OFFSHORE WIND ENERGY RESEARCH PROJECTS LIST V6

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Mike Blanch CCLRC OWEN@OWEN.org.uk 01235 445302

This document gives an overview of all the offshore wind energy related research projects known to Offshore Wind Energy Network (OWEN). The projects are listed in italics in the contents list below under appropriate categories:

1 ENVIRONMENTAL

1.1 Impacts

1.1.1 Assessment of the navigational impact of offshore wind farms proposed for UK sites

Funding agency: The Maritime & Coastguard Agency [MCA] MSA 10 / 6 / 200 (an Executive agency of the Department for Transport)

WWW Link: www.mcga.gov.uk

Contact as in the above link or directly to : Colin Brown: CCandCGBrown@aol.com

1.1.2 Investigation into the effects of electromagnetic fields generated by offshore windfarm cables under various conditions

Funding agency: COWRIE (Collaborative Offshore Windfarm Research Into Environment) Trust fund established by The Crown Estate based on the refundable financial deposits made by UK Round One Offshore Windfarm Developers.

Participating Organisations: The Centre for Marine and Coastal Studies, University of Liverpool, Centre for Intelligent Monitoring Systems, Ecconect Ltd, Applied Ecology Research Group.

Contact: Dr Carolyn Heeps carolyn.heeps@crownestate.co.uk

www site: http://www.crownestate.co.uk/estates/marine/windfarms/cowrie.shtml

Duration: October 2003 – August 2003. Report available August 2003.

Project description: A desk based study is required to calculate the strength, frequencies and wavelengths of the electromagnetic fields produced by both 33 kV (EPR) and 132 kV (XLPE) cables in association with offshore wind farms (both between turbines and the full length of cabling to the grid connection on land). The study should also calculate the effects of burial and/or shielding (at various depths, strata, sediment type and thickness) on electromagnetic fields. A key aspect of the work will be the identification and assessment of work in progress at other European windfarm site.

1.1.3 Assessment of Subsea Acoustic Noise Emission and Vibration from Offshore Wind Turbines and its Impact on Marine Wildlife

Funding agency: COWRIE (Collaborative Offshore Windfarm Research Into Environment) Trust fund established by The Crown Estate based on the refundable financial deposits made by UK Round One Offshore Windfarm Developers.

Participating Organisations: Subacoustech Ltd

Contact: Dr Carolyn Heeps (carolyn.heeps@crownestate.co.uk)

www site: http://www.crownestate.co.uk/estates/marine/windfarms/cowrie.shtml

Duration: May 2003 – March 2007

Project Description: This project aims to provide field data in relation to the potential impact of sub-sea acoustic noise and vibration produced from offshore wind turbines. Building on existing

desk based research the field data will be assessed to determine any behavioural or other effects on marine wildlife.

Stage One: a literature review and data to be collected from existing turbines to determine to what extent normal behaviour of marine wildlife might be affected by noise and vibration from wind turbines.

Stage Two: (subject to the outcome of stage one) requires generic information on acoustic and vibration effects through studies at a representative windfarm from pre-construction to operation. This will determine the spatial extent of the sound and vibration field and gather environmental data that may be used to model sound and vibration propagation in the region and to further assess the effects of noise and vibration from offshore wind turbine schemes on the behaviour of relevant marine mammal species and other marine organisms.

1.1.4 A comparison of Ship and Aerial sampling methods for marine birds, and their applicability to Offshore Windfarm Assessments

Funding agency: COWRIE (Collaborative Offshore Windfarm Research Into Environment) Trust fund established by The Crown Estate based on the refundable financial deposits made by UK Round One Offshore Windfarm Developers.

Participating Organisations: Netherlands Institute for Sea Research, Alterra, JNCC, NERI, Research and Technology Centre (Kiel University), Research Unit for Wildlife Population Assessment (St Andrews University) Wildfowl and Wetlands Trust.

Contact: Dr Carolyn Heeps (carolyn.heeps@crownestate.co.uk)

www site: http://www.crownestate.co.uk/estates/marine/windfarms/cowrie.shtml

Duration: May 2003 – November 2003 Workshop scheduled for October 2003.

