SCOTTISH NATURAL HERITAGE

Policy Statement

MARINE RENEWABLE ENERGY AND THE NATURAL HERITAGE: AN OVERVIEW AND POLICY STATEMENT

Policy Statement No. 04/01

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Introduction

1. The potential for harvesting wind, wave and tidal energy from around Scotland's coasts is huge. It could provide for Scotland's electricity needs several times over. There is therefore a growing interest in various types of marine renewable energy development, to contribute towards Scottish targets for electricity generation from renewable sources.

2. This paper provides an overview of the potential impacts on the natural heritage which may arise from different forms of marine renewable energy development, and the locational considerations which should guide such development in relation to natural heritage interests. Based upon that analysis, the paper sets out in **bold type** SNH's policy approach towards marine renewables.

3. **While recognising that there are as yet many uncertainties over potential natural heritage impacts, our broad conclusion is that marine renewable technologies should be looked to and encouraged to provide a significant proportion of the renewables component of Scotland's electricity supply.**

Background

4. SNH has long supported the development of renewable energy as an integral part of a programme designed to combat climate change. In doing so, we recognise that there will be associated natural heritage impacts. However, we are also aware that the effects of climate change on the natural heritage, if left unchecked, would be far more profound. SNH Policy Statement 01/02 on Renewable Energy [i] sets out our support in full. It stresses the need to identify those renewable technologies which can be most easily accommodated with least adverse impact on Scotland's natural heritage.

5. SNH's policy to date towards marine renewable energy has been one of encouragement, anticipating that in the marine environment there will be scope for generation with fewer or lesser environmental impacts than if the same amount of electricity were to be generated on land. The above policy statement says:

   'SNH encourages exploration of the natural heritage impacts of offshore wave and wind energy developments. Outwith areas of high scenic or marine wildlife value, such impacts may be lower than for land-based renewables. SNH supports strategic identification of appropriate locations and the development of appropriate technologies.'

6. The policy statement also refers to the significant adverse ecological impacts likely to be associated with tidal barrage proposals, and to the potential for tidal stream generation, if high velocity tidal channels, which are usually areas of distinctive marine natural heritage interest, are avoided.

7. The Scottish Executive has set an objective of producing 40% of electricity in Scotland from renewables by 2020. In doing so, the Executive has advised that a diverse mix of renewables will be required, including the development of marine resources. SNH has indicated that we would wish a significant proportion of generation capacity – around one third of the total installed capacity which will be required – to be derived from offshore technologies, notably offshore wind, wave, and tidal stream generation. If that generation capacity were sought solely through onshore wind power, the outcome would be adverse impact on many of Scotland's landscapes. Therefore, we have felt a need to refine our view on marine renewable technologies, beyond the relatively bland statement of encouragement above.

8. It is of course difficult to do so at a time when there is as yet limited experience beyond that gained from a few offshore windfarm developments in Europe and a number of pilot scale proposals for wave and tidal stream generators. Nonetheless, SNH has direct experience of one proposed offshore windfarm, in the Solway, and has liaised with HIE over the development of the European Marine Test Centre in Orkney, an area devoted to testing of pilot wave and tidal stream generators. A Strategic Environmental Assessment [ii] has been published of the potential for offshore wind development in three offshore areas around England and Wales, commissioned by DTI.

9. During 2002, SNH commissioned a review of possible marine renewable energy projects and their natural heritage impacts, undertaken for us by consultants Scott Wilson [iii] and drawing from previous research by others including a study of the environmental effects of offshore wind farms, conducted by consultants Metoc for the DTI[iv]. We have received comment on this report from three members of the Scientific Advisory Committee and from the Marine Conservation Society. We have reviewed work undertaken at the Robert Gordon University on the environmental impacts of tidal stream generators [v]. We are embarking on a seascape/landscape review of the potential capacity for offshore windfarms around the Scottish coast. SNH is in contact with the issues raised by English Nature and the Countryside Council for Wales for offshore windfarms around the English and Welsh coast, and with the COWRIE[1] research programme coordinated by the Crown Estate.

[1] COWRIE: Collaborative Offshore Wind Research into the Environment. The Crown Estate has established a trust fund using interest accruing from deposits by offshore wind

Many of the issues surrounding offshore wind development, and its potential generation capacity, have been summarised in the DTI document Future Offshore [vi], consulting on licensing processes for future offshore wind development.

10. Thus, SNH now has some insight into the potential for generation from marine renewable technologies, in and around Scottish waters, and is in some position to draw interim conclusions on such matters as the natural heritage issues likely to have a strategic bearing on the development of the industry, and those over which there is most uncertainty. This paper sets out to do that, and following from that analysis, to outline the range of issues which might be addressed within a fuller policy statement on marine renewables. At this stage in the development of the industry, this statement is necessarily provisional. We intend that this statement will be updated in time as real experience in marine renewables is gained.

11. There are a wide range of potential natural heritage impacts associated with marine renewables developments, and there is a danger that a paper on the topic could develop into an extensive catalogue of impacts. This document does not aim to be comprehensive; rather, it tries to provide a summary of those impacts which are thought to be the most significant. The Scott Wilson report provides a fuller statement on the range of impacts which may be expected.

Marine renewable electricity generation – the opportunities

12. A report commissioned by the Scottish Executive [vii] in 2001 provided estimates of the energy potentially harvestable from marine resources around the coast of Scotland. These estimates were variously constrained eg by the need for navigational corridors, and also by setting a maximum cost to the electricity generated at 7p per unit. Nonetheless, the potential energy available was assessed as:

Offshore wind	25 GW	(Giga-watts)
Wave	14 GW	
Tidal stream	7.5 GW	

For comparison, the average electricity consumption across the whole of Scotland is around 5.5 GW.

13. Despite that assessment, the industry is at a relatively early stage of development, and technologies are evolving fast. Offshore wind

developers. The fund is used for generic research into the environmental impacts of offshore windfarms and is guided by a multi-agency Steering Group.

farms represent the best-developed form of offshore renewable technology, with major offshore wind farms built off the coast of Denmark, several under construction elsewhere in the UK, and one with approval in the Solway Firth. Initially at least, the areas likely to be most suitable for development are near shore and shallow sea areas such as the Moray coast, Solway Firth, and east of Dundee.

