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Establishing an agenda for social studies research in marine renewable energy

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HIGHLIGHTS

- Existing marine renewable energy (MRE) research fails to address many social issues.
- Social acceptability is essential to the future viability of the MRE industry.
- An agenda is established for social science research into MRE.

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ABSTRACT

To date, academic research relating to Marine Renewable Energy (MRE) has largely focused on resource assessment, technical viability and environmental impact. Experiences from onshore renewable energy tell us that social acceptability is equally critical to project success. However, the specific nature of the marine environment, patterns of resource distribution and governance means experiences from onshore may not be directly applicable to MRE and the marine environment. This paper sets out an agenda for social studies research linked to MRE, identifying key topics for future research: (i) economic impacts; (ii) wealth distribution and community benefits; (iii) communication and knowledge flow; (iv) consultation processes; (v) dealing with uncertainty; (vi) public attitudes; and (vii) planning processes. This agenda is based on the findings of the first workshop of ISSMER, an international research network of social scientists with interests in marine renewable energy. Importantly, this research agenda has been informed by the experiences of developers, regulators and community groups in Orkney. The Orkney archipelago, off the north coast of Scotland, is home to the most intense cluster of MRE research, development and deployment activity in the world today.

1. Introduction

Marine renewable energy (MRE), in the form of wave and tidal current technology, has potential to become a major contributor to global energy needs (IEA, 2007). Full scale prototypes are now being tested with sea space being allocated for commercial deployment. This activity is distributed globally. The UK, in particular Scotland, finds itself at the vanguard of this new industry. A combination of political support, significant resources and technical expertise have contributed to this emerging situation. Within Scotland this activity is focussed on the archipelago of Orkney, home to the world's first full-scale grid connected test facility (European Marine Energy Centre—EMEC). The waters around Orkney have been designated as one of the UK's two

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Fig. 1. Workshop participants discuss the 'washing line'.

Marine Energy Parks and work is now underway to prepare sites for 1.6 GW of commercial development. In addition Marine Spatial Planning (MSP) processes are being developed in parallel with the technologies that they will ultimately regulate. Orkney, together with many maritime communities around the world, is now looking to the future in an attempt to understand the social, economic and environmental change that will accompany this new industry.

It is important to recognise that MRE is more than a technically challenging extension of onshore renewable energy development. The policy environment, governance, patterns of resource use, conservation values, and distribution of ownership rights are all substantively different from the situation onshore. This difference is evident in the emerging MSP framework, which recognises that approaches adopted on land may not be appropriate at sea (Jay, 2010; Kidd and Ellis, 2012). Furthermore marine energy development may play an important role in the redistribution of ownership rights in the marine environment. Increasingly, society looks to the sea to meet its growing resource needs and to stimulate economic growth. The European Union's 'Blue Growth' agenda typifies this aspiration (EU, 2012).

New technology offers both *access* to resources (e.g. fishing, oil and gas, aquaculture, marine energy, deep sea mining) and the ability to exercise *control* over marine space (e.g. radar, sonar, GPS, and satellite tracking). This underpins an on-going process whereby public rights and freedoms are supplanted by private rights, firstly by the creation of sovereign rights (e.g. Exclusive Economic Zones), then by the creation of private rights (e.g. sea bed leases, planning permission, and tradable quotas). Wave and tidal energy development is part of this evolving picture (Johnson et al., 2012). MRE developers require access to significant areas of sea and this will impact on the rights and privileges of other users of the marine environment.

To date, research into MRE has focused on resource assessment, device design, and environmental impact. Environmental research has concentrated on cetaceans, pinnipeds and birds. This is largely a consequence of statutory responsibilities and lobby groups promoting environmental issues. Consequently, social science research into marine energy has been given low priority.

The current balance of research effort, and funding, does not reflect the role of society in the development of MRE or its potential impact on coastal communities. Even if technical challenges are overcome and environmental impacts minimised, the development process may still be compromised by a failure to understand social issues. In direct response to this situation the International Network for Social Studies in Marine Energy (ISSMER) has been convened to bring together academics interested in social aspects of marine energy.

The first ISSMER workshop was held on 6–7 September 2012 in Orkney with the main aim to develop a research agenda for social studies in MRE. An important secondary aim was to exploit the location and industry/community links in the Orkney islands, Scotland, site of the European Marine Energy Centre, to develop a new kind of workshop process to make social issues present and visible.

