I6: Scoping the Environmental Impacts of Tidal Power Developments

Explanatory Note

For projects which require Environmental Impact Assessment (EIA), a scoping exercise must be undertaken early in the planning stages of the project. This enables the project to be designed to avoid or minimize negative environmental impacts and provides an opportunity to incorporate positive environmental enhancements into the project. Early consultation with all interested parties, including the Environment Agency, is an essential part of scoping. Even if a project does not require EIA under EIA legislation, it may be advisable (and in some cases necessary) to undertake a scoping exercise in any case (e.g. to support applications for other relevant consents and authorisations needed to carry out the project).

This guidance note aims to promote a good practice approach to scoping as part of the EIA process which in some respects goes beyond the statutory EIA requirements. When scoping a project, developers, or their consultants, should satisfy themselves that they have addressed all the potential impacts and the concerns of all organisations and individuals with an interest in the project.

This guidance note provides information on the most likely potential environmental impacts of tidal power developments. However, each project must be considered on a case-by-case basis as the detailed characteristics of the proposal and the site will determine the potential impacts.

This guidance is based on the main legal requirements on EIA stemming from the EC Directive and the UK Regulations. However, developers should seek independent legal advice to ensure that the proposed development is carried out in compliance with the requirements of this and any other relevant legislation, relating to planning as well as pollution control.

This guidance note must be read in conjunction with the *Scoping Handbook*, which provides general guidance on the Environmental Impact Assessment process and the scoping of projects.

In addition, the following scoping guidance notes are also relevant to *all* tidal power projects:

- A1 Construction works
- A4 Vegetation management and conservation enhancements
- C1 Barrages

The following scoping guidance notes *may* be relevant in certain circumstances:

- B5 Freshwater and marine fish farms
- F4 Marinas
- F6 Water-based recreation
- F7 Angling and sport fishing, including fish stocking
- J6 Navigation works and canal restoration

Contents

1. Introduction

1.1 This guidance note, in conjunction with the Scoping Handbook and the other notes listed on the previous page, seeks to help developers and other interested parties identify the potential impacts of tidal power developments on the environment as a whole. It should be emphasised that the list of impacts is by no means exhaustive and that a full investigation into *positive* and *negative* impacts should be undertaken. Early consultation with the Environment Agency, and other relevant organisations, will enable the identification of environmental issues and constraints and the avoidance of sensitive areas, thus reducing the need for redesigning and mitigating avoidable impacts at a later stage.

1.2 Following this brief introduction, an overview of the legal requirements for EIA in relation to tidal power developments is provided. The potential environmental impacts of such projects are identified in Section Three. The text and summary table in this section will enable the reader to begin to identify the likely impacts arising from the particular proposal under consideration. The subsequent sections present the mitigation measures that may be relevant to tidal power developments, followed by key references and further reading.

Background to development type

1.3 Tidal power development activities involve the extraction of energy from the rise and fall of the tides. This will involve the construction of a barrage across an estuary equipped with a series of sluice gates and a bank of low head axial turbines with which electricity can be generated. The stored energy in the water from the difference in water levels across the barrages is used to generate electricity from the fast moving water passing through the turbines from one side of the barrage into the other. Such projects provide a valuable source of non-polluting and continual renewable energy as well as reducing flood risks in these coastal areas. However, tidal power developments and their associated barrages do present potentially significant environmental impacts in terms of disturbance to the ecology and wildlife of estuaries, in particular the potential to cause serious disturbance to migrating fish. Therefore the need for fish passage facilities and also for fish exclusion mechanisms from the turbines will need to be considered during project design. Therefore a thorough scoping exercise and careful consideration of alternatives are of prime importance.

2. Development control and EIA

Development Control

2.1 The construction or extension of power stations with a capacity of 50 megawatts or more usually requires consent from the Secretary of State for Trade and Industry. Smaller power

stations fall under the control of the Town and Country Planning system and would require planning permission.

