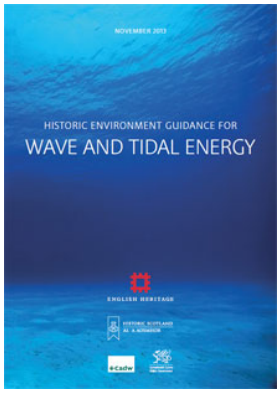
Historic England

Historic Environment Guidance for Wave and Tidal Energy



On 1st April 2015 the Historic Buildings and Monuments Commission for England changed its common name from English Heritage to Historic England. We are now re-branding all our documents.

Although this document refers to English Heritage, it is still the Commission's current advice and guidance and will in due course be re-branded as Historic England.

Please see our website for up to date contact information, and further advice.

We welcome feedback to help improve this document, which will be periodically revised. Please email comments to guidance@HistoricEngland.org.uk

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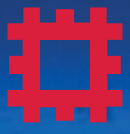
NOVEMBER 2013

HISTORIC ENVIRONMENT GUIDANCE FOR WAVE AND TIDAL ENERGY



ENGLISH HERITAGE

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AL A AOSMHOR

Cadw

Llywodraeth Cymru
Welsh Government

HISTORIC ENVIRONMENT GUIDANCE FOR WAVE AND TIDAL ENERGY

Summary

The recent growth in wave and tidal energy demonstrates our dependence on the sea in seeking to meet society's needs. It is the latest phase of a very long relationship with the sea for resources, driven this time by recognition that future use must be much more sustainable than in previous centuries. Mindful of our place in history as we shape the environment of the future, it is important that this new use of the sea does not detract from what remains of our predecessors' use and inhabitation of the coasts and seas around us.

The guidance is intended for wave and tidal energy developers; regulators; curators; environmental and engineering consultants; and archaeological contractors/consultants. It is intended to provide an introduction both to wave and tidal energy and to the historic environment, and to present guidance on specific issues where there is a common interest in achieving resolution. The guidance is intended to enable all parties to engage with the historic environment constructively; to help provide clarity in relation to planning; to avoid circumstances in which heritage assets become an unreasonable or unexpected constraint; and to create greater certainty for all concerned.

Giorrachadh

Tha am fàs o chionn ghoirid air lùth-nan-tonn agus lùth-an-làin a' leigeil fhaicinn mar a tha sinn an eisimeil air a' mhuir gus feumalachdan comann-dhaoine a thoirt a-mach. Is e a tha ann an ìre as ùire de chàirdeas gu math fada ris a' mhuir airson ghoireasan, air a stiùireadh an turas seo le mothachadh gum bu chòir gum biodh cleachdadh anns an ùine air thoiseach fada na bu sheasmhaiche na ann an linntean roimhe. Mothachail air an àite a tha againn san eachdraidh agus sinn a' cruthachadh àrainneachd an latha a-màireach, tha e cudromach nach toir an cleachdadh ùr seo den mhuir na tha e air fhàgail de chleachdadh is de chòmhnaidh nan daoine romhainn sna costaichean is sna cuantan mun cuairt oirnn air falbh.

Tha an stiùireadh seo ga amas air luchd-leasachaidh lùth-nan-tonn agus lùth-an-làin; luchd-riaghlaidh; comhairlichean mun àrainneachd agus mu innleadaireachd; agus luchd-cunnraidh/comhairle mu àrsaidheachd. Tha e mar amas gun toir e eòlas mun dà chuid lùth-nan-tonn agus lùth-an-làin agus mun àrainneachd eachdraidheil, agus stiùireadh mu cheistean sònraichte far a bheil ùidh choitcheann a thaobh fuasgladh a thoirt gu buil. Tha e mar amas gun cuir an stiùireadh seo air chomas dhan a h-uile pàrtaidh dol an sàs anns an àrainneachd eachdraidheil gu cruthachail; cuideachadh gus soilleireachadh a thoirt mu dhealbhachadh; suidheachaidhean a sheachnadh far am fàs maoin-dìleib na srian gun seagh no gun dùil; agus barrachd cinnt a chruthachadh dha na h-uile a tha an sàs.

Crynodeb

Mae'r cynnydd diweddar o ran ynni'r tonnau a'r llanw yn dangos ein bod yn dibynnu ar y môr wrth geisio diwallu anghenion y gymdeithas. Dyma'r cam diweddaraf mewn perthynas hir iawn â'r môr o ran sicrhau adnoddau, cam sydd wedi'i sbarduno y tro hwn gan gydnabyddiaeth y bydd yr ynni sy'n cael ei ddefnyddio yn y dyfodol yn gorfod bod yn llawer mwy cynaliadwy nag yn y canrifoedd a fu. Gan gofio'n lle ni mewn hanes wrth inni lunio amgylchedd y dyfodol, mae'n bwysig na ddylai'r ffordd newydd yma o ddefnyddio'r môr amharu ar olion ein rhagflaenwyr pan oedden nhw'n defnyddio ac yn byw ar yr arfordir a'r moroedd o'n cwmpas.

Mae'r canllawiau wedi'u bwriadu ar gyfer datblygwyr ynni'r tonnau a'r llanw; rheoleiddwyr; curaduron; ymgynghorwyr amgylcheddol a pheirianegol; a chontractwyr/ymgynghorwyr archaeolegol. Y bwriad yw rhoi cyflwyniad i ynni'r tonnau a'r llanw ac i'r amgylchedd hanesyddol, a chynnig canllawiau ar faterion penodol lle ceir diddordeb cyffredin mewn sicrhau atebion. Bwriedir i'r canllawiau alluogi pob parti i fynd ati'n adeiladol yn yr amgylchedd hanesyddol; helpu i roi eglurder ynghylch cynllunio; osgoi amgylchiadau lle daw asedau treftadaeth yn llyffethair afresymol neu annisgwyl; a chreu mwy o sicrwydd i bawb.

Eling Tide Mill, Southampton Water: a tidal range scheme that dates back over 600 years.
Image © Antony Firth/Fjordr.

KEY MESSAGES

Introduction

- This guidance is for everybody involved in developing wave and tidal energy, to ensure that such development is sustainable with respect to the historic environment.
- This guidance is intended to supplement previous guidance on offshore renewables by considering the specific circumstances and needs of wave and tidal energy.
- Understanding the respective roles of each party involved in wave and tidal energy development and the management of the historic environment is an essential starting point for effective dialogue.

The Historic Environment

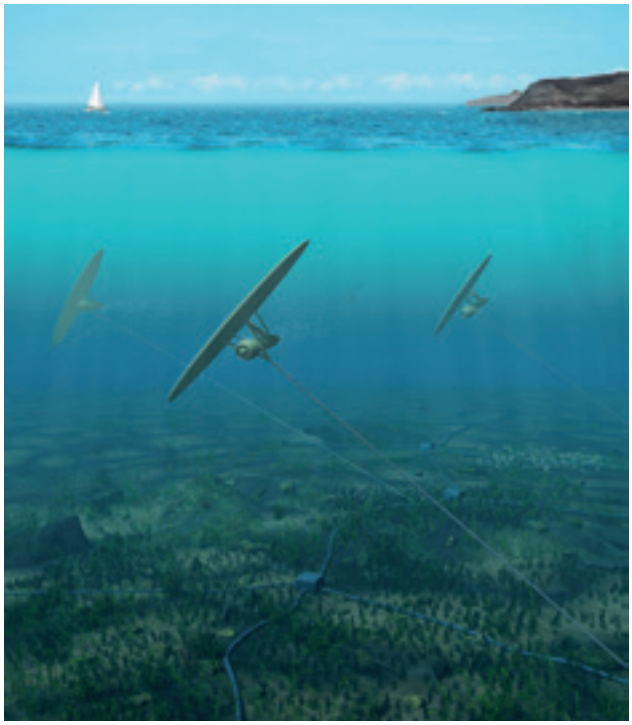
- The historic environment is a vitally important resource that is protected by international, European and domestic law and policy.
- A diverse range of heritage assets survives on the land, on the foreshore and under the sea, providing insight into the recent past and distant millennia.
- Important archaeological material can be found in high-energy environments.

Wave and Tidal Energy

- Although it is still at an early stage, wave and tidal energy development is expected to grow strongly. Schemes of increasing size and complexity will be consented and constructed over the next decade.
- Although there are key concentrations of wave and tidal energy development, projects are being proposed in many locations.
- The implications for the historic environment of the diverse range of wave and tidal technologies are largely driven by their configuration with respect to the seabed and their appearance at the surface, rather than the way in which electricity is generated.

Considering Effects

- The most significant adverse effects of wave and tidal energy development on the historic environment are likely to occur during the construction phase, but effects may arise prior to construction, in the course of operation, and during decommissioning also.
- A thorough appreciation of why heritage assets are important and how their importance can be affected by wave and tidal energy development is fundamental to decision-making by all parties.
- The effects of wave and tidal energy development on the wider historic environment, including implications for the setting of individual assets, will generally be more localised than for other offshore renewables. They must, however, be assessed adequately.



Deep Green is a tidal stream device that is tethered to the seabed and floats within the water column. The kite-like wing carries a turbine in the current. Image © Minesto.

- The coastal and marine historic environment still holds uncertainties and risks; these are best managed by improving the evidence base and working together.
- Other forms of development intended to support wave and tidal energy – such as ports/harbours and grid connections – may have important implications for the historic environment that must also be considered.

Key Issues

- In satisfying environmental requirements to address the historic environment in the course of consent, Developers create knowledge and understanding that can also be used to generate social and economic benefits for the wider public.
- Provisions for managing archaeological data should be set up at the start of a project.
- Site investigations for archaeological purposes are an integral element of overall site investigations and should be planned accordingly.
- Anomalies on the seabed can be difficult to characterise without direct observation; better field-based evidence of the forms and origin of anomalies will benefit individual schemes and the wave and tidal industry as a whole.
- Publicly accessible research is intrinsic to historic environment practice and enables all parties to gain maximum benefit from the investigations that are undertaken.

CONTENTS

How this guidance was prepared

The preparation of this guidance was initiated by English Heritage, which issued an open tender in January 2012. The contract for preparing the guidance was awarded to Fjordr Limited, a company specialising in marine and historic environment consultancy. Funding from Historic Scotland and Cadw enabled the geographical scope of the guidance to encompass Scotland and Wales also.

The text of the guidance was developed by Antony Firth of Fjordr Limited over the course of 2012, based on meetings and discussions with a wide range of archaeologists, developers and consultants. Key stakeholders provided comments on a preliminary draft in February 2013; public consultation took place in March and April 2013.

This guidance can be cited as follows:

Firth, A. (2013) *Historic Environment Guidance for Wave and Tidal Energy*. Published by Fjordr Ltd on behalf of English Heritage, Historic Scotland and Cadw.

Acknowledgements

The contribution to the guidance of staff from the commissioning organisations – English Heritage, Historic Scotland and Cadw – is gratefully acknowledged, in particular: Chris Pater and Edward Salter (EH); Philip Robertson and Adele Shaw (HS); and Polly Groom and Julie Osmond (Cadw).

Fjordr Ltd. is indebted to all the people who took the time to contribute to discussion and consultations in the course of preparing this document.

Original figures have been prepared by Will Foster Illustration. Many organisations provided additional images, as credited in the captions, for which we are very grateful.

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1. INTRODUCTION

This guidance is for everybody involved in developing wave and tidal energy, to ensure that such development is sustainable with respect to the historic environment.

The remains of a small ship thought to be the Fosil lost 1889 near Abersoch. *Shipwrecks can be found in various forms and environments.*
Image © Crown Copyright: Royal Commission on the Ancient and Historical Monuments of Wales (RCAHMW).

1.1 The recent growth in wave and tidal energy demonstrates our dependence on the sea in seeking to meet society's needs. It is the latest phase of a very long relationship with the sea for resources, driven this time by recognition that future use must be much more sustainable than in previous centuries. Mindful of our place in history as we shape the environment of the future, it is important that this new use of the sea does not detract from what remains of our predecessors' use and inhabitation of the coasts and seas around us.

1.2 Although it is growing quickly, the wave and tidal energy sector is still at an early stage of its development. There are still many challenges to industry and Regulators. Using this guidance should help address the challenges that the historic environment may present to wave and tidal energy, both for individual schemes and for the wider development of the sector.

1.3 This guidance has been commissioned by English Heritage, Historic Scotland and Cadw to provide practical guidance on the relationship between wave, tidal stream and tidal range energy and the historic environment. The objectives of the guidance are as follows:

- To review wave and tidal energy in terms of overall trajectory, current and future technologies, and likely geographical areas of development.
- To summarise the possible significance of effects of wave and tidal energy on the historic environment.
- To identify options and best practice for dealing with wave and tidal energy in terms of overall programmes and initiatives as well as individual schemes.

1.4 Early discussion between archaeologists and Developers is fundamental to achieving effective outcomes for all concerned. This guidance is intended to inform and help frame discussion of key points pertaining to wave and tidal energy and the historic environment.

1.5 The guidance is not intended to present a prescriptive 'handbook'. Each section can be consulted as the need arises. Following the introductory sections there are overviews of the historic environment and of wave and tidal energy that can be referred to according to the background of the reader. Guidance on considering the effects of wave and tidal energy development on the historic environment is then provided, together with further detail on several key issues.

1.6 This guidance applies to England, Scotland and Wales. Its geographical scope encompasses both the Inshore Regions (Territorial Sea) and Offshore Regions (Continental Shelf) of England, Scotland and Wales. It also applies to aspects of wave and tidal energy development that are carried out onshore. Although different legal, policy and consenting frameworks may apply to these different zones, the historic environment should be addressed in a comprehensive, joined-up manner across all of them.

2. RELATION TO OTHER POLICIES AND GUIDANCE

This guidance is intended to supplement previous guidance on offshore renewables by considering the specific circumstances and needs of wave and tidal energy.

2.1 This document does not replace existing guidance. It should be read in conjunction with existing policies and guidance.

2.2 References to existing policies and guidance are included in each section. The following guidance, including guidance and documentation prepared specifically for the Offshore Renewables sector, is especially relevant:

> *Historic Environment Guidance for the Offshore Renewable Sector* (Wessex Archaeology 2007)
>
> *Guidance for Assessment of Cumulative Impacts on the Historic Environment from Offshore Renewable Energy* (Oxford Archaeology and George Lambrick Archaeology and Heritage 2008)
>
> *Offshore Geotechnical Investigations and Historic Environment Analysis: Guidance for the Renewable Energy Sector* (Gribble and Leather, 2011)
>
> *Model Clauses for Archaeological Written Schemes of Investigation: Offshore Renewables Projects* (Wessex Archaeology 2010a)
>
> *Protocol for Archaeological Discoveries: Offshore Renewables Projects* (Wessex Archaeology 2010b)
>
> *Marine Scotland Licensing and Consents Manual – Covering Marine Renewables and Offshore Wind Energy Development* (Scottish Government October 2012)
>
> *Code of Practice for Seabed Development* (JNAPC 2006)

2.3 English Heritage, Historic Scotland and Cadw all provide guidance on a wide range of topics relating to the historic environment. Please see their websites for further information:

> *English Heritage* http://www.english-heritage.org.uk/publications/guidelines-and-standards/
>
> *Historic Scotland* http://www.historic-scotland.gov.uk/managingchange
>
> *Cadw* http://cadw.wales.gov.uk/historicenvironment/policy/historicenvironmentpolicy

2.4 The Institute for Archaeologists (IfA) is the professional body of archaeologists in the UK. Its functions include setting standards for the study and care of the historic environment. Standards and Guidance covering the main forms of archaeological investigation are set out below. Other relevant IfA standards and guidance are included in later sections of this document.

> *Standard and Guidance for Historic Environment Desk-Based Assessment* (IfA November 2012)
>
> *Standard and Guidance for Archaeological Field Evaluation* (IfA October 2008)
>
> *Standard and Guidance for Archaeological Excavation* (IfA October 2008)
>
> *Standard and Guidance for an Archaeological Watching Brief* (IfA October 2008)
>
> *Standard and Guidance for the Archaeological Investigation and Recording of Standing Buildings or Structures October* (IfA 2008)
>
> *Standard and Guidance for Nautical Archaeological Recording and Reconstruction* (IfA October 2008)

SeaGen: a tidal stream device with turbines mounted within the water column but capable of being raised above the surface for maintenance. Image © Marine Current Turbines, a Siemens Business.

3. ROLES AND PROCESSES

Understanding the respective roles of each party involved in wave and tidal energy development and the management of the historic environment is an essential starting point for effective dialogue.

3.1 Wave and tidal energy has the potential to make an important contribution to low carbon energy in the UK, to help achieve security of energy supply, and to give rise to a core of skills and experience that contributes to the UK's economy nationally and globally. These are all desirable objectives, which should be met as far as possible whilst also meeting society's aspirations for a rich, informative historic environment that can be enjoyed now and in the future.

3.2 As this guidance is concerned with development, it is tailored to the processes through which development takes place, and the roles that different parties play in the development process. Wave and tidal energy development requires consent from public authorities before construction can commence. Different forms of consent may be required depending on the circumstances of the proposed scheme and the Developer will consider this in deciding how best to progress their application. For example, applications may be split into onshore and offshore elements. Notwithstanding, applications for consent for wave and tidal energy development will normally need to be accompanied by information about its implications for the historic environment. In the course of determining whether the scheme should receive consent this information and the anticipated consequences for the historic environment will be examined, which may include additional representations from other parties and the public. The information about the historic environment that accompanies the application will need to be sufficient for this examination and should fully reflect comments made during scoping.

3.3 Consent may be subject to formal requirements relating to the historic environment usually known as 'conditions'. Conditions are secured in a number of ways so that they are legally binding on the Developer. Detailed requirements relating to the historic environment are commonly set out in an Archaeological Written Scheme of Investigation (WSI) to which formal conditions will refer. WSIs typically include a range of provisions prior to and during construction, and during operation and decommissioning, including adherence to the industry-wide Offshore Renewables Protocol for Archaeological Discoveries (ORPAD).

> *Model Clauses for Archaeological Written Schemes of Investigation: Offshore Renewables Projects* (Wessex Archaeology 2010a)
>
> *Protocol for Archaeological Discoveries: Offshore Renewables Projects* (Wessex Archaeology 2010b)

3.4 The guidance in this document is drawn from law, policy, professional standards and best practice. In addition to any legal obligations, the guidance becomes binding and enforceable through the requirement for information about the historic environment to be adequate when it accompanies applications for consent. It also takes effect through the conditions that may be attached to consent when it is determined. Thorough consideration and provision for the historic environment in the course of wave and tidal energy development is therefore an obligation, not an optional extra.

3.5 English Heritage, Historic Scotland and Cadw are the three **National Curators** for England, Scotland and Wales respectively. They are sometimes referred to as 'historic environment advisors'.

3.6 The national curators provide advice to the appropriate licensing authorities for wave and tidal energy offshore, usually referred to as the **Regulators**. These are as follows:

- Marine Management Organisation (MMO), which has powers delegated from the Secretary of State for the Environment for England;
- Marine Scotland, which is the directorate within the Scottish Government that is responsible for the integrated management of Scotland's sea;
- the Marine Licensing Team (MLT) of Natural Resources Wales, which is the principal adviser to the Welsh Government on the environment.