2. Methods and context

The ISSMER Workshop took advantage of the Orkney location as a key site in MRE development. It employed a novel format, with the aim of allowing local experts to have the primary voice. Academic presentations were avoided so that outcomes could develop from local MRE knowledge rather than prior assumption. The workshop organisers are embedded with the Orkney community through the International Centre for Island Technology (ICIT) Campus of Heriot-Watt University in the islands and on-going fieldwork. The organisers invited experts from the local community to enter into conversation with small groups of academics. The guest experts were briefed with a set of topics but were invited to shift topic and express their views freely. The conversations were akin to ethnographic interviews. Delegates listening and participating were encouraged to use the conversations to create notes about issues requiring more research. Notes took the form of individual observations, opinions and new research needs, which were collected and pinned up on a 'washing line'; 132 notes were recorded in this way and then classified into themes (see Fig. 1). These notes became the core data from which the agenda presented in this paper was developed[1].

Twelve guests entered into conversation with 25 invited delegates from 10 countries. The guest experts reflected the unique position of Orkney in marine energy research and development and represented: research and testing in the MRE industry; MRE developers with interests in specific technologies and sites; central and local government with responsibilities for planning; traditional industries of fishing and farming; and members of the local arts and literary community. All the guests had direct experience of MRE. The farmer, for example, was being asked to sell his land for the construction of onshore sub-stations taking power generated at sea. These expert guests were all known personally to the organisers and a high degree of trust existed between them all of which facilitated a relaxed and open discussion. It is worth noting that the results presented here are not intended to be a representative survey of stakeholder opinion. The purpose of the workshop was to create a reflexive process through which academics could learn from the individual experiences of stakeholders. A range of academic delegates contributed to the event including geographers, economists, social scientists, anthropologists, planners and business experts.

In all, twenty set piece conversations were held on the two days of the workshop. These were supported by field trips to the EMEC test facilities. Plenary sessions identified possible research questions and themes arising from the conversations, drawing on the notes pinned on the 'washing line'. These themes and questions are described in this paper under the 8 headings of Economic impacts; Wealth distribution and community benefits; Communication and

[1] The workshop report and the washing line comments can be viewed at www.issmer-network.org.

knowledge flow; Consultation; Future uncertainty; Public attitudes; Planning processes; and Comparative studies.

3. Economic impacts

3.1. Job creation in marine renewable energy

The transition from a high carbon economy to a low carbon economy is occurring at different speeds in different regions. Fundamental to this transition is the fact a low carbon economy will not be possible without economy-wide job creation and skills development. Public support, education, and linking local and regional employment strategies can support 'green collar' job creation through harnessing regionally-specific natural advantages (Potts, 2010).

Researchers routinely focus on job growth from renewable energy initiatives (Kammen et al., 2004; Martinez-Fernandez et al., 2010). UK studies suggest that MRE may generate 20,000 jobs (OVG, 2010). However the OECD-LEED (2012) and Miranda and Larcombe (2012) note the absence of an empirical foundation for understanding regional scale 'green growth' with further research needed to align job strategies, build partnerships, identify transferable skills, support entrepreneurship and leverage policy support. Local government officials at the workshop noted the need for a better understanding of the detail of job creation (what type of jobs, location and timescales). This information is important for infrastructure planners making decisions at the local level. Research was criticised as being too general. Existing econometric studies have attempted to identify employment impacts at the regional (Scottish) level (Allan et al., 2013). There remains a need for local scale datasets and policy relevant indicators. This includes understanding the geographic distribution of jobs. The potential for displacement of jobs was a specific concern raised by fishers and local government.

3.2. Supply chain and infrastructure readiness and preparation.

Industry representatives noted the readiness of regions to support MRE development as important for the success of the industry and the region's ability to benefit from it. In the absence of a dedicated supply chain MRE developers can draw from long-established maritime industries: oil and gas, fisheries, shipbuilding and repair, and traditional knowledge of local waters. Supply chain needs and gaps (Scottish Government, 2009; Canmet Energy, 2011; Obermann and MacDougall, 2013) need to be effectively communicated to existing local businesses to attract their participation in supply chain operations and to accrue the value to the region.

Workshop participants raised concerns that expenditure on work carried out locally, by external contractors, fails to *stick* in the local economy. MRE devices are generally sourced from other countries but support services could be sourced locally. The ability of companies and the community to keep benefits local depends on the development of local operational expertise, supporting services and technologies, as well as local ownership of the projects. Various models of local ownership exist that can return profits to the community (Colton and Howell, 2013).

