Natural England Board

Meeting: 12
Date: 16 September 2008

Paper No: **NEB PU12 06**

Title: **Natural England's Draft Policy on Wave and Tidal Energy**

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1. Purpose

1.1. The purpose of this paper is to present a draft policy on Wave and Tidal Energy. It has been informed by the Board's workshop on energy (April 2008) and discussions with external stakeholders, and sits within the framework provided by Natural England's sustainable energy policy (approved in April 2008). The full draft policy is attached at Annex 1.

1.2. Natural England recognises that climate change represents the most serious long term threat to the natural environment. We support the need to move to a low carbon economy, which will require significantly more efficient use of energy and a substantial investment in clean energy technologies for electricity generation, heat and transport fuel.

1.3. This draft policy is one of three energy policies (the others being a draft policy on wind energy and an approved policy on bio-energy).

It sets out the principles for Natural England to:

- help realise the potential of these important clean energy technologies in ways that minimise unacceptable adverse or irreversible impacts on the natural environment;
- guide the location and development of potential wave and tidal energy infrastructure.

2. Recommendations

2.1. It is recommended that the Board consider and agree the draft policy prior to external consultation and sign off by Chair.

3. Summary of Context for our Draft Policy on Wave and Tidal Energy

3.1. The UK has some of the best wave and tidal resources in Europe, with the potential to provide a considerable proportion of the UK renewable power market in future decades. A range of estimates show that between 15% and 20% of the UK's current electricity demand could be met by wave and tidal stream generation. Tidal power is a politically attractive option as it is highly predictable compared with some other forms of renewable energy. This has important implications for managing an uninterrupted energy supply that is based on several different power generation technologies. A summary of the various technologies that generate electricity from the tidal and wave resources is set out in Annex 2.

3.2. The Government's UK Renewable Energy Strategy Consultation (June 2008) notes that wave and tidal stream technology is in its infancy and views its contribution as a longer term solution. It suggests that these technologies could provide 2% (2 GW) of the UK's current electricity needs by 2020, with this rising to around 30% (30 GW) by 2050. Tidal range technologies are more established, and could provide at least a further 5% of UK electricity supply.

3.3. Large scale tidal range developments - barrages and lagoons - are likely to result in significant changes to the morphology and ecology of estuaries. They will lead to reductions in tidal propagation and increased coastal erosion. Saltmarshes and mudflats will be exposed to more wind-driven wave energy, and estuary profiles will flatten out because increased wave erosion will be accompanied by the creation of a depositional sub-tidal environment that reduces parallel processes of accretion.

3.4. The impact of tidal stream technologies is expected to be less significant for the natural environment but current uncertainty points to the need for further investigation, particularly because:

- the restricted range of appropriate sites has a significant overlap with areas of high biodiversity and landscape interest;

- submerged turbines may present a risk to mobile species such as cetaceans and fish;

- extraction of wave and tidal energy may also impact on habitats and species which rely on high energy environments for their survival (e.g. for feeding on plankton in the water column).

3.5. It is likely that a significant proportion of the potential locations for tidal energy projects lie within SPAs or SACs or in areas identified as possible Natura 2000 sites. Casework associated with these technologies will have a major impact on our business over the next five to ten years.

3.6. In August 2007, the Sustainable Development Commission produced a report on tidal energy in the UK, which included an evaluation of proposals for harnessing Severn tidal power.

The report concluded that:

- developing a barrage in the Severn Estuary needed to be investigated, but must comply with the European Directives on habitats and birds;

- tidal stream, lagoons and wave powered devices needed to be further developed and tested, with further impetus from Government.

3.7. Following the publication of this report, the Government instigated a feasibility study into the Severn Barrage proposals, in which Natural England is fully engaged.

3.8. The Renewables Obligation from 2009 onwards will provide further impetus for investment in tidal and wave technologies, by doubling the certificates for wave, in-stream tidal and barrages and lagoons generating less than 1GW.