3.7 Decision taking by Regulators has to accord with relevant policy and planning documents. Specifically, decisions about marine licences have to accord with the **UK Marine Policy Statement**, which has specific provisions on the historic environment, and with the different forms of **marine plan** that are currently emerging around England, Scotland and Wales.

3.8 For developments in England and Wales that are **Nationally Significant Infrastructure Projects (NSIPs)**, the relevant Secretary of State is the Regulator, advised by the Planning Inspectorate. At present, wave and tidal stream projects are not considered to be technically viable at over 100MW offshore (the threshold for 'nationally significant'), but major tidal range projects are being treated as NSIPs. Projects related to wave and tidal energy development, such as energy transmission or ports, may also be regarded as NSIPs.

3.9 Policy with respect to NSIPs is set out in National Policy Statements (NPSs), which include policies on the historic environment. English Heritage and Cadw, as part of Welsh Government, respectively, provide historic environment advice in respect of NSIPs in England and Wales. Scotland does not have a separate regime for NSIPs: Marine Scotland – advised by Historic Scotland – is the licencing authority for all forms of licensable activities.

> *Overarching National Policy Statement for Energy* (EN-1) (DECC July 2011)
>
> *National Policy Statement for Renewable Energy Infrastructure* (EN-3) (DECC July 2011)
>
> *National Policy Statement for Ports* (DfT 2012)

3.10 As well as advising Regulators on marine licensing, each heritage agency is also responsible for the **statutory protection** of significant heritage assets, including the authorisation of activities on designated heritage assets. If a scheme involves works in the area of a designated heritage asset, a separate consent may be required under the relevant legislation. The heritage agencies also care for specific historic properties, including many with coastal locations. Other responsibilities held nationally include maintaining and enhancing inventories (national monuments records – see below) and archives relating to the marine historic environment.

3.11 Where there are elements of wave and tidal energy schemes that require specific consent under the Town and

Country Planning Acts (see below), decision taking is the responsibility of **local planning authorities**, which are also encompassed in this Guidance by the term Regulator. Archaeology is a material consideration under the Town and Country Planning Acts; specific provisions on the historic environment are set out in national planning policies.

> *National Planning Policy Framework* (DCLG, March 2012) Chapter 12 Conserving and Enhancing the Historic Environment
>
> *Scottish Planning Policy* (Scottish Government, May 2013 (Consultation Draft)) Valuing the historic environment
>
> *Planning Policy Wales* (Welsh Government, Nov 2012) Chapter 6 Conserving the Historic Environment

3.12 **Local Government Archaeological Officers**, either within the local authority or in a different authority through a service agreement, provide historic environment advice to local planning authorities and to other local authority-based consenting bodies. As well as advising local planning authorities, local government archaeological officers are an important source of information about the historic environment in their area (usually held in inventories known as historic environment records (HERs) or sites and monuments records (SMRs) – see below), about recent investigations and results, and about the significance of heritage assets in a local context. Local Government Archaeological Officers are also referred to as **Local Curators** and are represented by the Association of Local Government Archaeology Officers (ALGAO).

> *Standard and Guidance for Stewardship of the Historic Environment* (IfA October 2008)
>
> *Standard and Guidance for Archaeological Advice by Historic Environment Services* (IfA August 2012)

3.13 In general, the Town and Country Planning Acts apply on land and down to low water, whilst marine licensing applies in tidal waters up to high water. Hence wave and tidal energy development – which often has elements on land, in intertidal areas and in fully subtidal areas – is likely to be subject to multiple consenting arrangements and responsibilities. National policies require terrestrial and marine planning regimes to be integrated. Both local curators and national curators are likely to be involved in advising their respective Regulators, so Developers are advised to establish contact with both at an early stage. It is likely that local and national curators will take the lead in advising on different aspects of the scheme, though this will depend on specific circumstances (including the presence of designated assets). Developers should seek early discussion of the respective roles of local and national curators with respect to their scheme.

Wello Penguin: a wave device tethered to the seabed. Image © Wello.

3.14 In addition to local and national Curators, the historic environment is represented by a wide range of organisations in civil society, often with a thematic, period-based or local/regional interest. These include numerous local history and archaeological societies, national amenity societies (which may have a formal role as statutory consultees in some instances), heritage NGOs and owners of heritage properties – including the National Trust and National Trust for Scotland. Developers should seek the perspectives of civil society organisations and the wider public on the implications of wave and tidal energy development for the historic environment in the course of preparing applications for consent.

3.15 **Technology companies** that are developing devices capable of converting energy in the marine environment into electricity are playing a key role in the wave and tidal energy industry. Other technology companies are focussing on particular components, or scaling-up production to the volumes that will be needed to install whole arrays both in the UK and around the world.

3.16 The development of devices is different – though obviously linked – to the development of arrays, which are groups of similar devices operating on commercial scales. **Array developers** are 'developers' in the sense usually applied to development on land and at sea. Some technology companies are also acting as array developers themselves, to establish that their devices can be deployed productively. Consortia of technology companies, developers and utilities are common.

3.17 It is important for archaeologists to understand the roles of different organisations individually and within consortia, but for ease of reference, the parties involved in proposing specific schemes – from one device to whole arrays – all are referred to in this guidance as Developers.

3.18 Membership-based trade associations such as RenewableUK, Scottish Renewables and the Renewable Energy Association (REA) represent the interests of the wave and tidal energy industry as a whole. These associations are engaged in a wide range of actions intended to promote and facilitate the marine renewable industry, including developing policy and lobbying.

3.19 Developers obtain advice and support from a wide range of **specialists and consultants**. In the phases of development prior to consent being granted, historic environment issues are likely to be addressed by planning and environmental consultants; consultants specialising in installation and engineering are likely to become increasingly relevant to the historic environment in post-consent design and construction phases. Interactions with the historic environment are also likely to ripple outwards to a variety of survey and construction companies.

3.20 **Archaeological consultants and contractors** are amongst the specialists that serve Developers. They are likely to be responsible for implementing many of the specific actions that arise from this guidance. The professional body of archaeologists is the Institute for Archaeologists (IfA), which sets out codes and standards for archaeological work, including the accreditation of individual archaeologists and archaeological organisations.

Oyster 800 being towed into position: a wave device built onto the seabed but with major elements that operate at the surface. Image © Aquamarine Power.

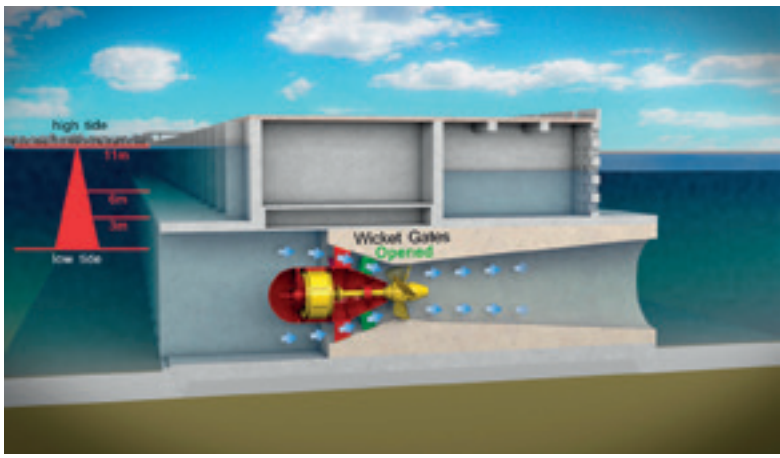
3.21 The**Crown Estate** owns and manages much of the foreshore, the seabed and the sovereign rights to the UK Continental Shelf. A lease is required from the Crown Estate in addition to consents for development. Agreements for Leases (AfLs) provide Developers with a degree of exclusivity over an area for the purposes of developing their scheme. As well as concluding AfLs and leases, the Crown Estate has identified some initial strategic areas for wave and tidal energy and is carrying out Enabling Actions in these strategic areas. The Crown Estate is also considering investing directly in individual wave and tidal projects, to help catalyse investment by others.

3.22 The**Department of Energy and Climate Change** (DECC) has responsibility across the UK for delivering UK Government policies towards wave and tidal energy. As well as developing policy and supporting R&D, DECC is implementing financial measures to support wave and tidal energy in its early stages, currently through the Marine Energy Array Demonstrator (MEAD) scheme administered by The Carbon Trust.

3.23 In Scotland, the **Scottish Government** is implementing a range of policies to support wave and tidal energy development. These include sponsorship of the Saltire Prize for a demonstrating a commercially-viable technology that generates electricity over a two-year period, and WATERS2 funding for R&D to support very low cost-of-energy devices, administered by Scottish Enterprise.

3.24 There is an important European dimension to the emergence of marine renewable energy, reflected in significant financial support for innovative wave and tidal energy technology provided by the **European Commission** through the new entrants' reserve (NER300) programme, using funds arising from emissions trading.

3.25 Of fundamental importance to the viability of wave and tidal energy in its current phases is the overall structure of the **energy market**. In common with other renewables, the cost of wave and tidal energy is currently higher than from conventional carbon-intensive generation; costs are only expected to fall once technologies have been proved and deployed at scales that enable cost reduction to occur. Notwithstanding the financial support noted above, wave and tidal energy requires very high levels of private-sector investment. Attractiveness to investors depends on the incentives that are applied to the electricity market, and certainty that Government policy in this area will continue to be supportive. The existing system of Renewable Obligation Certificates – which enable suppliers to demonstrate their use of renewable sources – and Electricity Market Reform are therefore key drivers for wave and tidal energy in the UK.



A tidal range device: cross section of turbine hall. Image © Swansea Bay Tidal Lagoon.

4. HISTORIC ENVIRONMENT: POLICY, APPROACHES AND TERMINOLOGY

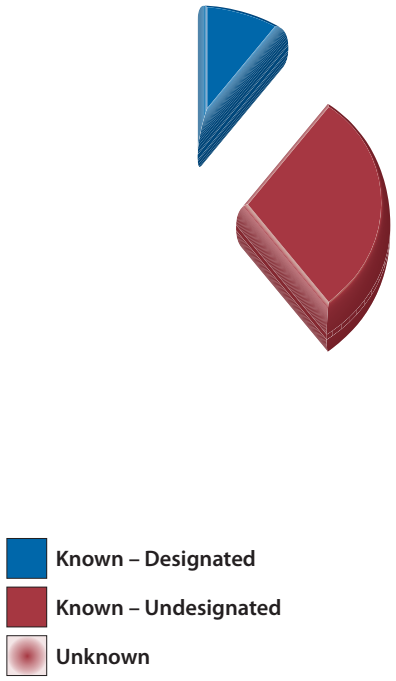
The historic environment is a vitally important resource that is protected by international, European and domestic law and policy.

4.1 Conservation of the historic environment is a devolved responsibility with specific policies, legal mechanisms and administrative arrangements in England, Scotland and Wales. However, there is considerable commonality in approach hence this single guidance document.

4.2 The **historic environment** comprises all aspects of the environment resulting from the interaction between people and places through time, including all surviving physical remains of past human activity, whether visible, buried or submerged. Despite being termed the 'historic environment', it has important economic and social as well as environmental values. The historic environment consists of **heritage assets**, which are buildings, monuments, wrecks, sites, places, areas or landscapes identified as having a degree of significance because of their heritage interest.

4.3 In England, the Government has stated that its vision is that the value of the historic environment is recognised by all who have the power to shape it; that Government gives it proper recognition and that it is managed intelligently and in a way that fully realises its contribution to the economic, social and cultural life of the nation. English Heritage's approach to the historic environment is set out in its *Conservation Principles*.

> *The Government's Statement on the Historic Environment for England 2010* (HM Government 2010)
>
> *Conservation Principles, Policies and Guidance for the Sustainable Management of the Historic Environment* (English Heritage 2008)
>
> *Scottish Historic Environment Policy* (Historic Scotland 2011)
>
> *The Marine Historic Environment: strategy for the protection, management and promotion of marine heritage 2012–15* (Historic Scotland 2012)
>
> *Historic Environment Strategy for Wales* (Welsh Government 2012)
>
> *Conservation Principles for the Sustainable Management of the Historic Environment in Wales* (Cadw March 2011)



Only a small proportion of heritage assets are designated; there are many more that are undesignated. Absence of designation does not imply lower significance. The existence or location of many heritage assets is often unknown prior to investigations preceding development.

4.4 Scottish Ministers' policies towards the historic environment are set out in *Scottish Historic Environment Policy*, which includes Scottish Minsters' vision and key principles. Scottish Ministers 'believe that the people of Scotland are entitled to expect the historic environment to be protected, cared for and used sustainably so that it can be passed on to benefit future generations.' Historic Scotland published its overall strategy towards the marine historic environment in 2012.

4.5 The *Historic Environment Strategy for Wales* includes measures to enable heritage protection and to encourage public access, enjoyment and participation. The

Cannon and hull timbers of the Drumbeg wreck site, which became Scotland's first Historic Marine Protected Area in 2013. Image © Crown Copyright, Historic Scotland – image produced by Wessex Archaeology.

strategy is intended to contribute to quality of life and quality of place, to enhance people's life chances, and also to create individual and community confidence and a sense of belonging. *Conservation Principles for the sustainable management of the historic environment in Wales* provides further guidance.

4.6 An overarching, UK-wide approach to the historic environment has been set out in the context of marine policy, starting with the UK Government's High Level Marine Objectives and developed in the UK's statutory Marine Policy Statement as follows:

> *The view shared by the UK Administrations is that heritage assets should be enjoyed for the quality of life they bring to this and future generations, and that they should be conserved through marine planning in a manner appropriate and proportionate to their significance. Opportunities should be taken to contribute to our knowledge and understanding of our past by capturing evidence from the historic environment and making this publicly available*
>
> *The UK Marine Policy Statement* (HM Government March 2011)
>
> *Our Seas – A Shared Resource: High Level Marine Objectives* (HM Government 2009)
>
> *Scotland's National Marine Plan* (Pre-Consultation Draft) (Scottish Government March 2011)

4.7 In each home country and across the UK Marine Area, these high-level statements of policy recognise the need to conserve the historic environment, but also the very great potential for mobilising the historic environment in achieving a wide range of important social and economic outcomes. This recognition will take increasing effect through the implementation of thematic, regional and area-based policies set out within marine spatial plans in each home country. As noted above, closely comparable policies are also set out in each home country in respect of terrestrial planning and National Strategic Infrastructure Projects, as applicable.

4.8 As well as policy, provision has been made in statute for the protection of specific heritage assets. The Ancient Monuments and Archaeological Areas Act 1979 (AMAA 1979) provides for 'Scheduled Monuments' on which certain works cannot be undertaken unless 'scheduled monument consent' has been granted. Section 1 of the Protection of Wrecks Act 1973 (PWA 1973) makes similar provision for wrecks below low water in England and Wales. In Scotland, the Marine (Scotland) Act 2010 has superseded the relevant provisions of the PWA 1973 through the introduction of Historic Marine Protected Areas (HMPAs). The Protection of Military Remains Act 1986, administered by the Ministry of Defence, and the Receiver of Wreck system, administered by the Maritime and Coastguard Agency also provide incidental protection of heritage assets. On land, the Treasure Act 1996 provides for the reporting and subsequent administration of discoveries of precious material and associated finds in England and Wales; in Scotland, the Treasure Trove system applies.

4.9 The UK's provision for the historic environment in law and policy is driven by the high value that UK society places on its heritage. However, the UK also has to meet its international responsibilities with respect to cultural heritage. Many of the World Heritage Sites in the UK are in coastal areas that are highlighted for wave and coastal energy development; specific policies apply to World Heritage Sites to give effect to their internationally–recognised Outstanding Universal Value.

Culver Hole is a remarkable example of the use of coastal resources in the past: the medieval dovecot is built into the entrance of a coastal cave in Wales, and is a Scheduled Monument. Image © Copyright GGAT.

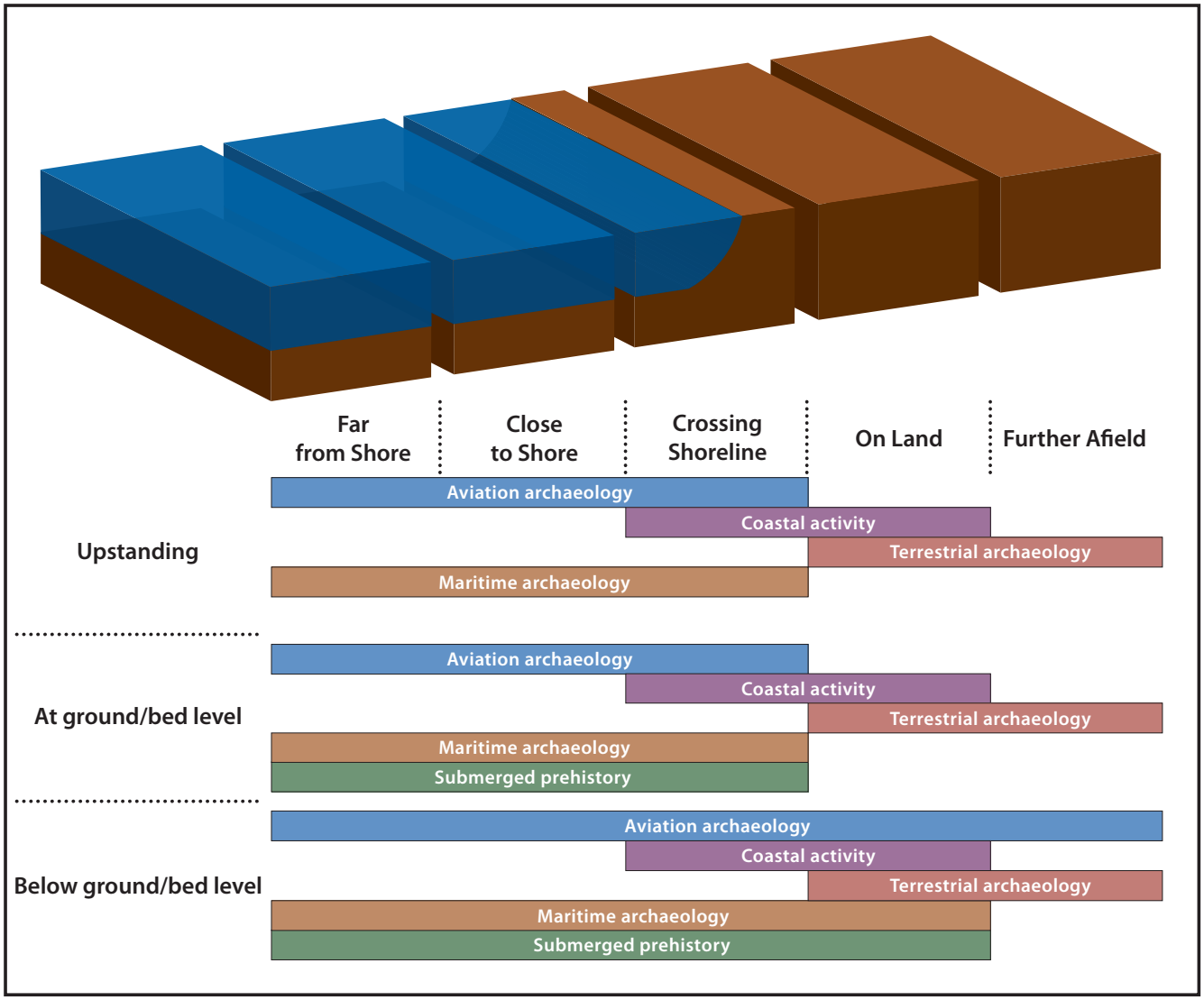
Skara Brae is a Neolithic settlement on the coast of Orkney, dating back about 5000 years. It is a prehistoric site of outstanding universal value protected under the World Heritage Convention 1972. Image © Antony Firth/Fjordr.