14. Wave and tidal power devices are still at the experimental stage. Pilot shoreline wave devices have been tested on Islay, several offshore wave devices are due to be tested at the European Marine Energy Test Centre in Orkney, and one tidal stream device is being tested in Yell Sound in Shetland.

15. Even if the technology develops to meet the engineering challenges of the marine environment, the potential to make use of offshore energy can only be realised if the transmission grid in Scotland is developed appropriately. At present the grid is based on accommodating major electricity generators within the central belt and distributing that electricity outwards. The capacity to accommodate generation from many parts of the Scottish coastline is very limited.

16. However, the Scottish Executive has acknowledged that a 40% target for 2020 will require substantial development of marine resources. Capital grants are available in addition to the more general framework of the Renewables Obligation (Scotland) (ROS), and industry is being strongly encouraged to undertake the research and development work required. A review of the ROS is to be undertaken in 2005 to ensure that it remains responsive to the emergence of new renewable technologies. In addition, one of the early tasks for the Forum for Renewable Development in Scotland has been to look at how marine renewable energy can be developed in Scotland. The Scottish Executive has aspirations for marine generation within Scottish waters, across a number of technologies, on a prototype scale in the years 2005-2010 and on a full commercial scale in the decade beyond.

Natural heritage protection in the marine environment

17. With the exception of fish farm proposals, the regulation of development below the mean low water spring tideline falls outwith the remit of the Town and Country Planning system, and associated environmental impact assessment requirements. However, renewable energy generators require consent under the Electricity Act 1989 and may be subject to environmental assessment requirements under the Electricity Act 1989 (Requirement of Consent for Offshore Generating Stations) (Scotland) Order 2002. Such developments may also require a

licence to establish structures on the seabed, under the Coastal Protection Act 1949, and for any deposit or placement in the sea under the Food and Environmental Protection Act 1985. The Wildlife & Countryside Act 1981 provides protection for a number of listed species and the Conservation (Natural Habitats) Regulations 1994 implements the EU Birds and Habitats Directives for territorial waters. UK legislation is expected to enable implementation of these Directives out to the boundary of UK sovereignty.

18. The UK is signatory to the OSPAR Convention for the Protection of the Marine Environment of the North Atlantic. Work is underway to identify marine species and habitats, and a network of marine protected areas, under this convention, though criteria have not yet been agreed. At present the only marine nature reserve in Scottish waters is the voluntary reserve at St Abbs. The waters around St Kilda form part of the St Kilda World Heritage Site.

19. Processes are underway to designate marine Special Protection Areas for birds, under the EU Birds Directive, and marine Special Conservation Areas, under the EU Habitats Directive, both forming part of the Natura 2000 suite of protected sites. The number and extent of such designations are still subject to discussion. Within such sites, there will be a stringent requirement that developments should not have an adverse effect on the integrity of the site or on the wildlife or habitat interests for which the site has been designated. Until the extent of the UK's conservation obligations under these Directives has been fully clarified, there will remain some uncertainty over the extent to which such designation may constrain the potential for renewable energy development.

20. More generally, pollution from shipping is regulated under the MARPOL International Convention for the Prevention of Pollution from Ships. In addition, a number of Marine Environmental High Risk Areas have been proposed for the Scottish coast, where special navigational precautions may be required to protect the environment from the risks of navigational mishap. The UK is required to develop integrated coastal zone management plans by 2006, and the Scottish Coastal Forum is taking a lead in developing initial proposals for Scottish waters.

Review of environmental impacts

21. This section sets out the major determining natural heritage issues likely to guide the development of each marine renewable technology. It brings together the findings from a number of review reports. While a comprehensive review of the natural heritage impacts of such devices would include a longer list of potential impacts, the aim of this section is to identify those likely to be critical to the development of each technology.

22. Tables 1-6 (pages 26-37) set out a summary of the principal impacts and potential mitigation measures. A separate impacts table is shown for each type of marine renewable. Marine renewable energy developments of different types have a number of common features – moorings or foundations, service craft, transmission cables to land – which mean that a listing of environmental impacts by type is to some extent repetitive. Nonetheless, the nature of the impact is often quite different – wave power devices are likely to change the wave regime, while any impact that offshore wind farms have on the wave regime is likely to be marginal. Moored wave devices may have little footprint on the benthos, while offshore wind farms have deep concrete foundations.

23. In contrast, transmission cables to land are common to and little different for all types of offshore marine renewable energy development. Therefore, the impacts of underwater cabling are identified separately in an initial table.

24. The impacts during the construction and operational phases of a development are identified in separate columns, as different stages in the lifecycle of a project have different impacts and levels of impact. For example, installation and decommissioning phases can create direct adverse impact with respect to seabed disturbance. Such impacts are generally predicted to be relatively short term and localised. However, impacts during the operational phase are longer lasting, eg noise emissions from machinery and any impact they may have on marine ecology.

25. In the following summary by technology type, only those impacts have been identified which are thought to have the potential to be sufficiently significant to be a determining factor in a consent decision, or which could require formally agreed mitigation measures before the proposal would be deemed acceptable (rated ** or *** in Tables 1-6).

26. This overview of the significance of impacts is a general one, based on the assumption that the resource in question is not subject to specific protection or conservation measures, for example for a development within a marine protected area or Natura site, or where the impact is on a species subject to special protection. Where such special protection provisions apply, then the significance of any impacts must be assessed against any specific tests relating to that form of protection. Thus for example, developments within or with the potential to affect a marine Natura 2000 site will be subject to stringent tests to ensure they do not adversely affect the particular marine natural heritage interests safeguarded by that site.

Underwater cabling

27. All three offshore technologies – wind, wave and tidal stream – share a requirement to bring the electricity to land via undersea cables. This on its own introduces a number of impacts and constraints.

28. Potential significant impact issues are:

- electromagnetic interactions with fish species (especially elasmobranchs – sharks and rays)
- seabed and habitat disturbance in burying, maintaining or removing the cable
- the coastal habitat, visual and landscape impacts of shoreline substations and landward transmission lines

Offshore windfarms

29. Offshore windfarms are likely to be larger than onshore, both in size of turbine (which will not be limited by access constraints) and in extent. This is an already proven technology - and Scottish waters offer the windiest sites in Europe. Wind speeds increase to the north, and energy yield increases with distance from shore – around a 30% increase at 10km offshore. Currently sites are limited to relatively shallow depths (15-30m) but this constraint is likely to relax. Zones of breaking waves have to be avoided.

