Living Seas





towards sustainable marine renewable energy in Scotland





Policy Futures Series No 2/2010



About the Scottish Wildlife Trust

THE SCOTTISH WILDLIFE TRUST, established in 1964, has the charitable purpose to advance the conservation of Scotland's biodiversity for the benefit of present and future generations. With more than 36,000 members, over 120 reserves and a network of volunteers the length and breadth of the country, we are proud to say we are now the largest voluntary body working for all the wildlife of Scotland.

Our vision is of a network of healthy and resilient ecosystems supporting expanding communities of native species across large areas of Scotland's land, water and seas. This is the 'Ecosystem Approach', which is the basis of The Wildlife Trusts' UK Living Landscapes and Living Seas initiatives.

This report should be quoted as: Boyd, R, Hughes, J & King, A (2010) Living Seas: towards sustainable marine renewable energy in Scotland. Scottish Wildlife Trust, Edinburgh.



Acknowledgements

The authors wish to thank the many people who have made comments and provided useful input during the preparation of this report. Particular thanks to Lissa Goodwin (The Wildlife Trusts). Thanks also to Phil Gilmour and Phil Alcock (Marine Scotland), George Lees and Brendan Turvey (SNH), Tom Mallows (The Crown Estate), Frank Fortune (Royal Haskoning), Ben Wilson (Scottish Association for Marine Science), Sarah Dolman (Whale and Dolphin Conservation Society), Aedán Smith and Rory Crawford (RSPB), Alan Wells (Scottish Environment LINK) and Fiona Henderson (Halcrow Group).

Any opinions, conclusions or errors in this report are the sole responsibility of the authors.

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Front cover image of waves, Wave Power device and Kittiwake (*Rissa tridactyla*) © Laurie Campbell. Above left image © Laurie Campbell.

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Executive summary

Marine renewables are set to play a key role in reducing Scotland's carbon emissions, helping to reduce climate change impacts on biodiversity. However, there is significant uncertainty over the level of risk to Scotland's unique and internationally important marine biodiversity from marine renewables development itself.

The Scottish Wildlife Trust believes that the most environmentally responsible approach to marine renewables development will be one that delivers a net reduction in carbon emissions while safeguarding marine ecosystems and nationally and internationally important marine habitats and species.

The principal conclusions of this report are:

- Marine renewables should play a key role in reducing Scotland's carbon emissions, helping to reduce climate change impacts on biodiversity.
- The Scottish Wildlife Trust supports the development and deployment of marine renewables where they are shown to be environmentally sustainable, *i.e.* where any localised, regional and wider seas impacts on marine ecosystem health are shown not to be significant and/or irreversible.
- There are concerns that nationally important marine features (including both species and habitats) are currently not adequately considered during the planning and deployment of marine renewables and must therefore be given greater consideration and protection.
- Marine renewable devices may enhance biodiversity (*e.g.* creation of artificial reefs) in some types of habitat, though protection of naturally species-poor habitats (*e.g.* certain soft bottom habitats) must also be a key consideration.

- There should be a precautionary and adaptive approach to marine renewable planning and deployment, coupled with investment into research on both localised and cumulative impacts of the technologies currently available.
- The Scottish Wildlife Trust believes the Ecosystem Approach (as set out by the UN Convention on Biological Diversity) should be used as a key decision-making tool when planning and deploying marine renewables.
- Governance processes and structures, including high-level government fora on marine renewables, must include representation from conservation agencies and third sector organisations.
- Conservation third sector organisations should work collaboratively with the renewables industry, government, the research community, The Crown Estate and other stakeholders to help ensure the environmental sustainability of marine renewables in Scotland.
- The Marine (Scotland) Act 2010 can, if implemented effectively, deliver environmentally sustainable marine renewable energy generation.

The purpose of this paper

The marine renewables industry in Scotland is in its infancy, but the scale and speed of proposed development is very significant. The Scottish Wildlife Trust recognises that marine renewables are set to play an important role in reducing Scotland's carbon emissions, helping to reduce climate change impacts on biodiversity. However, there is uncertainty over the level of risk to Scotland's unique and internationally important marine natural heritage from renewables development itself. Decisions taken now are critical if we are to ensure that development takes place in a way that is consistent with Scotland's long-term public interest in maintaining a healthy, functioning marine environment.

The Scottish Wildlife Trust has concerns about this potential risk to the marine environment, but believes that the emerging marine renewables industry has an opportunity to develop in a more environmentally sustainable way, and to make a positive contribution to sustainable marine development.

This paper examines:

- The current drive for marine renewables, including present plans and possible future developments.
- Key criteria for determining whether developments are truly within environmental limits in the context of sustainable development.
- Whether current decision-making processes can ensure that new developments meet such criteria.
- How the provisions of the Marine (Scotland) Act 2010, including the proposed new marine planning system, might best address environmental sustainability

Part 1 The drive for marine renewables



Part 1 The drive for marine renewables

Government targets for marine renewables

Scotland is on the cusp of profound changes to the way it generates energy. These changes are being driven by significant commercial opportunities, a strategic imperative for security of supply and a global climate crisis which is precipitating a rapid transformation towards low carbon energy technologies. Energy analysts predict that marine renewables have a central role to play in decarbonising the UK energy supply and meeting carbon emissions targets.¹ Moves to exploit energy from renewable marine sources represent an excellent opportunity for Scotland to develop a truly sustainable marine renewables industry: one which is able to plan, design and deploy technology in a way which minimises environmental impacts while tackling climate change.

The Scottish Government invested well over £100m between 2007 and 2010 in the development of

the marine renewables industry, with a focus on encouraging new technology and the infrastructure necessary to place Scotland at the forefront of renewable energy production in Europe.² The Renewables Obligation in Scotland, which uses the income generated by electricity suppliers to support the renewables industry, has been extended to 2040.³ Both UK and Scottish Governments have supported renewable energy as a means of reducing carbon emissions and delivering 'sustainable economic growth'.⁴ Indeed, alternative energy production enjoys higher levels of investment than, for example, energy conservation (i.e. reduction in carbon footprint),⁵ which – with a third of Scotland's emissions coming from housing – is a vital component of meeting carbon emissions targets.⁶

The recent Climate Change (Scotland) Act 2009, reinforcing the provisions of the EU Directive on Renewable Energy,⁷ sets statutory emissions targets and requires public bodies to both contribute to

Scottish targets for renewable energy

Scotland is committed to reducing carbon emissions by 42% on 1990 levels by 2020 and by 80% on 1990 levels by 2050. It aims to achieve a headline target of 20% of total Scottish energy use, 40% of electricity generation and 50% of gross electricity consumption (*c*. 8GW) from renewable sources by 2020, with an interim target of 31% of gross electricity consumption (*c*. 5GW) by 2011.⁸

Sources of marine renewable energy

Marine renewable energy can be extracted from three main sources: wind, wave and tide. In addition to these, there are also initial investigations into the feasibility of using marine algae to produce energy. Scotland has an estimated potential electricity production of 46.5GW from marine renewables. Of this, 25GW is expected from offshore wind, 7.5GW from tidal power (25% of the estimated tidal capacity for the European Union), and up to 14GW from wave power (10% of EU capacity). Total renewable electricity generating capacity may be 60GW or more, considerably greater than the existing capacity from all Scottish fuel sources of 10.3GW.⁹ On the assumption that renewable sources will operate at 30% of theoretical potential, it is estimated that 5GW will be required to achieve the 2011 target of 31% of gross energy consumption from renewables and 8.3–8.4GW to achieve the 50% target for 2020.¹⁰

delivery and report on those targets. The Scottish Government is also bound by the provisions of the EU Marine Strategy Framework Directive (MSFD) and the Marine (Scotland) Act 2010, which include adopting an Ecosystem Approach, sustainable development, marine planning, a network of marine protected areas and achieving targets for marine ecosystem health. These help to implement a range of international policy commitments in relation to halting biodiversity loss, marine protection and sustainable development.^{11, 12} It is vital to build strong links between actions – to generate energy, to tackle climate change and to create a healthy, sustainably managed marine environment - if Scotland is to create a marine renewables industry that is truly sustainable.

A snapshot of developments to-date

Offshore wind

Offshore wind is the most established marine renewable technology in the UK. It is estimated that 25GW of electricity can be generated from wind energy in the waters off Scotland. Yet the majority of developments exist off England and Wales because the inshore waters of Scotland were – until recently – considered too deep.^{13, 14} Technology, however, has now progressed sufficiently to allow turbines to be installed in deeper water.

In February 2009, The Crown Estate offered exclusivity agreements to nine companies and consortia for 10 sites for wind development within Scottish territorial waters (STW), with the potential to generate 6.4GW of wind power. These developments will require around 1300 offshore structures at today's 5MW turbine scale and a capital expenditure of £15bn to £18bn by 2020.15 There are two sites in the Solway Firth; one off the Mull of Kintyre; one off Islay; one off Tiree; one in the Moray Firth and four in the outer Forth and Tay adjoining Round 3 areas.¹⁶ Developers are able to begin initial survey and consultation processes but lease agreements will not be awarded for sites until the completion of the Scottish Government's Strategic Environmental Assessment (SEA) for offshore wind development within STW. Consent for individual developments on these sites is

expected by 2012, subject to the SEA, with construction and deployment taking place between 2014 and 2018.

Scotland has an estimated potential electricity production of 25GW of offshore wind. Between 2011 and 2020, offshore wind in Scotland is expected to move further offshore and to produce 1–4GW. Scottish Renewables, a trade body for the renewables industry in Scotland, suggests that 11.2GW of offshore wind projects have been earmarked for development.¹⁷

The Crown Estate Round 3 process identified two zones in the Scottish Renewable Energy Zone (beyond 12 nautical miles), in the outer Moray Firth and outer Forth, where Zonal Development Agreements were awarded to developers in January 2010 for a total of 4.8GW.¹⁸ This represents over 800 larger 5.9MW devices. The Firth of Forth site is adjacent to four wind sites in STW. The only deep water offshore wind turbines currently in operation in UK waters are two experimental prototypes, delivering electricity to the grid via the Beatrice oil platform 25km off the Moray Firth.

Leases for three wind demonstrator sites in STW were announced in March 2010. These will be small developments whose main purpose will be to test the sort of physical structures needed to deliver Round 3. Consents for these sites are expected by 2012–14, with construction following.

It is expected that all these wind energy programmes will begin large-scale installation by 2014–15, and that by 2020 around 3700 wind turbines may be installed in sites within immediate reach of Scottish manufacturing and installation facilities.¹⁹

Wave and tidal energy

Scotland has considerable wave and tidal energy resources, but technologies are not yet refined. Over 20 designs are in development in the UK. The European Marine Energy Centre (EMEC) in Orkney is the main UK test centre for wave and tidal technologies.²⁰ An SEA for wave and tidal energy in Scotland was completed in 2007.²¹ In November 2008, The Crown Estate held the first leasing round for commercial wave and tidal energy in the Pentland Firth and Orkney Waters (PFOW). Twenty companies bid for 42 sites, and seabed leases were announced in March 2010 for six wave and four tidal sites with a total of a 1.2GW installed capacity by 2020.²² This is significantly higher than the 700MW target. An interim marine spatial plan for the PFOW to direct renewables planning was produced in 2010. In March 2010, The Crown Estate announced a second leasing round for seven wave and tidal sites off the west coast.²³

Meanwhile, the Solway Energy Gateway is progressing proposals to harness tidal energy from the Solway Firth. The initial scoping process in October 2009 identified

Company/site	Output	Location	Status
Robin Rigg A&B E.ON	60 turbines Capacity 180MW Generating 6MW	54 45 00N 03 41 00W 9.5km off Rock Cliffe (Scotland)	In operation
Beatrice Wind Farm demonstrator project Talisman/ SSE	2 turbines Capacity 10MW Generating 5MW	58 06 20N 03 05 35W 25km off Moray Firth, next to Beatrice oil field	In operation
Siadar Wave Energy Project	4MW	Active breakwater at Siadar, North Lewis	Operation planned to commence 2011
Aberdeen Bay Offshore Wind Farm	Up to 115MW	Aberdeen Bay	Offshore Wind Demonstration Site. Exclusivity agreement awarded August 2010
Isle of May	Small-scale tidal device <500KW	Isle of May Special Area of Conservation	PhD to understand natural heritage sensitivities of a tidal device No consents yet sought
Islay Limpet	Small-scale wave device <500KW	Islay, Argyll	In operation
Islay	10 x 1MW tidal devices	Off Islay	Intend deployment 2013
Fall of Warness test site EMEC	5 test berths for new tidal devices	Off Eday, Orkney	Openhydro TGL (Tidal Generators Ltd) in the process of deployment Scottish and Southern Energy Openhydro device in operation
Billia Croo test site EMEC	4 test berths for new wave devices	Off Mainland, Orkney	Oyster device in operation. Oyster 2 under development (3 linked devices with total capacity of 2MW by 2011) Ocean Power Technology device consented and deployed 2010 Pelamis device deployed 2010

Marine renewable devices under construction or in operation in Scotland (2010)

five options: barrage, lagoon, reef, modular tidal stream units and tidal stream array in the form of a tidal fence. Of these, the barrage and lagoon options are thought to have greater environmental impact than the more innovative options currently short-listed. Further work would be required to fully assess the environmental impact of each one. A feasibility study into these options is underway.²⁴

Marine biomass

In 2009, the Scottish Association for Marine Science (SAMS) began a three-year research project to investigate the economic and environmental feasibility of growing and processing kelp to produce methane.²⁵ There is also research underway to use plankton to produce bioethanol.