Environmental Impact Assessment

2.2 Tidal power developments are not listed in the Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1999 (SI 1999 No. 293). However, Paragraph A11 of the DETR Circular 02/99, *Environmental Impact Assessment*, states that small stations using novel forms of power generation should be considered carefully, in line with the guidance given in PPG (Planning policy Guidance Note) 22, *Renewable Energy*. Furthermore, if a development for generating electricity from tidal power involves the construction of a barrage, EIA may be required.

2.3 Although a formal EIA of a proposed tidal power development may not be required, depending on the nature and location of the scheme, the Environment Agency and other statutory consultees and regulators may request environmental information concerning the proposal. An EIA may provide the most appropriate method for a developer to collate the necessary information.

3. Potentially significant environmental issues

3.1 The EIA Directive requires the EIA to 'identify, describe and assess…the direct and indirect effects of a project on the following factors: human beings, fauna and flora; soil, water, air, climate and the landscape; material assets and the cultural heritage; [and] the interaction between the [above] factors.' Socio-economic issues, health and safety in the workplace, material assets and the cultural heritage are all considered in EU Guidance on scoping (ERM, 2001a) but are not impacts categories for which the Environment Agency is the principal competent authority. Advice on these issues is presented in this guidance note without prejudice to the advice of the relevant competent authority, but the relevant competent authority should be consulted for each of these categories in all cases (further advice on the appropriate competent authority to contact is given in the Scoping Handbook).

3.2 Tidal power development activities have the potential to affect the environment in many ways. They can differ widely in terms of their mode of operation and location, and key issues are likely to vary from site to site. Therefore, it is recommended that expert advice on detailed technical issues should be obtained. The issues arising for all environmental receptors will change overtime. Developers and site operators should therefore consider the impacts arising from the construction phase, operational and decommissioning activities.

3.3 Environmental impacts can affect both humans and ecological resources. Potential impacts are discussed here in broad terms only as their nature and intensity will depend on the physical characteristics of the project and the composition of any polluting materials. An EIA of proposed tidal power development activities should take these factors into account in assessing potential impacts on the environment.

3.4 The following paragraphs should be read in conjunction with Table I6. This details the activities involved in the construction, operational and decommissioning activities, and the impacts arising from them.

Water environment

3.5 Surface water hydrology can be affected during all phases of tidal power development operations. The basin behind the tidal barrage, tidal current velocities will be reduced, in particular during the ebb. This will affect sedimentological and channel geomorphological processes in that normally mobile sediments will become immobile resulting in the deposition of materials in the shelter of barrage landfalls.

3.6 Surface water quality could be affected by a number of tidal power developments in the upper estuary away from the immediate effects of the barrage. The salinity of these waters could reduce significantly due to the reduction in the amount of sea water entering into the estuary with each tide. Also because the tidal barrage would lie across the path of waters moving sea ward from river mouths, this could result in the containment of effluents and chemical running off the land which would other wise be diluted out at sea. Indeed nutrient rich effluents could lead to the eutrophication of waters behind the barrage. Other potential water quality impacts could arise from the turbidity and sediment disturbance during the construction and decommissioning phases – this in turn could mobilise potential pollutants from the substratum.

3.7 Tidal power generation activities may have significant impacts on groundwater hydrology and quality. Barrage construction will result in the raising of groundwater levels and altering general ground water flow patterns. The presence of contaminants in the waters behind the barrage may present potential for becoming more concentrated and entering the groundwater system.

3.8 In order to protect vulnerable groundwater resources it is the policy of the Environment Agency to encourage new developments to locate in areas of low vulnerability to groundwater pollution. However, this policy does not imply an automatic prohibition on tidal power development projects within Source Protection Zones.

Land

3.9 Tidal power development projects will have implications for land take, the physical characteristics and land use of the site (i.e. including associated shore-based facilities). By their nature, such projects have the potential to change the site significantly. Issues to consider include: the effect on landscape character of the barrages, associated land based infrastructure including buildings and power lines and the disturbance to sediments within the estuary channels as well as to soils on shore from the construction and decommissioning activities.