Project Description: A desk study to examine and review the range of aerial and boat-based methods used to date, drawing in part upon current and existing offshore windfarm EIAs. As an important component of this work the successful contractor will be required to organise and chair a workshop to present draft desk study to others involved in aerial and boat based survey work for peer review. The proceedings of this workshop should be included as an appendix to the desk study.

1.1.5 Predicting the displacement of common scoter Melanitta nigra from benthic feeding areas due to offshore windfarms.

Funding agency: COWRIE (Collaborative Offshore Windfarm Research Into Environment) Trust fund established by The Crown Estate based on the refundable financial deposits made by UK Round One Offshore Windfarm Developers.

Partner Organisations: Centre for Applied Marine Sciences, School of Ocean Sciences, University of Wales, Bangor.

Contact: Dr Carolyn Heeps (carolyn.heeps@crownestate.co.uk)

www site: http://www.crownestate.co.uk/estates/marine/windfarms/cowrie.shtml

Duration: July 2003 – July 2005

Project Description: To develop a model to assist in predicting the effect of offshore windfarms (individually and cumulatively) on common scoter due to habitat loss and change. To link the non-breeding distribution of common scoter with environmental variables at selected sites. To identify the characteristics of preferred feeding areas for scoter within these sites. This to include description of density, species and size classes of prey.

1.1.6 Potential Effects of Offshore Wind Developments on Coastal Processes

Participating Organisations: ABP Marine Environmental Research Ltd (ABPmer) and Metoc
Funding Agency: Department of Trade and Industry (DTI) -New and Renewable Energy Programme

Duration: 2 years

Project description: A key issue recognised by this research was the need to design schemes that can cope with severe marine environmental conditions whilst being accommodated in the local marine environment with minimal impact. The study report is now available to download from: http://www.abpmer.co.uk/PublicationsAndReports.htm

Contact: Mr Bill Cooper (bcooper@abpmer.co.uk)

1.2 Conditions

1.2.1 ANEMOS

www site: http://anemos.cma.fr

Partners: 21 partners drawn from 7 different European countries - including CCLRC Rutherford Appleton Laboratory

Duration: Oct 2002 - Sept 2006 Funding body: European Commission [ERK5-CT-2002-00665]

Project description: The aim of the project is to develop accurate models that considerably outperform current state-of-the-art models, for onshore and offshore wind resource forecasting (statistical and physical). Emphasis is given on integrating high-resolution meteorological forecasts. For the offshore case, marine meteorology will be considered as well as information by satellite-radar images. An integrated software package, ANEMOS, will be developed to host the various models. This system will be installed by several utilities for on-line operation at onshore and offshore wind farms for local/regional/national wind prediction. The applications are characterised by different terrains and climates, on-/near-/off-shore farms, interconnected or island grids. The on-line operation by the utilities will permit validation of the models and analysis of how predictions can contribute to a competitive integration of wind energy in the developing liberalised electricity market.

Contact: Dr Richard Brownsword (r.brownsword@rl.ac.uk)

1.2.2 Forecasting Wind Power

Partners: CCLRC Rutherford Appleton Laboratory and Unit[E] UK Ltd

Duration: June 2001 - June 2004

Funding body: EPSRC [GR/N37308]

Project description: The exploitation of the UK's large onshore and offshore wind energy resource has been identified as an important part of the Government's Renewable Energy Policy. As wind energy is highly variable, accurate wind forecasting on the timescale of a few hours is required for wind energy to compete effectively under the New Energy Trading Arrangements (NETA). The project therefore aims to develop new methods for the improved prediction of wind power production in the UK. The development will concentrate on improving short-term predictive methods based on statistical analysis of wind speed and power time series data relevant to onshore sites to address the current needs of the wind energy industry. These techniques will be extended to prediction of wind power at offshore sites. The value of longer-range wind power forecasting based on the latest numerical weather prediction models in facilitating future large-scale integration of wind energy in the UK national grid will also be assessed. An economic evaluation of the methods for short-range onshore power prediction using a simple price forecasting model will be made. Finally a Windows-based software package to aid UK wind energy suppliers in formulating their trading strategies, will be written.

