

By e-mail

Charles Hendry
The Hendry Review of Tidal Lagoons
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Dear Mr Hendry

UK Review of Tidal Lagoons

Thank you for giving the Natural Resources Body for Wales (Natural Resources Wales) the opportunity to provide evidence on the UK Review of Tidal Lagoons.

The statutory purpose of Natural Resources Wales (NRW) is set out under the Environment (Wales) Act 2016. In the exercise of its functions under the Environment (Wales) Act 2016, NRW must pursue sustainable management of natural resources in relation to all of its work in Wales, and apply the principles of sustainable management of natural resources in so far as that is consistent with the proper exercise of its functions. NRW's duty (in common with the other public bodies covered by the Well-Being of Future Generation (Wales) Act 2015) is to carry out sustainable development as defined. NRW are also advisors to the Welsh Government on the natural heritage and resources of Wales and its coastal waters.

Our comments are therefore provided in the context of NRW's statutory purpose, functions, powers and duties.

With respect to tidal lagoon developments, NRW has a number of main roles:

- As a statutory advisor to UK Government and other planners such as The Crown Estate on development plans and strategic assessments of those plans.
- As a statutory advisor to decision-making authorities on project development under a wide range of legislation.
- As a licensing authority for a range of activities associated with tidal lagoon development under the Marine & Coastal Access Act 2009 (acting on behalf of Welsh Ministers); the Conservation of Habitats and Species Regulations 2010; the Wildlife & Countryside Act 1981; the Environmental Protection Act 1990; the Water Resources Act 1991, and the regulatory regimes introduced by the Pollution Prevention and Control Act 1999.

Given that potential lagoon projects also lie in English and Scottish waters, we recommend that the Review team also engages with English and Scottish organisations, especially Natural England, Environment Agency, the Marine Management Organisation, Marine Scotland, Scottish Environment Protection Agency and Scottish Natural Heritage.

NRW has gained considerable experience and understanding of the potential environmental effects of tidal range projects and possesses a range of expertise that is relevant to the consideration of the environmental implications of lagoon developments. NRW therefore welcomes the Review and is keen to contribute advice and expertise as it develops. At this stage, however, we have restricted

this response to high-level comments but would welcome the opportunity to provide more detailed written or oral evidence if considered appropriate.

NRW supports initiatives which expand energy generation from low carbon sources while minimising unnecessary impacts on the environment. In practice NRW believes that Government and other decision-makers, with the support of their advisors, must aim to steer the right kind of development to the right place.

This evidence submission highlights legislative requirements driven by European Union (EU) Directives. It is our understanding that in relation to EU derived legislation it is currently business as usual in terms of implementation, until and unless there are any agreed legislative changes. It is also worth noting that much of the environmental legislation that is derived from these Directives has been transcribed into UK law.

Our submission focuses on a number of important themes that we believe to be of particular significance to the Review from an environmental perspective. These include:

- The nature of the tidal lagoons as novel but complex developments
- The need for a strategic policy process to guide planning and decision making
- The complexity of interactions between lagoons and the environment and the effect of environmental legislation on decisions
- The potential benefits of tidal lagoons
- The need to build an evidence base to inform planning and decision-making
- The role of the consenting process in lagoon development

In summary, NRW is supportive of the sustainable development of natural resources, including renewable energy generation projects that are at appropriate locations and that ensure the sustainable management of natural resources. We consider that the best way to provide clarity and certainty would be through a UK-wide programme of development within a framework reflecting the policy and strategic planning priorities of Government including the devolved administrations.

Our comments are made without prejudice to any advice we may need to give, or decisions we may need to take, in a project specific context in respect of any current or future lagoon project.

I hope that you find these comments helpful. If you would like to discuss any of the points we have raised, please contact Nia Phillips (Nia.Phillips@cyfoethnaturiolcymru.gov.uk) in the first instance.

Yours sincerely,



Ceri Davies
Executive Director for Knowledge, Strategy and Planning

SUMMARY OF KEY MESSAGES

Strategic planning and policy

- A strategic, spatial and evidence-based approach to planning and assessment will be needed as a matter of urgency should UK Government decide to promote a programme of tidal lagoon development.
- A National Policy Statement for tidal lagoons - informed by the appropriate level of assessment of its environmental implications - would be a major benefit to the development of the sector, and would allow for opportunity to be maximised whilst at the same time minimising significant environmental risk.

Environmental effects and implications of environmental legislation

- The findings of the Severn Tidal Power Feasibility Study with respect to environmental considerations and concerns remain valid. Typically, the main effects of concern relate to: flood risk management; loss of intertidal habitat; hydrodynamic and morphodynamic changes to the physical environment; impacts on migratory and mobile species, and the consequent implications for areas that are designated because of their importance for biodiversity; water quality management and fisheries.
- Managing issues such as: far-field effects, compensatory measures, flood risk management and in particular cumulative effects, will be very challenging at the individual project level and will require a more strategic approach to planning and assessment.
- It may not be possible to mitigate for some effects at all and, where this is the case, legal derogations will be needed if projects are to proceed, which in themselves will prove challenging: numerous derogations from formal Water Framework Directive assessment procedures are likely to be required, and it may not be possible to design compensatory measures that satisfy accepted current interpretations of legal requirements.

Potential benefits

- There may be benefits to natural resource management as a result of lagoon development, for example in flood defence. However, the benefits for, and impacts upon, flood defence and coastal erosion are finely balanced and will be subject to locally specific considerations.

Evidence

- Government should continue to support ongoing research including that via the Offshore Energy Strategic Environmental Assessment programme, but also by appropriate allocation of funds to research identified by the Offshore Renewables Joint Industry Programme Ocean Energy prioritisation work.

Consenting and assessment process

- Systematic, comprehensive and rigorous scoping of project effects is essential at an early stage of project design and should be strongly encouraged.
- Adaptive management is a useful way of dealing with residual and unforeseen uncertainty, but it is not a substitute for Environmental Impact Assessment, and, in itself also raises complex issues, especially for permanent structures where options for subsequent intervention may be limited.
- NRW considers that decommissioning options can only be meaningfully considered close to the time of decommissioning itself and that all options (removal, partial removal or retention) should be retained up until that point.