4. Summary of Natural England's Draft Policy for Wave and Tidal Energy

4.1. Natural England believes that:

4.1.1. Wave and tidal energy has an important role to play in helping mitigate climate change and in delivering the United Kingdom's targets for reducing greenhouse gas emissions through an increased capacity for the generation of renewable energy.

4.1.2. Wave and tidal energy developments, together with their ancillary infrastructure (including transmission lines, sub-stations and access roads), have the potential to impact upon the marine and terrestrial environment, seascapes and landscapes.

4.1.3. Many emerging technologies need further development and demonstration to understand, assess and monitor their impacts upon the natural environment, to enable their potential contribution to renewable energy generation to be realised.

4.1.4. Wave and tidal energy developments must be appraised on thorough evidence based consideration of their impacts on the natural environment. Sound evidence must support any assessment and appraisals must also include a full lifecycle assessment of the carbon balance.

4.1.5. Proposals for wave and tidal energy development need to seek solutions which are consistent with legislation to avoid, reduce or compensate for unacceptable impacts on the marine, terrestrial and intertidal environment, particularly on nationally and internationally important protected areas. Wave and tidal energy developments also have the potential to contribute to marine stewardship in general and marine protected areas in particular.

4.1.6. Transmission and grid connection must form part of all environmental assessments. Natural England will continue to monitor and input into the development of the new offshore transmission licensing regime, to ensure that all environmental considerations are factored in.

Annex 1

Wave and Tidal Energy Draft Policy

Context

In common with wind resources, the UK has some of the best wave and tidal resources in Europe, with the potential to provide a considerable proportion of the UK renewable power market in future decades. There is a range of estimates which show that between 15% and 20% of current UK electricity demand could eventually be met by wave and tidal stream energy. Tidal power is highly predictable compared with some other forms of renewable energy and this has important implications for managing an uninterrupted energy supply that makes use of several different power generation technologies. A summary of the various technologies that generate electricity from the tidal and wave resources is set out in Annex 2

One of the Government's key long-term goals for energy policy is to cut carbon dioxide emissions by 60% by 2050, with real progress by 2020. Reductions in energy consumption, coupled with a real increase in renewable energy generation are integral parts of achieving this aim.

Government initially set a target of achieving 10% of electricity supply from renewable energy by 2010. This has now been superseded by a binding target of 20% of EU energy consumption to come from renewable sources by 2020, together with an agreement to cut carbon dioxide emissions by 20% on 1990 levels by the year 2020 and to reduce national energy consumption by 20%.

The UK is now negotiating what proportion of the EU's 2020 renewable energy target it will need to meet, and this is currently 15%. To achieve these targets, there will need to be a sizeable increase in investment in many forms of cleaner energy, including renewable energy and cleaner fossil fuel technologies, coupled with significant energy efficiency measures.

To put the renewable energy target in perspective, in 2006, 1.2% of total UK energy consumption came from renewables, with 4.6% of total electricity generation produced through renewables, predominantly from wind energy, sewage and landfill gas, co-firing biomass in power stations and large scale hydro-electric generation.

Government has issued its Renewable Energy Strategy (June 2008) for consultation. This recognises the potential long term contribution of wave and tidal stream generation, but that the technology is in its infancy and unlikely to make a significant contribution by 2020. It proposes that 2% (around 2GW) of the UK's current electricity needs could come from wave and tidal stream power by 2020, rising to 30GW by 2050. Tidal range technologies (e.g. barrages such as the Severn) could provide at least a further 5GW of UK electricity supply.

In August 2007, the Sustainable Development Commission produced a report on tidal energy in the UK, which included an evaluation of proposals for a Severn Barrage. The report concluded that developing a barrage in the Severn Estuary needed to be investigated, but must be compliant with the European Directives on habitats and birds. It also concluded that tidal stream, lagoons and wave powered devices needed to be further developed and tested, with further impetus from Government.

