Environmental and Consenting Barriers to Developing Floating Wind Farms Including Innovative Solutions

December 2016

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Executive Summary

Predicting and understanding the significance of the environmental consequences of any novel technology deployed into the marine system, often drives development and innovation in methods, tools and models to allow measurement and prediction of environmental impacts. The environmental science sector however, has historically suffered from low levels of investment to allow improvements in the necessary environmental technologies. Consequently, wherever possible, a reductive approach has been applied to attempt mitigation of project scale impacts, through sustainable engineering design. Nevertheless, the challenge of equipping regulators, their advisors and consultants to industry with adequate methods, tools and models still remains - and so the earlier the issues and needs can be identified, the more likely it is that costs and risks to first movers can be minimised.

NERC recognises the importance of innovating and translating recent and historical marine research science to support decision making in the development of the offshore renewable energy sector - and the evolution of technologies to support these processes is now regarded as an essential route to reduce the costs of environmental characterisation over large geographical areas, impact prediction and long term environmental monitoring at development sites.

At the present time, several floating wind demonstration projects are in development in the UK, and so this workshop, focussed on the environmental consenting barriers to developing floating wind, assembled a group of individuals with significant experience of the offshore renewable energy sector, from industry, regulatory, nature conservation, research and consultancy sectors, to discuss the innovation / translational R&D needed to support the development of the Floating Wind sector going forward.

It was clear from subsequent outputs of the workshop, that the necessary research science capability and advisory expertise is present within the UK marine science community, to prioritise and take forward the required R&D, and that a substantial proportion of the requirements identified, can be developed as result of translating (applying / adapting) existing science. However, the particular needs of floating wind - ultimately destined for deeper water further offshore - will require innovation across a number of environmental receptors / predictive methods in order to reduce the costs and risks of site development in the longer term.

Acknowledgments

The workshop which led to the production of this report could not have taken place were it not for the generous support from the Scottish Government in providing a venue, then assistance with planning and logistics.

We would also like to extend our thanks to those who helped to develop the workshop programme notably, Rhodri James and Angus Vantoch-Wood at the Carbon Trust and Cian Conroy of the ORE Catapult. We are obviously indebted to all those who participated on the day and who gave generously of their time to help us produce this report. Finally none of this would have been possible without support from NERC in funding this workshop.

This report is for information and a record of the workshop discussion, and is not a recommendation document for NERC or other supporters. The content of this report reflects the contributions of each participant. The wording and emphasis is that of the authors and may not reflect the views of the delegates or of the workshop funders.

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Background

The UK potentially has a significant opportunity to continue its leading role in offshore wind farm development by progressing with the commercialisation of floating wind. Floating foundations for wind turbines are seen as a solution to deploying in waters too deep for traditional foundations, or where the seabed is unsuitable for fixed foundations, and, a potential solution for accessing higher wind speeds further offshore remote from some stakeholder concerns. Demonstrator projects are in development in the UK and overseas waters, with the aim of deploying full scale commercial farms of floating wind farms in the near future.

Over the past five years, our understanding of the interactions between offshore renewable technologies (fixed wind turbines, wave and tidal devices) and environmental receptors has grown rapidly, and much of this information can be directly applied to predict the likely consequences of deploying floating wind structures offshore. However, there are also different and emerging environmental considerations specific to floating wind turbines, which need to be tackled, and early engagement over the issues will be beneficial for both industry and regulators especially where innovation, R&D is needed.

With this in mind, NERC, ARUP, the Carbon Trust, the ORE Catapult and the Scottish Government worked collaboratively to organise and deliver a workshop to identify environmental or consenting considerations which constitute barriers and risks to the industry, as well as identify innovative solutions.

The specific aims of the workshop were therefore to:

- Identify the main consenting and environmental risks/barriers to the development of floating offshore wind farms at a demonstration and commercial scale
- Identify the innovation and translational R&D needed to streamline and de risk planning, environmental consenting and post consent monitoring for floating wind,

This report summarises the outputs of the workshop and provides a synthesis of the information generated, with interpretation and recommendations for future action.

Workshop programme and attendees

The workshop took place on May 20th 2016 at Victoria Quay, Edinburgh by kind invitation of the Scottish Government. Individuals and organisations were invited to the workshop on the basis of their recent experience from the offshore renewables sector – either in environmental consenting or from innovation / R&D sectors, or because of their recent experience in taking forward a floating wind project – either from the industry / technology developer or regulatory perspective. It was therefore attended by stakeholders from a broad spectrum of organisations (see Appendix 1).

The agenda for the day included a series of talks to set the scene, beginning with Rhodri James of the Carbon Trust and Cian Conroy of ORE Catapult (OREC) who provided an overview of the status of technology, the different types of technology, implications for deployment, operation and maintenance.

An overview of consenting, environmental and stakeholder issues was then provided by Angus Vantoch-Wood of the Carbon Trust and Zoë Crutchfield from Arup. Ian Davies from Marine Scotland Science provided insights into anticipated issues and research needs for floating foundations, and highlighted where experience may allow us to rule out issues which are unlikely to apply to floating wind technologies.

John Watt of the Scottish Fishermen's Federation (SFF) described the complexities of the Scottish Fishing Industry, and highlighted the concerns over how we collectively manage the use of our seabed to allow sustainable use by different sectors including both the fishing and floating wind industries. Richard Trueman of Hartley Anderson provided an overview of the DECC Strategic Environmental Assessment (SEA) process, which includes plans for floating wind in the most recent programme assessed.

Finally, with focus on funding research and development, Sarah Keynes of NERC described the role of the NERC Innovation team and funding opportunities for translation of environmental science research in collaboration with industry, whilst Annie Linley presented examples of successful NERC projects recently completed in the marine renewable sector, to illustrate the impact of collaborative projects taken forward with innovation / translational science funding.

The full programme with details of questions posed and facilitated round table sessions together with guidance issued to facilitators is reproduced in Appendix 2.

Workshop Outputs

General comments and observations

1 Although specific R&D issues in relation to floating wind were identified, there is already a significant body of R&D related to other offshore renewable sub sectors which can be extrapolated, re-interpreted and further translated to support development of best practice for floating wind. Prior to commencing new research, translation from existing evidence bases should be fully investigated.

2 There are a number of inaccurate assumptions in relation to existing floating wind technologies from industry, regulators and stakeholders, including those which are the subject of demonstration projects. Better communication of the nature and potential impacts of the technology is needed across the board.

3 A continuing theme across workshops is that a major effort is required to promote data sharing in relation to the whole range of marine infrastructure projects (i.e. including O&G, shipping, subsea technologies) - to ensure that the best use of existing information is possible for planning and consenting purposes. Existing data sharing initiatives need to be better communicated.

4 There is a requirement for regular updates of R&D outcomes and sharing of evidence in relation to environmental and consenting impacts and risks. Those risks or impacts initially perceived as important but by evidence collected or general consensus considered to be non-significant in EIA terms, should be 'retired' to avoid the need for redundant or disproportionate data collection. This should be further considered during scoping stages of EIAs.

5 Further effort to develop environmental technologies for characterising environmental receptors, then monitoring post deployment, remains a significant challenge, but will be essential to drive down costs and risks of environmental/stakeholder aspects of consenting.

6 Industry and stakeholders need to collectively ensure that advances and innovations in technology including methodologies and models can be incorporated into EIA. This may require comparative studies to provide evidence and avoid further use of out dated or redundant methods.

Synthesis of discussion points

Ornithology

Baseline Data Collection: Many participants pointed to the very high cost of aerial bird surveys and the need to continue innovating for this purpose through radar, satellite applications and automated data processing methods given the likely continuing requirements for higher resolution data further offshore in the longer term. The lack of night time information is also considered an important deficiency in understanding the full extent of impacts on birds.

Impact Assessment: Population consequences of potential displacement and barrier effects were generally considered to be similar to fixed wind, however the consequences of a floating moving platform, (used by some floating wind technologies), on bird behaviour may vary with different species. There is a suite of models currently used for predicting displacement and concerns were raised as to whether these were fit for purpose. Post deployment monitoring at existing fixed wind farms is delivering useful understanding of displacement and/or barrier effects, however these tend to be localised and specific to named bird species.

There was general agreement that collision risk modelling for floating wind should be improved by developing a version of the Collision Risk Model (CRM) which takes into account the possible vertical movement and rotation of a floating wind platform, although the extent to which this is an issue, would need to be considered on a case by case basis, as movement can be insignificant in some technology designs. Within EIAs, consideration should also be given to the possibility of birds using floating foundations for roosting or increased feeding. This interaction with the possible Fish Aggregation Device (FAD) effect may be potentially significant for some species in combination with higher collision risk.

Marine Mammals

Impact Assessment: One of the most challenging issues associated with fixed wind, namely that of noise associated with piling offshore, may be entirely removed as result of adopting floating wind technology. Although some technology options include pin piles and helical technologies, these are unlikely to produce significant amounts of underwater noise compared to piling of fixed jackets or monopiles. There is a supposition that the use of mooring lines have resulted in snapping or vibrating noises underwater, and this needs to be further investigated and information shared for future developments.

The risk of entanglement in suspended cables and moorings lines has been a risk already investigated through an expert report SNH commissioned in relation to renewable energy[1]. The report concluded that *'Moorings such as those proposed for MRE [Marine Renewable Energy] devices will likely pose a relatively modest risk in terms of entanglement for most marine megafauna, particularly when compared to risk posed by fisheries. Nevertheless, some circumstances were identified where moorings associated with MRE devices could potentially pose a risk, particularly, 1) in cases involving large baleen whales and, 2) if derelict fishing gears become attached to the mooring, thereby posing an entanglement risk for a wide range of species (including fish and diving seabirds)'.*

The risk of entanglement of marine mammals at floating wind installations would need to be assessed – especially as individual test sites and pilot deployments are scaled up to arrays of devices. These multiple platform installations will inevitably affect larger sea areas with footprints incorporating a potentially significant amount of suspended cables and mooring lines. The cumulative effect of these factors and the prospect of other at sea activities, would also need to be considered.

Predicting the consequences of displacement of mammals from breeding / feeding areas within or adjacent to floating wind array footprints, also remains a challenge for fixed wind, wave and tidal energy. This is not only from the array footprints themselves, but as a result of interaction with other at sea activities, which cumulatively impact upon the habitat available for all species of marine mammal in UK waters. Whilst development of population level impact models for marine mammals is progressing, for instance, the interim Population Consequences of Displacement (PCoD) model[2], further work is required to ensure the robustness of baseline data used in the models, and with regard to assumptions on aspects of marine mammal life cycles which impact upon the population structure of species.

[1] Understanding the potential for marine megafauna entanglement risk from marine renewable energy developments http://www.snh.org.uk/pdfs/publications/commissioned_reports/791.pdf)

[2] http://www.gov.scot/Topics/marine/science/MSInteractive/Themes/pcod

Fisheries

There was considerable discussion at the workshop as to the perceived benefits, or not, of floating wind structures acting as Fish Aggregation Devices (FADs). Some perceive this as a positive impact, considering that limiting fishing in areas may create a 'safe zone' for fish (eg. juveniles may avoid predation and increase recruitment into fishery), whilst others commented that aggregating fish in one area close to a platform may increase the risk of being caught. Generally, it was agreed that further research into understanding how significant the effect of aggregating fish is and potential impacts, both good and bad, of any aggregation would be useful to inform discussions on exclusion of fishing opportunity by floating wind development and subsequent negotiation of compensation.

One difference raised in relation to fixed foundations versus floating technologies, was the potential for Electro-Magnetic Fields (EMF) to be generated from cables within the water column. Unlike conventional offshore wind, whilst export cables would still be buried, floating foundations require a cable to be deployed within the water column. A fuller understanding of potential for these cables to produce EMF fields and evidence to assess potential impacts upon electro-sensitive species may be required as floating wind expands.

Benthos

The main potential for impacting upon the seabed and thus benthos, is through use of anchors and anchor chains. Although it would be better to avoid sensitive benthic communities altogether, where important or protected benthic habitats are present in potential development areas, the micro-siting of anchors and moorings systems to minimise impacts on benthos may be a useful mitigation tool. This requires that industry is able to characterise the seabed more cost effectively and in a timely manner, for instance closer to construction windows.

This is especially relevant in deeper water habitats, largely unexplored to date, to ensure early detection of important communities which may require additional management measures. It is also possible that the use of novel anchoring technologies with very low surface expression and vertical axes may be a mitigation option at some development sites.

Brittlestar Beds © Mainstream Renewable Power

Commercial Fisheries

There was a general consensus that there is a need to recognise that there are some sea areas which are very good for fishing, which may have potential for floating wind. However a great deal could be done to mitigate the potential negative consequences of resource conflicts and build benefits for both sectors through closer communication and better understanding of the issues on both sides. This was highlighted by the interest in the talk by SFF explaining different fishing methods used around the UK Continental Shelf (UKCS) and the attendees who expressed how they had 'learnt a lot' just from this one presentation.

A key take home message from the workshop was that when floating wind developers are seeking a suitable development site, they should engage as early as possible with the MMO / Marine Scotland and local planning authorities as well as with the commercial fisheries sector, to ensure consultation and identification of constraints has been undertaken prior to settling on a particular site. This can achieve a great deal in terms of avoiding conflict in the early stages of a project and in building a constructive relationship between the developer and fishermen, and ultimately in facilitating co-existence and avoiding conflict in the longer term.