The drive for economies of scale and use of specialist services encourage developers to outsource services. Anticipating potential demand will enable communities to plan strategically to maximise the benefits accruing locally from service and supply contracts, employment, leases, taxes, tourism, and education. Local government should, therefore, develop strategies to recoup local benefits through aligning and developing local expertise to serve an emerging MRE industry (CSE, 2005). An industry cluster strategy to develop a hub of expertise and innovation can be effective (Lundquist and Power, 2002; Cortright, 2006). Orkney and Maine, USA propose industry cluster strategies for MRE in their jurisdictions (Ferland, 2008; CSE, 2005).

3.3. Non-market impacts

Potential damage to non-market values became apparent in discussions with fishers and artists and writers concerned about landscape impacts. Delegates noted that emerging frameworks around ecosystem services have potential to help understand the non-marketplace impacts of MRE. Ecosystem services are described as the *benefits that people obtain from ecosystems* (MES, 2005). Coastal ecosystems provide a wide range of these services (Beaumont et al., 2010). This includes, provisioning services such as fisheries; regulating services including climate regulation and hazard protection; and cultural services based on meaningful places and socially valued landscapes (Potts et al., 2014).

Academics and policy makers are paying increasing attention to service valuation (Saunders et al., 2010), particularly where it is a requirement of policy, e.g. EU Marine Strategy Framework Directive (MSFD). The usefulness of identifying ecosystem services is widely accepted. However debate surrounds the ability to make accurate monetary assessments (Beaumont et al., 2008), how to incorporate these valuations into real decision-making processes (Bertram et al., 2013) or indeed whether it is acceptable to monetize all ecosystem services (Sagoff, 2008) Table 1.

4. Wealth distribution and community benefits

All local stakeholders identified the need to maximise community benefits. MRE development depends for its success on local goodwill and the willingness of the community to absorb social, environmental and cultural change. As the MRE industry is still in its infancy, its positive and negative impacts for communities are poorly understood. However, lessons can be learned from other sectors. The case of oil development in Shetland in the 1970s was

Table 1
Economic Impacts: highlights for future research.

- What is the potential for job creation at the regional and local level?
- What is the extent of job displacement?
- Are new jobs going to be available to those displaced (e.g. fishers)?
- What migration is likely and what are the impacts on local services and infrastructures?
- What training is required for regional economies to capitalise on job creation?
- How can local supply chains be prepared in order to capture expenditure?
- What factors have produced successful MRE innovation clusters in some regions and not others?
- How can government support the establishment of innovation clusters around MRE?
- How will MRE impact on ecosystem services and how can this information be incorporated into decision making processes?
- Is the valuation of ecosystem services sufficiently robust to provide reliable results?
- Do monetary valuations of ecosystem services have meaning in real decision making processes?

Table 2
Commucnity Benefits: highlights for future research.

- What is the record of experience with community benefits in other sectors/locations, particularly onshore wind? Can they be replicated in the marine energy industry?
- Community ownership is another feature of onshore renewables, although uptake has been slow. To what extent is this replicable in the marine environment given different governance regimes and technological challenges?
- What governance and process measures are needed to allow for the creation of community benefit payments and what barriers exist to their implementation?
- Do onshore 'planning gain' arrangements have any relevance in a marine context?
- How do we identify relevant communities? Are agents needed to mediate between these communities and industry or act on behalf of communities?
- How does the balance of power between industry, government and communities affect the trade-offs made between marine renewable energy developments and environmental, economic, social and cultural issues?
- Stakeholders are not equal in their access to resources and capacity to participate. Are community concerns that commercial and national objectives will take precedence over local needs valid?
- How can the affected communities be identified, and inter-generational justice be assured, through whole-life cost/benefit analysis?
- If environmental, social and cultural capital is to be traded for profits or climate change mitigation, what are the distribution of life cycle costs and benefits?

repeatedly referred to in the workshop. MRE development may require coastal communities to sacrifice public benefits (e.g. rights of access, rights to fish). The perception that public rights are being sacrificed for private profit is a highly emotive issue and a source of tension (BBC, 2011). A neoclassical perspective suggests economic benefits come in the form of increased incomes and expenditure, which 'trickle down' through local multiplier effects. There are oil industry precedents for additional direct 'community payments' (Johnson et al., 2013). In the case of onshore wind, such community payments are now common (Renewable UK, 2011; Aitken, 2010). Developers at the workshop did not discount the possibility of payments but highlighted the fragile nature of the industry. Alternatives to direct payments include community ownership or shared equity schemes. The extent to which these models are relevant in the marine environment with different governance structures and different technological constraints remains an open question.

