Guidelines for Project Development in the Marine Energy Industry

Foreword

This document has been prepared in consultation with The European Marine Energy Centre Ltd (EMEC) and with other interested parties in the UK marine energy community. It is one of twelve publications in the *Marine Renewable Energy Guides* series, included in the following figure.

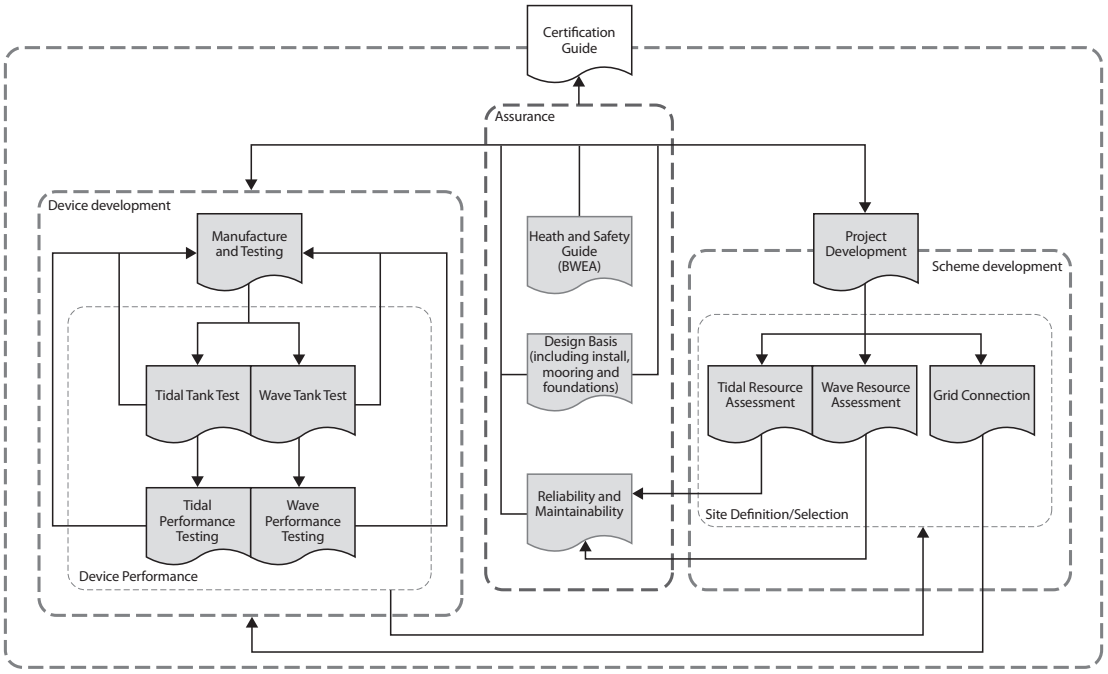

Figure 1 — Marine Renewable Energy Guides

Acknowledgements

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Guidelines for Project Development in the Marine Energy Industry

Marine Renewable Energy Guides

EMEC ORKNEY™
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Contents

Guidelines for Project Development in the Marine Energy Industry

Introduction

The aim of this document is to set up best practice in the development of marine power projects and disseminate this good practice throughout the industry.

This document has been drafted providing examples of the UK case and is based on current UK policy and legislation. It is, therefore, a live document to be reviewed and updated as policy, legislation and requirements change over time.

The guideline is based on a generic marine power project. It is not intended to be a guide on project management but aims to be of practical use for a broad range of project developers with different business and project objectives.

The guideline was developed based on the underlying assumption that the selected technology is mature and commercially available for the scale and type of development envisaged.

The guideline is divided into a number of sections, each of them covering a well-defined project development stage. The guideline follows a chronological order in line with the sequence in which those stages occur during the development process. The flow chart in Figure 2 illustrates the stages sequences and interrelation between them.

Under each project development stage two text boxes have been included, one at the beginning which highlights the key milestones and one at the end which contains a summary checklist of key issues the project developer needs to consider. Under each section, relevant UK examples have also been presented in text boxes with dotted borders around them. These examples also draw attention to any relevant UK legislation. The legislation cited is up to date at the time of publication.

Stakeholder engagement is considered throughout the project development at different levels of detail. A relevant consultation subclause is included under each project stage.

Health and Safety considerations are presented in a specific subclause under each stage in order to highlight the importance of Health and Safety.