30. While some existing oil infrastructure may be utilised in some ways – eg to channel underwater cables along or in former oil/gas pipelines – wind turbines are unlikely to be built on old oil platforms.

31. Development of offshore wind will be crucially dependent on new transmission capacity, and in particular the possibility of sea-based transmission lines down the east or west coasts of Scotland. It may be important to ensure there is spare capacity ringfenced for the development of marine renewables in any grid upgrade. Good port infrastructure will be required, but it is not crucial that the port is close by.

32. Potential significant impact issues are

- navigational risk – given the scale of wind turbine arrays, there will be need for marker buoys, night-time marker lighting, navigational exclusion zones, and possibly foghorn equipment.
- noise disturbance – typically monopile foundations will be driven to a depth of 35-40m and this means a major period of underwater piling operations, with potential disturbance to cetaceans.

- bird collision/displacement/barrier effects – while collision rates with turbines may be low, the scale and number of turbines means that in some areas there may be significant risk. Displacement and barrier effects have been observed. Areas of seabird concentration and migration routes require particular consideration, and will require new survey.

- landscape/seascape impacts – as turbines are likely to be large (150m or taller), arrays of turbines may have a strong visual and land/seascape impact, reducing with distance from the coast. Areas of special landscape value require special consideration. Requirements for navigational lighting may lead to significant night-time impacts.

33. In the phase 1 report conducted as part of the Strategic Environmental Assessment of three areas for offshore wind around the coast of England and Wales, the most significant risks identified are:

    - impacts on sediment transport
    - impacts on special areas of biodiversity value
    - collision risk, displacement, disturbance and barrier effects on birds
    - navigational risk – both cargo and passenger shipping

    Though these relate to the particular environment of the soft-sediment shallow –sea areas studied, it is likely that similar priorities might emerge from any study of shallow Scottish coastal waters.

<u>Offshore wave</u>

34. The wave regime on the Atlantic coast is much more energetic than on the North Sea coast; so commercial development is likely to be in the north or west, and hence subject to resolution of the present lack of transmission capacity.

35. Wave devices are likely to be at some distance offshore – dependent on the device, in the range 30-70m water depth, with the deeper water offering higher energy regimes. Within such a wave regime, a wave farm will be 3-4 times more compact in the area of sea used than a wind farm of corresponding capacity.

36. Floating wave devices are likely to have fewer adverse natural heritage impacts than other types, since seabed disturbance would be limited to moorings and transmission cables, and structures may be largely at water level.

37. Potential significant impact issues are:

- navigational risk – given that many devices will lie low in the water or on the surface of the water, there will be a need for marker buoys, night-time markers and possibly foghorn equipment. It will be important to keep wave farms well away from principal shipping lanes.

- antifouling – the need to have moving parts within the seawater environment is likely to lead to a need for regular maintenance action or the use of antifouling paints

- pollution – it is likely that early equipment may be prone to mechanical failure or break-up in severe storm conditions, and appropriate attention should be paid to the pollution from debris or leakage of hydraulic fluids.

- for large wave farms consideration should be given to the effect on the wave regime and any consequential effect on inshore habitats and shoreline sediments.

- displacement of breeding seabirds – care should be taken to avoid concentrations of breeding seabirds.

<u>Tidal stream</u>

38. Tidal stream devices are very much at the pilot device stage. There are two principal types of device currently being developed. One group uses the tidal stream to rotate rotor blades located beneath the sea surface. The other group uses the tidal stream to create an oscillatory motion of hydroplanes.

39. The depths in which they are likely to operate vary from 20-60m with tidal current velocities of between 2-10 knots. Some devices are mounted on the seabed and offer clearance above which would allow shipping to continue to use the channel. Others project above the surface. Distance from shore is dependent on the location of the tidal stream and the depth required for the mechanism,

40. Potential significant impact issues are:

- navigational risk – for those devices which do project to or near to the surface

- antifouling – the need to have moving parts within the seawater environment is likely to lead to a need for regular maintenance action or the use of antifouling paints

- effect on tidal flow patterns, downstream currents, sedimentation patterns and seabed morphology and their consequential impact on marine habitats within the channel.

- acoustic emissions of the devices and the effect on marine mammals/ecology

- collision risk

- disturbance during construction to marine and intertidal habitats and species

<u>Shoreline wave</u>

41. Shoreline wave devices are at a pilot stage, the main trial being on Islay. Present devices have a limited frontage, and convert wave energy into an air jet which drives a turbine generator.

42. Potential significant impact issues are:

    - landscape/visual impact – the impact of a concrete structure at the coastal edge, and any related transmission lines, may be high, depending on the character of the coastline

    - antifouling – the need to have moving parts within the seawater environment is likely to lead to a need for regular maintenance action or the use of antifouling paints

    - loss of wave energy - which could lead to potential sedimentation and modification to habitats and species

<u>Tidal barrage</u>

43. There are no major tidal barrage schemes proposed in Scotland at present. Tidal barrage schemes may involve wholesale change of a tidal estuary to an impoundment, and as such may affect the marine and intertidal habitat, the coastal landscape, and water quality and salinity.

44. Potential significant impact issues are:

    - loss of shoreline habitats – these are usually valuable for waders and for most of Scotland's major estuaries, subject to conservation designations

    - change in marine habitats - to adjust to brackish or freshwater conditions and increased build-up of nutrients

- change in estuarine hydrodynamics, including possible attenuation of the tidal regime, and change in associated patterns of sedimentation and erosion
- creation of a barrier to migratory fish – unless suitable fish passes are provided
- major change in the estuarine landscape – with loss of any intertidal zone and the creation of a barrage or causeway
- recreational sailing - establishment of impounded waters may provide new or easier opportunities for water recreation

45. Where tidal generators are proposed within existing barriers or causeways, such impacts may already have been caused by the barrier. If so, establishing a flow channel for energy generation could mitigate some of these impacts.