TIDAL LAGOON DEVELOPMENT

1. The European Union has adopted targets for the production of renewable energy. As a result of these targets, the UK Government is required, under the Renewable Energy Directive 2009, to ensuring that 15% of its energy demands will be met from renewable resources by 2020.
2. With respect to marine sources of renewable energy, the UK Government has to date mainly relied on the deployment of offshore wind to contribute to the targets. However, tidal range generation has the potential to help the UK reach its commitments by providing the country with a source of low-carbon, clean, reliable and secure energy.
3. The tidal lagoon sector remains in its infancy but proposed developments are already large, complex and mainly untested. Furthermore, information about the marine environment is often limited; for instance, much less is known about the distribution, behaviour and ecology of marine life than of terrestrial ecosystems, and acquiring new information is expensive and time-consuming.
4. These challenges mean that there is a great deal of uncertainty about the likely impacts and interactions of tidal range deployments with the marine environment.
5. Tidal lagoon projects are subject to several licences and permissions. The main (non-exhaustive) list of consents are:
 - Development Consent Order (DCO) under the Planning Act 2008¹;
 - Marine Licence (ML) under the Marine and Coastal Access Act 2009²;
 - Various Planning Permissions under the Town and Country Planning Act 1990³ not covered under the DCO;
 - Potentially a Harbour Revision Order under the Harbours Act 1964⁴, to extend Local Planning Authority jurisdiction;
 - Environmental Permits under the Environmental Permitting (England and Wales) Regulations 2010⁵;
 - Seabed lease from the Crown Estate Commissioners under the Crown Estates Act 1961⁶.
6. Some of the consents listed above will also require complex statutory assessment such as:
 - Environmental Impact Assessment under the Infrastructure Planning (Environmental Impact Assessment) Regulations 2009⁷ and the Marine Works (Environmental Impact Assessment) Regulations 2007⁸;
 - Habitats Regulations Assessment under the Habitats Directive 1992⁹ and Conservation of Habitats and Species Regulations 2010¹⁰, as amended;
 - Water Framework Directive compliance assessments under the Water Framework Directive 2000¹¹.

¹ The Planning Act 2008 <http://www.legislation.gov.uk/ukpga/2008/29/contents>

² The Marine and Coastal Access Act 2009 <http://www.legislation.gov.uk/ukpga/2009/23/contents>

³ The Town and Country Planning Act 1990 <http://www.legislation.gov.uk/ukpga/1990/8/contents>

⁴ The Harbours Act 1964 <http://www.legislation.gov.uk/ukpga/1964/40/contents>

⁵ The Environmental Permitting Regulations 2010 http://www.legislation.gov.uk/uksi/2010/675/pdfs/uksi_20100675_en.pdf

⁶ The Crown Estates Act 1961 <http://www.legislation.gov.uk/ukpga/Eliz2/9-10/55/contents>

⁷ The Infrastructure Planning (Environmental Impact Assessment) Regulations 2009

http://www.legislation.gov.uk/uksi/2009/2263/pdfs/uksi_20092263_en.pdf

⁸ The Marine Works (Environmental Impact Assessment) Regulations 2007 <http://www.legislation.gov.uk/uksi/2007/1518/contents/made>

⁹ The Habitats Directive http://ec.europa.eu/environment/nature/legislation/habitatsdirective/index_en.htm

¹⁰ The Conservation of Habitats and Species Regulations 2010 <http://www.legislation.gov.uk/uksi/2010/490/contents/made>

¹¹ The Water Framework Directive http://ec.europa.eu/environment/water/water-framework/index_en.html

7. These challenges and uncertainties result in a highly complex consenting and assessment landscape for tidal lagoon infrastructure deployment.

THE NEED FOR STRATEGIC PLANNING AND POLICY

Strategic Planning

8. In NRW's view, strategic planning and assessment of major development programmes helps to ensure that the risks of significant environmental impacts are minimised, which in turn helps to reduce the issues faced by developers in seeking consents for individual developments.
9. Whilst some risks may be avoided or mitigated by careful micro-siting of deployments or through operational controls it may not be possible to mitigate or compensate for others. Experience from the early deployment of offshore renewable energy developments has shown that strategic planning can help to avoid such risks, provided it is based on rigorous assessment supported by good evidence and robust research.
10. The ultimate aim of strategic planning is to investigate the potential to guide the development of the sector to locations which maximise the use of the energy resource, whilst minimising any significant adverse socio-economic and environmental impacts.
11. NRW therefore places great importance on the assessments of strategic plans such as Appraisal of Sustainability and Strategic Environmental Assessment (SEA)¹² as rigorous, structured and open evaluations of the effects of development. NRW has recently advised DECC on the UK Offshore Energy Plan Strategic Environmental Assessment (OESEA3)¹³. NRW agreed with the overall conclusion of the OESEA3 that the offshore energy plan (including tidal range) should proceed. NRW also strongly agreed with the recommendation made by the SEA that "*.... site specific assessments are undertaken before decisions can be taken on potential leasing and the desirability and acceptability of individual projects, and that successive tidal range proposals should consider the potential for local, regional and wider far-field effects to be generated cumulatively*" (we understand this recommendation to refer to a strategic analysis of locations rather than a piecemeal assessment of individual projects).
12. The Offshore Energy Plan is, however, a high level plan and so, although still requiring a strategic approach, many of the issues outlined in this paper will need to be resolved by more detailed planning and assessment.
13. Marine Planning, to be implemented under the requirements of the Marine & Coastal Access Act 2009, will be an important process for guiding the future development of marine renewable energy projects, including tidal lagoons. The process of multi-sectoral marine planning provides an opportunity to minimise conflicts but also exploit possible synergies between marine activities. Welsh Government has committed to the development of a Wales National Marine Plan and this will have implications for decisions taken on marine renewable proposals. With the development of such plans firmly underway, planners will need to liaise closely with Welsh Government to ensure that any plans for tidal range energy generation are fully considered.
14. NRW therefore considers that a strategic, spatial and evidence-based approach to planning and assessment of the potential effects of tidal lagoon development will be urgently needed should UK Government decide to promote a programme of lagoon development.

