Report on the Workshop for the Accelerated Deployment of Marine Energy

Contents

Executive Summary

This workshop was held to provide a scope for the follow-on activity to the refresh of the SUPERGEN Marine programme that is happening now. This particular activity is intended to drawn on and compliment activities already underway that are supported by other funding organisations. It is **not** intended to duplicate existing activities.

The subsequent call is to be an open call in that anyone with a research programme that meets the call definition and that will advance the deployment of Marine energy will be eligible to apply (normal EPSRC eligibility rules applying) and the successful applicants will be expected to become part of the SUPERGEN Marine activity.

The invitees to the workshop were chosen to representative of as many organisations with an Interest in Marine energy, whilst at the same time keeping numbers manageable. There were 44 attendees who were roughly one half academic, one third industrial and the remainder being from other funding organisations.

The workshop drew out a great depth of detail on the shape of the Marine energy sector and challenges that the sector faces as it moves towards deployment at scale. Whilst many of these challenges are beyond the scope or remit of the research councils they were captured for completeness.

The main findings of the workshop were that the following areas are important. Note that those highlighted are areas identified and mostly with research councils remit. Detail on the specific issues behind each of these can be seen in Appendix I.

- **Turbulence**
- **Resources**
- Design Issues
    - o **Cables, connections and the Grid**
    - o **Materials** and manufacturing
    - o **Resilience Reliability and Sustainability**
    - o Installation, maintenance and recovery
- Operational experience
- **Moorings and Foundations**
- **Environment and environmental impacts**
- **Policy**
- **Economics, costs and risk reduction**
- **Public attitudes and engagement**
- Synergies with other sectors and knowledge transfer
- Skills
- **Whole systems understanding**

The delegates were asked to consider which of these areas had the critical underpinning research challenges that would need to be addressed in order to accelerate deployment and from their input the following overarching call remit areas were chosen.

- o **Large scale Interactive coupled 3D modelling for wave and tidal energy resource and environmental impact.**
- o **Technology for device and environmental monitoring**
- o **Understanding extreme loading events and impact on devices and arrays.**

Background to the workshop

In 2009 planning for the next stage of the SUPERGEN programme was started. By 2011 SUPERGEN Marine would be coming to an end and presented an opportunity to refocus the activity to take into account the changes that had taken place in both the research and development funding landscape and the changed level of maturity of the technology.

A consultation exercise was undertaken in 2009, the results of which helped to define how the programme should evolve and a call for the new Marine energy 'Hub' was made in 2010. The new SUPERGEN structure is intended to provide leadership, ownership and to be more open than the previous programme. Specific research projects would be constructed in a more proactive manner and mechanisms for the inclusion of new ideas and people were built into the mechanism. The first stage to the new activity is the creation of the 'Hub' that would have a strong networking element alongside both structured and flexible research funding. Subsequently to the creation of the 'hub' challenge led activities would be initiated and supported. This workshop and call is the first of these challenge led activities.

In 2010 consultation began between the main government funding organisations with an interest in Marine energy with the aim of better co-ordinating their support. NERC and Defra held a sandpit in December 2010 and will be supporting several projects looking at the environmental aspects of marine energy. The research council's energy programme held this workshop and the TSB will be looking at the outputs of this workshop to help define their future strategy In this area. BBSRC, NERC, TSB and ETI were present at this workshop.

The workshop was attended by 44 delegates, 12 were industrialists, 5 were social scientists, 9 were environmental scientists and 18 were physical scientists and engineers. There were 23 academic institutions represented and 12 industrial/user organisations.

Findings of the workshop

The main issues raised at the workshop are listed here with a brief description. Appendix I contains the raw information from the post-it notes and much more detail on the issues beneath each heading. The interpretation of this detailed data is left to the reader.

Turbulence
There was a general issue around the understanding of the hydrodynamics interactions of devices and the marine environment and also in understanding the nature of the resource (see below). The issues identified varied from pure hydrodynamics modelling to the interactions of wake turbulence in marine turbines and the environment. This is an area that sits squarely in the remit of the research councils where the research is generic and underpinning.

Resources
This was closely related to the turbulence discussion. The issue here was to better understand the energy that is available to be extracted from the marine environment. The underpinning scientific knowledge required to build these resource maps falls with RC remit. This theme attracted a spread of interest across the disciplines as well as from the industry representatives as it was seen as something that would need to be done before large scale deployment takes place.

Design issues, cables and connection, Materials and Manufacturing
These were grouped together during the discussions as they dealt with related issues. As a group of themes they understandably attracted most attention from Physical scientists and industrialists,

though it became clear in discussions that other disciplines impact upon, and are impacted by, the design of the systems that may be deployed.

Design Issues
Design was considered to be an important aspect of device development. As such it is outside the remit of the research councils beyond fundamental research into materials, hydrodynamics etc that may be applied generically.

Cables, connections and the Grid This attracted limited interest, whilst it was noted that it is an important issue it is likely that the challenges will be addressed through other sources.

Materials and manufacturing
This is an area that will need to be addressed as deployment is scaled up, supply chain logistics and manufacturing are more in the remit of the TSB and ETI than the research councils, but the materials issues where they address the fundamental properties do fall within research council remit .