Contact: Dr Richard Brownsword (r.brownsword@rl.ac.uk)

1.2.3 Predicting Offshore Wind Energy Resources (POWER)

www site: http://www.eru.rl.ac.uk/POWER_project/POWER_project.htm

Partners: CCLRC Rutherford Appleton Laboratory, University of East Anglia, Risoe National Laboratory, Ecofys, KEMA Sustainable

Funding body: European Commission [JOR3-CT98-0286]

Project duration: Aug 1998 to Jul 2001

Project description: The project aims were to address the European offshore wind energy industry's need for accurate predictions of the wind energy resource at offshore locations. A novel methodology has been developed which can produce long-term and spatially detailed estimates of the wind conditions at offshore sites covering a wide area. Crucially, this methodology does not rely directly on offshore anemometry mast data (which are currently both temporally and spatially sparse and very expensive to gather) but instead the estimates are based on grids of atmospheric pressure data at mean sea level covering the area of interest. Within the POWER project, the new methodology will be applied throughout European Union waters to produce, in effect, an offshore wind atlas for the region.

Contact: Dr Jim Halliday (j.a.halliday@rl.ac.uk)

1.2.4 Recommendations for the design of offshore wind turbines (RECOFF)

Participating Organisations: Garrad Hassan & Partners Ltd., Risoe National Laboratory (Denmark), ECN (Netherlands), Germanischer Lloyd WindEnergie, CRES (Greece).

Funding Agency: CEC

WWW Link or brief description: Theoretical studies into many issues of offshore turbine design. Studies support the development of the forthcoming new IEC standard for offshore turbine design.

Contact: David Quarton: quarton@garradhassan.co.uk

1.2.5 Efficient Development of Offshore Windfarms (ENDOW)

Participating Organisations: Risoe National Laboratory, Uppsala University, Garrad Hassan, Robert Gordon University, Oldenberg University, SEAS, TECHWISE, NEG MICON, Energy Research Centre Netherland, Ecofys

Duration: Mar 2000 - Feb 2003 Funding body: European Commission [ERK6-CT1999-00001]

www site: http://www.risoe.dk/vea/projects/endow/mainendow.htm

The objective of the ENDOW project was to evaluate, enhance and interface wake and boundary-layer models for utilisation offshore. The project resulted in a significant advance in the state of the art in both wake and marine boundary layer models leading to improved prediction of wind speed and turbulence profiles within large offshore wind farms. Use of new databases from existing offshore wind farms and detailed wake profiles collected using a sodar provided a unique opportunity to undertake the first comprehensive evaluation of offshore wake model performances. The wake models evaluated vary in complexity from empirical solutions to the most advanced models based on solutions of the Navier-Stokes equations using eddy viscosity combined with a k-epsilon turbulence closure. Results of wake model performance in different wind speed, stability and roughness conditions provided criteria for their improvement. Mesoscale model simulations were used to evaluate the impact of thermal flows, roughness and orography on offshore wind speeds.

The model hierarchy developed under ENDOW forms the basis of design tools for use by wind energy developers and turbine manufacturers to optimise power output from offshore wind farms through minimised wake effects and optimal grid connections. The design tools are being built onto existing regional scale models and wind farm design software which was developed with EU funding and is in use currently by wind energy developers. This maximises the expected impact of this project through efficient use of existing resources and ease of upgrade for end-users.

Contact: Dr Rebecca Barthelmie (r.barthelmie@risoe.dk)

1.2.6 EUROWAVES: A user friendly tool for the evaluation of waves at any European coastal location

Partners: OCEANOR, National Technical University of Athens, Instituto Studio Dinamica Grande Masse

Funding: EU MAST Programme, project MAS3-CT97-0109

Duration: 11/97 - 10/00

WWW Link: http://www.oceanor.no/projects/eurowaves/

Contact: Dr Stephen Barstow (sbarstow@oceanor.no)

2 STRUCTURAL DESIGN

2.1 Loading

2.1.1 Design methods for offshore wind turbines at exposed sites (OWTES)

Participating Organisations: Garrad Hassan & Partners Ltd., Vestas Wind Systems, AMEC Wind Energy, Germanischer Lloyd WindEnergie, Delft University of Technology, Powergen Renewables Ltd.