Transmission network

Most UK marine energy resources are off the north

and west of the UK, often in remote places. There are clearly issues of sustainability in the transmission of electricity to urban centres. The national grid is not currently able to cope with the scale of development anticipated. Grid expansion on the north coast can take place only once developers have submitted grid applications, and will not be complete until at least 2014. The Crown Estate has concluded that an East Coast Interconnector (an offshore cable running down the east coast, to allow energy generated in Shetland and the Western Isles to access markets throughout Scotland) would be economically viable.

The Scottish Government has since approved plans to upgrade a 137-mile (c. 220km) AC transmission network of 600 pylons, upgrading an existing line, running from the Highlands to central Scotland (January 2010). There are carbon costs involved in transmission, although efforts are being made to reduce these.²⁶

Best estimates of timeline for future development²⁸

	·
2009	3 test devices installed at EMEC increasing to 10 devices by c. 2011/12
2009	Exclusivity agreements awarded for 10 offshore windfarms in Scottish Territorial Waters (STW) (Solway, Argyll, Hebrides, Moray, Tay and Forth)
2010	Lease agreements awarded for 3 wind demonstration sites in STW
2010	Lease agreements awarded for <20 commercial wave and 4 tidal lease areas in Pentland Firth and Orkney Waters with 1.2GW installed capacity by 2020 (PFOW)
2010	Ad hoc application for consent for test devices and demonstration arrays off northern and western coasts
2011	Further lease bidding rounds announced for wave and tide in Argyll, Western Isles and Shetland
2012–14	Construction commences for wave and tidal arrays in PFOW (subject to award of consents)
2013	Construction commences for offshore windfarms in STW (subject to conclusions of SEA and award of consents)
2013–15	Construction commences for Round 3 offshore windfarms – Moray, Tay and Forth (subject to award of consents)
2013–20	Commercial wave and tidal arrays in PFOW become operational (staged development at each site likely)
2018	Offshore windfarms in STW in place and operational
2018–20	Round 3 windfarms in place and operational
(ADAPTED FROM SNH, 2009)	

The National Renewables Infrastructure Plan proposes the staged development of critical terrestrial infrastructure to support marine energy development, with the aim of establishing a competitive position for Scotland in the industry market. It identifies 11 Scottish 'first phase' locations for rapid development to provide manufacturing, maintenance and port facilities and possible future locations on the Pentland Firth to support the wave and tidal sector. The Infrastructure Plan emphasises that planning and consenting will have to take place quickly to meet the planned installation timelines.²⁷ A Strategic Environmental Assessment (SEA) is expected on the Infrastructure Plan. The location of transmission networks can drive significant terrestrial development, with associated environmental impacts.

Part 2 Achieving environmental sustainability



Part 2 Achieving environmental stability

Environmental sustainability is one of the two overarching sustainability principles and a prerequisite for sustainable development.²⁹ The Scottish Wildlife Trust believes that the marine renewables industry has an opportunity to develop in an environmentally sustainable way and to make a positive contribution to sustainable marine development. This involves considering two fundamental and interrelated issues for environmental sustainability: climate change mitigation and marine ecosystems.

The environment and climate change – finding the balance

The extent to which marine renewables are or can be environmentally sustainable is a broader question than simply estimating the environmental impacts from development. It has to take into account costs and benefits both to the local marine environment and to natural ecosystems as a whole. It has to be based on a careful assessment of the net benefit of a proposed development. That calculation is all the more complex here because of the need to balance both Scottish and global priorities.

Many of Scotland's marine habitats and species are recognised as being of international importance, and its position between sub-polar and sub-tropical regions makes its marine ecosystems unique in a global context.³⁰ Among other internationally important features, Scotland's seas support nearly half the seabirds in the EU, including the largest northern gannet colony in the world; 36% of the global population of grey seal and the world's most northerly population of bottlenose dolphin. Scotland's nationally important marine features include most of the UK's reported sightings of the basking shark, most of the UK's maerl beds, horse mussel reefs, flameshell reefs, northern sea fan communities and coldwater coral communities.³¹ While some internationally important sites and species are protected, nationally important features and the wider ecosystems that support marine processes are not, unless they are integral to a specific internationally protected feature. The inadequacy of legislative protection is remedied in part by the Marine (Scotland) Act 2010, which provides for a new network of marine protected areas for nationally important marine features; the act also places a duty on public bodies for the 'protection and, where appropriate, enhancement of the health' of Scotland's seas. There is, therefore, a strong national and international imperative for the protection and enhancement of Scotland's marine habitats and species and of the ecosystems that support them.

There is now little doubt that climate change is affecting both marine and terrestrial ecosystems. The biodiversity impacts of ocean acidification on organisms constructed from carbonates, such as corals, are well-documented; but indirect effects on biodiversity due to changes on the air-sea exchange of CO_2 – including stratification, upwelling, ocean circulation and primary production – are less well known.³² On land, ecosystem impacts of climate change will be widespread.³³

It is clearly desirable to reduce climate change impacts on natural ecosystems, but it is also important to ensure that they are healthy and therefore as resilient as possible to these impacts. It is essential to acknowledge the growing body of literature demonstrating that a healthy, biodiverse and well-functioning marine environment is a resilient one, predicted to be much better able to cope with and adapt to the damage caused by climate change.³⁴ The literature also shows that protection of marine biodiversity supports the complex functions of marine ecosystems, thereby supporting the ocean's critical role as a carbon sink.³⁵ The key issue here is not so much whether renewables devices themselves cause environmental damage – although devices in estuaries may directly impact on carbon storage - but whether government policy and action on climate change actively support the wider health and protection of the marine environment in parallel to promoting alternative energy production.

Marine renewables are set to play a central role in meeting Scotland's carbon emissions targets.³⁶ Various estimates have been made of the life-cycle carbon impacts of renewables devices,³⁷ although these are likely to change as technology develops. One estimate for a hypothetical wave energy device calculates a carbon payback time of 1 to 2 years, although this is restricted to the structure itself and does not take account of associated infrastructure or transmission.³⁸ Such estimates certainly point to a net carbon benefit, although it would be helpful if such calculations were transparent and systematic within development planning.³⁹

Despite likely net carbon benefits, the various marine renewables technologies do pose a range of risks to the environment. There is still considerable uncertainty around the extent of these risks. Developments in shallow seas and estuaries, such as tidal barrages, may pose risks not only to ecology but to nutrient cycling and carbon storage. Potential impacts from wind turbines range from habitat loss and displacement of mobile fauna, smothering or scour of seabed species to noise and vibrational disturbance from construction. Potential impacts of wave and tidal devices are less easy to predict because of the wide diversity of technologies. Predicted impacts will, however, include disturbance, possible collision with devices and impacts on foraging areas and migratory pathways.⁴⁰ Alongside these risks are possible benefits: for example, from the creation of artificial reefs and the exclusion of other damaging marine activities from key areas of sea.

In addition to protecting marine ecosystems for environmental conservation reasons, it is important to ensure that they continue to provide essential goods and services. It is essential to ensure that large numbers of poorly planned marine renewables devices do not impact at a broad scale on key ecosystem functions and keystone species, like plankton movement, sandeel nursery grounds or fish migration paths. Such impacts would be damaging not only for the sea's ability to produce food, but would compromise its health and resilience to adapt to the impacts of climate change itself.

Clearly, a considered and precautionary approach is needed to ensure that marine renewables develop in an environmentally sustainable way.

The Scottish Wildlife Trust believes that marine renewables can only be environmentally sustainable where any damage caused by development does not impact significantly on ecosystem health, is reversible, and is outweighed by the net benefit of marine renewables in mitigating climate change-induced damage or otherwise benefiting marine ecosystems.

Assessment of environmental sustainability must take account of:

- The net carbon impact of development⁴¹
- Risk of damage to ecosystems as a result of unmitigated climate change
- Risk of damage to Scotland's marine ecosystems from development
- Any environmental benefits from development

Given that this assessment is likely to be in part a matter of careful judgement, the Scottish Wildlife Trust believes that the most environmentally sustainable approach is likely to be one that delivers a net reduction in carbon emissions while also maintaining the integrity and function of marine ecosystems and avoiding damage to nationally and internationally important features. This is essential to maintain the sea's natural capacity to deliver climate change mitigation and adaptation as well as a range of other essential goods and services.

It would be perverse for climate change mitigation measures to exacerbate the environmental damage already taking place as a result of climate change. There will clearly be benefits in many respects if marine renewables can be designed and located to be either environmentally benign or positively beneficial for the health and function of marine habitats, species and ecosystems.

The Ecosystem Approach to sustainability and marine ecosystem objectives

The Scottish Government is committed through the Marine Strategy Framework Directive and associated domestic legislation to taking an Ecosystem Approach to marine development and to achieving Good Environmental Status by 2020. These are two keystone principles which must guide the sustainable development of the marine renewables industry.

The Scottish Wildlife Trust outlined its thinking on what an ecosystem-based approach to conservation

could mean in practice in a previous Policy Futures paper, *Living Landscapes: towards ecosystembased conservation in Scotland*.⁴² The paper makes reference to the Convention on Biological Diversity definition of the Ecosystem Approach, which sets out 12 principles. The Ecosystem Approach is an important tool for achieving sustainable development as it is focused on defining the desired relationship between human activities and the natural ecosystems which host them. Increasingly, scientists are advocating approaches which assess the value of ecosystem goods and services. These include the significant potential of sustainably

Principles of the Ecosystem Approach

The 12 principles are:

- The objectives of management of land, water and living resources are a matter of societal choice. Ecosystems should be managed for their intrinsic values and for the tangible or intangible benefits for humans, in a fair and equitable way.
- 2. Management should be decentralised to the lowest appropriate level.
- 3. Ecosystem managers should consider the effects (actual or potential) of their activities on adjacent and other ecosystems.
- 4. Recognising potential gains from management, there is usually a need to understand and manage the ecosystem in an economic context. Any such ecosystem management programme should:
 - (a) Reduce those market distortions that adversely affect biological diversity;
 - (b) Align incentives to promote biodiversity conservation and sustainable use;
 - (c) Internalise costs and benefits in the given ecosystem to the extent feasible.
- 5. Conservation of ecosystem structure and functioning, in order to maintain ecosystem services, should be a priority target of the Ecosystem Approach.
- 6. Ecosystems must be managed within the limits of their functioning.
- 7. The Ecosystem Approach should be undertaken at the appropriate spatial and temporal scales.
- 8. Recognising the varying temporal scales and lag-effects that characterise ecosystem processes, objectives for ecosystem management should be set for the long term.
- 9. Management must recognise that change is inevitable.
- 10. The Ecosystem Approach should seek the appropriate balance between, and integration of, conservation and use of biological diversity.
- 11. The Ecosystem Approach should consider all forms of relevant information, including scientific and indigenous and local knowledge, innovations and practices.
- 12. The Ecosystem Approach should involve all relevant sectors of society and scientific disciplines.

managed marine ecosystems to provide carbon sequestering services and improve resilience to climate change impacts.⁴³ The 12 principles provide a decision-making framework to assist assessment of the broader impacts and benefits to the marine ecosystem of marine renewables.

The European Marine Strategy Framework Directive (MSFD) – currently being implemented throughout the EU – aims to protect, preserve and, where practicable, restore the marine environment by applying an ecosystem-based approach and putting in place measures to 'achieve or maintain good environmental status' in EU waters by 2020.44

The MSFD sets out 11 qualitative descriptors to guide the achievement of good environmental status.⁴⁵ The Marine (Scotland) Act 2010 assists the implementation of the MSFD by providing for marine plans to deliver on a set of marine ecosystem objectives. Work to identify a set of marine ecosystem objectives for Scotland is on-going, but they must be based on these qualitative descriptors.

Marine Strategy Framework Directive – qualitative descriptors of good environmental status

- 1. Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions.
- 2. Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystems.
- 3. Populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock.
- 4. All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity.
- 5. Human-induced eutrophication is minimised, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters.
- 6. Sea floor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected.
- 7. Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems.
- 8. Concentrations of contaminants are at levels not giving rise to pollution effects.
- 9. Contaminants in fish and other seafood for human consumption do not exceed levels established by Community legislation or other relevant standards.
- 10. Properties and quantities of marine litter do not cause harm to the coastal and marine environment.
- 11. Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment.

Part 2

Part 3 Making marine renewables sustainable



Part 3 Making marine renewables sustainable

The Scottish Wildlife Trust recognises the potential impacts of climate change on Scotland's marine biodiversity, and supports Scottish Government targets for carbon emission reduction and the replacement of non-renewable with renewable energy sources. It also accepts that marine renewables can play a significant role in reducing Scotland's carbon emissions. It does, however, believe that marine renewables development need not and *should not* compromise the integrity of Scotland's unique marine habitats, species and ecosystems.

Our starting position is that the most environmentally sustainable approach is likely to be one that delivers a net reduction in carbon emissions whilst also maintaining the integrity and function of marine ecosystems and avoiding irreversible environmental damage. Only this would support the sea's natural capacity to deliver climate change mitigation and adaptation, as well as a range of other essential goods and services.