Resilience, Reliability and Sustainability
In many ways these themes are related strongly to the themes described above and attracted a significant degree of interest. Again, where the issues are underpinning the remit will sit in RC remit. Device specific issues will be outside the remit of any following call.

Installation, maintenance and recovery
This theme was again considered very important by the Industrial and Physical science attendees. There was little in this theme that was in the research council remit, however it is something that is starting to be addressed though activities supported by other organisations.

Operational experience
This theme was identified as something the sector would need to gain but was not seen as a pressing issue. It is likely that it will become more important as deployment gathers pace.

Moorings and Foundations
This theme has been known as a challenge area for some time. Though it was highlighted as an issue current recent activity in this area probably mean that it is less of an issue for the Research Councils though some areas will be within remit.

Environment and environmental impacts
This theme attracted much cross disciplinary scientific attention, but not much industry interest. This is surprising given the environmental impact assessments that are going to need to be done by the industries before deployment permissions will be granted and the addressing of any public acceptance issues that may arise. Much of this research in this will fall within NERC and BBSRC remit and may be being covered through the NERC sandpit activity.

Policy
There was broad interest in this area. How much of this is in RC remit is unclear, but clearly policy makers need to be properly advised before they can make well informed policy decisions.

Economics, costs and risk reduction
When challenged to identify the most important issues this attracted some cross disciplinary interest, though surprisingly no industry representative voted for it. This could be because industry expects policy (see above) to take care of any issues. Reducing the costs of this technology and

making it competitive with first other renewables and then more conventional energy generation technologies is imperative if this technology is to succeed.

Public attitudes and engagement
This is a highly social science leaning theme and was strongly supported by the social and environmental scientists. There are issues over the communication of the communication of this technology given the experience of bioenergy and the wind sector, these issues must not be ignored by the engineers and physical scientists working in this area. This theme was taken forward in the challenge detail session. It will be imperative that PE is embedded in any future challenge activity.

Synergies with other sectors and knowledge transfer
This attracted little interest as an issue from the delegates, which was unusual given the fact that there were quite a lot of notes raising it as an issue. Where cross sectoral learning sits is uncertain, it is something that will have to happen as deployment progresses and will more than likely happen through specific interactions where there is a cross over of expertise between sectors.

Skills
This attracted no or little interest when it came to discussions. This could be due to the call for an IDC in offshore energy that the ETI/EPSRC will be supporting shortly, or it could be that training and skills provision is perceived as something that will happen as the needs of the sector arise and requires no additional effort at this time.

Whole systems understanding
Whole systems research, the interaction of all of the various elements of marine energy, falls within the remit of the Research Councils. A better understanding of how the whole system would operate, from the supply chain to array operation through to the markets will enhance the confidence of the sector and will be used to justify investment decisions. Understanding the place of specific devices within whole system is outside Research Council remit.

From the list of areas described the areas that were identified as being within remit were:

Turbulence
Resources
Cables, connections and the Grid
Materials
Resilience Reliability and Sustainability
Moorings and Foundations
Environment and environmental impacts
Policy
Economics, costs and risk reduction
Public attitudes and engagement
Whole systems understanding

APPENDIX I: Raw outputs of the Marine Workshop

Please note that the title in bold are the grouped headings, they are not indicative in themselves, but are merely a convenient heading for the detailed information that is listed below.

The bullet points are the post-it note issues captured as they were written.

The voting dots provide an indication of the level of importance that the delegates put on particular areas.

Red – Physical scientists
Blue – socio economic scientists
Green – Environmental/Biological Scientists
Yellow - Industrialists

It should be noted that some of these themes are within research council remit and some are not. We instructed the delegates to list the whole breadth of issues that face the sector so that they are captured. Only some of these will be taken forward as challenges that the research councils can support.

TURBULENCE
Dots: 2 yellow 2 red 1 green

This theme is effectively the hydrodynamics research that needs to be done in order to better understand the forces effecting devices in a marine environment. General hydrodynamic modelling falls within RC remit, although specific device modelling will not.

- Tidal resource turbulence
- Turbulence. Wave tide interaction underwater turbulence. Modelling and measurement
- Field data →models calibration of models of complex flows
- Turbulence. What is it? Where is it? Does it matter?
- Good 3-D characterisation of tidal stream water column
- Marine spatial planning (integrating all sea users – fishing – shipping – leisure)
- Co-marine sectors – working towards mutually beneficial solutions e.g. fisheries (inshore) – understanding behaviour of crustacean
- Navigational safety issues associated with shared use of marine areas (e.g. safe overhead clearance, bouyage in strong tidal streams)
- Resource assessment – or is it? Accepted and proven methods

RESOURCES
Dots: 3 Yellow 7 Red 4 Green 1 Blue

This is the research needed to better understand the energy that is available to be extracted from the marine environment. The underpinning scientific knowledge required to build these resource maps falls with RC remit. This theme attracted a spread of interest across the disciplines as well as from the industry representatives.