Delegates noted how public opposition was a significant obstacle for onshore wind and it was reasoned that public attitudes in the coastal marine environment will be no less significant. Three main research challenges were identified: first, to develop models for community benefits from MRE developments; second, to minimise the value conflicts exposed by MRE development; and third, to understand the economic, social and cultural impacts of the commercialisation of emerging MRE technologies Table 2.

5. Communication and knowledge flow

5.1. Knowledge-making

The creation, use, ownership and exchange of knowledge, was a recurrent theme in the workshop. This was distinct from formal consultation processes in the planning sphere. Consultants, local government, national planning officials and developers all raised this concern with the making and sharing of knowledge but nonetheless found it difficult to characterise the precise nature of the problem.

One particular aspect to emerge was the conflicting requirements of ensuring publicly available information (to speed development and improve planning and consenting), and retaining private information to secure individual and company advantage. A second aspect was the difficulty in understanding what kind of future was anticipated by different groups, who all have different knowledges and sources of information at their disposal.

5.2. Knowledge networks

The development of a new industry requires the movement of information and knowledge between all stakeholders. However, local communities with relevant expertise amongst mariners and fishers may understand sea conditions in ways that are different but complementary to scientific approaches. This includes social co-operation the embodied skills of fishing (Nightingale, 2011), experience of how navigation works at sea (Mclachlan and Mander, 2013) or modes of perceiving the environment that are very different to those of science (Hoeppe, 2007). Fishing representatives at the workshop felt their knowledge and experience was undervalued and ignored. Enabling information and knowledge to flow between groups would encourage the development of an MRE industry that was informed by, and therefore best adapted to, current circumstances, rather than assuming a uniform marine space. Such knowledge networks would also support the co-management of marine resources in contexts where environmental protection is also required (Phillipson and Symes, 2010).

Good communication is not merely a 'top-down' consultation process (see section 6), but must establish a cross-cutting network of knowledge between diverse groups – and be open to alternative and dissenting perspectives. This would make visible policy and local knowledge in marine energy, and, in the opposite direction, the impacts of marine energy at local and policy levels.

5.3. Communication infrastructures

Workshop delegates proposed research on communication and knowledge infrastructures. Understanding how information is made and how it moves amongst MRE actors and organisations is crucial. Research in fields, such as Science and Technology Studies (STS), and the anthropology of knowledge, provide extensive resources to address this issue (Steinberg and Philip, 2001; Helmreich, 2009; Orlove and Caton, 2010). Drawing on STS, Watts (2012) describes how the development of EMEC in Orkney has been supported by its 'distributed companies, people, places and landscapes' that form a kind of laboratory for future-making. Such research has the potential to move far beyond the model of the 'public understanding of science', and towards collaborative and co-produced studies that cross between social, environmental and physical science disciplines. Academic resources could be used to work with both the marine energy industry and local communities to understand knowledge-making and expand communications on many levels.

One characteristic that has a major effect on communication is instability within the MRE sector. Knowledge and facts are shifting and often unclear, even to those at the technical and regulatory forefront (see section 7). These shifts are to be expected within an 'industry-in-the-making'. Research in economic geography on regional development and flexible specialisation (e.g. Thrift and Amin, 1994) would be relevant here to explore interactions amongst co-located companies. For those at the edge of the knowledge network meanwhile (often local communities), industry instability can manifest as a lack of transparency and lead to distrust. Marine energy is largely comprised of SMEs and communication resources are limited. SMEs in MRE are reliant on venture capital funders, who require a very different communication process (often more 'bullish' to inspire continued funding). Ways of managing these communication processes must be found so that trust can be established between all MRE partners Table 3.

Table 3
Communication and Knowledge Flow: highlights for future research.

- What are the key knowledge networks emerging in the MRE sector and how does knowledge move between actors?
- How do different groups use knowledge to imagine futures for MRE and is this at variance with potential outcomes?
- What is the role for local 'informal' tacit knowledge in the process of MRE planning and consultation and how can its role be enhanced?
- What knowledge is used to 'construct' futures used to inform planning processes and shape public opinions?
- How can the rights of private companies to hold information be reconciled with the potential public benefits of making information freely available?

6. Consultation

Dialogue with stakeholders is now widely regarded as an essential component of contemporary spatial planning (Healy, 1992). As well as being mandated in some jurisdictions, effective consultation can also reduce socioeconomic and sociopolitical risk for MRE projects. Despite agreement on its importance, there was almost unanimity amongst workshop guests that the consultation process was not working.

