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Welsh Assembly Government

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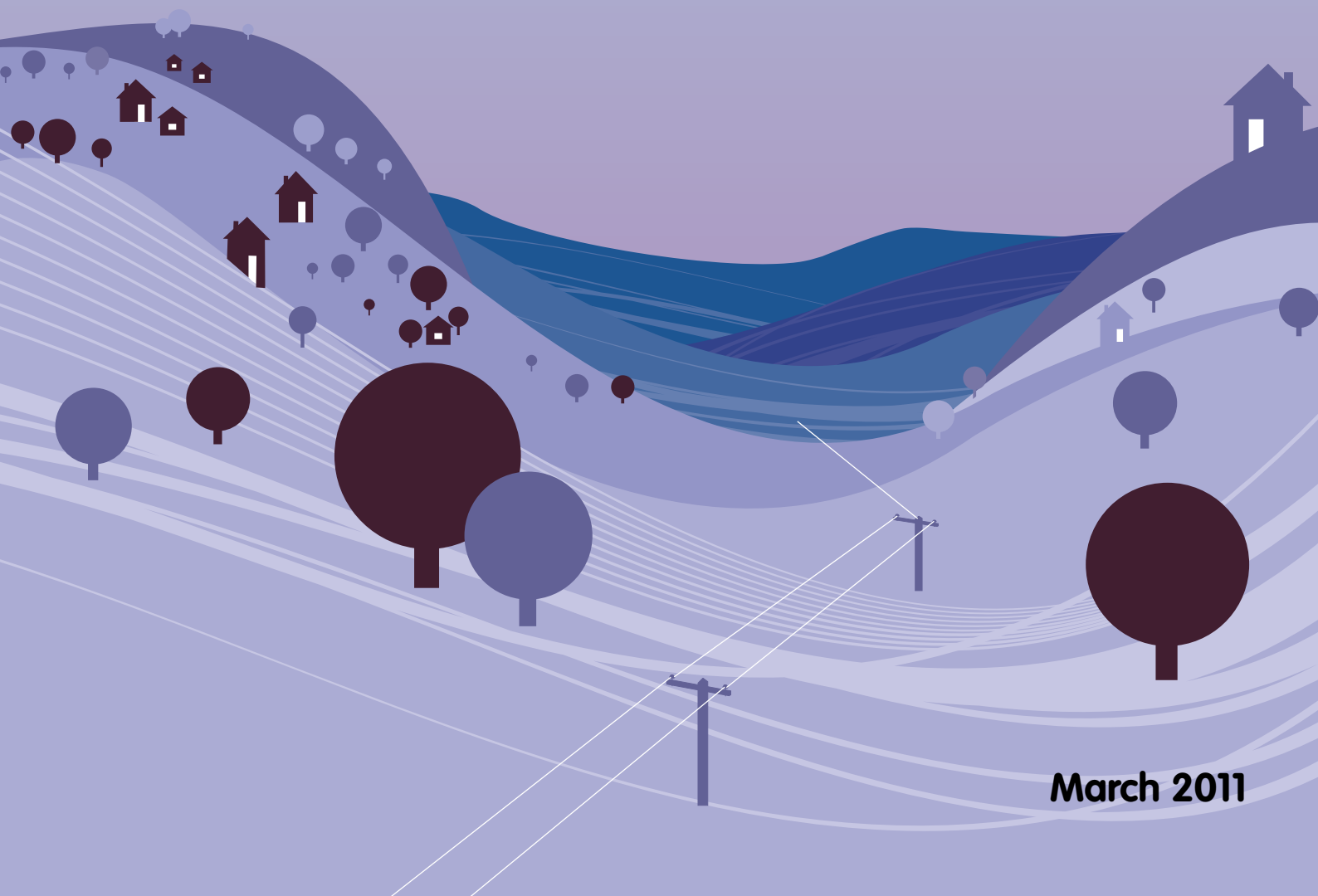
Marine Renewable Energy Strategic Framework

Technical Addendum

Report by RPS to the Welsh Assembly Government



March 2011

Executive Summary

S.1 The Marine Renewable Energy Strategic Framework (the MRESF) is a three stage project being undertaken by RPS for the Welsh Assembly Government. Stage 1 of the project was undertaken in 2008 and included a detailed literature review and consultation, aimed at understanding the existing situation as applicable to Welsh waters. Stage 1 included issues such as current understanding of the baseline environment, knowledge of potential impacts associated with wind, wave and tidal stream developments and aspects connected more directly to the renewables industry, such as device requirements and existing constraints on consent and development.

S.2 The project is currently progressing through Stage 3 and due for completion in 2011. The work undertaken during Stage 1 formed the foundations on which Stage 2 and 3 have been developed, however due to the rapid development of the industry and the degree of research currently underway, some aspects of Stage 1 could now be considered dated. To ensure the project remains contemporary at the time of completion (end of 2010; publication end of Q1 2011), the current report has been prepared, specifically to investigate potential changes, updates and additions in the following areas:

- Legislative requirements;
- Baseline data (covering Welsh waters);
- Increase in scientific certainty (understanding of the potential impacts of wind, wave and tidal stream from a global perspective);
- Updates to the potential areas of wave and tidal stream resource identified in Stage 1; and
- Continued liaison with projects with a degree of overlap.

S.3 The current report has been prepared as a Technical Addendum to the work undertaken in Stage 1 (RPS, 2008) and is accompanied by a number of reports completed during Stage 3 (WAG 2010a and 2010b; WAG 2011a and 2011b).

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1 Introduction

1.1 Overview

1.1.1 This report has been prepared by RPS for the Welsh Assembly Government (WAG) as a Technical Addendum to Stage 3 of the Marine Renewable Energy Strategic Framework (MRESF). The MRESF project has followed a 3 stage approach, with Stage 1 completed in 2008, Stage 2 running from 2009-2010 and Stage 3 being undertaken in 2010 and early 2011. The purpose of the current report is to provide an update on key aspects of the work undertaken in Stage 1, to ensure the overall project is contemporary at the time of finalisation (completed at the end of 2010; publication Q1 2011).

1.1.2 The MRESF is aimed at exploring and enabling the potential for renewable energy extraction from Welsh waters, with the intention being to minimise impacts on environmental resources and socio-economic activities, while maximising the potential for sustainable energy production to be gained from Welsh waters. The MRESF project forms part of the Welsh Assembly Government's commitment to promoting economic development of Welsh waters in a truly sustainable manner, and through such, achieving Wales' ambitions for low carbon energy generation and the significant contribution marine energy can make to meeting carbon dioxide and other greenhouse gas emission (GHG) reduction targets.

1.1.3 The MRESF project was commissioned to investigate offshore wind, wave and tidal stream energy, together with the potential for carbon capture and storage (CCS), within Welsh territorial waters. The overall aim of the project is to develop a framework for enabling the achievement of carbon dioxide emission (and other GHG) reduction targets through sustainable development of marine energy projects within Welsh waters.

1.2 Aims and Objectives

1.2.1 Stage 1 of the MRESF project involved considerable literature review and consultation, aimed at understanding current knowledge of the marine environment of Wales together with issues such as the potential wind/wave/tidal stream resource, potential sites for CCS, the legislative framework, potential impacts associated with developments and the main constraints on developments in Welsh waters. The work compiled under Stage 1 was finalised in 2008 and as such it is to be expected that some changes will have occurred in the intervening time. To ensure that the MRESF project as a whole is

contemporary when the project is completed at the end of 2010 (to be published in Q1) 2011, a brief review of the relevant changes and updates has been made here. The report is presented in the following sections:

- Section 1 – Introduction;
- Section 2 – Background to the MRESF Project;
- Section 3 – Ensuring Contemporary and Complete Reporting;
- Section 4 – Legislative Requirements;
- Section 5 – Baseline Data;
- Section 6 – Increase in Scientific Certainty;
- Section 7 – Management of Cumulative Data Layers;
- Section 8 – Potential Resource Areas;
- Section 9 – Parallel Work;
- Section 10 – Summary and Conclusions;
- Section 11 – Project Bibliography; and
- Section 12 – Baseline Drawings.

2 Background to the MRESF Project

2.1 Stage 1

2.1.1 Stage 1 of the Welsh Marine Renewable Energy Strategic Framework (MRESF) project was undertaken primarily during 2008, and was targeted at broad scale mapping of the marine environment in Welsh waters in GIS (covering environmental, social and economic interests), collating a comprehensive understanding of the current status of the wind, wave, tidal stream and CCS industries and reviewing existing knowledge of the potential impacts associated with such developments. Data gaps in the available information were assessed as a critical component of this phase of the work.

2.1.2 Stakeholder participation was undertaken during Stage 1 to ensure inclusion of appropriate and relevant information, identify the issues and concerns of stakeholders and to raise awareness of the project. The engagement of stakeholders and industry is seen as key to the success of the project, since the Framework will be an important decision support and governance tool for the Welsh Assembly Government with respect to maritime development and activities in Welsh waters.

2.1.3 Following the extensive literature review, Stage 1 assessed the available information to highlight potential constraints on development in Welsh waters. Such constraints included the following:

- Practical constraints (e.g. financing, sourcing of materials, grid connection);
- Site specific issues (e.g. resource availability, water depth, distance from shore);
- Support (ranging from local interest to government level and including issues such as financing, research);
- Legislative considerations (e.g. SEA, sustainability, consenting and nature conservation legislation);
- Existing use (i.e. existing human use such as shipping, fisheries and MOD); and
- Data requirements (e.g. quantity and quality of available data, ownership issues and cost of acquisition).

2.1.4 Preliminary constraint mapping in GIS was undertaken for data sets which included spatial extent information (primarily environmental, social and economic data), overlaid on areas documented as offering potentially exploitable wind, wave and tidal stream

resource. The resource mapping data were based on National and UK sources, primarily data from the Renewables Atlas, www.renewables-atlas.info, with minor refinements for tidal areas based on established RPS models. The aim of such mapping was to identify which constraints are most relevant in Welsh waters and which coincide with areas of potential resource (and therefore development interest). The constraint mapping undertaken during Stage 1 was preliminary and high level, with the process to be explored in more detail during Stage 3.

2.1.5 It should be noted that where an issue was identified as a key constraint, this does not necessarily translate as a significant impact; in fact, many of the constraints identified related to a lack of data or understanding upon which to assess significance and it is the lack of such information itself that represents the 'constraint'. The process was valuable in the subsequent identification of a number of potential projects aimed at increasing the knowledge base and thus provides a better understanding of the potential constraint on development presented by each issue.

2.1.6 The identification and assessment of data gaps undertaken as part of Stage 1 included a compiled list of data gaps and ongoing research connected to those gaps, which reflected the situation as it existed in 2008. The project team, in consultation with the Steering Group, then prioritised the data gaps, highlighting those issues that represent a greater degree of constraint on development in Welsh waters than others. It was from these prioritised data gaps that the projects taken forward in Stage 2 were drawn (see Section 2.2).

Carbon Capture and Storage

2.1.7 Research undertaken in Stage 1 highlighted the limitations in the baseline data available to assist in identifying potential sites for CCS in Welsh waters, with just three sites where further work may be beneficial noted within the 12nm limit. From the information presented in Stage 1, it appears that some areas may benefit from further investigation, however it is likely that extensive and detailed survey would be required with associated significant expenditure incurred to progress such potential further at this time. Although additional data may potentially be held by the oil and gas industry, it remains for such data to be identified and sourced, and again the release of such information, if such exists, would incur considerable cost. Given the data limitations and the extent of additional work required to increase the knowledge base, CCS has not been taken forward to Stage 3, beyond the provision of data collated in Stage 1, and as such has not been considered further within this Technical Addendum.

Offshore Wind

2.1.8 In addition to CCS, as discussed above, Stage 1 of the MRESF project included consideration of wind, wave and tidal stream energy. The extent to which offshore wind is included in Stage 3, and hence within this Technical Addendum, has been informed by work that has, primarily, been conducted or published since then.

2.1.9 On 10th December 2007, John Hutton, Secretary of State for Business Enterprise and Regulatory Reform (BERR), announced the commencement of a Strategic Environmental Assessment (SEA) to examine 25 gigawatts (GW) of additional UK offshore wind energy generation capacity by 2020. This followed the 8 GW planned for Rounds 1 and 2. On 4 June 2008, The Crown Estate (TCE) announced proposals for the third round of offshore wind farm leasing ('Round 3'). Both of these announcements fell within the timescale of Stage 1.

2.1.10 The environmental report for the Offshore Energy SEA (OESEA)[1] was published for consultation in January 2009, after Stage 1 ended, providing consideration of areas identified by TCE as offering 'indicative economic potential for offshore wind' as part of a UK wide assessment. Following the consultation period, the Government's decision on the SEA and TCE's Round 3 Zones was published on the 24th June 2009, which was to adopt a plan/programme for offshore energy, encompassing some 25GW of wind generation capacity and allowing TCE to continue with the competitive leasing round (Round 3). As part of this process, two potential zones were identified within or partially within Welsh waters by the TCE. These were the Irish Sea (which is partially within the 12nm limit for Welsh waters) and the Bristol Channel (which has some overlap with Welsh waters), with both areas subsequently taken forward for further consideration. Through the OESEA process, the environmental implications and spatial interactions of the draft plan were assessed, with a number of Round 3 areas taken forward by DECC[2], for leasing by the TCE[3]; albeit it with amended boundaries.

[1] UK Offshore Energy Strategic Environmental Assessment (UKOESEA). Future Leasing for Offshore Wind Farms and Licensing for Offshore Oil & Gas and Gas Storage. Environmental Report. DECC January 2009. www.offshore-sea.org.uk/consultations/Offshore_Energy_SEA/OES_Environmental_Report.pdf

[2] A Prevailing Wind – Advancing UK Offshore Wind Deployment. DECC June 2009. www.berr.gov.uk/files/file51989.pdf.

[3] www.thecrownestate.co.uk/round3

2.1.11 Consideration of marine renewable (wave and tidal) energy capacity will be included in the next OESEA which has recently been subject to a scoping exercise[4]. Further offshore wind capacity is not be considered as part of this exercise; the existing plan will be in place for a period of 5 years, and any revisions, including further potential offshore wind sites, will be considered as part of the update to that plan and the SEA process. Although offshore wind was included in Stage 1, it has not been considered further in the constraints mapping for Stage 3 (and consequently consideration of potential for sustainable development within Welsh waters) as the OESEA and the MRESF are unlikely to span a period in which additional offshore wind development, beyond Round 3 (and possible Round 1 and 2 extensions) would be identified in Welsh waters (i.e. within 12nm). Thus, although there may be potential for development of offshore wind within Welsh Waters in the future, any such potential would be evaluated in future iterations of the MRESF, in accordance with an updated OESEA or TCE leasing round. Offshore wind is therefore solely considered within the MRESF project in terms of information gathered in Stage 1, and hence not considered further in Stage 3 and therefore not addressed further here.

2.2 Stage 2

2.2.1 Following on from Stage 1, the aim of Stage 2 was essentially to investigate a core number of the key constraints identified in more detail. The project Steering Group considered all the information provided in Stage 1 and, in collaboration with RPS, the following projects were formulated for progression through Stage 2[5]:

- Work Areas 1 and 2 – Distribution of marine mammals in Welsh waters and collision risk with marine renewable devices (with a focus on high tidal flow areas);
- Work Area 3 – Underwater marine renewable devices and assessment of risk to diving birds (with a focus on high tidal flow areas);
- Work Area 4 – Collision risk of fish with wave and tidal devices;
- Work Area 5 – Potential effects of wave and tidal devices on military interests; and

[4] UK Offshore Energy Strategic Environmental Assessment (UKOESEA2). Future Leasing/Licensing for Offshore Renewable Energy, Offshore Oil & Gas and Gas Storage and Associated Infrastructure. Scoping for Environment Report. DECC March 2010. www.offshore-sea.org.uk/downloads/OESEA2_Scoping_Document.pdf

[5] It should be noted that the work undertaken in Stage 2 was not aimed at down grading the constraints, but instead was undertaken to increase the certainty in the constraint grade assigned. For example, if the constraint grade assigned was precautionary due to a lack of information, increasing the level of information enables the grading to be made on a more scientific basis, whether that is to increase, decrease or remain the same.

- Work Area 6 – Positive effects of marine renewables.

2.2.2 Of the above projects, work areas 4, 5 and 6 were wholly desk based, with primary fieldwork being undertaken to increase the knowledge base in work areas 1, 2 and 3. The additional information and understanding both of Welsh waters and the potential impact of marine renewables gained from the Stage 2 projects has been included in the summary of additional work post Stage 1 (see Sections 5 and 6).

2.3 Stage 3

2.3.1 The purpose of Stage 3 is to bring together the findings from Stage 1 and 2 and use them as the foundation on which to build the MRESF Framework. The methodology for Stage 3 was agreed between RPS, the Welsh Assembly Government and the Steering Group, with the Stage 3 scope of works includes a number of items of work to be completed, which can be summarised as follows:

- **Stakeholder Participation**. Involvement of Stakeholders via written correspondence to a questionnaire package (WAG, 2010a) and two workshops. A summary of stakeholder participation feedback in Stage 3 is presented in WAG (2010b);
- **Ensuring Contemporary and Complete Reporting**. There is a need to ensure that the MRESF is based on contemporary data and therefore where progress has been made or new work published since Stage 1 completed, these will be highlighted (current report);
- **Identification of Potential Generation Capacity**. In order to determine the potential contribution marine renewable energy in Welsh waters can make to energy generation, practical aspects need to be considered and not just the total energy potential. A summary of the potential generation capacity is included in RPS, in prep;
- **Constraint Management and Development of Potential Scenarios**. The approach to sustainable development, taking consideration of the various constraints on marine renewable energy development and the implications for both the existing situation and sustainable development. The information is summarised and presented in RPS (in prep.) alongside the potential generation capacity work;
- **Review of the Policy Context for Sustainable Marine Renewables Development**. What influence do overarching policy, guidance and targets have

on renewable energy developments? The review is contained within WAG (2011b); and

- **Project Dissemination**. The main dissemination method will be via the project specific website.

2.3.2 The current report has been prepared as a Technical Addendum to Stage 1, to bring the work up to date (at the end of 2010; published end of Q2 2011), and as such fulfils the bullet point 'ensuring contemporary and complete reporting'.

3 Ensuring Contemporary and Complete Reporting

3.1.1 Stage 1 was completed over 2 years ago and at the time was not formally issued outside the Steering Group. In the intervening period, and until completion of the project in early 2011, it is to be expected that a number of relevant developments will have occurred. Both to ensure that the overall project is contemporary to the issue date and to accurately inform the Stage 3 work, the work undertaken in Stage 1 needs to be reviewed to bring it up to date. The purpose of this report is to present the results of the review, forming a Technical Addendum to the overall MRESF reporting.

3.1.2 It is important for the project to undertake a brief review of appropriate issues to ensure the project remains current and applicable. The outputs will also be valuable for future projects, by providing a comprehensive review of the legislative framework for marine renewable applications, with a good understanding of both existing data and further relevant work in planning and in progress, together with an updated list of the main constraints on development in Welsh waters. The main changes that are directly applicable to the MRESF project have been summarised below:

- **Legislative requirements** – marine legislation/licensing has changed over the last 2 years, not least following the establishment of the Marine and Coastal Access Act 2009 and the Planning Act 2008;
- **Baseline data** – during Stage 1, it was noted that several projects in progress were likely to generate data of interest to the MRESF. For some, incomplete datasets were sourced and for others a note was logged with regard to future interest;
- The **constraints** identified in Stage 1 were based on a combination of issues, which essentially had the potential to represent a hurdle to development. Lack of scientific certainty was a significant aspect for several constraints, with the Stage 2 projects aimed at increasing scientific certainty for some of these areas of concern. In addition, it is likely that a number of additional projects/proposals will have been planned/undertaken/completed since Stage 1 was finished, which may influence the list of potential constraints (e.g. due to an increase in scientific certainty in the level of constraint applied or by increasing/decreasing the potential significance of an issue as regards potential impact); and
- The potential resource areas mapped during Stage 1 drew on the device specific data available at the time, e.g. minimum/maximum wave energy requirements, which was not always complete (given the limited number of devices that had at

that point progressed to full scale sea deployment and the commercial confidentiality with which the data are treated). However, the nature of the marine renewable industry means that wave and tidal stream technology is continually being developed. As such, it is likely that some of the device type data sourced during Stage 1 may not reflect the current industry status.

3.1.3 The current report has been prepared as a Technical Addendum to the Stage 1 work, with the aim of updating the points summarised above.

3.1.4 In addition to the work described above, there are a number of projects currently underway that have a degree of parity to Stage 3. These include work being undertaken by The Crown Estate (TCE), the Countryside Council for Wales (CCW) and the Welsh Assembly's Marine Conservation Zone team (MCZ). It was considered beneficial to the MRESF project to have early and, where necessary, ongoing discussions with the teams undertaking these projects, to enable an exchange of ideas and information of benefit to each project. The knowledge gained from these projects has also been summarised here (see Section 8).