Other ideas to improve site selection included increasing the use of Vessel Monitoring System (VMS) data in terms of availability for all to use, ensuring confidentiality and temporal resolution issues are managed. This could also be tied into increased use of heat maps for fishing activity and further education of how commercial fisheries data is interpreted and used by industry.

Within the group, concern was raised as to the processes followed by Government and the Crown Estate to decide on development areas and for leasing rounds. It was generally agreed that better quality socio-economic information needs to be integrated at all stages of marine planning, and SEA. It was also suggested that more robust and universally agreed methodologies for socio-economic impact analysis for EIA should be further investigated and that any research should take into account changes to the EIA Directive which should be in place by May 2017[3].

One issue raised, linked to mooring lines, is the potential risk of ghost nets becoming attached to mooring lines and the impact of this on fish and marine mammal species. However, there were no known instances of this having occurred in relation to mooring systems from other technology sectors reported at the workshop (See Marine Mammals for further details).

[3] http://ec.europa.eu/environment/eia/review.htm

Military and Aviation

It was recognised that the MoD and aviation sectors are both significant stakeholders to engage at an early stage of site development. However, many participants reported that engagement with the military has often been challenging for renewable energy developers in UK waters, apparently this is the result of the lack of resources within the relevant departments to deal with enquiries. In comparison with the military sector involvement in US, French or Australia market, the UK military is perceived as a serious barrier to development of renewables. Co-investment and collaboration with military bases has been a highly significant force for innovation and sharing of expertise in other countries. For instance, Open Hydro and DCNS, Carnegie and Australia naval school, Fred. Olsen and US engineers.

One potential issue identified for some floating wind foundations is whether foundations which allow for movement up and down vertically, will impact upon radar in a different ways to fixed foundations.

Civil Aviation Authority © Arup

Marine Planning

There was discussion in several groups regarding the need for a ‘hierarchy of decision making’ to underpin marine planning. Given the shift in economic footprint offshore and increasingly intensive use of the marine environment, traditional activities such as fishing have to co-exist with other sectors. Workshop attendees raised concerns that commercial fisheries may be dependent on exploiting a localised natural resource, and the siting and development of new renewable energy installations needs to be underpinned by clear, marine planning policy and guidance from government, to assist developers and the commercial fishing industry.

Workshop attendees raised concerns as to the level of strategic planning for energy at the UK wide scale as a significant risk for marine energy development overall. In specific reference to floating wind, participants highlighted the importance of including grid and storage issues in future SEAs, as this information is needed to increase the effectiveness of decision making.

Concern was expressed regarding the lack of ‘future proofing’ in relation to marine planning and climate change, which applies to all natural resource based sectors including renewable energy, fishing and marine conservation. Although fishing activity is likely to move in response to climate change as new stocks appear in the south, a renewables installation is unlikely to be adversely affected over its 25year life time and cannot change boundaries once installed. On the other hand, the boundaries of marine conservation areas (and associated management measures) may need to move to respond to both localised and/or wider climate change driven changes.

Workshop attendees were concerned that the MaRS planning tool currently used by The Crown Estate and Marine Scotland lacks integration of the full range of socio-cultural factors (for e.g. aesthetic impacts) and in comparison with other EU countries (i.e. Denmark), floating wind farm developers carry a significant burden of risk in the early stages of planning especially when marine planning fails to reach robust, evidence based conclusions.

Workshop attendees highlighted that a key issue is the collection and use of good quality science to inform the planning processes including better use of historical data and results of monitoring programmes. This is especially significant given limitation and priorities for public sector investment in monitoring baseline conditions in the current economic climate. However, workshop attendees acknowledged that industry and government bodies need to deal with the ‘here and now’ and so optimise the use of baseline information and impact assessment evidence that we have available to us today.

Floatgen Construction Site © Ideol Offshore

Environmental and Consenting Barriers:

Summary of the main issues identified including Technology Innovation and Research and Development needed

Environmental And Consenting Barrier Identified By Workshop Attendees	Need	Innovation, Research & Development
Ornithology		
Population level consequences of displacement / barriers to movement as result of FW array deployment plus supporting infrastructure	Need: Evidence to support, and further improvements in methods, and technology developments to reduce uncertainty of impact prediction.	Development of radar and remote sensing, for more cost effective monitoring,
Cumulative Impact Assessment (CIA) Scaling single turbine and floating wind demonstration sites to arrays and interactions with other offshore sectors.	Need: CIA research including pre, during and post development monitoring.	Remote sensing, more cost effective monitoring,
	Need: Standardised CIA process or model clear for both developers and decision makers to ensure a robust assessment is completed at EIA stage.	Watching brief – DEFRA and OSPAR work underway
Collision Risk Modelling (CRM) General concern was raised as to how either the Band Model could be further enhanced or whether a completely new model, if appropriate, should be developed.	Need: Development and recalibration of CRM specifically for FW platforms Either development of the existing Band Model or a well evidenced and researched new model to take into account the following: • Addition of sensitivity analysis for dealing with uncertainty • Vertical movement and rotation of FW platform and ultimately larger swept area of turbine blades. • Avoidance behaviour may be different for some species at FW platforms • Increasing bird activity in wind farm resulting from opportunity to rest on platforms may result in higher collision risk during operation. Review suitability of CRM for assessing collision risk for potentially affected species for fly through vs resting within FW array.	Development of CRM Modelling More cost effective monitoring including remote sensing to improve the confidence in modelled results.
	Need: Guidance in the use and presentation of material by both regulators and developers. • Development of guidance to ensure improvement towards correct application and data gathering • Worked up case studies to facilitate applications	New guidance / best practice rather than R&D needed
Bird movements & activity at ports • During assembly and maintenance of floating wind structures interaction with the port and surrounding environment. • Tow in and out of large structures into ports	Review suitability current methods / models for assessing impacts on birds in port environment	Review will determine requirements
Surveys • Workshop attendees raised concerns over the high cost of ornithological surveys in comparison to other industries especially at the demonstration scale. • Development of cost effective monitoring in offshore locations.	Need: Alternative survey techniques or better use of existing data. Need: Drive down the costs for surveys and improve data collected, applies equally to fixed wind and other industries.	Innovation and comparison of technologies needed including: • Development of drones • Novel remote sensing methods for enumeration of different sized birds in variety of habitats • Autonomous detection methods.

Environmental And Consenting Barrier Identified By Workshop Attendees	Need	Innovation, Research & Development
Marine Mammals		
Noise associated with pin piling / helical technologies needs to be evaluated for its significance for range of UK species	Need: Is this a research priority given comparisons to mono-piling a >3MW fixed wind turbine towers? Need: What evidence would be required to 'retire' an issue?	Further discussion with regulators and their advisors
Vibrating mooring lines / twisting snapping noises may be an issue at some sites depending on the species present and technology context	Need: Is this a research priority given comparisons to mono-piling a >3MW fixed wind turbine towers?	As above
Cumulative Impact Assessment: Consequences of displacement of feeding / breeding mammals from FW array sites – cumulative effect of displacement from other offshore sites / activities	Need: A more robust decision tool is required - particularly given the increasing activity offshore in renewable and other offshore sectors including O&G decommissioning (see ORJIPs)	Ideas included: • Development of the PCoD model needs to deliver a functional and credible working model – building on the existing 'interim PCoD' model and recent advances in R&D
Risk of entanglement in suspended cables / mooring lines – including scaling up to FW arrays with multiple cables / mooring lines	Need: Establish if there is adequate understanding of behavioural responses to suspended cables and mooring lines associated with FW structures to 'retire' this issue? Need: Risk assessment method for in combination / interacting issues • Does risk increase in extreme weather compounded by ghost fishing, and potentially interactions with other offshore sector activities?	
Fish		
EMF's from high voltage mid water cables may impact health and behaviour of migratory fish	Need: Review of laboratory and evidence collection via field experiments plus observations of at risk species (such as elasmobranchs)	Remote sensing / tagging for evidence collection on fish responses
Cumulative impact Assessment of inter array / multiple cables –	Need: Review of environmental evidence in relation to cumulative effect of multiple cables and trenching best practice. Are burial depths adequate to protect elasmobranchs and deeper water species ?	Review will determine requirements
Implications of reef effect and /or FAD effects for different species and potential for mitigation of fisheries displacement	Better prediction of modelled outcomes and potential effects – including socio-economic dimension	Watching brief INSITE programme outputs – which may help to determine future requirements
Impact of displacement of migratory fish species and / or elasmobranchs from FW array development site and associated infrastructure	Evidence that tags currently in use are fit for purpose (eg. skates and rays vs salmon etc) return rate can be very low – tag detection methods in development.	Further evidence of R&D requirement needed
Underwater Noise - Fish species at risk in deeper FW site waters need to be identified and potential for noise impact assessed	Need: Collate information on deep water species at prospective sites for FW array development including what is known about their responses to noise	R&D requirements depending on review

Environmental And Consenting Barrier Identified By Workshop Attendees	Need	Innovation, Research & Development
Benthos		
Characterisation of ground conditions is very costly – especially further offshore and in deeper water novel technologies (and analysis of data generated)	Need: Further automation to avoid high cost of data analysis and interpretation	Ideas included: • Advances in AUV / ROV technologies and data analysis to allow cost effective epibenthic surveys in deeper water further offshore • Better modelled geo profiles to support micro-siting of moorings, anchors systems
Impact of introducing concrete moorings /scour protection materials on benthic communities and identification of mitigation options	Need: Evidence gathering re technology – environment interactions – at other renewable sites – fixed wind. wave hub etc	Depending on outcome evidence gathering

Commercial Fisheries		
Poor knowledge and sharing of innovative / constructive mitigation options for commercial fisheries	Need: Draw together case studies of best practice - successful negotiation, site selection, mitigation options Need: Develop mitigation options	Developments in innovative fishing gear or technology to allow fishing close to structures.
Socio-economic impact of fisheries displacement as result of FW array footprint Impact of fisheries exclusion on fish stocks –socio-economic consequences Impact of reef effect on fisheries	Need: Standardisation of socio-economic assessment methods tailored for different fisheries (not a one size fits all) Need: Better models to predict impact of exclusion fishing from specified area on fish stocks and consequent spill over; need evidence from post deployment monitoring Need: Assessment of potential significance of reef effect and whether understanding its longer term potential can feed into the fisheries – FW industry discussions constructively Better models for prediction of both environmental and socio-economic effects	Innovative approaches to collecting data and modelling socio-economic impact for different fisheries; Synergies with INSITE programme (decommissioning) & fixed wind research
Impact of other losses to fishing – snagging, entanglement, lost gear etc. Compliance with exclusion agreements / provision of evidence for insurance claims etc.	Need: Improved methods for mapping and sharing information on snagging. (May be covered by use of Kingfisher Bulletin by FW industry). Need: Status of AIS / VMS systems for tracking commercial fishing vessels	Live discussions in FLOWW may help to identify more precise R&D needs

Landscape / seascape		
Not all FW sites will be remote locations offshore – possible visual impact of structures in deep water harbours	Need: Existing methodology for offshore visual impact could be adapted for FW offshore and onshore / dock side assembly locations.	Unlikely to need further R&D

Environmental And Consenting Barrier Identified By Workshop Attendees	Need	Innovation, Research & Development
Navigation and shipping		
Search and rescue lanes need to be clearly delineated – with array design including optimum accepted spacing to allow appropriate traffic movements, whether routine or recovery	Need: Assess whether any special measures apply to floating wind not already covered by fixed wind – eg. mooring system fails - platform untethered; Guidance for fixed wind could be extended to incorporate floating wind	
Collision risk - maritime traffic movements in and adjacent to array footprint and along towing routes – depending on at sea / weather conditions, mitigation for mooring / ballast failures etc. Cumulative Impacts esp close to shorewhere higher density of shipping	Need: Guidance on what is required. Refer to guidance for O&G sub structures / fixed wind best practice guidance – Could existing guidance be extended to include floating wind ? Need: Emergency preparation for floating structures losing anchors	Depending on advice from MCA / Trinity House
Health and safety		
Developers to consider the impact of increased activity associated with FW platform assembly / testing in port and resulting environmental impacts (e.g. noise etc.)	Standard development practice – will consider risks at all stages of the project development	
Consideration of vulnerability to accidents and whole range of at sea possibilities including the rescue of crew on structures offshore under extreme conditions	Standard development practice – will consider risks at all stages of the project development	
Structural integrity		
Future proof FW to CC induced changes in weather events	Need: What weather conditions should be modelled as standard?	
Moorings / anchors / cable design and integrity – exposure in open water to extreme metocean conditions – damage limitation / survivability / longevity / parts replacement	Need: Large scale cross disciplinary projects to design out risks - technology – environment interactions	Encourage collaboration between technology and wave/tidal/wind industry to optimise energy generation
Biofouling / corrosion of FW infrastructure including moving parts can compromise functionality	Need: Effective and environmentally friendly treatment for biofouling	Continue to build on collaborative R&D with main coatings manufacturers