¹² Strategic Environmental Assessment Directive - SEA Directive 2001/42/EC <http://ec.europa.eu/environment/eia/sea-legalcontext.htm>

¹³ UK Offshore Energy Strategic Environmental Assessment 3: Future Leasing / Licensing for Offshore Renewable Energy, Offshore Oil & Gas, Hydrocarbon Gas and Carbon Dioxide Storage and Associated Infrastructure. March 2016

National Policy

15. The UK Government has developed a policy framework for decisions about major infrastructure (Nationally Significant Infrastructure Projects, NSIP's). National Policy Statements (NPS's) have been developed for energy NSIP's (EN-1¹⁴ & EN-3¹⁵) and these contain policy advice to decision-makers specifically relating to renewable energy infrastructure. However, neither of these policies apply to lagoon technologies. In addition, a National Policy Statement for Nuclear Power Generation (EN-6¹⁶) has also been developed.
16. Although each of the NPS's differ, they each usefully set out the need and role of technology infrastructure, the economic, societal and environmental implications, all of which are defined in the context of UK Government policy. In some cases they set out suitable locations for development.
17. Critically the formation of these policies is informed by Sustainability Appraisal which identify strategic environmental risks and conflicts associated with sectoral development which in turn help to reduce environmental and consenting risk at the project level.
18. NRW is of the view that, should UK Government seek to encourage a programme of lagoon development: an NPS for tidal lagoons - informed by the appropriate level of assessment of its environmental implications - would be a major benefit to the development of the sector by balancing the need to maximise opportunity and minimising significant environmental risk.
19. For example, a tidal lagoon NPS might usefully include:
 - Public interest in tidal range technology (in the context of adopted policy);
 - Key requirements of development;
 - The contract for difference (CfD) process;
 - Key benefits and opportunities;
 - Suitable lagoon locations (defined by SEA, HRA and WFD);
 - Evaluation of the alternatives;
 - Relationships to other plans and policies, for example:
 - i. the Offshore Energy Plan and SEA;
 - ii. marine plans, and;
 - iii. planning policy
 - Devolution and regional policy / planning context;
 - Principles of good design;
 - Key consenting and assessment requirements;
 - Advice to decision makers, for example, on:
 - i. Key impacts and risks of development and known conflicts with other developments;
 - ii. How to deal with cumulative effects;
 - iii. Generic mitigation options that (i) must be employed or (ii) are encouraged;

¹⁴ Overarching National Policy Statement for Energy (EN-1), DECC, July 2011

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/47854/1938-overarching-nps-for-energy-en1.pdf

¹⁵ Renewable Energy Infrastructure National Policy Statement, DECC, July 2011

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/37048/1940-nps-renewable-energy-en3.pdf

¹⁶ National Policy Statement for Nuclear power Generation (EN-6), DECC, July 2011.

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/47859/2009-nps-for-nuclear-volume1.pdf

- iv. Synergies with other developments and activities and multiple benefits;
 - v. Associated development, and;
 - vi. Decommissioning
- b. And miscellaneous positions on, for example:
- i. Dealing with uncertainty and precaution through Adaptive management techniques;
 - ii. Reuse of information.
20. Notably, many of the areas of the UK that are suitable for tidal lagoon development are already known, and an NPS for tidal lagoons would be a useful way of exploring the merits of each of these locations.

ENVIRONMENTAL EFFECTS AND THE IMPLICATIONS OF ENVIRONMENTAL LEGISLATION

21. Tidal range developments have the potential to have a number of environmental impacts that can have considerable effects over large areas. The findings of the Severn Tidal Power Feasibility Study (STPFS)¹⁷ identified that such deployments raise a number of important environmental issues that represent a particular challenge; for example, understanding the impacts of the passage of migratory and estuarine fish across turbines. The study concluded, in this instance, that “*The possibility that Atlantic Salmon and twaite shad could become extinct locally...cannot be ruled out*”. Importantly, most of the findings of the STPFS remain valid. The environmental effects of lagoons and barrages have been usefully summarised by the House of Commons Energy & Climate Change Committee report into the Severn Barrage¹⁸ and a summary note from The Parliamentary Office of Science and Technology on the Environmental Impact of Tidal Energy Barrages¹⁹.
22. Lagoons may have a very wide array of environmental effects which are too complex to consider in any detail here. Typically, the main effects of concern relate to: potential flood risk management, loss of intertidal habitat, hydrodynamic and morphodynamic changes to the physical environment, impacts on migratory and mobile species - and the consequent implications for areas that are designated because of their importance for biodiversity, water quality management and fisheries. However, we have provided more detail about the main environmental considerations in Annex 1.
23. Many of these effects, often mediated by alterations to physical processes, can occur over very large distances. Assessments of the Cardiff – Weston Barrage as part of the STPFS indicated possible effects on hydrology as far afield as the northwest coast of Wales. This suggests that, although the effects of smaller lagoons are likely to be more localised, effects upon the environment are possible over a wide area.
24. In some areas where there may be multiple tidal lagoon developments, such as in the Severn Estuary, these effects are likely to act cumulatively and in-combination with one another to amplify the overall effect.
25. A tidal lagoon programme is likely to have major implications for flood risk management around the Welsh coast, potentially including both risks and benefits. The Review might usefully consider the implications of lagoon development on coastal flood risk, including the

¹⁷ Severn tidal power: feasibility study conclusions: <https://www.gov.uk/government/collections/severn-tidal-power-feasibility-study-conclusions>

¹⁸ A Severn Barrage? Second report of Session 2013-14 to the House of Commons Energy & Climate Change Committee. May 2013.

¹⁹ Environmental Impact of Tidal Energy Barrages. Post Note No 435. The Parliamentary Office of Science and Technology. June 2013.

effects on coastal communities, in particular an evaluation of the ability to deliver Shoreline Management Planning and wider flood risk defence schemes.

26. We consider that it will be a significant challenge, and arguably unrealistic, to address such issues at the individual project level and a more strategic approach to planning and assessment will be needed.

Cumulative impacts

27. For any major infrastructure project, the challenges posed by cumulative and in-combination effects (whereby the impacts of multiple projects or activities create an additive effect greater than that of an individual project) are complex and significant.

28. Understanding the challenges posed by such assessments are complex for a number of reasons:

- there is no well-established approach to undertaking cumulative impact assessments (for example how to decide which projects/activities to include);
- the uncertainties about project level impacts (for example potential collision risk to mobile species and habitat loss) are amplified;
- the current 'building block approach' to consenting can result in projects with larger environmental impacts receiving consent, whilst at the same time making it more difficult for more beneficial, but less environmentally damaging, projects to obtain consent subsequently.