4 Legislative Requirements

4.1 Introduction

4.1.1 The legislative requirements, together with planning policy and appropriate guidance that relate to CCS, offshore wind, wave and tidal stream were reviewed in Stage 1. However, there have been some considerable developments in some of those areas since Stage 1 was completed, and as such the relevant information presented in Stage 1 is now out of date. The information has been reproduced here in Section 4, updated where relevant for the situation as it exists in December 2010. It should be noted that issues connected to planning, policy and legislation are constantly evolving, for example the recent announcements following the General Election in May 2010.

4.2 Energy Policy in UK and Wales

4.2.1 Numerous documents have been published to provide information on and guidance about UK energy policy, with the following being of particular relevance to the current study. The Planning Act 2008, which includes aspects of relevance to Energy Policy, is discussed under Section 4.3.

Energy Act 2008

4.2.2 The Energy Bill 2007-2008 was given Royal Assent 26th November 2008 becoming the Energy Act 2008. The Act updates energy legislation to reflect the availability of new technologies and emerging renewable technologies, to correspond with the UK's changing requirements for secure energy supply and to protect our environment and the tax payer as the energy market changes. The main areas addressed by the Act include offshore gas infrastructure, CCS, the Renewables Obligation, the decommissioning of energy installations and offshore transmission. The Energy Act 2008, with the Planning Act 2008 and the Climate Change Act 2008, ensures that legislation underpins the UK's long-term energy and climate change strategy.

4.2.3 In regard to CCS and marine renewables, the content of the Energy Act 2008 includes the following:

- Creating a regulatory framework to enable private sector investment in CCS projects;

- Strengthening the Renewables Obligation to increase diversity of the UK electricity mix, improve reliability of energy supplies and help lower carbon emissions from the electricity sector;
- A strengthening of the statutory decommissioning requirements for offshore renewables and oil and gas installations; and
- Amending powers related to offshore electricity transmission.

4.2.4 The content of the Act is discussed further in Section 4.3.

Climate Change Act 2008

4.2.5 The Climate Change Bill was introduced into Parliament in November 2007 and received Royal Assent on 26th November 2008, becoming the Climate Change Act 2008. The key aims of the Act are to improve carbon management, helping the transition to a low carbon economy in the UK and to demonstrate UK leadership internationally. The key provisions of the Act include:

- A legally binding target of at least an 80% cut in greenhouse gas emissions by 2050 and a reduction in emissions of at least 34% by 2020;
- A carbon budgeting system which caps emissions over five year periods;
- The creation of the Committee on Climate Change, a new independent, expert body, to provide advice and guidance to Government on achieving it's targets and staying within its carbon budgets;
- An Adaptation Sub-Committee of the Committee on Climate Change, which will provide advice to, and scrutiny of, the Government's adaptation work;
- New powers to support the creation of a Community Energy Savings Programme by extending the existing Carbon Emissions Reduction Target scheme to electricity generators;
- A requirement for Government to report at least every five years on the risks to the UK of climate change and to publish a programme setting out how these will be addressed.

Marine and Coastal Access Act 2009

4.2.6 The Marine and Coastal Access Bill received Royal Assent on 12th November 2009. The Act was passed as part of the UK Government's commitment to introducing a new framework for the seas, aiming to establish a strategic system for marine planning,

striking a balance between conservation, energy and resource needs. Many of the changes associated with the Act, including the establishment of the Marine Management Organisation (MMO), relate to creating a planning and licensing system that clarify marine objectives and will result in better, more consistent decisions being made efficiently in a more straightforward system. The Act also introduces changes to fisheries management, conservation, coastal access and coastal zone management. The content of the Act is discussed further in Section 4.3.

Energy Act 2010

4.2.7 The Energy Act 2010 received Royal Assent on 8th April 2010. It implements key measures required to deliver DECC's low carbon agenda. The Act includes provisions for the introduction of mandatory social price support and increasing fairness in energy markets. There is also provision for the introduction of a new CCS incentive to support the construction of four commercial scale CCS demonstration projects in the UK and the retrofit of additional CCS capacity of these projects in the future, should this be required. There is also a requirement for the Government to prepare regular reports on the progress of decarbonisation of electricity generation in Britain and the development and use of CCS. The Act does not refer to marine renewables directly.

UK Renewable Energy Strategy

4.2.8 The UK Renewable Energy Strategy was launched as a consultation in June 2008 with the final document published in July 2009.

4.2.9 The strategy highlights the dual energy policy issues of tackling climate change while ensuring security of supply, with renewable energy highlighted as being a vital part of the overall strategy aimed at meeting the challenge. The lead scenario in the Strategy aims for more than 30% of electricity and 12% of heat generated from renewables and 10% of transport energy from renewables. In order to deliver these goals the Government will need to provide:

- Greater financial support for developing technologies;
- Swifter delivery, including in the planning system, supply chain, grid and sustainable bioenergy; and
- A stronger push on new technologies and resources.

4.2.10 Some of the measures that will help achieve this are:

- Extending and expanding the Renewables Obligation for major renewable electricity developments and introducing effective financial support for small-scale heat and electricity technologies in homes and buildings;
- Helping the planning system to deliver by streamlining the planning process, ensuring a strategic approach to planning working with all regions and devolved administrations to ensure are UK-wide approach and addressing the impacts of renewables deployment;
- Develop a stronger renewables industry through investment in key emerging technologies, supporting large scale investment in the sector and developing a skilled workforce;
- Investing strategically in the grid (including investment in a new offshore grid), ensuring appropriate incentives for new electricity grid infrastructure and removing grid access as a barrier to renewable deployment;
- Exploiting the full potential of energy from waste, increasing supply while meeting strict sustainability criteria, to limit adverse impacts on food prices, or other social and environmental concerns;
- Supporting technologies which could make a significant contribution to longer-term energy and climate needs. Marine energy is one such technology, and as a result a Marine Action Plan will be developed and investment increased by up to £60 million to help accelerate development and deployment in wave and tidal generation; and
- Maximising the benefits for UK business and jobs, by providing a clear long-term policy framework, working with Regional Development Agencies to tackle key blockages, considering support for specific technologies and addressing skills shortages.

National Policy Statements for Energy Infrastructure

4.2.11 With the passing of the Planning Act 2008 the UK planning system for nationally significant infrastructure projects was reformed, with the intention of providing a more efficient, transparent and accessible planning system. Under the system, development consent for nationally significant infrastructure was expected to be administered by a new independent body, the Infrastructure Planning Commission (IPC), with National Policy Statements (NPSs) at the centre of the new regime. They were intended to be the

primary consideration for decisions on applications for development consent (although the IPC was expected to have regard to other considerations such as local impacts, Marine Policy Statement (MPS) and marine plans and any other matters which the IPC thinks are both important and relevant to the decision).

4.2.12 In the run up to the May 2010 election, and immediately post, information was available in the general media regarding the intention to abolish the IPC. Subsequently, Decentralisation Minister Greg Clark announced the closure of the IPC on 29th June 2010, with the main change being that decision making power on nationally significant infrastructure projects is to return to Ministers. The Government must pass legislation to abolish the IPC, which is expected to be within the Decentralisation and Localism Bill, due to receive its first reading in November 2010. It is understood that the Government intends to replace the IPC with a Major Infrastructure Planning Unit, as part of the Planning Inspectorate. The Unit will broadly carry out the same functions as the IPC, with final planning decisions to be made by Ministers on the Units recommendations. Until the IPC is formally abolished, its functions will continue.

4.2.13 Some 12 National Policy Statements (NPSs) were planned, covering major infrastructure for energy, transport, waste, water and waste water. There are currently six NPSs for Energy Infrastructure, published for consultation in November 2009, with the consultation period closing on 22nd February 2010. The six NPSs for Energy Infrastructure are:

- The draft Overarching National Policy Statement for Energy (EN-1);
- The draft National Policy Statement for Fossil Fuel Electricity Generating Infrastructure (EN-2);
- The draft National Policy Statement for Renewable Energy Infrastructure (EN-3);
- The draft National Policy Statement for Gas Supply Infrastructure and Gas and Oil Pipelines (EN-4);
- The draft National Policy Statement for Electricity Networks Infrastructure (EN-5); and
- The draft National Policy Statement for Nuclear Power Generation (EN-6)

4.2.14 An additional NPS for Ports has also been published. It is understood that changes may be made to the NPSs by the coalition Government, for example regarding sustainability.

4.2.15 The Government is now re-consulting on the revised draft energy NPSs and associated documents (see www.energynpsconsultation.decc.gov.uk/home). There have been some significant changes made in response to the comments received. The more significant changes are listed in the Government's consultation document, but there are also minor changes throughout the documents. The current consultation closes on 24th January 2011.

Review of Energy Policy in Wales Part 1: Renewable Energy

4.2.16 The report for consultation was published in 2002, with carbon dioxide emissions and climate change, together with the associated repercussions, being key drivers of the document. The need to reduce emissions was regarded as critical, with increased fuel efficiency and use of low carbon fuel sources seen as the solution, in particular (given the title of the report) renewable energy. To achieve the desired mix of onshore and offshore wind, biomass, tidal and wave sources of energy, the removal of existing barriers to development was seen as essential. As part of this, the promotion and development of renewable energy and the setting of targets for renewable energy generation were also highlighted.

Energy Wales: Route map to a clean, low-carbon and more competitive energy future for Wales (2005)

4.2.17 The Energy Wales Route Map was aimed at laying a path for sustainable and secure energy supplies for Wales. It highlighted a commitment to both marine renewable developments and CCS, while recognising the input required to achieve these aims. A number of achievements and priority actions were given as part of the route map, including opportunities for marine renewables, cleaner fossil fuel plants and carbon capture. In particular, the document stated the following:

'In the medium to long term, we need to facilitate many more clean energy projects, including laying the base for a strong marine renewables sector'.

4.2.18 A number of key tasks are listed, with the following related specifically to marine renewables and carbon capture:

- Engage with stakeholders as appropriate on the construction of wind farms in waters off Wales;
- Examine the potential for marine, wave and tidal technologies in Wales through resource assessment and environmental evaluation;

- Look to increase marine renewable developers interest in establishing business presences in Wales;
- Make appropriate efforts to try to ensure that major demonstration projects are located in Wales by 2010;
- Look to keep open the long-term Severn barrage option; and
- Discuss the potential for carbon capture and storage.

4.2.19 There is, therefore, a clear commitment to future marine renewable energy developments, together with clean energy technologies such as CCS in Wales. The current project forms part of this drive, being aimed towards setting up a strategic framework within which energy extraction and CCS in Welsh waters can be carried out, in a sustainable fashion.

One Wales: A Progressive Agenda for the Government of Wales

4.2.20 The document was produced in 2007, to provide a four year programme aimed at improving the quality of life in Wales. The document covers issues as diverse as health, the economy, tourism, housing and education, with Section 8 titled 'A Sustainable Environment'. Climate change is highlighted as being 'the greatest threat to humanity', with the programme for addressing the issue including the following points:

- Tackling climate change;
- Supporting rural development;
- Achieving sustainable energy production and consumption; and
- Improving the local environment.

4.2.21 The document also included a section outlining support for the Energy Route Map and renewable energy in general, including research and development on and offshore.

Renewable Energy Route Map for Wales (2008)

4.2.22 The Renewable Energy Route Map for Wales builds on the 2005 document, aiming to combine a drive towards self-sufficiency in renewable energy with energy efficiency. The programme involves several strands, leading to the production of climate change and energy strategies to assist in meeting the commitment of an annual reduction of 3% in greenhouse gas emissions, from 2011 onwards. Renewable energy sources highlighted in the report include biomass, wave and tidal power, hydro-electricity, waste

and both onshore and offshore wind. Together with methods to generate renewable energy, the Route Map also looked at issues such as energy efficiency and micro-generation.

4.2.23 In addition to highlighting methods of generating power, or reducing demand, the consultation document summarises the consenting process through which developments were required to progress at the time the consultation document was compiled, (including the relevant consenting authority for Wales), together with the changes that have now been implemented following the passing of the Marine and Planning Acts. A brief summary of the existing electricity grid in Wales is also provided, together with potential topics for research and development.

The Welsh Assembly Government Energy Policy Statement (2010)

4.2.24 Following the commitment to reduce UK greenhouse gas emissions by 80% by 2050, this statement explains how the Welsh Assembly Government aims to achieve these reductions through three key areas:

- Maximise energy savings and energy efficiency in order to make producing energy from low carbon sources more feasible and less costly;
- Ensuring energy needs are met securely using low carbon sources. This will include a move to resilient low carbon energy production via indigenous (and thus secure) renewables (such as off and onshore wind, biomass, marine renewables, including tidal range and local, small scale generation); and
- Ensure that this transition to low carbon maximises the economic renewal opportunities for practical jobs and skills, strengthens and engages research and development sectors, promotes personal and community engagement and helps to tackle deprivation and improve quality of life.

4.2.25 The policy statement sets out targets for renewable energy generation with an overall aim to install 22.5GW capacity (or 48TWhr per annum) in the main by 2025. Much of this capacity will come from onshore and offshore wind, and marine renewable development (tidal range, tidal stream and wave), with significant contributions also coming from biomass and local, small scale generation (mainly PV, wind and hydro).

The Sustainable Development Action Plan

4.2.26 Section 121 of the Government of Wales Act 1998, subsequently repealed by the Government of Wales Act 2006, included a requirement for the National Assembly for

Wales to promote sustainable development. The 2006 Act included the following statement 'The Welsh Ministers must make a scheme ("the sustainable development scheme") setting out how they propose, in the exercise of their functions, to promote sustainable development'. The Sustainable Development Action Plan was produced by the Welsh Assembly Government to cover the period from 2004-2007. Of the issues addressed, climate change in particular is highlighted as being the 'greatest international sustainable development challenge'. The Plan set out key actions that were viewed as a route to delivering sustainable development in Wales. Of direct relevance to the current project, the key actions included the following:

- By 2010 100% of electricity used in all Assembly buildings will be supplied from renewable sources, or good quality embedded generation; with the Welsh Assembly Government working towards a similar figure for other public sector buildings; and
- By 2006 the Welsh Assembly Government will have established pilot projects that explore the potential of using renewable energy solutions in its policies and programmes, aimed at tackling fuel poverty amongst low income vulnerable households, particularly those unable to benefit from traditional improvement solutions.

4.2.27 The RPS report 'Review of the Policy Context for Sustainable Marine Renewable Development' (WAG, 2011a) discusses the issue of sustainability further.

Conservative Liberal Democrat Coalition Negotiations Agreement 2010

4.2.28 On 11th of May 2010 an agreement between the Conservative and Liberal Democrats was drawn up prior to forming a coalition government. This agreement covered a range of issues including those related to the environment. The parties agreed to implement a full programme of measures to fulfil ambitions for a low carbon economy. In regard to marine renewables, CCS and the renewables industry, this included:

- The establishment of a smart grid and the roll-out of smart meters;
- The full establishment of feed-in tariff systems in electricity – as well as the maintenance of banded ROCs;
- Measures to encourage marine energy;
- The establishment of an emissions performance standard that will prevent coal-fired power stations being built unless they are equipped with sufficient CCS to meet the emissions performance standard;

- Continuation of the present Government's proposals for public sector investment in CCS technology for four coal-fired power stations; and a specific commitment to reduce central government carbon emissions by 10 per cent within 12 months; and
- An agreement to seek to increase the target for energy from renewable sources, subject to the advice of the Climate Change Committee.

4.3 Legislation, Planning and Guidance

Legislative Consenting Process

4.3.1 Prior to deployment and construction of a project in UK territorial waters (out to 12nm), and the Renewable Energy Zone (REZ, which extends to 200nm), a number of legislative requirements need to be satisfied. These are summarised below. However, it should be noted that not all of these will necessarily apply and that local differences may occur as some consents are site dependent. There is potential for the licensing process to change further in the following 12 months, with any such changes to be posted on the MMO website (www.marinemanagement.org.uk). It should be noted that consultation is currently underway on a new Marine Licensing System, to be introduced by the Marine and Coastal Access Act 2009 and to be launched in spring 2011. Consultation documents are available at www.defra.gov.uk/corporate/consult/marine-licensing-system/index.htm.

4.3.2 All developments in Wales require either a lease from the seabed owner, (generally TCE but, in some areas, including the majority of the Severn Estuary, potentially private ownership such as the Swangrove Estate), or site licence (beyond UK territorial waters in the REZ where TCE does not own the seabed), accompanied by:

- For installations under 100MW, consent from the Marine Management Organisation (MMO, formerly the Marine and Fisheries Organisation, MFA), under the Electricity Act 1989, as amended by the Electricity Act, 2004;
- For installations over 100MW, consent from the Infrastructure Planning Commission (IPC) under the Planning Act 2009 (see Section 4.2 for potential changes);
- Currently, consent from Marine Consents Unit (MCU) of the Welsh Assembly Government, under both the Food and Environmental Protection Act (FEPA) 1985 and the Coastal Protection Act (CPA) 1949 are required. However, following the changes to the licensing regime in the Marine and Coastal Access Act 2009, it is

anticipated that the FEPA licence and CPA consent will be replaced by a single Marine Licence which will be issued by the MCU of the Welsh Assembly Government;

- Order from the Welsh Assembly Government (in Wales), under the Transport and Works Act (TWA), 1992. This provides an alternative to the Electricity Act (with FEPA, 1985) route for obtaining certain statutory rights necessary for the development of offshore projects, within the territorial waters of England and Wales. A TWA Order disapplies the need for consent under CPA if the works are authorised by a TWA Order, but this does not obviate the need for a FEPA licence. A TWA Order can also be used to disapply Section 36 of the Electricity Act;
- Consent from either the Secretary of State for Business, Enterprise and Regulatory Reform (via the Electricity Act 1989) or the local authority (under the Town and Country Planning Act 1990) for the onshore works; and
- Completion of an Environmental Impact Assessment through the Electricity Works (Environmental Impact Assessment) (England and Wales) Regulations 2000.

4.3.3 Potentially including:

- Consent from the Port/Harbour Authority if appropriate;
- Consent from the Environment Agency may be required under the Water Resources Act 1991 (if discharging/draining water or erecting structures, e.g. cabling, in, over or under a water course that is part of a main river);
- A European Protected Species (EPS) Licence may be required, if species protected under the Conservation of Habitats and Species Regulations 2010, and the Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 (as amended) (collectively known as the 'Habitat and Offshore Marine Regulations') are present. These licences are issued by the Marine Consents Unit (MCU) of the Welsh Assembly Government for developments within 12nm and the MMO for developments beyond 12nm;
- A potential damaging operation (PDO) consent from CCW may be required under the Wildlife and Countryside Act 1981 (including subsequent amendments), if a development is within a SSSI; and
- When a plan or project, either alone or in combination with other plans or projects, is likely to have a significant effect on a European Site, (i.e. on internationally important habitats and/or species), and is not directly connected with the

management of the site for nature conservation the developer is required to provide the Competent Authority with information to undertake a test of likely significance and potentially an Appropriate Assessment, under the Conservation of Habitats and Species Regulations 2010.

4.3.4 In regard to the legislative process for CCS, the Energy Act 2008 considers the issue, with the accompanying explanatory note commenting that:

'Permanent storage of carbon dioxide is a novel activity, and existing legislation to control depositions below the surface of the land and seabed is not well suited to licensing the storage of carbon dioxide…the Act establishes a framework for the licensing of carbon dioxide storage and the enforcement of the licence provisions'.

4.3.5 The framework established in the Act applies to the offshore area only. It also applies existing offshore legislation (for example the decommissioning legislation in the Petroleum Act 1998) to offshore structures used for the purposes of carbon dioxide storage. The Act, amongst other things, asserts the UK's rights to the use of the offshore sub-surface space for the storage of carbon dioxide. Further, in January 2008 the European Commission proposed a regulatory framework, in the form of the European Directive on the Geological Storage of Carbon Dioxide 2008/0014, to enable CCS. The legislative framework in the Energy Act appears to have been prepared prior to publication of the EC Directive, in part to provide the necessary licensing for a European CCS demonstration project, which is planned to be operational by 2014.