Environmental And Consenting Barrier Identified By Workshop Attendees	Need	Innovation, Research & Development
Energy extraction		
Effect of wind energy extraction by FW arrays at local/regional scale on physical & biological processes	Need Effective Model Need: Data collection to inform model	Idea: • Extend existing Ecowatt project to include wind energy extraction
Wind / wave and tidal energy resource extraction for electricity generation and effect on whole system function	Need: More holistic approach to capturing costs and benefits to include environmental, social and economic aspects	
Inter-annual variability in resource – longer term considerations and future proofing for climate change	Need: Developers need to know that resource is reliable enough to guarantee returns on investment over the 25yr project horizon and potentially in the longer term	R&D to support future proofing required across all renewable sectors

Strategic Planning / Leasing		
SEA Needs to further consider longer term resource needs of renewable based sectors Lack of future proofing for climate change in marine plans & SEA	Implications of recent R&D needs to be integrated into marine planning	Further discussion needed regarding best route to achieve this
There is no 'Hierarchy of rights' for resource use planners to underpin decision making – (the commons vs demand driven).	Need: Clear guidance to support transparent decision making processes A possible 'think piece' to underpin marine planning – cost / effort of achieving lasting compromise between industries based on natural resources is becoming prohibitive	Guidance rather than R&D needed
Grid availability – Is there a national plan/strategy. If not, should there be one?	Need: Grid availability is a clear driver in being able to effectively plan marine renewables. Cross refer infrastructure planning commission recent priorities	
Storage – integrate current thinking on storage to national energy strategy and planning	Need: To ensure storage is fully considered when planning for energy demand/supply.	
Better information on prospective sites is needed to support planning and early stages of development – including 'soft' constraints, cable routes	Need: Improved planning up front to save developer costs, failed projects, public perception. Include soft constraints / grid availability layers into MaRS planning tool to support early scoping discussions re leasing sites	
Site selection – Should be a process of selecting the best technology for a particular location. Align existing data to allow technology selection/ prioritisation of device types at particular locations e.g.. i.e. TLP or semi-sub with limited anchor spread. may reduce overall footprint of array	Need: Better integration of historical baseline datasets via MEDIN / BODC – across research / industry sectors / government agencies	

Conclusions and way forward

The following section provides a synthesis of the main planning, consenting and innovation needs to support development of floating wind identified in the workshop, with some suggestions as to how the needs might be addressed and taken forward.

Overarching issues relevant to all marine sectors

Improving data collection and sharing, impact assessment evidence and spatial planning is relevant to all marine sectors. Marine sectors are often managed by different devolved Governments or various Government Departments and this can mean it is not clear where the initiative or responsibility to facilitate progress in areas identified below should lie. However, this is not an excuse for lack of progress in such issues.

Marine planning – decisions / recommendations regarding sites for new infrastructure need to be future proofed for climate change, and underpinned by 'hierarchy of needs' reflecting national energy policy.

Development of models to allow population level consequences of mammals / birds / fish displacement / disturbance to be predicted for all renewable energy development sites including floating wind arrays, and their interactions with other marine sectors.

Identification of creative measures to facilitate co-existence and development of constructive / long term relationships which deliver benefits to both fisheries and renewables.

Cumulative impact assessment tools and methods need to be developed then standardised at to ensure appropriate trans-boundary cooperation / data collection and usable outcomes.

Synthesis of environmental impact evidence from relevant fixed wind, wave and oil and gas infrastructure components to inform consenting decisions for floating wind – guidance to assist consistent / transparent decision making.

Consequences of slow responses times and poor engagement on planning applications by MoD and resulting risk carried by developers.

Environmental knowledge gaps and innovation needs specific to floating windfarms

The following tasks are best progressed by industry or regulators and their advisors in collaboration with academics possibly using funds such as Innovation project or Follow on fund, / internships or commissioned through consultancies depending on the issue.

Review of Band CRM to assess suitability for floating wind. At a minimum this should assess the implication of vertical movement of the turbine blades on model out puts.

Review evidence in relation to entanglement and whether existing analysis recommendations are adequate to support decisions for floating wind.

Review of evidence on EMFs in terms of suspended cables in open water rather than buried.

Ghost fishing – review of prevalence and evidence base and potential to interact with mooring lines and cause entrapment on fish / mammals.

Prediction of the impact on fish and shellfish stocks of fisheries exclusion from array footprints and a quantification of spillover effect.

Synthesis of environmental impact evidence from relevant fixed wind, wave and oil and gas infrastructure components to inform consenting decisions for floating wind – guidance to assist consistent / transparent decision making.

Potential emerging / innovative technologies, models, methods and solutions

These issues may be addressed using different sources of innovation funding through the NERC and Innovate UK calls and / or jointly with the ORE and SATAPPS Catapults depending on the topic and availability of funding.

Review of remote sensing / airborne options for enumeration of birds is needed – then develop forward plan for strategic innovation needs - the high cost and extent / duration of bird surveys for FW demo projects is considered to be disproportionate.

Development of socio-economic modelling tool or method to quantify impact of fisheries displacement specific to different fisheries.

Assess suitability of AUVs for characterisation of benthic communities especially in deeper water offshore; compare cost and quality of data from AUV / ROV's – develop best practice.

Test and demonstrate AUVs with passive acoustic monitoring capability for mammal detection / mitigation during towing of FW platform to array site and deployment of supporting infrastructure.

Test ASVs / lidar for resource assessment at deeper water sites offshore – especially important to avoid high cost of installing met masts in deeper water.

Development and testing of hybrid acoustic systems for detecting avian collisions with turbine blades - this may be important at sensitive sites for named species.

Issues requiring cross disciplinary engagement of environmental scientists with engineers and economists

These issues in the main need well resourced projects and could potentially be taken forward in NERC / EPSRC / ESRC strategic science programme, or through Carbon trust OWA or in collaboration with ORE catapult where there is a distinctive innovation element. The issues need to be discussed further in future scoping workshops.

- Metocean / hydrodynamic modellers and engineering design of all components of FW infrastructure – platform / moorings / anchor systems / cables etc – this is to ensure that environmental impacts are designed out of technology where ever possible.
- Wind resource / atmospheric modellers and turbine / platform design engineers – to take account of extreme metocean conditions and optimise resource utilisation.
- Geomorphologists / modellers and anchor / moorings design – to identify optimum seabed – anchor / mooring solutions and maximise survivability of FW rigs.
- HVDC design and environmental impact – both open water and buried cables; methods for reducing cabling issues.
- Turbine design (esp blades) and acousticians – methods for detecting fine scale cracks / structural failure – possibly combined with collision monitoring.
- Resource assessment to FW array output – long term projections / inter-annual variability – refinement of these inputs to financial modelling.
- Implication of reef effect / FADs for fisheries displacement mitigation – combined with cross sectoral engagement for more positive outcomes.
- Impact of introducing concrete moorings /scour protection materials on benthic communities and identification of mitigation options.

The workshop attendees were unsure as to which organisation is best equipped to take forward the R&D / innovation to address the issues identified. However, coordination to ensure strategic focus on the most important priorities for the FW sector, and to minimise gaps and overlaps in R&D projects, will be essential to ensure cost effective use of resources.

Appendix 1: Workshop Attendees

Sarah Keynes	NERC
Sally Reid	NERC
Glenn Goodall	EPSRC
Ove Vold	Hywind/Statoil
Ole Stobbe	Ideol
Richard Trueman	Hartley Anderson
Ian Davies	Marine Scotland Science
David Pratt	Marine Scotland Policy
Paul Kirk	Marine Management Organisation
Rachael Plunkett	SMRU
Dougie Watson	The Crown Estate
Jess Campbell	The Crown Estate
Fraser Macdonald	FASTNET KE Fellow
Hina Bacai	SATAPPS CATAPULT
Liz Masden	UHI
Ian Campbell	UHI
Jørn Scharling Holm	DONG Energy
Jon Rees	CEFAS

Angus Vantoch-Wood	Carbon Trust
Cian Conroy	ORE Catapult
Zoë Crutchfield	Arup
Annie Linley	Independent
Guillaume Ardoise	Principle Power
Richard Wakefield	Atkins
Sarah Edwards	Xodus
Erica Knott	Scottish Natural Heritage
Kate Smith*	Natural Resources Wales
Alex Sansom	RSPB
Nick Dodson	Trinity house
John Watt	SFF
Malcolm Morrison	SFF
Christine Sams	National Oceanography Centre
Siobhan Browne	DECC (now DBEIS)
Marcus Thor	Hexicon
Jack Farnham	RES

*supplied written input

Appendix 2: Programme & Questions

Workshop to identify the environmental and consenting barriers to developing floating wind farms including innovative solutions.

Background

The UK potentially has a significant opportunity to continue its leading role in offshore wind farm development to progress to commercialising floating wind. Floating wind turbines have been proposed for many years, with ~30 different technologies in development internationally. They are seen as a cost effective solution to deploying in waters too deep for traditional technology, or where the seabed is unsuitable for fixed foundations, and a potential solution for accessing higher wind speeds further offshore. Demonstrator projects are in development in UK and overseas waters with the aim of deploying full scale commercial farms of floating wind farms in the near future.

Over the past five years, our understanding of the interactions between offshore renewable technologies (fixed wind turbines, wave and tidal devices) and environmental receptors has grown rapidly, and much of this information can be directly applied to predict the likely consequences of deploying floating wind structures offshore. However, there are also different and emerging environmental considerations specific to floating wind turbines, which need to be tackled and early engagement over the issues will be beneficial for both industry and regulators especially where innovation, R&D is needed.

Aims

The main aims of this workshop are to:

1. Identify the main consenting and environmental risks/barriers to the development of floating offshore wind farms at a demonstration and commercial scale
2. Identify the innovation and translational R&D needed to streamline and de-risk planning, environmental consenting and post consent monitoring for floating wind,

With this in mind the workshop will:

- Identify technologies, models and methods for environmental characterisation, impact assessment and monitoring which can be transferred from fixed wind, wave and tidal technologies and developed for floating wind farms,
- Identify the key new environmental knowledge gaps / innovation needs specific to development of floating windfarms, with focus on barriers to deployment and lowering the costs of environmental consenting and monitoring;
- Discuss potential emerging /innovative technologies and solutions for remote monitoring, data transmission and analysis, and how these might be taken forward and developed to benefit the industry.
- Identify cross disciplinary /organisational engagement of environmental scientists with engineers and economists necessary to facilitate best outcomes.

The workshop will be recorded and a report produced identifying main environmental and consenting risks to development of floating wind, new research needs, opportunities for translation of existing research outcomes (data, skills, insight), likely costs, potential projects and collaborators. The research needs will be prioritised in terms of their importance to contribute to facilitating deployment of floating wind.

Workshop Programme

The morning of talks will set the scene with different perspectives from developers, regulators and SNCBs – focussing on the real issues for floating wind – identified from recent experience whilst utilising the experience of the group to take a forward look and anticipate issues which may emerge in future.

The afternoon will consist of workshop round table sessions with all participants having the opportunity to rotate around all groups / tables. Each group will have a facilitator to provide synthesis at the very end of the afternoon.

A key challenge to participants will be to identify where integrated thinking between environmental scientists and design engineers can de risk future consenting.

Time	Topic	Who Presenting
09:00	Registration - Foyer of Victoria Quay	
09:30 - 9:40	Introductions and housekeeping Aims of the workshop	Sarah Keynes (NERC) Annie Linley / Zoë Crutchfield

09:40 - 10:00	Scene Setting
	• What is status of technology
	  • Foundations
	  • Turbines
	  • Anchoring Systems
	• Where different technologies have similarities
	• Operation & Maintenance
	• Overview of JIP
		Cian Conroy (ORE Catapult) & Rhodri James (Carbon Trust)

10:00 - 10:30	Overview of consenting / environmental issues already encountered with reference to Hywind, Kincardine, HIE - Dounreay demonstration site, Principle Power, Japanese Site	Zoë Crutchfield / Angus Vantoch - Wood
10:30 - 10:45	Break	
10:45 - 11:15	Marine Scotland - What Research is required / issues encountered to date / a forward look at anticipated issues / needs	Ian Davies
11:15 - 11:45	Commercial Fisheries interaction with development of floating wind	John Watt
11:45 - 12:15	Existing Research & Development, Innovation and translation funding opportunities	Annie Linley
12:15 - 12:30	Explain afternoon session	
12:30 - 13:30	Lunch	
13:30 - 16:00	Workshop Session - Facilitators	Rhodri James, Cian Conroy, Annie Linley, Zoë Crutchfield, Fraser MacDonald
16:00 - 17:00	Feedback and way forward	

PM - Workshop Sessions (All To Attend All Sessions)

Example Questions

1. What are the innovation needs / knowledge gaps with Floating Offshore Wind (participants challenged to really focus on these from recent experience of involvement in projects)

2. Main NEW planning, consenting and monitoring issues / knowledge gaps associated with floating wind

3. What are the possibilities and limitations to 're-using' sites that fixed foundations have abandoned?

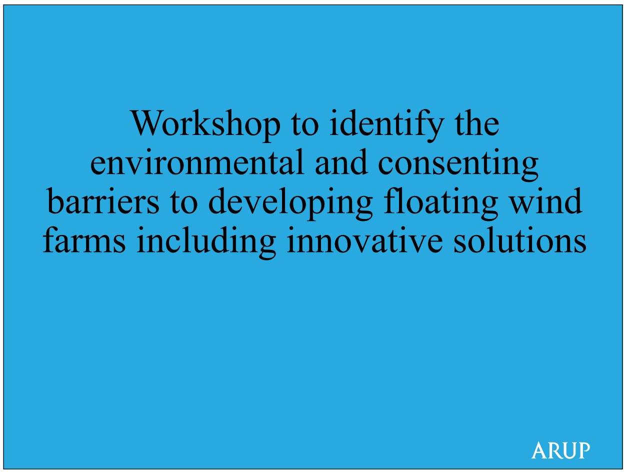
4. Existing technologies/ models / methods needing innovation and development for environmental characterisation / predicting environmental impact of floating wind