29. Given the level of complexity and uncertainties involved with tidal lagoon assessments there is a need for a robust, consistent and multidisciplinary approach to be developed, especially in locations where multiple projects are likely.

30. There is a growing body of literature describing the approaches to cumulative impact assessments and the difficulties that can be encountered. It may be useful for the Review to consider and refer to a recent publication by Judd *et al* 2015²⁰ which offers a useful analysis of cumulative impact assessment and a summary of relevant published information.

31. Resolving this challenge is partly down to better understanding the effects of lagoons. However, a strategic assessment of a tidal lagoon NPS which takes account of known lagoon development locations would be of considerable value in understanding, and then avoiding, significant cumulative and, or in-combination effects.

Environmental Legislation

Habitats Directive

32. The Habitats Directive (EC Directive 92/43/EC) and the Birds Directive (79/409/EEC) are transposed into UK legislation through the Conservation of Habitats and Species Regulations 2010 and referred to as 'The Habitats Regulations'.

33. The Habitats Directive sets out a process whereby a series of European sites (made up of Special Areas of Conservation (SAC's) and Special Protection Areas (SPA's)), are identified by national governments which together contribute to maintaining an agreed list of important habitats and species (features) across their biogeographic range – '*the Natura 2000 series*'.

²⁰ Judd, A.D; Backhaus, T., & Goodsir, F (2015). An effective set of principles for the practical implementation of cumulative effects assessment. *Environmental Science & Policy*: 54 254-262

The Habitats Directive also sets out how these sites should be designated, managed and protected in order to maintain the features of the site at Favourable Conservation Status.

34. Many of the environments in prime estuarine and coastal locations for tidal range technologies are also protected as SPAs, SACs, internationally recognised Ramsar Convention wetland sites (Ramsar's) or as nationally important Sites of Special Scientific Interest (SSSI's).
35. Decision-makers can normally only consent to plans or projects where it has been determined they will not adversely affect the integrity of a European site²¹. This means that decision-makers must have a high level of confidence that an adverse effect will not occur and this in turn creates requirements for a very high standard of evidence.
36. However, where an adverse effect cannot be discounted the Directive allows for a project to be approved if 3 tests are met:
 1. There are no feasible alternative solutions to the proposed development.
 2. There are '*imperative reasons of overriding public interest*' (IROPI).
 3. Compensatory measures must be secured that allow for the coherence of the European sites under the Natura 2000 series, to be maintained.
37. Although not yet formally confirmed through individual project assessments, the scale of anticipated development and the proximity to European sites means that there is a very high probability that adverse effects will result and that projects can only be approved by meeting these tests.
38. Government plans or policies for infrastructure, such as an NPS, typically act as support for and an important part of, an IROPI case.
39. However, on the basis of information typically available to developers and decision-makers it is very difficult to meet the 'alternatives' test because developers cannot feasibly take account of the full range of alternatives, which may include having to consider development locations outwith their ownership or control. An alternatives case is more feasible when considered strategically, as would be the case within an assessment of an NPS.
40. If the third test is to be met, effects will need to be legally compensated for (through habitat and species restoration or creation for example). This is likely to be on a very large scale and very costly and has already been recognised as a significant challenge by the STPFS.
41. Compensatory measures can only be definitively identified case-by-case and once all the impacts of a development have been defined. Typically, however, compensatory measures would address:
 - The re-creation of comparable habitat, which can in time be designated as a EU site;
 - The re-creation of comparable habitats as an extension to an existing site;
 - In exceptional circumstances, the classification of a new EU site for comparable features.
42. Given the likely scale of compensation required for tidal lagoon projects there may be competing demands, and conflict with existing arrangements, for delivering compensation for other schemes such as that already required for Shoreline Management Plans (SMPs). Where such conflicts exist, for example in the Severn Estuary, NRW considers it unlikely that

²¹ Habitats Directive: guidance on the application of Article 6(4). Alternative solutions, imperative reasons of overriding public interest (IROPI) and compensatory measures, DEFRA, August 2012
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/82647/habitats-directive-iropi-draft-guidance-20120807.pdf

the requirements for both sets of compensation (compensation for SMPs and compensation for tidal lagoons) can be met. Delivering both sets of requirements will have further knock-on effects as habitats and species are squeezed by the lack of available space at coastal margins.

43. Furthermore, the exploration of any land purchase to provide compensatory habitats may compete directly with land purchases for other schemes, such as that required for delivery of the SMPs. For example, the substantial interest in deployment of lagoon technologies within the Severn Estuary may significantly increase the demand for land within the estuary, which would in turn raise the costs associated with delivering compensation for other schemes such as the SMPs in the Severn.
44. In addition to finding suitable compensatory habitat, additional compensatory measures may be required for species, and, it is possible that some adverse effects may occur for which there is no known technical compensatory measure (e.g. extinction of genetically distinct fish populations).
45. There may be opportunities to work collaboratively to jointly deliver the compensatory requirements of a number of projects. However, this will require careful analysis on the basis of residual effects of each project as they emerge, and will be complex given the range of interests involved. This might also be a matter to be resolved strategically within a national policy for lagoons.
46. It could however be the case, that it may not be possible to determine and identify appropriate compensatory measures for tidal lagoon deployments.
47. Finally, we are aware that Tidal Lagoon Power Plc are undertaking a study to understand the requirements for compensatory measures that may be required as a consequence of their specific proposals in the Severn.