Air and Climatic Factors

3.10 Tidal power developments will have minimal effects local air quality and climate from machinery and vehicular emissions during the short lived construction and decommissioning phases only. The use of tidal power in place of electricity generation from fossil fuels will be positive and a significant move towards the reduction of global carbon dioxide emissions.

Ecology

3.11 The construction of a tidal barrage will have the potential to cause profound changes to the local ecology. Potential impacts may include disturbances to migrating fish, many marine species use estuaries and migrate within them to various sub-habitats at certain times of the year. In addition to this there may also be impacts upon local populations of invertebrates and the fish and birds, which feed off them; wading birds and over wintering bird species. Barrage construction would result in the reduction in mud flats exposed each day due to the reduced water levels therefore species such as mud wading birds could be adversely affected.
With regard to aquatic species the barrage may present a number of problems including acting as a barrier to migrating fish and potential mortalities to fish caused by collisions with turbine blades. The extent and acceptability of the ecological changes will need to be determined individually at each site

Human environment

3.12 The potential impacts of a tidal power development on the human environment may take a variety of forms including the need to maintain navigational access in order to maintain the local fishing, transport and tourism economy. The impacts are divided here into sections

covering socio-economic and health issues; amenity, visual impact and nuisance issues; and culture, heritage and archaeology.

3.13 The potential for socio-economic and perceived health impacts arising from tidal power developments are likely. During the construction phase tens of thousands of jobs are likely to result from the tidal barrage development. Once operational number of persons employed directly by the development will be reduced somewhat however, there are likely to be spin-off opportunities from water sports related activities and tourism created by the development. Such social issues should be considered when scoping an EIA. In addition to the amenity, visual impact and nuisance issues noted below, these may include.

3.14 The identification of which of these issues are significant or are perceived to be significant is an important function of public involvement during the scoping exercise. Understanding likely public concerns is a key issue and reference to experiences from other tidal power developments and any public representations to the local planning authority should be made.

3.15 Amenity, visual impact and nuisance issues that commonly need to be addressed are the visual impact of the barrage, associated infrastructure developments, and noise and vibration nuisance from traffic during both the construction and decommissioning of the site. Any restrictions to access that may arise as a result of the development should also be considered, as should the creation of nuisances such as mud on roads, slow construction vehicles on public roads etc.

3.16 Impacts on architectural and archaeological heritage and damage to archaeological features during construction, operation and decommissioning should be taken into account. The likelihood of there being any unrecorded sites and the site's influence on the potential for discovery should also be examined.

Table I6

3.17 The impact identification table highlights:

- sources of impact (development activities);
- potential impacts;
- receptors for these impacts.

3.18 It is recommended that the table is annotated and used during consultations with other interested parties. Reference should also be made to the prompt lists detailing impacts and sources of impacts in the Scoping Handbook.

Table I6. Summary of Key Potential Impacts of tidal power

		Activities and Potential Impacts		
Potential Receptors of Impact		**Construction phase**	**Operation phase/on-going site maintenance**	**Decommissioning / Post-operation**
WATER	surface water hydrology & channel morphology	**Use of vehicles and machinery** • increase in surface on the shore banks, runoff from soil compaction **Works next to or near water courses** • change in flow velocities • increased erosion and subsequent changes in bed and bank stability • increased flood risk **Earthworks** • disturbance to sedimentation patterns of water courses	**Physical presence of tidal barrage** • decrease in tidal range and extreme conditions, mean high water mark displaced • creation of areas of deposition in the shelter of the barrage landfalls • changes to tidal currents • retention of sediments behind the barrage inhibiting the movement of terrestrial sediments into the marine environment.	**Site decommissioning** • possible increased flood risk • sediment disturbance and turbidity • change to depositional patterns • change to mean high and low water marks • changes to erosional patterns of the estuary
	surface water quality	**Earthworks** • pollution & turbidity from suspended material • disturbance of contaminated sediments in he estuary and subsequent pollution of water **Materials management** • pollution from spills or leaks of fuel, oil and construction materials	**Materials management** • pollution from spills or leaks of fuel and oil from operational machinery and equipment **Physical presence of the tidal barrage** • decrease of estuarine salinity upstream of the development • increased retention time of potential pollutants e.g. sewage effluents and, and heavy metals behind the barrage	**Structure removal** • disturbance of sediments and potential pollutants – turbidity increase • risk of pollution from construction work activities, machinery oils etc to the water course.
	groundwater hydrology	**Earthworks** • changes to the water table • changes to groundwater distribution and flow	**Physical presence of tidal development** • rise in groundwater levels	**Removal of tidal barrage** • decrease in water table and return to original levels
	groundwater quality	**Earthworks** • potential disturbance and release of contaminated sediments and subsequent groundwater pollution **Materials management** • pollution from spills or leaks of fuel, oil and building materials from construction activity	**Materials management** • contamination from spills or leaks of fuel and oil	**Materials management** • potential pollution of ground water by chemicals, oils etc from works and vehicular activities associated with decommissioning