Four key criteria

The Scottish Wildlife Trust recommends the following criteria to assess the environmental sustainability of marine renewables:

1. Is environmental sustainability at the heart of the decision-making process?

Decisions on deployment of marine renewables should not be made purely on the grounds of climate mitigation and/or economic opportunity. The Scottish Wildlife Trust strongly believes that in order for the marine renewables industry to be environmentally and socio-economically viable in the long term, decisions on deployment of installations must be made consistently on the grounds of 'environmental sustainability'. Central to the the concept of 'environmental sustainability' is the protection of marine ecosystem health; or, put another way, protecting marine ecosystems' ability to function and providing a range of goods and services to current and future generations.

2. Do the benefits of carbon emissions reduction outweigh any damage to ecosystem health?

In the rush to achieve climate change targets and realise economic opportunities, it is vitally important not to lose sight of the *net benefit versus cost* question. For some installations, longer carbon payback periods in combination with damage to ecosystem health may mean the deployment should not proceed or should be located elsewhere. In determining this balance, account must be taken of:

- Impact on the delivery of marine ecosystem objectives for the relevant marine area
- Impact of cumulative and in-combination impacts of development
- Impact nationally and internationally on important habitats and species
- Impact on ecosystem functioning
- Whether a net cost scenario can be turned into a net benefit scenario through careful mitigation, compensatory and complimentary measures ('marine planning gain')

3. Are important habitats and species protected from irreparable damage?

Marine renewable energy developments should comply fully with the EU Habitats Directive and should not – either at individual development scale or in combination with other prevailing factors – cause long-term or irreparable damage to existing sites or species of national or international environmental importance. Where possible, they should enhance existing natural habitats and improve ecosystem connectivity.

4. Does current practice take into account the 12 principles of the Ecosystem Approach?

Taken together, the Convention on Biological Diversity's 12 principles of the Ecosystem Approach promote integrated management of the marine environment. It is an approach which, if implemented well, considers fully the cumulative impacts of different pressures affecting the underlying structure, function and key processes of the marine environment.

The Scottish Wildlife Trust believes the Ecosystem Approach should be applied to all strategic decisions relating to the development and deployment of marine renewables. The OSPAR Commission (Oslo Paris Convention) now use the Ecosystem Approach as an overarching concept for the basis of their work and recently committed to 'continue to further develop tools that support the Ecosystem Approach, such as integrated assessments, socio-economic analysis and area-based management tools, including marine spatial planning'.⁴⁶

How does current decision-making perform against the four key criteria?

The decision-making framework for the development of marine renewables must meet the criteria for environmental sustainability set out above if it is to contribute to sustainable marine development. If the decision-making framework at all levels meets the criteria then specific proposed development can do so too.

This section therefore applies the criteria to each aspect of this decision-making framework:

criterion met not fully met or uncertain not met

Legislative and policy directions

By the beginning of 2010, a raft of legislative, policy and strategic initiatives relevant to marine renewable energy had been produced. These ranged from the publication of an EU Directive on Renewable Energy, the Climate Change (Scotland) Act 2009 and the Marine (Scotland) Act 2010 to the Marine Renewables Road Map.⁴⁷

The Climate Change (Scotland) Act 2009, which was widely supported by government, industry and environmental bodies, sets strong emissions targets with associated duties and reporting procedures. It also includes a duty on public bodies to act sustainably and on Ministers to take advice on 'environmental considerations and, in particular, the likely impact of the targets on biodiversity'.

The Marine (Scotland) Act 2010 is of particular importance for the future planning of the sector. It establishes a statutory marine planning system with a national plan and regional plans that must deliver marine ecosystem objectives as well as a new network of Marine Protected Areas (MPAs). The Marine (Scotland) Act includes a general duty in relation to furthering the achievement of sustainable development, protection and, where appropriate, enhancement of the marine area, and climate change mitigation and adaptation.

Current marine renewables strategies show that government and industry are working towards their priority target of establishing an economically competitive industry quickly in order to achieve greater security of energy supply and to meet emissions targets (see, for example, Renewable Energy Framework (2008), Renewables Action Plan (2009), Marine Renewables Road Map (2009) and the National Renewables Infrastructure Plan (2010)).

Strategic environmental issues such as the environmental sustainability of the industry and carbon life-cycle impacts are not considered in these documents. The Strategic Environmental Assessments (SEA) associated with some of these documents touch on certain environmental issues. The SEA for the Renewables Action Plan concludes that environmental impacts will not be 'significant overall'. Where specific potential negative environmental impacts are identified there is an explicit assumption either that they would occur whether or not renewable energy is developed, or that mitigation would be adequate to address them.⁴⁸

Key issues for environmental sustainability – legaislative and policy directions

- Whilst the Marine (Scotland) Act offers real opportunities for sustainable development, national marine
 renewables strategies and associated SEA do not explore the full range of environmental sustainability
 issues involved in tackling climate change through alternative energy. The environment is not central to
 strategic decision-making on energy production.
- Although some informal sectoral planning has taken place, much of the strategic thinking, zone selection and lease agreements for marine renewables will have taken place before implementation of the Marine (Scotland) Act and roll-out of a formal marine planning system.

Relevant criteria

1 – Is environmental sustainability at the heart of the decision-making process?

X 4 – Does current practice take into account the 12 principles of the Ecosystem Approach?

Strategic planning: roles and responsibilities

The Scottish Government has a Scottish Energy Advisory Board, chaired by the First Minister, which oversees the work of the Renewable Energy Division and in turn oversees a range of matters, from grid issues and consents to public sector input.⁴⁹ A linked government group, the Forum for Renewable Energy Development in Scotland (FREDS), is chaired by the Minister for Energy, Enterprise and Tourism, and covers primarily industry and economic interests.

Marine Scotland was created as the marine arm of the Scottish Government in 2009. It is the planning authority for the new marine planning system and portal for the new streamlined system for renewables consents established by the Marine (Scotland) Act 2010.⁵⁰

The act places a sustainable development duty on public bodies and provides for the establishment of a statutory national marine plan and regional marine plans covering the Scottish inshore, which must deliver a set of national and regional-scale marine ecosystem objectives. Marine Scotland is responsible for ensuring Strategic Environmental Assessments are produced for national strategies, plans and programmes and is expected to take on the role of main Competent Authority under the Habitats Regulations. In response to the policy drives and initiatives originating from the Energy Advisory Board and FREDS in partnership with industry, Marine Scotland has attempted to develop the structures and processes necessary for energy development to take place within an environmentally responsible, sustainable development framework. Effective communication and collaboration between Marine Scotland and the energy sections of government, and government support for the status and resourcing of Marine Scotland, will be essential for this sustainable development framework to succeed.

The major marine renewables planning group established by Marine Scotland was the Marine Energy Spatial Planning Group (MESPG), a one-year time-limited group composed of statutory and industry bodies. It was tasked with four strategic strands of work:

- 1. Develop marine planning/locational guidance
- 2. Simplifying consents procedures
- 3. Establish an environmental monitoring and research strategy
- 4. Link to/facilitate regional initiatives

The MESPG had responsibility for taking forward the interim Marine Spatial Plan and Regional Locational Guidance for wave and tidal development of the Pentland Firth and Orkney Waters. It was also tasked with overseeing the SEA for STW wind. It is to be superseded by a new high level group, perhaps replacing FREDS, brought together by the Energy Advisory Board. It is currently unclear whether and how this new body will address environmental/ sustainable development and planning issues, particularly as FREDS has no representation from either statutory or non-statutory environmental bodies.

The creation of a discrete stakeholder advisory group – the Marine Strategic Studies Forum (MSSF), subordinate to MESPG – was unsuccessful, in part due to lack of government support. It is expected that two existing groups – the Marine Strategy Forum (MSF), chaired by the Cabinet Secretary for Rural Affairs and the Environment, and the Scottish Coastal Forum (SCF) – will be used to marshal stakeholder input on marine renewables, but there is some concern about the capacity of these groups to do this.

At regional level, the Pentland Firth Marine Energy Group (PFMEG), led by Marine Scotland and The Crown Estate, provides input to the interim marine spatial plan. Marine Scotland advocates that any developing regional renewables planning groups should adhere to the membership requirements for marine planning partnerships in the Marine (Scotland) Act in order to secure the right balance of stakeholders and officials.⁵¹

The Scottish Environment Protection Agency (SEPA) is responsible for delivery of obligations under the EU Water Framework Directive and Water Environment and Water Services (Scotland) Act 2003, including ensuring that transitional and coastal waters to 3 nautical miles (NM) meet 'good ecological status'.

Scottish Natural Heritage (SNH) advises Marine Scotland on marine natural heritage issues as they relate to marine renewables. SNH advice to developers currently focuses on European protected habitats and species, and has not yet broadened to address the provisions of the MSFD and Marine (Scotland) Act, particularly in relation to meeting Good Environmental Status/ecosystem objectives and safeguarding priority marine features.⁵² There has been no systematic approach to strategic planning for marine renewables. The pace, scale and location of future marine renewables development has been determined primarily by The Crown Estate (TCE) as landowner, which in turn has taken its lead from government climate change policy and targets. As a result, at the start of 2010, leasing rounds took place in the absence of a national marine plan.

TCE owns, on behalf of the Crown, almost all of Scotland's seabed out to 12NM and has renewable energy rights to 200NM. It has a duty to generate revenue for the Treasury but is a *de facto* public body, with what is essentially a stewardship duty to have 'due regard to the requirements of good management'.⁵³ Its key role in respect of marine renewables is as lessor, and it is required to undertake leasing rounds to comply with EU competition rules. It offers leases conditional on whether the development is granted the relevant statutory consents.

More recently, TCE has become increasingly proactive in encouraging developers to help meet government targets. Its leasing rounds for Round 3 – the Pentland Firth and Scottish Territorial Waters (STW) – have played a major role in galvanising and co-ordinating commercial energies. It is co-developer for Round 3 wind sites, co-financing developments up to the point of consent. It is not permitted to operate developments. Its efforts to secure collaboration between developers to address environmental issues has demonstrated the advantages of a single landowner/lessor arrangement, in contrast to the lack of coherence which has sometimes been evident in the planning of terrestrial renewables development.

In 2009, TCE confirmed that it is a Competent Authority under the Habitats Regulations. It undertook Appropriate Assessment for both Round 3 sites and for the Pentland Firth and Orkney Waters. The Crown Estate is a public authority under the Marine (Scotland) Act, which will place a range of qualified obligations on it, including general duties for the protection, enhancement and sustainable development of the marine area, reaching decisions in accordance with marine plans, and duties in relation to helping meet the conservation objectives for MPAs.

Key issues for environmental sustainability – strategic planning

- The creation of Marine Scotland provides a useful single government body for the planning of marine activities, with SNH and SEPA retaining their independent advisory roles. However, there is concern that the energy development agenda is leading, and that environmental sustainability issues are not given the necessary emphasis in strategic decision-making. In particular, zone selections and lease agreements have taken place in the absence of a national marine plan or national marine ecosystem objectives.
- To redress this, emerging high-level government groups with a marine energy focus will need a balance of representation from Marine Scotland, SNH and SEPA, as well as non-statutory environmental stakeholders.
- In addition, Marine Scotland must be given adequate resources and status to provide the necessary strategic planning and sustainable development input to energy decision-making within government. It also needs to develop stronger internal processes to link, for example, its data and science capacity with the development of planning tools.
- SNH advice to developers focuses on European protected habitats and species. In order to meet SNH
 obligations under the MSFD and Marine (Scotland) Act, this advice must be broadened to include
 priority marine features and marine ecosystem objectives. SNH will require adequate resources and
 good strategic direction to achieve this.
- The Crown Estate and other public bodies will have to be made aware of and adhere to the broader sustainable development and environmental requirements of the Marine (Scotland) Act as they engage in marine planning.
- Wider stakeholder involvement in decision-making is very limited. The MSSF stakeholder advisory group has failed, in part due to a lack of coherent government support. Developing structures for stakeholder involvement – for example, use of the existing MSF and SCF – must ensure that roles and relationships are formalised and wellresourced to give stakeholders a meaningful role in strategic decision-making.

Relevant criteria

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- 1 Is environmental sustainability at the heart of the decision-making process?
 - 4 Does current practice take into account the 12 principles of the Ecosystem Approach?

Strategic Environmental Assessment

Strategic Environmental Assessment (SEA) is designed to identify the significant environmental issues resulting from strategies, plans and programmes, and is a legal requirement for most significant national development proposals.⁵⁴ There is an inherent challenge in assessing the environmental impacts of marine renewables plans and programmes at such an early stage of the sector's development. This is especially so in advance of any detail of the type and extent of developments and actual data on their impacts. This fact – and particularly the paucity of environmental data – has limited the usefulness of SEA as a tool for the strategic selection of appropriate areas for development. The SEA for STW wind will be completed *post-hoc*, following considerable developer investment in specific areas of sea. There is no independent scrutiny of the SEA. Periodic review of the SEA in connection with 5-yearly reviews of marine plans, taking account of feedback from project-level developments, will be essential if SEA is to become a more useful tool in future.

SEA – Wave and tidal

The 2007 SEA for wave and tidal energy covers the Scottish marine area to 200NM and addresses a wide range of issues.⁵⁵ Nevertheless, its environmental conclusions are limited by data availability and it does not include estimates of carbon impact.⁵⁶ As a result, it is not as useful as it could be in the initial identification of appropriate and inappropriate areas for marine renewables development. Regional Locational Guidance was developed in 2010 for wave and tidal developments to supplement this.