Following the publication of this report, the Government instigated a feasibility study into the Severn Tidal Power options. A tidal power scheme on the Severn is particularly significant because of the scale and nature of the estuary (it is a hyper-tidal estuary with the second highest tidal range in the world). Tidal barrages have also been proposed across other estuaries around the English coastline (e.g. proposals for a Mersey barrage are currently at pre-feasibility stage). In exploring these opportunities, the Government has affirmed its commitment not to seek derogation of relevant European Directives.

The Renewables Obligation from 2009 onwards will provide further impetus for investment in tidal and wave technologies, by doubling the certificates for wave, in-stream tidal, barrages and lagoons generating less than 1GW.

Issues

Large scale tidal barrages and lagoons will result in significant changes to the natural environment. They affect large physical areas and can affect whole populations of species. Their impact on the morphology and ecology of estuaries involves reductions in tidal propagation, increased erosion from wind-driven waves and a reduction in the propensity for sediment deposition in inter-tidal environments. As a result, saltmarshes and mudflats are likely to erode, and estuary profiles will flatten out. The Eastern Schelde in Holland provides an important analogue that underpins these concerns[1]. Other important analogues include reservoirs which suffer wave-induced erosion. Barrages are also likely to have pronounced terrestrial impacts in terms of transmission, mineral extraction and associated ancillary development.

Tidal lagoons are likely to have a major impact upon the habitats within which they are situated. The technology is as yet untested and needs more work and modelling of the potential impacts.

The impact of tidal stream technologies is expected to be less significant, but there is considerable uncertainty and a need for further investigation, particularly because the restricted range of appropriate sites significantly overlaps with areas of high biodiversity and landscape interest. Submerged turbines may present a risk to mobile species such as cetaceans and fish. The extraction of wave and tidal energy may also impact on habitats and species which rely on high energy environments for their survival (e.g. for feeding on plankton in the water column). The full environmental impacts of these developing wave and tidal technologies are not well understood and further research is needed to ascertain their full implications.

A significant number of the potential locations for tidal energy projects lie within designated SPAs or SACs or in areas identified as possible Natura 2000 sites.

Policies

1. Role of wave and tidal energy

We believe wave and tidal energy has an important role to play in helping mitigate climate change and in delivering the United Kingdom's targets for reducing greenhouse gas emissions through increasing the capacity for the generation of renewable energy.

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[1] Pethick, J.S., Morris, R.K.A. & Evans. D. (in press). Nature conservation implications of a Severn tidal barrage – a preliminary assessment of geomorphological change. Submitted to the *Journal for Nature Conservation* and undergoing review.

The UK Government is committed to reducing greenhouse gas emissions, with reductions in energy consumption and increases in renewable energy generation part of achieving this long term aim. The Climate Change Bill is likely to set legally binding targets of 60% reduction on carbon dioxide emissions from 1990 levels by 2050, with an interim target of 22% reduction by 2020. The EU has also set a binding target of 20% of EU energy consumption to come from renewable sources by 2020. The UK contribution to this is under negotiation, and is likely to be 15%. The target has significant implications for electricity generation in the UK, with the proportion of electricity generation required from renewable sources expected to increase from less than 5% today to at least 32% by 2020 (an increase from 19 TWh to 120 TWh).

Evidence

Current wave and tidal generation accounts for a small fraction of total UK generation, with only two wave device schemes exporting 1.25 MW (0.001% of generating capacity) to the national grid. BERR predict that tidal range technologies (barriers and lagoons) could provide at least 5% of UK electricity supply, with wave and tidal stream technologies providing a further 2% (2 GW) of the UK's current electricity needs by 2020, potentially rising to around 30% (30 GW) by 2050.[2]

2. Impact of wave and tidal energy developments

We believe that wave and tidal energy developments, together with their ancillary infrastructure (including transmission lines, sub-stations and access roads), have the potential to impact upon the marine and terrestrial environment, seascapes and landscapes.

Different energy developments have different impacts on the natural environment, in terms of scale, significance and reversibility, dependent on the technology and location. A strategic approach is needed to any significant expansion of wave and tidal generation, with a strategic assessment of the impact of the UK's sustainable energy requirements and the optimal energy mix for mitigating climate change and minimising harm to the natural environment. Smaller scale wave and in-stream tidal technologies are likely to have less environmental impact.