Key issues for SNH

Changes in sedimentation, scour and dispersal (all technologies)

46. In general the impact of offshore renewables developments on current regimes, on sedimentation and scour patterns, and on pollutant flushing and dispersal seems likely to be modest (except in the case of tidal barrages), provided that arrays of devices are well spaced and not across the mouth of enclosed channels. The attenuation of wave energy by arrays of wave devices may be more significant, and regard should be paid to the potential impacts on nearshore and shoreline habitats.

47. **All marine renewables devices should be carefully modelled with attention paid to the potential sedimentation or scour impacts on marine and shoreline habitats, and changes in sediment transport or flushing and dispersal of pollutants.**

Use of antifouling paints (offshore wave, tidal stream)

48. Tidal stream and offshore wave devices depend on underwater moving parts and are therefore susceptible to fouling by the growth of marine organisms on active surfaces. The UK is signatory to an Antifouling Convention governing the use of anti-fouling chemicals, and there is considerable best practice experience from shipping and oil companies. Molluscs are recognised as particularly sensitive to antifouling chemicals though research pursued in support of the Water Framework Directive may reveal whether other species are also sensitive.

49. **Where practicable, the use of ultra-smooth surfaces and regular out-of-sea maintenance for marine renewable devices**

should be preferred to the use of anti-fouling paints. Where the latter are used, best practice should be mandatory; their use in areas where there are sensitive mollusc populations should be avoided, and the potential for cumulative impacts should be adequately considered.

Tidal channel habitats (tidal stream)

50. Sites which may offer the best opportunities for tidal stream are also likely to be of high natural heritage value, as the high energy environment has often led to a lack of human intervention. They may also represent some of the most pristine marine habitats, due to practical limitations on trawling. However, in general the magnitude of any impact is likely to be less in a high energy environment than for devices sited within a low energy environment.

51. Absorption of a proportion of tidal energy may lead to wider changes in the distribution of tidal energy, and reduction in overall tidal current velocities.

52. **Tidal rapids and BAP habitats should be avoided for tidal stream generators. SNH should work towards formulating a view on those tidal channels which can be used for this form of generation with least impact on the natural heritage. Careful hydraulic modelling is essential to gauge the impact of a tidal stream generator on the tidal regime itself.**

Cable laying and landfalls (all technologies)

53. There is a wealth of experience on cable laying and its impacts. On hard rock, cables are likely to be laid on the bottom and secured, while on softer sediments, they may be laid on the seabed, or in a trench prepared by trenching, ploughing, or jetting, dependent on the quality of the sediment. If cable maintenance is ever required, there may be further significant disturbance to the seabed if a grapnel is used to locate and lift the cable.

54. The potential for greatest impact is at the shoreline, where a cable may be exposed to changing sand levels. There is a need to ensure sufficient burial and that burial is not damaging to the shoreline habitat. Where needed, directional drilling methods can be used to enable a cable to pass to shore through hard rock rather than under a beach, though this is costly and may lead to some discharge of drill residues. In order to minimise landscape and visual impacts, it is normal for there to be a limited extent of undergrounding back from the coastal edge. Undergrounding requirements might be more extensive in scenic areas.

55. Substations and other infrastructure associated with cable landfalls will normally fall within planning control. NPPG 13 'Coastal Planning' recommends that where possible, coastal development should take place within sectors of already developed coast, though NPPG 6 'Renewable Energy Developments' indicates that due to the specific locational requirements of marine renewable energy developments, exceptions may need to be made.

56. **SNH will seek a coordinated approach which leads to a minimum of undersea cabling and landfalls and associated onshore transmission lines, sited in optimum locations. Cable landfalls which require significant onshore infrastructure should where possible be located within already developed coasts. Landfall techniques should be employed which ensure a minimum of damage to shoreline and coastal habitats.**

Underwater noise (offshore wind, tidal stream)

57. Cetaceans have good hearing and their navigation and in some instances prey location is based on the propagation and use of sound. Whales in particular are known to communicate over distances of 100 miles or more. There is therefore a fear that noise could damage hearing, leading to an inability to locate and navigate. It is possible that roundfish could be affected too, either through hearing or the operation of the swim bladder. Any disturbance to fish populations could impact on bird feeding patterns and distribution. Sea mammals also have acute hearing and may be prone to disturbance by underwater noise.

58. There is a major body of experience within the oil and gas industry on the impacts of piling and other underwater noise, and how to mitigate it, and it will be important to draw on that experience. Nonetheless this is a topic on which there is substantial uncertainty as to the significance of impacts, and has been recognised as such by the renewables industry and the Crown Estate through the COWRIE programme (see paragraph 9).

59. **SNH will take note of the conclusions, as they emerge, of research supported by COWRIE on the impact of noise disturbance from marine renewables in fish and cetaceans. There is a need to consider separately the impacts of construction noise and operational noise, including that arising from maintenance activity.**

<u>Electromagnetic effects on fish from underwater cables (all technologies)</u>

60. Evidence of electromagnetic impacts is not as yet well documented. Elasmobranchs are thought to be the most sensitive species, as they use electromagnetic detection when hunting prey.

They also include endangered species, eg the common skate, now listed as a BAP species.

61. **SNH will take note of the conclusions, as they emerge, of research supported by COWRIE on the impact of electromagnetic fields from cables on fish stocks.**

Bird displacement and collision risk (offshore wind)

62. As on land, birds may be prone to collision with turbines, or displacement by turbines, or flight paths may be modified or extended to avoid lines of turbines which present apparent barriers. Many seagoing bird species (eg fulmar) are characterised by a long lifespan and low annual breeding productivity, and for such species quite low-level impacts might nonetheless lead to a significant effect after a period of years. Distribution information is available on seabirds, but in general there is a lack of information on bird density or abundance or on patterns or frequency of movement; hence it is of limited value in assessing impacts. It is possible that navigational lighting on offshore wind turbines, for example for aircraft, may increase collision risks for bird species attracted by lights.

63. **For any offshore wind development, the impacts on birds should be fully assessed, informed where required by survey information on distribution, movements, and habitat preferences, and with regard to the potential for cumulative impacts within any one area. Strategic environmental assessment should be used to guide offshore wind development to areas where bird impacts are unlikely to be significant.**

Landscape and visual impacts (offshore devices)

64. Landscape and visual impacts are potentially greatest for offshore wind farms, given the vertical height and long-range visibility of wind turbines. Landscape, seascape and visual impacts should be considered not only from land-based views including popular beaches and coasts but also from popular ferry routes and from areas popular for marine recreation. Offshore wave devices, because they will sit on or close to the surface of the sea, are likely to have lesser landscape and visual impacts than offshore wind farms, but might nonetheless have a significant impact if sited within valued seascapes.