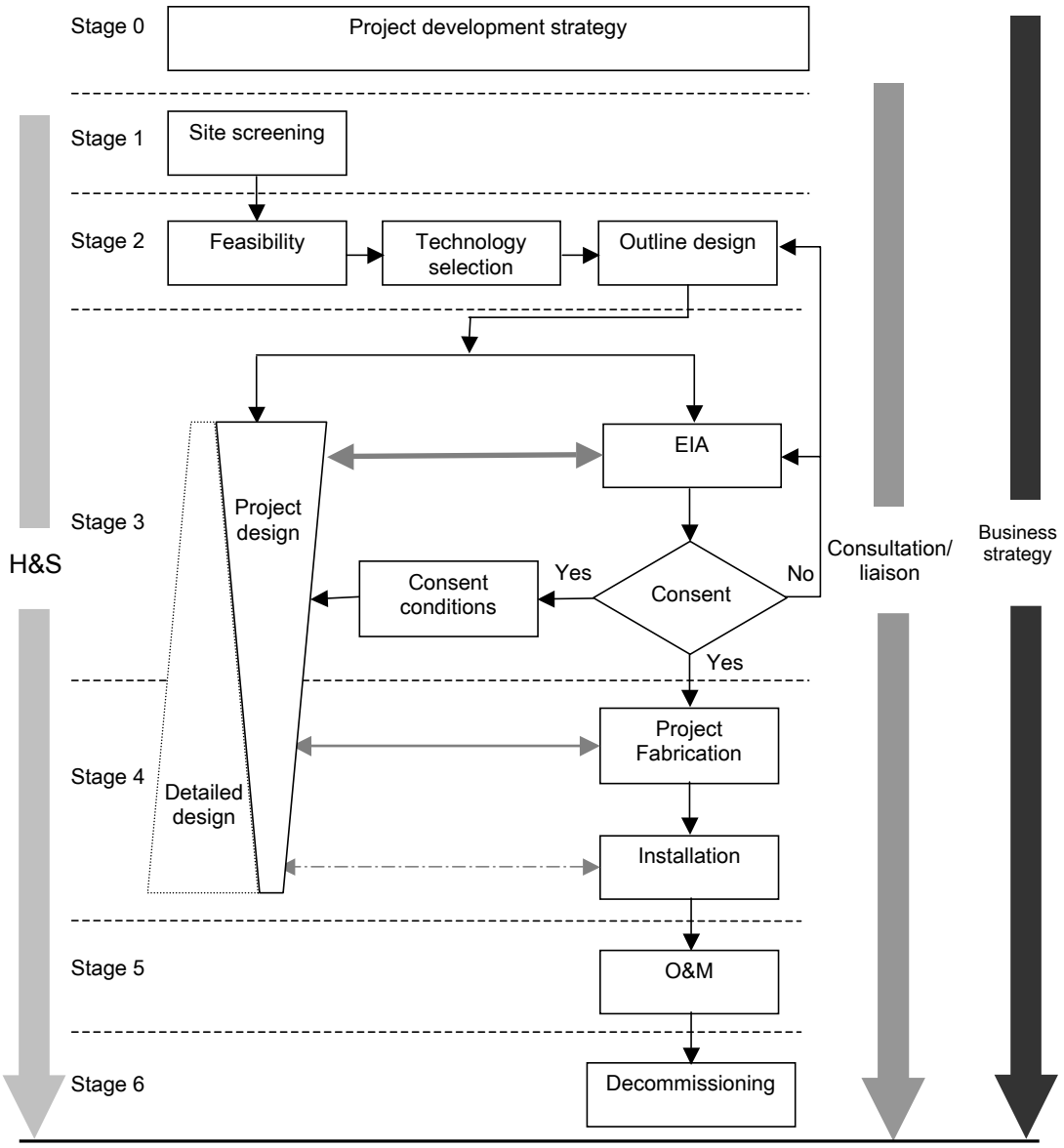

Figure 2 — Flow chart of Marine Power Project development

1 Scope

This document establishes guidelines for the development of a marine power project (wave or tidal stream). The document outlines the recommended processes and procedures to be followed in completing a marine power project from its conception through to decommissioning.

This document is applicable to the whole range of developers of marine power projects. It makes recommendations on the technical, environmental, Health and Safety, and commercial issues that need to be considered through the phases of feasibility,

conceptual and detailed design, manufacture, installation, operation, maintenance and decommissioning. It highlights regulations that are applicable to each stage of the process.

It is applicable to marine power project developments within the European context. However, most of the recommended processes and procedures can apply worldwide, while others will need to be adapted according to national policies and requirements.