4.10 Under the Valletta Convention, the UK is obliged to take into account the historic environment in planning and the development of major scheme; obligations on the UK to protect and manage landscapes are set out in the *European Landscape Convention (2000)*.

> *World Heritage Convention* (Paris, 1972)
>
> *European Convention on the Protection of the Archaeological Heritage* (revised) (Valletta, 1992)
>
> *European Landscape Convention* (Florence, 2000)

5. HISTORIC ENVIRONMENT: THEMES, ASSET TYPES AND CONTEXTS

A diverse range of heritage assets survives on the land, on the foreshore and under the sea, providing insight into the recent past and distant millennia.



The historic environment comprises many forms of heritage asset relating to different themes and in different present-day environments. This diagram indicates the range of historic environment topics that may be raised by each element of a wave and tidal scheme.

5.1 Wave and tidal energy development may have implications for a very wide range of different types of heritage asset, covering many different themes and in different environmental contexts.

5.2 Specific marine renewable schemes may have elements far offshore or in deep water, or they may focus on waters close to shore. In all cases, there will be some form of connection – usually cables or pipelines – that cross inshore areas, shallow water and the shoreline itself. The shoreline may be a muddy estuary, sandy beach, rocks and cliffs, an urban or industrial coastline or many other variations, all with different implications for the kinds of heritage asset that may be present. There is likely to be some form of construction required on land: excavation for cables/pipework; a sub-station; foundations for poles; access roads; parking; temporary works and so on. A wide range of works may also be required further afield, such as the development of construction or operations and maintenance facilities in ports and harbours, or the installation of grid connections.

5.3 Wherever there is excavation of the seabed, seashore or ground – even if it is temporary or shallow – there is potential for archaeological features to be present. Piling or drilling also penetrate the ground and can encounter archaeological material. If excavation, piling or drilling takes place within strata laid down a million years ago or more – before there is any evidence of humans in the UK – then archaeological material will not be present. Nevertheless, it is often necessary to disturb younger deposits that may be of archaeological interest in order to access such strata.

5.4 A principal difficulty with below-ground archaeology is that it lacks immediate visibility and its presence can therefore be a surprise. Archaeological processes such as assessment and evaluation – encapsulating a wide variety of methods – are used to try to detect archaeological material that is not visible otherwise.

5.5 Not all below ground deposits that have the potential to contain archaeological material will necessarily contain it.

There are many reasons why archaeological material may not be present: people may not have chosen to inhabit or use that particular place; no trace may have been left; or previous natural or human-induced processes may have caused them to be erased. However, it is not safe to assume that archaeological material is not present just because it would be inconvenient to acknowledge the possibility. Conclusions about an absence of archaeological material below ground should be evidence-based and reasoned.

5.6 As well as being buried, archaeological material may be present on the surface of the seabed, seashore or ground; and it may be upstanding. Archaeological material at the surface and upstanding is also susceptible to excavation, piling, drilling and so on, but it is sensitive in addition to many other forms of impact that are discussed below. However, material at the surface has the advantage of being more visible – directly or by remote methods – meaning that it can be identified in advance even if its character is not fully apparent.

5.7 Material that can be perceived because it is on the surface or upstanding can contribute to the historic environment over a wide area; it may be appreciated from a long distance, tacitly as well as consciously, and may add to the 'sense of place' associated with a landscape or seascape. Heritage assets can contribute to the character of a place without necessarily being recognised. Often it can be relatively small features of the historic environment that add character; patterns of field boundaries and details on vernacular houses, not just castles and mansions.

5.8 With such a wide range of environments that may be affected by wave and tidal energy development, the range of heritage asset types that might be encountered is very wide also. It is helpful to consider these in terms of the forms in which they might be encountered, recognising that these forms can be present in examples that are below-ground, on the surface or above-ground; and in combinations of all three.

5.9 Heritage assets may comprise single **artefacts**, individually or in groups. Some forms of ancient activity are represented only by artefacts; in early prehistory, in particular, people either did not build structures or they survive only rarely. In other cases, artefacts may have been lost or placed in apparent isolation, ranging from stray items of wreckage to hoards of coins or other precious items.

5.10 **Human remains** can be found as isolated skeletal material, in lone burials or in cemeteries of many graves or cremation deposits. Although cemeteries from recent centuries may be well-known, graves from more distant times can come to light with little forewarning.

5.11 **Ships, boats and aircraft** can be found in various circumstances, ranging from broad scatters of highly disrupted material to remarkably coherent structures. Although they occur as wrecks underwater, ships and boats can also be found buried in land that has been reclaimed; some of the most significant maritime discoveries have been found on 'land.'

5.12 The remains of **sites** of settled domestic, agricultural, industrial, ceremonial or military activity span at least 6,000 years and encompasses assets that vary from the robust to ephemeral, from discrete features to extensive complexes. Objects and structures are usually associated with a variety of deposits and surfaces that add contextual data to the artefactual material. How sites are understood and appreciated takes into account their surroundings, or **setting**, as well as the site itself. People have also manipulated the shape of the land and coast, and the plants and animals that live there, both intentionally and unintentionally. As the character of **landscapes**, coastlines and even the seabed is often a product of human intervention, they are also regarded as components of the historic environment.

5.13 Human intervention in the landscape can create very extensive features, but it also leaves microscopic traces. Tiny fragments of plants, insects, pollen, charcoal, plankton and so on can be scrutinised to reveal details of the **palaeo-environments** once inhabited by people.

5.14 These different forms of heritage asset illustrate the kinds of features that might be associated with any of the main themes likely to be encountered in wave and tidal energy development. The principal themes are:

- Submerged prehistory: human activity that occurred on land that has been submerged as a result of relative sea-level rise.
- Maritime: human activity associated with boats, ships and seafaring.
- Aviation: human activity associated with flight and aircraft.
- Coastal: a very wide range of human activity associated with living around and using coastal zones.

5.15 In very broad terms, archaeological material associated with these themes in the sea tends to concentrate either on the very distant past, over 10,000 years ago, or on the quite recent past, especially the Nineteenth and Twentieth Centuries. However, archaeological material of any age may present itself in the course of wave and tidal energy development, especially in the coastal and onshore elements of a scheme.

5.16 National and regional variations in chronology may be very important: in England for example there is evidence of human inhabitation extending back 900,000 years, whilst there is as yet no firm evidence of people living in Scotland before the most recent peak of glaciation (known as the Last Glacial Maximum – LGM), about 18,000 years ago.

5.17 The great changes that have occurred to the coast and the enormous diversity of human activity whose traces may be uncovered require particular attention when considering developments such as wave and tidal energy that encompass several different contexts. Over-concentrating on one theme or period whilst others are ignored is unlikely to satisfy the legal and policy requirements outlined previously. Approaches to wave and tidal energy development need to be 'seamless' – archaeologically coherent – across offshore, inshore, foreshore and onshore zones.

As well as preserving evidence of environmental changes that are important to understanding human inhabitation in prehistory, peat layers and other fine grained sediments can contain remarkable examples of organic artefacts – such as this Bronze Age hurdle track way near Swansea – that rarely survive on dry land. Image © GGAT.

6. HISTORIC ENVIRONMENT: ARCHAEOLOGY IN HIGH ENERGY ENVIRONMENTS

Important archaeological material can be found in high-energy environments.

6.1 Wave and tidal energy development is focussed in places where the sea conveys high levels of energy. This energy can take effect on both the surface of the sea and on the seabed, as well as on adjacent coastlines. Similarly high-energy environments will have prevailed throughout most of the periods in which archaeologists are interested, and will have implications for what archaeological material may have been deposited there, and what has survived until today.

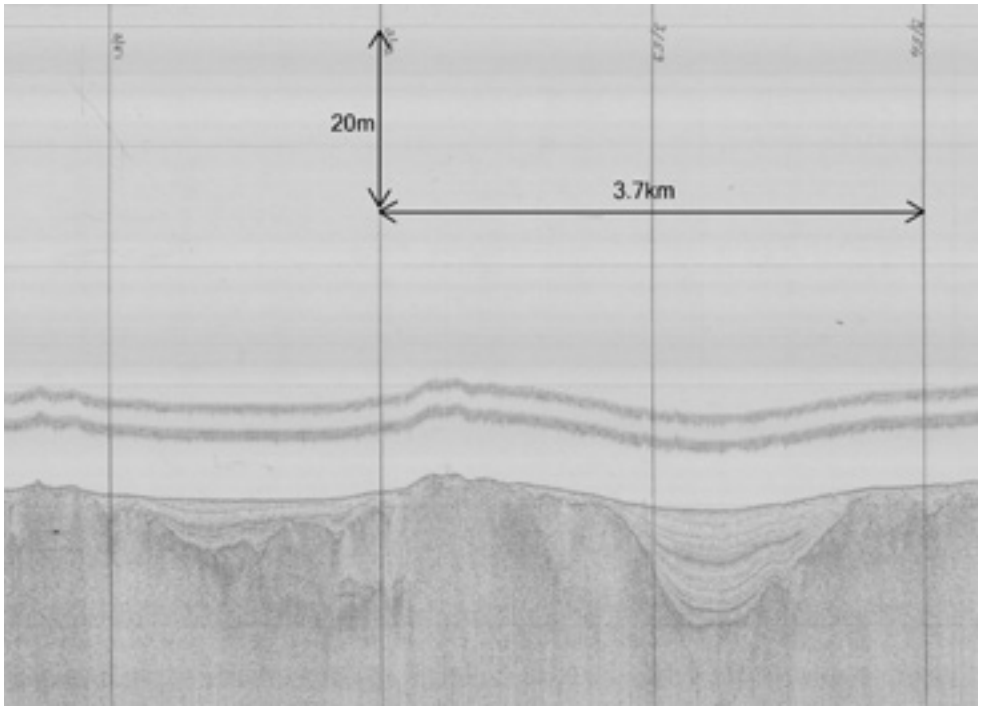
6.2 Waves and currents are hazardous to boats and ships, especially close to the coast where vessels have limited sea room and can come to grief on the shore. The hazard is probably greatest near the coast, but vessels can also founder through stress of weather out at sea, or be driven into collision or other calamity. Wave and tidal energy development is focussed on areas of such high energy that they are hazardous not only to craft powered by oars or sail, but also to vessels powered by coal or oil. Some of the areas of highest resource for tidal currents are also significant seaways because they are in places where the sea is constrained, or connect to the ocean. Areas of interest for wave and tidal energy often coincide, therefore, with areas where many ships have been lost.

6.3 Areas of interest for submerged prehistory and areas of wave and tidal energy interest also seem to coincide, though the causal link is not as clear as for shipwrecks. For example, the Isles of Scilly and the Isle of Wight off England have a long history of investigation of submerged landsurfaces; Orkney and the Western Isles are a current focus for submerged prehistoric research; and 'lost landscapes' have been mapped in both north and south Wales.

6.4 It might be assumed that whatever might once have been deposited on what is now the seafloor, whether it is wreck or ancient stone tools, the environment is so energetic that little could have survived. This assumption is not safe; conclusions about the survival of archaeological material should be based on direct evidence wherever it can be made available, not upon remote environmental proxies.

6.5 There are several reasons to question the assumption that archaeological material does not survive in high energy environments. First is the empirical evidence of many high-energy sites where archaeological material has survived; sometimes in poor condition, but often still significant and capable of interpretation. The second is that high-energy environments are not uniform; they often contain niches within which low energy conditions prevail, such as gullies and behind rock outcrops. Within such niches, fine-grained and delicate deposits can survive, preserving stratigraphic relationships and organic remains. A third reason is that archaeological material can itself create low energy conditions within a generally high-energy environment. An example might be the metal hull of a wreck or a cargo of stone, within and behind which sediment may accumulate and provide a matrix in which artefactual material can survive. In other cases, scour around archaeological material can cause localised erosion, creating depressions within which artefacts can collect.

6.6 Turning to adjacent coasts and land, it should also not be assumed that because an area seems 'wild' in the present, it would have been avoided in the past. Hard coastlines offered resources and opportunities to our predecessors, as demonstrated by numerous known sites. Coastlines that are uninhabited today may have hosted numerous phases of diverse human activity across the centuries, creating rich and complex layers of history. Again, assessments of presence or absence have to be based on evidence, not on today's preferences.



Sub-bottom profiler trace showing a possible palaeovalley to the east of Orkney. The channel probably became infilled in early prehistory, subsequently surviving the action of the sea over thousands of years and having potential to contain key archaeological and environmental remains. Image © ORCA; Contains British Geological Survey materials © NERC 1982.

7. WAVE AND TIDAL ENERGY: STATUS AND TRAJECTORY

Although it is still at an early stage, wave and tidal energy development is expected to grow strongly. Schemes of increasing size and complexity will be consented and constructed over the next decade.

7.1 Wave and tidal energy is still at an early stage of its development. Expectations are high, however, and it is anticipated that wave and tidal energy will make an increasing contribution to overall supply in the reasonably near future. Devices are already deployed in full-scale trials in various locations around the UK and some major commercial schemes are already in the planning process. Many leases have been agreed, covering extensive areas in their own right and, in strategic areas such as Pentland Firth and Orkney Waters (PFOW), the overall extent of wave and tidal energy development is considerable. In consequence, specific wave and tidal energy projects are already featuring in day-to-day casework relating to the historic environment.

7.2 Not just large arrays warrant attention from a historic environment perspective. Proposals to install small-scale and full-scale demonstrators, to build facilities at testing sites, or small community-scale schemes are developments in their own right that require archaeological attention.

7.3 In addition, studies and projects are underway to provide the infrastructure that will be necessary to construct and operate large-scale wave and tidal energy. In particular, there is a pressing timetable for reinforcement of the electricity transmission network – involving major schemes at sea and on land – to provide capacity for anticipated renewables, including wave and tidal energy. Redevelopment of ports and other facilities is also underway or planned to facilitate construction and, in particular, operations and maintenance.

7.4 In consequence, wave and tidal energy – despite very real uncertainties about its eventual forms – is certainly an active sector of marine development. It is not just a 'potential' sector that has yet to emerge.

7.5 Wave and tidal energy in the UK is developing in a global context, and world-leading activity is occurring here. The relative accessibility of wave and tidal resources – discussed below – is a factor in this, but it is not the only one. Wave and tidal energy is a potentially important sector in meeting domestic targets to reduce global warming, but also in contributing to the capacity to export renewable electricity. Given the current state of the world's economies, wave and tidal energy is also being highlighted domestically as a source of economic growth, jobs and inward investment, especially in places that might otherwise be considered peripheral to centres of economic activity. The scope, in due course, to export services, skills and expertise – devices even – to a global market is also an important consideration. Efficient consenting and construction of each scheme is important therefore to the overall development of wave and tidal energy, as well to the individual schemes themselves.

7.6 In domestic terms, the trajectory for wave and tidal energy is being set by commitments to increase the proportion of electricity generation from renewable sources. Countering climate change is the main driver, but security of supply and cost to consumers are also key factors.

A Pelamis wave device under construction in Scotland, indicating the scale of engineering involved. Image © Pelamis Wave Power.

The Pelamis is a wave device that floats on the surface and is tethered to the seabed. It is designed to operate in relatively deep water offshore. Image © Pelamis Wave Power.

> *The Renewable Energy Directive* (2009) sets a target for the UK to meet 15% of energy demand from renewable sources by 2020.
>
> *'Wave and tidal stream energy has the potential to meet up to 20% of the UK's current electricity demand, representing a 30-to-50 gigawatt (GW) installed capacity. Between 200 and 300 megawatts (MWs) of generation capacity may be able to be deployed by 2020, and at the higher end of the range, up to 27GWs by 2050.*
> *Studies have estimated the UK's total theoretical tidal range resource at between 25 and 30GWs – enough to supply around 12% of current UK electricity demand.'*
>
> *DECC https*://www.gov.uk/wave-and-tidal-energy-part-of-the-uks-energy-mix

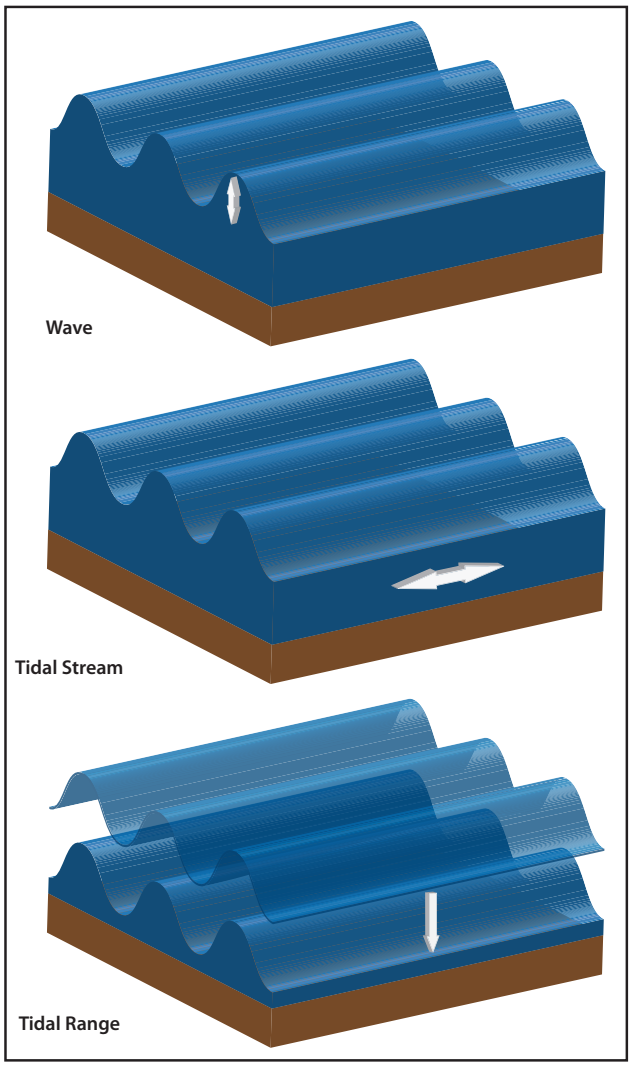
7.7 The commitment to wave and tidal energy is driven by recognition of the potentially large resources of wave and tidal energy that might be available to the UK. The challenge is to capture some of this potential resource with sufficient operational capacity to meet energy generation targets at rates that will become commercially viable. This challenge is being pursued through the identification of areas that have appropriate infrastructure and apparently high levels of resource within which schemes can be built.

7.8 This overall resource-led approach forms the basis of the Crown Estate's leasing. Given the variety of technologies and uncertainties about what will work best, however, different approaches to leasing are being pursued in parallel:

7.9 Several **test sites** have been leased where devices can be trialled both at small scales and full-scale, through to longer-term tests of consistent electricity generation (GWh Production). At these test sites, facilities such as subsea cabling for the devices, landfall, substations and grid connection are provided by the testing facility; the devices are 'hooked up' to these facilities for the duration of the tests.