		Activities and Potential Impacts		
Potential Receptors of Impact		**Construction phase**	**Operation phase/on-going site maintenance**	**Decommissioning / Post-operation**
LAND	landscape	**Excavations & earthworks** • creation of a new landform	**Physical presence of barrage infrastructure** • change in character of landscape	**Physical presence of former tidal development** • possible raised marshland
	soils	**Use of vehicles and machinery on land** • compaction • erosion **Earthworks** • further erosion of exposed soil • removal or alteration of soils on site for construction of ancillary structures	**Use of vehicles and machinery for associated land construction** • soil compaction • soil erosion	
	geology	**Excavations** • removal of rock by excavation works		
AIR	local air quality	**Use of vehicles and machinery** • emissions from construction site traffic • dust generation		**Use of decommissioning vehicles and machinery** • emissions from construction site traffic • dust generation in dry conditions
	regional / global air quality		**Electricity generation from tidal power** • operations will displace the combustion of fossil fuels reducing emissions for carbon dioxide, sulphur dioxide and nitrogen oxides	

		Activities and Potential Impacts		
Potential Receptors of Impact		**Construction phase**	**Operation phase/on-going site maintenance**	**Decommissioning / Post-operation**
FLORA & FAUNA	aquatic ecology	**Drainage works and use of vehicles on land** • negative impact on flora and fauna from increased sediment loading of streams **Materials management** • harm to aquatic flora and fauna from oil, fuel, cement or other substances entering watercourses	**Physical presence of tidal development** • changes to shallow water zonation patterns • modifications in the pattern and distribution of benthic organisms, hard and soft bottom organisms • fish mortalities associated with turbine collisions • potential inhibition to fish migratory patterns • algal blooms associated with water impoundment mat produce toxins affecting fish populations **Materials management** • direct and indirect effects from oil, fuel or other substances entering the aquatic environment	**Decommissioning activities** • continued effects of sediment disturbance and turbidity whilst works are in operation **Restoration design** • opportunity for enhancement of nature conservation value
	terrestrial ecology	**Earthworks and excavations** • habitat removal, fragmentation or severance • disturbance to, or loss of, species (including rare and sensitive species) • potential disturbance to breeding colonies of gulls, roosting, feeding and breeding birds	**Physical presence of tidal development** • potential alteration or loss of terrestrial habitats for wet land birds, loss of feeding grounds and refuge for migratory populations. • decrease in invertebrate populations could directly influence the population levels of shore birds • species elimination from certain sectors may alter carrying capacity of the estuary for wading birds etc. • potential decrease in area of bird feeding grounds due to changes in tidal heights • post barrage tidal curves indicate feeding times between tides for birds will decrease • excessive growth of green algae on inter-tidal flats may make them unsuitable for feeding wading birds **Expansion of recreational activities behind the barrage** • potential disturbance caused to roosting, feeding and breeding birds.	**Restoration design** • positive or negative effect on existing ecology from introduction of new (possibly non-native) species