2 Normative references

The following referenced documents are indispensable for the application of this document.

Assessment of Tidal Energy Resource, EMEC, 2009

Assessment of Wave Energy Resource, EMEC, 2009

Guidelines for Grid Connection of Marine Energy Conversion Systems, EMEC, 2009

3 Terms, definitions and abbreviations

3.1 Terms and definitions

3.1.1
bid
commercial offer

3.1.2
consent
agreement by legislative body

3.1.3
consenting authority
body granting consent

3.1.4
consultee
person or body of people from whom information or advice is sought

3.1.5
contract
document recording a written agreement enforceable by law

3.1.6
deployment area
space the equipment is to be installed in

3.1.7
development site
area of land or sea that the project will be installed in or on

3.1.8
distributed generator
electricity generation device connected to a distribution network rather than to the high voltage transmission grid

3.1.9
environmental receptor
entity that might be adversely affected by contact with or exposure too a contaminant of concern

3.1.10
marine energy converter technology
set of components which together convert the energy from the sea and turn it into electrical energy

3.1.11
marine power project
scheme or plan involved in harnessing energy from the sea and turning it into electrical energy

3.1.12
metocean data
meteorological and oceanographic condition information

3.1.13
project developer
company or organization involved in completing marine energy schemes or plans

3.1.14
supplier
body or organization providing goods or services

3.1.15
tender
offer to execute work for a fixed price

3.2 Abbreviations

CDM	Construction and Design Management
CE	Crown Estate
EIA	Environmental Impact Assessment
ES	Environmental Statement
FMECA	Failure Modes, Effects and Criticality Analysis
H&S	Health and Safety
HRCS	High-Resolution Continental Shelf Model
MAGIC	Multi-Agency Geographic Information for the Countryside
MCA	Maritime and Coastguard Agency

MCEU	Marine Consents and Environment Unit
MHWS	Mean High Water on Spring Tides
MOD	Ministry of Defence
NTSLF	National Tide and Sea Level Facility
O&M	Operation and Maintenance
O&MP	Operation and Management Plan
OREI	Proposed Offshore Renewable Energy Installations
PEP	Project Execution Plan
POL	Proudman Oceanographic Laboratory
PPA	Power Purchase Agreement
RoI	Return on Investment
SAC	Special Areas of Conservation
SCADA	Supervisory Control and Data Acquisition
SEA	Strategic Environmental Assessment
SFARP	So Far As Is Reasonably Practicable
SPA	Special Protection Areas
UKHO	UK Hydrographic Office

4 Stage 0 – Project development strategy

4.1 General

Before any development work commences, the project business objectives should be defined in order to inform the decision to progress with its development. Some forward planning should be done at this stage to outline the project development strategy and to get management commitment to progress with the preliminary investigations.

4.2 Outline project development strategy

The first step in making the decision to progress with a prospective project should be to define its objectives and outline its potential benefits to the developer. The project objectives should be in line with the developer's business objectives and strategy, which in turn will depend on the type and scale of business.

A market analysis should be undertaken in order to highlight the main drivers and constraints to the proposed development (financial, environmental and legislative) and assess their relevance, as well as identifying key competitors and potential customers.

An important element of the market analysis is the assessment of the current and planned legislative and policy framework and its impact on the marine renewables sector. This should include consideration of available economic support mechanisms and how their scope relates to the project.

Key project development and performance parameters (i.e. estimated project milestones or decision points, indicative acceptable costs, expected rate of return, etc) should be outlined at this stage.

NOTE This will assist in assessing the key potential against the level of commitment of the project developer.

If management commitment is obtained to progress with the initial investigations of the project feasibility, key milestones and decision points through the project development process should be agreed in advance.

Detailed project development strategy, including business case and Project Execution Plan (PEP) should be prepared and developed as more information becomes available.

NOTE The key project development stages and decision points are described in more detail under the relevant project stages.

At this stage a project risk register should be opened. This should be generated through a group workshop and should be maintained as a live document throughout the project.

5 Stage 1 – Site screening

5.1 General

This first stage in the development of a marine power project should be the identification of one or more potential locations for the proposed project.

NOTE 1 Finding a suitable site for the project depends on a number of legislative, technical, physical, environmental and economic factors.

The site identification should consist of a desktop screening exercise based on available data and should be aimed at identifying one or more promising sites within the wider area being considered.

NOTE 2 More detailed information and in-depth assessments are required at later stages in the project development.