7.10 Leases for **demonstration projects** are for single devices or small arrays where the whole scheme from device to grid connection is by the Developer. The anticipated output of demonstration projects is from <1MW to 4MW.

7.11 **Early commercial projects** are in the range 10–30MW. Full size **commercial projects** are likely to be greater than 30MW; leases and applications for consent are anticipated for schemes up to and above 200MW.



LEASES – TESTING SITES IN ENGLAND, SCOTLAND AND WALES	
EMEC Billia Croo	Scotland
EMEC Fall of Warness	Scotland
EMEC Scapa Flow	Scotland
EMEC Shapinsay Sound	Scotland
FabTest	England
Wave Hub	England
Solent Ocean Energy Centre	England

LEASES – TIDAL STREAM PROJECTS IN ENGLAND, SCOTLAND AND WALES		
Bluemull Sound, Shetland	Scotland	0.5 MW
North Humberside	England	0.5 MW
Esk Estuary, Montrose	Scotland	0.66 MW
Ramsey Sound, Pembrokeshire	Wales	1.2 MW
Lynmouth, Devon	England	1.6 MW
Mull of Kintyre, Argyll	Scotland	3 MW
Kyle Rhea	Scotland	8 MW
St David's Head, Pembrokeshire	Wales	10 MW
Skerries, Anglesey	Wales	10 MW
Sound of Islay	Scotland	10 MW
Lashy Sound	Scotland	30 MW
Ness of Cullivoe, Shetland	Scotland	30 KW
Isle of Islay	Scotland	30 MW
Sanda Sound	Scotland	35 KW
Brough Ness	PFOW	100 MW
Ness of Duncansby	PFOW	100 MW
Cantick Head	PFOW	200 MW
Westray South	PFOW	200 MW
Inner Sound	PFOW	400 MW

LEASES – WAVE PROJECTS IN ENGLAND, SCOTLAND AND WALES		
Burghead, Moray Firth	Scotland	–
Bernera, Isle of Lewis	Scotland	10 MW
Galson, Isle of Lewis	Scotland	10 MW
South West Shetland	Scotland	10 MW
North West Lewis	Scotland	30 MW
Siadar, Isle of Lewis	Scotland	30 MW
Farr Point	PFOW	50 MW
Marwick Head	PFOW	50 MW
West Orkney Middle South	PFOW	50 MW
West Orkney South	PFOW	50 MW
Brough Head	PFOW	200 MW
Costa Head	PFOW	200 MW

Tables listing testing sites, tidal stream projects and wave projects in England, Scotland and Wales.

Wave and tidal energy development makes use of three entirely different properties of the sea: the up and down motion of its surface; the lateral movement of whole waterbodies; and the 'head' that can be created by temporarily impounding the sea as it flows in or out. As they make use of different properties, different types of environment are favoured, and different approaches are being applied to energy generation.

8. WAVE AND TIDAL ENERGY: SPATIAL DISTRIBUTION

Although there are key concentrations of wave and tidal energy development, projects are being proposed in many locations.

8.1 The main technologies – wave, tidal stream and tidal range – have different characteristics and are unevenly distributed in terms of their general geographical attributes and their location around the UK.

8.2 In broad terms, wave energy is greatest where there is open exposure to the Atlantic; both deep water (offshore) and shallow water (inshore) technologies are being developed. North West Scotland and the South West approaches have the greatest resource.

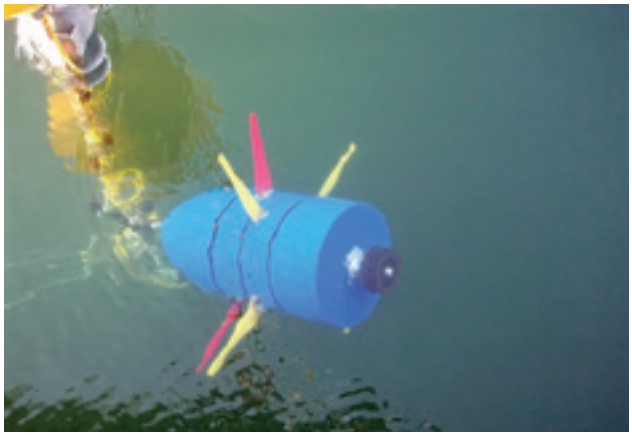
8.3 Tidal stream energy is greatest where tides are constrained by coastal features such as headlands, in sea lochs and in sounds or channels between islands/mainland, especially where different bodies of water meet. Consequently, tidal stream energy is essentially inshore. Major tidal stream resources are located around the Pentland Firth and Orkney, where the North Sea and Atlantic meet; in areas influenced by the North Channel between the Irish Sea and Atlantic; around Welsh peninsulas where the Irish Sea is constrained; in the Severn; around the Isle of Wight and in the Straits of Dover. Smaller but locally significant tidal stream resources occur at many other places, including around Land's End and around Great Yarmouth.

8.4 Tidal range energy is also focussed where the tide is constrained by a coastline and the coast itself forms part of a barrier that can be used to form a 'head' of water. Tidal range is therefore close inshore – though very large schemes may extend further off. Major tidal range resources are associated with many of our main estuaries and embayments such as the Severn; Dee; Ribble; Morecambe Bay; Solway; Wash; Humber. Again, smaller but significant tidal range resources occur in other estuaries also.

8.5 Unsurprisingly, the geographical spread of interest in wave and tidal energy reflects the distribution of the resource, though magnified by regional policies and initiatives. Undoubtedly, the greatest concentration of activity at present is in the Pentland Firth and around Orkney. There are further emerging foci around the Western Isles, Pembrokeshire and Cornwall. Individual schemes have also been proposed off Anglesey, in Swansea Bay and in the Humber, for example, and there are testing facilities at Blyth. A lease for a further testing centre of the Isle of Wight has also been agreed. As indicated above, significant tidal stream and tidal range resources are found at a variety of locations so it is possible that proposals could develop in other areas also.

8.6 Circumstances and encouragement have led to a degree of concentration, seeking to develop clusters, critical mass and centres of excellence. The availability – and case for enhancing – grid connection and port infrastructure also plays a part.

8.7 Pentland Firth and Orkney Waters (PFOW) has been identified as a strategic area by the Crown Estate and has been a focus for testing and commercial leases. No other strategic areas have been declared yet around England, Scotland or Wales. Rather, the approach taken has been to help identify areas that have potential for development – through Marine Scotland's Regional Locational Guidance (RLG; Scottish Government, August 2012) – but to let Developers come forward with proposed sites. An approach equivalent to that adopted for offshore wind – where Round 2 focussed on specific areas and Round 3 was based on defined zones – is not being pursued currently. Notwithstanding, consideration is being given to how best to provide a degree of geographical exclusivity to areas without sterilising them for subsequent development.

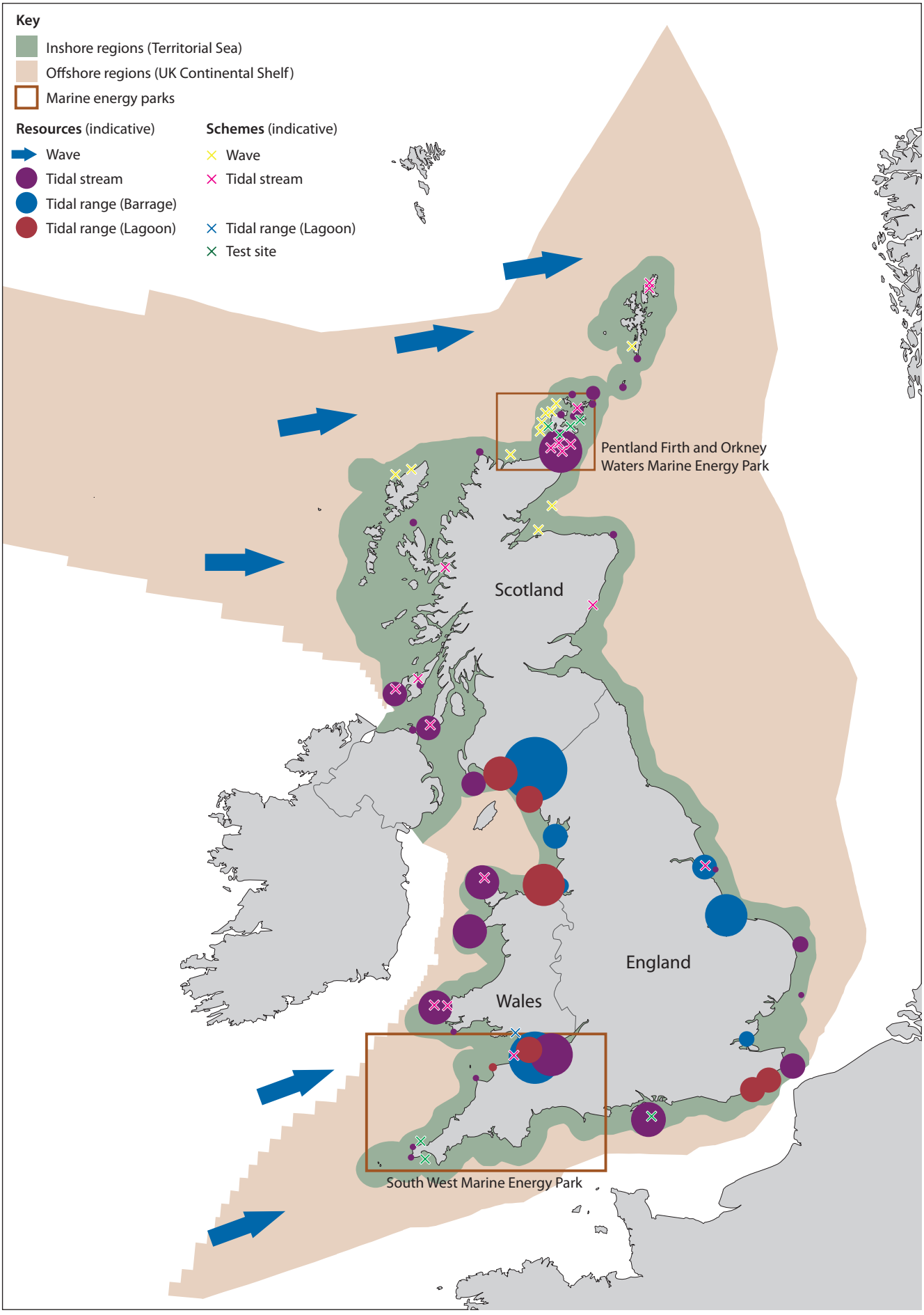


CoRMaT is a tidal stream device that floats in mid water and is tethered to the seabed. Image © Nautricity Ltd.

The SR250 has two tidal stream turbines mounted beneath a hull that floats at the surface and is tethered to the seabed. Image © Scotrenewables Tidal Power Ltd.

8.8 Marine Energy Parks have been declared for PFOW and South West England (SW MEP). The purpose of these parks is to increase profile and provide a banner for the development of partnerships. They do not have a status in terms of leasing or consenting.

> *Tidal Energy in Scottish Waters: draft regional locational guidance* (Scottish Government, August 2012)
>
> *Offshore Energy in Scottish Waters: draft regional locational guidance* (Scottish Government, August 2012)



In addition to an important cluster of wave and tidal energy development in the Pentland Firth and Orkney Waters, significant development is anticipated at many other locations. The apparent scale and distribution of marine renewables resources across Britain means that the further potential of this source of energy is considerable. Indicative resources are theoretical estimates of the wave and tidal energy resources available in broad geographic areas as shown in UK Wave and Tidal Key Resources Project: Summary Report *(Crown Estate, October 2012).*

Devices such as the SR250 that are tethered to the seabed can be removed for maintenance using relatively small vessels. Image © Scotrenewables Tidal Power Ltd.

8.9 In Scotland, the focus on PFOW has prompted area-based strategic studies and data acquisition, including multibeam and other seabed surveys by Marine Scotland and the Crown Estate. Strategic area-based data acquisition of this type may provide an important resource for gauging the presence and potential of archaeological material. Marine Scotland and Crown Estate data from PFOW was, accordingly, subject to review in the course of Historic Scotland's Project Adair.

> *Project Adair: mapping marine heritage sites in Orkney and the Pentland Firth* (ORCA, March 2012)

8.10 Although there is some significant clustering, the spatial development of wave and tidal energy is reasonably widespread. The introduction of marine planning, including thematic plans informed by regional locational guidance in Scotland and multi-use marine plans around England, may frame the spatial development of marine renewables more directly. For the time being, however, an exclusive focus on strategic areas or zones has not emerged so proposals for marine renewable schemes may be brought forward at many different places.

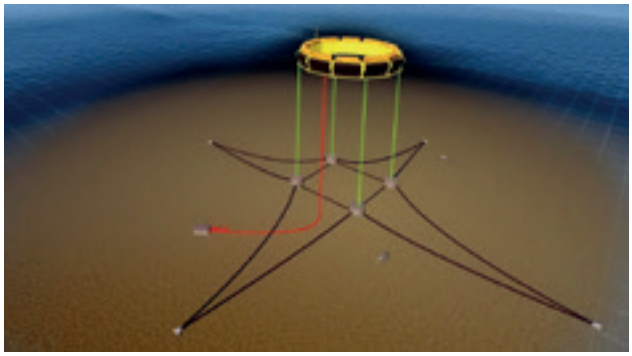
8.11 Given the reasonably widespread distribution of proposals, and with the exception of Project Adair, there have not been any systematic area-based approaches to consolidating and enhancing baseline archaeological data in support of wave and tidal energy. Such regional overviews could provide context to specific heritage assets or to questions of potential and significance. In the meantime, archaeological assessment seems likely to remain heavily dependent on Developers' own investigations in support of consents for individual schemes.

8.12 There is scope, however, to draw on other regional or thematic archaeological projects – such as those conducted with support of the Aggregate Levy Sustainability Fund – where they coincide with particular schemes; Curators can be expected to draw attention to such studies in the course of pre-application consultation.

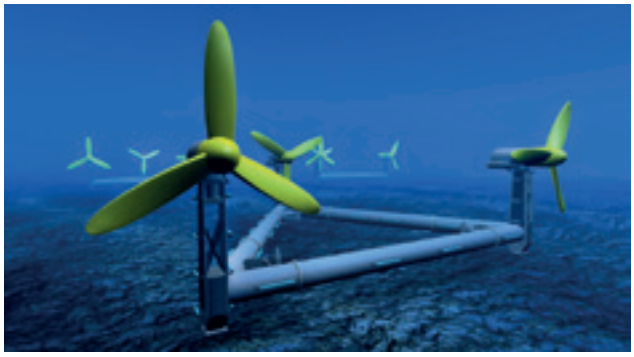
8.13 Alternatively, groups of Developers may find it cost-effective to collaborate in undertaking combined background studies for archaeological purposes. If a number of Developers are facing similar historic environment issues with respect to a particular region or theme, then it may be cost-effective to pool resources and adopt a combined approach to discussion with Curators. By way of example from another sector, the marine aggregate industry chose to adopt a collaborative approach in addressing the implications for a group of marine licences of highly important Palaeolithic remains found in the Palaeo-Yare Catchment off East Anglia.

8.14 The relatively broad spread of wave and tidal energy development may create a difficulty in building capacity among curatorial staff to support consenting, especially in regional or local authority contexts. Some concentrations, such as that around Orkney, are clear and have been met by the development of specialist skills and resources. Elsewhere, building curatorial capacity for wave and tidal energy – at a time when there is strongly increasing demand for capacity to address other forms of marine development also – may warrant particular measures. Training programmes for archaeologists in local and national authorities, and resourcing of additional posts, are approaches that have been adopted in response to other marine sectors and merit consideration for wave and tidal energy also.

AWS wave energy device, which floats at the surface in depths of around 100m. Image © AWS Ocean Energy, courtesy SSE.



Tethered devices require anchoring and connection systems at the seafloor. Image © AWS Ocean Energy, courtesy SSE.



DeltaStream is a tidal stream device that is built onto the seabed but has its major elements in the watercolumn. Image © DeltaStream, courtesy of Tidal Energy Ltd.

9. WAVE AND TIDAL ENERGY: TECHNOLOGIES

The implications for the historic environment of the diverse range of wave and tidal technologies are largely driven by their configuration with respect to the seabed and their appearance at the surface, rather than the way in which electricity is generated.

9.1 Though the details may be different, wave and tidal energy development has many things in common with offshore wind, which has been the focus of most previous historic environment guidance and practice. Inter-array connections, export cables, landfall, onshore infrastructure and connections to the grid are all reasonably familiar from an archaeological point of view. A consistent approach to all forms of marine-based renewable energy development is obviously sensible and facilitates the consideration of cumulative effects. However, when it comes to the principal technologies there are also some major differences:

- Whereas offshore wind is characterised by one principal technology – single large turbines mounted on tall columns, usually separated quite widely in arrays spread over large areas of sea – wave and tidal energy is using many different technologies.
- For offshore wind, the turbines, blades and columns need to be considered for potential visual effects on the historic environment over wide areas, but such visual considerations are likely to be more localised for wave and tidal energy technologies.
- The way in which offshore wind obtains energy from the environment – from moving air – does not affect the physical survival of archaeological material; wave and tidal technologies take energy out of the water so they may have implications for heritage assets that are also within or near that water.

9.2 Despite the diversity of technologies being used for wave and tidal energy there is a degree of overlap in archaeological terms. The types of energy – wave, tidal stream and tidal range energy – are not necessarily the most helpful categories. Instead, it may be more appropriate to start by considering where the device is situated (see illustration on opposite page).

9.3 Devices that float at the surface are being developed for both wave and tidal stream energy. As they are at the surface, they may have visual implications, especially as enhanced visibility may be necessary to reduce danger to navigation. Floating devices use anchor systems to hold their position; the anchoring system is the main interface with the seabed. Anchor systems may be gravity-based – resting on the seabed – or they may embed themselves into the seabed. As well as the anchors themselves, there are likely to be tethering cables or chain which move across the seabed. Inter array connections may be suspended within the water column but at some point the mid-water cables will connect to cables on the seabed.

9.4 Devices that float mid-water (i.e. at a level within the water column) are being developed for tidal stream energy. These will also require anchor systems and inter-array connections to the seabed. However, they do not themselves have a visual presence at the surface (though there may be navigation warning buoys associated with them). A further option is for devices to float at the surface so they have a visual presence there, whilst being mounted on mooring piles driven into the seabed.

9.5 Many different types and models of tidal stream device operate in mid-water and are supported by structures on the seabed. The seabed structures may be gravity-based (held stable on the seabed by their own weight) or piled. Although the device itself may not be visible at the surface when it is operating, several designs provide for the devices to be raised above the water for access and maintenance, hence their support structures protrude above sea level. Surface structures may be also associated with seabed-mounted mid-water systems for monitoring and testing equipment, especially for devices installed for trials so that they can be readily accessed for monitoring and modification. Inter-array connections are made between the individual structures along the seabed.