- Security of supply and climate variability
- Dynamic coupling of ocean models with CFD models (feedbacks)

- Effects of tidal energy extraction on behaviour of tide on both array and far field scales
- Uncertainty in resource assessment
- Cumulative and in-combination. Effects between arrays e.g.' resource blocking navigation routes
- Reduce uncertainty in exploitable resource assessment
- How do developments affect the availability of the energy resource
- Maximum sustainable resource (extraction environ interactive)
- How do developments interact at large spatial scales?
- Investor confidence. Nrace →data issue stockbroker – using existing data better. Tidal < what are the constraints? (summary)
- Consenting UK resource map – geographical/regional/local/device scale
- Accurately representing wave and tidal devices into shelf – scale models
- Tidal and wave. Site selection with respect to large scale oceanography (e.g. tidal symmetry, stratification)
- Resource assessment for array planning wave and tide
- Resource assessment issues – data for device optimisation – data for grid scale effects – modelling tools (and there validation)
- Resource estimates and forecasting
- Uncertainty in wave resource for wave farm yield and environmental impact
- Improved wave forecasting (seconds → decades)
- Tidal fences. Identify effects of devices in fences rather than arrays
- Sustainability of wave/tide energy supply in a changing climate?
- Inter – annual and inter – seasonal variability of resource v scale of impact of energy extraction
- Modelling of resource for grid balancing on short-med-long term
- Continuity of supply (spatially and temporally)
- Supply chain. Acoustic holographic measurement
- Cost effective resources assessment and monitoring (e.g. HF radar)
- Lack of long term metocean data prior to financial commitment
- Using ADAP transects (acoustic Doppler current profiler)
- Resource assessment field measurement

Design issues, cables and connection, Materials and Manufacturing were all grouped together as they dealt with related issues.

As a group of themes they understandably attracted most attention from Physical scientists and industrialists, though it became clear that other disciplines impact upon and are impacted by the design of the systems that may be deployed. Design of specific devices will be outside RC remit, though underpinning issues especially around materials will be within RC remit.

DESIGN ISSUES

Dots: 6 Yellow 7 Red

- Bio fouling solutions appropriate new technologies and relevant for development
- Design for – manufacturability – service ability
- Mass manufacturing production engineering
- Marinisation of components thro' – design – materials
- Material technologies
- Cavitation erosion composites

- Materials and advanced construction techniques
- Supply chain – materials – corrosion free – composites – anti–fouling –new disruptive materials
- Rotating power conversion
- Effective tools for through life planning – maintenance, skills, design etc
- Predicting and managing unavoidable risk – financial regulatory, supply chain social
- Minimisation of risk/uncertainty: financial, regulatory, supply chain, social
- Regionalisation of skills – how and where to develop appropriate industry clusters to manufacture
- Investment decisions in certain lots of carry – best mechanism
- Public acceptability regulation is a mess. Market public for investment by big industry. Multiple devices → of skills regulation, maintenance
- Arrays
    - Understanding combined wave and tidal effects
    - Fluid: structure interaction – turbulence – wakes – wave current interacts –
    - Cable risks – scour - prediction of installation
    - Reliable cable burial/predictable
    - Cable installation in high currents
    - Electrical design of arrays power converter technology for → control → power collection → transmission to shore
    - Array infrastructure sub–sea design
    - Environmental considerations as driver for design (to promote technology convergence and "design out" environmental impacts)
- Generators and electrical conversion
    - Bearing for generators → direct drive
    - Power conditioning for wave and power devices
    - Power take off systems
    - Higher efficiency power take off devices
    - Sealing or fully flooded operation
    - Power take off methods
    - Gearless generator technology
    - Power conversion slow speed/direct drive m/cs DE:DE systems (multipoint
    - smart convertors/conditioners
- Offshore structures
    - Impact of highly unsteady loading on turbines
    - Design of dynamically loaded structures
    - Cable connection
    - Structural loads in waves and currents
    - Understanding relationships between model – scale, moderate scale and prototype testing
- Cable and connections to network
    - Infrastructure wet – mateable power data cable connectors
    - Development of standardised connection componentry
    - Reliable undersea cable connection (inter – device in arrays)

CABLE CONNECTION AND GRID

Dots 2 Yellow 2 Red 1 Blue

This attracted limited interest, whilst it was noted that it is an important issue it is likely that the challenges will be addressed through other sources.

- Standardisation of design and performance methodologies

MATERIALS and MANUFACTURING

Dots 1 Blue

- Supply chain/infrastructure/ comms/telemetry for fluid/energy/environment monitoring
- Integrated design – of design – of arrays – of networks – of projects
- Reducing cost – aimed at accepting development and for commercial delivery
- Reduce complexity (device)
- Improving performance and reducing cost
- Standardized performance metrics
- Combined supply chain and infrastructure for wind/wave/tide supply chain design for up–scaled manufacture
- Logistics and infrastructure requirements

RESILIENCE, RELIABILITY AND SURVIVABILITY

Dots 7 Yellow 10 Red 3 Green 1 Blue

In many ways this is related very strongly to the themes described above and attracted a significant degree of interest. Again where the issues are underpinning the remit will sit in RC remit. Device specific issues will be outside the remit of any following call.