		Activities and Potential Impacts		
Potential Receptors of Impact		**Construction phase**	**Operation phase/on-going site maintenance**	**Decommissioning / Post-operation**
HUMAN ENVIRON -MENT	socio-economic[1]	**Earthworks and excavations** • disruption of services such as electricity, gas, water, or telecommunications due to the presence of underground cables and pipes • construction-related employment **Negative publicity** • potential effect on property values in the vicinity	**Tidal development operations** • potential affects to property values • creation of employment associated with maintenance and running of the barrage **Recreation activities** • creation of jobs associated with the development of water spots related activities due to water impoundment	**Decommissioning works** • employment generated by the disassembly of the tidal structures **Restoration design and after-use** • public perception of the area may improve following sensitive restoration plans
	health and safety[1]	**Earthworks and excavations** • risk of injury on construction site **Negative publicity** • adverse reaction to perceived environmental and health issues	**Turbine operations** • risk of harm to humans using the estuary for recreation purposes from currents created by the barrage and turbines	**Decommissioning works and excavations** • risk of injury on site
	amenity	**Construction** • temporary disruption to recreation activities and amenity value of the estuary	• possible alteration of access to certain parts of the estuary • creation of fisheries, recreation associated activities	**Restoration design** • provision of amenity/recreational area
	nuisance	**Use of vehicles and machinery** • noise from construction traffic and operations • mud on roads	**Creation of large body of impounded water** • algal blooms • potential for waterborne diseases – Weils etc. • midges during warm weather conditions • increased dampness, flooding of cellars and floor voids in near by housing developments due to raised water table	**Decommissioning works and excavations** • temporary noise • generation of extra construction related traffic • disturbance
	architectural and archaeological heritage[1]	• damage to known or unknown features of archaeological or cultural importance		

Additional site specific issues:

[1] The Agency considers that key impacts to be identified and assessed are likely to include the following, but further advice and guidance should be sought from the relevant competent authority, as included in the Scoping Handbook.

4. Mitigation measures

4.1 Following the scoping exercise and the identification of potential environmental effects, mitigation measures should be proposed to avoid or reduce potential negative impacts to air, water, land, ecology and humans, or to introduce positive aspects to the development. Guidance has been provided by the Environment Agency to assist developers on a range of relevant subjects in the form of Pollution Prevention Guidelines - see "References and Further Reading" in the Scoping Handbook.

4.2 A primary consideration in impact mitigation must be the siting of a tidal power project. The development should avoid damage to important ecological sites and high quality landscapes. Also, it is Environment Agency policy to seek the preferential location of developments in areas, which are not vulnerable to groundwater pollution (Environmental Agency, 1998b). It is strongly recommended therefore that developers undertake an assessment of alternative sites.

Mitigating the impacts of construction activities

4.3 Construction. Operation and the decommissioning activities of tidal power plants all have the potential to affect all environmental receptors. However, the following list summarises the mitigation measures most relevant to tidal power developments:

- phasing of construction work to minimize disturbance to wildlife at sensitive times of year, such as during the breeding season or when young are being raised;
- use of techniques to minimize compaction of soil, such as restricting access during wet conditions, and using protective boarding and low ground pressure machinery. If necessary, soil should be carefully removed and stored for subsequent reinstatement;
- use of dust control strategies on land;
- storage of fuel, equipment and construction materials so as to minimize the risk of soil contamination or water pollution (see Environment Agency, 2000f);
- setting the route and timing of construction traffic so as to avoid residential areas or other sensitive human receptors (e.g. schools, hospitals, nursing homes);
- access roads should avoid riparian zones and should be built using appropriate construction materials.

Mitigating the impacts of the operational phase

4.4 Although sensitive siting and design of a tidal power plant are some of the principal means for avoiding or reducing its environmental impacts, further measures can be introduced to minimize impacts occurring from the ongoing management of the site. An overall consideration for the proposed tidal power development is that its design and operation are in accordance with planning conditions and other relevant legislation.

4.5 The measures have been arranged according to their primary receptor, however it should be noted that many of the following mitigation measures are inter-related. For example, correct handling and storage of chemicals and construction equipment, would serve to reduce the impacts of such an incident on soils, surface and ground waters, and ecology.

