3m research Centre for Energy and the Environment (CfEE) opened to boost development of the green economy in Scotland. This prestigious new centre offering laboratories, technician's rooms, videoconferencing facilities and office space and is the base for a £4m Marine Renewable energy and the Environment (MaREE) programme which will play a pivotal role in the development of wave and tidal power within the region. A nucleus of over 20 staff deliver world class research which will enable the developing wave and tidal sector to accelerate development and enhance the socio economic prospects of the area.

The ERI has invested in £400k of marine equipment which will provide vital data to the marine renewables industry in terms of resource optimisation and environmental impacts. The team are creating new and novel modelling techniques which will deliver wind wave driven models and shelf scale tidal models allowing developers to ascertain how storm surges will affect devices in the water. Weather window modelling and prediction could lead to significant benefits when it comes to operations and maintenance activities.

Research into environmental impacts of wave and tidal devices is using innovative approaches to monitor birds, benthos and fish and these studies will inform policy makers, regulatory bodies and government departments.

Renewable energy is a fast moving industry and the research outcomes at ERI and sharing of knowledge between academics, industry and energy suppliers will benefit the economy enormously in the future. It will have a transformational effect on the region as the largest wave and tidal power resource is located in the Highlands and Islands. The resources combined with the infrastructure and

skills base at ERI will allow the region to have unrivalled potential to become a renewable energy powerhouse.

The Centre for Energy and the Environment will play a major part in developing the marine renewable sector. It is this collaborative way of working – with communities, with academic institutions, with government and public agencies, and with industry – that means what happens in Caithness and Sutherland will be vitally important for Scotland.

Dr. Nicolas Desroy

Title: Tidal power and the aquatic environment of la Rance

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The Rance basin, on the northern coast of Brittany (France), offers considerable potential to make a full-scale assessment of the ecological impact of a tidal power station. The operating constraints of the installation impose highly specific "tidal" conditions on the waters in the basin: (1) periods of slack water are out of phase with high water lasting particularly long, (2) mean water level is raised by approximately 3 m and (3) tidal range varies between 4.0 and 7.0 m, depending on whether the turbines are operating in one or both directions. Reduction in tidal range is correlated with a reduction in the surface area of the intertidal zone: the exposed zone accounts today for 50% of the total area of the basin. Gradually, after the scheme was put into service, an increasingly diverse flora and fauna became established since mmigratory organisms (including fishes) are able to pass via sluice gates and turbines.

To determine modifications induced by management of the Rance estuary, benthic communities were used as bioindicators of environmental change. Previous works carried out on these biological compartments have shown that the ecosystem is now evolving independently of the initial perturbation due to the construction of the dam between 1963 and 1966. We can consider that since the 80's, biological interactions drive changes of benthic invertebrate populations and communities. The new ecological equilibrium established remains fragile and, being linked to the degree of stability of abiotic conditions, depends to a large extent on the operating conditions of the power station.

In the framework of MAREN program, we focused on the benthic communities located in the upstream part of the basin, considered as the most sensitive/variable. The main action consists to describe the distribution of the benthic communities in this part of the Rance basin, 45 years after the operating of the tidal power scheme. This new status has been compared to the previous one carried out in 1995. Comparison shows a relative stability of benthic assemblages, despite modifications of their faunistic composition. This sampling underlined the presence in high densities (up to 260 ind.m^{-2}) of the Manilla clam (introduced by aquaculture). In order to assess the long-term impact of the tidal power scheme functioning on the estuarine benthic communities, we considered a "sister" estuary: the Trieux estuary, devoid of power station at its mouth. A similar study carried out on this estuary clearly showed the existence of similar assemblages than in the Rance estuary.