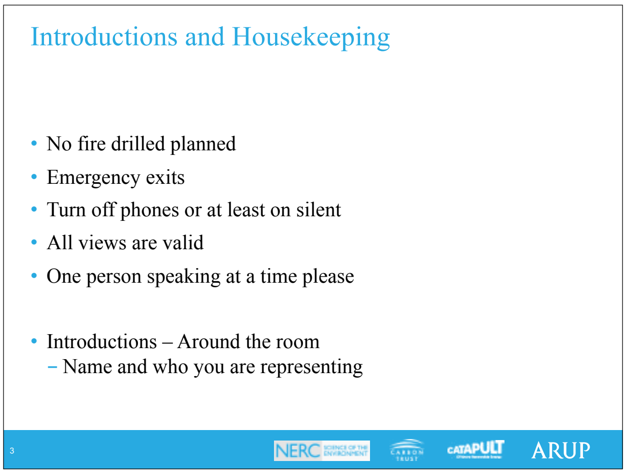
5. Cross disciplinary / cross organisational engagement needed to stimulate appropriate funding calls and facilitate collaboration for innovation / R&D

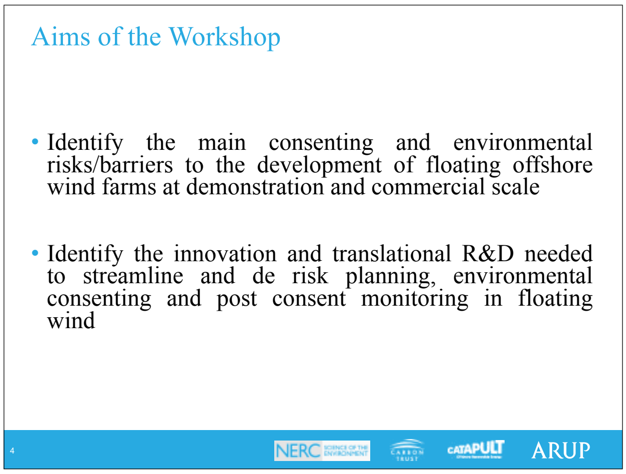
Workshop Outputs

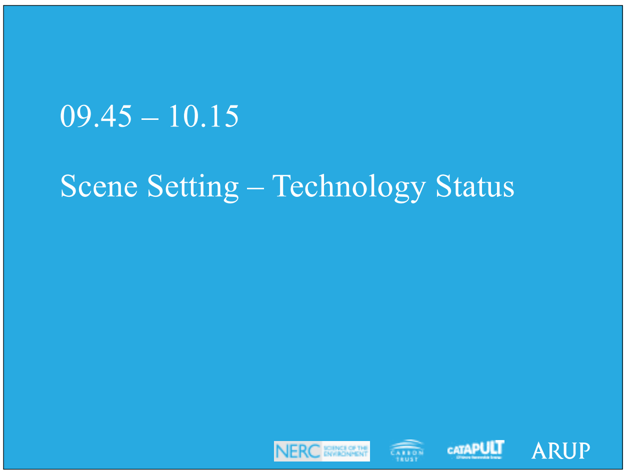
The final output of the workshop will be a report of the day's proceedings together with a synthesis of the R&D innovation needs and opportunities for research translation for the floating wind industry, with a perspective informed by considering engineering design - environmental science jointly, and historical experience of fixed wind, wave and tidal energy deployment.

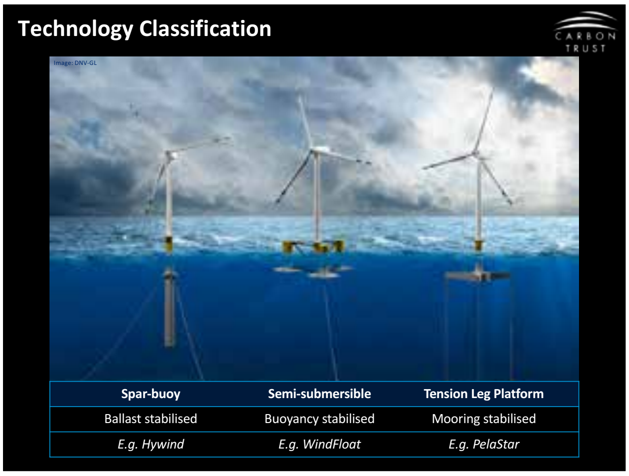
Appendix 3: Presentations

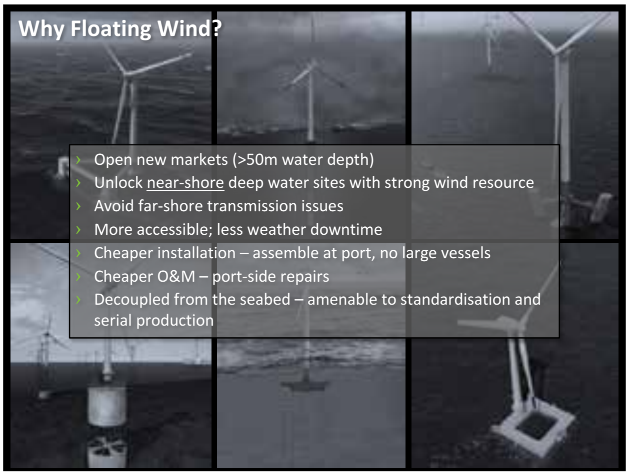








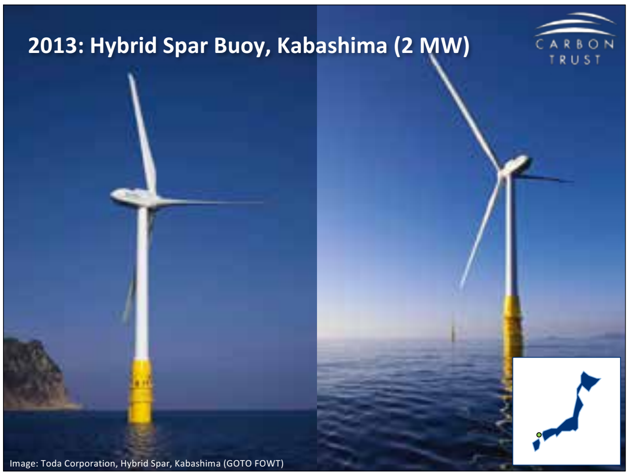

Technology Classification
CARBON TRUST
Spar-buoy
Semi-submersible
Tension Leg Platform
Ballast stabilised
Buoyancy stabilised
Mooring stabilised
E.g. Hywind
E.g. WindFloat
E.g. PelaStar


Why Floating Wind?
Open new markets (>50m water depth)
Unlock near-shore deep water sites with strong wind resource
Avoid far-shore transmission issues
More accessible; less weather downtime
Cheaper installation – assemble at port, no large vessels
Cheaper O&M – port-side repairs
Decoupled from the seabed – amenable to standardisation and serial production


Three Leading Markets for Floating Wind
CARBON TRUST
United States
Europe
Japan
Current status:
4 operational projects
15 MW

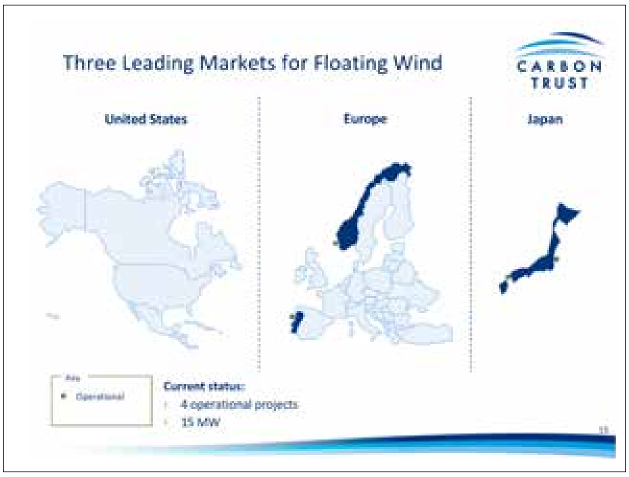

2009: Hywind, Norway (2.3 MW)
CARBON TRUST
Image: Statoil – Hywind, Norway


2011: WindFloat, Portugal (2 MW)
CARBON TRUST
Image: Principle Power – WindFloat, Portugal

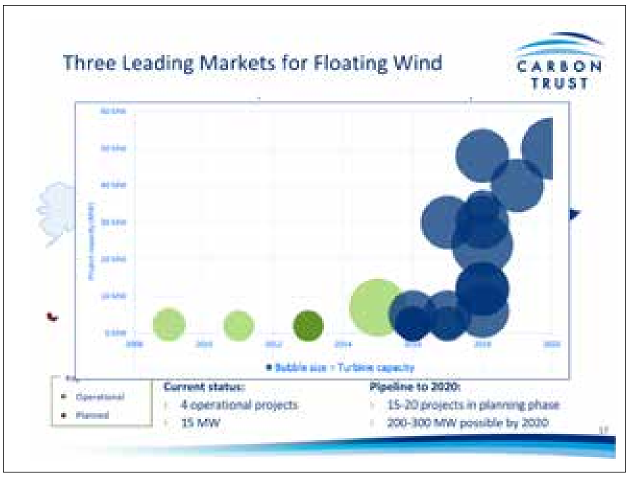

2013: Hybrid Spar Buoy, Kabashima (2 MW)
CARBON TRUST
Image: Toda Corporation, Hybrid Spar, Kabashima (GOTO FOWT)

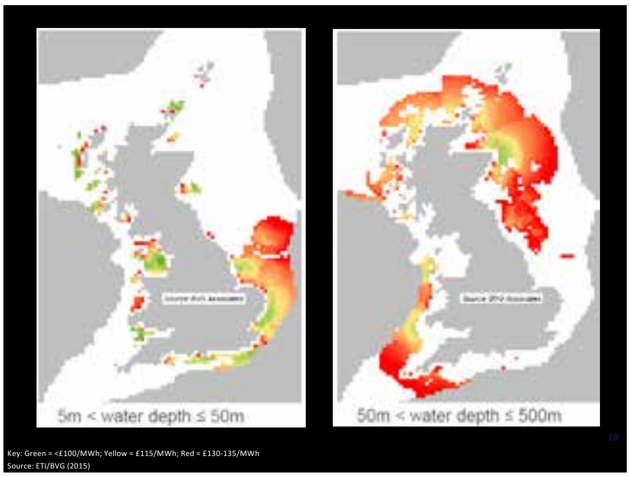

2013: Compact Semi-Sub, Fukushima (2 MW)
CARBON TRUST
Image: Japan Marine United – Advanced Spar
Image: Mitsui Engineering & Shipbuilding – Compact Semi-Sub

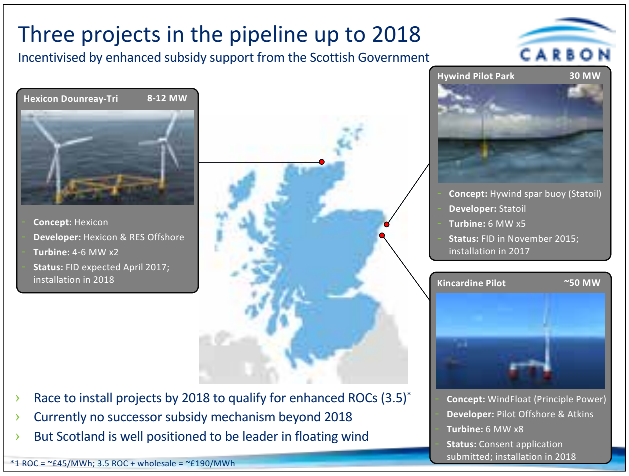

2015: V-Shape Semi-Sub, Fukushima (7 MW)
CARBON TRUST
Image: Mitsubishi Heavy Industries

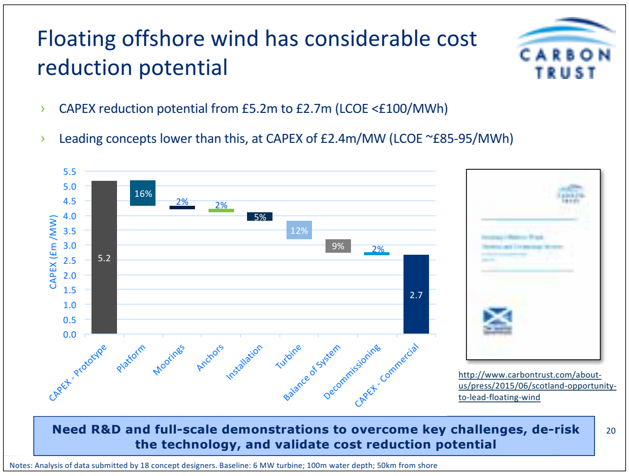

Three Leading Markets for Floating Wind
CARBON TRUST
United States
Europe
Japan
Current status:
4 operational projects
15 MW