Funding Agency: CEC (Joule), UK DTI, Novem (Netherlands Renewables Agency)

WWW Link or brief description: Research into wind & wave loading of offshore turbine structures. Based on results of monitoring one of the Blyth offshore turbines. See attached paper.

Contact: David Quarton: quarton@garradhassan.com

2.1.2 Dynamic Response of Wind Turbine Structures in Waves.

Participating Organisations: University of Newcastle upon Tyne (A.Incecik)., University of Glasgow (N. Barltrop), Imperial College of Science,Technology and Medicine (JMR Graham), W.S. Atkins, Amec Border Wind, Garrad Hassan & Partners.

Funding Agency: EPSRC (total cost £360K over 36 months)

WWW Link or brief description: The accurate prediction of dynamic response of wind turbine structures due to breaking waves is fundamental for the safe and efficient design of wind turbine support structures and their foundations. The research aims at the development of a methodology to predict the hydrodynamic loading due to breaking or near breaking waves (steep waves) and the resulting dynamic stresses throughout the structure. This information will provide input in estimating the ultimate load carrying capacity and fatigue life of the wind turbine support structure and the loading on the foundations. During the study various prediction tools were assessed and/or developed through numerical as well as experimental studies. The project has undertaken measurements of wave forces and some theory for models of wind turbine towers in shallow water waves in a laboratory wave tank in order to study integration of wave forces into the structural dynamics of the turbine.

Contact: Prof Mike Graham (m.graham@ic.ac.uk) or Prof. Atilla Incecik (atilla.incecik@ncl.ac.uk)

2.1.3 Opti-OWECS: Structural and Economic Optimisation of Bottom-mounted Offshore Wind Energy Converters

Participants: TU Delft, Kvaerner Oil and Gas Ltd., Kvaerner Turbin AB, University of Sunderland, Energie Noord West

Funding: EU JOULE Programme, project JOR3-CT95-0087

Duration: to 1998

WWW Site: http://www.windenergy.citg.tudelft.nl/content/research/ooorder.shtml

Contact: WindEnergie@citg.tudelft.nl

2.2 Foundations

2.2.1 Application of Suction Caisson Foundations to Offshore Windfarms

Participating Organisations: SLP Engineering Ltd (Project Manager), Oxford University, HR Wallingford Ltd, NEG Micon Rotors Ltd, Fugro Ltd, Shell International Renewables Ltd, Garrad Hassan & Partners Ltd, GE Wind.

Duration: August 2002 to August 2004

Funding Agency: DTI (£917k) and industry participants (£373k) : overall project £1290k.

Application WWW Link: http://www-civil.eng.ox.ac.uk/research/offshore/reports/dtiwind.pdf

Paper describing Project:
Byrne, B.W., Houlsby, G.T., Martin, C.M. and Fish, P.M. (2002) "Suction caisson foundations for offshore wind turbines." Journal of Wind Engineering, Vol. 26, No. 3, pp 145-155
http://www-civil.eng.ox.ac.uk/people/gth/j/j71.pdf

Description of Project
Offshore structures are traditionally founded on piled foundations, which are expensive to install and decommission. One alternative for offshore wind turbines would be to use shallow skirted foundations installed using suction. These are called suction caissons and have been used for a number of projects in the oil and gas industry. Suction caisson foundations are advantageous as they can be installed within hours whereas piling may take several days and is more exposed to weather downtime risks. Within this research project a number of different structural and shallow foundation configurations are being considered including multi-foundation and single foundation structures. In each case the response of the foundation to the different loading conditions must be understood. A number of different themes are being pursued, including issues of installation, ultimate capacity, in-service performance, cyclic loading, scour and scaling, so that the foundation response is fully understood. The research project is aimed at delivering design guidelines and theoretical models of foundation response for suction caisson foundations that could be used during the design of offshore wind turbines.