If a technology is selected beforehand, then the potential technical, physical and environmental constraints influencing the site identification should be assessed in relation to the technology's performance characteristics.

NOTE 3 The guidance for the site screening process is based on the assumption that a marine energy converter technology was not preselected by the project developer.

Key milestones

- Shortlist candidate site(s).
- Identification of key issues and potential 'show-stoppers'
- Preparation of Stakeholders Engagement Plan.

5.2 Legislative and jurisdictional considerations

5.2.1 Strategic Environmental Assessment (SEA)

NOTE The Strategic Environmental Assessment Directive (2001/42/EC), through the relevant national legislation applying the Directive, makes provisions to assess the environmental impacts of certain plans and programmes in order to ensure the protection of the environment and promote sustainable development by integrating environmental considerations into the preparation of those plans and programmes.

In the UK the following regulations implement the SEA Directive:

- **The Environmental Assessment of Plans and Programmes Regulations 2004** – these regulations apply to any plan or programme which relates either solely to the whole or any part of England, associated territorial waters and waters in any area for the time being designated under Section 1(7) of the Continental Shelf Act 1964.
- **The Environmental Assessment of Plans and Programmes (Scotland) Regulations 2004** – these regulations apply to plans or programmes which relate solely to the whole or any part of Scotland.
- **The Environmental Assessment of Plans and Programmes (Wales) Regulations 2004** – these regulations apply to plans or programmes which relate solely to the whole or any part of Wales.
- **The Environmental Assessment of Plans and Programmes Regulations (Northern Ireland) 2004** – these regulations apply to plans or programmes which relate solely to the whole or any part of Northern Ireland.

Further information on SEA can be found on http://www.offshore-sea.org.uk.

The project development process should identify whether a Strategic Environmental Assessment (SEA) for marine power projects has been developed for the area of study and what are the provisions relevant to the proposed project.

5.2.2 Legislation and planning policies

Other relevant EU and national legislation and existing or projected planning policies should also be identified and their relevance reviewed.

NOTE This will establish the policy framework for the proposed project.

5.2.3 Jurisdiction

Jurisdictional limits and restrictions affecting for example extinguished rights of navigation and requirements for seabed leasing agreements should be identified during the site screening stage.

NOTE In the UK The Crown Estate (CE) is the owner of the majority of the seabed out to the 12-nautical-mile limit of territorial waters and, therefore, the organization granting the lease agreements. For sites within the renewable energy zone, CE issues a licence, and not a lease, to develop a renewable energy installation as they are not the owners of the seabed beyond the UK territorial waters.

5.3 Technical and physical considerations

5.3.1 Resource availability

The first step in the site screening should be the identification of areas with suitable marine resource. At this stage the resource assessment should be merely based on indicative average resource figures.

A marine power project should be located in areas of suitable marine climate in order to maximize the energy extraction and make the project commercially viable.

NOTE 1 What is considered a suitable marine resource varies from project to project and is subject to a number of factors, such as the type of marine power device, local characteristics, operability and maintainability and project objectives.

The suitability of a marine climate for project development also depends on other factors. For wave projects the swell frequency and type, seasonal variations and extreme conditions will have an influence in the power output, marine energy converter survivability and weather windows for maintenance operations. Changing bathymetry and coastal topography can have an impact on the tidal stream resource and its suitability. Please also refer to the following Marine Renewable Energy Guides: *Assessment of Tidal Energy Resource* and *Assessment of Wave Energy Resource*.

Available metocean data should be collected in order to gain a better understanding of the marine climate in the area of interest.

NOTE 2 In the UK a number of existing data sources can be used for a preliminary desktop assessment of the marine climate, including (but not limited to):

- The Department of Business, Enterprise and Regulatory Reform's (BERR's) Atlas of UK Marine Renewable Energy Resources for an initial UK overview of wave and tidal stream resources.
- Data from existing wave and tidal buoys deployed across the UK waters for a more refined estimation of the marine climate within a particular region. This data can be resourced from organizations such as the Metereological Office (Met Office), the UK Hydrographic Office (UKHO) and the Proudman Oceanographic Laboratory (POL). Licence conditions and fees might apply. This data can be used in combination with computer modelling for improved estimates.
- Predicted wave data from two different models, Met Office European Wave Model and Met Office UK Inshore Wave Model.
- Predicted tidal data from the (3-D) Waters Model [High-Resolution Continental Shelf Model (HRCS)] developed by POL. Licence restrictions and fees might apply.
- Admiralty Tidal Stream Atlas and Admiralty Tide Tables from UKHO. Licence restrictions and fees might apply.
- European Centre for Medium Range Weather Forecasting.