9.6 Some mid-water devices are being designed as small arrays on a single structure that is mounted on the seabed. These small arrays can be deployed in multiples to make up larger arrays. The seabed structure on which the small arrays are mounted is capable of being recovered to the surface as a whole. This means that they are not visible at the surface during operation, but the seabed structures may be extensive. As above, inter-array connection is at the seabed.

Oyster 800 wave device in operation during testing. Image © Aquamarine Power.

9.7 Some devices – such as the Oyster – have fixed elements that are mounted directly on the seabed, while the moving parts project through the water column up to the surface. The top part of the Oyster, for example, is visible during operation. As the device itself (rather than its supporting structure) requires elements that are both at the surface and on the seabed, it needs relatively shallow water. The Oyster device pumps high-pressure water to turbines that generate electricity onshore, hence the inter-array connections are pipes rather than cables.

9.8 Large structures that house turbines are used for both wave and tidal range energy. The WaveGen Limpet is deployed in a structure that looks like a breakwater, built onto the seabed or seashore and protruding above the surface; tidal barrages and lagoons are broadly similar, where a structure is used to create a head of water that drives multiple turbines within it. Cabling and connections are likely to be housed within the structure itself.

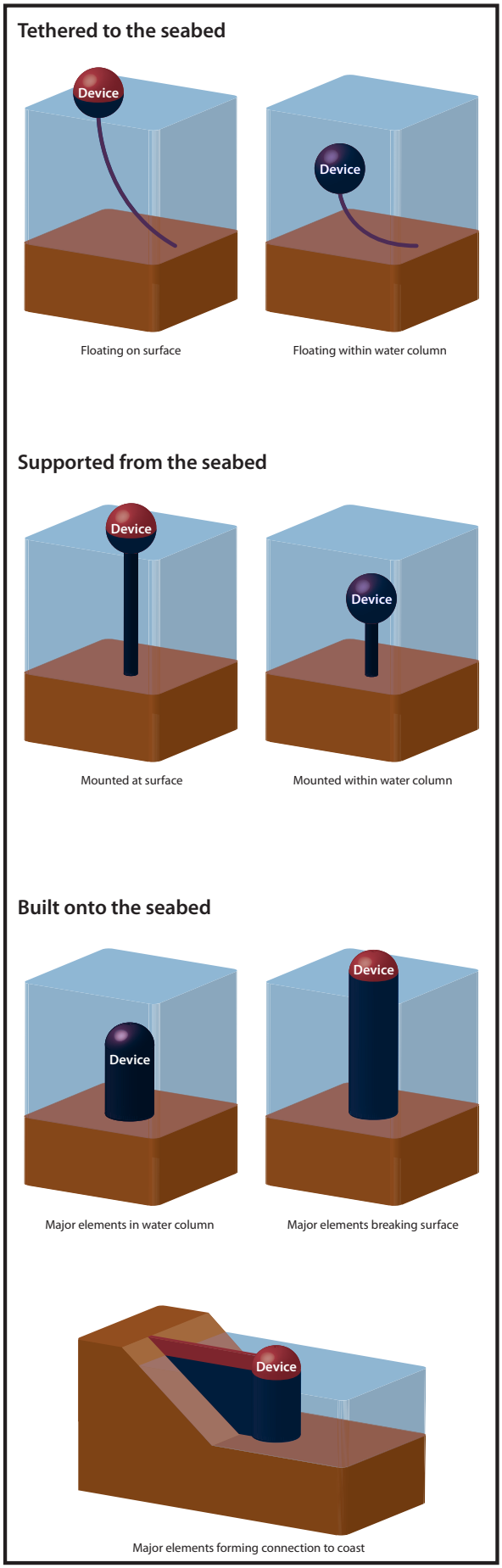
9.9 In all cases, wave and energy devices are complex devices that are being placed directly into high-energy environments. Whether they are built onto the seabed, supported above it, or tethered they require a scale of engineering that may not be immediately apparent from schematics, photographs or even drawings.

9.10 The efficiency of wave and tidal energy devices – in terms of the power they can extract – is highly dependent on their positioning relative to the resource (as well as a range of other engineering constraints). The relationship between devices – how energy extracted by one device affects the energy available to other devices – may also be sensitive. In general, this means that the precise position of each device is integral to the overall design, and opportunities for micro-siting to avoid heritage assets may be very limited. Offshore wave devices are more flexible in terms of siting; but the positioning of tidal stream devices is likely to be highly constrained.

9.11 Most devices use some form of inter-array connections on the seabed, using technologies that are common to the different devices and also to other forms of seabed construction, such as offshore wind and oil and gas. One potential difference is that wave and tidal energy devices tend to be in high-energy environments, including environments where the seabed consists of swept rock. Cables may lie directly on the seabed, be pinned, held in place by gravity structures (e.g. concrete mattresses), or trenched into the seabed, depending on circumstances. Landfall may be achieved relatively simply by trenching across the foreshore, but there are a variety of circumstances in which directional drilling may be preferred or required.

9.12 All devices will need some form of onshore hardware for connecting their output to the onshore grid. Where the device generates electricity directly, electricity in cables will make landfall, as for offshore wind. In cases like the Oyster, however, pipes containing a flow and return of water come to the shore, powering a turbine in facilities onshore. Different devices generate different voltages and currents, so in some cases extensive onshore facilities might be required to achieve the necessary conversions prior to joining the grid.

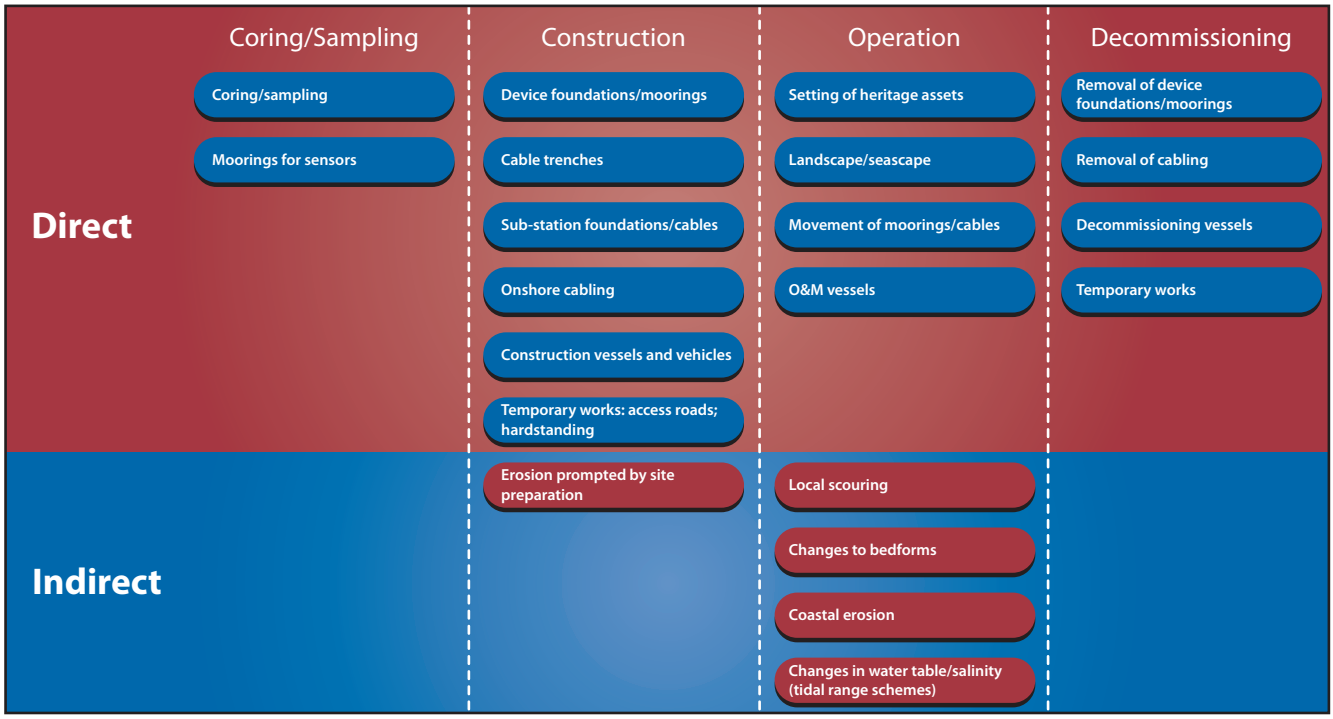
9.13 The different forms of device have significantly different implications for construction on-site, on the adjacent coast, and at facilities further afield. Equally, different design concepts are being developed for operations and maintenance – a major issue for wave and tidal energy – which may have different implications for the historic environment.



Wave and tidal energy development is characterised by a wide variety of technologies and approaches. Although details will vary greatly, the way in which devices are placed is likely to have a major influence on the impacts that may affect historic environment during construction and operation. This schematic can be applied to both wave and tidal energy, and to many different technologies.

10. POTENTIAL IMPACTS FROM WAVE AND TIDAL ENERGY DEVELOPMENT

The most significant adverse effects of wave and tidal energy development on the historic environment are likely to occur during the construction phase, but effects may arise prior to construction, in the course of operation, and during decommissioning also.



Effects on the historic environment can arise at each stage of wave and tidal energy development, and may be direct or indirect. This diagram gives an indication of the sorts of impact that may warrant consideration.

10.1 A distinction is drawn here between impacts and effects, where impacts are changes caused by a scheme or plan, and effects are the consequences of those changes. Wave and tidal energy have a wide range of impacts, some of which may have effects on the historic environment. Some of these effects may be adverse. Many of the impacts described here may have no effect on the historic environment, or the effect may not be significant.

10.2 Wave and tidal energy may give rise to beneficial effects where the significance of heritage assets is enhanced by development-led investigation, for example, or by increasing public benefit associated with the historic environment.

10.3 Direct effects are those that arise where the impact is immediately upon a heritage asset. Indirect effects arise where an impact gives rise to another process, such as sediment transport, that applies to the heritage asset. All unmediated impacts on heritage assets and their settings should be regarded as 'direct', including visual and noise impacts, for example.

10.4 Direct and indirect effects can arise both from the proposed scheme and from the activities necessary to implement the scheme. For example, direct effects may arise from impacts on heritage assets from vessels and vehicles carrying out installation even though the device has no direct effect. The effects that arise from activities associated with constructing, operating or decommissioning a scheme are sometimes referred to as 'secondary' but this should not be taken to imply that they are any less significant for the archaeological heritage.

10.5 Cumulative effects are those that arise from the impacts of multiple projects, including different schemes of the same type and schemes of different types. Consideration of cumulative effects encompasses schemes for which applications have been submitted in addition to schemes that have been built or consented.

10.6 When potential impacts are set out for assessment they may be framed in terms of the scheme's 'Rochdale Envelope', which is the maximum parameters within which the scheme will be designed in detail. The Rochdale Envelope is the 'realistic worst-case scenario', which may need to be expansive to accommodate rapidly changing technologies. The eventual scheme may be well within the parameters that are assessed.

10.7 Different impacts can have the same effects: exposure of archaeological material to deterioration can be a direct effect of dredging, or an indirect effect of scour around a new structure. Where multiple impacts occur to a single receptor, consideration may need to be given to the in-combination effects.

10.8 **Impacts prior to construction** relevant to the historic environment may arise in the course of site investigation. Intrusive site investigations such as coring and test pitting for environmental or engineering purposes can have direct effects on archaeological material. Clump weights or anchors for sensors could also give rise to impacts. However, such site investigations will generally give rise to data that will help in assessing the overall effects of the proposed scheme on the historic environment. So long as known heritage assets are avoided, the ORPAD protocol for unexpected discoveries is observed, and opportunities are taken to integrate archaeological objectives within the site investigations, the effects of site investigation impacts are likely to be beneficial rather than adverse.

10.9 The potential **direct effects from construction** are numerous and can occur in each of the environments within which wave and tidal energy schemes are installed: offshore; inshore; intertidal and on land.

10.10 Construction impacts from the devices themselves will be dependent, to some extent, on where the device is situated, as outlined in the section on wave and

tidal technologies. The impacts of devices that float in mid-water or on the surface will arise primarily from the system used to moor them, such as anchors or gravity moorings, and their associated chains and cables. Devices that are mounted on the seabed in some way will have impacts arising from the supporting structure, irrespective of whether the major elements of the device itself are close to the bed, in mid-water or at the surface. The structures used to support devices take a variety of forms; all are likely to have impacts to the seabed through, for example, piling or preparation of the ground for gravity structures. The footprint of the construction impacts of these different forms of device will vary widely, however, as will their relation to any heritage assets in the vicinity. It need not follow that a big excavated footprint will cause a big effect; but equally the potential effects of mooring arrangements may be extensive even if each anchor is relatively small.

10.11 Although they only need impact a narrow, shallow corridor, inter-array cables or pipes tend to be extensive and may give rise to direct effects during construction, depending on the type of ground and the form of installation. The scope to microsite individual lines may be more limited than assumed, because of design parameters (such as minimum radii for curves) and cost implications.

10.12 Other offshore infrastructure – such as metocean monitoring facilities or sub-stations – can give rise to direct effects equivalent to device installation. Impacts that could arise from installing sinkers or anchors for the navigational buoyage around an array may also need to be considered.

10.13 Export cables or pipes have impacts similar to inter-array cabling, though they may be even more extensive (especially if the array is far offshore). They will cross a range of environments, and there may be additional forms of impact at the landfall depending on the type of coast and the methods adopted. Trenches tend to be narrow and shallow, but this need not prevent them from having adverse effects on heritage assets, as previous cases have shown. So long as they avoid upstanding features, cables laid on the surface of the seabed are unlikely to have significant direct effects on the historic environment. Equally, landfall based on directional drilling through older strata is not likely to have significant adverse effects on the historic environment. However, where the drilling goes through more recent strata – such as at the start and end of the line – or where the ground has to be prepared or pits excavated, then the footprint of these impacts must be considered.

10.14 Onshore cabling and the construction of onshore infra-structure, sub-stations and so on can give rise to a variety of direct effects associated with groundwork and excavation.

10.15 As noted above, direct impacts may also arise from construction vessels or vehicles, or from temporary works to accommodate them. Jack-ups and anchors can give rise to effects at a considerable distance from the construction footprint, for example. The fact that hardstanding or access roads – or dredging for construction vessels – is only temporary makes no difference to the permanence of their effects on the historic environment if they are cut through archaeological deposits. Impacts may also arise from the winning of construction material on site; any proposed winning will have to be carefully assessed, and provision made to ensure that excavation does not vary from the footprint that has been assessed.

10.16 Direct effects from construction may also occur if there is a visual impact from installation equipment, or if construction noise has a significant effect on a heritage asset by changing its setting, for example.

10.17 **Indirect effects from construction** may occur if construction activity prompts a process that has an impact on a heritage asset. Preparation of the seabed for an installation, for example, might interfere with sediment transport causing a previously buried heritage asset to become exposed to degradation.

10.18 **Direct effects from operations** are likely to be quite limited. One potential exception is the impact of chains or cables used to moor wave and tidal energy devices moving on the seabed. Mooring usually involves extensive length of chain/cable resting on and in the seabed, some of which will move as the tide changes or because of increasing swell, for example. Such movement is likely to have adverse effects on most forms of heritage asset lying on or just below the surface of the seabed across which chains or cables move. This could be a relatively large area overall.

10.19 The other main form of direct effect on the historic environment that may arise from operation of a scheme is visual impacts. The characteristics of different wave and tidal technologies in terms of whether devices are visible during operation have already been flagged. Onshore infrastructure such as sub-stations, and especially overhead cables, can also have effects that endure throughout the lifetime of the scheme. Visual impacts can occur from shore to sea and vice versa; they are discussed later in this guidance.

10.20 Other direct effects during operation and maintenance may be of a similar character to those during construction, so far as vessels are concerned. If jackups or large anchors are required in the course of maintenance, for example, then these may give rise to adverse effects. This possibility is obviously greatest where the form of device requires heavy equipment; maintenance by smaller workboats is unlikely to be problematic.

10.21 For the historic environment, **indirect effects during operation** are very much dependent on the impacts that the scheme may have on wider environmental processes. The consequences of changes in sediment transport are an important example, encompassing localised changes such as scour around individual structures or cables, and any extensive effects arising from the removal by the scheme of energy from the natural system. Changes resulting in movement of major bedforms or erosion of the seabed or coast could be a particular concern. Alternatively, increased sediment deposition or reductions in wave energy reaching the shore could have beneficial effects for the historic environment.

10.22 Changes to sediment transport arising from tidal range devices such as barrages will warrant particular attention to impacts on heritage assets both upstream and downstream of the scheme. Erosion of the seabed and coastline, which may expose previously unknown sites to degradation, will be a particular concern. A further range of impacts may arise from the operation of tidal range schemes if they alter the hydrology of the wider region. Manipulating the level of tidal water may have consequences for the level and quality (including salinity) of groundwater in surrounding areas, which may in turn be important for the survival of important waterlogged remains. Such effects may only become apparent over long periods of time, which needs to be anticipated in providing appropriate monitoring and mitigation.

10.23 The impacts from **decommissioning** are unlikely to be different in character to those discussed with respect to construction and operation. Impacts from vessels and vehicles are likely to be amongst the most significant. Visual impacts and noise from decommissioning may also have an effect on heritage assets, though it will only be of limited duration.

11. SIGNIFICANCE

A thorough appreciation of why heritage assets are important and of the degree to which they may be affected by wave and tidal energy development is fundamental to decision-making by all parties.

11.1 Significance is at the heart of both Environmental Assessment and of the management of the historic environment.

11.2 In both Strategic Environmental Assessment (SEA) and Environmental Impact Assessment (EIA), information has to be provided about likely significant effects on the architectural and archaeological heritage and landscape, and about measures to prevent, reduce and offset significant adverse effects.

11.3 Historic environment policy requires that heritage assets are conserved in a manner appropriate to their significance. Where the whole or part of a heritage asset is to be lost, mitigation actions to record and understand the significance of the asset is required before the loss occurs. The desirability of sustaining and enhancing the significance of heritage assets is something that planning authorities are expected to take into account in determining applications.

11.4 Although significance is central to both environmental assessment and to consenting decisions about heritage, 'significance' is actually being used for two different things:

- In environmental assessment, the concern is for the *significance of* ***effects*** on heritage assets;
- In consenting, the concern is for the *significance of* ***heritage assets*** that may be affected.

11.5 In this respect 'significance' in historic environment policy equates broadly to the 'importance' of a receptor in environmental assessment.

11.6 The sources of the significance of heritage assets – the various relationships that people have with the historic environment that result in them valuing heritage assets – are set out in existing guidance. Scottish Ministers have highlighted the intrinsic, contextual and associative characteristics of heritage assets, for example, whilst English Heritage and Cadw cite evidential, historical, aesthetic and communal value.

> *Conservation Principles, Policies and Guidance for the Sustainable Management of the Historic Environment* (English Heritage 2008)
>
> *Scottish Historic Environment Policy* (Historic Scotland 2011)
>
> *Conservation Principles for the Sustainable Management of the Historic Environment in Wales* (Cadw March 2011)

11.7 English Heritage has provided further detail on the significance of various types of heritage asset in its series of Designation Listing Selection Guides and Introductions to Heritage Assets, including for ships and boats.