Changes and Additions to Nature Conservation

4.3.6 A number of changes and additions to existing nature conservation legislation and designated sites, as applicable to Welsh waters, have taken place since the end of 2008. These include the following:

- Potential extensions to existing Natura 2000 sites (the extension to the existing Liverpool Bay SPA);
- Areas of Search for offshore Natura 2000 sites (none in Welsh waters, although the 'north west Anglesey reef' lies just outside Welsh waters);
- The identification of Marine Protected Areas in Wales is currently underway and the MRESF project team is in discussion with the WAG Marine Conservation Zone (MCZ) team to enable discussion and the exchange of relevant information as it becomes available. However, it should be noted that in Welsh waters, such sites will be termed 'Highly Protected Marine Conservation Zones', which are defined as

'sites that are protected from extraction and deposition of living and non-living resources, and all other damaging or disturbing activities. In highly protected MCZs the whole environment present will be protected covering all the water column and seabed and all habitats and species present, whether present permanently or temporarily' (www.ccw.gov.uk/landscape--wildlife/managing-land-and-sea/marine-policies/planning--management/marine-protected-areas/wmcz-project.aspx);

- Potential Marine Conservation Zones in the south west of England, as identified by Finding Sanctuary (www.finding-sanctuary.org). Areas currently under investigation include iR1 (which runs follows the Median line in the Bristol Channel) and iS1, iS2, iS3, iS4 and iS5 (which are all in the Severn Estuary);
- Irish Sea potential Marine Conservation Zones (all fall just outside Welsh waters, however Zone 3 is off north west Anglesey, Zone 4 south west from the Llyn Peninsula and Zone 5 is west of Pembrokeshire).

4.3.7 Changes to Natura 2000 sites are limited to the extension to the SPA in Liverpool Bay, which was classified as a SPA on 20th August 2010, and areas being considered in offshore waters. An offshore area being considered for SAC status is termed an 'Area of Search'. The nearest such sites to Welsh waters are submarine structures in the mid Irish Sea and North-West Anglesey reef (see www.jncc.gov.uk/pdf/AreasOfSearch_Apr10.pdf). Both these sites fall outside Welsh waters. Although no formal Natura 2000 designation yet applies to these areas, given the interest as a potential site, it is likely that a similar process to that for a more formally designated site would need to be followed.

4.3.8 For the MCZs, the level of protection for potential sites in UK waters is difficult to determine as for such sites outside Welsh waters this is expected to be variable. It is anticipated that all MCZs in Welsh waters will be highly protected sites within the existing Natura 2000 network of sites, however no geographic areas have yet been identified.

Planning

4.3.9 In addition to the changes in licensing since Stage 1 (as discussed above), there have also been a number of changes to planning legislation following the passing of both the Planning Act 2008 and the Marine and Coastal Access Act 2009 (also known as the Marine Act). As regards planning the overall aim of the Marine Act is given as follows:

'The Act creates a strategic marine planning system that clarifies our marine objectives and priorities for the future, and directs decision makers and users towards more efficient, sustainable use and protection of our marine resources'.

4.3.10 To achieve this, the Marine Act outlines a two staged approach. The first stage involves the joint creation of a Marine Policy Statement (MPS), to be agreed between UK Government departments and the devolved administrations, to create a more integrated approach to marine management and setting both short and longer-term objectives for sustainable use of the marine environment. The MPS has recently been subject to a second consultation, with amendments expected to be made during 2010 and the final version in spring 2011 (www.marinemanagement.org.uk/marineplanning/index.htm). The second stage relates to the creation of a series of marine plans, which will implement the policy statement in specific areas, using information about spatial uses and needs in those areas. The plans will cover human activities and associated infrastructure and will not remove the requirement for site specific assessment (i.e. EIA), rather they will provide 'advice and steer marine users towards a more efficient, sensible use of marine space'.

4.3.11 The WAG intend to consult on their approach to marine planning in early 2011. The key purpose of the consultation will be to seek views on the way in which the WAG intends developing marine planning in Wales in line with its powers and responsibilities under the Marine Act 2009. The consultation will set out the WAG's intention to develop a national plan for the Welsh inshore area and a national plan for the Welsh offshore area and adopt them by 2012/13. The consultation will also set out options for, and asks questions on, how the WAG should plan on a sub-national level in order to embed more detail in the national plans.

4.3.12 The Planning Act received Royal Assent on 26 November 2008 the first 8 parts of which create 'a new system of development consent for nationally significant infrastructure projects'. As discussed in Section 4.2, key to the new planning system was the establishment of an Independent Planning Commission (IPC), to decide on major infrastructure proposals. It was intended for the IPC to determine projects that are outside the devolution settlement (i.e. Nationally Significant Infrastructure Projects) thus covering a range of infrastructure projects, including some energy projects (above threshold criteria) and underground storage of gas. In the marine environment, the IPC was therefore made responsible for issuing development consents for large offshore renewable energy projects (i.e. those with a capacity greater than 100MW). As

discussed in more detail in Section 4.2, following the May 2010 General Election, the coalition Government is intending changes to the process.

4.3.13 As part of the drive towards improved marine planning, a Marine Spatial Planning Pilot was undertaken in the Irish Sea (www.abpmer.net/mspp/). The aim of the Pilot was to obtain a better understanding of the current situation, information on marine planning and to develop a pilot project to test the feasibility and practicality of applying a marine spatial plan. The Pilot identified a number of benefits of developing Marine Spatial Plans, in particular for the achievement of sustainable development. Notes of caution were also given, including the absence of key data sets.

4.3.14 The principles of Marine Spatial Planning (MSP) have yet to be applied specifically to Welsh waters (although the Pilot did extend to parts of north Wales) however the current project will provide much useful data which can be used to inform the development of a MSP for Welsh waters, as and when such is developed. There are many synergies between the two initiatives, both seeking to establish a baseline of understanding with respect to spatial uses, requirements and sensitivities in the marine area on a broad scale, and encompassing both natural and socio-economic resources. The spatial coverage of information considered in this study will inform the development of a Welsh MSP, at an appropriate scale to allow the development of the regional seas approach, providing for management both within Welsh territorial waters, and across administrative boundaries, where the regional sea approach dictates the appropriate 'management unit'. The WAG anticipate consulting on the proposals for marine planning in early 2011 (see Section 4.3.11) including options for spatial planning in Welsh waters. To provide for management at this scale, it is considered important that any Welsh MSP integrates with MSPs in adjacent territorial waters.

Guidance

4.3.15 Several documents have been published in the last few years, aimed at providing advice and guidance to regulators and developers as regards marine renewable development in the UK. Due to the more advanced state of the offshore wind industry, a greater proportion of these tend to be directly related to offshore wind. Whilst these can be used as a starting point for marine renewable developments, an increasing number of documents are aimed specifically at wave and tide. The UK documents identified as part of this study are summarised in Table 4.1 below.

Table 4.1: UK Advice and Guidance Documents for Marine Renewable Developments

Title of Document	Author	Date	Relevance to Wind/Wave/Tide
Generic Guidance			
Best Practice Guidelines for Wind Energy Development	BWEA	1994	Wind
Guidelines for Health and Safety in the Marine Energy Industry	BWEA/EMEC	2008	Wind, Wave and Tidal
EIA and the Consenting Process			
Guidance notes for Environmental Impact Assessment in respect of FEPA and CPA requirements	CEFAS	2004	Wind
Guidance notes: offshore wind farm consents process	DTI and MCEU	2004	Wind
Guidance on the Electricity Works (Environmental Impact Assessment) (England and Wales) Regulations 2000	DTI	2000	Wind, Wave and Tide
Environmental Impact Assessment (EIA): Guidance for developers at the European marine energy centre	EMEC	2005	Wave and Tide
Guidance on consenting arrangements in England and Wales for a pre-commercial demonstration phase for wave and tidal stream energy devices (marine renewables)	DTI	2005	Wave and Tide
A Review of Assessment Methodologies for Offshore Wind farms	BTO	2009	Wind
Establishing best practice for the documentation and dissemination of marine biological data	Seeley, B, Parr, J, Evans, J and Lear, D	2008	Wind, wave and tide
Review of cabling techniques and environmental effects applicable to the offshore wind farm industry	BERR	2008	Wind
Decommissioning offshore renewable energy installations. Consultation on guidance relating to the statutory decommissioning scheme for offshore renewable energy installations in the Energy Act 2004	DTI	2006	Wind Wave and Tidal

Title of Document	Author	Date	Relevance to Wind/Wave/Tide
Guidance on Environmental Impact Assessment of offshore renewable energy development on surfing resources and recreation	Surfers against sewage	2009	Wind, Wave and Tidal
Guidelines for Ecological Impact Assessment in Britain and Ireland - Marine and coastal	IEEM	2010	Wind, Wave and Tidal
OSPAR Guidance on Environmental Considerations for Offshore Wind Farm Development	OSPAR Commission	2008	Wind
Towards standardised seabirds at sea census techniques in connection with environmental impact assessments for offshore wind farms in the U.K.	Camphuysen, CJ, Fox, AD, Leopold MF and Petersen IK	2004	Wind
Developing guidance on ornithological cumulative impact assessment for offshore wind farm developers	COWRIE	2009	Wind
A review of assessment methodologies for offshore wind farms	Maclean, Wright, Showler and Rehfisch	2009	Wind
Assessment of the effects of offshore wind farms on birds	Ecology Consulting/DTI	2001	Wind
Consultation			
Best practice guidelines: Consultation for offshore wind energy developments	BWEA	2002	Wind
The protocol for public engagement with proposed wind energy developments in Wales	Centre for Sustainable Energy, BDOR Ltd and Capener, P	2007	Wind
BWEA recommendations for fisheries liaison	BWEA	2004	Wind
Shipping and Navigation			
Assessing the navigational impact of offshore wind farms proposed for UK sites	MCA	2002	Wind
IALA recommendation O-117 on the marking of offshore wind farms Edition 2	IALA	2004	Wind
IALA recommendation O-131 on the marking of offshore wave and tidal energy devices Edition 1	IALA	2005	Wave and Tide
IALA recommendation O-139 The Marking of Man-	IALA	2005	Wind, Wave

Title of Document	Author	Date	Relevance to Wind/Wave/Tide
Made Offshore Structures			and Tide
DTI Consultation on Safety Zones	DTI	2006	Wind
Guidance on the assessment of the impact of offshore wind farms: methodology for assessing the marine navigational safety risks of offshore wind farms	DTI, MCA and DfT	2005	Wind
Wind farm Shipping Route Template	MCA	2006	Wind
Proposed UK Offshore Renewable Energy Installations (OREI) - Guidance on Navigational Safety Issues	MCA	2004	Wind, Wave and Tide
IMO guidelines for formal safety assessment	IMO	2002	
Guidance to mariners operating in the vicinity of UK offshore renewable energy installations	MCA	2007	Wind, Wave and Tide
Applications to the Secretary of State for Business, Enterprise and Regulatory Reform for the Establishment of Safety Zones Around Offshore Renewable Energy Installations under the Energy Act 2004	BERR	2007	Wind, Wave and Tide
Aviation			
CAP 168 – Aerodrome Licensing	Civil Aviation Authority	2010	Wind
CAP 764 – CAA Policy and Guidance on Wind Turbines	Civil Aviation Authority	2010	Wind
Wind Energy and Aviation Interests – Interim Guidelines	DTI	2002	Wind
Visual Impact			
Guide to best practice in seascape assessment	Hill, M, Briggs, J, Minto, P, Bagnall, D, Foley, K and Williams, A	2001	Wind
Visual assessment of wind farms: best practice	University of Newcastle	2002	Wind
An assessment of the sensitivity and capacity of the Scottish seascape in relation to offshore wind farms	Scott, KE, Anderson, C, Dunsford, H, Benson, JF and MacFarlane, R	2005	Wind
Guidance on the Assessment of the Impact of Offshore Wind Farms: seascape and visual impact	DTI, Countryside	2005	Wind

Title of Document	Author	Date	Relevance to Wind/Wave/Tide
report	Agency, CCW, SNH		
England's historic seascapes consolidating the national method	Tapper, B and Johns, C	2008	Wind, Wave and Tide
Guidelines for landscape and visual effect assessment	IEMA/Landscape Institute	2002	Wind, Wave and Tide
Visual analysis of wind farms – Good practice guidelines	SNH	2006	Wind
Wind turbine development – Landscape assessment, evaluation and guidance	Breckland Council and King's Lynn and West Norfolk Borough Council	2003	Wind
Cumulative Effects of Wind Turbines	DTSU/DTI	2000	Wind
Nature Conservation			
Wind farm development and nature conservation: a guidance document for nature conservation organisations and developers when consulting over wind farm proposals in England	English Nature, RSPB, WWF-UK and BWEA	2001	Wind
Marine Renewable Energy and the Natural Heritage: An overview and policy statement	SNH	2004	Wind, Wave and Tide
Nature conservation guidance on offshore wind farm development (draft for consultation)	Defra	2005	Wind
The deliberate disturbance of marine European Protected Species	JNCC	2008	Wind, Wave and Tide
The protection of marine European Protected Species from injury and disturbance. Draft guidance for the marine area in England and Wales and the UK offshore marine area.	JNCC	June 2010 (draft)	Wind, Wave and Tide
Wet Renewable Energy and Marine Nature Conservation: Developing Strategies for Management	ABPmer	2009	Wave and Tidal
Archaeology			
Guide to good practice on using the register of landscapes of historic interest in Wales in the planning and development process	CCW, Cadw and WAG	Undated	Wind, Wave and Tide

Title of Document	Author	Date	Relevance to Wind/Wave/Tide
Guidance for the assessment of cumulative impact on the historic environment from offshore renewable energy	Oxford Archaeology	2007	Wind, Wave and Tide
Historic Environment Guidance for the Offshore Renewable Energy Sector	Wessex Archaeology	2007	Wind, Wave and Tide
Wind Energy and the Historic Environment	EH	2005	Wind
Standard and Guidance for Archaeological Desk based Assessment.	IFA	2001	Wind, Wave and Tide
Health and Safety			
Health and safety guidelines for wind farm development	BWEA	2002	Wind
The Health and Safety Risks and Regulatory Strategy Related to Energy Developments	The Health and Safety Executive	2006	Wind, Wave and Tide
Carbon Capture and Storage			
Best Practice for the Storage of CO_2 in Saline Aquifers	Ed A Chadwick, R Arts, C Bernstone, F May, S Thibeau and P Zweigel	No date	CCS

4.4 Climate Change Targets

4.4.1 The UK Government is committed to a number of targets related to the issue of climate change, which stem from European and national articles. The Welsh Assembly Government has additional commitments made specifically for Wales, with the Wales Climate Change Strategy (WAG, 2010c) setting out how the Welsh Assembly Government will deliver its commitments to set targets for reduction in emissions and adaptation to the impact of climate change. Specific targets and commitments made relate to a number of issues connected to climate change, including emissions of carbon dioxide and development of renewable energy. Recent commitments include the Climate Change Act 2008 (Section 4.2.5) and the Copenhagen Accord 2009 with the UK Renewable Energy Strategy (Section 4.2.8) and the Welsh Assembly Government Energy Policy Statement also setting out details of how these commitments can be met. An overview of the targets and commitments made is presented below in Table 4.2.

Table 4.2: Climate Change Targets Applicable to Wales

Commitment	Target	Target Date
Global		
Kyoto	Reduction in greenhouse gas emissions of 12.5% from 1990 levels	2012
Copenhagen (temperature rise)	Limit of 2°C temperature rise	unspecified
Copenhagen (peak emissions)	Peak greenhouse gas emissions by 2020	2020
Copenhagen (emission reduction)	50% reduction in greenhouse gas emissions	2050
European Union		
Reduction in EU energy consumption	20%	2020
Reduction in carbon dioxide emissions	At least 20% from 1990 levels, with a proposal for 30% provided other developed countries commit to comparable reductions and developing countries contribute adequately	2020
EU renewable energy consumption	20%	2020
Biofuel in petrol and diesel	10%	2020
Temperature rise	Limit of 2°C	unspecified
UK Government		
Climate Change Act 2008	80% cut in greenhouse gas emissions from 1990 levels	2050
Climate Change Act 2008	34% cut in greenhouse gas emissions from 1990 levels	2020
Climate change programme	Reduction in greenhouse gas emissions of 20% from 1990 levels	2020
Renewables Obligation	Increase in electricity generated by renewables by 20%	2020-21
Carbon reduction commitment	Reduction in electricity consumption for organisations with an electricity consumption greater than 6,000MWh per	Auction of carbon allowance from 2013

Commitment	Target	Target Date
	annum	
Climate change levy	Cut in annual emissions of 2.5 million tonnes	2010
Welsh Assembly Government		
Annual reduction in greenhouse gas emissions	3%	2011 onwards
Electricity used in Assembly buildings	Supplied from renewable or good quality embedded generation	2010
Renewable energy pilot projects	Establish pilot projects to explore using renewable energy solutions aimed at tackling fuel poverty	2006
Renewable energy generation	Increase renewable energy generating capacity (from off and onshore wind, biomass, marine renewables and small scale generation) in Wales to 22.5GW (or 48TWhr per annum)	2025

4.5 Strategic Environmental Assessment

4.5.1 The EU Directive on the assessment of the effects of certain plans and programmes on the environment (2001/42/EC) refers to Strategic Environmental Assessment (SEA). SEA is the process through which the environmental impact of plans and projects can be assessed at a strategic level, i.e. above the level of individual plans or projects. Essentially, it is a broad scale assessment of potential impact from particular types of development in a particular area. It is often undertaken prior to a round of development, to highlight issues that specific projects will need to consider or flag up areas of particular sensitivity. The approach is particularly useful for issues such as cumulative effect and to assist in identifying key data gaps at an early stage. There are five sets of SEA across different sectoral interests that are of current interest to this study, as summarised below.

Oil and Gas

4.5.2 For the purposes of the Oil and Gas Licensing SEA (www.offshore-sea.org.uk) the UK continental shelf was divided into 8 areas, with an SEA to be undertaken on each.

Currently, the SEA process has been completed for Areas 1-6, with work ongoing in Areas 7 and 8. Welsh waters are covered by SEA Areas 6 and 8. Although not directly related to renewable energy (see Section 4.5.5 below), the documents accompanying each SEA provide a large amount of background and baseline information on each area.

Offshore Wind

4.5.3 Subsequent to the DTI (now DECC) progressing with an SEA for oil and gas, the SEA process for offshore wind commenced in 2002 (www.offshore-sea.org.uk/site/scripts/downloads.php?categoryID=23). The assessment focused on three discrete areas of sea, located in Liverpool Bay, Greater Wash and Thames Estuary. Of these, the Liverpool Bay area falls partially within Welsh waters. Developers of Round 2 offshore wind farms were strongly advised by the DTI (now DECC) to 'take into account the advice given in the SEA Environmental Report, including the possible impact on fishing, navigation and other users of the sea' (http://www.offshore-sea.org.uk/site/). For the purposes of the current study, the documents provide an overview of the potential impacts and their significance, together with baseline data (see Section 2.1).

Scottish Renewables SEA

4.5.4 An SEA has subsequently been undertaken in Scottish waters, to assess potential issues for wave and tidal energy development (www.seaenergyscotland.co.uk). The full report was published in March 2007. The main objectives of the project were set out as follows:

- To assess, at a strategic level, the effects on the environment of meeting the Marine Energy Group report target for establishing 1,300MW of marine renewables capacity around Scotland by 2020;
- Advising and supporting the Scottish Executive in the development and implementation of its marine renewable energy strategy and informing future development of planning guidance for marine energy development;
- To inform the project level decision making process for all stakeholders (to include regulator and developer); and
- To facilitate focused investment into the marine renewable energy sector in Scotland.

Offshore Energy SEA

4.5.5 As a follow up to the Oil and Gas SEAs for Areas 1-7, BERR (now DECC) published a scoping report in December 2007 and following consultation an Environmental report (known as UK OESEA) was issued in January 2009. This SEA considered the environmental implications of a draft plan/programme to enable: further seaward rounds of oil and gas licensing, including gas storage in UK waters; and further rounds of offshore wind farm leasing in the UK Renewable Energy Zone and the territorial waters of England and Wales to a depth of 60m. The objective of the wind leasing was to achieve some 25GW of generation capacity, in addition to the 8GW already constructed or in planning.

4.5.6 During 2010, DECC proposed to undertake an exercise to update and extend the scope of the Environmental Report and issue it for consultation to enable further licensing/leasing for offshore energy (oil and gas, gas storage including CCS and marine renewables – tidal stream and wave). To distinguish it from the 2009 Environmental Report (UK OESEA), the updated and extended Environmental Report will be referred to as OESEA2 (Offshore Energy SEA2) and the scoping document (http://www.offshore-sea.org.uk/downloads/OESEA2_Scoping_Document.pdf) was published for consultation on the 4th of March 2010, with the Environmental Report due out for consultation in early Q1 2011. This is the most relevant SEA to the MRESF project as this SEA will include a preliminary plan of potential tidal and wave resources areas for demonstration (rather than commercial) developments sites in England and Wales.

Northern Ireland Offshore Wind and Marine Renewable Energy SEA

4.5.7 The Department of Enterprise, Trade and Investment (DETI) commissioned an SEA to investigate the potential effects that the development of offshore wind and marine renewable energy (wave and tidal stream devices) on the coastline of Northern Ireland and territorial (12nm limit) marine environment. The results of the SEA will used by DETI to inform the development, and implementation of, its offshore wind and marine renewable energy Strategic Action Plan (SAP). The scoping study for the SEA was published for consultation in April 2009 and was published with the SAP (which is being developed in parallel to the SEA) in December 2010, with a subsequent 12 week consultation on the SAP closed on the 8 March 2010.