65. **Offshore development should not prejudice the quality of designated landscapes including NSAs, and elsewhere should be located so as to limit adverse impacts on landscape and seascape character.**

66. SNH is undertaking an offshore windfarm seascape study which will lead to a view on those coastal areas best able to accommodate offshore wind development without adverse impact on landscapes and seascapes.

67. There is a risk that the cost of underwater cabling may lead to exploration of sites closer inshore than is desirable from the point of view of accommodation within landscapes and seascapes. It will be desirable that distances from shore are proposed with a view to minimising overall natural heritage impacts and not driven solely by cost.

68. Lighting of wind turbines is dictated by navigation requirements and the laws of the sea through the Coast Protection Act 1949, and are hard to influence, though lighting may have a significant visual and landscape impact. **There is a need for exploration of lighting requirements, including the potential for directional shielding of lights, and to adopt best practice.**

<u>Wild coasts (all technologies)</u>

69. SNH's policy statement 'Wildness in the Scottish Countryside' addresses the need to identify and protect those areas of countryside valued for their qualities of remoteness and wildness. At the coast, there are parallel qualities which are not captured in that document, and in the marine environment, though much of the seabed has been affected by extensive use for fishing, some areas remain distinctively pristine. National Planning Guidance NPPG 13 indicates that planning authorities should identify 'isolated coasts' in which there should be a presumption against development.

70. **Planning authorities and decision makers should give consideration to protecting the wild, isolated and undisturbed qualities which characterise some parts of Scotland's coastline. Hitherto undisturbed marine areas also merit special consideration, and development constraint in such areas is more justified.**

Marine recreation (offshore wind, offshore wave)

71. Much recreation is based on enjoyment of beaches and accessible parts of the coast. Coastal recreation areas should be identified, and care taken that marine renewables development does not prejudice any seascape qualities which form an important part of that experience.

72. Recreational navigation issues should be considered separately from commercial navigation. If developments steer clear of the main shipping lanes, then they are likely to be moved further into recreational yachting areas. Inshore, sea kayaking, windsurfing, and dinghy sailing should be considered as well as yachting. There is as yet little experience in the UK of how such recreational interests might interact with renewables developments.

73. Exclusion zones may be required during constructional and decommissioning periods, to separate other craft from heavy construction/decommissioning traffic. However during the operational phase, there is a question as to whether exclusion zones need always apply to small recreational vessels, subject (for offshore windfarms) to there being adequate headroom available below turbine blades.

74. Consideration should be given to the extent to which underwater cabling may preclude anchoring by recreational craft.

75. **SNH will encourage the development of better information on the prime inshore areas used for marine recreation, and how recreational users interact with renewable developments.**

Fisheries (all marine technologies) and artificial reefs (offshore wind)

76. There has been some research on the distribution of fishing effort in the Clyde and Moray Firths, but little elsewhere. Few areas are not utilised in some way for fishing. Assessment of impacts should take into account not only the impact on fishing activity and any impact on the habitats critical to the ecology of the target fish species, but also the potential impact on the natural heritage arising through resultant displacement or change in location and types of fishing. Both inshore and offshore fisheries are important and may have different sensitivities. Some work has been done by the Joint

Nature Conservation Committee and UKD digital mapping to identify key breeding/spawning areas.

77. Evidence from studies of existing areas protected from fishing suggest that populations of fish and shellfish may increase locally. Where renewable energy sites in Scottish waters provide protection from fishing, the benefits are likely to be most relevant to sedentary species of crustaceans and molluscs. The protected stock within the site may act as a reproductive reservoir that enhances recruitment to stocks in adjacent areas. Any benefits to commercial fisheries would, however, be very site-specific and depend on a number of factors including the size of the site, habitat type, proximity to other unfished areas, and any disturbance from non-fishing activities.

78. Little is known about the potential impact of estuarine renewables developments on routes for migratory fish species.

79. The installation of offshore wind turbines will involve the loss of some natural seabed habitat. However, new habitat (eg rock armouring) will also be created, and there is the potential for some mitigation of habitat loss if these new substrates are suitable and well designed. The material and design of the substrate can have a profound effect on its suitability for colonisation by marine species, and experience from existing artificial reefs should be used to inform design. In relation to the potential for providing improved feeding grounds for birds, consideration should also be given to the possible disbenefit of attracting seabirds into a zone of collision risks.

80. **SNH should have regard for any impacts on fisheries, as part of our balancing duty to have regard for socio-economic interests, but our prime concern will be the protection and sustainable management of the natural heritage.**

81. **Offshore windfarms will result in the creation of artificial habitats which if sympathetically designed could help mitigate impacts on biodiversity and on commercial fisheries. However, until their value is more conclusively demonstrated, such benefits should not weigh strongly in the decision-making process.**

Navigational risk (all marine technologies)

76. The potential consequences of navigational collision are very significant – most importantly for the risk to human life. From an environmental point of view, however, the potential consequences are also very serious, on account of the potential for release of oil or other pollutants into the marine environment and consequent damage to wildlife and habitats.

77. In location of structures, the importance of keeping shipping channels clear needs to be recognised, and the potential requirement for good marker lighting and foghorns, despite the fact that these may have adverse visual and aural impacts, and that night lighting may also attract birds. Given the degree of reliance upon visual navigation, at least for smaller vessels, low-lying devices like offshore wave farms are potentially a greater hazard than highly visible structures like offshore wind turbines. Radar reflections from offshore wind turbines may diminish the effectiveness of on-ship radar, and there is some uncertainty as to whether the currents in underwater cabling can affect ship navigational systems. Unlike major oil and gas installations, marine renewable developments will not have standby vessels to provide backup warning of potential collisions. Also, route diversions around marine renewable developments may increase congestion within remaining channels, and hence increase the risk of vessel-to-vessel collision.