SEA – Wind

In February 2009, TCE made 10 exclusivity agreements totaling 6.4GW for marine wind in STW. This was in advance of an SEA – initially deemed by Scottish Government as unnecessary due to the deep waters close to shore. However, with growing commercial interest, an SEA was initiated in spring 2009 (for waters 0–12NM). This was completed after the UK Offshore Energy SEA, which covers Scottish waters between 12–200NM and English and Welsh waters from 0–200NM.

The approach here could have been better – conducting a single SEA for Scottish waters in their entirety – but it should be noted that the Scottish SEA has benefited from the UK SEA, which provided useful information. It is promising that the SEA for Scottish waters will categorise spatial areas into three types – areas excluded from development, areas with considerable environmental constraints

Key issues for environmental sustainability – Strategic Environmental Assessment

- The early stage of development of the industry, uncertainty about its scale or the extent of its impacts and incomplete environmental data reduce the usefulness of SEA as a tool to assess whether significant impacts will result from large-scale marine renewables deployment. It is of concern that the 2007 SEA predicts only minor environmental impacts on the environment, relying on project-level EIA and Appropriate Assessment to address actual impacts. SEAs for marine renewables pre-date the implementation of the Marine (Scotland) Act, including marine ecosystem objectives and marine plans. Periodic review of SEA in connection with 5-yearly reviews of marine plans, taking account of feedback from project-level developments, will be essential if SEA is to become a more useful tool in the future.
- SEAs have, to date, been of limited use in zonal selection, although the SEA for STW wind will contain spatial categories. The SEA for STW wind post-dates selection of leasing areas and initial exclusivity agreements, reducing its role in strategic planning.
- Scottish territorial and offshore waters are covered by two separate SEAs and two separate authorities, making a joined-up UK approach to strategic environmental issues more challenging, although Marine Scotland is now the consenting body for both.
- There is no independent scrutiny of SEAs.
- Carbon life-cycle impact assessments do not currently figure in SEAs.

- 1 Is environmental sustainability at the heart of the decision-making process?
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and areas with limited environmental constraints – paving the way for SEA to be more useful in zonal selection in the future. Exclusive lease agreements will not be issued until the SEA is complete.⁵⁷

While industry would have welcomed an earlier SEA, the quality of the SEA has been enhanced by the environmental data gathered and the initial exploration of cumulative issues in relation to proposed wind developments.

The Crown Estate has since awarded Round 3 Zonal Development Agreements in the Scottish offshore on the basis of the UK SEA.

Regional planning

The Marine (Scotland) Act provides for regional marine plans to balance the full range of competing interests in key parts of the Scottish inshore. The first regional plan for marine renewables in the Pentland

Aquamarine Power – the Oyster

The 'Oyster', being tested at Billia-Croo near Stromness for Aquamarine Power, is the world's largest working hydro-electric wave energy converter. It converts nearshore wave energy into electricity using a mechanical hinged flap connected to the seabed at around 10m depth. Each passing wave moves the flap, driving hydraulic pistons to deliver high pressure water via a pipeline to an onshore electrical turbine. Multiple devices are designed to be deployed in wave farms typically of 100MW or more. The 'Oyster' uses water as its hydraulic fluid for minimum environmental impact. Its sponsors claim that it has a minimal environmental footprint and is effectively silent in operation.

interest. Case-study – interim Marine Spatial Plan for the Pentland Firth and Orkney Waters with Regional Locational Guidance (RLG)

Firth and Orkney Waters is termed an 'interim'

marine plan because it predates the formal marine

planning system and is centred on only one sectoral

Stage 1 of the interim Marine Spatial Plan framework (MSP) and draft Regional Locational Guidance (RLG) were consulted on in March 2010 by the MESPG. The approach taken to planning and environmental issues is very promising. Among the issues identified for consideration are the need to adopt an Ecosystem Approach to management, the 'need for increased protection of nationally important habitats and species not covered under European legislation', the requirements of the Marine (Scotland) Act – including the new network of MPAs – locally important habitats and species, and environmental



SeaGen – Strangford Lough

'SeaGen' is the name given to the 1.2MW tidal energy convertor that was installed by Marine Current Turbines Ltd in Strangford Lough, a European Special Area of Conservation and Special Protection Area, in April 2008. Pre-installation environmental monitoring began at the site in May 2004 and a baseline environmental report covering benthic habitats, marine mammals and seabirds was completed in August 2006. The environmental impact of 'SeaGen' is being monitored continuously by an independent science team throughout the licensed 5-year installation period.



data gaps. Importantly, there is acknowledgement in the MSP of the need to maintain ecosystem resilience against the impacts of climate change. The MSP process has involved significant bathymetric and environmental data collection, including seabirds, (regional scale) benthic habitats, bathymetry and proposed cetacean research. Both the Stage 1 MSP and the draft RLG make reference to broad-scale and cumulative impacts. The draft RLG identifies areas of opportunity, but also considers the impacts of multiple developments and encourages coordination between developers. It also refers to device design in interactions with other sectors, including the environment.

After Stage 1 consultation, the interim MSP and RLG will progress to Stage 2, building the information base, filling gaps and developing governance

structures. It is expected that this process will build the foundations for a statutory MSP and underpin RLG Stage 3, which could be completed in late 2011.⁵⁸ Given these timings, the RLG will only be able to inform the latter stages of development rather than the early stages of planning.

Despite the fact that any planning process for the Pentland Firth will come after the identification of leasing areas and the agreement of leases, there is some confidence that environmental issues are being considered, albeit *post-hoc*. The interim MSP and accompanying RLG are an attempt to supplement the absence of a planning framework and to provide a pilot model-based approach to inform formal marine planning. However, stakeholder involvement in the MSP and RLG process has been limited to consultation and workshops.

Key issues for environmental sustainability – regional planning

- Marine Scotland has made a promising start, albeit later than desirable, to planning the sector in one area, but this role will need to be fully supported and resourced elsewhere to ensure effective planning in the lead up to the formal marine planning system.
- The RLG and MSP for the Pentland Firth and Orkney will be completed too late to inform zonal selection and lease agreements.
- Stakeholder involvement in the MSP and RLG process has been more limited than would be expected in formal planning.
- Environmental data collection over summer 2009 by Marine Scotland provides a valuable overview, but the MSP acknowledges that environmental data collection by the Marine Scotland survey ship *Scotia* can provide only a snapshot of what is there. Data are inadequate for certain key elements, including cetaceans.
- Cumulative and in-combination impacts and thresholds for development cannot be taken into account in the interim plan because of the uncertainty of impacts from the wide range of wave and tidal technologies, particularly in array or at large-scale.

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Formal marine planning is expected to take place through Marine Planning Partnerships, which will provide more direct engagement to stakeholders in the plan-making process.

Marine renewables development in other sea areas, for example Argyll and Shetland, will also pre-date a formal planning system. Marine Scotland envisages that these areas will not be subject to a wellresourced interim plan, like the Pentland Firth and Orkney, but that planning will be limited to selected strategic data collection.⁵⁹ Planning for marine renewables will require adequate resourcing to be effective.

Device design and testing

Wind turbine design is fairly standard above the surface, having the benefit of onshore wind technology. Typical turbines each have the capacity to generate 3–5MW, but technology is moving to larger turbines. Currently, the height to the turbine hub is around 70m, with 50m-long blades. Turbines 5MW and over are likely to be spaced at around 1km. To date, UK wind turbines have been installed using mono-piles (a single foundation on the seabed). They may also be multi-piled, or have large concrete 'gravity' bases. The cabling is usually laid using ploughs and anchors to pull cables along the seabed. The lifespan of a wind farm is expected to be up to 50 years. Current policy is for turbine bases to be removed or cut back to the level of the sea floor on decommissioning. The experience of the oil and gas industry in anchoring devices may prove useful. Developers are likely to decide on turbine design once they understand their site, although this is likely to be subject to regulatory input through the consenting process. Further data collection is planned.

Wave and tidal devices vary greatly in design, with over 20 different devices being tested in the UK alone.⁶⁰ They may be installed in the foreshore, shallow estuaries, open bays and offshore areas, and be anchored to the seabed using gravity bases, anchors or piles. While several single devices will have been tested at EMEC or elsewhere, the broadscale environmental impacts of a range of different devices or arrays of devices are more difficult to predict and monitor.

Equimar, a multi-partner EU project covering 11 countries,⁶¹ is using modelling to compare devices in terms of ecological footprint. Although companies may claim that they are minimising ecological or carbon costs, actual impacts will remain unknowable until full device/array deployment. It is likely that if a device is shown to have very significant negative environmental impacts commercial viability will suffer and it may not receive consent.⁶² Once the impacts of the various device designs are better

Key issues for environmental sustainability – device design and testing

- Ecological and carbon impacts are not always major influences on the market success of a device, although serious ecological impacts would be likely to affect commercial viability. Device environmental assessment should be formally considered alongside the engineering performance assessment.
- There is no means of fitting the most appropriate technology to the most environmentally-appropriate site or of ensuring that devices are sited to maximise energy generation. This is difficult to achieve given the early stage of the industry, but effective marine planning could ensure that this happens.

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known, there will be opportunity for the consenting process to take this into account.

Initial results suggest that benthic impacts are within natural variability and that there are not expected to be significant seabird impacts. The device shuts down when a marine mammal enters a prescribed 50m zone. Evidence is being used to refine and adapt monitoring, with the possibility of moving to an automated sonar system for shutting down the device when necessary. However, it is unclear whether shut-down can be an economically feasible way of addressing environmental risks in the context of commercial roll-out.

'Deploy and monitor' – a precautionary approach

'Deploy and monitor' is an approach currently under development by the Scottish Government, and it is being discussed in broad terms for wave and tidal devices. It may prove to have relevance for wind. Policy guidelines or minimum standards for implementation have not yet been agreed. Nevertheless, it is already being widely advocated by industry. 'Deploy and monitor' attempts to overcome the perceived circular problem encountered by industry that devices cannot be consented due to lack of information on environmental impacts, and that information on environmental impacts cannot be collected in the absence of operational devices. It is understood that the intention is to take a phased approach to full deployment, beginning with the installation of a single device following EIA and monitoring each stage to show environmental impacts are acceptable prior to expanding the development. There is uncertainty over whether a 'deploy and monitor' approach, by its nature riskbased, can meet the absolute tests of the Habitats Directive. Government is currently exploring this.

Key issues for environmental sustainability – deploy and monitor

- The terms and conditions for 'deploy and monitor' must be agreed by key stakeholders prior to roll-out to ensure the approach adequately safeguards the environment.
- There is uncertainty over whether a 'deploy and monitor' approach, by its nature risk-based, can meet the requirements of the Habitats Directive.
- Pressure for large-scale development may mean that a risk-based approach exposes important marine features to serious levels of risk. This is of concern where developers have to limit their monitoring effort according to their resources.
- Adaptive management and feedback into SEA have yet to be fully considered. Monitoring strategies need to be geared to adaptive management as new tools emerge and knowledge increases.
- Small-scale deployment and monitoring does not necessarily provide the information needed to regulate large-scale commercial developments.
- It is important that this approach does not act as a precedent for development and that scale-back can be used to address any problems encountered once the devices are in place.

- 2 Do the benefits of carbon emissions reduction outweigh any damage to ecosystem health?
- 3 Are important habitats and species protected from irreparable damage?
 - 4 Does current practice take into account the 12 principles of the Ecosystem Approach?

While it is difficult to take a position on 'deploy and monitor' without further information, the Scottish Wildlife Trust believes that a precautionary, phased approach to development - underpinned by excellent data, monitoring and adaptive management, and based on spatial planning – is likely to help ensure that the industry develops sustainably. This phased approach should involve starting with small-scale development that avoids all but low risk areas, moving to a situation where development, having been shown to be environmentally benign, could therefore be extended. Mitigation measures should be tested as part of this approach, and monitoring results would feed into adaptive management and SEA. There should be a presumption in favour of the avoidance of sensitive sites and species to prevent risk of damage. It is essential that 'deploy and monitor' does not compromise Habitats Directive obligations.

Taking account of impacts on important habitats, species and ecosystems

Levels of protection

A limited number of marine habitats and species are protected under the Habitats Directive.⁶³ There are currently 34 marine Special Areas of Conservation (SACs) in Scottish waters.⁶⁴ Since August 2007, the UK has had the legal mechanism to designate Special Areas of Conservation (SACs) in the UK offshore area under the Offshore Marine Conservation (Natural Habitats &c.) Regulations 2007. Work led by the Joint Nature Conservation Committee (JNCC) should deliver sites in offshore waters to complete the UK SAC network by 2012.

Certain species (European Protected Species), including all cetaceans, are listed on Annex IV of the Habitats Directive. Under the Habitats Regulations (through which the Habitats Directive is implemented in the UK), it is an offence to recklessly disturb or to deliberately or recklessly kill or injure any dolphin, porpoise or whale. Licences may be obtained from Marine Scotland authorising activities with potential to cause such disturbance or harm (such as tidal turbine operation), but these are granted under strict conditions.⁶⁵ The Bonn Convention – and specifically the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS) – obliges signatories, including the UK, to apply a range of research and management measures aimed at the conservation of all cetaceans.