Water Framework Directive

48. The Water Framework Directive (WFD) (2000/60/EC) provides for the management of all inland surface waters, groundwater and coastal waters in order to prevent and reduce pollution, promote sustainable water use, protect the aquatic environment, improve the status of aquatic ecosystems and mitigate the effects of floods and droughts. The Directive sets the objectives for all water bodies classified under it and creates a mechanism through which each signatory must aim to bring its water bodies to acceptable standards. It is required that progress is reported back to the European Commission (EC) on a 6-yearly basis via River Basin Management Plans (RBMPs).
49. Tidal lagoon projects must ensure compliance with the WFD objectives and ensure that projects do not lead to deterioration in status. If a project results in a water body failing to meet its required status under the WFD, then the competent authority responsible for authorising the project must ensure that tests under Article 4.7 of the Directive are satisfied. Furthermore, an assessment must also be carried out under Articles 4.8 and 4.9: that the objectives of a water body in the same river basin district are not permanently excluded/compromised and the project is consistent with the implementation of other EC environmental legislation.
50. The Article 4.7 tests are as follows:
 - a. all practicable steps are taken to mitigate the adverse impact on the status of the body of water;

- b. the reasons for those modifications or alterations are specifically set out and explained in the relevant RBMP and the objectives are reviewed every 6 years;
 - c. the reasons for those modifications or alterations are of overriding public interest and/or the benefits to the environment and to society of achieving the objectives set out are outweighed by the benefits of the new modifications or alterations to human health, to the maintenance of human safety or to sustainable development, and;
 - d. the beneficial objectives served by those modifications or alterations of the water body cannot for reasons of technical feasibility or disproportionate cost be achieved by other means, which are a significantly better environmental option.
51. Multiple lagoons around the UK Coast, with potential impacts in host water bodies and hydrologically connected water bodies, have the potential to require Article 4.7 derogations in many water bodies. Furthermore, when considering the deployment of multiple schemes, consideration of cumulative and in-combination WFD impacts will be necessary and the potential need for multiple Article 4.7 derogations may extend to many other water bodies.
 52. In NRW's view, and without prejudice to any advice we may give or decisions we may take in the future in the context of any specific development, numerous derogations under Article 4.7, may be required for future tidal lagoon development at the scale that has been proposed.
 53. Given the limited application of Derogations under Article 4.7 in estuarine and coastal water bodies, further information and guidance that would help regulators apply the tests of WFD Article 4.7 and have greater confidence in assessment of the impacts of lagoons on WFD ecological status, would be welcomed.
 54. WFD derogations need to be considered from an early stage in project planning to ensure all possible mitigation is inbuilt into scheme design - including considerations such as location and micro-siting of turbines to minimise impacts. This early consideration is essential to ensure that any potential developer is able to demonstrate that Article 4.7 has been considered through selection of locations and design options appraisal.
 55. In relation to both the Habitats Directive and Water Framework Directives, it is worth noting that individual projects alone (as well as in-combination / cumulatively) have the potential to cause effects that are sufficiently significant to require derogations to be applied before approval can be given. This will be at significant financial cost to the developer.

Associated Development and interactions with Other Activities

56. It is important to consider the effects of tidal lagoon deployment on other users of the marine and coastal areas where lagoons will be sited. Shipping, ports, extraction of marine aggregates, and commercial and recreational fishing all occur extensively around the UK coast and interactions with these activities, such as activity displacement and resource sterilisation, will need to be considered.
57. Sourcing the construction material required to build multiple projects will also be a relevant consideration in terms of cumulative effect. Whilst existing mineral planning permission may have been subject to impact assessments, the quantities and transportation routes required may lead to new reserves and permissions needing to be found where impacts have not yet been assessed. For example, the Tidal Lagoon Cardiff Scoping report²² indicates a potential requirement for approximately 10 million cubic metres of sandy material (with additional requirements for quarry run and rock armour). The existing marine aggregate permissions in

²² Proposed Tidal Lagoon Development, Cardiff, South Wales, Environmental Impact Assessment Scoping Report, March 2015
<https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010073/EN010073-000054-Scoping%20Report.pdf>

the south west region allow for extraction of approximately 2 million cubic metres of sand per annum. Therefore a single project would potentially use up the supply that would have been available for many other constructions activities.

58. Terrestrial infrastructure (such as transport and grid connections) will almost certainly be needed including electricity transmission networks both on- and off-shore. This will also require careful planning, that is best achieved at a strategic level to avoid stranding of assets.

POTENTIAL BENEFITS

59. The net benefits of tidal lagoon energy generation should be viewed as contributing to combatting the deleterious effects of climate change. Tidal lagoon deployments will help the UK meet its renewable energy targets by providing a source of low-carbon, clean, predictable energy over a 120+ year generation period.

60. However, from an NRW perspective, there are also other benefits that lagoon generation may potentially bring in the form of potential coastal and flood defence. Such benefits may include:

- Reduced coastal / storm surge risks for land within the lagoon walls or immediate vicinity;
- Reductions in wave height / energy due to the much reduced fetch leading to reduced risk of overtopping and therefore flood defence breach / failure;
- Possible mitigation against fluvial flooding;
- Possible mitigation against future sea-level rise;
- Where lagoon walls become a new line of defence there may be savings to the public purse as a result of private capital investment displacing public spending.

61. It is important to note, however, that the benefits for, and impacts upon, flood defence and coastal erosion management are finely balanced and highly location specific, and will need to be considered by the decision maker on a case-by-case basis.

62. More generally, it is important to recognise that lagoon developments may conflict with other existing national planning policy. For example, Welsh Government's Planning Policy Wales Technical Advice Note 15²³ specifies flood risk zones would be incompatible with some ancillary land uses, including some associated with lagoon development such as housing development in the lagoon hinterland, due to the residual and potentially increased risk of flooding that may result should the flood defence offered by a lagoon subsequently fail.

63. The construction of any flood alleviation scheme, whether associated with the construction of a tidal lagoon or otherwise, should be to reduce the frequency of flooding to existing development and not to facilitate new inappropriate development. Flood risk can be reduced but not eliminated. In coastal areas new development in flood risk zones will be particularly vulnerable in the future if sea level rise and storminess increases. The building of a lagoon will not entirely remove land from being at risk of flooding and should therefore not be seen as a mechanism to aid development in flood risk areas.

64. There can be an inherent difficulty in accurately identifying costs and benefits at an early stage when considering some of the issues related to the development of tidal lagoons. Whilst it may be possible to identify some standard benefits and costs that would apply to any proposed lagoon, others will be entirely dependent on local factors. For example in one location it may be possible to demonstrate a benefit due to a wave sheltering effect from lagoon walls, whilst in another location the same wall design may need to be identified as a cost due to increased flood risk from wave reflection. Nevertheless, in order to further

²³ Technical Advice Note (TAN) 15: Development and Flood Risk (2004) <http://gov.wales/topics/planning/policy/tans/tan15/?lang=en>

understand the potential benefits of tidal lagoon deployment, NRW considers that there would be benefit in compiling a strategic analysis of the costs and benefits to flood risk management as part of a wider assessment of any strategic plan for tidal lagoons.