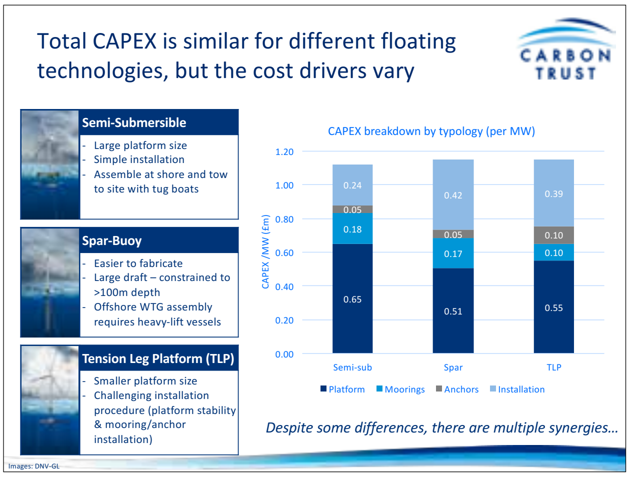

Three Leading Markets for Floating Wind
CARBON TRUST
United States
Japan
Current status:
4 operational projects
15 MW
Pipeline to 2020:
15-20 projects in planning phase
200-300 MW possible by 2020

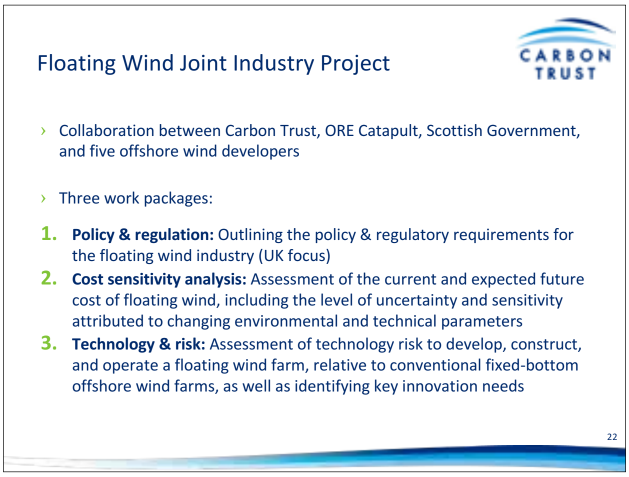

Three Leading Markets for Floating Wind
CARBON TRUST
Bubble size = Turbine capacity
Current status:
4 operational projects
15 MW
Pipeline to 2020:
15-20 projects in planning phase
200-300 MW possible by 2020


5m < water depth ≤ 50m
50m < water depth ≤ 500m
18
Key: Green = <£100/MWh; Yellow = £115/MWh; Red = £130-135/MWh
Source: ETI/BVG (2015)


Three projects in the pipeline up to 2018
Incentivised by enhanced subsidy support from the Scottish Government
CARBON
Hexicon Dounreay-Tri 8-12 MW
Concept: Hexicon
Developer: Hexicon & RES Offshore
Turbine: 4-6 MW x2
Status: FID expected April 2017; installation in 2018
Hywind Pilot Park 30 MW
Concept: Hywind spar buoy (Statoil)
Developer: Statoil
Turbine: 6 MW x5
Status: FID in November 2015; installation in 2017
Kincardine Pilot ~50 MW
Concept: WindFloat (Principle Power)
Developer: Pilot Offshore & Atkins
Turbine: 6 MW x8
Status: Consent application submitted; installation in 2018
Race to install projects by 2018 to qualify for enhanced ROCs (3.5)*
Currently no successor subsidy mechanism beyond 2018
But Scotland is well positioned to be leader in floating wind
*1 ROC = ~£45/MWh; 3.5 ROC + wholesale = ~£190/MWh


Floating offshore wind has considerable cost reduction potential
CARBON TRUST
CAPEX reduction potential from £5.2m to £2.7m (LCOE <£100/MWh)
Leading concepts lower than this, at CAPEX of £2.4m/MW (LCOE ~£85-95/MWh)
CAPEX (£m /MW)
5.2
16%
2%
2%
5%
12%
9%
2%
2.7
CAPEX - Prototype
Platform
Moorings
Anchors
Installation
Turbine
Balance of System
Decommissioning
CAPEX - Commercial
http://www.carbontrust.com/about-us/press/2015/06/scotland-opportunity-to-lead-floating-wind
Need R&D and full-scale demonstrations to overcome key challenges, de-risk the technology, and validate cost reduction potential
20
Notes: Analysis of data submitted by 18 concept designers. Baseline: 6 MW turbine; 100m water depth; 50km from shore


Total CAPEX is similar for different floating technologies, but the cost drivers vary
CARBON TRUST
Semi-Submersible
- Large platform size
- Simple installation
- Assemble at shore and tow to site with tug boats
Spar-Buoy
- Easier to fabricate
- Large draft – constrained to >100m depth
- Offshore WTG assembly requires heavy-lift vessels
Tension Leg Platform (TLP)
- Smaller platform size
- Challenging installation procedure (platform stability & mooring/anchor installation)
CAPEX breakdown by typology (per MW)
CAPEX /MW (£m)
Semi-sub
Spar
TLP
Platform
Moorings
Anchors
Installation
Despite some differences, there are multiple synergies...
Images: DNV-GL


Floating Wind Joint Industry Project
CARBON TRUST
Collaboration between Carbon Trust, ORE Catapult, Scottish Government, and five offshore wind developers
Three work packages:
1. Policy & regulation: Outlining the policy & regulatory requirements for the floating wind industry (UK focus)
2. Cost sensitivity analysis: Assessment of the current and expected future cost of floating wind, including the level of uncertainty and sensitivity attributed to changing environmental and technical parameters
3. Technology & risk: Assessment of technology risk to develop, construct, and operate a floating wind farm, relative to conventional fixed-bottom offshore wind farms, as well as identifying key innovation needs
22


Thank you for listening
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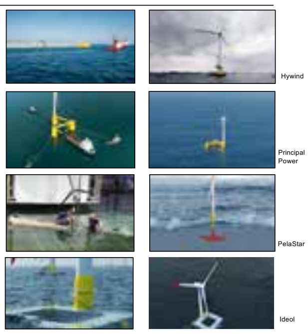
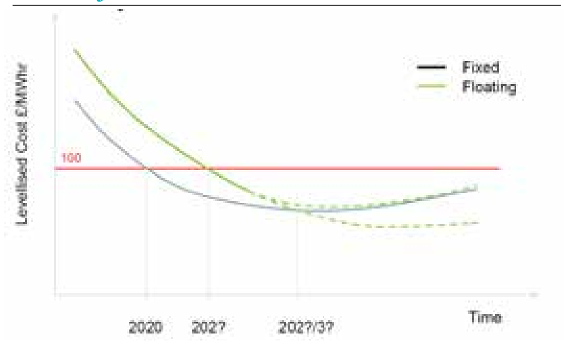
CATAPULT
Offshore Renewable Energy
Floating wind projects: Innovations and developments
20/05/2016
Innovate UK

A rapidly accelerating sector

- Since 2009 sites have been developing to support prototypes and demonstration
  - Karmøy
  - Aguçadoura (Wave)
  - Wavehub? (Wave)
- Technology programmes supporting floating wind and sub components
  - EU (FP7, NER 300, H2020)
  - US (DOE)
  - Japan (Nedo, Ministry of Economy, Trade and Industry)
- Planning for success……



Cost Trajectories



Commercialisation Challenges

- Deployment Volumes
- Regulatory
- Infrastructure

Technology challenges and priorities relate to:

- Wind turbine,
- Support structure,
- Moorings and anchors,
- Electrical infrastructure,
- Installation and maintenance,
- Design standards and tools.

Innovation programmes

- LIFES 50+ Concept development to TRL 5 (€7.3M)
  - Uncertainty and Risk Management
- TLP Wind (£900K)
  - Techno economic assessment
- Component testing

Olav Olsen Iberdrola Ideol Nautilas

Cumulative Learnings of Floating

- Floating substructures build on experiences from other sectors including oil and gas, fixed-bottom offshore wind and shipbuilding.
- Greatest opportunity for 'leaps' are in nascent or areas specific to floating offshore wind,

Nascent	A new technology or process is being used for the floating substructure and is, as yet, untested. Learning is expected to happen rapidly on reaching commercial-scale deployment.
Emerging	An established process is being applied in a new context. Learning due to novelty of application will be balanced by experience from other sectors.
Mature	An established process or technology is being applied in the same or a similar context to its historical uses.

- A sub-system approach to each technology identifies areas for advancement

Floating Wind: Sub Components

Function	System/sub-system/element	System/sub-system/element	[illegible] TLP	Spar	Semi
Structural integrity	Substructure	Primary Steel Fabrication	Emerging	Emerging	Emerging
		Secondary Steel Fabrication	Emerging	Emerging	Emerging
		Mechanical Outfitting	Emerging	Emerging	Emerging
		Coatings	Mature	Mature	Mature
		Cathodic Protection	Mature	Mature	Mature
	Crew transfer system		Nascent	Nascent	Nascent
Power transmission	Electrical interface (umbilical)	Transmission Cable	Mature	Mature	Mature
		Substation	Emerging	Emerging	Emerging
		Array Cable	Nascent	Nascent	Nascent
Station keeping	Mooring system	Mooring (catenary, taut, etc.)	Nascent	Emerging	Emerging
		Anchors / piles	Emerging	Emerging	Mature
		Fairlead	Emerging	Emerging	Emerging
		Yaw system			Nascent
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]

Floating Wind: Sub Components

[illegible]	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Project Development	Permits		Nascent	Nascent	Nascent
	Engineering		Nascent	Nascent	Nascent
	Site Assessment		Mature	Mature	Mature
	Project Management		Emerging	Emerging	Emerging
	Bank Fees and Insurance Charges		Emerging	Emerging	Emerging

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10.15 – 10.35

Overview of consenting / environmental issues

NERC CATAPULT ARUP

Floating Wind

Overview of consenting & environmental issues

Zoe Crutchfield – Marine Environment Lead, Arup

ARUP

BIG FAT CAVEAT

- Potential impacts from scoping opinions, various reports, own knowledge
- We (Zoe & Angus) don't necessarily think these impacts are significant or the areas we should be researching
- We are trying to stimulate debate and discussion
- Good to rule issues out (retire them)
- Think worldwide

35 ARUP

EIA – What's normal?

- Describe the Baseline – desktop and data collection (if necessary)
- Consider impacts/effects
  - Assessment of cumulative and in-combination impacts
  - Construction
  - Operation
  - Decommissioning
  - Both on and offshore potential impacts
- Mitigation – measures proposed
- Monitoring – an indication of the proposed monitoring.

36 ARUP

Changes to EIA Regulations

- Competent Experts must prepare the Environmental Report (no longer an ES)
- Monitoring: monitoring for significant environmental effects & mitigation
- Screening / Timeframe changes
- Health Impact Assessment – Assessment of impacts of a proposed project on human health
- Vulnerability to accidents and disasters
- Better consideration of alternatives

- NEED TO FUTURE PROOF OUR RESEARCH

European Commission

37 ARUP

Floating Wind Foundations Onshore – Anything different?

- Cable Landfall
- Onshore cables & connection to grid (poss. substation)
- Perhaps new, more remote locations – different species
- Onshore construction sites – different to fixed?

38 ARUP

Biological Environment

*'It needs to be categorically established which species are present on and near the site, and where, before the application is considered for consent'**

What

Where

When

Why

Scale of required data collection?

Proportionality – Demo vs. Commercial

**MS Kincardine Offshore Wind Farm Scoping Opinion*

39 ARUP

Biological Receptors – Full life cycle

Receptor	Pathway	Potential Impacts		
		Construction	Operation	Decommissioning
Benthos	Cables, Anchors, other seabed intrusion	Different species, inland waterways, ports?	Marine species,	Where floated to? Re-use? More limited timescale projects?
Fish & Shellfish	Changes to seabed, habitat type, pressures, if aquaculture used – knock on impacts	Ports/Inland waterways	Offshore – Fish aggregation devices – does this help/hinder?	What happens when you take structure away?
Marine Mammals	Moving structures, platforms to haul out, anchor chains, underwater noise	Different species closer to shore	Demo vs. Large Array – scale up of impacts?	Noise?
Ornithology	Collision risk, displacement, disturbance	Different species – onshore	Offshore – perhaps in different / new areas Are current tools fit for purpose?	What happens when you take them away (Cormorants no longer have a resting place?)
Seascape / Landscape	Some moving structures	Impacts during construction – may be temporary but…	Do we have the tools to assess moving structures?	When to leave?
Non native species	Ballast Water Discharges, Marine Growth	Will depend on where construction takes place	Marine Growth – How cleaned? O&M?	Where taken to? More re-use

40 ARUP

Physical Environment

- Sediment movement
- Coastal Processes
- Wave and Tide
- Sea temperature

- Is there anything new/different to other offshore structures?
  - Anchors – O&G FPSO, Semi subs, drill rig etc.
  - Continual changes to seabed?
  - Floating foundations installed where fixed not viable

41 ARUP

CARBON TRUST

Floating Wind Workshop: The Human Environment

Angus Vantoch-Wood
Carbon Trust

20th May 2016
Victoria Quay

Floating Wind Workshop
The Human Environment:

Caveat:

- The potential issues identified are not necessarily ones that will be valid however we are consciously starting with a wide scope.
- Our intention is to stimulate discussion.