A few species, for example cetaceans and basking sharks, are protected under the Wildlife and Countryside Act 1981 from 'reckless disturbance or damage' to 12NM. Not being a European Protected Species, there is no requirement for an EPS licence to authorise activities that could disturb or harm basking sharks. However, strict conditions apply relating to the nature of the activity and the action taken to minimise or avoid impact.⁶⁶

Seabirds are protected while at their nests, and Special Protection Areas (SPAs) can be designated to protect a few species (listed as rare or vulnerable on Annex I of the Birds Directive, or that are regularly occurring migratory species). Forty-nine existing terrestrial SPAs have at least one seabird as a qualifying interest. In 2009, it was announced that 31 Scottish SPAs were to be extended in marine areas adjacent to the breeding site to include essential resting and feeding areas. SPA coverage is currently incomplete: seaward extensions are being considered for red throated diver, terns and shags. Work on offshore aggregations of non-breeding seabirds has been in progress by JNCC for several years.

Nationally and locally important marine habitats and species – including those appearing on Scotland's biodiversity lists – do not enjoy specific statutory protection, although the Nature Conservation (Scotland) Act 2004 places a duty on every public body and office-holder 'to further the conservation of biodiversity' so far as is consistent with the proper exercise of their duties.⁶⁷ Ecosystem processes do not currently have any statutory recognition or protection.⁶⁸

There is promise of improvements in the extent of marine protection. The Marine (Scotland) Act 2010 places a duty on Scottish Ministers and public authorities to 'further the achievement of sustainable development and to protect and, where appropriate, enhance, the Scottish marine area'. The Act also provides for the creation of a new network of nature conservation marine protected areas (MPAs), where features of national and local community importance can be protected, including rare, threatened or representative features. It is expected that a network of these sites will be designated by 2012.

The principles of ecological coherence, connectivity and representiveness will enable ecosystems to be considered in MPAs, and marine plans will have to deliver on marine ecosystem objectives. Priority marine features will also be considered as part of wider seas planning outwith MPAs, although it is as yet unclear what this will mean in practice.

Risk of damage – a snapshot

Scientific understanding on the predicted sensitivities and impacts of marine renewables on marine habitats and species is increasing at every stage – from survey, construction and operation to decommissioning – and much of it is being translated into current practice.⁶⁹ Different technologies have different potential impacts. Understanding of wind energy impacts is most advanced as a result of more advanced developments elsewhere in Europe.⁷⁰ It remains the case, however, that the actual impacts of large scale development of all technologies in a Scottish setting will be uncertain until such developments are in operation and the results of monitoring are available.

Detailed studies of potential impacts of wave and tidal devices based on best available evidence have been undertaken as part of Appropriate Assessment.⁷¹ The main sources of potential damage from wave and tidal devices are believed to be disturbance or displacement of key species during construction and habitat loss beneath the device footprints. During operation, the main risks are from injury through collision with moving components, disturbance due to operational noise, barrier effects, changes to benthic habitats and loss of foraging areas. The main risks of impact from wind developments during the construction phase are similar to wave and tidal, with a particular concern over the noise impacts of pile driving. Barrier effects, potential changes to benthic habitats and foraging areas (both positive and negative) are also considered important.

For benthic habitats, the main risks of damage are predicted to be from:

- Smothering with waste materials during construction (particularly reefs)
- Changes of hydrodynamic regime (from wave and tidal devices or tidal barrage-type devices) causing physical seabed changes
- Loss of intertidal area (from tidal barrage-type devices)
- Localised seabed damage from installations contacting the seabed

For seabirds, the main risks of damage are predicted to be from:

- Collision of nocturnal and diving birds with devices or associated installations (mainly wave and tidal devices)
- Direct loss of foraging, breeding and wintering habitat (for all technologies, but particularly tidal barrage-type devices)
- Disturbance and displacement
- Increased predation by rats and mink where devices give easier access to breeding sites⁷²

For marine mammals, the main risks are predicted to be from:

- Noise or vibrational disturbance and displacement, particularly from vessels, side scan sonar surveying, dredging, pile-driving and drilling
- Collision with structures (mainly wave and tidal devices)
- The creation of barriers obstructing movement to feeding grounds and other important life-cycle areas⁷³

For fish, the main risks are believed to be from:

- Noise and vibration sensitivity to the frequency of sound varies across fish species
- Collision with operational structures (mainly wave and tidal devices)
- The creation of barriers to migration
- Elasmobranchs (sharks, skates and rays) are at risk from electromagnetic disturbance along cable alignments

The risk of damage to ecosystem integrity and function from marine renewables has not been considered in any depth. The issue has been raised that greater understanding is needed of a whole range of ecosystem components, including water column ecology and processes and the role of benthos and fish within wider ecosystems.⁷⁴

The growing body of scientific literature allows some quantification of potential impacts. Nedwell et al. (2004) developed a decibel (dB) scale to estimate the effects of sound on marine species.75 Studies show that certain levels of noise can damage hearing and even kill fish⁷⁶ and that pile-driving can cause temporary or permanent hearing loss at close proximities.77 Porpoises can hear shipping from a distance of 1–3km depending on the frequency of noise.⁷⁸ Monitoring of noise levels from pile-driving at Round 1 wind sites has shown that noise levels can be high, although these will vary according to the seabed type and installation methods.⁷⁹ Marine mammals are known to show avoidance responses to pile-driving, with masking of vocalisation and change in swimming direction occurring as far as 20km or more from a wind farm development.⁸⁰ Studies during the construction of two offshore wind farms in Danish waters revealed a decrease in harbour porpoise abundance during the construction phase at both sites.⁸¹ Operational noise is believed to be less of a threat, although there are concerns about the noise of larger turbines (5–6MW) and tidal turbines.⁸² Fish are known to aggregate around wind farm piles giving rise to concerns about collision.⁸³ However, there may also be benefits to fish from the presence of artificial reef structures.⁸⁴

The significance and gravity of these risks is greater where a nationally or internationally important

habitat or species is involved, where environmental damage is likely to be long-term or irreversible, and where apparently small impacts – cumulatively or in-combination with other factors – pose a threat at an ecosystem scale.

These risks, combined with the great uncertainty surrounding the actual nature and extent of impacts from marine renewables devices and the location of at-risk marine features, suggests that a high level of precaution and a phased approach is needed in planning and deployment. Proposed mitigation ranges from adjusting the timing and amplitude of construction noise and turning off wave and tidal devices when a marine mammal approaches, to taking care to minimise damage to benthos. While mitigation is desirable where it is shown to be effective, it is the Scottish Wildlife Trust's view that there is currently an over-reliance on mitigation much of it untested – to address environmental risk. As a result, development is being proposed within or near internationally important sites supporting protected species. A precautionary approach suggests that sensitive sites and species should be avoided until impacts are better known, and that mitigation should be a last rather than a first resort. Development should be scaled-up gradually to allow for adequate assessment of cumulative and incombination impacts.

Assessing environmental impacts

All devices require consent from Marine Scotland. Those above 1MW need a Section 36 consent which requires completion of an Environmental Impact Assessment (EIA).⁸⁵ Schemes below the 1MW threshold must be supported by documentation considering environmental effects.⁸⁶ Marine Scotland guidance on EIA and Appropriate Assessment (AA) for marine renewables, and SNH guidance on survey and monitoring protocols to inform EIA and AA and to establish post-construction impacts, were produced in 2010. The Collaborative Offshore Wind Research into the Environment (COWRIE) data collection and research process (see Offshore wind, page 28) has provided an excellent basis for undertaking environmental assessment and monitoring.

Where a European protected site or Ramsar site is likely to be significantly affected by a project or plan, the responsible authority has to prepare an AA before it can consent to the project or approve the plan. A project or plan cannot be permitted if it will adversely affect the integrity of that site/ species, except in very limited circumstances. In practice, this offers a high level of protection to these important sites. However, AAs do not have to consider species on the list of European Protected Species under Annex IV of the Habitats Directive: for example, the majority of cetaceans passing through EU waters.

Plan-level AAs have been completed for the Pentland Firth and Round 3 wind sites. There are inherent difficulties in preparing plan-level AAs before the actual impacts of devices are clear. Data and knowledge of impacts on habitats, species and ecosystems are acknowledged to be a serious issue even in the Pentland Firth, where data collection has been targeted.⁸⁷ Both the Pentland Firth and Round 3 AAs conclude that there will be no adverse effect on the integrity of European/ Ramsar sites and associated species, despite the lack of knowledge on the extent or nature of developments, and, in the case of the Pentland Firth, on the technology proposed. The AAs are able to support this conclusion on the basis that the relevant authorities believe that identified mitigation measures, future conditions to lease agreements, regulatory consents and future project-level AAs will ensure that no adverse effect will result. Even where adverse impacts are identified under the Habitats Regulations, development can still be authorised where there is no alternative and there are imperative reasons of overriding public interest, although mitigation and compensatory measures have to be taken.88

Marine Scotland, the authority for all marine-related issues, commercial and environmental, is also the regulator. SNH provides both advice on environmental impacts and is a statutory consultee during the consent process. SNH undertakes site condition monitoring of European sites, although it has recently discontinued site condition monitoring for seabird SPAs due to lack of resources. Current SNH guidelines recommend a minimum of two years of baseline environmental monitoring data in preparation for formal EIA, and post-construction monitoring.⁸⁹ SNH's power to object to a project on environmental grounds is a vital tool in preventing environmentally damaging development. While SNH has provided advice to developers on wider biodiversity issues, current SNH advice on marine renewables focuses on European protected features, and has not yet been broadened to embrace the requirements of the MSFD and Marine (Scotland) Act.⁹⁰

There are concerns that, in practice, it will be difficult for SNH to object to projects, particularly where damage will result to wider biodiversity features that do not enjoy European protection. SNH's founding legislation places a duty on it to promote the sustainable use of the natural heritage.⁹¹ Where national or local biodiversity is concerned, SNH undertakes a TAWPI ('Taking Account of Wider Public Interest') assessment prior to considering an objection to development relating to a non-statutory site or species, in order to fulfil its sustainable development obligations. SNH has expressed concern that even ensuring compliance with European legislation may make SNH appear unsupportive of the industry.⁹²

Although European Natura sites enjoy the highest level of legislative protection, precedents are being set for the establishment of marine renewable developments within them, notably with test devices in Strangford Lough SAC/SPA in Northern Ireland.

The roll-out of marine planning may allow for the identification of national priority marine features and more effective screening-out of areas unsuitable for development, as well as management to ensure marine ecosystem objectives are met. The new network of MPAs will protect certain priority marine features, while it is hoped that others will be taken into account through wider seas measures. Marine Scotland and SNH will need to be fully resourced and supported to enable them to deliver these commitments.

Environmental data collection and management

There is general consensus that baseline information on important marine biodiversity and knowledge about its interactions with marine renewables devices needs to be more comprehensive, of better quality and more accessible to ensure that environmental impacts can be assessed and addressed properly. In particular, the distribution of national priority features and features of importance for ecosystem integrity and function are very poorly understood, as are impacts on these features.

TCE uses the Marine Resource System (MaRS), a marine spatial planning tool which employs complex sustainability indexing to identify potential areas for sectoral development. It is updated as new information becomes available, although intellectual property rights mean limits on access to data. MaRS cannot, for example, include environmental information provided for the regulator, such as EIA data. MaRS contains information on designated sites and several data layers on wider marine biodiversity, although this is given less weight during the initial zonal screening process.93 The wider value to decision-making of what is a potentially excellent SMART tool is reduced by the fact that there is no agreed consensus or transparency on how the various types of data are weighted, and the tool is not easily accessible for use by other bodies.

Marine Scotland is aware of the limitations of MaRS and hopes to develop a central framework database of unweighted environmental data, incorporating commercial information where it is available. There remains the issue that project-level data relating to licences is often confidential. Marine Scotland anticipates that an ongoing SNH project to standardise monitoring protocols will provide an opportunity for Scottish Government to set ground rules in relation to data access.⁹⁴

Offshore wind

COWRIE (Collaborative Offshore Wind Research into the Environment) is a Crown Estate trust fund set up in 2001 that acts as a hub for research into the environmental impacts of offshore wind energy, including funding, data management and dissemination. Its main environmental project areas cover birds, marine mammals, acoustic impacts, fish, shellfish and benthos. It is a very useful resource and facilitates strategic planning, collaboration between developers and data sharing, with some relevance for wave and tidal development. However, COWRIE is expected to end in its current form, and it is uncertain whether it will be replaced. The Crown Estate has also provided resources for survey, including funding aerial surveys of all Round 3 offshore wind zones, as well as the east coast STW regions and has identified around £700,000 for further work on birds, mammals and fish.