Evidence

Wave and tidal energy generation are embryonic technologies, and therefore evidence on their impacts on the natural environment does not yet exist. Although barrages too, in the UK, are an embryonic technology evidence does exist from elsewhere. Barrages create a physical block or "throttle" within a water-body such as an estuary. This affects tidal propagation and consequently tide levels fall. Most of the immediate impact lies in the upper inter-tidal zone where saltmarshes cease to be inundated on higher tides and change from halophytic communities towards ruderal mesotrophic grasslands. Evidence of this can be found from published studies on the Eastern Schelde where a storm surge barrage was completed in 1987[3]. Subsequent changes arise from progressive erosion processes largely influenced by wind-driven waves but underpinned by the reduction in tidal energy that is responsible for mobilising and re-depositing sediment in the inter-tidal zone. Lower

[2] Renewable Energy Consultation (2008) drawn from BWEA. Path to Power (2005) and UKERC. Marine (wave and tidal current) Renewable Energy Technology Roadmap (2008).
[3] Mulder, J.M.P. and Louters, T. 1994. Changes in basin geomorphology after implementation of the Oosterschelde estuary project. *Hydrobiologia* **282/283:** 29-39.

tidal range means lower levels of sediment mobilisation and consequently sediment lost from erosion events is not redeposited during quiescent periods. There are further analogues provided by freshwater reservoirs, including several big examples in the USA such as Lake C.W. McConaughy in Nebraska[4]. In-stream technologies do not impart these considerable physical changes and are consequently likely to be comparatively benign in this respect.

3. Development of technologies

We believe many emerging technologies need further development and demonstration to understand, assess and monitor their impacts upon the natural environment, to enable their potential contribution to renewable energy generation to be realised.

The UK is emerging as a global leader in marine energy technology, although it is still evolving and many questions remain over site suitability and possible environmental impacts.

At least thirty suitable tidal stream locations have been now been identified around the UK and the UK is at the forefront of the development of these technologies. One tidal stream prototype, currently supported under BERR's Technology Programme, is the Seaflow project, which has been demonstrated full-scale off the north Devon coast since June 2003.

There are also three wave power devices in operation in the UK. The LIMPET (Land Installed Marine Powered Energy Transformer), a 500 KW shoreline oscillating water column on the Scottish island of Islay; SeGen commercial tidal energy system in Strangford Lough, Northern Ireland, which at 1.2MW capacity is currently the world's largest tidal device; and a 750 KWt Pelamis sea snake, a hinged contour device that is the first deep-water grid-connected trial, currently installed at the European Marine Energy Centre, Scotland where it is undergoing testing.

It is estimated that wave energy has the potential to provide as much renewable energy as the wind industry, but the development of wave technology is currently at the same level as the wind industry was 10 years ago.

The concept of generating electricity from tidal barrages has existed for over 100 years. There is though limited global experience, with the largest and oldest electricity-generating barrage at La Rance, France, opened in 1966. This 240 MW barrage has demonstrated the long term feasibility of barrages, but due to a lack of baseline data, provided little evidence of the effect of the barrage on the estuarine environment.

Tidal lagoons are a totally untested technology, with no current overseas examples in operation, although a proposal has been put forward for a scheme in Swansea Bay.

Evidence

As these are embryonic technologies, evidence is very limited. A marine current turbine has been trailed off the North Devon coast, and has demonstrated the technology in harsh environment. Another trial of tidal stream technology has been consented in the Humber Estuary. There will be up to 4 wave devices tested at WaveHub off the north Cornwall coast

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[4] Joeckel, R.M. & Diffendal Jr., R.F., 2004. Geomorphic and environmental change around a large, ageing reservoir: Lake C.W. McConaughy, Western Nebraska, USA. *Environmental and Engineering Geoscience* **Vol. X**(1): 69-90.

4. Appraisal of proposals

We believe that wave and tidal energy developments must be appraised on thorough evidence based consideration of their impacts on the natural environment. Sound evidence must support any assessment and any appraisal must also include a full lifecycle assessment of the carbon balance.