78. **Reducing navigational risks should be seen as an environmental as well as a safety objective. A good understanding of regulatory requirements and the risks associated with both marked and unmarked structures will be needed if a balanced view is to be taken on the need for navigational marking and its associated impacts.**

Outstanding uncertainties and research needs

79. Many of the potential impacts in the marine environment are characterised by a high level of uncertainty, either because there is an absence of data, or because the effects have not yet been adequately studied. This has been recognised by Government, the industry and the Crown Estate (see for example, the 'Future Offshore' consultation) and has led to the establishment of the COWRIE programme of research which is of general benefit to the offshore renewables industry in clarifying impacts.

80. Annex 1 (page 38) sets out the major areas of uncertainty or lack of knowledge which seem likely from the above analysis to be of importance to decision-making. It indicates where topics are already being addressed through the COWRIE programme or through other work by SNH. It also includes the range of topics identified as in need of research in a report by Robert Gordon University [v] on the environmental impacts of tidal stream energy.

81. These areas of uncertainty, in circumstances where important natural heritage interests are affected, indicate the need for a precautionary approach. There is a need to continue to work at removing these areas of uncertainty, through research either

undertaken by SNH or in collaboration with other parties, and making good use where appropriate of ongoing monitoring undertaken by developers who have operational developments.

82. **SNH will encourage development of the COWRIE and other research programmes to address the outstanding uncertainties and research needs identified in Annex 1.**

Comparison of impacts

83. While at this early stage of the development of the technologies it may be incautious to generalise, the review of impacts above suggests a hierarchy in terms of the likely significance of their marine and coastal natural heritage impacts:

LEAST NATURAL HERITAGE IMPACT

↑

Offshore wave devices appear to offer major generation opportunities in return for relatively limited natural heritage impacts, particularly if moored (rather than bottom-founded) devices can be developed, if sited well offshore and outwith valued seascapes, and provided that risks in relation to navigation can be adequately addressed.

Tidal stream devices, provided they are not sited in confined high current velocity channels likely to be of natural heritage value, also appear to offer significant generation opportunities in return for limited natural heritage impacts, especially if they are below surface and allow sufficient navigational clearance.

Shoreline wave devices may have a significant impact on coastal landscapes. Shoreline wave devices are most appropriate where such built development on the shoreline is compatible with the existing nature of shoreline development or coastal protection works; or elsewhere where any adverse impacts on the landscape or wild qualities of an undeveloped coast can be justified with reference to the quantity of energy capture or the experimental value of the device.

Offshore wind farms are likely to have an appreciable impact on the natural heritage, in terms of species (notably birds), landscape, and the pollution consequences from navigational risk. In general, landscape and visual impacts as viewed from land will diminish with distance from the coast, though this may be less true within enclosed waters or estuaries.

Tidal barrage schemes are likely to have major impacts on the natural heritage, particularly of shoreline soft sediment habitats. Small-scale schemes, and tidal generators installed within an existing barrier or causeway, may have more limited impacts.

↓

MOST NATURAL HERITAGE IMPACT

All the above technology types may be expected to be comparable in terms of the impact of any landward transmission lines which are required.

84. Despite the length of the list of key issues described above in paragraphs 46-84, the potential impacts of most of these technologies appear moderate relative to the impacts of land-based types of renewable energy.

Large scale hydro-electric power, for example, is associated with large concrete dams, extensive landscape change, transformation of water bodies and disturbance to fisheries. Onshore windfarms have major visual and landscape impacts, often at closer range to people than for offshore windfarms and in areas more highly valued for their landscape, and they require extensive installation of vehicle service tracks. The impacts of windfarms on terrestrial bird populations, too, have to be carefully considered, in relation to nesting sites and feeding habitat. Again as an overall generalisation, our judgement is that all of the above marine renewable technologies – with the exception of tidal barrage schemes - have the potential for lesser natural heritage impact than for comparable energy generation onshore, assuming they are sensitively sited and designed.

Locational considerations

85. There is a need, as early as possible in the development cycle of marine renewables, to move towards a locational strategy which will enable investment in marine survey, and land-based infrastructure such as an enhanced transmission grid, to be targeted efficiently. Such a strategy should have regard to the categorisation of coastal areas within NPPG 13 ‘Coastal Planning’ as developed, undeveloped or isolated, with a presumption against new development on isolated coasts and a caution against development within undeveloped coasts unless there are no alternative sites. Though NPPG 6 ‘Renewable Energy Developments’ makes clear that offshore wind and wave developments may have specific locational requirements which require exceptions to these general policies to be made, one role of a marine renewables locational strategy should be as far as possible to secure this broad coastal planning framework.

86. Government is required under the terms of a European Directive to develop an Integrated Coastal Zone Management Strategy (ICZM) by 2006. Such a strategy for Scottish waters should be seen as helping to develop a framework for the development of marine renewable energy. It will be important that the Scottish Coastal Forum, in developing a draft ICZM Strategy for Scotland, includes adequate reference to marine renewable energy.

<u>Marine designations</u>

87. The marine ecosystem is highly interconnected, with mobility of many species over long ranges. Therefore, approaches to the management and conservation of the marine environment need to be founded more widely than relying on the identification and safeguarding of protected areas. A wide variety of regulatory mechanisms may be used, tailored to the different uses made of the sea. Spatial planning and zoning can play a strong role in securing

such good overall integrated management. Protected areas can play a role within such spatial planning, but may be ineffective if established in isolation from other measures.

88. Some forms of marine protected area may be compatible with renewables development: for example a fishery exclusion zone could be utilised for an offshore wind farm. Marine Natura 2000 sites, however, will be subject to a requirement that any development should not have an adverse effect on the integrity of the site. Any renewable energy proposals would require an appropriate assessment to demonstrate that they do not have such impacts. In general, in areas designated specifically to protect the marine natural heritage, or in habitats of special importance for protected species, marine renewable energy developments should not be permitted if they could have a significant adverse impact on the natural heritage subject to protection.

89. In addition a number of marine habitats and species have more general protection under the EU Habitats Directive. Special consideration is likely to be needed to protect habitats such as biogenic reefs, and cetacean movement and feeding zones, outwith the confines of marine designations.