…So everything Zoe just said…

43

Floating Wind Workshop
The Human Environment:

A point for clarification: Floating wind offers the opportunity to deploy further off shore however there is a likelihood that deep water **near shore** locations will be exploited first.

Should far-shore sites be exploited at commercial scale, stakeholder considerations will change due to distance from shore.

- Near shore; nearshore small vessel fishing, heritage.
- Far shore; deep sea trawler fishing, oil and gas.

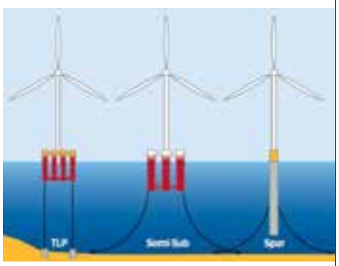
Demonstration/Pilot array sites may therefore face different (and potentially *higher*) impact considerations per turbine than more commercial sites (further far shore studies are required however to validate this).

44

Floating Wind Workshop
The Human Environment: Fisheries

Potential high conflict of use in fishing areas due to:

- There is little opportunity for co-location (except with TLP).
- Mooring footprint for Semi Sub and Spar Buoy technologies.
  (4-6 x water depth mooring spread ∴ for 50-250m = 200-1500m exclusion for fishing)
- Full commercial sites may be located in major trawling areas require:
  - Fishing intensity studies.
  - Higher international engagement.



45

Floating Wind Workshop
The Human Environment: Navigation and Safety

Regulations and legislation to date (IALA, Marine Licencing, Collision Regs etc.) may be adequate however unique areas for consideration relate to the following categories:

- **Mobility** (or potential for mobility) of the turbine structure and in particular:
  - *Planned operational movement* of structures (e.g. winched yawing to maximize resource capture) this may result in taught moorings and/or minor reduction in SAR lanes etc. Particularly relevant for multiple turbine and integrated wave/wind?
  - *Unplanned operational movement* such as sea swell or high wind swinging which could result in reduction in SAR lanes (~20m) and turbine distances.

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Floating Wind Workshop
The Human Environment: Navigation and Safety

Fukushima Forward project
Spar buoy ballasting failure
14/05/16

- **Critical failure**
  could result in:
  - Loss of station.
  - Sinking.
  - Dragging arrays?

Project developers would be required to develop an emergency response plan for such instances and show 3rd party verification of the mooring system.

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Floating Wind Workshop
The Human Environment: Navigation and Safety

- **Site Identification**
  - Prohibit anchorage and fishing warnings on navigational maps.
  - Potential 50m safety zone around structures? Some stakeholders have argued this is an ineffective and thus *refutable* designation if not policed.
- **Search and rescue**
  Further out to sea response times will clearly increase making considerations for helicopter rescue even more pertinent.
  (rescuing someone from a 200m high moving structure in the stormy sea!)

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Floating Wind Workshop
The Human Environment: Lifecycle

CARBON TRUST

- Potential for higher navigational, radar, noise or aviation issues during;
  - Port side fabrication/breakdown: Large mobile structures (175m+).
  - Installation/Removal: During tow-out/in and hook-up/removal.
  - O&M specifically the maintenance: 'Sheltered service' locations if these include a permanent mooring (e.g. for a designated large farm service locations).

Wind Farm Construction Phases

Fixed Wind	Survey & Prep	Foundation & TP	Turbines	Cables	
Floating Wind	Survey & Prep	Anchors & Moorings	Cables WTG @ Port	Turbines	

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Floating Wind Workshop
The Human Environment: Military

CARBON TRUST

- Submarine/submerged activity could be affected due to mooring and cable spreads (such as at the RLGO proposed North - Minch site).
- Potential higher radar interference due to mobile spinning blades.
- Susceptibility to terrorism or theft even?!

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Floating Wind Workshop
The Human Environment: Potential Mitigations and Solutions

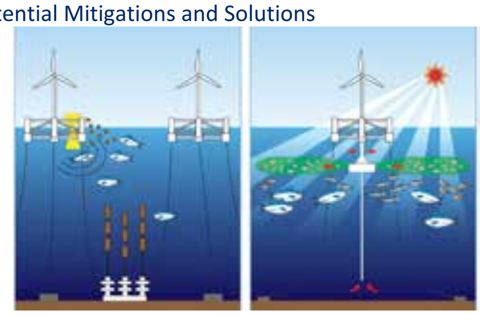
CARBON TRUST

- All stakeholders stressed early engagement as the key to successful management (i.e. site selection *after* initial consultations).
- Fishing industry is potentially most impacted by large scale far-shore floating sites. Can R&D initiatives help mitigate these and reduce stakeholder conflict?
  - Validation of potential benefits claimed (e.g. "FAD" studies).
  - Opportunities for mutual site use integration (static fishing systems, integrated fishing systems).
  - Further research of solutions are not necessarily exclusive use (e.g. TLP).

51

Floating Wind Workshop
The Human Environment: Potential Mitigations and Solutions

CARBON TRUST



Marine Farm and Fertilization options?

Fukushima Forward project

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Thank you for Listening

Carbon Trust
Innovation Team
Forsyth House
93 George Street
Edinburgh EH2 3ES
Scotland

10.35 – 10.45

Friends of Floating Offshore Wind

Ole Stobbe

54

10.45 – 11.00

Break

NERC CARBON TRUST CATAPULT ARUP

11.00 – 11.20

Marine Scotland

What Research is required / issues encountered to date / a forward look at anticipated issues / needs

NERC CARBON TRUST CATAPULT ARUP

What Research is required / issues encountered to date / a forward look at anticipated issues / needs

The Scottish Government

Dr Ian M Davies

(Marine Scotland Science)

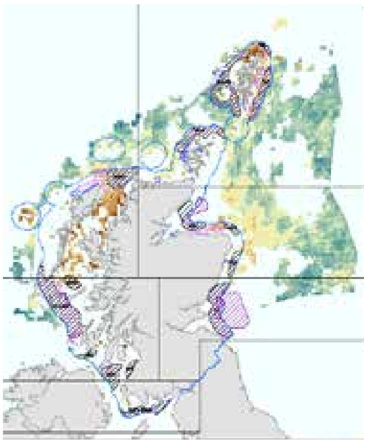
marine scotland science

Marine Scotland's roles in renewable energy

Planning authority

Licensing authority

Science support



Sectoral Marine Planning

2011 Marine Scotland Science Scoping Report

- Constraint layer clipped by depth used to identify potential floating turbine areas

Marine mammals

marine scotland science

Pressure	Comment	Consequences for impact
Piling noise	Probably no piling	Reduced
Mooring lines	Entanglement or confusion risk to large mammals	Increased, but probably not important
Mooring lines	Ghost fishing	Increased. Significance not clear

Sea birds

marinescotland science

Pressure	Comment	Consequences for impact
Collision	Vertical and horizontal movement of turbine head due to wave action, tide, etc.), and this may not be taken into account in current modelling. Blade clearance height above sea level may be lower than possible for fixed bases.	Consequences not clear
Displacement	Likely to displace birds, as fixed wind. Scale of effect may depend on turbine spacing	Unlikely to change?
Barrier effect	May depend on turbine spacing	Unlikely to change? Multiple devices on one structure may alter power extraction density
Location	In time, would be further offshore, lower breeding bird densities	Probably reduced, although demo sites tend to be close to shore

Fish

marinescotland science

Pressure	Comment	Consequences for impact
Mooring lines	Ghost fishing	Increased. Significance not clear
New habitat	Reef effect and colonisation potential	Decreased
Power transmission cables	Emf from cables in mid-water	Increased, but significance not clear
Piling noise	Probably no piling	Reduced

Seabed

marinescotland science

Pressure	Comment	Consequences for impact
New habitat	Reef effect and colonisation potential	Decreased
Habitat disturbance	Physical interaction with seabed	Probably reduced, certainly less than gravity bases
De facto protected area	Reduced fishing pressure in the wind farm	Reduced
Habitat disturbance	Offshore sites will probably require longer cable routes to shore	Increased

Physical processes

Pressure	Comment	Consequences for impact
Currents	No foundations, less interaction	Reduced
Waves	Energy extraction from wind	No change? May be dependent on turbine spacing (power extraction density)
Mixing	Reduced vertical mixing, nutrient recycling and primary production	No change? May be dependent on turbine spacing (power extraction density)

Fishing

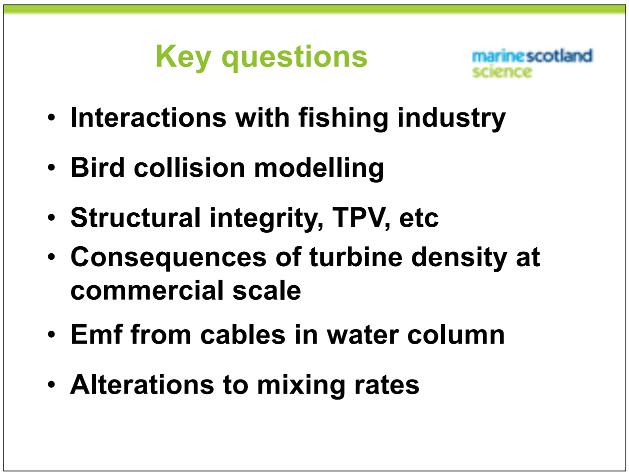
marinescotland science

Pressure	Comment	Consequences for impact
Exclusion	Spread of anchors and mooring lines	Increased
Entanglement	Loss of fishing gear	Increased
De facto protected area	Reduced fishing pressure in the wind farm, refuge effect	Decreased ?

Other matters

marinescotland science

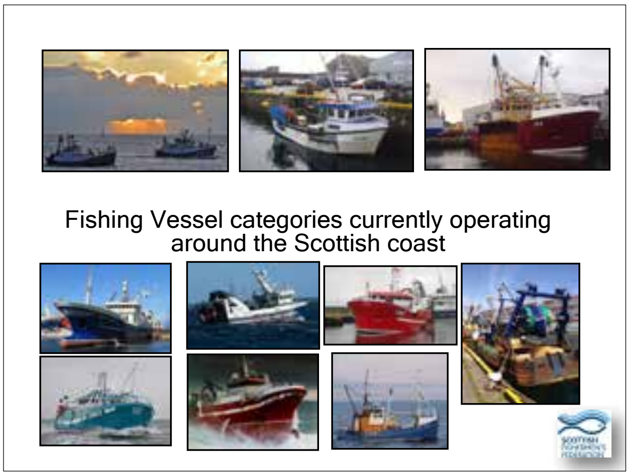
Pressure	Comment	Consequences for impact
Disturbance	Faster and simpler installation, less traffic, less time, less disturbance	Reduced
Visual impact	In time, would be further offshore, less visual impact from shore	Reduced
Navigation risk	Presence of new offshore structures	No change? May be dependent on turbine spacing (power extraction density)
Structural integrity	Uncertainty about survivability of structures. Knowledge available from oil industry	Increased


Key questions
marine scotland science
• Interactions with fishing industry
• Bird collision modelling
• Structural integrity, TPV, etc
• Consequences of turbine density at commercial scale
• Emf from cables in water column
• Alterations to mixing rates

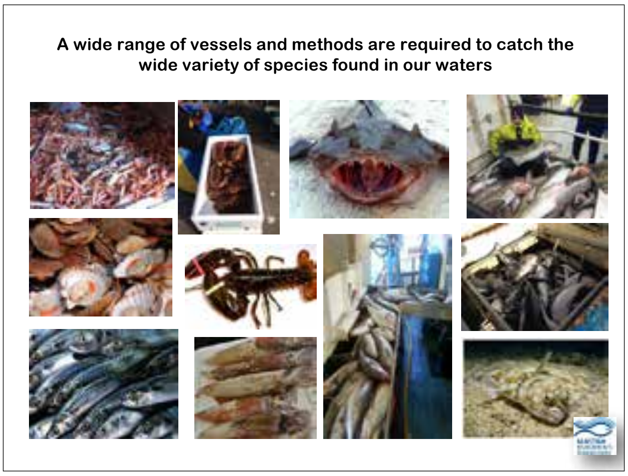

11.20 – 11.45
Implications for Commercial Fisheries
NERC
CATAPULT
ARUP

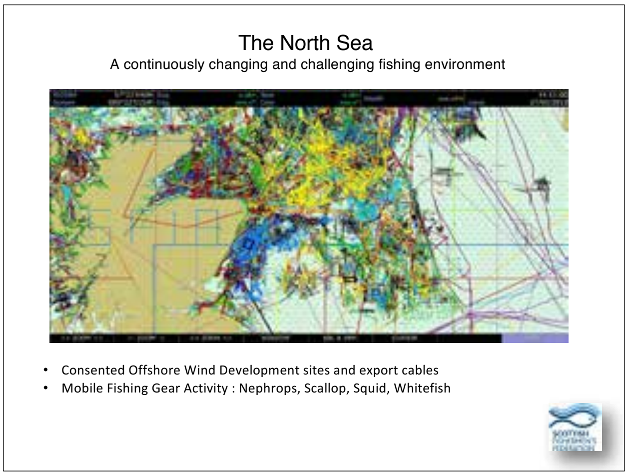

Floating Wind
Commercial Fisheries
Can we collocate/coexist ?
SCOTTISH FISHERMEN'S FEDERATION