Severn Estuary SEA

4.5.8 A feasibility study and SEA for tidal range energy in the Severn was commissioned by DECC (with support from the Welsh Assembly) to assess the potential for tidal range energy in the Severn, together with the need for an Appropriate Assessment to be undertaken. In January 2009, DECC published the findings of Phase 1 of the study, including the scoping study for the SEA. This was published for public consultation, which was conducted between January and April 2009 and asked for views on:

- A recommended shortlist of schemes for more detailed analysis;
- The scope of the SEA; and
- The issues the feasibility study is considering and how these are being approached.

4.5.9 Following the consultation period, five schemes were shortlisted including the Cardiff to Weston barrage, two smaller barrages and two lagoons. These were deemed to be potentially technically and economically feasible at that time. The Feasibility Study was subsequently published in October 2010 (see www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/renewable/severn_tidal_power/severn_tidal_power.aspx), with the conclusion by the UK Government being as follows:

'The Government has concluded that it does not see a strategic case to bring forward a tidal energy scheme in the Severn estuary at this time, but wishes to keep the option open for future consideration'

4.5.10 Although not a consultation, the Government is taking comments on the decision until January 2011.

4.6 Sustainability Appraisal

4.6.1 Under UK legislation, a Sustainability Appraisal must be prepared for regional and local development plans. It is similar to a SEA, but includes assessment of social and economic inputs, in addition to environmental inputs. A Sustainability Appraisal is used by planning authorities to assess whether proposed plans and policies meet sustainable development objectives.

4.6.2 While the requirement to carry out a Sustainability Appraisal and SEA are distinct, it is expected that in the future both can be satisfied in one single appraisal process.

4.6.3 Sustainability Appraisals should:

- Take a long term view of the expected social, economic and environmental effects of a proposed plan;
- Check that sustainability objectives are turned into sustainable planning policies;
- Reflect global, national, regional and local concerns; and
- Form an integral part of all stages of plan preparation

4.6.4 As the MRESF is aimed at providing a governance tool rather than providing a plan or programme there is no requirement for a Sustainability Appraisal (SA) to be undertaken. Instead, sustainability is in integral to the transparent process used in the MRESF and the final development scenario outputs generated (see WAG (2011b)), which considers the wave and tidal resource, in light of existing social, economic and environmental uses of Welsh territorial waters.

5 Baseline Data

5.1 Introduction

5.1.1 Data describing the baseline environment of Welsh waters was collated during Stage 1, including information on the existing natural, human and economic environment. The information was summarised in the Stage 1 report (RPS, 2008), together with a comprehensive bibliography (see Section 10). Where data were available in GIS, these were mapped during Stage 1, to visually demonstrate the type and extent of baseline data available for Welsh waters.

5.1.2 It was recognised during Stage 1 that a number of key projects were in progress, and anticipated to report during the timeframe of the MRESF project, with the data viewed as beneficial. In addition, a number of new projects have been undertaken in the intervening timeframe. The purpose of this section of the Technical Addendum is to identify new work describing the baseline environment of Welsh waters progressed and/or completed since Stage 1 finished, with the information listed below, and, where available in GIS format, in Figures B-1 to B-21; with Figure B-1 providing an overview of the study area. The bibliography compiled during Stage 1 has been updated as appropriate, with additions marked as such (Section 11).

5.2 Physical Environment

5.2.1 The main new non GIS data for the physical environment of Welsh waters is available via ongoing or relatively long term monitoring programmes, such as work by Marine Renewable Energy Development in Scotland (www.mreds.co.uk), the strategic wave monitoring network (www.cefas.co.uk/data/wavenet.aspx) and wave height studies using satellite data undertaken at the National Oceanography Centre (www.noc.soton.ac.uk). These tend to relate either to individual monitoring points or broad scale projects, extending up to the oceanic scale. A study lead by Liverpool University (www.pol.ac.uk/home/research/theme6/tidalIrishSea.php) investigated the tidal power potential of the eastern Irish Sea, including some of the waters off the north coast of Wales.

5.2.2 New GIS physical environment data identified are limited to a BGS lead project which updated seabed sediment maps (see www.bgs.ac.uk/products/digitalmaps/digmapgb-plus/).

5.2.3 The GIS data held for the physical environment are presented in Figures B-3i to B3iv.

5.3 Water and Sediment Quality

5.3.1 No additional specific work for water or sediment quality has been identified, although ongoing work such as the Environment Agency monitoring programme will have gathered additional data over the intervening period.

5.3.2 The GIS data held for sediment and water quality are presented in Figure B-4.

5.4 Landscape and Seascape

5.4.1 Two key datasets describing the existing baseline for landscape and seascape for Wales and Welsh waters have been completed since Stage 1 ended. In addition, the seascape dataset includes data layers giving seascape sensitivity to tidal stream and wave devices. The project outputs from these have been sourced for the MRESF project and are available on the CCW website, including GIS datasets (www.ccw.gov.uk; see Section 11.2 Project Bibliography reference listings 1019 to 1073).

5.4.2 The GIS data held for landscape and seascape are presented in Figures B-5i to B-5viii. For information purposes only, Figures B-5i to B-5v provide CCW landscape datasets. Figures B-5vi to B-5viii present interpreted Seascape sensitivity data layers provided by CCW.

5.4.3 During the constraint mapping undertaken in Stage 3 of the MRESF (WAG, 2011b) it was noted that data layers that fall wholly on land would not be included without additional data processing, purely because the geographic footprint of the wave and tidal stream resource areas identified were fully within tidal waters and hence did not overlap with terrestrial interests. During discussions with the Steering Group, it was apparent that although the processed seascape data maps produced by CCW do extend seawards, the source data does not include features such as National Trust land and National Parks. To ensure full inclusion of these features in the constraint mapping, the RPS project team undertook additional data processing to generate a Zone of Theoretical Visibility (ZTV), which essentially shows areas of land that the observer points can theoretically observe, with the method followed described below.

5.4.4 To generate a ZTV a set of Observer Points must be generated. As the National Parks and National Trust designations are defined as regions rather than points, it was necessary to define an indicative set of discrete locations that are representative of the

area. A 250m grid was generated for the entire study area and where a grid cell intersected a designation, a point was generated (Diagram 5.1). This created a point dataset that matched the extents and coverage of the designation, with these points used as Observer Points.

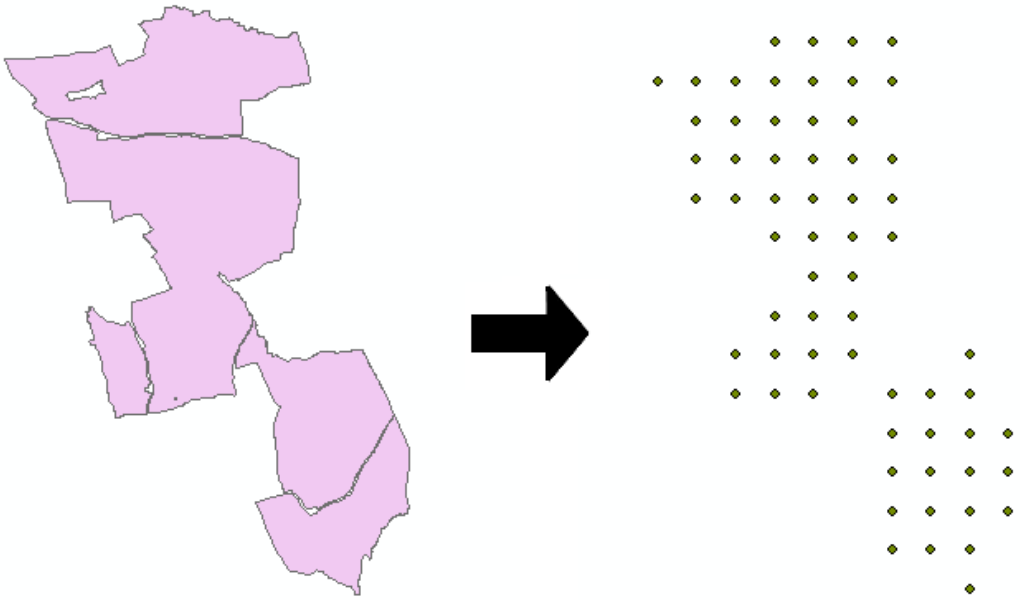


Diagram 5.1: Indicative Generation of Observer Points

5.4.5 Due to the large number of Observer Points generated the dataset was split into a grid containing a maximum of 100 possible locations, which allowed the ZTV to be split up into a set of smaller ZTVs that were more practicable to process. Using the ArcGIS Spatial Analyst Extension a viewshed was generated for each batch of 100 Observer Points, including Earth Curvature and refractivity in the calculation and with the maximum visible distance set at 24km. A combined ZTV was generated to show visibility for the entire study area (Figure B-5vix; with this data layer being taken forward into the constraint mapping (see WAG (2011b)).

5.5 Marine Mammals

5.5.1 A number of reports and projects related to the marine mammal baseline for Welsh waters have been completed and published since Stage 1 ended. These have been summarised in Table 5.1 below.

Table 5.1: Summary of Marine Mammal Baseline Data completed since 2008

Project/Report Title	Author	Date	Availability
Sarn Cynfelyn to the Dyfi Estuary: Habitat and Cetacean Survey 2006/7	Hughes, P. and Hughes, R, E.	2009	CCW Marine Monitoring Report No. 69.
Post doc study at St Andrews compiling and analysing all seal tagging data from the past 25 years	Unknown	N/A	In progress
Distributions of Cetaceans, Seals, Turtles, Sharks and Ocean Sunfish recorded from Aerial Surveys 2001-2008	WWT Consulting		Report to Department of Energy and Climate Change
High Resolution Video Survey of Seabirds and Mammals in the Moray Firth, Hastings, West Isle of Wight and Bristol Channel Areas in Periods 5, 6 and 7	Rhys Hexter and HiDef Aerial Surveying Ltd	2009	COWRIE
Atlas of the Marine Mammals of Wales	M.E. Baines and P.G.H. Evans	2010	CCW Marine Monitoring Report No. 68

5.5.2 The Atlas of Marine Mammals of Wales has been sourced in GIS format. Additional work on the digital marine mammal data was undertake subsequently and provided to the MRESF by CCW, including data on the vulnerability of marine mammals to tidal stream devices (CCW, 2011 in prep.). Additional work included the marine mammal work conducted as part of Stage 2 of the MRESF project (Wilson and Gordon, 2011, and Gordon *et al.,* 2011).

5.5.3 The GIS data held for marine mammals are presented in Figure B-6i-6iii, and the CCW cetacean vulnerability presented in Figure B-6iv, and the equivalent for grey seals in Figure B-6v.

5.6 Birds

5.6.1 Several new studies related to baseline data for birds in Welsh waters, including projects at proposal stage, projects in progress and as final reports. The work identified is summarised in Table 5.2 below.

Table 5.2: Summary of Bird Baseline Data proposed, in progress and completed since 2008

Project/Report Title	Author	Date	Availability
Analysing existing GPS and conventional satellite-tracking data for four key migratory bird species: svalbard barnacle geese, Greenland barnacle geese, light-bellied brent geese and Greenland white-fronted geese	N/A	N/A	DECC RAG proposal
Compilation of species reports	N/A	N/A	DECC RAG proposal
Understanding whooper swan migration patterns and potential interactions with wind farms	N/A	N/A	DECC RAG proposal
Tidal Atlas. A GIS based resource, collating data on environmental resources potentially sensitive to tidal stream devices.	CCW	N/A	Project in progress
Welsh aerial surveys	DECC RAG	N/A	Project in progress
An inventory of bird survey data of relevance to marine renewable energy and other offshore industries	DECC RAG	N/A	Project in progress
Use of coastal waters by breeding terns	COWRIE	N/A	Project in progress
The determination of foraging range and diving depths by diving seabirds, especially in the Orkney and Pentland Firth wave and tidal resource areas.	SNH awarded to RPS	N/A	Project in progress
Field Surveys to Determine Abundance, Distribution and Flight Patterns of Waterbirds, Seabirds, and Seaducks in the Nearshore Atlantic	MMS	N/A	Project in progress
High Resolution Video Survey of Seabirds and Mammals in the Rhyl Flats Area	Rhys Hexter and HiDef Aerial Surveying Ltd	N/A	www.offshorewind.co.uk/assets/cowrie%20high%20definition%20imagery%20final%20report20%20091130.pdf
Manx shearwater at Skomer			http://research.microsoft.com/en-us/um/cambridge/projects/habitats/
GPS tracking of the foraging movements of Manx Shearwaters *Puffinus puffinus* breeding	Guilford, T.C., Meade, J.,	2008	Ibis 150, 462-473

Project/Report Title	Author	Date	Availability
on Skomer Island, Wales	Freeman, R., Biro, D., Evans, T., Bonadonna, F., Boyle, D., Roberts, S. & Perrins, C.M.		

5.6.2 Additional work included the marine mammal work conducted as part of Stage 2 of the MRESF project (RPS, 2011a and 2011b). The GIS data held for birds are presented in Figure B-7i-7viii, drawing largely on the data provided by CCW, which has combined GIS datasets for birds in Welsh waters, and includes a GIS data layer for the vulnerability of diving seabirds to tidal stream devices prepared by CCW (2011, in prep.) and presented in Figure B-7viii.

5.7 Fish Ecology

5.7.1 Work of direct relevance to fish ecology in Welsh waters was published by Cefas subsequent to the baseline data layers being finalised for the preparation of the Framework (see WAG (2011b)). For completeness, the data layers have been incorporated into the baseline datasets for information only and are presented alongside the existing data by Coull *et al* (1998) and can be sourced from the Cefas website at www.cefas.co.uk/our-science/fisheries-information/marine-fisheries/ecologically-important-fish-habitats/distribution-of-spawning-and-nursery-grounds.aspx.

5.7.2 Other projects that are known to be in progress, that have some relevance for fish ecology, are:

- The CCW Tidal Atlas, a GIS based resource, collating data on environmental resources potentially sensitive to tidal stream devices;
- GIS mapping of basking sharks in Welsh waters (understood to be in progress for CCW, although the status is unknown); and
- Work on seabed communities in strong tidal streams at EMEC (which will inevitably be orientated towards Scottish habitats but may have some applicability to Welsh habitats).

5.7.3 The GIS data held for fish ecology are presented in Figure B-8i-8vi. Figure B-8i and B-8ii were the layers in the preparation of the Approach to Sustainable Development (see WAG (2011b)) and Figures B8-8iii to B-8vi are provided for information only.

5.8 Benthic Ecology

5.8.1 Limited work on the benthic ecology of Welsh waters, which is new to the MRESF project since the end of Stage 1, has been identified, although a report published by CCW in February 2010 provides a very useful summary of existing benthic data for Welsh waters in the context of biodiversity (see www.marlin.ac.uk/prodsandpubs.php). The work that the project team are aware of is currently in progress and consists of the following:

- The CCW Tidal Atlas, a GIS based resource, collating data on environmental resources potentially sensitive to tidal stream devices;
- Extension of HapMap work to extend the maps to include all Welsh waters (see www.habmap.org); and
- Two DECC RAG proposals related to *Sabellaria* (understood to cover the genetic diversity of *Sabellaria* and the longevity/stability of *Sabellaria spinulosa* reefs).

5.8.2 The GIS data held for benthic ecology are presented in Figure B9i (Benthic Ecology) and Figure B-9ii (Sensitivity of Benthos to Commercial Fishing).

5.9 Plankton

5.9.1 No new research on plankton in Welsh waters has been identified by the project team.

5.10 Designated Sites

5.10.1 Since Stage 1 was completed towards the end of 2008, there have been a number of changes in the available data on designated sites in and adjacent to Welsh waters. These are summarised as follows:

- GIS data layers for the distribution of Annex I habitat features within Welsh marine SACs (provided by CCW);
- Additional GIS data layers for Annex II mobile species provided by CCW (see Sections 5.5 and 5.6);

- Identification of Areas of Search, for sites under investigation for interest as offshore SACs (see Section 4.3.7); and
- Formal designation of the Liverpool Bay SPA extension (see Section 4.3.6).

5.10.2 In addition, work is currently underway to identify Highly Protected Marine Conservation Zones in Welsh waters, although no sites have as yet been identified (see Section 4.3.6). Potential Marine Conservation Zones adjacent to Welsh waters are currently under investigation in the Irish Sea and Bristol Channel, with further information in Section 4.3.6.

5.10.3 The GIS data held for designated sites are presented in Figure B-10i (Designated Sites) and Figure B-10ii (SAC Habitat Features).

5.11 Shipping

5.11.1 No new work on shipping in Welsh waters has been progressed since Stage 1 ended. Stage 1 did highlight two potential projects, namely the potential for the Maritime and Coastguard Agency (MCA) shipping data to be more widely available and work planned by MREDS to investigate surface collision risk between wave and tidal devices and vessels, although no feedback on the progress of these have been received to date.

5.11.2 The GIS data held for shipping are presented in Figure B-11, including IMO Routes and Separation Zones ad Shipping Density data collated in 2008 for Stage 1. The former includes a 500m buffer (buffers calculated throughout on radius) for the constraints mapping undertaken as part of the Approach to Sustainable Development (WAG, 2011b).

5.12 Tourism and Recreation

5.12.1 Limited new work on recreation and tourism has been identified, with the main source being the ongoing audit at Pembrokeshire, for which an interim report has been published (see www.pembrokeshirecoastalforum.org.uk).

5.12.2 The GIS data held for tourism and recreation are presented in Figure B-12i to 1B-2iv. Appropriate buffers have been used for some features e.g. 50m for boat cruising routes and 250m for marinas for the constraints mapping undertaken as part of the Approach to Sustainable Development (WAG, 2011b).

5.13 Archaeology

5.13.1 No studies of direct relevance to the marine archaeology of Welsh waters has been identified since Stage 1 ended. The only possible project of interest is an American Minerals Management Service (MMS) project, which is looking to update and digitise archaeological baseline studies for the Atlantic planning areas (www.mms.gov/offshore/RenewableEnergy/Assets/PDFs/AE_SDP_2009_2011_FINAL.pdf), although it is considered unlikely that the project outputs will contain information of relevance for Welsh waters.

5.13.2 The GIS data held for archaeology are presented in Figure B-13, A 50m buffer has been used for wrecks and statutory buffer for protected wrecks for the constraints mapping undertaken as part of the Approach to Sustainable Development (WAG, 2011b).

5.14 Commercial Fisheries

5.14.1 Several new studies related to baseline data for commercial fisheries in Welsh waters, including projects at proposal stage and projects in progress. In addition, some of the work completed or underway on fish ecology is also relevant here (see Section 5.7, e.g. the updates to fish spawning and nursery grounds). The work identified is summarised in Table 5.3 below.

Table 5.3: Summary of Commercial Fisheries Baseline Data proposed, in progress and completed since the end of 2008

Project/Report Title	Author	Date	Availability
Sea Fishing Atlas of Wales	Countryside Council for Wales	2010	www.ccw.gov.uk/landscape--wildlife/managing-land-and-sea/sea-fishing-atlas-of-wales.aspx
Potential project to look at temporal data (spawning, nursery for fish species). Demersal fish species and potential for association with sediment types and bathymetry	Countryside Council for Wales	N/A	Unlikely to be within MRESF timescale
Development of spatial information layers for commercial fishing and shellfishing in UK waters to support strategic siting of offshore windfarms	COWRIE sponsored, undertaken by ABPmer	2008	www.offshorewindfarms.co.uk/Assets/9COWRIE%20FISH%20VALUE%20Report%20march%2009%20Final.pdf
Fishing Activity Maps	South Wales Sea	N/A	www.swsfc.org.uk/home.htm

Project/Report Title	Author	Date	Availability
	Fisheries Committee		
Further development of marine pressure datalayers and ensuring the socio-economic data and datalayers are developed for use in the planning of marine protected area networks	Defra sponsored work, being undertaken by Cefas	N/A	In progress
Potential Wave Hub impacts and exclusion zone benefits plus general changes in fish ecology	PRIMaRE	N/A	Dependant on progress at Wave Hub
Effect of the Horns Rev 1 offshore wind farm on fish communities	Orbicon; DTU Aqua (Naturfocus; DHI)	N/A	In progress
Investigating fishery responses to the construction of an offshore wind farm	N/A	N/A	DECC RAG proposal
The Economic Impact of OCS Wind Development on Commercial Fishing	MMS project	N/A	In progress
Marine biomass culture in association with offshore renewables. Proof of-concept study to demonstrate the feasibility and implications of large-scale macroalgae culture in association with offshore renewables e.g. wind farms	NERC funded, being undertaken by SAMS	N/A	In progress

5.14.2 The GIS data held for commercial fisheries are presented in Figure B-14i to B-14iii.

5.15 Military Use

5.15.1 The main research into Military interests completed since Stage 1 ended is the MRESF Stage 2 project 'The Potential for Interaction between Wave and Tidal Stream Devices with Military Interests in Welsh Waters' (RPS, 2010), which although primarily concerned with potential impacts, did provide more detailed understanding of the existing military use of Welsh waters. Other work of relevance is ongoing research by the MoD, understood to include issues such as radar infill, radar processing software and stealth turbine technologies, although no outputs have been sourced. The final project with some degree of relevance identified since Stage 1 ended is the current project being undertaken in Germany on sonar transponders for offshore wind energy converters (http://rave.iset.uni-kassel.de/rave/pages/raveSonarTransponders). The work is understood to have particular relevance for submarines.