Wave and tidal

There is no equivalent to COWRIE in the wave and tidal sector, although some COWRIE research results are relevant. In 2008, Fisheries Research Services (FRS) produced a strategic research assessment for wave and tidal.⁹⁵ Various data gaps have been identified, both by MESPG itself and by others.⁹⁶ MESPG embarked on a gap analysis of wave and tidal research in early 2010.^{97, 98} MESPG has responsibility for co-ordinating strategic environmental research with 37 research projects underway, of which five are generic, 17 relate to seabirds, 11 to marine mammals, 2 to habitats and 2 to fish.⁹⁹

Marine Scotland has asked SNH to develop a project plan proposing environmental data collection and research for the next few years to provide a more coherent picture of environmental issues in the marine environment. SNH is closely involved with identifying and undertaking research to inform marine renewable development. Fifteen discrete pieces of work are underway, but these are largely focused on wave and tidal interactions with European protected marine mammals and fish species, and seabirds.¹⁰⁰

Cumulative impacts and adaptive management

It is difficult to gain an overview of possible or actual cumulative or in-combination impacts of multiple devices or device impacts in combination with other developments. This is partly because so few devices have been deployed and impacts are uncertain. The government target of 46.5GW output

Key issues for environmental sustainability – habitats, species and ecosystems

Risk of damage

- The combination of risk and uncertainty in relation to impacts on important marine features suggests that a high level of precaution and a phased approach is needed in planning and deployment.
- There is currently an over-reliance on mitigation to address environmental risk. As a result, development is being proposed within or near internationally important sites supporting protected species. A precautionary approach suggests that sensitive sites and species should be avoided until impacts are better known, that development should be scaled-up gradually and that mitigation should be a last rather than a first resort.

Assessing environmental impacts

- Knowledge of the location of many features of national importance, or of importance for ecosystem integrity and function, is still very limited, as is knowledge of the impacts upon them. This is likely to remain the case unless resources are allocated to survey, monitor and protect these features.
- Currently, SNH advice on marine renewables focuses on European protected features, and has not yet been broadened to embrace the requirements of the MSFD and Marine (Scotland) Act. There is concern that it will be difficult in practice to safeguard important marine features that are not protected by European legislation.
- In the absence of a marine planning framework and a strategic overview of appropriate areas for development based on sound environmental data, a development-led rather than strategy-led approach is being taken. Project-level EIA, and in some cases AA, often serve as the only way of identifying important marine features. Feedback from project level to strategic level is not yet taking place. This reactive approach does not provide clarity for developers or security of investment.

Environmental data collection and management

- Although COWRIE and MESPG have played an important role, there is no single co-ordinated data collection and management system for marine renewable energy and no consistency in how data are collected, stored, accessed and maintained.
- The costs of collecting baseline data are a particular issue with smaller-scale wave and tidal devices, where testing the technology forms a high proportion of developer costs. Lack of resources could compromise the quality of data collection by developers.
- Knowledge exchange and accessibility are a major issue. Even where data are available, there is often a charge: for example, from organisations like the Sea Mammal Research Unit or Seazone. While TCE holds developers' data and has the GIS decision support tool MaRS (Marine Resource System), there is no single accessible source of developer information, in part due to commercial confidentiality. There seems to be little collaboration between developers on data collection for wave and tidal devices, although TCE intends to improve this situation. Knowledge exchange is poor across government and between developers and researchers.
- Research, baseline data collection and monitoring are not yet accompanied by effective and accurate communication of results.



from marine renewables based on the potential of the energy resource equates to over 23,000 2MW devices, or 9300 5MW devices, over the coming years.¹⁰¹ Currently, lease agreements are for a total generational capacity of 12.2GW – equating to 6100 2MW devices or 2440 5MW devices – in any case, a significant level of development.¹⁰²

No upper threshold for development based on environmental limits has been set. SEA and Planlevel AAs are too indicative to provide a realistic assessment of cumulative impact, so this issue is left to project level. EIA legislation requires consideration of cumulative impacts,¹⁰³ and project-level AAs are required to demonstrate that there will not be an adverse effect on European site integrity, either alone or in-combination with other plans or projects. This is very difficult to assess or demonstrate in practice at project level.

Partial evidence is the enemy of precaution. Even where a single development is shown to have insignificant impacts, multiples of such developments, with multiple 'insignificant' impacts, can potentially add up to a significant cumulative impact. There is currently no clear mechanism for adaptive management, nor the baseline data necessary to allow reassessment of impacts against a predevelopment state. Without such evidence, the risk of a 'death by a thousand cuts' outcome is a possibility. Decisions to scale-back development may be difficult *post-hoc* because no single development can be held responsible. This is one of the issues of greatest concern for the environmental sustainability of marine renewables development.

This serious shortcoming has clearly been recognised by some players in marine renewables and there is promise for future improvement. The industry is at an early stage and can take steps to address these concerns. It is hoped that the marine planning process and associated SEA review will provide the baseline data and feedback essential for the assessment of cumulative impacts and adaptive management. The Crown Estate has undertaken some valuable work in ensuring development collaboration between developers involved in the exclusivity agreements for wind.¹⁰⁴

Collaboration between wave and tidal developers is more difficult to achieve as they tend to be small

companies competing for a successful technology. Cumulative impacts are also less easy to assess for wave and tidal than for wind, because technologies vary greatly in design and have not been deployed as arrays outside test sites. Despite this, The Crown Estate is proposing to set up a developers' forum for the Pentland Firth and Orkney Waters leasing round, at which collaboration will be progressed. TCE is also working with the Scottish Government to take a regional approach to key receptors: for example joint commissioning of bird surveys at regional scale to inform assessments of 'in-combination' and cumulative impacts.

As lessor for all marine renewables sites, TCE has the ability to include obligations in lease conditions: for example, requiring lessees to demonstrate, as required by the Habitats Directive, that their development will not have an impact on specified marine wildlife, either singly or in combination.¹⁰⁵

Potential for synergy between environmental and renewable energy objectives

Inger *et al.* (2009) suggest that, if appropriately managed and designed, marine renewable

developments could increase local biodiversity and potentially benefit the wider marine environment. Installations have the capacity to act as both artificial reefs and fish aggregation devices, which have been previously used to help restore damaged ecosystems, becoming *de facto* marine protected areas, which have proven successful in enhancing both biodiversity and fisheries.

The Scottish Association for Marine Science is undertaking research on artificial reef creation in relation to renewables devices.¹⁰⁶ Because the industry is at an early stage, these issues have not been fully addressed. Early exploration of these possibilities by decision-makers and appropriate research, device and array siting and design is required to progress this effectively. It will also be important to recognise that such artificial habitats will not be appropriate in all ecosystems, and that the ecological needs of each site will have to be considered.

The Scottish Wildlife Trust strongly supports the development of such synergies where they are ecologically appropriate and sees this as a key research priority.

Key issues for environmental sustainability – synergy between environmental and renewable energy objectives

• Potential synergies with fisheries and biodiversity interests are currently given insufficient weight in planning marine renewables developments. The Scottish Wildlife Trust strongly supports the development of such synergies where they are ecologically appropriate and sees this as a key research priority.

Relevant criteria		
	1 – Is environmental sustainability at the heart of the decision-making process?	
	2 – Do the benefits of carbon emissions reduction outweigh any damage to ecosystem health?	
	3 – Are important habitats and species protected from irreparable damage?	
	4 – Does current practice take into account the 12 principles of the Ecosystem Approach?	

Part 3

Part 4 The future: what marine planning needs to deliver



Part 4 The future: what marine planning needs to deliver

Marine renewables can play a key role in reducing Scotland's carbon emissions, thereby helping to reduce climate change impacts on biodiversity, but there is uncertainty over the level of risk to Scotland's unique and often internationally important marine biodiversity from marine renewables development itself.

The Scottish Wildlife Trust would like to see improvements in the current planning framework for marine renewables development in order to safeguard Scotland's marine ecosystems and meet MSFD and Marine (Scotland) Act requirements.

We have identified 10 areas which we believe should be addressed by government, industry, NGOs and other stakeholders, that would help to ensure the environmental sustainability of marine renewables:

Lack of high-level links between energy and environment sectors

High-level groups focused on energy production are government/industry dominated, and environmental sustainability issues are not fully integrated into decision-making. Better co-ordination and shared objective-setting across the energy/climate change and marine environment/planning sectors of government and SNH will better support sustainable development and ensure compliance with the MSFD and Marine (Scotland) Act.

Lack of adequate precaution

Economic and political drivers and the imperative to deploy renewables to cut carbon emissions have resulted in a development-led rather than a strategy-led approach, with development taking place in the absence of an adequate strategic planning framework. A symptom of this is an overreliance on mitigation rather than the planned avoidance of sensitive areas. The strategic approach offered by the Marine (Scotland) Act will post-date much marine renewables development activity. 'Deploy and monitor' may support precaution, but the approach must provide adequate environmental safeguards.

Environmental sustainability

Although significant efforts are being made to 'catch up' to minimise risk to the environment, the requirements of the MSFD and the Marine (Scotland) Act have not been fully integrated into decisions on energy production. The environmental and planning sectors of government and public bodies need to be adequately resourced and supported, and their role in strategic planning for marine renewables fully recognised. The important role of healthy marine ecosystems in natural carbon storage and in ensuring resilience to climate change impacts shoud be more fully expressed in climate change policy. Design of devices to benefit marine biodiversity has not yet been prioritised.

Resources

Resources and capacity allocated to the environmental and sustainable development aspects of marine renewables planning are currently far lower than the resources and capacity allocated to the economic development of the industry. Investment is required to address environmental and sustainable development issues, from data collection and research to establishing planning processes, supporting planners and environmental regulators and building capacity across public bodies and other stakeholders.

Priority marine features and ecosystem function

While the Habitats Directive ensures that a limited number of protected sites and species are taken into account in development decisions, the potential impacts of development on other priority marine features and on ecosystem integrity and function are not fully considered. In particular, SNH advice on marine renewables development focuses on European protected features and has not been broadened to include MSFD and Marine (Scotland) Act requirements.

Environmental data

Baseline data and understanding of impacts on habitats, species and ecosystems, although growing, is still lagging significantly behind development proposals. Data are insufficient for the assessment of impacts on national priority features not protected by the Habitats Directive – and on features important for ecosystem integrity and function – as well as the assessment of cumulative and incombination impacts.

Cumulative and in-combination impacts

The Habitats Directive allows, in principle, for the cumulative and in-combination impacts of development to be considered in respect of some marine habitats and species, but there is concern that speed of development and lack of baseline data will make such impacts difficult to assess. While the Marine (Scotland) Act may offer improvement through regular review of SEA and marine plans, there is uncertainty over how well such impacts will be considered for features not protected under the Habitats Directive.

Setting upper thresholds for development and adaptive management

The Habitats Directive allows, in principle, for developments to be scaled-back to reduce impacts on some marine habitats and species. There is no equivalent process for features not protected under the Habitats Directive. In the absence of data and policy advice on other priority marine features and ecosystem functions, setting upper thresholds for development and scaling back or amending development for these features will be difficult to achieve.

Carbon impacts

Initial estimates indicate that marine renewables will deliver a net carbon benefit, but there is no requirement to calculate and minimise carbon impacts either as part of strategic development decisions or at project level.

Third party engagement

There is currently no independent expert scrutiny of key environmental documents, for example SEA. Non-statutory stakeholder groups – for example, communities and environmental non-governmental organisations – are not yet adequately involved in decision-making. Improved stakeholder involvement could improve levels of trust, information sharing and the quality of and support for decision-making.

The emerging marine renewables industry has an opportunity to develop in a more environmentally sustainable way, and to make a positive contribution to sustainable marine development.

In order to do this, the Scottish Wildlife Trust believes that marine renewables development should deliver a net reduction in carbon emissions while maintaining the integrity and function of marine ecosystems and avoiding damage to nationally and internationally important features.

Where ecologically appropriate, marine renewables development should be designed and located to benefit marine biodiversity. A healthy and functioning marine environment will help to support the sea's natural carbon storage capacity, help to ensure marine biodiversity is resilient to the effects of climate change and support the delivery of a range of other essential marine goods and services like food production and nutrient cycling.

The provisions of the Marine (Scotland) Act and associated management structures offer an excellent opportunity to achieve this. Part 4

Part 5 Maximising environmental sustainability: recommendations for implementation of the Marine (Scotland) Act 2010



Part 5 Maximising environmental sustainability: recommendations for implementation of the Marine (Scotland) Act 2010

The Scottish Wildlife Trust believes that the provisions of the Marine (Scotland) Act 2010, if well implemented, offer an excellent opportunity to ensure that the industry can meet the Scottish Wildlife Trust's criteria and develop sustainably. This legislation will establish a new statutory planning system of national and regional marine plans, a set of marine ecosystem objectives which plans must deliver, a streamlined licensing system and a new network of marine protected areas. The act includes general duties on Scottish Ministers and public authorities. Essentially, this means building the Ecosystem Approach and associated ecosystem objectives and tools for site and species protection into marine renewables planning.