Wave and tidal developments will have a range of impacts, potentially including impacts on nature conservation, landscape, geological features, recreation and cultural interests and the historic environment. Some projects such as barrages have the potential to be highly detrimental to flood risk management on the coast[5] and could lead to much higher levels of public expenditure on flood defence which could have wider ramifications for the natural environment.

Evidence

The Sustainable Development Commission in their assessment of the potential for tidal energy in the UK, noted that tidal energy installations, regardless of their size would have varying levels of environmental impact, which will require varying levels of environmental assessment and monitoring for consenting purposes. Such schemes will also require environmental baseline assessment and monitoring as part of an Environmental Impact Assessment.[6]

The Countryside Council for Wales undertook a literature review to assess 43 marine renewable energy devices, including wave and tidal devices. The study assessed the environmental changes anticipated from the separate devices, with an assessment of the potential magnitude of those changes at a variety of marine locations with varying levels of sensitivity. The report highlighted a number of gaps in the available knowledge base and its limited scope.[7]

Scottish Natural Heritage has also undertaken a review of the key issues and environmental impacts of the developing marine renewable energy industry in Scotland. It concluded that *"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."*[8]

5. Impacts on marine and intertidal environment

We believe proposals for wave and tidal energy development need to seek solutions which are consistent with legislation to avoid, reduce or compensate for unacceptable impacts on the marine, terrestrial and intertidal environment, particularly on nationally and internationally important protected areas. Wave and tidal energy developments also have the potential to contribute to marine stewardship in general and marine protected areas in particular.

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[5] Van Zanten, E. & Adriaanse, L., 2008. *Verminderd getij: Verkenning naar mogelijke maatregelen om het verlies van platen, slikken enshorren in de Oosterschelde te beperken*. Hoofdrapport. Rijkswaterstaat. 80pp. – This document outlines the major expenditure programme being developed by the Dutch to rectify the impact of the Eastern Schelde barrage.
[6] SDC. Turning the Tide (2007).
[7] CCW. Potential impact of marine renewable energy developments (2005).
[8] SNH. Marine Renewable Energy and the Natural Heritage (2005).

Natural England has a statutory duty to advise on the impacts of development on protected areas, including those designated for nature conservation and landscape reasons.

Wave and tidal developments affecting Natura 2000 sites must be considered within the framework set by European legislation, and specifically will need to be compliant with the European Directives on Habitats and Birds. For any development to proceed on a Special Areas for Conservation (SAC) or Special Protection Areas (SPA), the Habitats Regulations require that any proposal which is going to have an adverse effect on the protected site must pass through a series of tests, culminating in, if the developments are consented, a requirement for compensatory habitat. The scale of this habitat creation is likely to be of a magnitude significantly in excess of any habitat creation undertaken to date in the UK, and it is not yet clear that issues affecting all habitats and species can be adequately resolved.

A number of estuaries, including the Severn, are bordered by AONBs and Exmoor National Park. The implications for landscape and seascapes will need to be fully considered.

<u>Evidence</u>

Natural England is proceeding with the identification of a network of Marine Protected Areas which will include the European SACs and SPAs and nationally important Marine Conservation Zones (MCZ) off the English coast. The nature of some of these sites such as offshore reefs in high tidal streams and areas of open water means they are also likely to be favoured for wave and tidal energy projects. Estuaries such as the Severn, Mersey and Solway, together with embayments such as Morecambe Bay, which are of interest for tidal range developments, support extensive sandflats, mudflats and saltmarshes which are home to a very significant proportion of the western European population of wildfowl and wading birds. All of these sites are afforded the highest level of nature conservation protection, with designations ranging from SPAs and SACs under the EC Birds and Habitats Directives respectively; to Ramsar Sites under our obligations as a signatory to the Ramsar Convention on wetlands of international importance; Sites of Special Scientific Interest; and in the case of MCZs, the forthcoming Marine Bill/Act. Solutions which are consistent with the relevant legislation to avoid, reduce or compensate for impacts will be required.