- Survivability of devices (extremes)
- Survivability
- Impacts of extreme events on device arrays
- Understanding interaction between reliability, maintenance and access
- Survivability/reliability and weather extremes
- Survivability in extreme events
- Design for reliability component
- Resilient infrastructure - are there points of failure?
- How might devices etc be affected by extreme events/uncertainties
- Reducing uncertainty in prediction of operational and survivable performance (computation and physical test)
- Reliability for long term
- Technology resilience in environment
- Durability of composites (high submergence)
- <u>Reliability</u> achieving high maintenance free operating panels
- Impact of environment on device operation and performance →reliability
- <u>Debris</u> what are the effects of debris on devices and economic efficiency
- Reliability growth – new methods/approaches
- <u>Preventing frame growth</u> – blades – structures
- Understanding extremes and designing for survivability/reliability
- Condition monitoring
- Intelligent control to avoid catastrophic failure →linked to condition monitoring
- <u>Survivability</u> extreme weather events
- Reliability
- Reliability – pitching mechanisms – blade integrity – accelerated testing – test platforms – maintenance free – flooded op

- Long term reliability
- Improved reliability of devices and components
- Reliable sub – sea electrical/ mechanical technology
- Reliability and lifestyle assessment
- Structure vibration
- Structural integrity and health monitoring
- Remote sensing/monitoring
- Status based condition monitoring

INSTALLATION MAINTENANCE AND RECOVERY

Dots 9 Yellow 4 Red

This theme was again considered very important by the Industrial and Physical science attendees. It is unlikely that much of the technology described in this section will be in the remit of the RCs, but is likely to be in ETI or TSB remit.

- More resilient construction methodology/operations e.g. less impacted by weather
- Novel power take off development to suit wave tide and wind
- Little operational experience for current and wave devices
- <u>Operational experience</u>
- Reducing array costs
- Mooring and anchoring arrays – not single units
- Real understanding of the operational environment
- Development and proving of deployment technologies
- Full understanding of site availability for deployment and maintenance (modelling combined with weather forecasting etc)
- Deployment of subsea technology in high energy tidal environment
- <u>Operations in high tidal flows</u> tools to predict dynamic behaviour of installation and vessels
- Wide area sea state "real time" – (wave) – for forecasting – verification of models – for operations
- Cost of small changes in tidal amplitudes on port operations – who pays?
- Navigational risk and practise
- Understanding impacts of up scaling mire device → arrays
- Arrays/up scaled deployment integrated resource planning

OPERATIONAL EXPERIENCE

Dots 1 Yellow 2 Red 1 Blue

This theme was identified as something the sector would need to gain but was not seen as a pressing issue. It is likely that it will become more important as deployment gathers pace.

- <u>Safety</u> – collision risk – fisheries risk (West haven type)
- Maintenance strategies
- Installation and recovery
- Availability of sufficient (large) installation vessels
- and M methods – health and safety – access to devices – remote condition monitoring
- Cost effective installation
- Installation method(s)

- Forecasting for →O&M → device control
- O&M facilities for assets far from shore
- O&N weather restrictions
- Component design for ease of O&M →industry O&M
- Installation and vessels – reduced deployment time
- Efficient installation and recovery methods
- Deployment and maintenance supply chain
- Installation and maintenance of tidal devices in deep (>50m) water and v high currents
- Supply chain rovs for high currents robotic operations/repairs
- Infrastructure and home facilities
- Novel installation and recovery techniques
- Affordable installation access and removal
- Autonomous installation techniques
- Autonomous ROVs for O&M
- Intervention retrievability
- Supply chain multi – purpose installation vehicles vessels
- Wave generation →mooring → foundation (INTERACTION)
- Use of available facilities

MOORING AND FOUNDATIONS

Dots 1 Yellow 4 Red

This theme has been known as a challenge area for some time. Though it was highlighted as an issue current recent activity in this area probably mean that it is less of an issue for the RCs.

- Reduced cost foundations and installations
- Sediment transport impacts and mooring design
- Moorings – esp in arrays
- Mooring footprints →minimisation →shared foundations moorings
- Moorings/fix ups deep water installation/performance scour, sedimentation, fouling whole system respire
- Hydrodynamic loading on mooring cables
- Cost effective ground investigation – minimising cost for arrays
- Supply chain moor ups, umbilicals
- Increasing water depth deployment
- Rapid multi unit installation
- Foundation installation
- 25 – 50 year life span resilience or moorings/anchors
- Mooring in a current
- Array mooring dynamics → (and installation)
- <u>Economical</u> fixed foundation/anchoring technology
- Foundations and structures →cost reduction and standardization
- Capex reduction trough optimised structures and foundations
- Deepwater moorings

ENVIROMENT AND ENVIRONMENTAL IMPACTS
Dots 1 Yellow 6 Red 6 Green 2 Blue

This theme attracted much cross disciplinary scientific attention, but not much industry interest. This is surprising given the environmental impact assessments that are going to need to be done by the industries before deployment permissions will be granted. Much of this research will fall within NERC and BBSRC remit and may be being covered through the NERC sandpit activity.