The following schema illustrates how the provisions of the Act cascade to individual marine renewables projects:

Marine (Scotland) Act 2010 key provisions

- Duty to further the achievement of Sustainable Development, including the protection and, where appropriate, enhancement of the health of the Scottish marine area
- Duty to act to mitigate and adapt to climate change
- Duty to prepare and adopt a national marine plan and discretion to produce regional marine plans
- Duty to include marine ecosystem objectives (MEOs) in national and regional plans
- Duty to monitor and report on the effectiveness of plans in meeting their objectives
- Duty to create a network of marine protected areas (MPAs) and review whether their objectives are being met
- Option to consider socioeconomics in the designation of MPAs
- Duty to assess the impact of prohibition or restriction of activities within MPA on the environment within and outwith MPA as well as on socioeconomic interests

Marine Scotland and the National Marine Plan

- National MEOs Ecosystem Approach – MEOs underpin socioeconomic objectives and place the environment at the centre of sustainable development
- National strategy based on sustainable development, taking account of carbon impacts, integrating climate change, energy and the environment
- National data management
- Network of MPAs protecting international, national and local priorities
- Identified nationally important
 marine features
- Planning process identifies strategic zonal direction in balance with other interests, taking the Ecosystem Approach
- Reporting and review between regional and national levels provides for adaptive management, reviewing thresholds and areas for development according to environmental limits

Regional Marine Plans

- Regional MEOs Ecosystem Approach placing the environment at the centre of decision-making
- Plan-level SEA and AA
- Planning process identifies appropriate zones for development in balance with other interests, taking the Ecosystem Approach, finding synergies where possible
- Regional Locational Guidance (RLG) underpins planning, taking account of international, national, and, where appropriate, local biodiversity priorities, MPA network, device design, cumulative and incombination impacts
- Oversight of deploy and monitor and effectiveness of mitigation
- Reporting, review, data-sharing between project, regional and national levels provides for adaptive management, reviewing thresholds and areas for development according to environmental limits

Marine Renewables Projects

Future Policy Directions

The Scottish Wildlife Trust believes that the following recommendations for future policy could help Scotland achieve environmentally sustainable marine renewable energy:

NOW The Challenge	THE FUTURE What the Scottish Wildlife Trust believes the Marine (Scotland) Act and associated management structures must deliver	
Lack of high-level links between energy	• The UK Marine Policy Statement provides a strong framework for sustainable development, with environmental sustainability a guiding principle.	
and environment sectors	 There is co-ordination and shared objective-setting across the energy/climate change and marine environment/planning sectors of government and SNH to support sustainable development and ensure compliance with the MSFD and Marine (Scotland) Act. 	
	 Marine Scotland works with energy/climate change sections of government to produce a Sustainable Marine Renewables Strategy to provide context for the sustainable use of marine renewables. 	
	 Emerging high-level government groups making decisions about the development of marine renewable energy include a balance of environmental and marine planning bodies as well as other key stakeholders. 	
	 Marine Scotland works with energy/climate change sections of government to ensure that incentives to drive forward marine renewables are 'sustainability proofed' to ensure they do not encourage damage to marine biodiversity, and encourage synergies between marine renewables and marine biodiversity protection and enhancement. 	
Lack of precaution	• The Marine (Scotland) Act is fully implemented, following the principles of the Ecosystem Approach.	
	 A precautionary, phased approach is taken to the scaling-up of marine renewables development, underpinned by excellent data, monitoring and adaptive management and accompanied by effective spatial planning. The terms and conditions for this approach are agreed by key stakeholders prior to roll-out to ensure adequate environmental safeguards. 	
	 This precautionary approach avoids important habitats, species and ecosystem functions and does not compromise Habitats Directive obligations. 	

NOW The Challenge	THE FUTURE What the Scottish Wildlife Trust believes the Marine (Scotland) Act and associated management structures must deliver
Prioritising the environment	 Marine Scotland and SNH are fully supported by government in their role of integrating Marine (Scotland) Act and MSFD requirements into all aspects of marine planning and development.
	• A 'sustainable development' test is developed and applied to large-scale developments as part of marine planning, to provide an index of sustainability for planning purposes.
	• Marine planning and associated SEA are based on a natural resource audit of plan areas to allow identification of appropriate zones for development.
	• Design and location of development benefits the environment where ecologically appropriate, with the most appropriate technology fitted to the most environmentally-appropriate site.
Resources	 Resources and capacity are targeted to ensure marine renewables meet Marine (Scotland) Act and MSFD requirements and the industry develops sustainably. In particular, resources are allocated to fill gaps in data collection and research, to establish planning processes, support planners and environmental regulators, and build capacity across public bodies and other stakeholders.
Protecting nationally important marine features and ecosystem function	• Marine Scotland and SNH undertake provisional identification and mapping of national priority marine features and features important to ecosystem integrity and function at the earliest opportunity and these are taken into account in development decisions.
	• Regional Locational Guidance for marine renewables underpins planning and takes account of internationally, nationally and, where appropriate, locally important marine biodiversity, marine protected areas, sustainable device design, ecosystem functions and cumulative and in-combination impacts.
	 Sensitive habitats and species and important ecosystem functions are avoided. Best practice is developed and adopted by developers to ensure accessment of
	environmental impacts is thorough and effective.
Environmental data	• The Crown Estate, regulators, SNH, eNGOs and research bodies work together to establish and resource a national marine data management system, co-ordinated research and monitoring programmes and improved data-sharing and knowledge transfer between marine sectors, research and the policy and regulatory community. This is directed in the short-term towards filling knowledge gaps and in the long-term to providing good baseline data for all planned areas to aid a sound understanding of marine renewables impacts on habitats, species and ecosystems.
	 Gaps filled include identification, mapping and impact assessment in relation to national priority marine features and features important for ecosystem integrity and function.

NOW The Challenge	THE FUTURE What the Scottish Wildlife Trust believes the Marine (Scotland) Act and associated management structures must deliver
Cumulative and in-combination impacts	 Review of marine plans and associated SEA provide an effective mechanism for feeding project-level information back to regional and national plan level to enable prediction, assessment and review of cumulative and in-combination impacts on the full range of internationally and nationally important features. Marine Scotland, as the single marine authority, takes responsibility for dealing with the wider consequences of marine renewables development on the marine environment.
Setting upper thresholds for development and adaptive management	 Government ensures that marine ecosystem objectives are strong targets used as part of marine planning to inform threshold-setting and adaptive management to ensure development operates within environmental limits. Co-operation between authorities means that lease and consent decisions are taken in accordance with marine ecosystem objectives and that strict conditions are set to ensure developers minimise environmental and carbon impacts. A phased and well-monitored approach to development, review of marine plans and associated SEA provide effective mechanisms for adaptive management, including scale-back where appropriate. Decision-support tools are provided to facilitate this.
Carbon impacts	 Marine renewables strategy and policy takes full account of the role of marine ecosystems in carbon storage and resilience to climate change effects. There is a requirement to assess the full life-cycle carbon impact of marine renewables development at strategic and project level. There is a requirement for devices to have an environmental and carbon impact assessment alongside the engineering performance assessment.
Third party engagement	 There is independent scrutiny of key environmental documents. There is full transparency and communication of the rationale for development decisions. There are effective mechanisms for communication and, where possible, collaboration, between marine sectors, the policy and regulatory community, the research community, the eNGO community and local stakeholders. Developing structures for stakeholder involvement ensure that roles and relationships are formalised to give stakeholders a meaningful role in strategic decision-making and to improve trust and buy-in.

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- 7 Scottish Government (2008) Making Scotland a Leader in Green Energy.
- 8 Wave and Tidal Energy Support Scheme (WATES) £13 million capital and revenue grant; Establishment of EMEC – £16 million investment; Carbon Trust – £5.5 million sponsorship in 2009/10; Beatrice Downwind Project – £3 million government support; Scottish European Green Energy Centre – £1.6 million; Energy Technology Partnership (ETP) – £40– £50 million annual budget; Saltire Prize – £10 million innovation prize for wave and tidal energy.

- 9 The Renewables Obligation (Scotland) (ROS), operates by obliging licensed electricity suppliers to provide an increasing proportion of electricity which they supply to customers in Scotland from eligible renewable resources. A Renewables Obligation Certificate (ROC) is a green certificate issued to an accredited generator for eligible renewable electricity generated within the United Kingdom. One ROC is issued for each megawatt hour (MWh) of eligible renewable output generated. A 'banded' ROC system has recently been introduced, with 5 bands for wave, 3 for tidal and 1.5 for wind. www.ofgem. gov.uk/Sustainability/Environment/RenewablObl/ Pages/RenewablObl.aspx www.scotland.gov.uk/ Publications/2009/12/Energy-sources/Q/Page/2
- 10 See Scotland's 2010/2011 budget 'Climate change... our purpose focuses on increasing sustainable economic growth'. www.scotland.gov.uk/ Publications/2009/09/17093831/4
- 11 One of the two guiding principles of the five agreed principles of Sustainable Development is that of 'living within environmental limits'. www.scotland.gov.uk/Topics/Environment/ SustainableDevelopment/7368
- 12 The Scottish Government has international commitments under the Oslo-Paris (OSPAR) Convention and World Summit on Sustainable Development (WSSD) to create 'an ecologically coherent network of well-managed Marine Protected Areas', to 'halt the decline of biodiversity across the European Union'.
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- 14 Crown Estate (2009) submission to Scottish Government Energy Committee inquiry into renewable energy. www.scottish. parliament.uk/s3/committees/eet/inquiries/ energyFuture/74CrownEstate-(The).pdf

- 15 Scottish Enterprise & Highlands and Islands Enterprise (2010) National Renewables Infrastructure Plan. www.scottish-enterprise.com/ nationalrenewablesinfrastructureplan.pdf
- 16 The four Forth/Tay sites are Inch Cape, a 905MW project, awarded to RWE Npower Renewables Ltd and SeaEnergy Renewables Ltd (Inch Cape Offshore Wind Farm Limited); Bell Rock, 700MW, Airtricity Holdings UK Ltd and Fluor Ltd; Neart na Gaoithe, 450MW, Mainstream Renewable Power Ltd and Forth Array, 415MW, Fred Olsen Renewables Ltd. The Moray Firth site is a large wind development inshore of the Beatrice oil platform turbines.
- 17 J. Hogan, pers. comm. 19 February 2010.
- 18 Moray Firth Zone 1: The Crown Estate partner is Moray Offshore Renewables Ltd, 75% owned by EDP Renovaveis and 25% owned by SeaEnergy Renewables – 1.3GW, covering 520km², 28km from mainland, 30-57m depth. Firth of Forth Zone 2: The Crown Estate partner is SeaGreen Wind Energy Ltd equally owned by SSE Renewables and Fluor – 3.5GW, 30-70m depth, 23-80km from mainland, 2852km².
- 19 Scottish Enterprise & Highlands and Islands Enterprise (2010).
- 20 Devices tested at EMEC include Pelamis, OpenHydro, Oyster and Neptune.
- 21 Scottish Government (2007).
- 22 Five of the wave sites are just west of mainland Orkney, with one just north of Cape Wrath. Three of the four tidal sites are in the Pentland Firth, with one south of Westray.
- 23 Wave sites are to the west of Shetland, north of Tiree, west of Colonsay and west of the Western Isles. Tidal sites are to the west of Kintyre and two off Islay. http://thescotsman.scotsman.com/news/ Second-wave-of-renewable-projects.6175069.jp
- 24 www.solwayenergygateway.co.uk
- 25 www.biomara.com

26 The Carbon Trust estimates a loss of 2% per 100kW hour in cable transmission of electricity to shore. www.carbontrust.co.uk/SiteCollectionDocuments/ Various/Emerging%20technologies/Technology%20 Directory/Marine/MEC%20cost%20estimation%20 methodology%20-%20report.pdf

The average transmission loss in the UK system is currently 1.5%. www.ofgem.gov. uk/Sustainability/Environment/Policy/ SmallrGens/CommArrgChgsandEmbdded/Pages/ ChgsandEmbdded.aspx

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- Scottish Enterprise & Highlands and Islands Enterprise (2010). First phase sites are Leith, Dundee, Nigg, Energy Park Fife at Methil, Aberdeen, Hunterston, Arnish, Campbelltown/Machrihanish, Ardesier, Peterhead, Kishorn.
- 28 Adapted from SNH, 2009. These are best estimates only.
- 29 The two overarching principles are living within environmental limits and ensuring a strong, healthy and just society. The three contributory principles are achieving a sustainable economy, promoting good governance and using science responsibly. Environmental sustainability is living within environmental limits, that is within the assimilative and regenerative capacity of the biophysical environment.
- 30 Hiscock, K. and Breckels, M. (2007) Marine biodiversity hotspots in the UK. www.wwf.org.uk/ filelibrary/pdf/marinehotspots.pdf; www.jncc.gov.uk
- 31 Scottish Government (2008) Scotland's Seas: towards understanding their state. www.scotland.gov.uk/ Publications/2008/04/03093608/0. Duncan, C. and Boyd, B. (2007) Finding NIMAs, the case for nationally important marine areas.
- 32 Hardman-Mountford et al. (2009).
- 33 Secretariat of the Convention on Biological Diversity (2009).