65. Furthermore, and as described above, should the approval of any tidal lagoon project require significant areas of compensatory habitat to be secured under the Habitats Directive, then in our view, there is serious risk that these requirements would be in conflict with other plans or projects that also need to secure compensatory habitat around the coast.

THE NEED TO DEVELOP AN APPROPRIATE EVIDENCE BASE

66. Taking full and proper account of environmental considerations early in the planning, assessment and consenting processes will be crucial for the success of future projects.
67. Gaps in information lead to uncertainty within assessments which in turn make it difficult for decision-makers to reach robust decisions. For example, there is a notable lack of evidence upon which to base assessments of changes to physical processes, estuary morphology, the disturbance to the behaviour of key species such as fish and the consequences of habitat loss. There is also insufficient understanding about the ability to compensate or mitigate for many of these effects, particularly in reducing effects on migratory fish and habitat loss. Annex 1 provides a more detailed overview of the gaps in understanding environmental effects.
68. However, work to identify how some of these gaps in understanding might be filled is now underway through the Offshore Joint Industry Programme for Ocean Energy (ORJIP OE). Critically, the ORJIP OE has no funds of its own to allocate to research, it can only carry out a detailed analysis of the research that will be needed.
69. DECC's OESEA programme is a key source of research funding but is already stretched to cover the wide range of research required to underpin planning of all offshore energy technology.
70. NRW encourages UK Government to continue to support research within the OESEA programme, and also to ensure appropriate allocation of funds towards research that is identified by the ORJIP OE prioritisation work as far as possible (including via research councils and European Regional Development Funding).
71. There could be significant benefits in developing multidisciplinary research programmes which simultaneously address engineering and environmental issues for tidal range technologies, by encouraging and facilitating research to develop novel engineering and technical solutions to environmental issues. We believe that adopting such an approach will greatly benefit the tidal range sector, for example when considering the potential benefits that tidal lagoons may offer as defence against flood risk or as a way of enhancing local populations and habitats.
72. Gathering vital evidence about the marine environment and its interactions with infrastructure necessarily requires the amalgamation of information and data from a variety of sources. The importance of data dissemination and knowledge exchange to promote research and innovation within industry should not be underestimated. We encourage UK Government to help support and implement initiatives such as the Marine Data Exchange²⁴ which provides renewable energy stakeholders with access to survey data and reports collated during the planning, construction and operation of projects.

²⁴ The Crown Estate Marine Data Exchange: <http://www.marinedataexchange.co.uk/>

CONSENTING AND ASSESSMENT PROCESS

73. Decisions about whether or not to approve consent for tidal lagoon developments require large amounts of scientific information to be presented, and a number of complex environmental assessments to be completed. This is largely completed through a legally required process known as Environmental Impact Assessment (EIA).
74. The objective of EIA is to identify potentially significant impacts and offer solutions through avoidance, reduction or mitigation mechanisms so that these can be taken into account by decision-makers. NRW continues to support developers in collating the necessary information and analysing it in a manner that allows robust and informed decisions to be taken.
75. Preparing the necessary information prior to an application being made can be a lengthy, complex and expensive process. However, a poorly developed application poses considerable risks because it increases the risk of a project failing to obtain approval whilst still committing developers, regulators and consultees to considerable resource outlay during project determination. Critical to minimising the impact of this is the need to form well developed project scopes, informed by engagement with statutory consultees, at as early a stage as possible. Future projects should make an allowance for this in project programming and financing.
76. The production of 'Evidence Plans' as a formal pre-application mechanism should be widely encouraged across the UK. Evidence plans allow a more structured approach to evidence gathering and analysis, helping to address and agree requirements earlier in the process²⁵.

Adaptive Management

77. It may be the case that, following a robust environmental assessment process, projects will reach the point of application without having been able to address all potential environmental risks definitively, and residual uncertainties may remain. In some cases risks may be unforeseeable or the likelihood of occurrence and the nature of any management measures to mitigate against a risk cannot be reasonably identified, or expected to be identified, at the time of project commencement.
78. Where this is the case it may be possible to apply the principles of adaptive management in deploying technologies, based on a greater understanding of the likelihood of occurrence of such effects, once the development has been deployed. However, care is needed with such an approach – adaptive management is not a substitute for EIA. Before adopting such an approach it is necessary for developers to exhaust all possible conventional assessment as part of the EIA prior to application. This is especially important for infrastructure such as lagoons that once deployed will in effect be 'permanent' fixtures. Adaptive management will also need to be demonstrably achievable in order to avoid incurring adverse effects that cannot be mitigated against at a later date.
79. Where a mitigation plan has been agreed as part of project approval, an adaptive management approach may be of value in monitoring the effectiveness of the plan post commencement to ensure that the envisaged benefits and outcomes are delivered, or if not, to allow for the plan to be adapted accordingly. As such, adaptive management should be used as a structured, iterative approach to environmental assessment that allows the management of a project (projects) to be adjusted on the basis of learning once the

²⁵ Habitats Regulations: Evidence plans for Nationally Significant Infrastructure Projects. DEFRA Sept 2012.
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69601/pb13825-habitats-evidence-plans.pdf

development has been deployed. This will be at ongoing cost to the developer as maintenance, monitoring and mitigation costs over the lifetime of the project will be required. Should a project be required to cease operation due to unforeseeable environmental impact, then the ultimate 'cost' could be a reduction in energy generation which could in turn have significant financial implications.

80. Adaptive management should therefore use mechanisms that can detect the trajectory of effects to allow action to be taken before an undesirable level or threshold of effect has been reached. In particular, where adaptive management is being relied on to comply with the Habitats Directive, it should clearly provide for effects arising from the project to be detected and any necessary action taken in response, before any such effects constitute adverse impacts on any designated feature of a Natura 2000 site.
81. Adaptive management must be adequately resourced and financed, and the commitment of resources by all parties involved needs to be secure throughout the timescale over which the adaptive management will operate.
82. Adaptive management has significant benefits but raises complex issues especially for tidal lagoon projects that are in effect permanent structures where the options for future intervention may be limited.