- Understanding of environmental impact for consenting and legal obligations
- Fisheries impacts "We need to understand impacts on fisheries"
- Benefits/costs of developments – ecosystem services etc
- Changes in mixing lead to subtle alteration in residual flows and sediment transport?
- Detecting environmental impacts against background of climate change
- Climate change and resource change
- Cumulating impact (environmental, navigational and resource)
- Eco system interchange positive and negative
- Environmental interactions – large mobile species (marine mammals and basking sharks, turtles etc) – seabirds
- Environmental impact modelling method
- "Ecosystems approach to environmental effects" – reduce focus on headline species – indentify indicator species
- Knowledge of impact on key species
- Bird poo on wind turbines – cost of keeping them clean and safe to access
- Environmental legislation and impact
- Understanding eco system consequence of physical changes
- Developing predictive modelling capacity for environmental effects
- Generic models for noise impact
- Addressing environmental impacts e.g. replacement habitat
- Alteration of habitat from any kind of structure →change in fish species that live there – habitat directive
- Impacts of marine conservation zones on MRE
- Understanding MPA effects
- Understanding the environmental considerations e.g. turbulence
- Impacts of wave and energy arrays on near shore morph dynamics (environmental impacts AND opportunities)
- Far field effects of arrays on costal environments
- Far field effects
- Understanding far– field physical effects of extracting energy
- Understand of high energy tidal flow environment and structural design of turbine blades
- Impacts (environ and other) of additional infrastructure needed to support MRE industry in UK
- Environmental problems associated with device deployment – esp installation vessels (e.g. azimuth props and seal damage….)
- Hydrodynamics and env. Impact
- Noisy operations associated with deployment – e.g. DP vessels in environmentally sensitive areas
- Acoustics – measurement – modelling – interactions – mammals
- Environmental research at prototype/pre commercial sites (as per TSB–MCT Strangford Lough)

- Technology development for all aspects environmental monitoring (i.e. remote sensing etc) (to reduce costs etc)
- Telemetry
- “SMART” monitoring cheaper quicker automated environmental monitoring
- Shorter bird surveys. Not 2 years
- Cost effective monitoring protocols/tools for EIA etc
- Influence of marine renewable power generation on natural environment. Better understanding leading to better concerting decisions
- Impact on wildlife
- Environmental impact. Expected to be euro. Needs to move “what is it” and “is it acceptable”
- Impact of moorings at large scale on seabed and communities knock on effects throughout water column
- Simplified environmental impact assessments (unified across EU)
- Pre – consenting needs – methods? What needs to be measured?

POLICY
Dots 3 Yellow 1 red 2 Green 2 Blue

There was broad interest in this area. How much of this is in RC remit is unclear, but clearly policy makers need to be properly advised before they can make well informed policy decisions.

- Tidal extraction leads to change in resource across international boundaries →legal issues? International planning needed
- Providing relevant information to regulators
- Streamlined – consenting – env. Impact assessment
- Rescheduled frame works – which might be needed
- Organising for innovation and implementation at regional level: which industry clusters and where
- Policy support for bringing 2nd generation devices forward (including ensuring supply chain is in place) what should it be?
- Streamlining policy and consenting environment to be simple and transparent
- Bring back barrages
- Complexity – knowledge – regulatory regime – policy options
- Uncertainty – science – social/political values – regulation
- How to align developer/industry timescales with research output timescales
- Getting data out of developers (to inform regulation and research)

ECONOMICS/COSTS AND REDUCING FINANCIAL RISK, FUNDING
Dots 3 Red 2 Green 2 Blue

When challenged to identify the most important issues this attracted some cross disciplinary interest, though surprisingly no industry representative voted for it. This could be because industry expects policy (see above) to take care of any issues.

- Reduced uncertainty in future national infrastructure plans (ports, grid connection)
- Reliable resource assessment for estimating returns on investment – including future climate
- Developing/inspiring confidence in industry and technology

- Reducing risks to develops, investors and insurers
- Effective tools for predicting, managing and minimising risk through the life cycle – political/regulatory, supply chain, social, financial etc
- Reduced mass (device) mass costs
- Cost reduction
- Wave needs step changes to reduce costs
- Cost to challenge wind <12p/kwh and confidence
- Money
- Reduce cost. Through monitoring techniques
- Cost/incentives
- Cost reduction
- Conflicts of UBE: priorities – liability – co ordination
- Sustainability of industry given high levels of investment in equipment and only small projects
- Improved cost modelling requires
- Understanding existing costs then reducing p/kwh across lifecycle
- Driving down costs
- Financing
- Understanding economic development potential, supply chain development and community benefit
- Lack of funding

PUBLIC ATTITUDES/ENGAGEMENT

Dots 1 Yellow 2 Green 2 Blue

This is a highly social science leaning theme. It was interesting that none of the physical scientists noted it as highly important given the experience of other technologies. However, this theme was taken forward in the challenge detail session. It will be imperative that PE is embedded in any future challenge activity.

- Dealing with stakeholder (public) resistance
- Stakeholder engagement – how do they want and expect to be involved?
- Coping/managing public/stakeholders involvement
- Public engagement – two way conservation or information provision
- Social perceptions/acceptance of infrastructure required to support industry (onshore and off shore)
- "Public acceptability" – understanding stakeholder values – community benefits how can they be enhanced
- Building community support engagement
- Public attitudes and acceptability

SYNERGIES WITH OTHER SECTORS/KNOWLEDGE TRANSFER

No dots

This attracted little specific interest as an issue from the delegates, which was unusual given the fact that there were quite a lot of notes raising it as an issue. Where cross sectoral learning sits is uncertain, it may be that it is outside RC remit and is something that will need to be addressed as deployment progresses.