SFF Ten Member Associations
SHETLAND
ORKNEY FISHERIES
SPFA
SWFPA
FVA&OA
FFA
Clyde Fishermen's Association
ANGLO-SCOTTISH FISHERMEN'S ASSOCIATION
SCOTTISH FISHERMEN'S FEDERATION

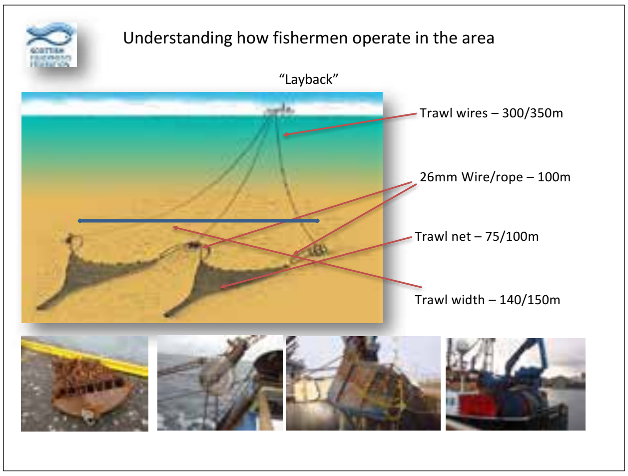

Fishing Vessel categories currently operating around the Scottish coast

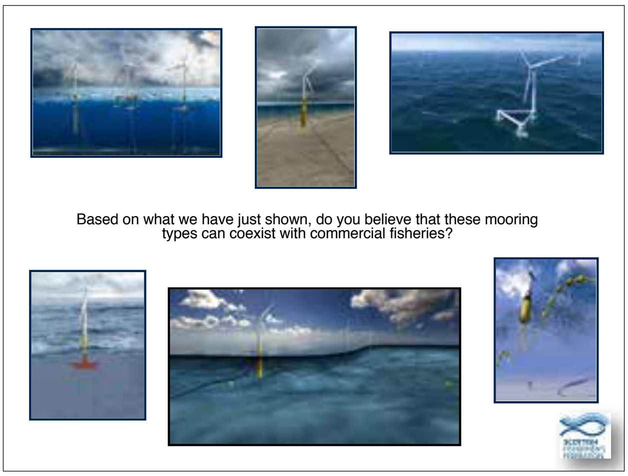

Fishing Methods used by Scottish Vessels
Each method shown depends on four very important factors:
• Vessel suitability
• Target species
• Water depth
• Seabed type
Over and above all these, fishermen also have to consider oil & gas infrastructure, subsea cables, MPAs, SAC and shipping lanes

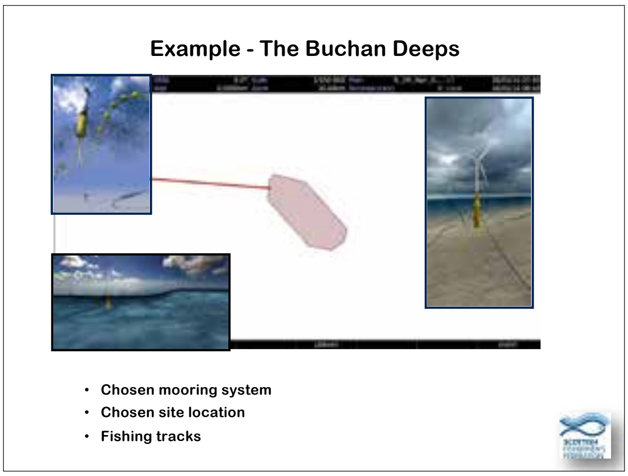

A wide range of vessels and methods are required to catch the wide variety of species found in our waters


The North Sea
A continuously changing and challenging fishing environment
Consented Offshore Wind Development sites and export cables
Mobile Fishing Gear Activity : Nephrops, Scallop, Squid, Whitefish


Understanding how fishermen operate in these areas


Understanding how fishermen operate in the area
"Layback"
Trawl wires – 300/350m
26mm Wire/rope – 100m
Trawl net – 75/100m
Trawl width – 140/150m


Based on what we have just shown, do you believe that these mooring types can coexist with commercial fisheries?


Example - The Buchan Deeps
Chosen mooring system
Chosen site location
Fishing tracks

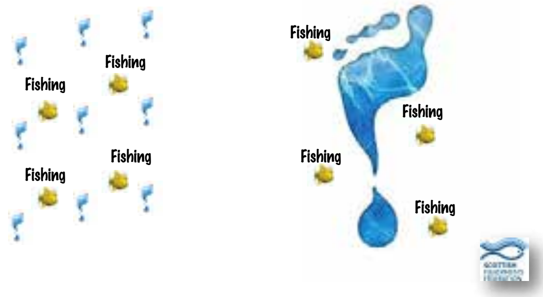
The Footprint!

- Is one mooring system better/ less impactful than another?
- What drives a Developer towards a specific system?
- Fishermen can't just change fishing methods and still catch the same target species, which could allow continued operating within the floating wind farm
- Unlike fixed offshore wind, there are no mitigation measures which can be recommended in an attempt to achieve co-existence
- Collaborative site selection for any wind farms is vital!

Co-existence or Non-existence

Fixed wind or taught wire moorings

Floating wind with anchor style moorings



Offshore Wind - Fixed / Floating

- Footprint of a single fixed turbine is 50m / 1000m anchor spread
- Snagging risks are highest around the mono pile or jacket / snagging risks are everywhere
- Mitigation measures can reduce risks, no safety zones / the whole area becomes an exclusion zone for fishing
- Inter array cables - buried / in the water column

Going Forward

1. Can Floating Wind lessen their impacts as they become larger full scale developments?
2. Can the impacts be reduced to the levels of Fixed Wind?
3. If Developers genuinely aim to achieve coexistence and collocation, can these hurdles be overcome?
4. Possibly Developers need to understand better what is already ongoing within their chosen development area.

11.45 – 12.00

DECC Strategic Environmental Assessment

NERC CARBON TRUST CATAPULT ARUP

DECC Offshore Energy SEA 3 Assessment & Conclusions for Floating Wind

Richard Trueman
Hartley Anderson Ltd

May 2016

DECC SEA Programme

- Commenced in 1999 - SEA 1 for oil and gas licensing
- Series of SEAs around the UKCS
- R2 Wind SEA (2003)
- OESEA (2009) – oil and gas, gas storage and offshore wind
- OESEA2 (2011) - oil & gas, offshore wind, wave and tidal stream, gas and carbon dioxide storage
- OESEA3 (2016) – as for OESEA2 but includes tidal range

Purpose of OESEA 3

- Consider the environmental implications (including spatial issues) of licensing/leasing for the various elements of the draft plan/programme and its reasonable alternatives
- Inform the UK Government's decision
- Provide routes for public and stakeholder participation in the process

Draft plan/programme – offshore wind

- To enable further offshore wind farm leasing in the relevant parts of the UK Exclusive Economic Zone and the territorial waters of England and Wales to contribute to the achievement of UK renewable energy targets and longer term decarbonisation goals. The technologies covered include turbines of up to 15MW capacity and **tethered turbines in waters up to 200m.**
- The Scottish Renewable Energy Zone and the territorial waters of Scotland and Northern Ireland are not included in this part of the plan/programme.

Offshore wind – prospective areas (OESEA3)

- Fixed foundations - water depths of <60m
- tethered turbines - water depths of 50-200m
- Potential deployment area for tethered turbines - within 100km of coast, average wind speeds >9ms^{-1} and water depth >50m (Wood *et al.* 2013*).
- Indicative only as range of other factors (e.g. grid access, proximity to ports) determine location

*Wood et al. (2013). Position paper: Provision of Environmental Studies: Final Report. Cefas and others for Glosten Associates.

Offshore wind –prospective areas (UKCS)

Wind resource and current wind farm status

- Average wind speed (m/s) at 110m, 1984-2014 (TCE 2015 dataset)
- UK offshore wind generation capacity - in planning (3.07GW), consented or under construction (14.46GW) and operational (5.01GW)

Indicative operational dates and target installed capacities for UK wind farm zones

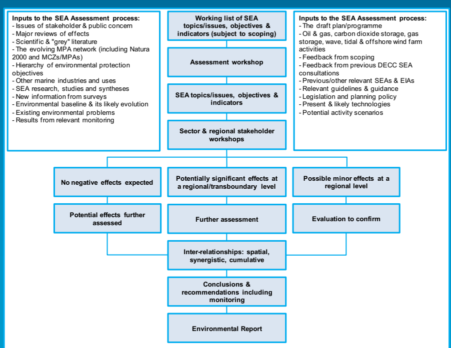
2015 - 2020

2020 onwards

Floating wind demonstration projects

- Within the currency of this SEA (5 years), expected that most commercial proposals will be for fixed foundation wind farms, with tethered turbines continuing to be demonstrated for commercial deployment in the 2020s.
- UK proposals for demonstrator scale deployments include:
  - Hywind Scotland Pilot Park - five 6MW Hywind devices 30km off the coast of Peterhead (granted lease)
  - Dounreay Tri Floating Wind Demonstration Project – two 4-8MW turbines 6-9km off Dounreay (pre-application scoping stage),
  - Kincardine offshore wind farm - eight 6MW semi-submersible turbines located approximately 15km offshore from Aberdeen (in planning)
  - PelaStar demonstrator to be installed at WaveHub off Cornwall (not proceeding).

OESEA3 Assessment process



Key receptors and sources of potentially significant effect with respect to offshore wind

Biodiversity, habitats, flora & fauna
Physical damage to biotopes from infrastructure construction, vessel/rig anchoring
Behavioural and physiological effects on marine mammals, birds and fish associated with construction phase noise
The introduction and spread of non-native species
Behavioural disturbance to fish, birds and marine mammals from physical presence of infrastructure and support activities
Collision risks to birds and marine mammals
Collision risks to bats
Barriers to movement of birds
Geology & soils
Physical effects of anchoring and infrastructure construction (including cables) on seabed sediments and geomorphological features (including scour)
Landscape & seascape
Potential effects of development on seascape including change to character (interactions between people (and their activities) and places (and the natural and cultural processes that shape them
Other users of the sea, material assets (infrastructure, and natural resources)
Interactions with fishing activities (exclusion, displacement, gear interactions, "sanctuary effects")
Other interactions with shipping, military, potential other marine renewables and other human uses of the offshore environment
Cultural heritage
Physical damage to submerged heritage/archaeological contexts from infrastructure construction, vessel/rig anchoring etc. and impacts on the setting of coastal historic environmental assets and loss of access.

Constraint mapping to inform OESEA3

- Indicative spatial constraints mapping used to highlight potential areas which may be more constrained for marine renewables.
- Provides a snapshot of the current situation as some of the constraints listed are likely to change over time (e.g. changes to aggregate licence areas, oil and gas decommissioning etc.).
- List of constraints not comprehensive as some don't lend themselves to easy spatial analysis (e.g. fishing) but these covered elsewhere in the SEA.

Constraint mapping to inform OESEA3

Hard constraints: likely to definitively and consistently exclude development
Areas subject to lease by The Crown Estate for offshore wind, wave or tidal energy.
Aggregates licence and application area
Aggregate exploration and option areas.
Active offshore marine cables and pipelines: 500m buffer
Oil and gas infrastructure: 500m buffer representing safety zones (surface and subsurface)
Oil and gas infrastructure: 6nm buffer
IMO vessel routeing measures
MoD PEXAs: selected danger areas
Navigation: Primary Navigation Routes 1 (PNR1) with 1nm buffer
Protected wrecks

Additional constraints: presume against, but not definitively exclude development, e.g. subject to further assessment, developer dialogue and mitigation
Natura 2000 sites: designated, candidate, possible, draft
Marine Conservation Zones
MoD PEXAs: other areas.
NATS radar areas
Navigation: MCA 'siting potential with comprehensive assessment' areas (draft and unpublished OREI 2 areas)
Helicopter Main Routes (HMRs)
Offshore mine lease areas
Gas storage and CCS lease areas
OWF: Agreements for lease – cable corridors
Indicative recreational sailing routes, and sailing and racing areas.

Constraint mapping to inform OESEA3

Seabed area remaining after removal of hard constraints (km²)

Resource	Regional Sea				
	1*	2	3	4	6*
Fixed foundation: 0-60m	6,134	17,133	4,578	7,044	8,172
Tethered foundation: 50-200m	25,726	1,333	653	47,187	2,106

Areas in Regional Sea 1 may be preferred for tethered devices compared to Regional Sea 4 due to reduced technical and cost constraints including distance to shore and calmer metocean conditions.

Constraint mapping to inform OESEA3

Draft, proposed and designated conservation sites

Conclusions

- Given the demonstrator scale and low number of potential projects in the pipeline, no significant environmental effects at a strategic level likely over the lifetime of OESEA3.
- OESEA3 will be periodically reviewed by DECC in the context of new information on technologies, effects, or plan/programme status which will cover any rapid commercial development of floating wind within the lifetime of the SEA.