5.15.2 The GIS data held for military use are presented in Figure B-15.

5.16 Aviation and Radar

5.16.1 The available data on aviation and radar has been updated by the CAA, with the most up to date GIS files sourced.

5.16.2 The GIS data held for aviation and radar are presented in Figure B-16.

5.17 Grid Infrastructure

5.17.1 The Transmission Access Review prepared by Ofgem (www.ofgem.gov.uk/NETWORKS/TRANS/ELECTRANSPOLICY/TAR/Pages/Traccrw.aspx), which has a chief aim of being able to 'better support the delivery of the Government's aspiration of 20 percent of electricity supplied by renewable generation by 2020 and any targets that may be agreed at European Union level'.

5.17.2 In addition, there are current plans for cable links between Wales and Ireland. The most advanced appears to be a link to north Wales (see www.eirgridprojects.com/projects/east-westinterconnector), with preliminary plans for a route into Pembrokeshire (see http://www.imerapower.com/page10/page10.html), although how firm the plans for Pembrokeshire are not apparent.

5.17.3 The GIS data held for grid infrastructure are presented in Figure B-17.

5.18 Cables and Pipelines

5.18.1 No new information on the baseline for cables and pipelines in Welsh waters has been identified since Stage 1 ended.

5.18.2 The GIS data held for cables and pipelines are presented in Figure B-18, including a statutory buffer of 500m for the constraints mapping, undertaken as part of the Approach to Sustainable Development (WAG, 2011b).

5.19 Aggregate Dredging

5.19.1 No new information on the baseline for marine aggregate dredging in Welsh waters has been identified since Stage 1 ended.

5.19.2 The GIS data held for marine aggregate dredging are presented in Figure B-19, including a buffer of 250m for dredging routes used in the constraints mapping, undertaken as part of the Approach to Sustainable Development (WAG, 2011b).

5.20 Oil and Gas

5.20.1 A new licensing round for oil and gas interests in Welsh waters was announced after the completion of Stage 1, with the information available at https://www.og.decc.gov.uk/upstream/licensing/26_rnd/index.htm.

5.20.2 The GIS data held for oil and gas are presented in Figure B-20, including a buffer of 500m for oil and gas installations, when used in the constraints mapping, undertaken as part of the Approach to Sustainable Development (WAG, 2011b).

5.21 Licensed Disposal Sites

5.21.1 No new information on the baseline for licensed disposal sites in Welsh waters has been identified since Stage 1 ended.

5.21.2 The GIS data held for licensed disposal sites are presented in Figure B-21, including relevant statutory buffers.

5.22 Renewable Energy

5.22.1 The majority of new work connected to marine renewables of relevance to Welsh waters since Stage 1 ended is focused around strategic planning, particularly at SEA level. Such work has included the UK Offshore Energy Strategic Environmental Assessment (www.offshore-sea.org.uk/consultations/Offshore_Energy_SEA/index.php), work by the Pembrokeshire Coastal Forum (e.g. WSP – Action Plan (Phase Two) Pembrokeshire – The Haven: Maximising Maritime Assets & Links to Ireland) and work on tidal range energy in the Severn (see 4.5.8-4.5.10, although note that tidal range is outside the scope of the current project). In addition, a number of similar projects have been completed, although these are outside Welsh waters (e.g. the Guernsey Renewable Energy Commission 'Regional Environmental Assessment Scoping Report', the Northern Irish 'Offshore Wind and Marine Renewable Energy in Northern Ireland', the South West RDA review of offshore renewables and the Scottish Government's 'Pentland Firth and Orkney Waters Marine Spatial Plan'). A new application for tidal energy has been submitted towards the end of 2008 by Tidal Energy Ltd in Ramsey

Sound off Pembrokeshire, in addition to existing projects that are progressing through planning, e.g. the MCT project at the Skerries (see RPS, 2008).

5.22.2 The GIS data held for renewable energy are presented in Figure B-2, including a buffer of 250m when used in the constraints mapping, undertaken as part of the Approach to Sustainable Development (WAG, 2011b).

6 Increase in Scientific Certainty

6.1 Introduction

6.1.1 A key output from Stage 1 was the identification of data gaps and constraints on development of marine renewable energy in Welsh waters. It was on the basis of these data gaps and constraints that the projects undertaken in Stage 2 were identified. A large part of the problem behind the data gaps and uncertainty identified was the result either of a lack of data or very limited information on which decisions could be made. Where little is known about the potential impacts of a development, consenting tends to become harder to achieve, with a precautionary approach often being followed, potentially coupled by perhaps more rigorous monitoring and mitigation than would be expected for a more scientifically studied industry. These all bring complications for developers and regulators.

6.1.2 Progress in understanding the existing baseline environment of Welsh waters since Stage 1 ended is summarised in Section 5. This section summarises the work understood to be planned, proposed, in progress and completed since the end of Stage 1 of relevance to increasing current understanding of the potential impacts associated with wind, wave and tidal stream. Although the baseline information is restricted to information of relevance to Welsh waters, the information presented here has been sourced globally, as the potential impacts associated with devices are anticipated to have a degree of similarity regardless of location a strategic overview is appropriate.

6.2 Physical Environment

6.2.1 A number of projects connected to understanding the potential for change in the physical environment connected to the use of marine renewables have been identified since Stage 1 ended. The list includes projects at various stages, from proposal through to completed and published work. The work identified is summarised in Table 6.1.

Table 6.1: Summary of work relating to Potential Changes in the Physical Environment proposed, in progress and completed since 2008

Project/Report Title	Author	Date	Availability
Research Priority 3 – Marine Energy	Welsh Low Carbon Research Institute	Ongoing	www.lcri.org.uk/research.html
Seabed and shoreline processes and the dynamic response to energy extraction and mixing	PRIMaRE	N/A	Proposal
An Integrated Modelling Framework for Environmental Impact Assessment of Large-Scale Arrays	SuperGen PhD	N/A	In progress
Wave Attenuation Calculations for Various Designs of Wave Devices	MMS	N/A	In progress
A Further Review of Sediment Monitoring Data	ABPmer, Cefas and HR Wallingford	2010	www.offshorewindfarms.co.uk/Assets/Non_Technical_Summary_v2.pdf
Hydrodynamic Effects of Kinetic Power Extraction by In-Stream Tidal Turbines	PHd dissertation by Brian L. Polagye	N/A	http://depts.washington.edu/nnmrec/docs/20090313_PolagyeB_thesis_HydrodynamicEffects.pdf
Dynamics of scour pits and scour protection – Synthesis report and recommendations (Milestones 2 and 3)	HR Wallingford, ABPmer and Cefas	2008	www.berr.gov.uk/files/file50448.pdf
Review of Round 1 sediment process monitoring data – lessons learnt	ABPmer, Cefas and HR Wallingford	2008	www.berr.gov.uk/files/file50440.pdf
Energy Extraction from the Florida Current, How Many Turbines is Too Many?	MMS	N/A	In progress
An integrated modelling framework for EIA of large-scale arrays	MREDS PhD Studentship	Started 2008	In progress
Wake Modelling	Northwest National Marine Renewable Energy Centre	N/A	In progress
Review of models to predict effects on sediments and coastal processes	DECC RAG	N/A	Proposal – unclear if still proposed
Coastal Process Modelling for Offshore Wind Farm Environmental Impact Assessment: Best Practice Guide	ABPmer and HR Wallingford	2009	www.offshorewindfarms.co.uk/Assets/Coastal%20process%20modelling%20best%20practice%20guide%20Final%20report%20sept%2009.pdf

6.3 Water and Sediment Quality

6.3.1 Three projects currently in progress have been identified that may increase the knowledge base as regards current understanding of the potential for marine renewables to impact on water and sediment quality. These have been summarised in bullet form below:

- Survey and Evaluation of Potential Environmental Effects from Antifouling Paints, Lubricants, Hydraulic Fluids and other Chemical Products Potentially used at Offshore Facilities. MMS project currently in progress (see www.mms.gov/offshore/RenewableEnergy/Assets/PDFs/AE_SDP_2009_2011_FINAL.pdf);
- Welsh Low Carbon Research Institute;
- Ongoing generic research at Glasgow and Newcastle Universities (e.g. see
  - http://research.ncl.ac.uk/barnacles/Site/Publications.html;
  - www.gla.ac.uk/marinestation/prc_frame.html; and
  - www.gla.ac.uk/marinestation/prc_frame.html); and
- Research into the 'Fate and Effects of Spilled Transformer Oil (Dielectric Fluids) on the Marine Environment' between the MMS and Louisiana State University (see http://www.mms.gov/tarprojects/636.htm).

6.4 Landscape and Seascape

6.4.1 Limited research into the potential impact of marine renewables on landscape and seascape has been identified. The work noted since the end of Stage 1 is restricted to two projects in progress and a potential proposal. These have been summarised below:

- Evaluation of Visual Impacts on Historic Properties (research in progress by MMS, see http://www.mms.gov/offshore/RenewableEnergy/PDFs/Visual_Impacts_on_Historic_Properties.pdf);
- Production of data layers for seascape sensitivity to wind, wave and tidal stream (provided by CCW; see Section 11.2 Project Bibliography references 1019 to 1073);
- Evaluation of Lighting Schemes for Offshore Wind Facilities and Impacts to Local Environments (research in progress by MMS, see

www.mms.gov/offshore/RenewableEnergy/Assets/PDFs/AE_SDP_2009_2011_FINAL.pdf); and

- A potential proposal looking at the effectiveness of visual limits used in Round 2 (status/proposer unknown).

6.5 Marine Mammals

6.5.1 A considerable number of research projects aimed at further understanding potential impacts on marine mammals associated with offshore wind, wave and tidal stream were identified that have been instigated since the end of Stage 1. The majority of these are yet to be completed and as such the significance of the work in terms of increasing the level of understanding of potential impacts cannot be determined. The work identified has been summarised in Table 6.2 below.

Table 6.2: Summary of work relating to Increasing Understanding of the Potential Impact of Marine Renewables on Marine Mammals proposed, in progress and completed since 2008

Project/Report Title	Author	Date	Availability
Assessment of Risk to Marine Mammals from Underwater Marine Renewables Devices in Welsh Waters	Stage 2 Project for the MRESF	2011	Gordon *et al.,* 2011 and Wilson and Gordon, 2011
Underwater acoustic interactions between emerging tidal-energy technologies and vulnerable vertebrates	PhD funded by SNH/SEPA with SAMS	N/A	In progress
Research Priority 3 – Marine Energy	Welsh Low Carbon Research Institute	Ongoing	www.lcri.org.uk/research.html
Collision Risk of Fish with Wave and Tidal Devices	Stage 2 Project for the MRESF	2010	ABPmer, 2010
The impacts of acoustic and electromagnetic noise from marine energy conversion devices on the behaviour of organisms	MREDS PhD studentship	N/A	In progress
RITE tidal turbine project in New York to determine in-situ risk of fish strike and noise monitoring	Verdant Power	N/A	In progress
Acoustic output from devices: acoustic characterisation and monitoring	SAMS	N/A	In progress
Characterisation and Potential Impacts of Noise	MMS	N/A	In progress

Project/Report Title	Author	Date	Availability
Producing Construction and Operation Activities on the OCS			
RAVE Project - Measurement of the operational underwater noise emission of wind turbines of the alpha ventus offshore wind farm	FH Flensburg - University of Applied Sciences	N/A	In progress
Effects of Pile Driving Sounds on Auditory and Non-Auditory Tissues of Fish	MMS	N/A	In progress
Mitigation of Underwater Pile Driving Noise During Offshore Construction: Final Report	Department of the Interior, Minerals Management Service. Engineering & Research Branch	2010 onwards	Report Number: M09PC00019-8 (Phase 1), Phase 2 being initiated
Effects of Pile-driving Noise on the Behaviour of Marine Fish	Mueller-Blenkle, C., McGregor, P.K., Gill, A.B., Andersson, M.H., Metcalfe, J., Bendall, V., Sigray, P., Wood, D.T. & Thomsen, F	2010	COWRIE Ref: Fish 06-08, Technical Report 31st March 2010
RAVE – hydro sound alpha ventus: Research and testing of a layered bubble curtain in the testfield alpha ventus	Institut für Statik und Dynamik (ISD), Uni Hannover, Menck GmbH, Kaltenkirchen	N/A	In progress
Behavioural analyses of pelagic and benthic mobile organisms around energy devices	MREDS PhD studentship	N/A	In progress
Offshore renewable energy structures as artificial islands: implications for dispersal, population connectivity, and biogeography of coastal species	SuperGen PhD	N/A	In progress
The impacts of offshore power production: mitigation through habitat provision	SuperGen PhD	N/A	In progress
The performance of invasive marine species on off-shore artificial structures	SuperGen PhD	N/A	In progress
Work at the Race Rocks tidal turbine on artificial reefs		N/A	In progress
Potential Artificial Reef Effects of Offshore Wind Facilities	MMS	N/A	In progress
Will there be changes in benthic communities and fish fauna that are attributable to the artificial hard substrate used?	RAVE - Research at Alpha Ventus (German windfarm)	N/A	In progress

Project/Report Title	Author	Date	Availability
Artificial reef effect and fouling impacts on offshore wave power foundations and buoys – a pilot study	Olivia Langhamer, Dan Wilhelmsson, Jens Engstro¨m	2009	Estuarine, Coastal and Shelf Science 82 (2009) 426–432
Environmental Impact Assessment: WP6 of EquiMar project. Estimating collision risk of fish, birds and marine mammals with submerged devices	EquiMar (University of Edinburgh)	N/A	In progress
RITE tidal turbine project in New York to determine in-situ risk of fish strike and noise monitoring	Verdant Power	N/A	In progress
Non-physical fish deterrents	Herriot-Watt University	N/A	In progress
Study of the Effects of Electromagnetic Fields from Undersea Transmission Lines on Marine Wildlife To Assist in Evaluating Impacts of Renewable Energy Projects on Outer Continental Shelf	MMS	N/A	In progress
Literature review of the effects of electro-magnetic fields and noise arising from Marine Renewable Energy infrastructure on Atlantic Salmon, sea trout and European eel	SNH awarded to Cranfield University	N/A	In progress
EMF-sensitive fish response to EM emissions from subsea electricity cables of the type used by the offshore renewable energy industry	Gill, A.B., Huang, Y., Gloyne-Philips, I., Metcalfe, J., Quayle, V., Spencer, J. & Wearmouth, V	2009	www.offshorewindfarms.co.uk/Assets/Report%20EMF%20COWRIE2%20EMF%20FINAL_Combined_april%2009.pdf
Guidance on Survey and Monitoring in Relation to Marine (Wave and Tide) Renewables Deployments in Scotland	SNH funded. Awarded to Haskoning	N/A	In progress

6.6 Birds

6.6.1 A considerable number of research projects aimed at further understanding potential impacts on birds associated with offshore wind, wave and tidal stream were identified that have been instigated since the end of Stage 1. The majority of these are yet to complete and as such the significance of the work in terms of increasing the level of

understanding of potential impacts is yet to be determined. The work identified has been summarised in Table 6.3 below.

Table 6.3: Summary of work relating to Increasing Understanding of the Potential Impact of Marine Renewables on Birds proposed, in progress and completed since 2008

Project/Report Title	Author	Date	Availability
Assessment of Risk to Diving Birds from Underwater Marine Renewables Devices in Welsh Waters	Stage 2 Project for the MRESF	2011	RPS, 2011a and 2011b
Research Priority 3 – Marine Energy	Welsh Low Carbon Research Institute	Ongoing	www.lcri.org.uk/research.html
Review of techniques to detect seabird presence and movement below the sea surface and determine potential application in the vicinity of tidal turbines	SNH awarded to RPS	N/A	In progress
Identifying a range of options to prevent avian collision with wind turbines and modelling collision risk against a range of mitigation options, using a UK based case study	Defra sponsored	N/A	Proposal
Assessment methodology for determining collision impacts of marine renewable energy devices (excluding offshore wind farms) on marine birds	SNH sponsored	N/A	In progress
Environmental Impact Assessment: WP6 of EquiMar project. Estimating collision risk of fish, birds and marine mammals with submerged devices	EquiMar (University of Edinburgh)	N/A	In progress
Are Flying Wildlife Attracted to (or Do they Avoid) Wind Turbines?	Board of Trustees of the University of Illinois (Champaign, IL)		unknown
Investigation of responses of birds in flight to an offshore wind farm	N/A	N/A	DECC RAG proposal
Measuring the interaction between marine features of a Special Protection Area [Bass Rock gannets] with proposed offshore wind farm development zones through telemetry	N/A	N/A	DECC RAG proposal
Analysis of ESAS data to investigate potential foraging behaviour-offshore wind farm overlap	N/A	N/A	DECC RAG proposal
Developing analytical techniques for visual data collection associated with offshore wind farm development	N/A	N/A	DECC RAG proposal
High Definition Imagery for Surveying Seabirds and Marine Mammals: A Review of Recent Trials and Development of	Chris B. Thaxter & Niall H.K. Burton	2009	COWRIE

Project/Report Title	Author	Date	Availability
Protocols			
Cumulative effects of planned offshore wind farm development on divers	SNH awarded to RPS	N/A	In progress
Assessment methodology for determining cumulative impacts of marine renewable energy devices (excluding offshore wind farms) on marine birds	SNH awarded to RPS	N/A	In progress
Guidance on Survey and Monitoring in Relation to Marine (Wave and Tide) Renewables Deployments in Scotland	SNH awarded to Royal Haskoning	N/A	In progress
Revised best practice guidance for the use of remote techniques for ornithological monitoring at offshore windfarms	Walls, R.J., Pendlebury, C.J, Budgey, R., Brookes, K. & Thompson, P.	2009	http://www.offshorewindfarms.co.uk/Assets/RPS_COWRIE_REMTECH-08-08_04062009_final.pdf

6.7 Fish Ecology

6.7.1 The potential for offshore wind, wave and tidal stream devices to impact on fish ecology is currently subject to a number of studies that have been started following the end of Stage 1. In a similar manner to the work being undertaken on marine mammals and fish, the majority of these studies have yet to report and as such the significance of the work in terms of advancing the science base has yet to be determined. The work identified is summarised below in Table 6.4.