> *Ships and Boats: Prehistory to Present. Designation Selection Guide* (English Heritage May 2012)
>
> *Ships and Boats: Prehistory to 1840. Introduction to Heritage Assets* (English Heritage March 2012)
>
> *Ships and Boats: 1840 to 1950. Introduction to Heritage Assets* (English Heritage September 2012)

This iron cannon from the Spanish Armada wreck of El Gran Grifón *on Fair Isle – which has been half-sectioned by the movement of rounded boulders and shingle – illustrates the potential for significant archaeological material to be present even in harsh environments. Image © Colin Martin.*

11.8 The significance of a heritage asset is a property of what the asset means (or could mean) for society. Although the significance of a heritage asset is based on the material characteristics of the asset, it is not contained wholly within the material itself. Consequently, the significance of a heritage asset can be conserved, recorded, understood, sustained, enhanced etc. even if the material of the asset is lost. However, the significance of heritage assets cannot be entirely captured by being 'converted' into a paper or digital record if the asset itself is damaged or removed, hence the continuing emphasis on protecting heritage assets 'in situ' as a first option.

11.9 The adverse effect of a heritage asset being damaged or lost cannot be wholly offset by mitigation. Nonetheless, development-led investigations can add to the significance and appreciation of assets in many cases. The investigations that accompany marine development create new information about the range, distribution and survival of heritage assets, and about their implications for understanding our human past. These beneficial effects of development ought to be recognised and maximised where possible.

11.10 Heritage assets that have been designated under both statutory and non-statutory mechanisms are regarded as having such significance that substantial loss or harm should be exceptional and should not be permitted unless demonstrably necessary to deliver public benefits that outweigh the harm or loss.

11.11 Designation indicates that the asset exceeds a threshold of significance, but designation and significance are not the same things. It is important to be aware that on both land and at sea there are many significant heritage assets that are not designated. It is common practice throughout the UK to manage highly significant assets through means other than designation, including through the planning and licensing of development. In addition, there are highly significant assets that are yet to be discovered, and which cannot therefore be designated. As a result, policy recognises that there are non-designated heritage assets that are demonstrably of equivalent significance to those that are designated, and which are subject to the same policy principles as if they were designated.

11.12 Designation indicates significance, but because designation and significance are not equivalents, different types of designation cannot be used generally as a proxy for levels of significance. In addition, policy with respect to the historic environment is concerned with conserving all heritage assets according to their significance, not just those whose significance is indicated by designation.

11.13 Consequently, it is not satisfactory to focus attention on designated heritage assets alone. Consideration of the historic environment has to encompass all heritage assets, which are to be managed according to their significance, both designated and undesignated.

11.14 Historic environment policy expects all parties to consider the significance of heritage assets. The assessment of significance, by both Developer and Curator, must be transparent and evidence-based. Questions of significance are relevant to strategic decisions as well as to specific wave and tidal schemes.

11.15 Regulators have responsibilities for identifying and assessing the significance of particular heritage assets affected by proposals. They will do this based on information provided by their historic environment advisors and by Developers. In so doing, they are required to take into account the particular interest in the assets and the value they hold for this and future generations. They are also expected to apply this understanding to avoid or minimise conflict between conservation of significance and the development that is proposed. Consequently, Regulators can be expected to provide a view on the significance of heritage assets to Developers, including their view on the significance of particular assets. More generally, they can be expected to provide a view on the significance of types of assets and the themes they represent, based on their understanding of the historic character of their area.

11.16 With respect to individual schemes, Developers are expected to describe the significance of heritage assets that are affected. The level of detail in such descriptions should be proportionate to the asset's significance and no greater than is sufficient to understand the potential effects of the proposal on that significance.

11.17 For the purposes of environmental assessment, the significance of the effect of a proposal on the significance of each heritage asset has to be described. The level of detail will depend on the significance of the asset and the potential effects of the proposed scheme upon it.

11.18 Levels of detail can be expected to be different for heritage assets according to levels of knowledge of their presence, identity and character. Where the presence of heritage assets is not known for certain but can be reasonably inferred, their potential significance should still be described based on such regional or thematic information about the asset type as is available.

11.19 Curators will wish to decide on a case-by-case basis what level of detail is sufficient. Hence, levels of detail should be discussed in pre-application consultation. It may be advantageous to develop and agree generalised schema for levels of detail to which both Developers and Curators can refer.

11.20 In their scoping reports, Developers should state the levels of detail they intend to provide and the sources of information they will use in the course of EIA. In their formal responses to scoping, Curators should comment directly on what the Developer has proposed about levels of detail and sources of information. Commitments in scoping and scoping responses need to be respected in order to avoid divergent expectations later in the application process.

11.21 Some types of heritage asset present particular difficulties in considering significance. Developers and consenting authorities are encouraged to discuss the approach to significance that is to be adopted for these types – and for such others as are relevant – in the course of pre-application consultation. Examples of heritage asset where the attribution of significance is likely to warrant pre-application discussion include:

- Wrecks lost since 1840, which are not especially rare but which reflect a period of very swift changes in shipping, technology and society
- Former terrestrial deposits and features laid-down or created at times of lower sea-level
- Reports of apparently isolated finds
- Geophysical anomalies, net snags and other seabed features whose origin is uncertain

Significance is a key term that is used in two different ways in considering wave and tidal energy and the historic environment. In both its uses, the determination of significance can be complex. Understanding the relationship between the significance of heritage assets and the significance of effects requires a thorough appreciation of impact sources and pathways.

12. HERITAGE ASSETS IN THEIR WIDER SURROUNDINGS

The effects of wave and tidal energy development on the wider historic environment, including implications for the setting of individual assets, will generally be more localised than for other offshore renewables. They must, however, be assessed adequately.

12.1 People's experience, understanding and appreciation of heritage assets are not bounded by the confines of the assets themselves. Heritage assets have a place in the wider environment to which they contribute and from which they can be perceived, either overtly or tacitly. The way in which people experience the historic environment in its wider surroundings can be affected by wave and tidal development.

12.2 Safeguarding what is important about people's wider experience of the historic environment is a major focus of policy. Reference to relevant guidance is strongly advised (see box) as approaches to this topic vary between the home countries:

> *UK Marine Policy Statement* (HM Government March 2011) Section 2.6.5 Seascape
>
> *The Setting of Heritage Assets: English Heritage guidance* (English Heritage October 2011)
>
> *Seeing the History in the View: a method for assessing heritage significance within views* (English Heritage May 2011)
>
> *Managing Change in the Historic Environment: Setting* (Historic Scotland October 2010)
>
> *Guide to Good Practice on using the Register of Landscapes of Historic Interest in Wales in the Planning and Development Process. Revised* (2nd) Edition including Revisions to the Assessment Process (ASIDOHL2) (Cadw 2007)

High visibility is intrinsic to the location of some archaeological sites. Huntcliffe in Cleveland was the site of a Roman Signal Station, one of a defensive chain along the North Sea coast. Image © Tees Archaeology.

12.3 Although visual perception is a key factor, the effects of development on people's appreciation of the historic environment include other aspects of perception. Sometimes these are relatively straightforward to gauge and assess, such as the effect of additional noise on a heritage asset that was previously tranquil. In other cases, the effects may be difficult to pin down. Heritage assets can have a wide range of associations for people that may be compromised: the 'feel' of a heritage asset may be changed; or their 'sense of place' in the wider environment may seem to be diminished by degradation of the historic elements of its character.

12.4 There are two main sets of issues in respect of the wider effect of wave and tidal energy schemes on the historic environment: first, issues arising from the devices at sea; second, issues arising from onshore infrastructure. Supporting development such as reinforcement of the electricity transmission network and harbour works may also give rise to concerns relating to their wider effects.

12.5 Where devices are installed wholly below the water, with no element of their structure observable above water during operation, then their wider effects on the historic environment onshore are plainly limited only to infrastructure that is itself onshore. For the purposes of assessing the historic environment, the wider effects of devices that are wholly submerged when operational may be scoped-out.

12.6 Where devices are submerged when operational but visible for maintenance and so on, the effect on the historic environment onshore will be of limited duration and visual impacts might again be scoped out.

12.7 Where the device itself is submerged but it is supported by structures that remain visible, then visual effects on the historic environment will need to be considered. Where the device is present at the surface during operation, again its visual effects will need to be assessed.

12.8 The degree to which a scheme has visual impacts on the historic environment is strongly related to the appearance of the proposed devices or structures. At sea, steps have to be taken to ensure that devices and structures are visible to other sea users for safety of navigation and to enable legitimate activities to carry on. Mitigation measures for the historic environment relating to appearance should not be proposed if they compromise safety or legitimate sea-use. Nonetheless, so long as such requirements are not compromised, Developers are encouraged to explore measures – such as micrositing, screening or paint schemes – that can reduce the visibility of devices and structures in respect of the historic environment sensitivities that are identified.

12.9 Devices and structures at the surface may affect views 'inwards' towards heritage assets from both land and sea, as well as views 'outwards' from heritage assets. Many heritage assets at the coast and on islands are prominent from the sea and are enjoyed in this context by people passing by on recreational boats, ferries and other watercraft. Views of monuments across the water from one piece of land to another – across a bay or channel – may also be affected if the intervening sea contains visible devices and structures.

The siting of Duns and Brochs in western and northern Scotland is an example of apparently strong connections with the sea in prehistory, even though direct evidence of seafaring is still rare. Image © Antony Firth/Fjordr.

12.10 Such effects may occur even if the heritage asset was not intended to be prominent or viewed from the sea. Visibility might not have been part of the original context of the asset, but if visibility contributes to the context in which the asset is appreciated today, then it needs to be taken into account. For example, historic coastal defence batteries were not intended to be especially visible – quite the opposite in fact – but the original requirements of a broad range of fire may mean that they are widely visible nonetheless.

12.11 In other cases, visibility from the sea was intrinsic to the original design and contributes to the asset's significance, as with lighthouses or buildings intended to impart a commanding presence over a waterway. Equally, visibility from the sea may not have been an intended feature originally, but a heritage asset may have gained a wider maritime context because it has become used as a seamark by mariners. Towers, spires and chimneys may have become features whose visibility from the sea contributes to their context in this way.

12.12 Past visibility from the sea can be identified as a component of the significance of a heritage asset by using historic charts, where available. It is common for early charts – and ancillary documents such as books of views and pilots – to include information about the visibility of coastal features. Such sources can show that it was not visibility as such that was important, but visibility from certain points. For example, if features were important because they could be lined-up to provide a route through a channel, it is only their visibility along this line that confers significance; devices not on this line need have no effect.

12.13 Heritage assets do not need to be visible to have setting or a landscape context. Some submerged heritage assets also have relationships with their surroundings that can be perceived and appreciated, and which may be affected by development. In rare instances, the visible presence of a device near a wreck site might be considered to detract from the significance of the place of wrecking, even though there is no physical impact on the wreck.

12.14 A perceived effect on the setting of a submerged asset is not something that need be confined to archaeologists; installing a device or a cable close to a particular wreck site may be considered 'inappropriate' locally. People's perceptions of places they consider historically significant can be complex and difficult to assess; if such sensitivities are expressed, it is advisable to explore them directly at an early stage.

12.15 What is significant about a place, and how a scheme may have the potential to cause significant adverse effects – even at a distance – will require information and discussion in the course of developing a scheme. Where the effects are unlikely to be significant it may be possible to scope the matter out of the assessment altogether, subject to there being sufficient certainty about the scheme and its wider effects on the historic environment.

12.16 It should be borne in mind that wave and tidal energy developments have a restricted lifespan and will be removed. As their impact in this respect is time-limited and reversible, they may be regarded as transient relative to the age of the heritage assets. This may be a contentious issue, as transience relative to the age of a heritage asset may count for little amongst the people whose experience of those assets is affected. The intended impermanence of a scheme may not be regarded as mitigating adverse impacts that occur during its lifetime, even if that lifetime is quite short.

13. UNCERTAINTY AND RISK

The coastal and marine historic environment still holds uncertainties and risks; these are best managed by improving the evidence base and working together.

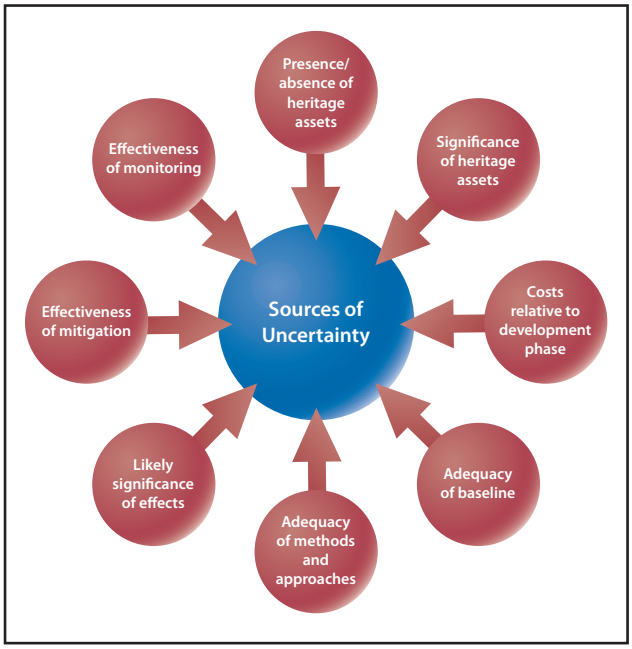
13.1 Gauging whether a wave or tidal scheme is likely to have significant adverse effects on the historic environment invokes two main forms of uncertainty:

- Uncertainty about what heritage assets might be present within the scheme's immediate and secondary footprints;
- Uncertainty about the significance of heritage assets that may be affected.

13.2 Despite important improvements in the last decade, both of these forms of uncertainty reflect the relatively poorly developed baseline of historic environment data for marine areas. In terms of the first form of uncertainty, the pre-existing baseline within a scheme footprint is likely to record little direct evidence of archaeological material; in terms of the second form of uncertainty, the paucity of regional and national baseline evidence makes it hard to place particular heritage assets within a context within which their significance can be assessed.

13.3 Uncertainty in the pre-existing baseline for scheme footprints may be particularly acute for wave and tidal energy schemes because they tend to be located in areas that have not been subject to detailed survey in the past. Lack of previous survey data may be a particular challenge in near shore areas.

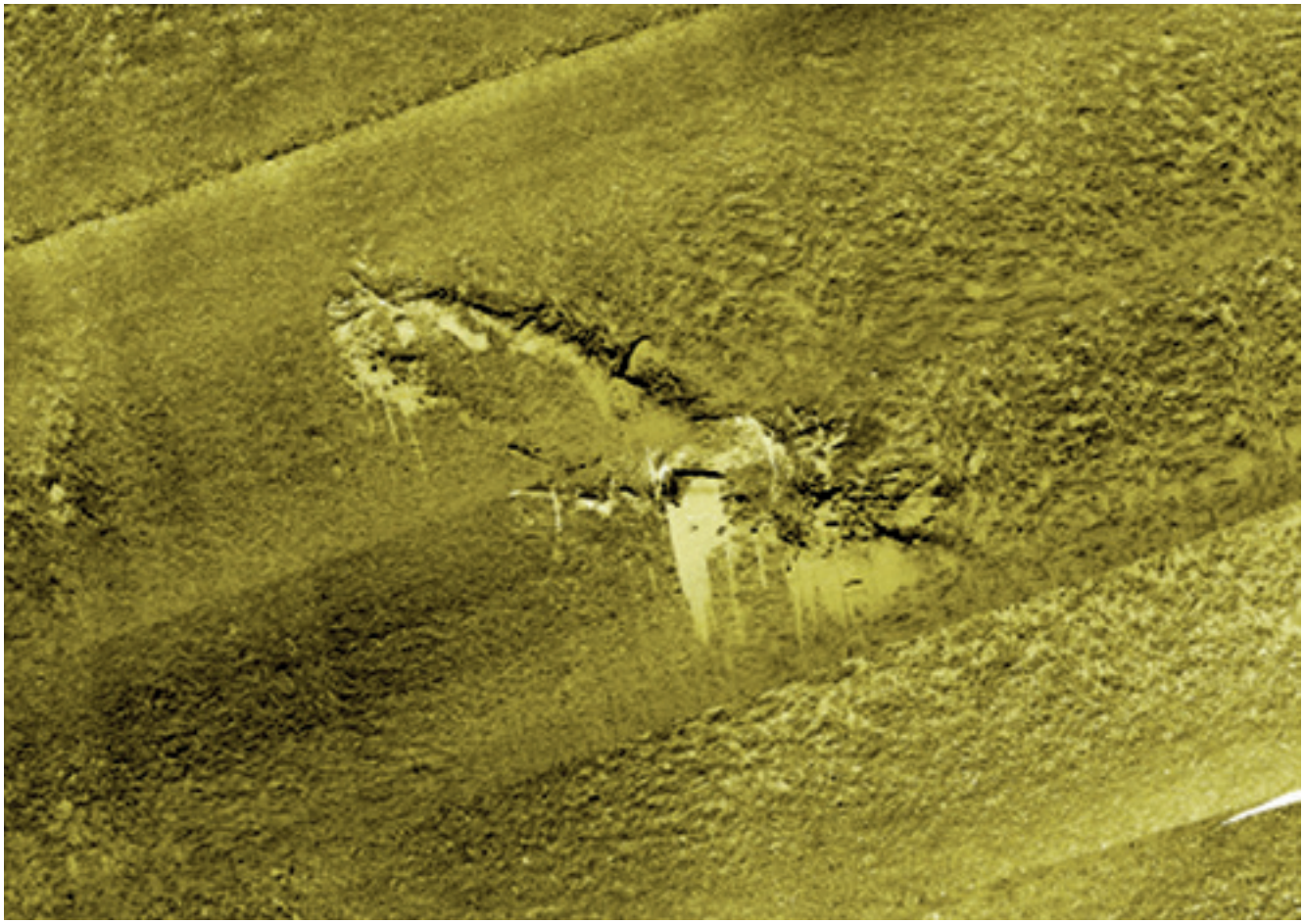
13.4 Regional and national evidence is increasingly being mobilised to guide assessments of significance, focussing on particular classes of asset and particular periods. These may not, however, be available for all forms of asset or be sufficiently detailed to provide immediate guidance to inform Developers over the specific heritage assets they find themselves having to deal with.



Many factors need to be taken into account in discussing strategies for addressing the historic environment in wave and tidal energy development, aiming for delivery of a successful scheme rather than just completing the next phase.

13.5 These uncertainties introduce risks for the Developer. There are risks both to the consenting process and to the construction and operation of the scheme. Successful consenting is put at risk where the baseline evidence on the presence of heritage assets is insufficient , or where significance has been assessed in a manner that is not supportable. Statements about the presence/absence and significance of heritage assets will endanger the application if they are based on assumptions rather than evidence.

Evidence of maritime activity can be ephemeral, but shell middens often form major accumulations – implying intense human activity in places that may now seem remote. Image © Antony Firth/Fjordr.



Sidescan image of a Nineteenth Century sailing ship. Although initially thought to be the Diamond *lost in 1825, subsequent research and tree-ring dating suggests that it may be a later as yet unindentified vessel. Image © Crown Copyright: RCAHMW.*

13.6 Once consent is achieved, successful construction and operation will be put at risk if archaeological material becomes known, or if greater significance becomes apparent, while activities are underway. Unexpected discoveries can cause delay and expense, and may result in on-going constraint if – for example – the only way to manage a discovery is to resort to statutory designation. A heritage asset becoming apparent when construction vessels are on site, or because of scour around an installation, could seriously affect critical schedules and finely balanced budgets.