- Integrating marine with other renewable systems such as wind turbines
- Need for the identification of synergies with other sectors
- How might we learn from failures in off shore wind? E.g. ensuring environmental risk liability business?
- Knowledge transfer from oil and gas →MRE
- Competing with oil and gas for people and infrastructure
- Production of a strategic research agenda in combination with knowledge transfer from other sectors is req.
- Knowledge transfer between parallel projects to avoid repetition/overlap
- Marine protected areas. Are these synergies with more energy zones and designation of MDA's
- Habitat enhancement opportunities
- Working to achieve co – benefits with other users of the sea
- Opportunities for synergies with other uses of sea areas (fisheries/aquaculture….)

SKILLS

No dots

Surprisingly this attracted no or little interest. This could be due to the IDC in offshore energy that the ETI/EPSRC will be supporting shortly, or it could be that training and skills provision will happen as the needs of the sector arise.

- Skills shortage
- Skills training technicians (not PhDs)

WHOLE SYSTEMS

Dots 1 Green 1 Blue

Whole systems research, the interaction of all of the various elements of marine energy, falls within the remit of the RCs when generic understanding is needed or being sought. Understanding the place of specific devices within whole system is outside RC remit.

- Whole system modelling tools – using wave and tidal into H– D ecosystem models (for LT planning and scenario analysis(
- Whole system device optimisation →CO2 minimisation →LCA minimisation → facilitatory decommissioning
- Modelling across length scales – coupling models – regional ↔area ↔array ↔device with feedback coops (non – linear)
- Systems approach/modelling
- "Whole system" uncertainty →technical →policy →environ / how they interact
- Whole system optimisation (and control)

APPENDIX II: Challenge Proformas as filled in by the delegates.

Please note that these should not be read as the projects that should be considered but as examples only of what may be good workpackages.

The Challenge: To Reduce Cost of Energy (Trade off Between Capex and Opex Through Improved Reliability)

Whose remit is this? EPSRC/ETI/TSB/Carbon Trust

Is work in this are already being done? If 'yes' please provide details.

SUPERGEN – Marine (Exeter/Durham/Heriot – Watt)
SUPERGEN – Wind – Drive trains (Durham)
NCATS – Offshore wind and wave and tidal
NAREC – Test rigs
Device developers (confidential)

Why is this holding back deployment?

The devil is in the detail

Uncertainty in established failure data and failure modes →large uncertainty in operational costs

No "large scale" evidence for array reliability

Cost of energy – estimation of energy output

How would work in this area accelerate deployment?
Systematic approach to component optimisation/design

Underpinning knowledge to feed into design codes (which need adaptation for marine re)

Design fit for purpose

Grater research/development work to increase rate of growth

What work would be needed to be done in order to overcome this challenge.

Understanding ARRAY reliability issues

SPECIFIC research to understand failure mode

Building of a "Public" reliability (VERY IMPORTANT) data knowledge base – quality/integrity

Understand role of monitoring (machines and components)

Inform integration to maintenance schedule

Mitigation methodologies

The Challenge: Large Scale Interactive Resources Modelling in 3 – D for tide and wave devices
Whose remit is this? EPSRC
Is work in this are already being done? If 'yes' please provide details. Partially in PERAWAT and LCRI, but only using 2-D or local scale
Why is this holding back deployment? The current studies are giving resource uncertainty at local and large scale, because of the inherent simplifications in the model hydro dynamics. There is gross uncertainty about the turbulence, particularly in flows with high tidal stream currents, and this is significantly holding back deployment.
How would work in this area accelerate deployment? Improved resource estimated would be provided to assist developers at particular sites and would provide more accurate predictions of environmental Impact for consenting. This also improves national resource estimates and would enable deployment at the most attractive sites
What work would be needed to be done in order to overcome this challenge. 1. Set up 3-D large scale numerical model for UK continental shelf 2. Nest dynamically fine scale 3-D model for device representation (in arrays and arrays of arrays) 3. Include non – linear characterisation of device interactions (e.g. wakes, power output, wave radiation, drag etc) 4. Fully coupled time – stepping solution back to step 1 above 5. Assess morphological and water quality indicated parameters associated with array effects on receptors 6. Assess flood risk impact due to variations in peak water levels

The Challenge: Improving the Regulation/Policy Context
Whose remit is this? Government/Policy Advice Bodies
Is work in this are already being done? If ‘yes’ please provide details. Marine spatial planning (MMD, Marine Scotland, local planning Authorities) Streamlines consents MS Act and MCA Act
Why is this holding back deployment? Concerns about obtaining consents/permissions Costs of consents/EIA Potential conflicts Trans – boundary co – operation requires support/advice/guidance Uncertainty about future law/policy – investment risk
How would work in this area accelerate deployment? Training in policy/regulation Development of guidance
What work would be needed to be done in order to overcome this challenge.