Table 6.4: Summary of work relating to Increasing Understanding of the Potential Impact of Marine Renewables on Fish Ecology proposed, in progress and completed since 2008

Project/Report Title	Author	Date	Availability
Literature review of the effects of electro-magnetic fields and noise arising from Marine Renewable Energy infrastructure on Atlantic Salmon, sea trout and European eel	SNH awarded to Cranfield University	N/A	In progress
Collision Risk of Fish with Wave and Tidal Devices	Stage 2 Project for the	2010	ABPmer, 2010

Project/Report Title	Author	Date	Availability
	MRESF		
The impacts of acoustic and electromagnetic noise from marine energy conversion devices on the behaviour of organisms	MREDS PhD studentship	N/A	In progress
Acoustic output from devices: acoustic characterisation and monitoring	SAMS	N/A	In progress
Characterisation and Potential Impacts of Noise Producing Construction and Operation Activities on the OCS	MMS	N/A	In progress
RAVE Project - Measurement of the operational underwater noise emission of wind turbines of the alpha ventus offshore wind farm	FH Flensburg - University of Applied Sciences	N/A	In progress
Effects of Pile Driving Sounds on Auditory and Non-Auditory Tissues of Fish	MMS	N/A	In progress
Underwater acoustic interactions between emerging tidal-energy technologies and vulnerable vertebrates	SNH / SEPA funded PhD with SAMS	N/A	In progress
Mitigation of Underwater Pile Driving Noise During Offshore Construction: Final Report	Department of the Interior, Minerals Management Service. Engineering & Research Branch	2010 onwards	Report Number: M09PC00019-8 (Phase 1), Phase 2 being initiated
Effects of Pile-driving Noise on the Behaviour of Marine Fish	Mueller-Blenkle, C., McGregor, P.K., Gill, A.B., Andersson, M.H., Metcalfe, J., Bendall, V., Sigray, P., Wood, D.T. & Thomsen, F	2010	COWRIE Ref: Fish 06-08, Technical Report 31st March 2010
RAVE – hydro sound alpha ventus: Research and testing of a layered bubble curtain in the testfield alpha ventus	Institut für Statik und Dynamik (ISD), Uni Hannover, Menck GmbH, Kaltenkirchen	N/A	In progress
Behavioural analyses of pelagic and benthic mobile organisms around energy devices	MREDS PhD studentship	N/A	In progress
Offshore renewable energy structures as artificial islands: implications for dispersal, population connectivity, and biogeography of coastal species	SuperGen PhD	N/A	In progress
The impacts of offshore power production: mitigation through habitat provision	SuperGen PhD	N/A	In progress

Project/Report Title	Author	Date	Availability
The performance of invasive marine species on off-shore artificial structures	SuperGen PhD	N/A	In progress
Work at the Race Rocks tidal turbine on artificial reefs		N/A	In progress
Potential Artificial Reef Effects of Offshore Wind Facilities	MMS	N/A	In progress
Will there be changes in benthic communities and fish fauna that are attributable to the artificial hard substrate used?	RAVE - Research at Alpha Ventus (German windfarm)	N/A	In progress
Artificial reef effect and fouling impacts on offshore wave power foundations and buoys – a pilot study	Olivia Langhamer, Dan Wilhelmsson, Jens Engstro¨m	2009	Estuarine, Coastal and Shelf Science 82 (2009) 426–432
Environmental Impact Assessment: WP6 of EquiMar project. Estimating collision risk of fish, birds and marine mammals with submerged devices	EquiMar (University of Edinburgh)	N/A	In progress
RITE tidal turbine project in New York to determine in-situ risk of fish strike and noise monitoring	Verdant Power	N/A	In progress
Non-physical fish deterrents	Herriot-Watt University	N/A	In progress
Study of the Effects of Electromagnetic Fields from Undersea Transmission Lines on Marine Wildlife To Assist in Evaluating Impacts of Renewable Energy Projects on Outer Continental Shelf	MMS	N/A	In progress
EMF-sensitive fish response to EM emissions from subsea electricity cables of the type used by the offshore renewable energy industry	Gill, A.B., Huang, Y., Gloyne-Philips, I., Metcalfe, J., Quayle, V., Spencer, J. & Wearmouth, V	2009	www.offshorewindfarms.co.uk/Assets/Report%20EMF%20COWRIE2%20EMF%20FINAL_Combined_april%2009.pdf
Guidance on Survey and Monitoring in Relation to Marine (Wave and Tide) Renewables Deployments in Scotland	SNH funded. Awarded to Haskoning	N/A	In progress

6.8 Benthic Ecology

6.8.1 The potential for offshore wind, wave and tidal stream devices to impact on benthic ecology is currently subject to a number of studies that have commenced/been commissioned since the end of Stage 1. In a similar manner to the work being undertaken on marine mammals, fish and birds, the majority of these studies have yet to

report and as such the significance of the work in terms of advancing the science base has yet to be determined. The work identified is summarised below in Table 6.5.

Table 6.5: Summary of work relating to Increasing Understanding of the Potential Impact of Marine Renewables on Benthic Ecology proposed, in progress and completed since 2008

Project/Report Title	Author	Date	Availability
Seabed communities in strong tidal streams	EMEC	N/A	In progress
Research Priority 3 – Marine Energy	Welsh Low Carbon Research Institute	Ongoing	www.lcri.org.uk/research.html
Relating Incident Wave and Current Characteristics to the Morphology of the Kelp *Laminaria digitata*	SuperGen PhD	N/A	In progress
Exploring Links Between Wave Regime Changes and Biotic Assemblages	SuperGen PhD	N/A	In progress
Wave energy conversion and the marine environment. Colonisation patterns and habitat dynamics	Olivia Langhamer		Dissertation from Uppsala University
Will there be changes in benthic communities and fish fauna that are attributable to the artificial hard substrate used?	RAVE - Research at Alpha Ventus (German windfarm)	N/A	In progress
Mapping the sensitivity of benthic habitats to fishing in Welsh waters - development of a protocol	Hall, K., Paramor, O.A.L., Robinson L.A., Winrow-Giffin, A., Frid C.L.J., Eno, N.C., Dernie, K.M., Sharp, R.A.M., Wyn, G.C.& Ramsay, K	2008	www.llfa.org.uk/blogger/Liverpool%20%20CCW%20seabed%20sensitivity%20final%20report.pdf
Establishing best practice for the documentation and dissemination of marine biological data	Becky Seeley, Jon Parr, Jayne Evans, Dan Lear	2008	www.offshorewindfarms.co.uk/Assets/sDATA_14_11_08_FINALREPORT.pdf

6.9 Plankton

6.9.1 No specific work on the potential impacts of wind, wave and tidal stream devices on plankton was sourced during Stage 1, although the issue is sometimes considered in broader studies such as SEAs. The situation has continued, with the only potential work identified understood to be underway at MREDS, although very limited information is

available. The work is understood to include water column processes and pelagic dynamics.

6.10 Designated Sites

6.10.1 Depending on the reasons for a site being designated (i.e. which habitats and species are present), a number of the projects identified in Section 6 can be used when assessing the potential impact of offshore wind, wave and tidal stream devices on designated sites. Work specifically investigating potential impacts on designated sites included a SNH funded PhD currently in progress, which is understood to be looking at the 'potential ecological impacts of a small scale tidal device at the Isle of May Special Area for Conservation (SAC)'. The nPower Juice fund also published a report titled 'Wet Renewable Energy and Nature Conservation: Developing Strategies for Management'. The various MCZ teams have also considered marine renewables (see Section 4.3).

6.11 Shipping

6.11.1 Just one project was identified that is investigating potential impacts from wind, wave and tidal stream devices on shipping since Stage 1 ended. Very little information was available, however it is understood to be either a proposal or work in progress at MREDS, which is investigating the surface collision risk between wave and tidal devices and vessels.

6.12 Tourism and Recreation

6.12.1 It is understood that the American MMS is undertaking a review of existing information of tourism and recreation with relevance to marine renewables (see www.mms.gov/offshore/RenewableEnergy/Assets/PDFs/AE_SDP_2009_2011_FINAL.pd), and although this would naturally be expected to be focused on the American situation, it may include information of relevance, particularly for assessing potential impacts.

6.13 Archaeology

6.13.1 No studies were identified following the end of Stage 1 that are looking at potential impacts from wind, wave and tidal stream on archaeology.

6.14 Commercial Fisheries

6.14.1 Relatively few studies have been identified in relation to the potential impacts of wind, wave and tidal stream on commercial fishing which have been progressed since the end of Stage 1. Where studies have been noted, none have reported to date and as such it is not possible to assess the effect of the work on the existing scientific knowledge base. The projects identified have been summarised in Table below.

Table 6.6: Summary of work relating to Increasing Understanding of the Potential Impact of Marine Renewables on Commercial Fisheries proposed, in progress and completed since 2008

Project/Report Title	Author	Date	Availability
Potential Wave Hub impacts and exclusion zone benefits plus general changes in fish ecology	PRIMaRE	N/A	Dependant on WaveHub
Effect of the Horns Rev 1 offshore wind farm on fish communities	Orbicon; DTU Aqua (Naturfocus; DHI)	N/A	In progress
Investigating fishery responses to the construction of an offshore wind farm	N/A	N/A	DECC RAG proposal
The Economic Impact of OCS Wind Development on Commercial Fishing	MMS	N/A	In progress
Marine biomass culture in association with offshore renewables	Funded by NERC, being undertaken by SAMS	N/A	In progress

6.15 Military Use

6.15.1 The only work that has investigated the potential impact of marine renewables on military interests that has been identified since Stage 1 ended is the MRESF Stage 2 project 'The Potential for Interaction between Wave and Tidal Stream Devices with Military Interests in Welsh Waters' (RPS, 2010). The project specifically looked at which aspects of wave and tidal development were of concern to the military in Welsh waters and whether there were particular geographic areas where a greater potential for conflict would result.

6.16 Grid Infrastructure

6.16.1 No studies were identified following the end of Stage 1 that are looking at potential impacts from wind, wave and tidal stream on the existing grid infrastructure.

6.17 Cables and Pipelines

6.17.1 No studies were identified following the end of Stage 1 that are looking at potential impacts from wind, wave and tidal stream on cables and pipelines.

6.18 Renewable Energy

6.18.1 The potential for renewable energy developments to interact with other devices, both within the same development and with separate developments, will have been considered and/or assessed in the various SEA programmes identified in Section 4. In addition, a UKERC workshop (titled UKERC Spatial Planning for Marine Renewable Energy Arrays) was held in March 2009 and included discussions on potential cumulative impacts.

6.19 Aggregate Dredging

6.19.1 No studies were identified following the end of Stage 1 that are looking at potential impacts from wind, wave and tidal stream on marine aggregate dredging.

6.20 Oil and Gas

6.20.1 No studies were identified following the end of Stage 1 that are looking at potential impacts from wind, wave and tidal stream on oil and gas.

6.21 Licensed Disposal Sites

6.21.1 No studies were identified following the end of Stage 1 that are looking at potential impacts from wind, wave and tidal stream on licensed disposal sites.

6.22 Aviation and Radar

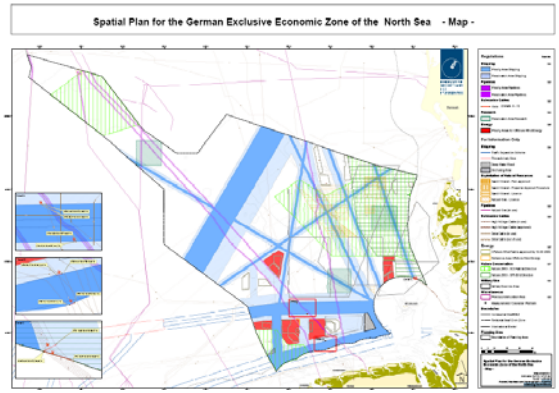
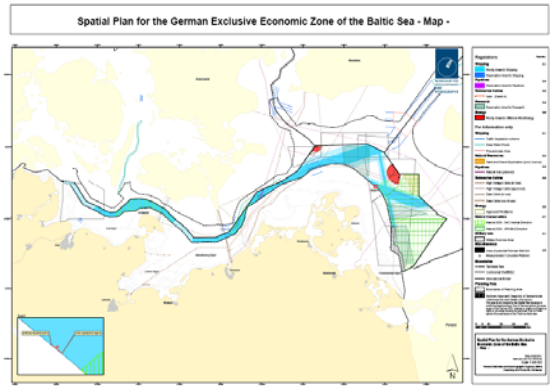
6.22.1 No studies were identified following the end of Stage 1 that are looking at potential impacts from wind, wave and tidal stream on airspace and radar.

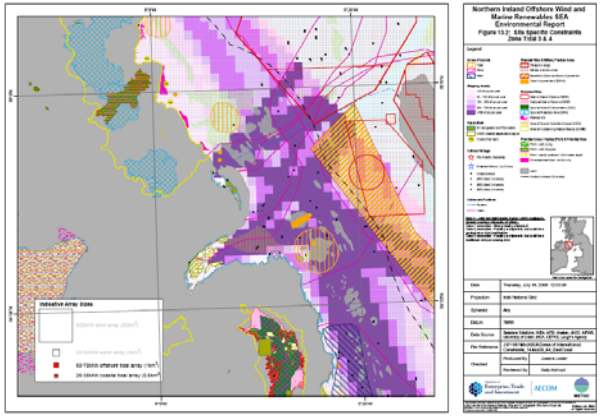
7 Management of Cumulative Data Layers

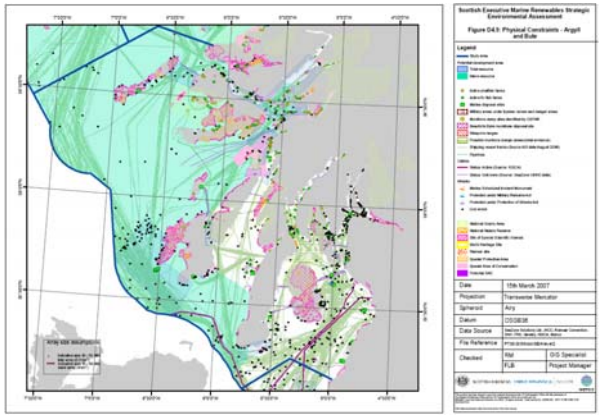
7.1.1 Broad scale, strategic mapping projects such as the MRESF bring with them a need to display cumulative data layers in a clear and readable manner. However, the number of data layers involved can make displaying sufficient information in a 2-D manner challenging. Several projects have recently encountered similar issues, with a brief summary of these, together with the approach adopted, provided here. The method designed for the MRESF has been informed by the experiences of previous projects, together with the specific requirements of the MRESF.

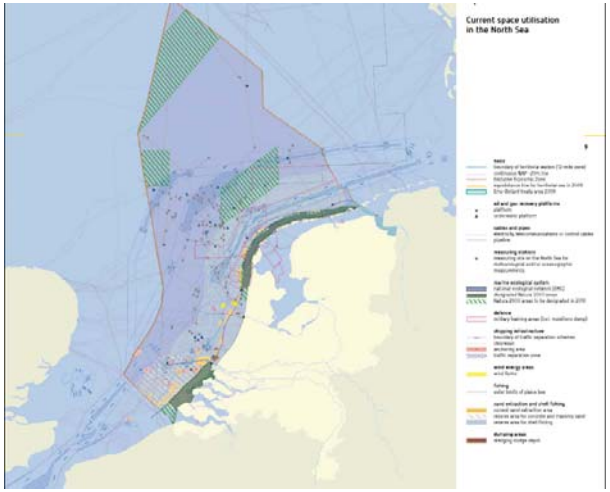
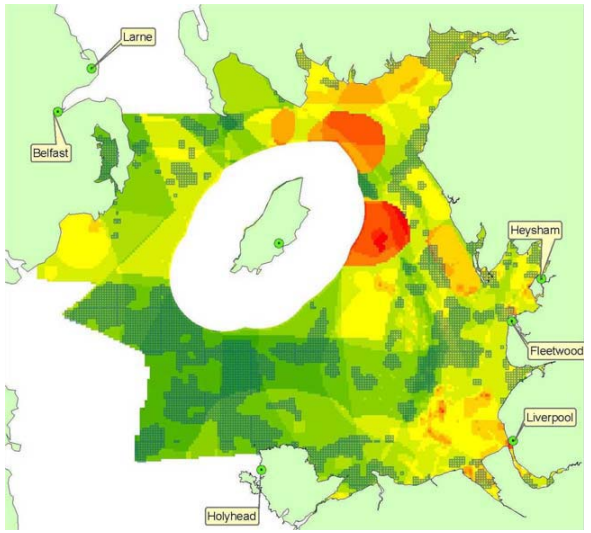
Table 7.1: Summary of Approaches Taken by Projects using Multiple Data Layers

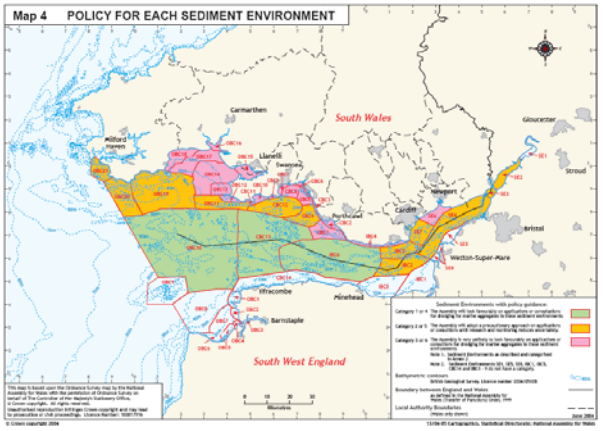
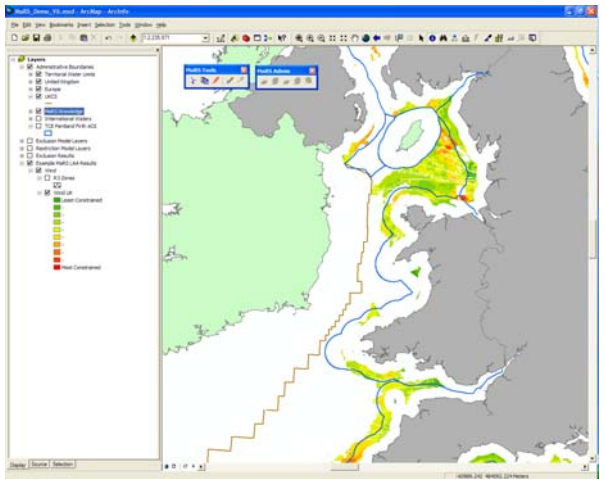
Country	Website	Plan Type	Purpose	Cumulative Data Layers	Example of Cumulative Data Layer Mapping
Australia	www.environment.gov.au/coasts/index.html	Marine Bioregional Planning	Undertaken on a geographic zone basis. Involved collating baseline environmental information (human and natural environment), with GIS mapping for each area.	No information sourced on bringing the data together to develop a plan or how cumulative data layers were managed.	None sourced
Australia	www.gbrmpa.gov.au/corp_site/management/zoning/zoning_maps.html	Zoning on the Great Barrier Reef	To create zones where different activities are permitted.	Uses processing methods in GIS to map areas for individual zones, therefore no cumulative data layers presented.	None sourced
Belgium	www.mumm.ac.be/EN/Management/index.php	A Master Plan for the North Sea	Used as an ongoing management tool to assess interaction between existing and planned activities, enabling management of impacts on the environment in an integrated manner.	Uses baseline data in GIS and spatial analyst. Data layers are shown as overlapping and areas of potential conflict mapped.	

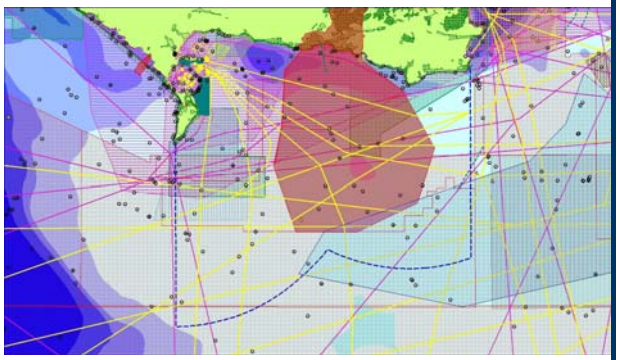
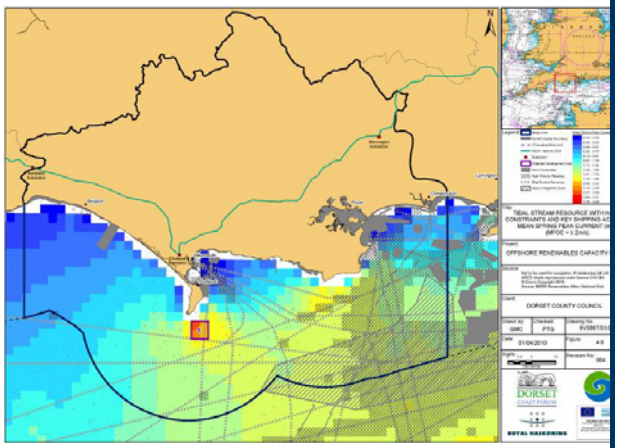
Country	Website	Plan Type	Purpose	Cumulative Data Layers	Example of Cumulative Data Layer Mapping
Germany	www.bsh.de/en/Marine_uses/Spatial_Planning_in_the_German_EEZ/index.jsp	Spatial planning for the German North Sea and Baltic Sea	Spatial planning for the German Exclusive Economic Zone (EEZ) in the North Sea and Baltic Sea for economic and scientific use, with regard to safety and efficiency of maritime traffic as well as protection of the marine environment.	Have identified target areas and priority areas for specific activities e.g. shipping, with the potential environmental impact of each area assessed.	 
Germany	www.unesco-ioc-marinesp.be/msp_practice/germany_mecklenburg	Spatial planning for the German coastal state waters of Mecklenburg-Vorpommern	Aimed at integrating economic and social activities. Included identifying suitable areas for defined uses, areas reserved for defined uses and priority areas for defined uses.	None shown	None sourced

Country	Website	Plan Type	Purpose	Cumulative Data Layers	Example of Cumulative Data Layer Mapping
Northern Ireland	www.offshorenergyni.co.uk/	Development of a Strategic Action Plan for offshore wind and marine renewable energy	Understanding the potential offshore wind, wave and tidal resource in the context of potential environmental impacts.	Mapped areas of potential resource and various aspects of the existing environment (human and natural) separately, with final figures depicting areas of potential resource overlaid by existing environment features.	
Norway	www.regjeringen.no/en/dep/md/Selected-topics/hav--og-vannforvaltning/integrated-management-of-the-barents-sea.html?id=87148	Sectoral management plan.	Set up in a staged process. The first established the existing environment, the second identified associated impacts up to 2020, the third assessed overall pressure and impacts and the fourth generated a management plan.	Mapped baseline environment and assessed potential impact of economic/social activities on natural environment. Established descriptive (i.e. not GIS) plans for minimising environmental impact while permitting activities.	None sourced