Prof Roger Falconer, FRENG

Title: Flood Risk Assessment and Sediment Transport Impacts for the New Severn Barrage

By Prof. Roger Falconer, Dr. Reza Ahmadian and Dr. Bettina Bockelmann-Evans

Hydro-environmental Research Centre (HRC),

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The presentation will first review the background to the Severn Barrage proposals and summarise the key hydro-environmental impact assessment studies undertaken by the HRC, at Cardiff University, as part of the MAREN project. In particular, emphasis will highlight new results focusing on model predictions of the far field effects of different barrage configurations and recent field studies in the Severn estuary. Emphasis will also focus on the potential benefits of two-way, vis-à-vis ebb tide only, generation and low head turbines. The results will show that two-way power generation, not previously considered in much detail for such large impounded basins, offers the opportunity to provide almost as much power as ebb tide only generation, reduce the peak disturbance to the grid, minimise several of the environmental concerns, offer reduced flood risk threats upstream of the structure and increase recreational opportunities in the estuary. An outline will also be given of previous research undertaken by the HRC, in collaboration with Aberystwyth University.

More recent studies will also be presented, highlighting the predicted far field effects of the new barrage and the estuary's response to climate change and sea level rise, both without and with the barrage. In the first instance comparisons will show the effects of using boundary conditions for an Irish Sea model, using boundary conditions taken from Scotland to the north coast of Northern Ireland and from well south of Eire to the south west of England, in comparison with a Continental Shelf model, using boundary conditions taken just beyond the shelf. In comparing both sets of model results it will be shown that: firstly, any model used to investigate the far field effects of a Severn barrage needs to extend beyond the Continental Shelf and, secondly, the far field effects of a barrage operating under two-way generation are predicted only to exhibit any significant effects on the hydrodynamic characteristics in the Severn Estuary and the Bristol Channel, whereas a barrage operating under ebb tide only conditions also exhibits changes in the hydrodynamics in the Irish Sea.

The impact of the barrage on the maximum water levels was then considered in more detail within the Bristol Channel and Severn Estuary. Based on the model studies for the new barrage design, i.e. the Hafren Power Barrage, the results showed that the barrage would have the following impacts within the Channel and Estuary: (i) there was predicted to be a peak increase in the maximum water levels in the Channel, between the Irish Sea and the barrage site, of about 25 cm; (ii) the maximum water levels in the estuary upstream of the barrage site were predicted to be reduced by typically 2 m; and (iii) although modelling studies have not been carried out to predict backwater levels in the rivers upstream of the barrage site, including the rivers Wye, Usk and Severn, based on the significant reduction in the maximum water levels of up to 2 m in the estuary, it is inevitable that the maximum water levels for all rivers flowing into estuary (including the River Severn) will be reduced for some considerable distance upstream, thereby reducing flood risk to numerous vulnerable communities.

Prof. Carlos Guedes Soares

Title: Numerical Modelling to Assess the Wave Energy Potential of the Atlantic European Coast

The numerical models developed within the MAREN project to evaluate the wave energy resources of the Atlantic European Coast are described and discussed. The areas included in this study were: Ireland west coast, UK South Western coast, France west coast, northern Spain and Canary Islands and Portugal's continental and island coasts, including the already existing as well as potential test sites for renewable energy devices.

In order to characterize the wave conditions and assess the wave energy potential, two state of the art spectral models were used: WAVEWATCH III for wave generation and deep water propagation and SWAN (Simulating WAves Nearshore) model for wave propagation in intermediate and shallow water. Wind fields implemented in both models were taken from ERA Interim data base, owned by the ECMWF (European Centre for Medium Weather Forecast).

Validation tests were carried out with buoy data so that the model's performance could be evaluated. The wave parameters used for validation were significant wave height (Hs), mean wave period (Tm) and peak period (Tp), when available. The theoretical values for wave power were calculated using the energy transport vectors given by the wave model SWAN.

After the validation work, calculations are on-going to calculate the resources for a 30 years period in order to produce appropriate statistics that will be able to characterise the present wave resource climatology in the areas referred above.

Keywords: Spectral models, SWAN, WAVEWATCH III, Wave power

Professor Michael Hartnett

Title: Review of MAREN Project and Environmental Regulation of Marine Renewable Energy

Michael Hartnett, Noreen O'Brien, David Fallon, Darren Coppinger and Stephen Nash, National University of Ireland, Galway

This presentation will review the objectives of the MAREN Project and briefly present some of the project outcomes; several reports have been published and an interactive database developed for general use in the marine renewable energy community will be presented.