Lessons from offshore wind energy underscore the importance of consultation processes that are transparent and provide early information to stakeholders (British Wind Energy Association, 2011). Equally important is the creation of two-way communication exchanges between stakeholders and MRE regulators/decision-makers. Collectively, these practices will support the development of a *social. licence* to operate, providing social legitimacy and credibility to a project based on community and stakeholder perceptions and perspectives (Thomson and Boutilier, 2011).

Lack of trust, transparency, and decreasing credibility, along with poor communication and an imbalance of power, are factors often cited as contributing to the diminishment of stakeholder engagement. These types of issues were raised by nearly all the groups interviewed in the workshop, including those directly involved, developers, regulators and other stakeholders (e.g. landowners, fishers and coastal communities).

In several jurisdictions stakeholder consultation is required by law. For example in the U.S. and in Nova Scotia, Canada, where the Community Feed-in-Tariff (COMFIT) requires two community consultation sessions. The EU MSFD, the UK Marine Acts and marine development consenting protocols all place strong emphasis on involving affected communities. During the workshop, fishers and landowners noted they felt disenfranchised but (along with others) paradoxically complained about consultation overload as well as a lack of time. In the context of MRE, consultation is happening simultaneously on several different levels. The Crown Estate, the government, and developers are conducting public consultations with regard to seabed leases, emergent marine planning and consenting regimes, and individual developments.

Innovative approaches to consultation include the use of new technology and the arts. Real-time interactive mapping has been used to identify conflicts among sea users (Alexander et al., 2012). While the use of creative arts in consultation has been *underappreciated*, its role is becoming increasingly recognised as an innovative method for capturing stakeholders' values. *Orkney Futures*: *A Handbook* shares creative reflections on the future of the Orkney Islands (Watts and Peebles, 2012). Given the extent of MRE research and development in the area, this collection of prose and poetry provides insight into the sense of place imagined by its collaborators. Listening to workshop guests highlighted the varying degrees to which stakeholders believe consultation has been effective. Dissonance among stakeholders revealed important opportunities for research and collaboration with respect to consultation Table 4.

Table 4
Consultation: highlights for future research.

- What exactly are the failings of existing planning/consultation procedures?
- How can alternative forms of consultation be embedded in a formal planning process?
- Do the arts have a role in exploring values and encouraging public engagement?
- How can 'latent' stakeholders, whose interest might not appear until planning decisions have been made, be engaged?
- How do we differentiate between different communities (of interest and geographic) in the consultation process?
- What versions of consultation are appropriate for different forms of community and industry engagement?

7. Future uncertainty

Uncertainty pervades the MRE sector and represents a key cross-cutting theme for future research. During the workshop planning officials stressed the difficulty presented by multiple uncertainties. Ambitious targets and projections for MRE deployment such as the Crown Estate's 1.6 GW by 2020, suggest rapid development (Crown Estate, 2011; DECC, 2011). However, the absence of detail and consensus on pathways for achieving these targets combine with uncertainties regarding: e.g. the location and scale of MRE developments, land requirements, the extent of closed areas, to create problems for actors trying to make business decisions and plan for the future. As a result, the emerging nature of the industry, its technology and potential environmental and socioeconomic effects, create uncertainty around the likely sociotechnical systems that marine energy will form.

Uncertainties about the future pose difficulties for both the public and private sectors, who are tasked with making decisions, including investment in infrastructure (e.g. grid capacity, ports and harbours development), investment in supply chains (e.g. capital investment, personnel and training), and community services (e.g. roads, housing and schools provision). The uncertainties surrounding MRE development also create difficulty for other sectors as they assess the potential impact of MRE on their own futures. A surprising example from the workshop was the case of a local farmer, whose land *may* be required by the electricity grid company and MRE developers. As a consequence he is left unsure whether to make long-term investments in livestock.

There is some tentative enthusiasm in the sector to tackle some knowledge gaps collaboratively (Mclachlan, 2010). The NERC Marine Knowledge Exchange Hub offers an example of such activity. However, it should not be assumed the provision of more 'facts' will necessarily lead to wider stakeholder support (Mclachlan, 2011; Mclachlan and Mander, 2013). Indeed, as already experienced in the MRE sector, knowledge gaps and uncertainties can result in the adoption of the precautionary principle, potentially triggering decision-making paralysis (Gill et al., 2012; Jude, 2013). On issues such as: local jobs, economic benefits, the impact on marine mammals, conflicts and complementarities with other sea users, social science researchers can offer a critical engagement with the production and use of knowledge by different actors. Comparing communication and interpretations of predicted, perceived and actual impacts and associated calls for the adoption of approaches for decision-making under uncertainty, such as adaptive management/marine energy pathways, offer rich areas for research (Gill et al., 2012; Jude, 2013) Table 5.