Decommissioning

83. Under the requirements of the Energy Act 2004²⁶, developers responsible for energy installations are typically required to submit a plan which sets out their decommissioning intentions. DECC guidance^{27, 28} usefully sets out these obligations and arrangements for considering and approving draft plans (including for environmental assessment).
84. In addition, under the Marine Works (EIA) Regulations 2007, and the Marine & Coastal Access Act 2009, decommissioning will be considered as part of the marine licence determination.
85. The decommissioning provisions in the Energy Act 2004 reflect the UK Governments view that a developer should be responsible for ensuring that their consented project is decommissioned at the end of its useful life, and makes clear that the intention of the legal requirement is to ensure that developers do not default on their decommissioning liabilities (safety, environmental and economic). Developers should be responsible for meeting the *full* costs of decommissioning.
86. Nevertheless, at the end of the operational lifetime of a project it is possible that a lagoon will have become so integrated with the local environment that removal is undesirable from an ecological and wider environmental perspective. However, given the anticipated lifetime of a lagoon (120+ years), it is almost impossible to predict with any certainty how the local environment will have adapted over the lifetime of a project - such that the risk posed to any enhancements by decommissioning cannot be quantified accurately.
87. Different options for decommissioning, and the extent and feasibility of future maintenance of infrastructure after decommissioning, will have impacts on environmental receptors.

²⁶ Energy Act 2004: <http://www.legislation.gov.uk/ukpga/2004/20/contents>

²⁷ Decommissioning of offshore renewable energy installations under the Energy Act 2004. Guidance notes for Industry. DECC, January 2011 (revised). https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/80786/orei_guide.pdf

²⁸ Tidal Lagoons attached to land – addendum to guidance under the Energy Act 2004: Consultation on extension of the 'Decommissioning of offshore renewable energy installations under the Energy Act 2004' guidance to include tidal lagoons attached to land. DECC, October 2014.

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/362688/tidal_lagoons_attached_to_land.pdf

However, without detailed assessment and full costing of each of the options, it is simply not possible to meaningfully advise on the most suitable decommissioning option for a particular project.

88. NRW considers that all decommissioning options must be retained within a decommissioning plan required prior to commencement of works with further assessment and refinement of the agreed plan closer to decommissioning itself.
89. The Review might usefully consider the need for universally adopted guidance that sets out the information that should be included within tidal lagoon decommissioning plans prior to construction and the range of options that should be retained, namely: maintain, removal and partial removal.

ANNEX 1: KEY STRATEGIC ENVIRONMENTAL EFFECTS, CONSIDERATIONS AND EVIDENCE GAPS

Summary table of key environment effects, considerations and evidence gaps likely to impact on planning, consenting and assessment of tidal range deployments. Note that these are not listed in any order of priority.

Topic	Key issues	Gap in understanding
Physical Processes	Hydrodynamic, geomorphological and sediment changes (incl. near and far-field effects); cumulative and in-combination effects; associated secondary impacts to intertidal and subtidal habitats and species; effectiveness of mitigation (or enhancement) and monitoring measures that are currently untested / unproven;	Scope and quality of physical baseline data and level of characterisation to inform EIA/HRA/WFD assessment requirements.
		Uncertainties around impact assessment methods.
		A need for strategic physical baseline datasets to inform tidal range developments.
		Better knowledge and collation of available modelling tools and other assessment techniques to predict medium to long-term morphological changes.
		Medium to long-term morphological modelling prediction.
		Prediction/mapping medium to long-term morphological changes to substrate and habitats.
		Agreed approaches to assess impacts on sediment budgets and transport within and between sediment cells.
		Modelling decommissioning scenarios.
		Agreed procedures to establish far and near-field effects (e.g. study boundaries, grid resolution).
		Numerical models to predict physical, biological and ecological interactions/ changes.
		Habitat creation measures to offset predicted loss of coastal and estuarine habitats other than saltmarsh e.g. intertidal sand and mud.
Fish	Potential impacts to fish caused by: collision/ passage through turbines; entrainment; changes in foraging and migratory behaviour; disturbance and displacement; barrier effects to movement and migration; local extinction of populations; noise impacts; changes in water quality and sedimentation; immediate and long-term	Model estuarine and near coast fish behaviour (e.g. potential attraction/avoidance/ barrier effect).
		Migratory routes of diadromous fish (particularly eel, lamprey, shad and salmon).
		Habitat utilisation by fish species and fish prey.
		Water quality changes and fish populations.
		Need to better understand the synergistic and/or cumulative effects of (construction) contaminants on fish and prey species.
		Effects of construction/ operational noise on hearing ranges for key fish species and risk of barrier effects.
		Migratory fish and tidal turbines interactions - turbine passage/blade strike effects and/or injury

	<p>population level impacts; loss of supporting habitat and species; cumulative and in-combination effects; effectiveness of mitigation (or enhancement) and monitoring measures that are currently untested / unproven.</p>	<p>rates and impacts to populations is little understood and requires further development.</p>
		<p>Life history and population modelling parameters/data to improve confidence in EIA/HRA.</p>
		<p>Climate change responses and resilience in fish populations.</p>
		<p>Potential risk of multiple turbine passes leading to increased risk of re-entrainment.</p>
		<p>Responses of fish to changes in migratory cues as a result of tidal range developments.</p>
		<p>A substantive review of effective and suitable mitigation and monitoring strategies for marine/estuarine and freshwater diadromous fish is required.</p>
		<p>A review of the economic value of river / estuarine / coastal fisheries (commercial/recreational/heritage).</p>
		<p>Stock assessment tools for marine and estuarine fish populations in order to define appropriate impact assessments at the population level.</p>
		<p>Tools needed to assess cumulative effects of projects in order to improve confidence in EIA / HRA.</p>
		<p>Tools to accurately assess WFD fisheries impacts in hydrologically connected water bodies.</p>
		<p>Effects of EMF from transmission cables on fish would improve confidence in EIA and HRA.</p>
		<p>Appropriate and proportionate objectives and methodologies for site characterisation surveys to inform EIA / HRA /WFD is required.</p>
		<p>Long-term effects on migratory fish populations and assemblages adjacent to tidal range developments.</p>
Marine mammals	<p>Potential impacts as a result of: collision; entrapment; changes in foraging behaviour; near and far-field disturbance and displacement; barrier effects to movement; noise impacts; impacts on local and far-field hydrodynamics; immediate and long-term population level impacts; loss of supporting habitats and species and alterations to foraging grounds; cumulative and</p>	<p>Near and far-field effects of disturbance and displacement around tidal range developments - including potential permanent loss of habitat and foraging grounds.</p> <p>Thresholds of acceptable mortality - a better understanding of population level impacts and methods to assess the significance of population level impacts to confidence in EIA/HRA.</p> <p>Risk of collision.</p> <p>Objectives and methodologies for site characterisation surveys to inform EIA/HRA processes.</p> <p>Underwater/operational construction noise (injury, disturbance, masking of vocalisations)</p> <p>Local and far-scale hydrodynamics change consequence for feeding and foraging areas.</p>