Under the Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment (SEA Directive) an SEA is required for a plan or project that is likely to have significant environmental effects and sets the framework for future development consent of projects requiring an Environmental Impact Assessment (EIA). Across Europe different approaches to the development of regulatory framework for both Strategic Environmental Assessment and Environmental Impact Assessment have been adopted by different countries with regard to marine renewable energy. The main developments by MAREN Partners countries in these areas will be presented and some comparisons made between the different approaches. As a group the MAREN Project has also contributed to informing national policy in relevant marine policy through various national consultation processes. Some of the policy initiatives that the MAREN Project has contributed to at presented.

John Keating

Title: OceanEnergy Limited & Marine Renewable Energy Association, an Irish Perspective.

OceanEnergy Limited is a specialised commercial company developing wave energy technology. The company has over the past 10 years developed and tested its OE Buoy technology to the stage where it is now one of the world's leading technologies for harnessing the power of the oceans. The device through careful development has the advantage of a robust and practical design, one moving part and proven survivability having withstood more than two years of live sea trials in Atlantic waves during testing off the Galway coast. OceanEnergy's location as an Irish-based company is perfectly suited for its research and development work given Ireland's location is one of the world's most favorable climates for wave energy power. In 2012, OceanEnergy was selected to occupy a berth at Wavehub, the UK wave development centre in Cornwall.

The MRIA represents Ireland's Marine Renewables community in the fields of Wave and Tidal Energy. The Association includes amongst its members firms engaged in device development and manufacture, developers of projects and sites based on Marine Renewables, academic researchers, consultants, professional firms and contractors as well as interested individuals. The MRIA is now recognised as a leading reference point for all stakeholders in the sector and plays an important role in representing and advancing the interests of its members to a diverse and wide ranging audience.

Ciaran Kennedy

Title: FATIGUE LIFE OF GLASS FIBRE REINFORCED POLYMER COMPOSITE MATERIALS IN OCEAN ENERGY DEVICES

Ciaran Kennedy, Sean Leen, Conchúr Ó Brádaigh, Institute for Environmental, Marine and Energy Research, NUI Galway Mechanical Engineering, NUI Galway, Ireland.

Ocean energy device prototypes are currently being tested and production arrays will be deployed over the next few years. Glass fibre reinforced polymer (GFRP) is a candidate low cost material for all or part of the structure of ocean energy devices. The fatigue performance of GFRP while immersed in seawater is investigated in this study. Fatigue testing of epoxy/E-glass and vinyl ester/E-glass has been performed on water aged coupons and an SN curve is presented with a comparison to unaged fatigue tests. Degradation of the elastic modulus of the material during fatigue cycling, both wet and dry, is also discussed. Finally some comments and recommendations are made on the use of GFRP in ocean energy applications.

Ciaran Kennedy (c.kennedy8@nuigalway.ie) will be the corresponding/presenting author.

Inigo J. Losada

Environmental Hydraulics Institute "IH-Cantabria". Santander (Spain).

Title: "IH Cantabria Research on Offshore Wind Energy schemes from MAREN project"

Wind power is the predominant offshore renewable energy resource. In the last years, offshore wind farms have been revealed as a viable technical and economic source of electrical power. The economic feasibility of offshore wind farms depends on how favorable offshore wind conditions are compared to onshore sites. Installation and maintenance costs must be balanced with the quality of the resource. Europe is currently the clear leader when it comes to offshore wind power, as it leads the offshore wind market today and is expected to do so well into the next decade. Most offshore wind farms are located in the North Sea, while the European Atlantic coast still remains under development.

IH Cantabria has investigated several aspects regarding the offshore wind energy scheme in the Atlantic area. The following actions developed within the MAREN project are related with: Environmental Impact Assessments (EIAs) and hydro-environmental impacts of offshore wind farms within the Spanish framework; methods to evaluate regional-scale offshore wind energy resources, wind energy atlases for the European Atlantic region, and Climate Change impact on offshore wind resource under several socio-economic climate scenarios.