Table 5
Future Uncertainty: highlights for future research.

- To what degree are stakeholder concerns about uncertainty complementary?
- What is the cumulative impact of uncertainty across the sector for various stakeholders? Are there areas of decision paralysis due to cumulative uncertainties?
- Does analysis of uncertainty allow identification of potential interventions that could shape the sector and its impacts?
- How can public and private sector actors be helped to deal with uncertainty?
- How can uncertainty be considered in the consultation process?
- How does uncertainty affect public attitudes towards MRE?
- Can we work with stakeholders to articulate diverse possible futures for marine energy?
- Can social researchers work as part of interdisciplinary teams to engage stakeholders 'upstream' in the research process?

8. Public attitudes

At the workshop it became clear that there were divergent views about many aspects of MRE such as the appropriateness, social and environmental impact; and the benefit to the local economy. This is perhaps unsurprising given the diversity of stakeholders present. Interestingly, the guests' perceptions of wider public attitudes towards MRE were also divergent. The potential for strong variations in public attitudes regionally and internationally and the importance of considering social, cultural and political differences was noted.

Public attitudes have had a clear impact on the course of onshore wind energy (Wolsink, 2007; Bell et al., 2005, 2013) and a similar situation for MRE can be readily hypothesised. More fundamentally, MRE provides opportunities to examine community engagement with new technology in predominantly rural and remote coastal settings, where tensions between environment and development may be particularly apparent. Social studies of MRE can also contribute towards nuanced accounts of the on-going *creation* of communities, landscapes and rural development strategies in the search for lower carbon economies.

The limited evidence available suggests public attitudes are positive. An estimated 77% of the UK population is in favour of MRE (DECC, 2013). More in-depth case studies generally support this picture whilst highlighting more complex dynamics worthy of further research. Devine-Wright (2011) found that a tidal energy converter potentially enhanced 'place attachment' through community pride, but triggered concerns surrounding environmental impacts, consultation processes and community benefits. A similar range of views were expressed at the workshop. It was also noted that in the case of wind energy in Orkney, community pride associated with experimental installations, at Burger Hill in the 1980s, had, over the years, turned to more polarised and cynical positions as the industry commercialised. Studies investigating the Wave Hub test facility in Cornwall, England, have identified generally positive views about wave energy (Bailey et al., 2011). However, McLachlan (2009) found support for Wave Hub varied according to assessments of 'symbolic fit' based on interpretations of place and technology. Research investigating values associated by the public with different MRE technologies prior to deployment is emerging (Voke et al., 2013), and given current uncertainties, the exploration of anticipated versus actual impacts as perceived by the public represent areas for further research.

The notion of who 'the public' are in the literature varies considerably from active participants and key stakeholders such as fishers and surfers, to local residents, tourists, recreational visitors and the population as a whole. It will be an on-going task to track longitudinally – in contrast to most existing research – how these constituencies interact in relation to MRE projects. This may be with a view to minimising value conflict. Such research could enable diverse community voices to be heard. For example, whilst Scottish fishers appear to be broadly supportive of MRE, research suggests the majority are still in the early stages of forming views (Alexander et al., 2013a, 2013b). Similarly, Bailey et al. (2011) suggest a 'silent majority' exists with still unformed opinions. This highlights the importance of future research exploring the role of information in the development of attitudes towards MRE, and the identification of who represents 'trusted sources' of information in different contexts.

On the negative side, it is possible that MRE may be perceived as 'enclosing' for private use ocean resources that are currently perceived as open. Fishing representatives to our workshop were close to this position. This shares resonances with some public and political opinion following 1980s UK utility privatisations (Strang, 2004). Alternatively, tangible positive effects such as local job opportunities or community payments, or a more intangible pride in green energy production, could also drive public attitudes. As such, research opportunities are emerging as the industry develops, technology evolves and deployment is up scaled. MRE development provides opportunity to research changing attitudes as companies evolve from localised start-ups to larger companies with outside investment.

Research has potential to uncover symbolic interpretations of place and technology and document how attitudes interact with the practices of those who support or oppose MRE. Failures may be as relevant as successes for this task. Overall, this would enable broad shifts in attitudes over time (Wolsink, 2007; Bailey et al., 2011) to be related to the actual course of public policy, planning processes and community activism, and, even more significantly, to the evolution of the MRE sector as a whole and the changing perceptions of the sea, land and coast in a decarbonising society Table 6.