<u>Non-natural heritage siting constraints</u>

90. All offshore marine renewable proposals will have to take account of a number of general siting constraints which relate to interests other than the natural heritage. The most important are likely to be:

Avoid:

- existing undersea cables or pipelines (though it may be highly appropriate to route additional cables alongside)
- ammunitions dump areas
- MoD firing ranges or undersea test or training areas
- areas allocated to mineral extraction by dredging (Tay and Forth)
- wrecks and other areas of archaeological merit
- prime fisheries areas
- shipping corridors and areas where navigation is difficult
- (offshore wind only): areas which will interfere with MoD or airport radar

91. In addition an overriding constraint will be the need for sufficient landward grid capacity close to an adjacent shoreline.

<u>Strategic environmental assessment</u>

92. In its 'Future Offshore' proposals in December 2002, DTI set out proposals for a strategic environmental assessment (SEA) to be conducted of three areas of coastal waters in which offshore wind

developments might be licensed. While this approach is welcome, there were some deficiencies:

- environmental assessment was not formally deployed in the selection of these three areas;
- the timescale for the SEA, driven by the need to have generation in place before 2010, was inadequate;
- the SEA was restricted to offshore wind.

93. In Scotland there is an opportunity to deploy SEA in advance of any significant scale marine renewable development (with the exception of Robin Rigg which is already approved). A Scottish SEA for marine renewables could make a substantive contribution to proposals for Integrated Coastal Zone Management.

94. **SNH recommends that an SEA be undertaken covering all Scottish waters (and adjacent UK waters), and including offshore wind, wave and tidal stream technologies. The SEA should be timed to enable completion by late 2005, in the expectation that the period 2005-2010 will begin to see developers' commercial interest in marine renewable schemes.**

Conclusions

95. **Having reviewed the potential impacts of marine renewable energy developments on the natural heritage, SNH strongly encourages exploration of marine renewable energy resources with a view to these making a significant contribution towards overall Scottish renewable electricity targets.**

96. **SNH considers that, if sensitively designed and sited, marine renewables have the potential to have a lesser adverse effect than land-based renewable developments of a comparable capacity. Offshore wave and tidal stream generators appear to have the potential to make least impact.**

97. **SNH recommends that in pursuing such development, the following principles should be adopted:**

- **a Strategic Environmental Assessment should be undertaken for all marine renewable technologies, as outlined in the preceding section;**
- **the incentives available to developers, whether by grants or through the Renewable Obligation (Scotland), should be sufficient to facilitate a substantial contribution to Scotland's renewable electricity mix from marine renewables, if engineering challenges are satisfactorily overcome;**

- **if sites are properly selected, offshore wave and tidal stream appear, provisionally, to be the technologies offering the most abundant generation capacity in return for the least natural heritage impact;**
- **in general SNH is likely to oppose tidal barrage development unless a tidal barrage forms a component of a structure required for other purposes;**
- **underwater transmission requirements, landfalls and associated onshore transmission should be carefully coordinated and sited;**
- **in areas designated specifically to protect the marine natural heritage, or in habitats of special importance for protected species, marine renewable energy developments should not be permitted if they could have a significant adverse impact on the natural heritage subject to protection;**
- **support should be directed at resolving the environmental uncertainties identified in Annex 1; and**
- **it will be important to monitor and obtain feedback on the environmental impacts of first and second generation developments, so as to guide the further development of the industry.**

98. These conclusions are necessarily of a provisional nature, until such time as real and practical experience has been amassed on marine energy developments and their predicted and actual environmental impacts. SNH intends to revisit and refine this statement once such experience is gained.

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Tables 1-6: Summary of principal impacts and potential mitigation measures

1 Underwater cabling
2 Offshore wind farms
3 Offshore wave
4 Tidal stream
5 Shoreline wave
6 Tidal barrage

Impact significance:

In identifying levels of significance, the following key has been used:

* likely to have some impact on this aspect of the natural heritage. May require design attention but unlikely to be a determining factor in a consent decision

** potential for an impact on this aspect of the natural heritage which will require formally agreed mitigation measures before the proposal would be deemed acceptable

*** potential for an impact on this aspect of the natural heritage of such significance that this would justify refusal of consent

(Impacts rated ** and above have been listed in the main text)

Uncertainty:

In identifying levels of uncertainty, the following key has been used:

* some uncertainty, but outcome is sufficiently clear to enable a decision

** an area of substantial uncertainty, such that detailed work may be required in order to predict impacts, or the development may be allowed to proceed in a way which can be adapted to different levels of impact

*** true impacts are unknown, and prediction is currently little more than an educated estimate

It is important that these tables are not used as a full checklist for environmental assessment. Any environmental assessment is likely to address a much more detailed list of potential impacts. Also, this overview of significance assumes that the marine natural heritage which is potentially affected is not subject to special protection measures, eg by designation.

1 UNDERWATER CABLING

Impact category	impact detail	construction	operation	mitigation	significance	uncertainty
Hydrology						
Water quality	release of contaminated sediments	X		minimise disturbance of sediments. Avoid areas of contamination	*	
	turbidity from redistribution of sediments	X		minimise disturbance of sediments	*	
Marine habitats	habitat & species loss and disturbance	X		minimise disturbance of habitat. Ploughing has less impact than jetting	**	
Marine species	electromagnetic field effect on elasmobranches		X	Deep burial of cables	**	*** (COWRIE)
Birds	disturbance	X			*	
Landscape/ amenity	land-based connection to grid		X	siting within developed coasts; siting usually back from coastal edge; undergrounding cables	**	
Recreation						
Fisheries	risk of nets snagging		X	bury cables; use areas not used for fisheries	*	
Navigation						

2 OFFSHORE WIND FARMS

Impact category	impact detail	Construction	Operation	mitigation	significance	uncertainty
Hydrology	attenuation of waves and tides		X	good modelling at design stage	*	
Water quality	turbidity and habitat damage from turbine bases	X		use minimum profile foundations	*	
	leakage of pollutants in accidents	X		good environmental management	*	
	erosion of sacrificial anodes		X		*	
	use of antifoulants		X	adhere to best practice	*	
	leakage of hydraulics		X	good environmental practice	*	
Marine habitats	loss of soft sediment species through scour or sedimentation		X		*	
Marine species	underwater noise impacts on sea mammals and fish from piling, and from vibration	X	X	slow-start piling profiles	**	**

	underwater noise effects on fish and sea mammals from turbine operation, and servicing boats		X	bubble curtains	**	**
Birds	bird collision risk		X	avoid bird concentrations, minimise lighting	**	** does lighting have an effect on birds?
	displacement of birds, by turbines or service craft	X	X	avoid bird concentrations time construction operations to avoid critical periods	*	*
	barrier effect to birds		X	avoid regular transit routes, site at distance from shore	*	**
Landscape/ amenity	impact of temporary storage and handling areas	X		careful siting and management	*	
	impact on landscape and onshore visual amenity		X	site at distance from shore	**	
	lighting of turbines for sea and air navigation		X	minimum lighting; directional shielding	*	
	foghorns		X		*	
Recreation	exclusion of recreational craft from area adjacent to turbines	X	X	minimise exclusion area	*	
Fisheries	exclusion of fishery vessels		X		*	

	possible fish stock recovery zone		X	create beneficial habitats	*	**
Navigation	risk to passenger shipping – human life	X	X	lighting, foghorns, chart info, improved radar	***	**
	risk to cargo shipping – loss of goods and oil pollution	X	X	lighting, foghorns, chart info, improved radar	***	**