- 34 By maintaining, or restoring, biodiversity and ecosystem services, Ecosystem-based Adaptation (EbA) can help people adapt to the adverse effect of climate change and simultaneously support development objectives and reduce risk disaster. The actions we need now are not only about protecting ecosystems, but about protecting the earth's life support systems. Herr, D. and Galland, G.R. (2009).
- 35 The sea is the world's second largest carbon sink after the atmosphere itself. It is estimated to have absorbed around a third of the total carbon (150Gt) from human activities since 1850 and contains about 50 times as much inorganic carbon as is found in the atmosphere. A recent report by the United Nations Environment Programme concluded that, 'Minimisation of pressures, restoration and sustainable use are management options that can help [oceans and coastal] ecosystems maintain their important carbon management function'. Trumper, K. et al. (June 2009). Also Laffoley, D.d'A. and Grimsditch, G. (eds) (2009). 'Moving forward with Marine Protected Areas, Marine Spatial Planning and area-based fisheries management techniques is not only a political imperative for biodiversity conservation, food security and shoreline protection, but also now for helping mitigate climate change'. See also Secretariat of the Convention on Biological Diversity (2009).
- 36 For Example, Poyry (2006); FoE *et al.* (2009); Helweg-Larson and Bull (2007).
- 37 UK Parliamentary Office of Science and Technology (2006) Carbon footprint of electricity generation, Postnote 268. www.parliament.uk/documents/ upload/postpn268.pdf. Harrison, G. (2002) Life Cycle Assessment of Renewable Energy Sources and Energy Networks. www.see.ed.ac.uk/~gph/carbon/
- 38 The Carbon Trust, life-cycle energy and emissions of marine energy devices. www.carbontrust.co.uk/ SiteCollectionDocuments/Various/Emerging%20 technologies/Technology%20Directory/Marine/ Other%20topics/Life-cycle%20energy%20and%20 emissions%20of%20devices%20.pdf
- 39 It is of concern that there is currently no requirement for a full life-cycle carbon impact assessment at strategic or project level for marine renewable energy developments, including, in the case of estuaries and shallow seas, the expected impact on the sea's natural role in carbon storage. The SEAs

for wave and tidal and STW wind do not include a carbon calculation, as details of technology are uncertain (Fiona Henderson, Halcrow pers.comm. 3 March 2010). The impact of proposed tidal barrage developments on natural carbon storage, for example on the Solway, has not been considered.

- 40 Abpmer (2009). This study explores environmental issues around siting, device design, construction, operation and decommissioning in relation to wave and tidal technologies. Collaborative Offshore Wind Research into the Environment (COWRIE) has funded many studies of the environmental impacts of wind energy. www.offshorewindfarms.co.uk
- 41 This should include carbon displacement of operation, carbon costs of construction, decommissioning, transmission, associated infrastructure, and any impacts on the sea's natural carbon storage capacity.
- 42 Hughes, J. and Brooks, S. (2009) Living Landscapes: towards ecosystem-based conservation in Scotland, Policy Futures Series no 1/2009, Scottish Wildlife Trust, Edinburgh.
- 43 Herr, D. and Galland, G.R. (2009).
- 44 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?u ri=OJ:L:2008:164:0019:0040:EN:PDF

(3) 'The marine environment is a precious heritage that must be protected, preserved and, where practicable, restored with the ultimate aim of maintaining biodiversity and providing diverse and dynamic oceans and seas which are clean, healthy and productive.'

(8) 'By applying an ecosystem-based approach to the management of human activities while enabling a sustainable use of marine goods and services, priority should be given to achieving or maintaining good environmental status in the Community's marine environment, to continuing its protection and preservation, and to preventing subsequent deterioration'.

45 Criteria for these have been published. EC DG Environment (2010), Elements for the Commission decision on criteria on good environmental status under Article 9(3) MSFD.

- 46 Bergen Statement arising from Ministerial Meeting of the OSPAR Commission: September 2010. www.ospar.org/html_documents/ospar/news/ ospar_2010_bergen_statement.pdf
- 47 An EU Directive on Renewable Energy was announced in early 2008 and is expected in due course. It will establish national renewable energy targets that result in an overall binding target of a 20% share of renewable energy sources in energy consumption in 2020. It also aims to remove unnecessary barriers to the growth of renewable energy: for example, by simplifying the administrative procedures for new renewable energy developments. There is no reference to environmental impacts apart from those related to climate change.
- 48 For example, 'Whilst..there are ongoing challenges including: the decline and poor condition of some habitats...In the absence of the RAP it is expected that many of these environmental problems will continue...Initial analysis of the RAP suggested that there was potential for some significant negative effects on the environment. However, following further consideration of available mitigation measures, these effects were not predicted to be significant overall'. Renewables Action Plan: Strategic Environmental Assessment for the Scottish Government (2009).
- 49 For an overview of Scottish Government structures as of July 2009, see http://209.85.229.132/ search?q=cache:xWtUITrvWo4J:www.scotland.gov. uk/Publications/2009/07/06095830/5+renewable+e nergy+division+scottish+government&cd=1&hl=en&c t=clnk&gl=uk
- 50 Developers must have a lease from The Crown Estate and relevant deployment consents/licences including licences under the Food and Environment Protection Act 1985 (FEPA) and consents under the Coast Protection Act 1949 (CPA). If the offshore generating station is proposed to have over 1MW in capacity, consent from the Scottish Ministers under s.36 of the Electricity Act 1989 is also required. Pending the outcome of the Marine (Scotland) Act, the Government's Energy Consents Unit (ECU) has entered into an agreement with the Scottish FEPA and CPA regulatory authorities enabling applicants to access a single point of application and initial enquiry for Electricity Act, FEPA and CPA applications.

- 51 Phil Gilmour pers. comm. 11-3-10.
- 52 Brendan Turvey, pers. comm. 24-3-10.
- 53 The Crown Estate Act 1961. www.thecrownestate. co.uk/02_crown_estate_act_1961_text.pdf
- 54 The Environmental Assessment (Scotland) Act 2005. www.opsi.gov.uk/legislation/scotland/acts2005/ asp_20050015_en_1 transposes the EU Strategic Environmental Assessment Directive 2001.
- 55 Scottish Government (2007) The SEA addresses bathymetry, geology and sediments, marine and coastal processes, seabed contamination and water quality, protected sites and species, benthic ecology, fish and shellfish, marine birds, marine mammals, fisheries and mariculture, historic environment, cables and pipelines, military activities, disposal areas, shipping and navigation, tourism and recreation, noise, electric and magnetic fields, seascape, grid connection and decommissioning.
- Scottish Government (2007) The SEA states that, 56 'only very small parts of the study area have actually been surveyed in detail, and most of these are in coastal areas...Information relating to offshore areas is very limited'. It identifies substantial gaps in baseline environmental data, gaps in understanding of how devices and arrays interact with the marine environment, lack of knowledge of the predicted effects of marine devices and of the effectiveness of mitigation. Yet it concludes that 'it may be possible to meet the Scottish Government Marine Energy Group's proposed target of 1300MW of marine renewable energy generating capacity with, generally, minor effects on the environment, although there are notable gaps in our knowledge'.
- 57 S3W-32081 Liam McArthur (Orkney) (LD) (Date Lodged Tuesday, March 2, 2010).
- 58 Phil Gilmour, pers. comm. 11-3-10.
- 59 Phil Gilmour, pers. comm. 11-3-10.
- 60 Scottish Government/Marine Scotland (May, 2009), table of device designs, p.89.
- 61 www.equimar.org
- 62 Scottish Renewables, pers. comm. 19-2-10.

- 63 European Habitats Directive Annex I habitats in UK waters that can be considered for protection: estuaries, lagoons, large shallow inlets or bays, submerged or partly submerged sea caves, sandbanks slightly covered by water all the time, mudflats and sandflats not covered by water at low tide, reefs and submarine structures made by leaking gases. Annex II marine species that can be considered for site protection: grey seal, common seal, bottlenose dolphin, harbour porpoise and otter. Annex IV, which covers species requiring protection wherever they occur, includes all cetaceans residing in or passing through UK waters. These measures apply to 200NM.
- 64 See endnote 63.
- 65 SNH (May 2009) Tidal turbines and Natura 2000.
- 66 SNH (May 2009).
- 67 Nature Conservation (Scotland) Act 2004. www. opsi.gov.uk/legislation/scotland/acts2004/ asp_20040006_en_1
- 68 The Nature Conservation (Scotland) Act 2004 requires public bodies and public office holders to have regard for the Convention on Biological Diversity in carrying out their functions.
- 69 See, for example (March 2009) Wet renewable energy and marine nature conservation: developing strategies for management. www.abpmer.co.uk/ files/R1451_Final_05Mar09.pdf. The hub of research on wind is the Collaborative Offshore Wind Research into the Environment (COWRIE). www. offshorewindfarms.co.uk
- 70 See endnote 69.
- 71 For example, The Crown Estate, 2009 and in press.
- 72 The Crown Estate, 2010, RSPB, 2008.
- 73 The Crown Estate, 2010.
- 74 UKERC, 2009, Spatial planning for marine renewable energy arrays workshops.
- 75 Nedwell et al., 2004.
- 76 Hastings and Popper, 2005.
- 77 Thompsen et al., 2006, WDCS, 2008.
- 78 Thompsen et al. 2006.

- 79 Nedwell, 2007.
- 80 Tougard et al. 2003, Nedwell et al. 2007.
- 81 Teilmann et al. 2006.
- 82 WDCS, 2008.
- 83 Wilhelmsson et al. 2006.
- 84 Linley et al. 2007.
- 85 Scottish Government (1999, 2009).
- 86 Best practice guidance for a new streamlined consenting process, with a guide to EIA and AA for wave and tidal, was in consultation draft in March 2010.
- 87 For example, the consultation on the Pentland Firth and Orkney Waters MSP and RLG highlights data gaps in relation to protected features, including baseline conditions of potential future Annex I Habitat sites; baseline distribution of mobile species, particularly marine mammals, birds at sea, and non-commercial fish species; the impacts of marine installations and developments on marine species, especially with regards to sensitivity to noise in the marine environment, the effects on behaviour and physiology (Scottish Government/Marine Scotland, 2009).
- 88 How European offshore marine sites are protected. www.jncc.gov.uk/Default.aspx?page=4551. In practice, there are always likely to be alternative sites and methods of generation so this provides good protection.
- 89 These are recommendations only; SNH has undertaken work to formalise guidance on survey and monitoring requirements.
- 90 Brendan Turvey, SNH, pers.comm. 24-3-10.
- 91 SNH's founding legislation, the Natural Heritage (Scotland) Act 1991 sets out SNH's duties. They are to secure the conservation and enhancement of Scotland's natural heritage; foster understanding and facilitate enjoyment of it and encourage its sustainable use. In carrying out its work, when it is appropriate to do so, SNH has to consider: actual or possible changes to the natural heritage; the needs of agriculture, fisheries and forestry; the need for social and economic development; the need to look after places of archaeological or historical interest; the interests of landowners and the interests of local communities. SNH also applies TAWPI – Taking Account of Wider Public Interest – in responses to statutory consultations.

- 92 SNH, 2009 09-3-1.
- 93 Tom Mallows, TCE pers. comm. 21-1-10.
- 94 Phil Gilmour, Marine Scotland, pers. comm. 11-3-10.
- 95 Davies I.M. (2008) Strategic research assessment for wet renewables, FRS Internal Report 11/08. www. marlab.ac.uk/Delivery/Information_resources/ information_resources_view_document.aspx?resour celd=31136&documentId=3104
- 96 See, for example, Shields et al. (2009), which identifies data gaps for wave and tidal in the Pentland Firth, including benthic habitat mapping, noise, disturbance, collision risk and electromagnetic impacts on marine mammals, Phase 1 intertidal survey, fish spawning and nursery areas, seasonal fish survey, seabird foraging, deterrents for marine mammals and the impact of device design on marine biota. It concludes that paucity of data precludes an assessment of the overall impact of marine renewables on the area. Also RSPB, 2008.
- 97 George Lees, SNH, pers. comm.
- 98 Davies I.M. (2008) Strategic research assessment for wet renewables, FRS Internal Report 11/08. www. marlab.ac.uk/Delivery/Information_resources/ information_resources_view_document.aspx?resour celd=31136&documentId=3104
- 99 This information is available from MESPG.
- 100 SNH, 2010.
- 101 Scottish Government (2008).
- 102 Round 3 zonal development agreements are for4.8GW, STW wind for 6.4GW, with up to 1GWproposed for the Pentland Firth.
- 103 European Commission, DG Environment (1999) http://ec.europa.eu/environment/eia/eia-studiesand-reports/guidel.pdf. Also CEFAS (2004) 'The need to consider cumulative impacts is a requirement of the EIA process. Projects to be incorporated in such an assessment must include those in the past, present and foreseeable future. Projects to be incorporated in such an assessment must include not only other potential wind farms but also other types of projects taking place in the marine environment or onshore so that all elements of the infrastructure are assessed'. www.cefas.co.uk/publications/files/ windfarm-guidance.pdf

- 104 Three working groups of wind farm developers on the north, east and west coasts have been formed. In November 2009 the Forth and Tay Offshore Wind Group (FTOWG), composed of four companies and covering sites totalling 475km² with a combined capacity of 2470MW (in addition to 3700MW for the adjacent Round 3 zone), announced that they will collaborate to ensure their respective proposals are developed in a manner that is co-ordinated and sensitive to the environment. Since its inception, the Forth and Tay Offshore Wind Working Group has held meetings with representatives of the adjacent Round 3 offshore wind site outside Scottish Territorial Waters, and a number of key stakeholders defined a common approach to bird studies and prepared scoping document to understand the in-combination and cumulative impacts. Collaboration on surveys, methodologies and assessments and work on birds, marine mammals and seabed conditions is planned, in consultation with stakeholders. Where joint commissioning of work is not possible, The Crown Estate is working to ensure consistency in data collection methods to permit direct comparison between sites.
- 105 Tom Mallows TCE pers. comm.
- 106 www.sams.ac.uk/commercial-1/commercial-1/ artifical-reef-technology-and-consultancy-services



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Marine mamma Habi ve S В ivers y O lim Rir nate rgy 5 sessment VIa sses es Target S Offsho e BIOC Wind 2 (oy & mon al arine mammals osyste change Climate /av vable Offshore pecie idal e