9. Planning processes

The workshop was attended by marine planners (national and local), developers and other stakeholders. Discussion around planning centered on two themes; (a) consultation (discussed above) and (b) integration. The topic of integration can be divided into three strands: (i) Integrating local/regional, national and international, with potential for conflict between priorities and processes between levels; (ii) integrating terrestrial and marine planning: developments and their impacts which cross the land-sea divide; and (iii) integrating old and new activities – further characterised as a conflict between public freedoms/rights (e.g. navigation and fishing) and private rights (exclusive use of sea space for profit).

MRE deployment will require access to large areas of sea. This new demand on sea space is happening against a rapidly evolving institutional landscape for the management of sea space. In particular, EU policy for marine areas raises several governance issues regarding the process of decision making and how to deliver agreed policy outputs and outcomes. In response to the various marine directives, national governments are now establishing legislation. Transnational cooperation within the European Regional Seas is not well established (Kannen, 2012). One problem is that national planning cultures and expectations differ. For example, some governments prioritise environmental designations (German Federal Ministry for Environmental Protection, 2011; Ahlhorn et al., 2010), while others take a much more incremental approach to adaptive management.

Furthermore, neither national nor EU policies are consistent in their targets and justification (Kannen, 2012). The Integrated Maritime Policy stresses the contribution of marine areas to economic growth (including MRE), while the MSFD aims to achieve "good environmental status" (GES) and the Habitats and

Table 6
Public Attitudes: highlights for future research.

- What is the current level of public knowledge about MRE, how does the public inform itself and what is the role of the media in this process?
- What are the principle drivers of public attitudes?
- How important are socio-cultural contexts in shaping public attitudes?
- How important are processes (consultation, decision making, governance, wealth creation) relative to physical impacts (size, visibility, noise) in shaping opinion?
- What values and value conflicts shape public opinion during MRE development?
- Are attitudes towards the development of the sea (e.g. enclosure of commons and perceptions of ownership) significantly different when compared to land?
- Might thresholds exist that trigger changes in attitudes?

Table 7
Planning Processes: highlights for future research.

- What principles and criteria are used to resolve place-based conflicts? Are underlying norms and values made explicit?
- How are different planning processes connected and integrated with other policies?
- How do planning and planning processes at sea integrate with neighbouring sea areas, terrestrial uses and terrestrial planning processes?
- How can tacit knowledge be included in the planning and decision making process and how can the ecosystem understanding of politicians and practitioners be enhanced?
- What is the cumulative impact of MRE developments in the localities affected?
- How could the benefits and losses that different futures will lead to for different stakeholders be articulated and how are they currently communicated?

Bird directives focus on protected areas. This leaves room for interpretation in practical decision making, in particular when recognising that the terms “good” and “sustainable” are unclear. Therefore, key integration issues on how MRE development can be reconciled with ecological protection remain unsolved. The need for clear and consistent principles covering both the process and the substantive outcomes of marine spatial planning, including the definitions and measurement of “sustainability” and “good environmental status”, is pivotal (Suárez de Vivero and Rodríguez Mateos, 2012).

Given the diversity of institutional approaches in Europe, and beyond, it becomes particularly important to analyse and monitor the quality of planning processes. This may involve exploring the degree to which planning processes are spatial, integrated, inclusive, sustainable, linked to regulation and strategies for action, and also whether values inherent in the implementation are made transparent and the implementation agency is subject to accountability processes. Guidance for quality assurance of (spatial) planning processes in marine environments is provided by ICES (2012) and Cormier et al. (2013) and a vision for transnational cooperation by Gee et al. (2011). Significantly more social science research on planning processes and comparative studies looking at different regions, different institutional arrangements and different implementation processes would be a particularly useful foundation for institutional learning.

Integration of terrestrial and marine planning is an issue of increasing relevance (Smith et al., 2012). MRE developments typically cross the land sea divide. Furthermore, the external impacts generated at sea may be experienced on land and vice versa. A lack of integration increases risks for developers and creates the potential for conflict between planning systems (operating at different institutional levels) with different priorities.

Effective MSP requires data and detailed analysis of ecological physical and social components (Douvere, 2008; Backer and Frias, 2012; Ban et al., 2010). Though regulation in the end is always based on values and judgments, scientific research, expert and tacit local knowledge altogether can support involved actors to identify common grounds and increase acceptance of decisions when underlying norms and values are made explicit. However, to link back to process qualities, trust and communication between stakeholders is required to interpret this body of knowledge Table 7.