3 OFFSHORE WAVE

Impact category	impact detail	construction	operation	mitigation	significance	uncertainty
Hydrology	attenuation of waves impacting on adjacent sedimentation patterns and habitats		X	good modelling used to guide siting and design	*	*
Water quality	leakage of hydraulic fluids		X	good environmental practice	**	
	leakage of pollutants in accidents	X		good environmental management; contingency planning	*	
	erosion of sacrificial anodes		X		*	
	use of antifoulants		X	adhere to best practice	*	
Marine habitats						
Marine species	underwater noise effects on sea mammals and fish	X	X		*	** (COWRIE)
Birds	displacement of breeding seabirds	X	X	avoid concentrations of breeding seabirds and feeding areas	**	*
Landscape/ amenity	impact on seascape		X	care in choice of location	*	

	lighting for navigation		X	minimum lighting; directional shielding	*	
	foghorns		X		*	
Recreation	exclusion of recreational craft from area of wave generator	X	X	minimise exclusion area	*	
Fisheries	exclusion of fishery vessels		X		*	
Navigation	risk to passenger shipping – human life	X	X	lighting, foghorns, chart info	***	**
	risk to cargo shipping – loss of goods and oil pollution	X	X	lighting, foghorns, chart info	***	**

4 TIDAL STREAM

Impact category	impact detail	construction	operation	mitigation	significance	uncertainty
Hydrology	attenuation of tidal currents and impact on sedimentation patterns		X	good modelling at design stage	*	
Water quality	leakage of hydraulic fluids		X	good environmental practice	**	
	leakage of pollutants in accidents	X	X	good environmental management	*	
	erosion of sacrificial anodes		X		*	
	use of antifoulants		X	adhere to best practice	*	
Marine habitats	loss of habitats for turbine bases		X	avoid valued habitats (eg in high tidal velocities)	*	
	smothering of habitat and changes in food sources		X	avoid sensitive habitats	**	*
Marine species	underwater noise impacts on sea mammals and fish	X	X		*	** (COWRIE)
	collision risk with		X		**	***

	marine mammals					
Birds	underwater collision risk for deep-diving species		X	use minimum depth in areas of diving species	*	*
Landscape/ amenity	impact on landscape of any superstructure		X	careful siting; or avoid devices with superstructure	*	
Recreation						
Fisheries	exclusion area for use of nets		X	chart info	*	
Navigation	risk to passenger shipping – human life	X	X	chart info; avoid navigational channel, use minimum depth	***	**
	risk to cargo shipping – loss of goods and oil pollution	X	X	chart info; avoid navigational channel, use minimum depth	***	**

5 SHORELINE WAVE

Impact category	impact detail	construction	operation	mitigation	significance	uncertainty
Hydrology	change in shoreline sedimentation		X	good modelling		
Water quality						
Marine habitats						
Marine species						
Birds				avoid bird colonies and feeding areas	*	
Landscape/ amenity	impact on coastal landscapes		X	avoid areas of sensitive landscape	**	
	noise from some generator types		X	quiet generators; avoid areas used by public		
Recreation						
Fisheries						
Navigation						

6 TIDAL BARRAGE

Impact category	impact detail	construction	operation	mitigation	significance	uncertainty
Hydrology	change in sedimentation patterns		X		***	
Water quality	change from saltwater to freshwater or brackish		X		**	
Marine habitats	change from saltwater to freshwater or brackish benthic habitats		X		**	
Marine species	change in inshore marine habitats		X		**	
Birds	loss of shoreline wader habitats		X		***	
Landscape/ amenity	alteration of estuarine landscape – may have benefits as well as disbenefits		X		***	
Recreation	may offer protected waters for recreational craft		X		*	

Fisheries	change in estuarine fisheries; barrier to migratory fish		X	use of fish passes	**	
Navigation	interruption to estuarine navigation		X		**	

ANNEX 1

Outstanding uncertainties and research needs

These are the topics for which it seems likely that resolution of outstanding uncertainties will be most important in decision-making. Of the following, COWRIE has commissioned work in areas (A). SNH is commissioning work in area (B).

- impact of noise disturbance from marine renewables on fish and cetaceans (A)
- impact of electromagnetic fields from cables on fish stocks (A)
- mortality from bird collisions in the marine environment (A)
- displacement of birds from benthic feeding areas (A)
- sensitivity of Scottish seascapes to marine renewables development (B)
- concentrations of seaduck populations
- information on the abundance and patterns of movement of seabirds
- potential beneficial impact of device foundations on fish breeding
- the value of no-take zones in the Scottish marine environment
- exploration of lighting requirements and the use of shielding
- the effect of navigational and aircraft lighting for offshore wind turbines on bird collision risks
- the effect of estuarine developments on migratory fish species
- the effect of estuarine developments on carrying capacity for birds - and the potential for consequential impacts on UK populations
- the interaction of marine recreation users and offshore generators

The report [v] by Robert Gordon University on environmental impacts of tidal stream energy also identified the following topics as needing further examination:

- effects on tidal flow patterns, sedimentation processes and seabed morphology
- effects of support structures on the wave and tidal dynamics, and implications on sedimentation and seabed movement
- collision risk
- acoustic emissions
- vibrations and visual impacts
- ecological impact of installation and operation of tidal energy devices;
- Life Cycle Analysis
- need for toxic comparisons in antifouling prevention methods