Country	Website	Plan Type	Purpose	Cumulative Data Layers	Example of Cumulative Data Layer Mapping
Scotland	www.seaenergyscotland.net	SEA for wave and tidal energy	To examine the environmental effects from the development of wave and tidal power and to inform the preparation and delivery of a strategy for the development of marine energy.	Mapped individual potential constraints (i.e. existing natural and human environment) and areas of potential resource separately.	
Scotland	www.scotland.gov.uk/Publications/2010/05/14155353/17	SEA for offshore wind	The Draft Plan considers the potential for offshore wind energy development within 12 nautical miles of the coast and proposes options for the short, medium and long term.	Maps in GIS the potential wind resource areas with individual constraints, to compare proximity/overlap.	Figures not applicable for cumulative data layer management
Sweden	www.sweden.gov.se/sb/d/2023/a/107951	To improve management and environmental status of Swedish maritime waters.	Plan based, to include fixed zones for protection and use. Very legislative driven.	Mapped the existing environment (human/natural) and discussed potential areas of conflict.	None sourced

Country	Website	Plan Type	Purpose	Cumulative Data Layers	Example of Cumulative Data Layer Mapping
The Netherlands	www.verkeerenwaterstaat.nl/english/topics/water/water_and_the_future/delta_committee/thedeltacommittee.aspx	Integrated Management Plan for the North Sea 2015.	Involves mapping existing interests followed by discussion on each interest, taking into consideration potential interaction (beneficial and in conflict) with other interests.	Cumulative layers mapped but potential conflicts/constraint issues resolved through written discussion. Includes a discussion on how much area is required for the wind energy capacity desired together with how this may interact with existing users. The result was a number of potential wind farm search areas.	
UK	www.defra.gov.uk/environment/marine/legislation/mcaa/index.htm	Marine Spatial Planning	A number of strands are involved in the UKs marine spatial planning, with a general approach of planning and managing the seas in a more joined up manner. The Pilot (www.abpmer.net/mspp/docs/finals/MSPFinal_report.pdf) looked at a better understanding of spatial planning and its applicability to UK waters, being aimed at testing its feasibility and practicality	Emphasis on the planning and management process. Used GIS analysis of data layers to assess degree of conflict between different users for three scenarios	

Country	Website	Plan Type	Purpose	Cumulative Data Layers	Example of Cumulative Data Layer Mapping
Wales		Marine Aggregate Dredging Policy	Produced as part of an integrated strategy for fine aggregates in south Wales.	Assessed how favourably applications for aggregate extraction would be received for different areas within the Severn and Bristol Channel, taking account of issues such as acceptability, need for aggregates and existing use (including nature conservation and coastal areas). Information presented as a description per area, with the overall areas mapped.	
UK	www.thecrownestate.co.uk/mars	Marine spatial planning system	To facilitate the better understanding and sustainable planning of the marine estate	The MaRS database uses multi-criteria analysis to investigate areas with the most development potential and least risk	
UK	https://lra.le.ac.uk/bitstream/23	The FASTTRAC Project	Development of a toolkit for combining aggregate resource	Looked at methods of overlaying different types of	Figures not applicable for cumulative data layer management

Country	Website	Plan Type	Purpose	Cumulative Data Layers	Example of Cumulative Data Layer Mapping
	81/3996/1/TheFASTRACProjectMaster.doc.pdf		and archaeological assessment	data (e.g. airborne or ground collected)	
UK	www.coastms.co.uk/conferences/436	Marine Spatial Planning Conference	To share experience of updates in marine spatial planning	Mapping displayed tended towards overlaying multiple data layers	 
UK	www.abpmer.net/marine-planning/	Spatial planning tool	Website aimed to highlighting research into marine planning practice and learning from relevant experiences	Includes case studies and reference to existing plans	For information

7.1.2 There are a number of projects in recent years that have looked at combining several different data layers within GIS as part of a strategic, broad scale mapping project, generally for purposes of marine spatial planning. Although the projects have been undertaken internationally and for different purposes, there do tend to be similarities in the approach to how the data is displayed and how combining the information from cumulative data layers is handled. The following summarises the main approaches taken:

- Description of baseline data in the text, with the area of interest separated into zones in GIS. Further discussion in the text relevant to each zone, resulting in a final GIS map summarising conclusions;
- Collation of baseline data, preparing separate maps for individual issues (e.g. nature conservation, benthic ecology, shipping), sometimes with key sensitive areas highlighted, with analysis as a description in the accompanying text;
- Presentation of overlapping of baseline data layers, generally overlaid by the area of interest (e.g. renewable energy resource areas) to show potential zones of conflict, with analysis as a description in the accompanying text;
- Collation of separate baseline data maps and then applying a GIS analysis tool to process the data resulting in a single output, with analysis as a description in the accompanying text; and
- Collation of separate baseline data maps and then applying a GIS analysis tool to process the data to enable different scenarios to be tested, with analysis as a description in the accompanying text.

7.1.3 The approach taken by the MRESF project draws on the experiences of previous projects, together with feedback from the Stakeholder engagement process (WAG, 2010a), with the aim of maximising the benefit that can be derived from the presentation of cumulative data layers in GIS for display in a 2-D format. The following summarises the method applied:

- Preparation of baseline data maps for individual issues;
- Preparation of maps depicting areas of potential wave and tidal stream resource;
- Assign a ‘constraint rank’ to each baseline data layer, each rank being colour coded to reflect the level of potential constraint on development, on a 1-5 scale where 1 indicates ‘no likely constraint’ and 5 ‘likely to preclude development’;
- Overlay constraint layers onto the areas of potential resource;

- Process the data to understand how many data layers are found in individual areas and the associated constraint rank, enabling greater understanding of the cumulative constraint at individual points. Display the information in a numerical format (e.g. 0,0,0,0,0). Each digit represents the number of data layers ranked from 5 (the first digit) to 1 (the fifth digit).

7.1.4 The approach taken to presenting the GIS mapping information is designed to increase the appreciation of potential levels of constraint on development for the various areas of potential resource. The information is not intended to be used as a stand alone source of data, but to be used in connection with the associated text presented in RPS, in prep.

8 Potential Resource Areas

8.1.1 A detailed review of wind, wave and tidal devices was undertaken during Stage 1, including information on the type of device, how it operates and status of the device together with information on device requirements such as energy, water depth and distance from shore. The devices identified were grouped to ensure the process was 'device blind'. Given the rapid progress of the industry, it was to be expected that additional information would have become available since Stage 1 ended and as such a review was undertaken, with additional data logged where sourced. Additional information was also gathered during the Stakeholder Participation Process (WAG, 2010a). Of particular interest was data of relevance for mapping resources areas. A summary of the device type data is presented below in Table 8.1 for wave and tidal stream devices. Where the information has been updated since Stage 1 ended, it is highlighted in **Bold**.

8.1.2 The main change in potential resource since Stage 1 is a function of the data used in the Renewables Atlas. Essentially, the 2004 version (which was used during Stage 1) used different wave height data than the 2008 version (which is being used in Stage 3) and as a result sufficient wave height for several device types is now only available for a few months of the year. However, closer examination of the data demonstrates that the mean significant wave height requirement of 2m is just above that within much of Welsh waters, and hence a 'buffer' to the minimum wave requirement has been applied, bringing the value of search to 1.8m, to enable a fairer representation of the potential resource.

8.1.3 Additional information on the potential resource in Welsh waters is given in RPS, in prep.

Table 8.1: Summary Device Type data used to plot potential Resource

Energy Type	Device Type Group	Device Type Sub-Group	Distance from shoreline	Water depth	Energy Requirement
WAVE	Shoreline	Oscillating Water Column (OWC)	0m - few 100m if on breakwater	5-8m up to maximum 15m. Economic preference around 10m	**Annual 15-30kw/m, significant wave height 1m and period 8-12s**

Energy Type	Device Type Group	Device Type Sub-Group	Distance from shoreline	Water depth	Energy Requirement
		Hydraulic pressure	0m	4m	-
		Overtopping	0m	6-15m	18 kW/m
	Nearshore	Oscillating Water Column (OWC)	**Less than 2km**	**10-50m**	**9kw/m**
		Overtopping Collector	**No constraints identified**	**50-80m**	-
		Single point/Buoy	Between 500-800m up to 8km	30-40m ideal, up to 80-100m	**20kW/m, significant wave height above 1m, wave period 5-15 seconds**
		Oscillating wave surge converter	**10m-1km**	10-50m (very variable between devices)	**1-3m swell or 40kw/m^2**
	Offshore	Oscillating Water Column (OWC)	10-16km	**30-100**	**60kw/m**
		Single point/Buoy	2km quoted as economic presence in some cases, out to max +10km, with few to 20km	**20-100m, some needing >50m**	**20kW/m**
		Multi-Buoy	**3-20km**	**20-100m**	**2m wave height or 4kw/m**
		Attenuators	**5-50km**	**30-100m**	**25-55kw/m**
		Overtopping Collector	**5-25km**	**20->40m**	**24kw/m**
TIDAL	Stream	Rotating turbine	**<100m-5km**	**Generally 20-60m with some >100m**	Min >5knots or 2-2.5m/s spring peak velocity (some potentially 1.5m/s)

Energy Type	Device Type Group	Device Type Sub-Group	Distance from shoreline	Water depth	Energy Requirement
		Hydroplanes, hydrofoils and sails	Coastal (especially estuaries) with potential for some devices offshore	Shallow coast or potentially offshore	2m/s tidal velocity
		Single Blade	-	-	-
		Venturi Effect	Often rivers, estuarine, narrow straits	2m (rivers) 10-60m (marine)	2m/s tidal velocity

9 Parallel Work

9.1.1 There is a degree of similarity and/or cross over with a number of projects that are currently underway, both in Wales and nationally across the UK. To ensure the MRESF project fits with these projects, and to facilitate information exchange on key ideas, a series of meetings have been held with the appropriate project teams, with additional meetings planned. The projects identified are as follows:

- The Crown Estates MaRs project (www.thecrownestate.co.uk/mars);
- The Welsh Assembly Governments Marine Conservation Zone project (e.g. see http://wales.gov.uk/docs/desh/publications/100301marinemcznewsletteren.pdf); and
- The Marine Conservation Zone (MCZ) project.

9.1.2 The Crown Estate is currently undertaking a GIS mapping and interpretation project, and an initial discussion between RPS staff and TCE's team was held in London on 12th October 2009, with a follow up meeting on 25th March 2010. Additional meetings are planned and contact is ongoing. A meeting with CCW was held on the 19th April and contact is ongoing with CCW with respect to data sources and the marine spatial planning work currently underway, including the additional vulnerability/sensitivity provided on marine mammals (see Section 5.5), seabirds (see Section 5.6) and seascapes (see Section 5.4).

9.1.3 An initial meeting with the Welsh Assembly's MCZ team was held on the 5th May 2010. This team are identifying potential highly protected areas as part of an ecologically coherent network of Marine Protected Areas. The aim is to take into consideration, where feasible, social and economic factors when such areas are designated. As such, continued contact was agreed to enable information to be exchanged and for the potential wind, wave and tidal stream resource to be taken into consideration when potential sites are identified for consultation and when the final list of sites is drawn up. Such contact will also allow key issues and problems to be discussed and data sources to be exchanged, ensuring a coherent/compatible approach, comparable outputs and cross referencing of data.

10 Summary and Conclusions

10.1.1 The Technical Addendum has been prepared as part of Stage 3 of the MRESF project, with the aim of updating the information compiled during Stage 1 and presented in RPS, 2008. This report has been prepared during 2010 and can be considered current to December 2010 to the best knowledge of the project team. The rapidly evolving nature of the marine renewables industry, as evidenced by the changes and additional information available between Stage 1 and Stage 3, can be expected to continue, with any such new information to be incorporated into future revisions of the MRESF project.

10.1.2 Considerable input has been received during the development of this Technical Addenda, and during the MRESF as a whole, with such input essential to understanding the progress of research programmes, key projects and changes in legislation. Of particular note is the feedback provided during the Stakeholder Participation Process (see WAG, 2010b) and via the project Steering Group, which is comprised of members from the following:

- The Welsh Assembly Government;
- Defence Estates – Ministry of Defence;
- The Crown Estate;
- Countryside Council for Wales;
- Department of Energy and Climate Change;
- Hartley Anderson Ltd;
- Cefas;
- Marine Management Organisation; and
- Department of Transport.

10.1.3 The MRESF project as a whole Is due for publication in early 2011. As a whole, the project will remain contemporary to the time of reporting, with the potential for future updates and/or revisions. However, it is intended that as part of the overall project dissemination the project website will be maintained, enabling the data collection aspect to remain live, logging, providing links and potentially holding sources of information of relevance to Welsh waters and marine renewables as they become available to the project.

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11.2 Project Bibliography

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1039	Briggs, J. and White, S.	2009	Welsh seascapes and their sensitivity to offshore developments 1 No: 16 Regional Seascape Unit Name: Braich y Pwll and Bardsey Island
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1042	Briggs, J. and White, S.	2009	Welsh seascapes and their sensitivity to offshore developments 1 No: 19 Regional Seascape Unit Name: Penrhyn Du to Pen-ychain (Abersoch and Pwllheli)
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1057	Briggs, J. and White, S.	2009	Welsh seascapes and their sensitivity to offshore developments 1 No: 35 Regional Seascape Unit Name: Ramsey Island to Skomer Island (St Brides Bay)
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1079	Offshore Energy SEA	2009	APPENDIX 2 – SEA WORKSHOPS
1080	Offshore Energy SEA	2009	A3a.1 PLANKTON
1081	Offshore Energy SEA	2009	A3a.2 BENTHOS

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1082	Offshore Energy SEA	2009	A3a.3 CEPHALOPODS
1083	Offshore Energy SEA	2009	A3a.4 FISH AND SHELLFISH
1084	Offshore Energy SEA	2009	A3a.5 MARINE REPTILES
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1089	Offshore Energy SEA	2009	APPENDIX 3d - WATER ENVIRONMENT
1090	Offshore Energy SEA	2009	APPENDIX 3E – AIR QUALITY
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1092	Offshore Energy SEA	2009	APPENDIX 3G - POPULATION AND HUMAN HEALTH
1093	Offshore Energy SEA	2009	APPENDIX 3h – OTHER USERS AND MATERIAL ASSETS (INFRASTRUCTURE, OTHER NATURAL RESOURCES)
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1096	Offshore Energy SEA	2009	APPENDIX 4 – OTHER POTENTIALLY RELEVANT INITIATIVES
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960	Parsons Brinckerhoff Ltd	2008	SEVERN TIDAL POWER - SCOPING TOPIC PAPER ORNITHOLOGY
961	Parsons Brinckerhoff Ltd	2008	SEVERN TIDAL POWER - SCOPING TOPIC PAPER Navigation
962	Parsons Brinckerhoff Ltd	2008	SEVERN TIDAL POWER - SCOPING TOPIC PAPER Migratory & Estuarine Fish
963	Parsons Brinckerhoff Ltd	2008	SEVERN TIDAL POWER - SCOPING TOPIC PAPER Marine Ecology
964	Parsons Brinckerhoff Ltd	2008	SEVERN TIDAL POWER - SCOPING TOPIC PAPER Marine and Estuarine Water Quality
965	Parsons Brinckerhoff Ltd	2008	SEVERN TIDAL POWER - SCOPING TOPIC PAPER Landscape and Seascape
966	Parsons Brinckerhoff Ltd	2008	SEVERN TIDAL POWER - SCOPING TOPIC PAPER Hydraulics and Geomorphology
967	Parsons Brinckerhoff Ltd	2008	SEVERN TIDAL POWER - SCOPING TOPIC PAPER HISTORIC ENVIRONMENT
968	Parsons Brinckerhoff Ltd	2008	SEVERN TIDAL POWER - SCOPING TOPIC PAPER Freshwater Environment and Associated Interfaces
969	Parsons Brinckerhoff Ltd	2008	SEVERN TIDAL POWER - SCOPING TOPIC PAPER FLOOD RISK AND LAND DRAINAGE
970	Parsons Brinckerhoff Ltd	2008	SEVERN TIDAL POWER - SCOPING TOPIC PAPER Carbon footprinting
973	Parsons Brinckerhoff Ltd	2008	SEVERN TIDAL POWER Habitats Regulations Assessment: Stage 1 - Preliminary Screening Report

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977	Parsons Brinckerhoff Ltd	2008	SEVERN ESTUARY TIDAL POWER - SCOPING TOPIC PAPER Noise and Vibration
982	Parsons Brinckerhoff Ltd in association with Black & Veatch Ltd	2008	DEVELOPMENT IN THE SEVERN ESTUARY - INTERIM OPTIONS ANALYSIS REPORT VOLUME 2 - APPENDICES B & C
983	Parsons Brinckerhoff Ltd in association with Black & Veatch Ltd	2008	Analysis of options for tidal power devlopment in the severn estuary - Interim OptionsAnalysis Report, Volume 2 - Appendices B & C
984	Parsons Brinckerhoff Ltd in association with Black & Veatch Ltd	2008	Analysis of options for tidal power devlopment in the severn estuary - Interim OptionsAnalysis Report, Volume 1
516	Parsons, ECM, Clark, J, Ross, A and Simmonds, MP	Undated	The conservation of British cetaceans: A review of the threats and protection afforded to whales, dolphins and porpoises in UK waters
517	Parvin, SJ and Nedwell, JR	2005	A brief review of mitigation strategies for reducing the impact of piling noise during construction of the Greater Gabbard wind farm
518	Parvin, SJ and Nedwell, JR	2006	Underwater noise and offshore wind farms
605	Parvin, SJ, Harland, E and Nedwell, JR	2007	The Target Strength of marine mammals, and estimated performance of Active Acoustic Monitoring systems
606	Parvin, SJ, Nedwell, JR and Harland, E	2007	Lethal and physical injury of marine mammals, and requirements for Passive Acoustic Monitoring
775	Parvin, SJ, Nedwell, JR and Workman, R	2006	Underwater noise impact modelling in support of the London Array, Greater Gabbard and Thanet offshore wind farm developments.
519	Parvin, SJ, Workman, R, Bourke, P and Nedwell, JR	2005	CONFIDENTIAL: Assessment of tidal current turbine noise at the Lynmouth site and predicted impact of underwater noise at Strangford Lough
879	Patrício, S, Soares, C and Sarmento, A	2009	Underwater Noise Modelling of Wave Energy Devices
520	Pawson, MG, Pickett, GD and Walker, P	2002	The coastal fisheries of England and Wales, Part 4: A review of their status 1999-2001
521	Pawson, MG, Tingley, D, Padda, G and Glenn, H	2007	EU Contract FISH/2004/011 on 'Sport Fisheries (or Marine Recreational Fisheries) in the EU
522	PB Power	Undated	Technical appraisal of the CETO wave power generation devices

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920	PB Power	2006	Summary Report, Powering the Nation, A review of the costs of generating electricity
523	Pembrokeshire Coastal Forum	Ongoing	Coastal Recreation GIS database
524	Penrose, R and Pierpoint, C	1999	The use of Welsh coastal habitats as calving and nursery grounds for the Harbour porpoise (Phocoena phocoena)
525	Penrose, RS	2007	Marine Mammal and Marine Turtle Strandings (Welsh Coast) Annual Report 2006
526	Percival, SM	2001	Assessment of the effects of offshore wind farms on birds
527	Petersen, IK	2004	Investigation of birds during the operational phase of the Nysted offshore wind farm
528	Petroleum Exploration Society of Great Britain	2007	Structural Framework of the North Sea and Atlantic Margin
529	Pettersson, J	2003	Waterfowl and offshore wind farms. A study in southern Kalmar Sound, Sweden. Spring and autumn migrations 1999-2003
531	Pierpoint, C	2001	Harbour porpoise distribution in the coastal waters of SW Wales
532	Pierpoint, C	Undated	Harbour porpoise (Phocoena phocoena) foraging strategy at a high-energy near-shore site in south-west Wales, UK
533	Pierpoint, C and Allan, L	2000	Cetacean site use and boat traffic on the Ceredgion Marine Heritage Coast, West Wales 1994-99
534	Pierpoint, C and Allan, L	2001	Cetacean site use and boat traffic at New Quay on the Ceredigion Marine Heritage Coast, West Wales 2000
535	Pierpoint, C and Allan, L	2004	Bottlenose dolphins and boat traffic on the Ceredigion Marine Heritage Coast, West Wales, 2002 and 2003
536	Pierpoint, C and Allan, L	2006	Bottlenose dolphins and boat traffic on the Ceredigion Coast, West Wales, 2004 and 2005
537	Pierpoint, CJL	2005	Pre-construction monitoring of harbour porpoises at Scarweather Sands offshore wind farm, SW Wales – first interim report
538	Pierpoint, CJL	2007	Pre-construction monitoring of harbour porpoise at Scarweather Sands offshore wind farm, SW Wales – Annual Report 2005-06