10. Comparative studies

Marine renewables are an agent of change, potentially restricting traditional activities such as shipping and fisheries and leading to conflict amongst local sea users (Kannen, 2012; Alexander et al., 2013a, 2013b). These new developments face a situation where information about long-term impacts and cumulative effects is limited and highly uncertain and where long-term time series of data covering this change do not (yet) exist (Kannen, 2012; Kannen et al., 2013; Busch et al., 2013). Given these circumstances, the workshop repeatedly noted the value in learning from experiences in other locations and/or industrial sectors.

In many cases, MRE development will involve actors and investors from outside coastal areas entering local communities and creating impacts on existing marine activities and associated infrastructure. In contexts such as Orkney, developments are driven mainly by local and regional actors, there is potential to overlap with traditional ways of living and local perceptions of seascape and landscape. Comparative studies on themes such as conflicts and mitigation are inherently useful in minimising the negative impacts of development in peripheral and remote coastal regions.

In this context, comparative studies have two roles:

(a) From a scientific perspective comparative studies help explore the contextual drivers of community adaptation and the cross-cultural lessons surrounding community acceptance or conflict. Comparative analyses can enable aggregation of results from individual cases to higher levels of analysis at the national or international scale. They provide the opportunity to gain a deeper insight into the complexities and social realities of environmental planning.
(b) From a practitioner perspective, (policy makers, marine planners, or investors and industry) comparative studies drive a learning process of what works and what does not, an exchange of experience and the identification of “good practice” facilitating the design of better planning and consenting processes. Comparative research may reduce the risk of failure of individual projects, support successful implementation of MRE policies and achieving renewable energy targets Table 8.

11. Conclusions

This paper has advanced an agenda for social science research into MRE. In the workshop upon which it is based, a novel approach was adopted to give academic researchers the opportunity to learn directly from real-world experiences. Discussions took place at the cutting edge of research, development and deployment, involving those negotiating sea space and the communities experiencing MRE development.

Three substantive conclusions can be drawn from the workshop:

- Commercial-scale MRE development has potential to have major impact upon established patterns of sea use, rights of access, and social and cultural value systems.

Table 8
Comparative Studies: highlights for future research.

- The oil and gas industry offers many examples of rapid industrialisation in rural locations. What can be learned about socio-economic impacts and community benefits?
- What can MRE learn from offshore wind development in congested European sea space?
- What differences are there in institutional settings and socio-cultural contexts and can factors of success and failure be determined?
- How can the stories of different communities be communicated?
- How can local knowledge/narratives become incorporated into decision making?
- At what point in a development process can experiences from other places be used?
- Can deployment of the same technology in different cultural settings result in different outcomes?
- Can we look at different technology roll-outs and learn from them?

- Current models of consultation are failing to engage communities, initiate debate, communicate options and proposals or stimulate feedback. There is a need to reconsider what counts as consultation.
- Uncertainty (concerning the scale and timing of future development, the technologies involved, impacts and governance) pervades all debate, frustrating decision-making processes and related consultation.

The broader purpose of our work has been to develop areas for research which both respond to and reach beyond existing social science themes. While social science has long held an interest in societal and environmental change, research on MRE development has the potential to help re-think substantial questions in many of its fields. In economics and human geography, for example, issues of networking and scale in job creation and industrial clustering will be re-thought as MRE development happens in predominantly rural and remote locations. Those interested in social aspects of the creation and of knowledge (such as sociologists and anthropologists) may find diverse ways of knowing – and indeed ways of being uncertain – amongst MRE communities that challenge easy assumptions of 'expert' and 'lay' identities. Even amongst issues that are perhaps predictably important in our agenda (job creation, the allocation of sea space, community benefits), we reveal important nuances, such as the potential for strong regional variations in public attitudes. Coastal communities are by no means homogenous as a category and neither are they so internally, and it will be a task for social science disciplines to track both diverse forms of MRE development and diverse responses to it. Underlying all of these is the opportunity for social science involvement in MRE right from its early stages, in which social science can be not merely a *post hoc* evaluative tool – perhaps lamenting poor consultation processes or missed economic opportunities – but a partner from the start in securing positive development and giving a voice to all those involved and affected.

It is clear that understanding social interactions associated with MRE is vital to the successful assimilation of large scale commercial MRE development into the marine environment. As new energy landscapes begin to involve the sea and coast as well as the land, collaborative and future-oriented social science research has many roles to play.

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