The Challenge: Cost Reduction and Investor Confidence
Whose remit is this? Private Sector, Government
Is work in this are already being done? If 'yes' please provide details. EMEL – limited support Collaborative research
Why is this holding back deployment? Identify areas of common/shared cost that could be reduced by cooperation/shared R&D Fear of making mistakes "Public" Shortage of deployment/installation
How would work in this area accelerate deployment? Reduce Costs??
What work would be needed to be done in order to overcome this challenge. Explore public investment mechanisms Expand projects like EMEC Explore regulatory devices to help reduce risk

The Challenge: Understanding Values and Getting "Buy – In"
Whose remit is this? Government/Research Councils
Is work in this are already being done? If 'yes' please provide details. Yes but 1. Small scale 2. Site specific 3. Some consideration as part of general projects
Why is this holding back deployment? Objections to development Lack of investor confidence (Risk Aversion) Inconsistent/conflicting polices Lack of understanding of key values Commercial secrecy
How would work in this area accelerate deployment? Develop cooperative positions – remove objections Develop synergies across sectors Facilitate easer regulation/licensing Minimise future objections
What work would be needed to be done in order to overcome this challenge. To embed "social/policy" aspect into research programmes Targeted research on impacts of developments on fisheries and other uses – shipping leisure…..tourism/military How do we enhance community benefits from marine renewables

The Challenge: Optimising Knowledge Gain from Existing and Accruing Environmental Data and Understanding

Whose remit is this? DEFRA/DECC/CE/Research Councils/All Stakeholders

Is work in this are already being done? If 'yes' please provide details.

NERC scoping study has identified main data centres

Developers collect data for env. Statements, but do not share because of perceived commercial advantage

Why is this holding back deployment?

Slows down consent

Increases costs

Inhibits innovation and understanding

No coherent or generic knowledge base which would be feasible

Collect once use many times

How would work in this area accelerate deployment?

Deals with above

N.B. learned from offshore wind, oil and gas, deal database (geol. And well data held by BGS funded by oil and gas as a cooperative)

What work would be needed to be done in order to overcome this challenge.

Legislation

Government pays for monitoring

Industry levy?

Network formation

Pro-active survey of potential sites (EMEC/E.CT/Wave hub/…)

Long term research studies at demo and pre-commercial sites

The Challenge: Technology Development for Cost-Effective Environmental Monitoring for Site Characterisation, Installation, Operation and EIA

Whose remit is this? EPSRC/NERC/TSB

Is work in this are already being done? If 'yes' please provide details.

Remote sensing that can be used in this field and aligned to the needs of industry

- Acoustic
- Radar
- Satellite
- AUV,UUV, Gliders, Cameras, Laser, IR

Why is this holding back deployment?

Cost and time for site development, EIA, etc.
Challenges of keeping in situ kit working in extreme environments
Limited data availability and coverage

How would work in this area accelerate deployment?

- Improve consistency, coverage, reliability and costings
- Reduced manpower (or do more with it!)
- Ease consenting
- Better targeting of site investigations in space and time

What work would be needed to be done in order to overcome this challenge.

Technology transfer
Agreement on standard methods
Audit what is out (Ground truth)
Comparative monitoring at demonstrator sites that already have data

The Challenge: Predictive modelling Capacity for assessing Environmental Impacts, Including Future Scenarios
Whose remit is this? Cross disciplinary whole system research
Is work in this are already being done? If 'yes' please provide details. Yes – but very piecemeal Physical modelling, good except for effects of MEC's Ecological modelling, less developed, ok for higher trophic levels Human activity modelling
Why is this holding back deployment? High level scenario analysis is lacking Uncertainties owing to a lack of coherent whole system understanding Cumulative and interactive effect not understood (dynamic interaction of multiple arrays) Takes longer and is more expensive to do EIA without this
How would work in this area accelerate deployment? Brings increased certainty and consistency to decision making Shorter, less expensive EIA's Identify REAL questions to address within whole system Deals with all the above
What work would be needed to be done in order to overcome this challenge. Integration of physical and ecological models (and fisheries models) Building on existing work at demonstrator sites Validation data Site specific case studies Address future scenarios including climate change and resource change

The Challenge: Wave Resource Assessment – Fitness for Purpose
Whose remit is this? NERC/EPSRC (ESRC)
Is work in this are already being done? If 'yes' please provide details. Marine energy atlas Background in wave climatology Supergen marine ETI(limited) ETUS studies
Why is this holding back deployment? Investor uncertainty Lack of understanding of extreme conditions Intermittency (lots of time scales) and wholistic security Required as inputs to grid assessment, economic assessment and environmental assessment Site section Inform device choices
How would work in this area accelerate deployment? Increasing investor confidence Inform integrated planning Reduce technical uncertainty in resource assessment
What work would be needed to be done in order to overcome this challenge. Need work on timescales * short term performance (~day) * medium term (project output ~ year timescale) * longer term (decadal – climate change) Translation of background work to wave energy applications Resource correlations in exceptional conditions (very cold winters) and grid impacts Establish a standard methodology Extreme data sets