The research includes work at Oxford University (£478k) under three main themes, each with a dedicated researcher, a) laboratory work, b) field testing, and, c) theoretical modelling. Work has also been carried out at HR Wallingford to investigate the effect of bed liquefaction, scour and potential remedial measures. There is significant industry involvement by SLP Engineering, Garrad Hassan and Fugro as well as input from the potential end-users (Shell International Renewables, NEG Micon and GE Wind).

Contact details:
Prof Guy Houlsby, Oxford University (guy.houlsby@eng.ox.ac.uk)
Dr Byron Byrne, Oxford University (byron.byrne@eng.ox.ac.uk),
David Danson, SLP Engineering Ltd (david.danson@londonslp-eng.com)
Tom Coates, HR Wallingford (ttc@hrwallingford.co.uk)

2.2.2 Novel Foundations for Offshore Wind Turbines

Participating Organisations: Oxford University

Investigators: Prof Guy Houlsby, Dr Byron Byrne, Dr Chris Martin

Start Date: Awarded in early 2002 to finish in 2005

Funding Agency: EPSRC - Value £221k

This research grant enables the work at Oxford University, in the **Application of Suction Caisson Foundations to Offshore Windfarms** project described above, to be extended from two years to three years.

Grant application: http://www-civil.eng.ox.ac.uk/research/offshore/reports/epsrcwind.pdf

2.2.3 Development of Research Tools for Offshore Wind farms Implementation

www site: http://www.eru.rl.ac.uk/mufow.pdf

Partners: University College London, CCLRC Rutherford Appleton Laboratory

Funding body: EPSRC [GR/L10987]

Project duration: Jan 1997 to Dec 1999

Project description: This project 1) developed analytical and numerical design tools suitable for evaluating and optimising the designs for floating offshore wind farms; 2) applied the tools developed to the Multi Unit Floating Offshore Wind farm (MUFOW) concept; 3) performed parametric and feasibility studies on non-technical implementation issues. The principal technical problems addressed within the project include development of analysis tools for modelling the interaction between the motion of a vessel in waves and the aerodynamic performance of wind turbines mounted upon it, determination of an optimum hull-form for a MUFOW structure including an investigation of secondary issues such as vessel weathervaning, and development of tools to analyse blade and hub loads in vessel-mounted wind turbines. In addition, investigations on siting and cost considerations for floating offshore wind farms were completed, and potential sites for development and the comparative cost of floating wind energy were assessed.

Contact: Dr Jim Halliday (j.a.halliday@rl.ac.uk)

2.3 Wind turbine operation

None notified

3 ELECTRICAL DESIGN AND CONTROL

3.1.1 Aries-Gemini

Participating Organisations: Wavelength Solutions Ltd

Funding Agency: Internal

WWW Link or brief description: www.wavelengthsolutions.co.uk

Wavelength Solutions Limited is a leading British manufacturer and supplier of broadband wireless, radar and fibre products and solutions for the transmission and reception of data, voice and video images, more effectively, more economically and more securely than competing technologies.

Contact: Brett Harker (bharker@wavelengthsolutions.co.uk)

http://www.wavelengthsolutions.co.uk/, http://www.scipher.com/

3.1.2 Electrical Stability Of Large Offshore Wind Farms

Participating Organisations: Electrical Energy and Power Systems Group, UMIST

Funding Agency: EPSRC Grant GR/N05000/01

WWW Link or brief description: The first generation of UK offshore wind farms is likely to include large installations (up to 100 MW) of fixed speed wind turbines, using induction generators, connected to distribution networks with relatively low short circuit capacity. One important limit on the size of wind farm which may be connected to a given distribution network is the steady state stability limit and the margin which is required for satisfactory operation. The wind farms will become unstable and overspeed when the terrestrial system voltage is depressed by faults. Remote faults over a wide part of the distribution network may result in the wind farms tripping and a consequent loss of generation. Mal-operation of this type will become progressively less acceptable as the ratings of the wind farms increase in comparison with the capacity of the terrestrial power system. The project will investigate electrical stability of large, offshore wind farms, techniques and computer tool to predict instability and remedial measures which may be taken to improve the stability of large wind turbines. The project is timely as steady state and dynamic instability is potentially a significant constraint on the development of the UK offshore wind energy resource.
http://194.66.183.26/WEBSITE/GOW/ViewGrant.ASPx?Grant=GR/N05000/01&bannerlink=Programme%20support