Protecting the water environment

4.6 In order to minimise potential impacts on the water environment in the design and running of tidal developments must ensure that:

- an appropriate water management system is used, including, for example, efficient land drainage and the use of constructed ponds for receiving site runoff to reduce the impact of runoff on nearby water courses;
- hazardous or potentially polluting materials such as fuel, oil or wastes going to landfill, must be sited on an impervious base away from water, properly bunded and kept locked when unattended;
- oil interceptors or drip trays are used in vehicle parking areas associated with the development on land, and are inspected and cleaned regularly;
- a risk assessment is carried out for each substances to be stored on site, for example maintenance fluids, residues etc, and the appropriate containment measures installed;
- an Emergency Plan is formulated and tested through exercises to ensure that procedures to prevent or mitigate impacts due to accidents or spillages are in place and operate effectively (some developments may require such plans to be formulated and the Environment Agency should be consulted to identify where this is the case).

Protecting the land environment

4.7 Certain measures noted above for protecting the water environment, such as the formulation of en emergency plan will also reduce the likelihood of soil contamination. Impacts on soils and landscape may also be mitigated by the following:

- appropriate designs for buildings and structures on site;
- appropriate screening for visual impacts;
- effective stabilisation of altered landforms so as to minimise soil erosion and the potential for water pollution from suspended solids;
- use of drip trays under stationary machinery to prevent oil and grease contaminating soil and groundwater.

Protecting the air environment

4.8 Developers should consider the aspects of the development that are likely to lead to air emissions. Such aspects can include vehicle and machinery emissions mainly for the construction phase.

Protecting ecology

4.9 Measures designed to prevent or reduce impacts to water or land will also benefit ecological populations. It is recommended that a formal dialogue be set up between the development and conservation interests with the primary objective being the development of ‘ameliorative and creative measures as options wherever necessary. The following list identifies further strategies for reducing or avoiding impacts to terrestrial and aquatic species and their habitats:

- construction of fish passes specific to the range of fish in the locality, more than one may be needed as not all species can use the “standard” fish pass design, e.g. eels have specific requirements;

- ♦ establishment of a monitoring programme a pre-scheme study in order to monitor potential environmental impacts and possible mitigation measures;
- ♦ existing habitat features should be incorporated into site design and protected from change;
- ♦ the development should aim to introduce a quasi-tidal regime for plant and animal species dependent upon tidal rhythms;
- ♦ further habitats should be created to compensate for habitat losses and to improve the landscape and ecological potential for the site, for example the provision of wildlife sanctuaries, coastal lagoons and protected intertidal areas;
- ♦ restoration plans should incorporate measures to improve the ecological status of the former development site;
- ♦ incorporation of fish passes should be constructed to bypass the sluice gates and turbines so that the migration of fish populations is not disrupted. However the design and siting of the fish pass would be critical;
- ♦ options to reduce fish mortalities as described above include the installation of sonic generators producing one-second hammer blow pulses in the vicinity of the turbines and sluices so as to act as warning signals to fish nearby;
- ♦ regular once weekly flushing with sea water through the barrage may be necessary to maintain ecological stability on the landward side of the development.

Protecting the human environment

4.10 Some of the measures noted above can also reduce possible impacts on humans, notably the risk assessment and emergency planning measures. Further mitigation measures more specific to the human environment are listed below:

- ♦ management operations should aim to minimise disturbance to adjacent residential and recreational uses;
- ♦ where access restrictions result from the tidal power development to the estuary and adjacent land, arrangements for alternative access should be made including the provision of lock gates for river traffic;
- ♦ safety concerns should be addressed by such measures as implementing strict health and safety procedures for workers, and the installation of adequate security to prevent trespass and vandalism and accidents and injury to members of the public;
- ♦ sites of archaeological or cultural interest should be preserved in situ where possible. As relocation is rarely feasible, thorough archaeological investigation should be undertaken where damage is unavoidable.

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GEHO0411BTRZ-E-E