The Challenge: Optimising Tidal Energy Generation
Whose remit is this? NERC/EPSRC/(ESRC)
Is work in this are already being done? If 'yes' please provide details. Perawatt →ETI call on site – site interaction Marine energy atlas Carbon trust – challenge/accelerator Walkington/wolf…
Why is this holding back deployment? Investor uncertainty. Potential scale and value Input to grid assessment and planning Input to economic assessment Site selection Input to environmental assessment
How would work in this area accelerate deployment? Increase investment (sector, inward to UK) Inform integrated planning (Grid, Build, order….) Address environmental concerns Reduce resource uncertainty
What work would be needed to be done in order to overcome this challenge. Tidal models (progress on ETI) Coupled 3D models (hydrodynamic, Ecosystems. Economic) • "Water to Wire" • Morphodynamics • Ecological • Economics } FEEDBACKS! Validation and field methodology Variation on time scales • Daily • Fortnight • Long term

Proforma for the final session (Design issues, Energy Conversion and Delivery)

The Challenge: To Increase yield and Reduce Risk in the Energy Conversion and Network Delivery of Wave and Tidal Energy

Whose remit is this? RCUK, Academia, Industry, test houses, (TSB/ETI/CT….)

Is work in this are already being done? If 'yes' please provide details.

Yes – in some areas (and not enough) – but not in an integrated manner

ETI, SUPERGEN, TSB, Carbon Trust, RDA's FPT/ …8

Why is this holding back deployment?

While risk is high and yield is uncertain, the technology is not readily bankable and suppresses growth of the sector. Up-scaling WILL revive the confident investment in arrays and clusters that can only be assured by future move on fluid-structure interaction, array interactions, electrical interconnection, group control and network compliance, design for maintenance, installability, safety and environment is also essential

How would work in this area accelerate deployment?

Reducing uncertainty and risk and increasing yield will raise investor confidence & participation – increasing the scale of individual commitment and installed capacity per venture

This would increase market volume and consolidate the supply, installation and service sectors

What work would be needed to be done in order to overcome this challenge.

Design for short and long term survival with acceptable structural loadings and installed costs in a dynamic environment

Develop the ability to consistently, reliably install and operate control arrays on time, to cost, with maximum energy yield

Develop an integrated design process from resource to wire that maximises yield with minimum cap and op costs and delivers grid – compliant electricity

Make greatest use of existing network assets and make most effective investment in new technology and network extension to absorb 2020 target capacities and beyond

Proforma for the final session Materials and Manufacturing

The Challenge: Reduce Mass and Cost in Construction Deployment and Installation
Whose remit is this? EPSRC →TSB →ETI
Is work in this are already being done? If 'yes' please provide details. No – 1st generation technologies in concept phase. Existing technologies are not cost effective (1K tonnes/mega – watt /notional cost = £6m Target ≤£3m mega watt (inc)
Why is this holding back deployment? Cost is too high – not economic – reduce weight reduce cost throughout supply chain
How would work in this area accelerate deployment? Cost effectiveness Attract investment
What work would be needed to be done in order to overcome this challenge. Lighter materials and durability and maintainability or Reduced complexity of components to reduce mass – reduces service and maintenance costs or Step stage Develop radically new design concepts (power capture and conversion concepts) e.g. Fish in reserve (out of the blue) Who are the manufactures – other areas What do they want and what can they build Are these people a source of ideas as well as scientists Device dividers could this be user centred design or a design approach

Basic Science

The Challenge: Improve Survivability of Devices in Extreme Loading
Whose remit is this? EPSRC (Generic)/TSB/Industry (device specific)
Is work in this are already being done? If 'yes' please provide details. Some work by device developers – either based on rule/code based design or tank testing (model)
Why is this holding back deployment? Uncertainty in survivability → uncertainty of risk →uncertainty of OPEX, CAPEX →investor Confidence issues
How would work in this area accelerate deployment? Increased investor confidence Rational assessment of risk →appropriate costs Understand trade – off between CAPEX and OPEX
What work would be needed to be done in order to overcome this challenge. Improved understanding of model – test scaling Improved simulation tools for highly unsteady non linear loading Integration of design for safety(Asset integrity)/design for production (Energy) (Loss of revenue) Improved understanding of ARRAY survivability Issues related to extreme loads from debris (dead cows) and big rocks Improved design of survival modes to avoid catastrophic failure

The Challenge: Effective and Efficient Marine Installation and Operations in Challenging Marine Environments
Whose remit is this? EPSRC TSB ETI CT Developers
Is work in this are already being done? If 'yes' please provide details. Individual developers – pragmatic approach for prototype deployment and operation TSB underpinning Techs call 2010 – 3 projects Possible up coming ETI projects – linked to foundation design research (knowledge transfer)
Why is this holding back deployment? Installation is disproportionately high proportion of cost of marine power High risk involved – weather and environment windows, costs of delays uncertain OFM costs stalling investment
How would work in this area accelerate deployment? De– Risking of investment by reducing uncertainty Increase affordability of projects Improved health and safety
What work would be needed to be done in order to overcome this challenge. Review of lessons learnt to date on foundation, installation, O&M. Research and development of techniques enabling use of cost – effective and available vessels (MW scale, short term) Research enabling optimal techniques for GW scale installation and operation. Identification of technique and route to market (longer strategy) Understanding behaviour of vessels in high tidal areas, near shore – high wave environments Research into remote monitoring of moorings and foundations, device condition for survivability Research to identify disruptive technologies that step – change costs of installation, O&M