13.7 Undoubtedly, the best way to address risks arising from the possible presence and significance of heritage assets within the footprints of the scheme is to obtain direct evidence of what is on or in the seafloor. Integrated site investigations that include archaeological objectives alongside engineering or environmental objectives may offer the most cost-effective approach, but investigations whose primary purposes are archaeological may also be necessary.

13.8 Inevitably, archaeological involvement in site investigations will have its own costs. Much can be done to reduce these by early and thorough integration of archaeological objectives with other site investigations. Deferring archaeological investigations to later stages may mean that risks to the consent and/or construction are left unresolved. The costs of dealing with archaeological issues only once there is an incident will be greater if solutions have to be found at later stages when flexibility is less.

13.9 In seeking to balance archaeological costs and risks, especially if high-resolution survey is to take place only after consent, there is considerable merit in adopting a phased or staged approach. A staged approach can enable early broad-scale site investigations to be complemented by more detailed investigations once there is greater certainty about the scheme's actual design. This will require careful articulation – and good communication – between consent-phase investigations and construction-phase investigations, for example.

13.10 As well as resolving uncertainties about specific areas or features, the direct evidence that arises from site investigations can help reduce uncertainty – and increase confidence – in overall methods and approaches. Increased confidence is important for the Developer in their forward planning; it can also be important in demonstrating to Curators that a method or approach is sustainable, thereby facilitating discussions about consent or the drafting of conditions.

13.11 To address risk arising from uncertainty about significance, Developers may find it helpful to work together, in discussion with Curators, to develop baseline data and interpretations to inform discussion about the significance of particular classes of heritage asset in an area. Providing additional regional or thematic context, within which the significance of a particular asset can be gauged, may resolve this kind of issue.

13.12 As well as uncertainty about baseline and significance, there may also be considerable uncertainty about how the significance of an asset may be affected by impacts attributable to the scheme. In particular, indirect effects may be difficult to distinguish from effects that would occur irrespective of the scheme. Improving the understanding of relatively diffuse forms of impact is another arena within which a strategic approach by multiple Developers, in conjunction with Curators, may be helpful.

14. THE HISTORIC ENVIRONMENT AND OTHER SCHEMES RELATING TO WAVE AND TIDAL ENERGY DEVELOPMENT

Other forms of development intended to support wave and tidal energy – such as ports/harbours and grid connections – may have important implications for the historic environment that must also be considered.

14.1 Two issues are commonly raised in anticipating extensive development of wave and tidal energy: grid connection and port infrastructure. Both have direct implications for the historic environment.

14.2 Grid connection is the term applied to the provision of a suitable point at which electricity generated by wave and tidal energy can be connected to the electricity transmission network. Three transmission licensees operate the transmission network: National Grid; Scottish Power Transmission; and Scottish Hydro Electric (SHE) Transmission. The transmission network has been shaped historically by the location of generating stations fired by fossil fuels or nuclear power, and by the main centres of population. This does not reflect the anticipated location of offshore renewables – especially wave and tidal energy resources – which focuses on areas that are peripheral to the transmission network. New capacity is therefore required to extend the transmission network to places to which wave and tidal energy schemes can connect.

14.3 It is worth distinguishing here between the transmission network developed by transmission licensees, and onshore transmission initiated by wave and tidal energy Developers to reach the transmission network. Wave and tidal energy Developers may have to provide extensive onshore transmission between their landfall and the network. This provision will normally be addressed as part of the wave and tidal energy scheme. The discussion here relates to the reinforcement of the transmission network itself. This reinforcement potentially includes upgrading and uprating of existing circuits, new circuits, subsea High Voltage Direct Current (HVDC) links, and associated infrastructure such as substations.

14.4 Major transmission projects are subject to planning and consent procedures that are intended to address environmental concerns. Such projects have the same range of implications of the historic environment as other aspects of wave and tidal energy development, and the guidance in this and other documents – and the policies on the historic environment referred to here – are equally relevant to reinforcement of the transmission network.

14.5 Consideration of the historic environment should be factored-in to the discussion of options and routes for transmission network reinforcement. On land, the respective merits for the historic environment of overhead lines and underground cables should be considered at an early stage: overhead lines may raise concerns about setting and landscape character; whereas the installation of underground cables can require extensive investigations to address the potential for buried heritage assets. Route details are likely to be very important in resolving such issues. Where reinforcement of the transmission network requires work at sea, then the entire route will be subject to the same policies and guidance as apply to scheme-specific cabling.

Historic structures such as this slipway at Pembroke Dock – which was second only to Plymouth for building Royal Navy ships in the mid-late C19th – may be capable of sensitive reuse in supporting the wave and tidal energy sector. Image © Antony Firth/Fjordr.

Onshore facilities at the EMEC test site at Billia Croo, Orkney, with the test site itself in the background. Image © Antony Firth/Fjordr.

14.6 Where proposals for transmission networks and specific wave and tidal energy proposals are closely related, it is important that the relation between the schemes is made apparent in discussing the historic environment. It may often be possible to develop an overarching approach to assessment and mitigation that is of benefit both to grid reinforcement and to the wave and tidal energy scheme itself.

14.7 Wave and tidal energy development is boosting the requirement for suitable port infrastructure, both for construction and – in particular – for operations and maintenance (O&M). The different forms of wave and tidal energy device have very different requirements in terms of the plant (i.e. vessels) needed to install and service them. Some devices have to be carried aboard a ship or barge and craned into place using massive specialist vessels. Other devices are designed to be towed to and from site by much smaller workboats. Equally, there are a variety of needs for construction and maintenance space, including space for laying out pipelines and cables onshore.

14.8 With such variety, generalisations are difficult, but it seems likely that construction and O&M will prompt development both at major ports distant from the wave and tidal energy sites, and at small and medium-sized harbours that are much closer. Bearing in mind that wave and tidal energy development is occurring at a distance from major industrial centres, the smaller harbours implicated by wave and tidal energy development may have seen relatively low levels of previous development in recent decades, and their archaeological potential may be considerable.

14.9 Ports and harbours can have a particularly rich historic environment. They often have deep historical roots themselves, making use of geographical circumstances that encouraged a focus of maritime and coastal activity long into the past. They typically have a mix of heritage asset types in a variety of environments: historic buildings and harbour structures; archaeological remains buried beneath successive lines of quays; and wreckage and anchorage debris recording centuries – even millennia – of sea-use. These types of asset may be affected by the building of new sheds, piling for new jetties and quays, construction of improved road or rail access, and dredging of berths and navigation channels, for example.

14.10 Wave and tidal energy is presenting opportunities for the regeneration of ports and harbours that were once very significant historically, but which have declined for various reasons. It is important to keep this in mind when considering the possible impacts on heritage assets of port redevelopment. Often these heritage assets are directly related to the history of the port, reflecting former glories. Conservation of significant features need not deter regeneration so that older ports are prevented from re-establishing themselves by the relics of the past. Imagination and creativity on the part of both Developers and Curators can enable the historic character of ports to contribute to their renewed success as places to work and visit.

15. ENHANCING PUBLIC BENEFIT

In satisfying environmental requirements to address the historic environment in the course of consent, Developers create knowledge and understanding that can be used to generate social and economic benefits for the wider public.

15.1 Government policy towards the historic environment is not just that it should be conserved, but that it should also be mobilised to generate economic and social benefits.

> *The Government's Statement on the Historic Environment for England 2010* (HM Government 2010)
>
> *Scottish Historic Environment Policy* (Historic Scotland 2011)
>
> *Historic Environment Strategy for Wales* (Welsh Government 2012)

15.2 The historic environment is fascinating to many people: in local and more distant communities; in the workplace; and amongst visitors. The archaeological investigations carried out in the course of consenting and constructing wave and tidal energy schemes may not reach these audiences, except perhaps in the relatively technical formats of EIA documents. Obligations on Developers to publish important results from their archaeological investigations, which arise from planning policies and conditions on consent, tend to be discharged through papers in academic journals and monographs. What is under consideration here is the steps that Developers can take of their own volition to extend the public benefits of their work.

15.3 Dissemination of information about archaeological methods and results in accessible printed forms – leaflets and booklets – is a relatively low-cost way of increasing awareness, especially in local communities, of the steps that Developers take to meet their archaeological obligations. Similarly, the web can provide an engaging way for sharing information – especially cartographic, photographic and documentary data – that has served its primary purpose for a scheme but does not deserve to be hidden in a few comb-bound reports or pdfs.

15.4 The historic environment is a great resource for increasing public benefit. It is a rich source of new stories, and of new perspectives on old stories. It is very tangible, made up of things and places whose materiality can have a profoundly engaging effect for people. Encouraging people to touch artefacts and experience places for themselves are ways of making the most of the historic environment's capacity to inform and stimulate. Trails, viewpoints and memorials can draw peoples' attention to aspects of apparently familiar surroundings upon which Developers' investigations have shed light. Digital technologies can provide place-based information to people as they move around the landscape physically, or from their armchairs.

15.5 The experience of artefacts and places can be extended and enhanced through a wide range of arts including creative writing, poetry, sculpture, photography, painting music, drama and so on. These arts can be used to engage with a wider public than might traditionally be expected to take an interest in the historic environment.

15.6 In considering public benefit in respect of the historic environment, it is useful to think about different audiences, such as the communities who live near the scheme or are affected by its operation; people who work in the vicinity of the scheme (including those who are employed directly by it); and people who visit the area. At a greater distance, the internet has created audiences that are global; queries about the archaeology and history of local places, communities and individuals may be received from all around the world. Children who live in or visit the area are important audiences that can be reached through schools and other organisations. Historic environment-based activities can be used to engage children across many different subjects, including broader topics such as marine science, climate change and sea-use management.

Heritage assets can be a prominent and sometimes incongruous component of coastal and marine environments. Even just a little historical context can help enhance their significance and add to people's sense of place. Image © Antony Firth/Fjordr.

Intertidal peat shelf: results from development-led investigations can raise public awareness of coastal features that might otherwise be unrecognised, and help inform public debate on topics such as climate change and renewable energy. Image © Copyright GGAT.

15.7 There are various forms of outdoor recreation at the coast and on the sea through which people can engage with the historic environment, including heritage assets that are submerged. High-energy coastal and marine environments are often favoured for outdoor recreation, hence the particular relevance to wave and tidal energy development. Recreational diving is an obvious example, but although wreck diving is already popular the historic information available about wrecks is sometimes quite limited. Geophysical data of the quality obtained routinely in the course of seabed surveys may be a complete revelation, even on wrecks that are dived frequently. Such data may also prompt interest from sea anglers and recreational sailors, who may be familiar with wrecks as charted features but not with the actual forms they take, or the histories associated with them. Action by Developers to increase awareness of the many historic features of our coasts and seas may be very positively received by recreational sea-users.

15.8 Interest in wrecks and other seabed features – as well as in heritage assets at the coast – can also be stimulated in people who stay on or close to land. Coastal paths, coasteering and sea kayaking are all examples where there is still great potential to increase awareness of the historic environment with results from scheme-specific investigations.

15.9 These examples highlight potential social benefits, but they have an economic aspect too when they add to the experience of locals or visitors, increasing their enjoyment and propensity to explore further. It is inescapable that the historic environment makes a significant contribution to the attractiveness of the coast for recreation and tourism, which are both major sources of economic activity especially in the types of area in which wave and tidal energy development is focussed. Consequently, Developers can expect to augment their overall contribution to local economies where they apply the results of their archaeological investigations more broadly in the community, beyond the confines of consenting.

15.10 Developers should also consider the interest that their own workforce, and that of contractors and others, may have in the history of the environment in which they are working. Examples from other industries have shown how workers are willing to engage with archaeologists to learn more about the things that can be found in the course of work, and how this can help to make mitigation measures more effective as well as contributing to interest in the workplace.

15.11 People have been exploiting the marine environment for millennia for a wide range of resources, including energy. Fish traps and tide mills are just a couple of examples where people have for centuries sought to grapple with issues that the wave and tidal energy industry is dealing with today. Developers are encouraged to engage with the wider public by placing their proposals within the context of such enduring themes, informed – not just constrained – by the historic environment.

16. ARCHAEOLOGICAL DATA, DATA MANAGEMENT AND ARCHIVING

Provisions for managing archaeological data should be set up at the start of a project.

16.1 As with many other environmental and engineering topics, the management of data associated with wave and tidal energy development is important for the historic environment also. Whether at a strategic or scheme-specific level, available data has to be sourced, marshalled and augmented; the acquisition and processing of new data is resource-intensive; and there are major benefits in making data available at the end of a project.

16.2 Historic environment data encompasses a range of digital and 'hard copy' forms. One particular form of 'data' that is unique to archaeology is the artefactual material itself: objects that have an information value – as well as other attributes – that cannot be reduced to paper or digital records and which are retained alongside more conventional data. The totality of the data – written, drawn, photographic, material – is referred to by archaeologists as 'the archive.'

16.3 There are legal and professional obligations to prepare a well-managed archive in the course of archaeological work, and for the archive to be deposited for long-term preservation and public access at the end of the project. These obligations, which apply to Developers and the archaeologists they employ, are set out in planning policies, standards, guidance and conditions attached to consent. Archaeological obligations with respect to data are additional to data-sharing requirements arising out of seabed leases, for example. Although commonly associated with the end of projects, creation – and eventual deposition – of the archive is a key driver in managing data from the outset of a project.

> *Standard and Guidance for the Collection, Documentation, Conservation and Research of Archaeological Materials* (IfA October 2008)
>
> *Standard and Guidance for the Creation, Compilation, Transfer and Deposition of Archaeological Archives* (IfA October 2009)
>
> *Archaeological Archives: a guide to best practice in creation, compilation, transfer and curation* (Brown September 2011)
>
> *Guides to Good Practice http://*guides.archaeologydataservice.ac.uk/g2gp/Contents (Archaeological Data Service/Digital Antiquity)
>
> *Marine Environmental Data and Information Network (MEDIN) http://*www.oceannet.org/marine_data_standards/

16.4 Approaches to data management and archiving are contending with very rapidly changing circumstances in a technical sense, not helped by pressure on the public authorities who are expected to act as repositories. Further, more practical experience and clearer responsibilities for archives has arisen from land archaeology than from offshore. Wave and tidal energy schemes, which have both land-based and marine elements, have to accommodate these differences in trying to manage data in an integrated manner. It is important to address potential difficulties in schemes that cross the land-sea boundary at an early stage. By way of example, projections and co-ordinate systems, which are critical to spatial-data and positioning, are of as fundamental importance to archaeology as other topics. Decisions about data structure, nomenclature, labelling of areas or zones and so on need to be addressed explicitly at an early stage, and to be discussed with Curatorial authorities and the repository where it is anticipated the archive will eventually rest.

Point cloud of individual multibeam soundings from the wreck of the German escort vessel F2 in Scapa Flow. The huge increase in marine survey capabilities over the last two decades requires effective strategies for handling and storing very large data sets. Image © Crown Copyright, Historic Scotland – image produced by Wessex Archaeology.

16.5 Although in principle the archive will be unified, elements of it may be deposited or copied to different places; the requirements of these different places will have to be addressed – or at least anticipated – in data management decisions at the outset.

16.6 More generally, data management procedures need to include the creation and maintenance of metadata so that there is a record of how data has been sourced and manipulated. The maintenance of metadata is especially important for recording relationships between raw and processed datasets, especially if they are to be deposited in different repositories.

16.7 A further key concern is the physical and intellectual property rights (IPR) associated with data and archives. Archaeological objects are always owned by someone in the present, irrespective of original ownership or the passage of time. Ownership will usually have to be transferred from the owner to the repository where the archive is to rest. The situation in respect of IPR will have to be clear in order for deposition to proceed, taking into account any IPR in data that has been incorporated within the project archive, or from which project data has been derived. Establishing ownership and IPR in the later stages of a project can be very difficult, so it is much better to log these from the start. It is recommended that clear mechanisms are introduced in the earliest stages of a project to keep track of ownership and IPR as part of the metadata associated with different data types – including artefactual material.

16.8 In planning for data management, it is worth noting that wave and tidal energy is likely to draw on the same kinds of archaeological sources as are commonly used for other forms of marine development, both at strategic and scheme-specific levels. There is much previous experience

upon which to draw. Secondary sources (books and 'grey literature'), historic maps and charts, and geophysical and geotechnical data are likely to predominate in understanding the archaeological baseline for a region or scheme, and can present particular challenges in terms of availability, formats and volumes of data.

16.9 Inventories of archaeological sites are a critically important source of data. The main national archaeological records are the National Record of the Historic Environment (NRHE – formerly NMR) in England, Canmore in Scotland and the National Monuments Record of Wales (NMRW). These inventories are usually the most comprehensive archaeological records in respect of marine areas.

16.10 Local inventories are maintained or accessed through local authorities and are generally known as Historic Environment Records (HERs) or Sites and Monuments Records (SMRs). HERs/SMRs generally provide the most comprehensive record of heritage assets and investigations on land and are the usual starting point for collating coastal and land-based evidence. In some cases, HERs/SMRs will also contain the most comprehensive record of marine heritage assets based on local sources.

16.11 The Wreck Index of the UK Hydrographic Office (UKHO) is an important non-archaeological inventory that should be used alongside archaeological records.

16.12 Data held in these records can be accessed in a variety of ways, increasingly online. Canmore is directly accessible for web-based searches. The NMRW can be accessed through Coflein, whilst the contents of the NRHE can be accessed through Past Scape. HeritageGateway provides access to the National Heritage List for England (the list of designated heritage assets) and to many local HERs in England that are now online. HERs in Wales can be accessed through Archwilio. In Scotland, PastMap provides access to a range of datasets. Where SMR/HER data are not available online they can be accessed through the relevant local authority. The UKHO Wreck Index can be accessed through various commercially available marine data products.

PastScape http://www.pastscape.org.uk/

Heritage Gateway http://www.heritagegateway.org.uk/gateway/

Coflein http://www.coflein.gov.uk/

Canmore http://canmore.rcahms.gov.uk/

PastMap http://pastmap.org.uk

Archwilio http://www.archwilio.org.uk/

16.13 As well as being inventories of heritage assets, these archives host large volumes of digital and paper records that may be relevant to understanding the historic environment near a wave and tidal scheme. Data such as historic air photographs, photographic and documentary collections are likely to be available, either online or by request. Local record offices and museums may also be an important source of data.