There is also potential for wave and tidal energy developments to contribute to marine stewardship in general and marine protected areas in particular through managing other more harmful activities on the seabed at particular sites. The evidence for this can be seen at a number of fisheries exclusion zones around the UK but still has to be demonstrated at a renewable energy generation site.

6. <u>Transmission and grid connection</u>

We believe that transmission and grid connection must form part of all environmental assessments. Natural England will monitor and input into the development of the new offshore transmission licensing regime, to ensure that all environmental considerations are factored in.

As the more productive wave, tidal and wind energy resources are predominantly in the north and west of the country, these are likely to be away from existing high-capacity grid connections and transmission lines. There is therefore likely to be a need for significant upgrading and extension of the grid, with the landscape and environmental impact of transmission lines, pylons and sub-stations[9].

Laying cables in marine or coastal locations can also have a range of environmental impacts, including damage to sensitive habitats, disturbance to marine mammals from construction noise and impacts upon fish movements and populations.

Evidence

We have evidence on the impacts of high power transmission lines from our experience in managing wind energy casework. As well as the disturbance issues arising from construction, we believe that the electro-magnetic field which can be generated by under-water transmission lines can affect the behaviour of sharks, rays and eels, although the significance of this impact appears unlikely to be biologically significant[10]. Armouring or burying the cables may further reduce the potential for any impact on even sensitive species, while appropriate planning of cable routes, or avoiding installing of the cables during sensitive periods, may also help to reduce the potential for any impact.

[9] JNCC. Energy and Nature Conservation (2008).
[10] DRAFT COWRIE 2.0 Electromagnetic Fields (EMF) Phase 2, May 2008, A.B. Gill et al

Annex 2

Wave and Tidal Energy Technologies

Electricity generation from the tides utilises the energy that drives the tidal cycle within estuaries and along the shoreline. These currents can be exploited to turn turbines to produce electricity.

- Tidal range technologies use the difference in water height between high and low tide by impounding – in barrages and lagoons - volumes of water at high tide, then releasing it through turbines at lower tide levels.
- Tidal barrages involve proven technology with one example in France and another in Canada. They have been built to exploit the natural process of water levels rising and falling within estuaries. They fill on the rising tide after which sluices are shut and the system undergoes a period of inactivity until a sufficient "head" of water has developed as the tide outside falls. The differential in height between the water within the barrage and that on the declining tide means that water drops through turbines which then generate electricity in the same manner as other hydroelectric projects.
- Tidal lagoons are also larger scale constructions built to exploit the natural process of water levels rising and falling, but they are not necessarily confined to estuaries. They work by constructing a ring structure to temporarily trap and release tidal flows, to generate electricity – in a similar manner to barrages. They are, however, an untested technology.
- Tidal stream (or marine current) technology involves underwater structures that support turbines that are placed in a naturally occurring high energy tidal stream. Tidal streams are sea currents whose speed is magnified by topographical features such as headlands, inlets and straits. The technology used for tidal streams differs from tidal barrages because it involves the suspension of turbines in a high energy sub-tidal environment (i.e. similar to submerged wind turbines). This is relatively new technology that is expected to operate in challenging environments where the energy regime creates massive strains on infrastructure
- Tidal fences are an example of tidal stream technology that can have similar environmental impacts to that of barrages, if deployed across the breadth of a body of water. The advantage of a tidal fence is that all the electrical equipment (generators and transformers) can be kept high above the water. Also, by decreasing the cross-section of the channel, current velocity through the turbines is significantly increased. The first large-scale commercial fences are likely to be built in South East Asia. The most advanced plan is for a scheme across the Dalupiri Passage in the Philippines that is expected to generate up to 2200 MW of peak power (with a base daily average of 1100 MW).
- Wave energy unlike tidal range or tidal stream technologies, takes advantage of continuous displacement by wave activity and involves structures that are placed on the sea bed or floated on the sea surface. They can be deployed either on the shoreline or in deeper waters offshore.