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539	Pierpoint, CJL, Baines, M and Earl, S	1999	Field trials of the POD – an acoustic data logger – to monitor harbour porpoise activity in Newport Bay, Pembrokeshire
902	Ploskey, GR and Carlson, TJ	2004	Comparison of Blade-Strike Modelling Results with Emperical Data
540	PML Applications Ltd	Undated	SEA 8 Technical Report - Hydrography
541	PML Applications Ltd	Undated	Synthesis of Information on the Benthos of Area SEA 8
542	PMSS	2007	Wave Dragon Pre-Commercial Wave Energy Device
828	PND Engineering	2005	Pile Driving Noise Attenuation Measures Technical Report Final, Project 21132
543	Polagye, B	Project in progress	Impacts of large scale kinetic power extraction from time-unsteady tidal estuaries
544	Polagye, B and Previsic, M	2006	System level design, performance, cost and economic assessment - Tacoma Narrows Washington tidal in-stream power plant
915	Polagye, B and Thomson, J	2010	Screening for Biofouling and Corrosion of Tidal Energy Device Materials: In-situ results for Admiralty Inlet, Puget Sound, Washington
852	Polagye, B, Kawase and Malte, P	2009	In-stream tidal energy potential of Puget Sound, Washington
545	Pollock, C and Barton, C	2006	An analysis of ESAS seabird surveys in UK waters to highlight gaps in coverage
546	Poole, J	2007	North Wales Tidal Lagoon
760	Popper, A R; Carlson, T J; Hawkins, A D; Southall B A and Gentry, R L	2006	Interim Criteria for Injury of Fish Exposed to Pile Driving Operations: A White Paper
547	Potter, IC, Bird, DJ, Claridge, PN, Clarke, KR, Hyndes, GA and Newton, LC	2001	Fish fauna of the Severn Estuary. Are there long-term changes in abundance and species composition and are the recruitment patterns of the main marine species correlated?
548	Potts, GW and Swaby, SE	1993	Marine and Estuarine fish of Wales
549	Potts, GW and Swaby, SE	1994	Marine and estuarine fishes of Wales : Review of the monitoring programme for Wales with an analysis of the 1993/94 results

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550	Potts, GW and Swaby, SE	Undated	Marine and estuarine fishes of Wales : review of the monitoring programmes for Wales 1994 to 1998; and update 1998-1999
551	Potts, GW and Swaby, SE	Undated	Marine and estuarine fishes of Wales : update of the monitoring programme for Wales (1999-2000)
552	Poupart, GJ	2003	Wind farms impact on radar aviation interests - final report
553	Poupart, GJ	2005	An assessment of the impact of the proposed Gwynt y Môr offshore wind farm on marine radio navigation and communication systems
750	POWER	2006	Correspondence from Pushing Offshore Wind Energy Regions (POWER) to the Energy Review Team
554	Previsic, M	2004	Offshore wave energy conversion devices
555	Previsic, M and Bedard, R	2007	California wave power demonstration project: Bridging the gap between the completed Phase 1 project definition study and the next phase - phase 2 detailed design and permitting
556	Previsic, M, Siddiqui, O and Bedard, R	2004	Economic Assessment Methodology for Offshore Wave Power Plants
976	PricewaterhouseCoopers LLP	2008	Severn Estuary Tidal Power Financing and Ownership Options, Report on the financing and ownership options for developing a project to generate tidal power from the Severn Estuary
557	Project in progress	Project in progress	Baseline noise assessments against which noise levels of when devices are operational can be assessed
558	Project in progress	Project in progress	Baseline wildlife observations underway against which change can be assessed when devices are in the water
559	Project in progress	Project in progress	EMEC has a joint project with SMRU to develop sonar devices to monitor potential collisions and possible damage
560	Project in progress	Project in progress	Funding for an ROV project to characterise the benthos in the site and cable route against which change can be assessed
561	Project in progress	Project in progress	Understand that a project investigating models to predict effects on seabed and coastal processes is active
562	Project in progress	Project in progress	Understand that a study on cable techniques and effects for offshore wind farms is active

ID	Author	Date	Title
563	Project in progress	Project in progress	Understand that there is a RAG project to tag seals during and post wind farm construction
564	Project in progress	Project in progress	Undertaking studies to determine shipping in the area to provide advice to developers and to enable them to address device specific safety issues
565	Project in progress	Project in progress	Use of GPS location tags to monitor seal interactions with tidal stream turbine
566	Project in progress	Undated	Aerial surveys of birds in strategic wind farm areas 2005-2006
567	Project in progress	Undated	Aerial surveys of birds in strategic wind farm areas 2006-2007
568	Project in progress	Undated	Aerial surveys of birds in SW region 2006-2007
569	Project in progress	Undated	Energetic costs of barrier effects on birds
570	Project in progress	Undated	Fishing in and around offshore wind farms
571	Project in progress	2008	Review of cabling techniques and effects applicable to the offshore wind farm industry
572	Project in progress	Undated	Review of reef effects of offshore windfarm structures and potential for enhancement and mitigation
926	Project Management Support Services (PMSS)	2006	Wales Marine Energy Site Selection
573	Proposal	Proposal	Radar studies of bird migration volume, timing, altitude and spatial distribution
574	Proposal	Undated	Behavioural responses of red-throated divers and common scoter to windfarm construction and operation
575	Proposal	Undated	Seabed communities in areas of strong tidal streams
576	Proposal	Undated	Use of sonar imaging to monitor seal (and other large animal) interactions with tidal stream turbine
577	Puget Sound Tidal Power LLC	2007	Tacoma Narrow Tidal Power Feasibility Study
578	Pullen-Appleby, J	2005	English Sea Power c. 871 to 1100
579	QinetiQ Ltd	2004	Cycloidal tidal power generation - phase 1
925	Quest Underwater Services Ltd	Undated	Kentish Flats Offshore Windfarm, Post Construction Debris Survey Diving Confirmation

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978	Ramanathan, T and Coombes, A	2008	Severn Barrage Railway Infrastructure Feasilibity Study
863	Rasser, M	2008	Effects of Pile Driving Sounds on Auditory and Non-Auditory Tissues of Fish
581	Raytheon Canada Ltd	2006	On advanced mitigating techniques to remove the effects of wind turbines and wind farms on the Raytheon ASR-10/23SS radars
582	Reade, L	Project in progress	Research route map for the environmental sustainability of marine renewable energy
583	Rees, EIS	2004	Subtidal sediment biotopes in Red Wharf and Conwy Bays, North Wales: A review of their composition, distribution and ecology
584	Reid, JB, Evans, PGH and Northridge, SP	2003	Atlas of Cetacean Distribution in north-west European waters
585	Renewables Advisory Board	2006	The Marine Bill: consultation response from the Renewables Advisory Board
919	Research and Library Services, Northern Ireland Assembly	2009	Marine Energy Research Paper 52/09
798	Rhys Hexter HiDef Aerial Surveying Ltd	2009	High Resolution Video Survey of Seabirds and Mammals in the Moray Firth, Hastings, West Isle of Wight and Bristol Channel Areas in Periods 5, 6 and 7 2009 – Technical Report –
1009	Ricci, P, Lopez, J and Villate, JL	2009	Equitable Testing and Evaluation of Marine Energy Extraction Devices in terms of Performance, Cost and Environmental Impact Grant agreement number: 213380 Deliverable D7.1 Summary of Attributes of Cost Models used by different Stakeholders
1001	Ricci, P, Lopez, J, Plaza, J, Scuotto, M, Villate, JL, Myers, L, Dhédin, JF and Retzler, C	2009	Equitable Testing and Evaluation of Marine Energy Extraction Devices in terms of Performance, Cost and Environmental Impact Grant agreement number: 213380, Deliverable D5.1 Guidance protocols on choosing of electrical connection configurations - DRAFT

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1004	Ricci, P, Villate, JL, Scuotto, M, Zubiate, L, Davey, T, Smith, GH, Smith, H, Huertas-Olivares, C, Neumann, F, Stallard, T, Bittencourt Ferreira, C, Flinn, J and Sorensen, HC	2009	Equitable Testing and Evaluation of Marine Energy Extraction Devices in terms of Performance, Cost and Environmental Impact Grant agreement number: 213380 Deliverable D1.2 Recommendations from other sectors DRAFT
1006	Ricci, P, Villate, JL, Scuotto, M, Zubiate, L, Davey, T, Smith, GH, Smith, H, Huertas-Olivares, C, Neumann, F, Stallard, T, Bittencourt Ferreira, C, Flinn, J, Boehme, T, Grant, A, Johnstone, C, Retzler, C and Sorensen, HC	2009	Equitable Testing and Evaluation of Marine Energy Extraction Devices in terms of Performance, Cost and Environmental Impact Grant agreement number: 213380 - Deliverable D1.1 Global analysis of pre-normative research activities for marine energy
1003	Ricci, P, Villate, JL, Scuotto, M, Zubiate, L, Davey, T, Smith, GH, Smith, H, Huertas-Olivares, C, Neumann, F, Stallard, T, Bittencourt Ferreira, C, Flinn, J, Boehme, T, Grant, A, Johnstone, C, Retzler, C and Sorensen, HC	2008	Equitable Testing and Evaluation of Marine Energy Extraction Devices in terms of Performance, Cost and Environmental Impact Grant agreement number: 213380 Deliverable D1.1 Global analysis of pre-normative research activities for marine energy DRAFT
530	Ricci, R, Saulnier, J-B and de O. Falcão, OF	2007	Point-absorber arrays: a configuration study off the Portuguese West-Coast
850	Riddoch, L	2009	Sonar and seals: spotting the problem
586	Robert Gordon University and Centre for Environmental Engineering and Sustainable Energy	2002	Scoping study for an environmental impact field programme in tidal current energy
587	Robinson, D	2005	Gwynt y Môr Offshore Wind Farm Coastal Process Study
761	Rodmell, DP and Johnson, ML	Undated	The Development of Marine Based Wind Energy Generation and Inshore Fisheries in UK Waters: Are They Compatible?
588	Rogers, SI	1997	A review of closed areas in the United Kingdom Exclusive Economic Zone
589	Royal Haskoning	1996	Bristol Channel marine Aggregates; Resources and Constraints research Project

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591	Royal Haskoning	2004	Strangford Lough Marine Current Turbine
592	Royal Haskoning	2005	Thanet Offshore Wind Farm
593	Royal Haskoning	Undated	Potential impact of propsoed Seagen marine current turbine on Strangford Lough European protected features, sub-features and sub-feature attributes
594	RPS	2005	Environmental Statement Non Technical Summary London Array Ltd
595	RPS	2006	Walney offshore windfarm ornithological impact assessment
596	RPS Kirk McClure Morton	2005	Tidal energy turbine - Strangford Narrows Hydraulic model studies
597	RSK Environment	2002	Barrow Offshore Windfarm
598	RSK Environment	2003	Shell Flat Offshore Wind Farm
599	RSPB	2000	The Development Of Boundary Selection Criteria For The Extension Of Breeding Seabird Special Protection Areas Into The Marine Environment
600	RSPB	2008	A response by the Royal Society for the Protection of Birds to the Sustainable Development Commissions report 'Turning the Tide - Tidal Power in the UK' supporting construction of a sustainable Severn Barrage
601	RWE Group	2005	Gwynt y Mor Offshore Windfarm: Environmental Statement
602	RYA	2005	Identifying Recreational Cruising Routes, Sailing and Racing Areas within the SEA 6 Area
603	RYA	Undated	Identifying Recreational Cruising Routes, Sailing and Racing Areas within the SEA 8 Area
604	RYA and the Cruising Association	2004	Sharing the wind: Recreational boating in the offshore wind farm strategic areas
607	Sacau, M, Pierce, GJ, Stowasser, G, Wang, J and Santos, MB	2005	An overview of cephalopods relevant to the SEA 6 area

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609	San Pedro Bay, Ltd., Vestas Wind Technology A/S and Energy Research Consultants	1992	Los Angeles Harbour Wind Power Plant, San Pedro Breakwater, San Pedro Bay. Research Report - avifaunal impact
610	Sarmento, A, Brito-Melo, A and Neumann, F	Undated	Results from sea trials in the OWC European wave energy plant at Pico, Azores
611	Sarmento, AJNA, Neumann, F and Brito-Melo, A	2004	Non-technical barriers to large scale wave energy utilisation
612	Schulting, RJ, Trinkaus, E, Higham, T, Hedges, R, Richards, M, and Cardy, B	2005	A Mid-Upper Palaeolithic human humerus from Eel Point, South Wales, UK
613	Schwartz, SS	2006	Proceedings of the Hydrokinetic and Wave Energy Technologies Technical and Environmental Issues Workshop. Washington, DC. October 26-28, 2005
614	Schweitzer, H	2007	The 'Drogheda Boat
615	Scope in development	Undated	Seascape baseline
616	Scope in development	Undated	Effectiveness of visual limits used in R2
617	Scope in development	Undated	Further aerial bird surveys of offshore areas of potential renewable energy interest
618	Scott Wilson and Downie, A.J	2003	A review of possible marine renewable energy development projects and their natural heritage impacts from a Scottish perspective
619	Scott, BE	2007	A Renewable Engineers Essential Guide to Marine Ecology
942	Scott, KN	2004	International Regulation of Underwater Noise
620	Scottish Enterprise	2005	Marine Renewable (Wave and Tidal) Opportunity Review
621	Seasearch	Undated	Entrances of Milford Haven
885	Seasearch	2007/2008	South Cardigan Bay Seasearch Summary Report
985	Secretary of State for Energy & Climate Change	2009	Written Ministerial Statement, Severn Tidal Power Feasibility Study

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622	Seller, B, Bruce, T and Wallace, R	Project in progress	Modelling Marine Energy Converters: Tank Testing and Numerical Simulation
951	Severn Tidal Power	2001	Annex 2: Severn Tidal Power: Strategic Environmental Assessment Scoping Report
971	Severn Tidal Power	Undated	Severn Tidal Power Phase One Consultation - Government Response
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623	Shaw, TL	1980	An environmental appraisal of tidal power stations:with particular reference to the Severn barrage
624	Shepherd, B, Weir, C, Golightley, C, Holy, T and Gricks, N	2006	Underwater noise impact on marine mammals and fish during pile driving of proposed Round 2 offshore wind farms in the Thames Estuary
1099	Shroeder, D	2009	ENVIRONMENTAL STUDIES PROGRAM: ONGOING STUDIES :Effects of EMF from Transmission Lines on Elasmobranchs and Other Marine Species
793	Side, J, Want, A, Beharie, B and Bell, M	Undated	WS10: Predicting and measuring the effects on a wave exposed shore of energy removal – the first year
1008	Simas, T, Moura, A, Batty, R, Thompson, D and Norris, J	2009	Equitable Testing and Evaluation of Marine Energy Extraction Devices in terms of Performance, Cost and Environmental Impact Grant agreement number: 213380 Deliverable D6.3.1 Deliverable D6.3.1 Uncertainties regarding environmental impacts. A draft.DRAFT
1007	Simas, T, Moura, A, Batty, R, Vernont, G, Paillard, M, Abonnel, C, Thompson, D and Norris, J	2009	Equitable Testing and Evaluation of Marine Energy Extraction Devices in terms of Performance, Cost and Environmental Impact Grant agreement number: 213380 Deliverable D6.1.1 Existing legislation, perspectives and evolution of other similar technologies DRAFT

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625	Sims, DW, Southall, EJ, Metcalfe, JD and Pawson, MG	2005	Basking shark population assessment
626	Sims, DW, Southall, EJ, Richardson, AJ, Reid, PC, Metcalfe, JD	2003	Seasonal movements and behaviour of basking sharks from archival tagging: no evidence of winter hibernation
627	Skov, H	2006	Environmental Impact Assessment Marine Mammals in the NW3 Area, Irish Sea
628	Smith, H and Millar, DL	2005	Detailed wave climate modelling off the north Cornwall coast
629	Smith, HCM, Millar, DL and Reeve, DE	2007	Generalisation of wave farm impact assessment on inshore wave climate
630	Smith, NJP	1987	The Deep Geology of Central England: the prospectivity of the Palaeozoic Rocks
931	SMRU	2001	Technical Report TR_006 Technical report produced for Strategic Environmental Assessment – SEA2 BACKGROUND INFORMATION ON MARINE MAMMALS RELEVANT TO SEA2
631	SNH	2004	Marine Renewable Energy and the Natural Heritage: An overview and policy statement
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633	Soerensen, HC, Hansen, R, Friis-Madsen, E, Panhauser, W, Mackie, G, Hansen, HH, Frigaard, P, Hald, T, Knapp, W, Keller, J, Holmen, E, Holmes, B, Thomas, G, Rasmussen, P and Krogsgaard	Undated	The wave dragon - now ready for test in real sea
634	Solandt, J-L	2007	Outer Bristol Channel Megafaunal Surveys
867	Solberg, T, Hjertager, BH and Bove, S	2006	CFD Modelling of Scour Around Offshore Wind Turbines in Areas with Strong Currents
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776	Southall, B., Berkson, J., Bowen, D., Brake, R., Eckman, J., Field, J., Gisiner, R., Gregerson, S., Lang, W., Lewandoski, J., Wilson, J., and Winokur, R.	2009	Addressing the Effects of Human-Generated Sound on Marine Life: An Integrated Research Plan for U.S. federal agencies. Interagency Task Force on Anthropogenic Sound and the Marine Environment of the Joint Subcommittee on Ocean Science and Technology. Washington, DC
637	Southall, EJ, Sims, DW, Metcalfe, JD, Doyle, JI, Fanshawe, S, Lacey, C, Shrimpton, J, Solandt, J-L and Speedie, CD	2005	Spatial distribution patterns of basking sharks on the European shelf: preliminary comparison of satellite-tag geolocation, survey and public sightings data
839	Speakman, J, Gray, H and Furness, L	2009	University of Aberdeen report on effects of offshore wind farms on the energy demands on seabirds
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881	SSMEI	2008	A Marine Spatial Plan for the Shetland Islands, Part Two Marine Atlas Consultative Draft
639	Still, D, Little, B, Lawrence, SG and Carver, H	1994	The Birds of Blythe Harbour
845	Stokes, A, Cockrell, K, Wilson, J, Davis, D, Warwick, D	2010	Mitigation of Underwater Pile Driving Noise During Offshore Construction: Final Report
640	Stone, CJ	2003	The effects of seismic activity on marine mammals in UK waters, 1998-2000
641	Stottrup, JG	2002	Half-year investigation for the project entitled: Investigations on the artificial reef effect on fish from a marine wind turbine at Horns Reef
642	Strange, C	1989	Salmon stock monitoring. Part 1; a review of techniques for salmon stock monitoring in relation to tidal power barrages. Part 2; survey of juvenile salmon population in the R. Wye in relation to monitoring the effects of a tidal energy scheme
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644	Strong, PG, Lerwill, JK, Morris,	Undated	Pembrokeshire marine SAC grey seal monitoring 2005

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	SR and Stringell, TB		
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646	Subacoustech Ltd	Project in progress	Assessment of subsea acoustic noise emission and vibration from offshore wind turbines and its impact on marine wildlife
647	Sun, X and Bryden, I	Project in progress	Establishment and Assessment of Laboratory Testing Procedures of Tidal Current Energy Devices
648	Sustainable Development Commission	2007	Turning the Tide: Tidal power in the UK
988	Sustainable Energy Ireland	2004	Scoping for the Strategic Environmental Assessment on Plans to Develop Offshore Renewable Energy Notice under Section 11 of the European Communities (Environmental Assessment of Certain Plans and Programmes) Regulations 2004, S.I. No. 435 of 2004
1127	Swift, R	2009	Assessment of Performance of Tidal Energy Conversion Systems
927	Tambke, J and Lange, B	2008	Rave Research at Alpha Ventus, The Research Initiative at the first German Offshore Wind Farm
649	Tarrant, VE	2000	The U-boat offensive 1914-1945
945	Tasker, ML, Karwatowski, J, Evans, PGH and Thompson, D	1998	Proceedings of the Seismic and Marine Mammals Workshop London 23-25 June 1998
650	Taylor, JRM and Motion, A	2005	Estimating wave energy in Scottish waters from hindcast data
651	Taylor, S	2002	The Severn Barrage - Definition study for a new appraisal of the project
652	Teilmann, J, Carstensen, J, Dietz, R and Edren, S	2004	Effect on seals at Rodsand seal sanctuary from the construction of Nysted offshore wind farm based on aerial surveys
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656	The Engineering Business Ltd	2003	Stingray tidal stream energy device - Phase 2
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658	The Engineering Business Ltd	2005	EB Frond Wave Energy Converter
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661	The Sea Trust	Undated	Proposal for a management plan of harbour porpoise near Strumble Head near Fishguard
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874	Thetis Energy Ltd	2009	Proposed Torr Head Tidal Scheme, Environmental Scoping Report
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