Alistair Maltby

Title: Living North Sea Project

The Rivers Trust is lead beneficiary for the North Sea Region Interreg project, Living North Sea, which has looked at migration issues and possible solutions for diadromous fish. The project partnership was made up of 15 partners from all seven North Sea countries and included government agencies, local authorities, NGOs and research institutions.

Living North Sea consists of two main areas of work:

1. An examination of the knowledge gaps surrounding sea trout migration in the North Sea, and an attempt to fill some knowledge gaps using genetic, tagging and tracking tools.
2. An attempt to quantify and describe the types of man-made structure causing significant problems to diadromous fish migration, and demonstration of approaches to mitigate for these problems.

Keywords:

The Rivers Trust, catchment management, rivers trusts, community, Living North Sea, sea trout, diadromous fish, barriers, fish migration

Dr. Stephen Nash

Title: Investigations Into Tidal Stream Energy Extraction in the Shannon Estuary

Stephen Nash, Noreen O'Brien, David Fallon, Darren Coppinger and Michael Hartnett, National University of Ireland, Galway

This paper presents details of numerical modelling investigations into the harvesting of tidal stream energy by tidal turbines in the Shannon estuary - a large, tidally active estuary on the west coast of Ireland. Commercial deployments of tidal turbines will comprise fields of devices similar to wind farms. These tidal farms have to be carefully designed with respect to many inter-related issues: energy take-off; device orientation and spacing; interactions between devices; hydro-environmental impacts. The focus of this research was the determination of the far-field hydro-environmental impacts of a tidal turbine array, and the effect of device spacing on any such impacts.

The Shannon River and its estuary is one of the largest systems in the British Isles. The tidal range at the mouth of the estuary is over 5m during normal spring tides, inducing currents up to 2.5m/s in water depths of 35m. The estuary has been rightly identified as a potential location for tidal energy extraction; however, little detailed analysis has been carried out to determine accurate potential. A two-dimensional hydrodynamic model has been amended to include the effects of energy take-off on the governing momentum equations. This model is used to investigate the deployment of tidal turbine arrays in the Shannon Estuary. This paper presents details of changes in hydrodynamic regimes due to different turbine densities. In particular, the research considers how tidal ellipses are altered due to the presence of devices. Results show that there can be significant changes to the semi-minor and semi-major axes, leading to changes in maximum speeds and directions of flow. The latter is highly significant, since tidal energy converters cannot rotate into the flow stream, it is important that their orientation is correctly determined a priori. Results also quantify likely changes to flow regimes within and outside the tidal farm; the effects outside the farm are shown to extend considerably. Depending on the density, significant changes are made to the tidal regime, mainly within and upstream of the farm. Likely hydro-environmental impacts are summarised through the determination of flushing/residence times of the estuary with and without the turbines. It is shown that significant changes may take place.

James Tedd

Title: ESB - Industry experience in Marine Renewable Energy

The vast ocean energy resource off the west coast of Ireland provides a fantastic opportunity to be exploited. ESB has been involved in ocean energy since early stage trials in the 1970s and has worked with many leading technology developers of both wave and tidal stream energy including Wavedragon, Wavebob, Ocean Energy, Aquamarine Power, Pelamis Wave power and Marine Current Turbines. ESB has also worked collaboratively with other utility partners and is playing a leading role in developing ocean energy in Ireland

The presentation outlines the development stages of Wave Energy, the potential opportunity in Ireland, the state of art of this technology, and the development pathway. The WestWave project, a collaborative project led by ESB, to put Ireland at the forefront of ocean energy globally is presented. WestWave aims to install and operate wave energy converters capable of generating 5MW of clean electricity, while harvesting only a tiny fraction of the massive power hitting the west coast of Ireland. The project will demonstrate Ireland's ability to construct, deploy and operate wave energy converters. It will also pave the way for commercial projects, in terms of consenting procedures, such as foreshore licensing, permitting, electrical grid access and local infrastructure