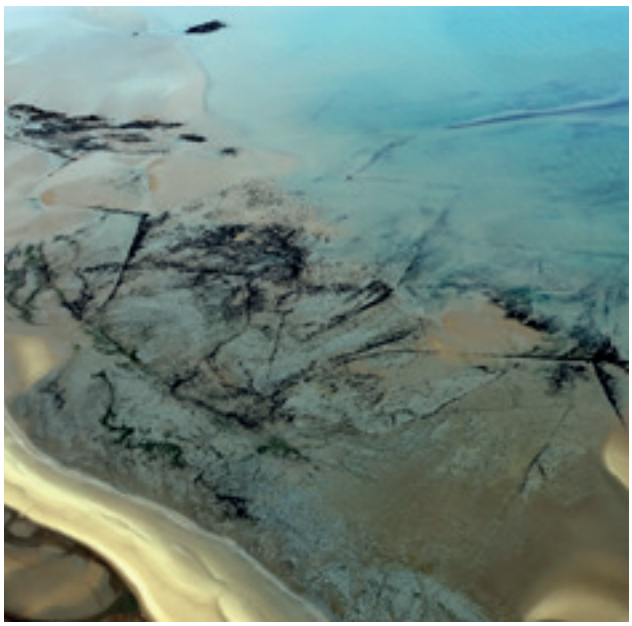
16.14 Although there is an increasing amount of data on the historic environment available, covering both land and sea, the characteristics of the data need to be kept in mind. Archaeological data – especially at sea – is only rarely based on systematic survey of a whole area. Often, archaeological data has been collated from a variety of observations and sources over the last century or so, ranging from highly accurate and detailed investigations to brief observations or accidental discoveries. It is very important that archaeological records, even if they appear to refer to something that is 'known', are each considered in their own terms. Many records – particularly in the marine environment – refer to historically documented losses rather than actual wrecks, often without precise positional information. These records may be indicative of the archaeological potential of an area in general terms, or may help in investigating the loss of a named ship, but their implications have to be considered cautiously.

16.15 Much is known – or partly known – about the historic environment. Nonetheless, there is still great uncertainty with respect to many classes of archaeological material. At sea, records of wrecks prior to the mid-Nineteenth Century, and about the wrecks of smaller vessels, tend to be relatively poor. Precise positional information about aircraft losses is often lacking. Firm information about submerged prehistoric material is usually quite specific to a place even if it appears to have wider implications. Information may be especially poor from areas targeted for wave and tidal energy. Such high energy environments may have been especially hazardous in the past, losses are less likely to have been observed or reported by survivors, and such areas have not been easy to survey in detail over the intervening years.

16.16 Fortunately, many coastal areas have benefitted from systematic archaeological surveys in recent decades. Even in such cases the scope of the survey may have been limited by accessibility – especially towards low-water – and coastal change may have covered and uncovered sites subsequently.

16.17 Archaeological inventories – and the archaeological staff that maintain them – are an essential starting point in seeking to understand what is known or likely to be present within a region or scheme footprint. The data must be interpreted skilfully in conjunction with other sources – and in accordance with established guidance – to achieve a satisfactory account.

16.18 Even after the best use of existing data, uncertainties about the presence and character of heritage assets are likely to remain. It is unlikely that the implications for the historic environment of wave and tidal energy development will be adequately assessed using only desk-based methods and existing data. Some provision for field investigation will usually be necessary.



Aerial photograph showing a complex array of intertidal fishtraps in Swansea Bay. Image © Crown Copyright: RCAHMW.

17. SITE INVESTIGATIONS

Site investigations for archaeological purposes are an integral element of overall site investigations and should be planned accordingly.

17.1 Site investigation by geophysical and geotechnical survey is, undoubtedly, as important for dealing with the implications for the historic environment of wave and tidal energy as it is for other marine sectors. Geophysical and geotechnical survey is likely to remain the main source of site-specific data. Other forms of site investigation – such as drop-camera, ROV or diver-based investigations – can also provide valuable archaeological evidence.

17.2 Archaeological objectives can often be integrated into surveys that have other objectives, such as surveys whose initial focus is engineering, ordnance or habitats. The integration of archaeological objectives into other proposed surveys is both an effective and proportionate approach to historic environment data collection.

17.3 A separate survey for primarily archaeological purposes may be required if opportunities for integration are missed. A separate archaeological survey may be a cost-effective option if the area of concern has already been narrowed down, rather than carrying out an entire extensive survey in accordance with archaeological specifications. The need to understand the character of an asset may also give rise to a need for further high-resolution survey.

17.4 Archaeological aspects of survey are likely to have implications for programming and costs. These need to be planned for, acknowledging that ineffective integration and unplanned arrangements are likely to be costly and disruptive.

17.5 Specific information on preferred survey specifications can be obtained from sections 5 and 6 of the *Model Clauses for Archaeological Written Schemes of Investigation*.

Detailed guidance on geotechnical investigations is provided in *Offshore Geotechnical Investigations and Historic Environment Analysis*.

Model Clauses for Archaeological Written Schemes of Investigation: Offshore Renewables Projects (Wessex Archaeology 2010a)

Offshore Geotechnical Investigations and Historic Environment Analysis: Guidance for the Renewable Energy Sector (Gribble and Leather, 2011)

Standard and Guidance for Archaeological Geophysical Survey (IfA October 2011)

17.6 Archaeological considerations should be taken into account in the earliest phases of planning for site survey and interpretation, based on specialist advice where necessary. Involving archaeologists in decision-making will be the most effective way of optimising the approach to site investigations.

17.7 In pre-application discussions, Curators should encourage Developers to consider opportunities for incorporating archaeological objectives within site investigations. Curators should also indicate what forms and level of archaeological information from site investigations they expect to accompany applications.

17.8 Developers should seek the views of Curators and arrange for site investigation teams to obtain early archaeological advice. It can sometimes be difficult in the early stages of a scheme to ensure that there is direct communication between engineers, surveyors, managers and archaeologists – especially as different consultants and contractors may be involved. Poor communications at this stage will result in important opportunities for optimised site investigations being missed.

17.9 Careful attention should be given to the different options for integrating archaeological objectives in the course of both data acquisition and processing/interpretation.

Intertidal survey of a possible fishtrap on the Welsh coast. Direct observation is often necessary to effectively characterise features recorded from documentary, cartographic and photographic sources. Image © Cotswold Archaeology.

17.10 During data **acquisition,** there may be advantages to having suitable archaeologists present during geophysical, geotechnical or other site investigations. The availability of expertise to provide on-the-spot interpretation or advice, to respond to changing circumstances, and to optimise initial recording, are all good reasons for including archaeologists within survey teams. Decisions about whether to include archaeologists in the site investigation team should take into account: the anticipated character of heritage assets that may be encountered; the likely need for specialist interpretation or recording on site; and whether the team will need to vary investigations in the field based on judgements about initial results.

17.11 If it is anticipated that archaeologists will be present during acquisition, advanced notice should be provided about specific health and safety or certification requirements, so that archaeological contractors can arrange for suitable staff to be available.

17.12 Different approaches can be taken to incorporating archaeological advice into data **processing and interpretation**.

17.13 Best practice is for archaeologists to examine the raw results of site investigations – geophysical data; geotechnical core material; video footage – and to carry out their own processing and interpretation. This approach provides the most transparent relationship between acquired data and the archaeological conclusions that are drawn from it.

17.14 An alternative is for archaeologists to review information that has already been processed, such as core logs and photographs; geophysical images that have already been selected as 'anomalous'; selected stills from video footage and so on. This has the advantage that archaeological effort is more tightly focussed on features that appear to be of archaeological interest, but there is a risk that archaeologically important data may have been left out or obscured by processing and selection by non-archaeologists.

17.15 A further alternative is to invite archaeologists to provide a commentary on the completed interpretation of the data: reviewing a geotechnical or geophysical report, for example. This option is even more tightly focussed, but it is also much more dependent on non-archaeological processing, selection and interpretation.

17.16 These different approaches may each have their place for different forms of site investigation at different stages of developing and constructing a wave or tidal energy scheme. It is important that Developers are aware of the implications of the different approaches for addressing uncertainty and managing risk. It is also important that Curators make clear – at an early stage – their expectations about how archaeological expertise is to be incorporated into processing and interpretation.

17.17 It is common for archaeological involvement in site investigations – both for data acquisition and processing/interpretation – to be staged or phased. The intention is to match the level of detail (and costs) to the level of information that is required at the time. Importantly, staged approaches allow for feedback and review between the stages, so that effort and resources can be targeted according to results.

17.18 Although staged approaches have numerous advantages, they are dependent on the availability of suitable data management and storage facilities, so that later phases of work can recommence efficiently. It is especially important that geotechnical samples are properly stored, or recorded and sub-sampled, if a delay is anticipated between acquisition of core material and its archaeological examination. Core material that has been acquired at considerable expense has been rendered virtually unusable for archaeological purposes by poor core storage in some cases.

One of the engines from the previously unrecorded crash site of a B-24 Liberator at a general depth of 56m, taken from the video of an archaeological site investigation using a ROV. Image © Wessex Archaeology.

17.19 Integration of archaeological objectives within site investigations should continue post-consent, especially in the more detailed site investigations that may accompany design phases and preparation for construction. This includes integration with construction contractors and their own site investigation teams. Post-consent site investigations can be especially valuable in resolving archaeological uncertainties that were deferred in the EIA/application phase, as they are likely to achieve a level of detail that is more appropriate to determining the archaeological character of features. Surveys targeting anomalies that could get in the way of construction or present an ordnance risk might provide evidence to enable archaeologists to remove them from the lists of 'possible' heritage assets to be protected by exclusion zones, for example.

17.20 Where a programme of monitoring surveys is planned to achieve or demonstrate compliance in respect of other environmental considerations, it may be helpful for the programme to incorporate archaeological objectives. Monitoring requirements for archaeological purposes are likely to be amongst the conditions on consent, especially if there are concerns about indirect impacts such as archaeological material being exposed by scour or by changes to bedforms. Integrated monitoring of the historic environment alongside other environmental issues will be more efficient than having separate monitoring programmes.

18. ANOMALIES

Anomalies on the seabed can be difficult to characterise without direct observation; better field-based evidence of the forms and origin of anomalies will benefit individual schemes and the wave and tidal industry as a whole.

18.1 The term 'anomaly' is used here to refer to anything that appears to be physically present that might have an archaeological origin. Anomalies are usually observed only indirectly, that is to say their true character and origin is not immediately apparent from the method through which they have been observed. They are 'anomalous' because they do not appear to match the natural background; they may prove to be artificial and of archaeological interest, but they may also prove to be a trace caused by the methodology itself, by something artificial but of no archaeological relevance, or turn out to be natural after all. Anomalies are most commonly associated with geophysical survey, but features identified as fishing snags are a form of anomaly too. Anomalies can be found in geophysical data on land, and in air photographs.

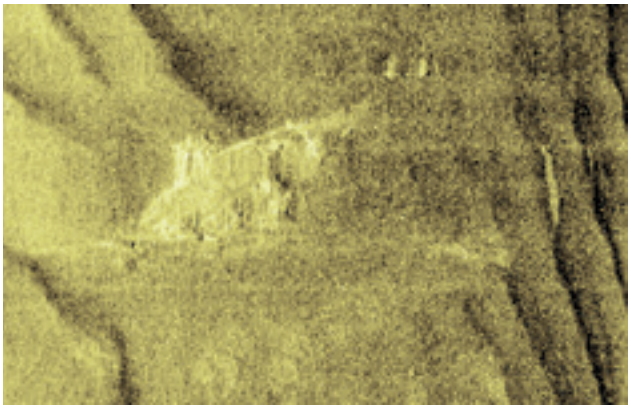
18.2 Most anomalies will prove to be of negligible archaeological interest. However, they are a major concern for wave and tidal energy on several counts:

- Unless attributable to a glitch in acquiring or processing data – anomalies are a sign that something is actually present. They are 'known' even if their character is uncertain.
- It is reasonable to assume that the most important heritage assets may only be revealed initially as anomalies; the form and origin of anomalies is ambiguous, so they may represent undocumented, ephemeral site types of the sorts that are poorly represented in archaeological inventories: smaller wrecks; older wrecks; aircraft wrecks.
- Establishing the origin of anomalies usually requires some form of visual inspection, which may have implications for costs and timetabling.
- With specific relevance to wave and tidal energy – the option of avoiding all anomalies outright is unlikely to be available because of the constraints on the layout of wave and tidal energy schemes.

18.3 Anomalies present a number of difficulties to the consenting and construction phases of marine development. They require consideration because of their potential to be of archaeological origin; but often little can be said about their character, significance or implications in the absence of direct observation.

18.4 These difficulties may be exacerbated by the quantity of anomalies. Modern survey equipment can reveal very high numbers of anomalies. Its high resolution can help in distinguishing items that are clearly not of archaeological origin, but the overall count is likely to be augmented by features that would not have been apparent in surveys using previous generations of equipment. Where schemes are extensive, the number of anomalies is likely to render observation of each one impracticable.

18.5 One approach to dealing with numerous uncharacterised anomalies in the course of consenting has been to defer the issue to a later phase by proposing to avoid them all in the course of construction, irrespective of whether they are of archaeological origin or significance. This is a relatively cheap approach, but such a commitment while consenting can become a major constraint in the course of detailed design. If anomalies become entrenched in EIA commitments or constraint layers in GIS, the cost of satisfying such obligations in the course of construction can be very great. The constraints of an avoidance-based approach may be acute in the development of wave and tidal energy schemes, where there is much less flexibility to microsite individual devices and cables than in other forms of scheme.



Indistinct and ambiguous anomalies can be difficult to interpret. This anomaly proved to be the site of the four engine B-24 Liberator bomber shown on the previous page. Like all military air crash sites it is automatically protected from damage and interference under the Protection of Military Remains Act 1986. Image © Wessex Archaeology.

18.6 Generally, a flexible evidence-based approach to anomalies is more desirable than the overly precautionary approach of avoiding each anomaly even though it might prove to be of no archaeological consequence. An evidence-based approach is likely to include taking steps to obtain direct observational data on at least some anomalies in the course of seeking consent. As noted elsewhere in this guidance, suitable surveys – such as benthic video surveys – to which archaeological objectives are appended, may present a cost-effective opportunity to examine selected anomalies.

18.7 By organising the investigation of anomalies thematically (e.g. by grouping anomalies into different forms), direct observation of selected anomalies might be framed in terms of a sample from which broader inferences can be made. Such observations and inferences will enable both Developers and Curators to achieve a more balanced view of the archaeological potential that anomalies may present.

18.8 There is an overall lack of data on anomaly character upon which broader generalisations about the significance of anomalies can be based because it has been common to avoid anomalies without establishing their origin. This is a clear example where improving the knowledge-base for decision-making has been precluded by the approach adopted. There is therefore a major opportunity for an evidence-based approach to anomalies that can help overcome the widespread difficulties that anomalies present. Feedback based on direct observation of the actual character of anomalies will increase confidence in conclusions about their origins in general: what proportion represent geological features such as glacial erratics, outcrops or bedforms; what proportion are recent debris of no archaeological interest; and what forms of anomaly are most likely to represent archaeological material. Such conclusions will benefit not just individual schemes or Developers, but – if experience is shared – the whole wave and tidal energy industry.

19. ASSESSMENT, ANALYSIS AND PUBLICATION

Publicly accessible research is intrinsic to historic environment practice and enables all parties to gain maximum benefit from the investigations that are undertaken.

19.1 The historic environment warrants conservation in its own right, as a facet of the environment that we should safeguard for future generations. There is also a strong interest in sharing what is known about the historic environment with the public at large, and with furthering our understanding of the human past as a scientific endeavour, and to enable us to better manage its conservation. Improving understanding of the historic environment and sharing that knowledge are fundamental to archaeological practice.

19.2 In the context of wave and tidal energy, understanding and sharing knowledge are also essential to 'adaptive management' – using the consequences of previous management to inform future management – so that decision-making and actions become more effective and efficient with experience.

19.3 In the UK Marine Policy Statement, this is expressed as follows:

> *Opportunities should be taken to contribute to our knowledge and understanding of our past by capturing evidence from the historic environment and making this publicly available, particularly if a heritage asset is to be lost.*

19.4 Research is commonly split into two elements: assessment and analysis.

19.5 **Assessment** (sometimes referred to as 'post-excavation assessment' or 'post-fieldwork assessment') means reviewing results and determining where further work is likely to make a useful contribution. Assessment was introduced in the 1980s to bring order to rather indeterminate research following archaeological fieldwork that could run for years without conclusion; it entails selectivity and prioritisation, and careful costing and timetabling. Preparation of an Assessment Report (known as a Data Structure Report in Scotland) is a process that requires considerable archaeological experience and insight.

19.6 **Analysis** encompasses a wide range of detailed investigative techniques, including literature review, science-based procedures, computer reconstructions, modelling and so on. The output from analysis is a narrative that sets out transparently and robustly the contribution made to knowledge by the investigations. Analysis need not address every aspect of the investigations or the heritage assets that were examined; in the light of assessment, analysis addresses only what is significant. Aspects of an investigation not covered by analysis can always be accessed directly from the project archive, to which the Assessment Report will serve as a guide.

19.7 Reports prepared in the course of assessment and analysis will normally be submitted to the Regulator and the Regulator's advisors, and form part of the project archive. It is usual for copies of project reports – known as 'grey literature' – to be added to the relevant national and local historic environment records, which are publicly accessible. Access to grey literature is facilitated through OASIS – Online AccesS to the Index of archaeological investigationS, which includes the online 'Grey Literature Library'. Short notes of investigations may also be published in local, period- or theme-specific journals, and series such as *Discovery and Excavations in Scotland* and *Archaeology in Wales*. These measures are intended to make sure that the results of archaeological work are available and can be consulted in future.

19.8 Nonetheless, project reports are prepared in the first instance to meet the specific requirements arising out of the consenting process. They are not necessarily accessible or suitable for other readerships. As made clear in the UK Marine Policy Statement, important results will usually warrant formal **publication**, especially where a heritage asset is to be lost. With respect to individual schemes, publication requirements will usually be invoked by conditions on consent. Publication usually takes the form of a paper in a peer-reviewed academic journal or – if the results are particularly extensive – as a book or monograph. Proposals for publication – including costs and timetable – will normally be included in the Assessment Report.

19.9 The preparation of project reports and publications also presents an opportunity to prepare more widely accessible publications such as leaflets and booklets that can be circulated to communities and stakeholders. Information can also be made available on project web sites. There is often a strong appetite for archaeological information: both about the methods that have been applied; and the results that have been achieved. Although Developers sometimes express concern that publicising archaeological results may provoke concerns about specific archaeological sites from the public, which might cause complications to a scheme, experience suggests that this is unlikely to be the case. Concerns about commercial confidentiality can usually be accommodated also; material of archaeological interest need not be accompanied by information that is sensitive or restricted.

19.10 Publication (whether the focus is academic or for a wide public) provides opportunities for Developers to present the work they have commissioned to local communities and media. Publication can therefore be accompanied by press releases, news items for radio and television broadcasters, and material for circulation online and through social media. There is often a vigorous appetite for archaeology across these different media.

19.11 The paragraphs above have focussed on scheme-level assessment, analysis and publication. The overall benefit – for academic and popular understanding; and for future decision-making – will be greater where effort is also directed to regional or wider syntheses. Responsibility for synthesis does not rest primarily on Developers, though it is their interests to encourage it. Industry bodies, Regulators, their historic environment advisors and other organisations with strategic responsibilities are encouraged to initiate projects that collate and synthesise the results of scheme-specific investigations so that their methodological and archaeological results can be mobilised effectively in future decision-making.

Intertidal 'breakwater' protecting a landing place in north west Scotland. Maritime sites can be difficult to date; sites on the adjacent shore range from prehistory to the C19th. Image © Antony Firth/Fjordr.

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