	in-combination effects; effectiveness of mitigation (or enhancement) and monitoring measures that are currently untested / unproven.	<p>Potential risks and consequences of entrapment for marine mammals.</p> <p>Appropriate mitigation options and how they might be effectively monitored.</p>
Birds	Impacts as a result of: collision; entrapment; changes in foraging behaviour; near and far-field disturbance and displacement; barrier effects to movement; immediate and long-term population level impacts; loss of supporting habitats and species and alterations to foraging grounds; cumulative and in-combination effects; effectiveness of mitigation (or enhancement) and monitoring measures that are currently untested / unproven.	<p>Near and far-field effects and consequences of disturbance and displacement - including potential permanent loss of habitat and foraging grounds.</p> <p>Thresholds of acceptable mortality for a number of bird species - methods to assess the significance of population level impacts would improve confidence in EIA/HRA.</p> <p>Interactions with marine and diving birds - behaviour of birds around tidal range developments to better understand the real levels of risk of collision.</p> <p>Appropriate and proportionate objectives and methodologies for site characterisation surveys to inform EIA/HRA is required.</p>
Benthic (subtidal and intertidal)	Direct loss of subtidal and intertidal habitats and supporting species, particularly those that are features of protected sites; effects from changes in water quality and sediment transport and deposition; changes to intertidal / subtidal habitat exposure as result of changing water levels within and outwith a lagoon; impacts to planktonic communities and recruitment of benthic organisms; potential introduction of marine invasive species; cumulative and in-combination effects; effectiveness of	<p>Prediction of impacts of tidal range developments via coastal processes e.g. sediment transport and deposition and how this translates into effects on the subtidal.</p> <p>Change prediction at a biological community level as a result of partial separation of waterbodies as a result of impoundment walls.</p> <p>Impacts on planktonic communities within impoundments and corresponding uncertainty with respect to how to calculate impacts to algal communities.</p> <p>Effectiveness of habitat translocation / re-creation e.g. seagrass beds if used as a mitigation or compensation approach.</p> <p>Biodiversity enhancement of hard substrata if used as a mitigation or compensation approach.</p> <p>Introduction, rate and spread of Marine Invasive Non-Native species (MINNS).</p> <p>Uncertainty of the risks of increased introduction of MINNS via shipping associated with the sourcing of aggregate materials for construction.</p>

	mitigation (or enhancement) and monitoring measures that are currently untested / unproven	
Coastal ecology	Isolation and loss of connectivity; constraints to ecological shifts; compaction; smothering; impoundment; cumulative and in-combination effects; effectiveness of mitigation (or enhancement) and monitoring measures that are currently untested / unproven.	There is a need to better understand the potential effects of impoundment on saltmarsh habitat.
		Further understanding needed of the potential impacts on saltmarsh vegetation as a result of decrease in tidal range.
Flood	Near and far-field effects of flood risk; changes to wave height and direction; restriction of tidal and fluvial flows; cumulative and in-combination effects;	Design of project infrastructure to ensure resilience to potential flood risk and damage over the lifecycle of a project (taking account of latest guidance on sea-level rise and increased storminess due to climate change), as well as a need to consider integration of scheme design for flood risk minimisation alongside mitigation to impacts to ecology.
		There is a need to understand and assess the potential for tidal range developments to pose a flood risk to themselves.
		Changes to existing areas of flood risk as a result of tidal range developments as well as understanding how a particular project may affect the integrity and standard of coastal defences.
		Flood alleviation and/or coastal protection benefits, including as a compensatory or mitigation measure.
Sea Level Rise	Appropriate consideration of future sea-level rise over the lifetime of project deployments	Effect of projected Sea Level Rise (SLR) on other pressures and impacts (in particular changing tidal levels, shifting habitats (in response), extreme events) in-combination with the impacts of project-level developments themselves.
		Options for improving flood protection where possible to maintain or improve levels of protection to people, property and infrastructure.
HRA / Compensatory Habitat	Direct loss of protected habitats and species which are features of SPAs, SACs and Ramsars; cumulative	Direct, indirect, in-combination and cumulative projects on the short- medium- and long-term integrity of the Natura 2000 series.
		Compensation habitat offset that ensures that tidal range developments do not have an adverse impact on the Natura 2000 series - identification of

	and in-combination effects;	<p>habitat or other resource of appropriate type, value and scale.</p> <p>Effectiveness of habitat creation and restoration and other more innovative measures (for example reduction in marine mammal bycatch in fisheries to offset effects).</p> <p>Prediction of environmental responses to compensatory measures over varying timescales.</p> <p>Conflicts between need for compensation habitat creation and other statutory obligations (e.g. designated sites). Offset should not contradict or compete directly with other offset requirements (e.g. Shoreline management plan compensation).</p>
WFD	How to determine if a project may result in impacts to other hydrologically connected water bodies.	<p>Tools and methodologies to determine thresholds for acceptable change, for WFD biological elements.</p> <p>Impacts on migratory fish in the marine environment and how they translate to impacts to stock and WFD status of migratory fish upstream in freshwater catchments.</p> <p>Clear guidance and instruction is needed to inform what information is required to better inform the 'Significantly Better Environmental Options' WFD 4.7 Derogation test.</p> <p>Cost/Benefit Analysis tool to assign a quantitative/monetary cost to deterioration in a WFD water body– such tools should be used to inform any necessary 4.7 derogation tests.</p>
Seascape and landscape	Visual impacts of developments both during construction and operation	Economic value of seascape and any change in this as a result of tidal range developments is required.
Decommissioning	Uncertainty over information requirements and understanding of environmental change in the long-term.	<p>There is a need to develop guidance with respect to Information requirements for plans and projects at application.</p> <p>Agreed approaches are needed to determine how to predict future status of the environment and effects over the very long-term.</p>