Contact: Professor N Jenkins http://www.ee.umist.ac.uk/mcee/

4 CONSTRUCTION AND O&M

4.1.1 CONMOW: Condition Monitoring for Offshore Wind Farms

Participating Organisations: ECN Wind Energy (NL), Siemens Nederland BV (NL), Loughborough University (UK), Risø National Laboratory (DK), Garrad Hassan and partners Ltd. (UK), Pall Corporation (E), Gram&Juhl APS (DK), Prüftechnik CM GmbH (D)

Funding Agency: EC (ENK5-CT-2002-00659) and by Novem (2020-02-11-10-006).

The CONMOW project aims at developing techniques for diagnostics and condition monitoring of wind turbines (and farms) at remote areas and selecting and demonstrating a suitable set of techniques.

Contact: Luc Rademakers (rademakers@ecn.nl)

4.1.2 DOWEC project (Dutch Offshore Wind Energy Converter)

Participating Organisations: LM Glasfiber Holland, Van Oord ACZ, Ballast-Nedam, ECN and TU Delft under the leadership of NEG-Micon Holland.

Funding Agency: EET-program of the Dutch Ministry of Economic Affairs

The optimisation of an O&M plan for a possible DOWEC wind farm 50 km offshore.

Contact: Luc Rademakers (rademakers@ecn.nl)

4.1.3 Offshore Wind Installation and Maintenance Using an Orangutan

Participating Organisations: Oreada & Wind Turbine Manufacturer (tbc)

Funding Agency: N/A

WWW Link: http://www.offshorewindsolutions.com/technology.html

Contact: James Ingram James.Ingram@Oreada.com

4.1.4 Merlin Wind Turbine Installation System

Participating Organisations: The Engineering Business Ltd

Funding Agency: TBC

WWW Link or brief description: www.engb.com

Contact: toby.bailey@engb.com

4.1.5 Geotechnical Instrumentation of an Offshore Caisson Foundation Trial

Participants: Prof G T Houlsby (Oxford University)

Funding: EPSRC (GR M55657)

Duration: 01/12/98 - 31/05/00

WWW Link: http://www-civil.eng.ox.ac.uk/research/offshore/trial.htm

Contact: Guy.Houlsby@eng.ox.ac.uk

5 OTHER (NETWORKS, FINANCING, ETC)

5.1.1 Offshore Wind Energy Network (OWEN)

www site: http://www.owen.org.uk

Role: Network co-ordinators

Funding body: EPSRC [GR/M00886]

Network duration: Oct 1998 to March 2002 and April 2002 to March 2005

Network description: OWEN promotes research on all issues connected with development of the UK's offshore wind resource and encourages co-operation and partnership between and commercial organisations and researchers.

Contact: Mike Blanch (OWEN@OWEN.org.uk)

5.1.2 Concerted Action CA-OWEE

Participating Organisations: TUDelft (NL); Garrad Hassan, John Brown + 10 other non-UK

Funding Agency: EU

WWW Link or brief description: www.offshorewindenergy.org

Contact: arh@offshorewindenergy.co.uk or M.B.Zaaijer@CiTG.TUDelft.NL

5.1.3 Investment Incentives, regulation and technological diffusion: The financing of wind energy projects in Europe.

Participating Organisations: Centre for Regulation and Competition and the School of Management, University of East Anglia

Funding Agency: School of Management, University of East Anglia

WWW Link or brief description: http://www.ccr.uea.ac.uk/projects/DiazRaineythesis.shtml and http://www.mgt.uea.ac.uk/staff.asp?id=mg284254

Contact: Ivan Diaz-Rainey (i.diaz-rainey@uea.ac.uk)