Relevant recommendations

- Whilst recognising that individual projects will be assessed on a case by case basis through the relevant planning process, developments (individually or cumulatively) should aim to:
  – avoid impingement on major commercial navigation routes where this could significantly increase collision risk or lead to appreciably longer transit times;
  – avoid occupying recognised important fishing grounds in coastal or offshore areas (where this would prevent or significantly impede sustainable fisheries);
  – avoid interference with civilian aviation operations necessary to ensure aviation safety, efficiency and capacity, including radar systems, unless the impacts can be mitigated, are deemed acceptable, are temporary or can be reversed;
  – avoid jeopardising national security for example through interference with radar systems or unacceptable impact on training areas unless the impacts can be appropriately mitigated or are deemed acceptable in consultation with MoD;
  – avoid causing significant detriment to tourism, recreation, amenity and wellbeing as a consequence of deterioration in valued attributes such as landscape, tranquillity, and biodiversity;
  – explore opportunities for co-location which could mitigate potential spatial conflicts with existing users.
- In respect of ecological receptors, a precautionary approach to facility siting in areas known to be of key importance to bird and marine mammal populations is recommended unless evidence indicates that impacts can be appropriately mitigated.

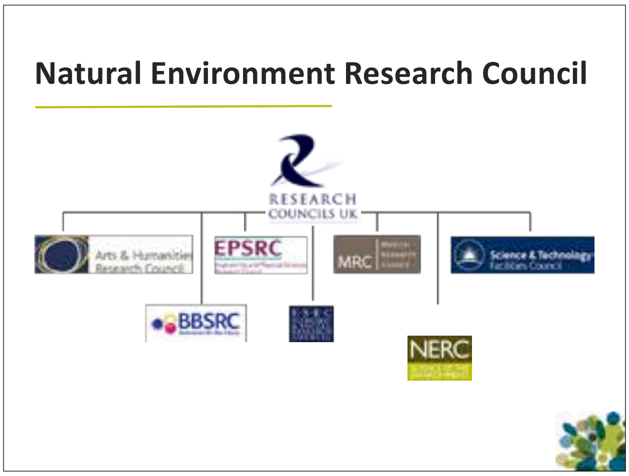
Thank you

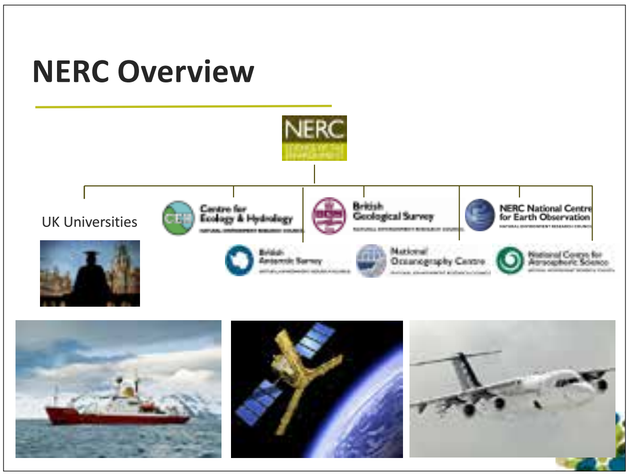
12.00 – 12.20

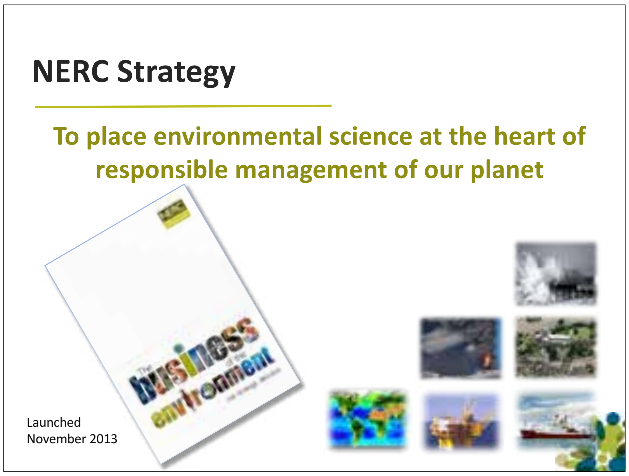
Existing Research & Development Future Funding Opportunities for Innovation and Translation

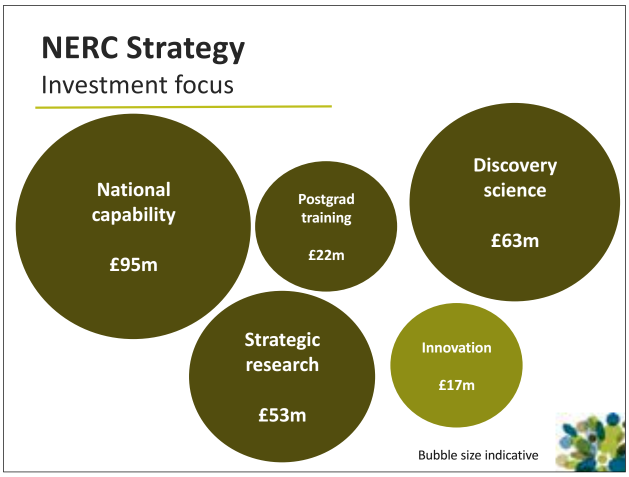
NERC CARBON TRUST CATAPULT ARUP


NERC
NERC perspective on innovation
Floating Wind workshop
Environmental and consenting barriers to developing floating wind farms, including innovative solutions
Sarah Keynes
NERC Knowledge & Innovation Manager: Natural Resources
Tel: 01793 411541 | Email: saryne@nerc.ac.uk
20 May 2016


Natural Environment Research Council
RESEARCH COUNCILS UK
Arts & Humanities Research Council
EPSRC
MRC
Science & Technology Facilities Council
BBSRC
NERC


NERC Overview
NERC
UK Universities
Centre for Ecology & Hydrology
British Geological Survey
NERC National Centre for Earth Observation
British Antarctic Survey
National Oceanography Centre
National Centre for Atmospheric Science


NERC Strategy
To place environmental science at the heart of responsible management of our planet
The business of the environment
Launched November 2013


NERC Strategy
Investment focus
National capability
£95m
Postgrad training
£22m
Discovery science
£63m
Strategic research
£53m
Innovation
£17m
Bubble size indicative


NERC Innovation
Working with business
Partner with business to help find and use environmental science they need
• Understand needs: How can science, knowledge & evidence help business?
• Broker access: to data, expertise and skills
• Translate existing research: Develop innovative tools, approaches & solutions
• Co-design research: where new knowledge is needed
The business of the environment
http://www.nerc.ac.uk/business/

NERC Innovation: Renewable Energy

What's next?

Floating Offshore Wind Farms

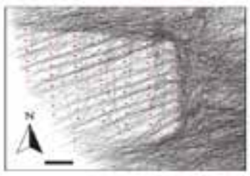
What environmental science can be translated? and Where is innovation needed ?

- Consenting and environmental risks/barriers
- Streamlining and de-risking – planning, consenting, monitoring
- Innovation funding opportunities: http://www.nerc.ac.uk/innovation/together/opportunities/

What exactly are the funding opportunities ?

- **Innovation projects** (academic with business / policy partner up to £100k)
- **Innovation internships** (again with partner – shorter duration ~6months)
- **Follow on fund** – ('pathfinder' to understand the opportunity followed by full proposal)
- **Knowledge Transfer Partnerships**

NERC Innovation project : Review & update avian collision risk models (CRMs)



- large numbers of migrating / foraging birds in, around or transiting offshore windfarms
- needed to improve collision risk modelled outcomes for EIAs;

Reviewed all current options updated current CRMs.
elizabeth.masden@uhi.ac.uk
(collaborators via steering group : Vattenfall, Dong, MMO, MS, SNH, NRW)

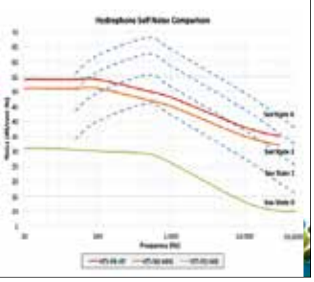
NERC Innovation internships – best value for money and most significant impact !

marine scotland, The Scottish Government, regen SW, TIDAL ENERGY, mojo maritime, RSPB, Wave Hub, MEYGEN, EMEC, baker consultants, GARDLINE GROUP, Ultra ELECTRONICS, SIEMENS, SUSTAINABLE, 4OSOUTH ENERGY

Baker consultants + SMRU : Development of a monitoring protocol for underwater noise

Objective : to minimise costs associated with personnel, set-up and servicing, + ensure appropriate data for EIA to comply with regulations.
Outcome : Improved duty cycle protocol and the intern now employed by Baker consultants on offshore windfarm noise monitoring

Passive acoustic monitoring device: SM2M+ from Wildlife acoustics

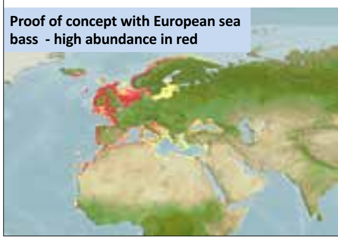


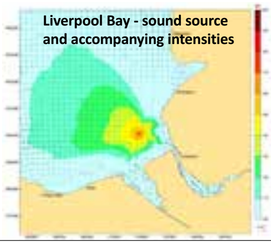
PML Applications Ltd + SAMS : de - risking biofouling of marine energy devices

Objective: biofouling of navigation buoys used to predict impact on wave and tidal energy converters plus infrastructure eg. moorings
Outcomes : decision support tool plus contracts awarded by MERSK and SHELL to Adrian MacLeod using same approach

Knowledge Transfer Partnership
HR Wallingford + Univ of Exeter :

Objective : to improve an existing modelling tool which predicts movements of marine fish in relation to anthropogenic noise .
Outcome : KTP awarded to Rick Bruintjes with HRW and Bristol University; further work in collaboration of Marine Scotland and EON using NaREC dock for noise experiments with at risk species





MRE KE programme - 'matchmaking' for innovation projects, KTPs / CASE awards etc.

SEAFISH, HR Wallingford, nffo, Seiche, JNCC, RSPB, aquatera, RPS Energy, FOREWIND, EMEC, Scottish Natural Heritage, DONG energy

'Discovery' science – but with parallel rapid translation !

Eg. Site characterisation and monitoring with AUVs

- Multi beam / photography already exists - (competes with ROV ?)
- PAM being tested vs static array C-pods
- Problem of power ! (batteries up to 400kms) – docking stations next step ?
- Need to develop robust risk mitigation strategies eg. vs fishing gear !

Joint Strategic Response - NERC with strategic industry / government organisation as partner

EPSRC Engineering and Physical Sciences Research Council, Innovate UK, The Crown Estate, marinescotland, The Scottish Government, Department for Environment Food & Rural Affairs, Department of Energy & Climate Change, Catapult Offshore Renewable Energy

12.20 – 12.30

Workshop Session Explained

NERC, Carbon Trust, Catapult, ARUP

Groups

Zoe Crutchfield	Cian Conroy	Annie Linley	Rhodri James	Fraser MacDonald
Ole Stobbe	Jack Farnham	Ove Vold	Guilliame Ardoise	Jorn Scharling Holm
Liz Masden	Richard Trueman	Richard Wakefield	Christine Sams	Sarah Edwards
Sarah Keynes	Sally Reid	Glenn Goodall	Angus Vantoch-Wood	Peter Douglas
Julie Black	Hina Bacai	Erica Knott	Alex Sansom	Rachael Plunkett
Ian Campbell	Jon Rees	Malcolm Morrison	John Watt	Jess Campbell
Paul Kirk	Siobhan Browne	Douglas Watson	Ian Davies	Phil Gilmour

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ARUP

12.30 – 13.30

Lunch

ARUP

13.30 – 14.30

First Workshop Session

Receptor Specific

ARUP

14.45 – 15.00

First Workshop Session

What is a priority?

ARUP

15.00 – 15.15

Break

ARUP

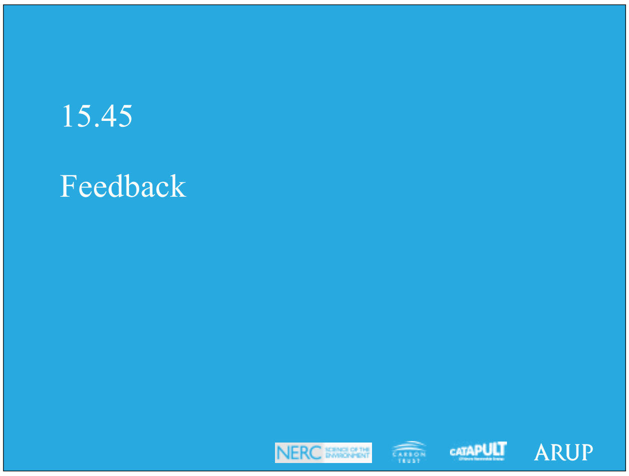
15.15 – 15.30

Re-use of fixed foundation sites

What are the possibilities and limitations to reusing sites that fixed foundations have abandoned?

ARUP


15.30 – 15.45
What is needed for Marine Spatial Planning?
NERC
ARUP


15.45
Feedback
NERC
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For further information please contact:

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