It should be noted that other developments in the same area might significantly affect a project.

NOTE 3 The wave train energy might be shielded by other developments further offshore, which might be more extensive. Tidal stream developments in the same channel or flow stream will share the same energy resource, limiting the numbers of turbines which can be cost-effective downstream.

The project development process should identify, therefore, any existing and planned offshore developments in the area.

NOTE 4 This information will be used to compile the cumulative environmental impacts at later stages of the project development.

5.3.2 Electrical connection

A grid connection point in the proximity of the proposed project location with adequate capacity shall be used to export the electricity generated.

Early discussions with the relevant operator of the transmission or distribution network, as appropriate, should be had in order to identify whether a suitable grid connection point is available in the area of study.

NOTE Factors that determine the suitability of a grid connection point include (but are not limited to):

- proximity to an area with good marine resource;
- access to a suitable landfall point without significant technical, environmental and economic constraints;
- available grid capacity;
- access for construction and maintenance.

Not only the current but the project grid availability shall be identified at this stage in terms of future connection of other prospective generators and planned grid upgrades.

5.3.3 Bathymetry

Appropriate water depths are required for the efficient operation of marine energy converters.

NOTE Different wave energy technologies are designed to operate efficiently at different water depths. For tidal stream energy converters, the required bathymetry at the selected site will depend on the dimensions of the selected technology and the tidal range. Bathymetry will also be a significant parameter for the screening of a cable route.

First estimates of bathymetry levels can be obtained from navigation charts of the area of study. Additional sources of information might be available, which would vary from country to country.

In the UK, for example, tidal level variations at hourly intervals for representative spring and neap tides can be obtained from quality checked tide gauge data from the National Tide & Sea Level Facility (NTSLF) database for tidal stream projects.

5.3.4 Seabed morphology

NOTE 1 The seabed morphology will determine which areas are suitable for the installation of the project infrastructure, including the sub-sea cables. It will also govern the likely fixing and mooring requirements for the marine energy converters and other project infrastructure, as well as the laying and protection methods for the sub-sea cables.

An initial assessment of the geotechnical characteristics of the seabed at candidate sites should be undertaken where possible using existing data.

NOTE 2 In the UK available data sources for the seabed conditions for initial consultation include:

- British Geological Survey's United Kingdom Offshore Regional Reports – these cover regional geology and shallow seabed sediments;
- UKHO Admiralty Charts and SeaZone digital datasets;
- nearshore seismic survey data (where available).

Available data sets for the coastal conditions for initial consultation include:

– Shoreline management plans;

– FutureCoast – a database of predictions of coastal evolutionary tendencies over the next century;

– LiDAR and beach profile data;

– wave and tide data;

– historical and current aerial photographic data.

5.3.5 Logistics

When identifying an appropriate location for a marine power development the proximity to suitable harbours should be considered for vessel mobilization for installation and maintenance activities as well as the availability of specialist services.

5.4 Environmental considerations

5.4.1 General

As part of the site screening a high level assessment for the identification and evaluation of potential environmental constraints in the larger area of study should be undertaken. Some of the key factors that should be taken into account are described in 5.4.2–5.4.6.

5.4.2 Designated areas

NOTE 1 There are numerous sensitive areas along the European coastal waters that are designated under European and relevant national nature conservation legislation. The designations are aimed to protect the integrity of these sites' habitats. Developments in designated areas are limited to minimize any adverse impacts that could be caused.

A preliminary identification of any designated areas at international, national, regional or local level should be undertaken.

NOTE 2 In England this information can currently be obtained from the MAGIC (Multi-Agency Geographic Information for the Countryside) database at http://www.magic.gov.uk

Particular attention should be given to the internationally designated Special Areas of Conservation (SAC) and Special Protection Areas (SPA), whose provisions are made by the EU Habitats Directive (92/43/EEC) and the EU Birds Directive (79/409/EEC), respectively.

5.4.3 Ecology

The project development process should review any existing information on the local habitats, both onshore and offshore, in order to evaluate their sensitivity and identify any protected species in the area that could potentially impact on the site identification. Special attention should be paid to avifauna (resident and migratory), benthic ecology, cetaceans and fish and shellfish resources.

NOTE Existing information might be available in the form of published documents and reports at regional or local level.

5.4.4 Archaeology and historical heritage

Indicative location of wrecks, marked on navigational charts, and other identified conservation areas and archaeological sites will present constraints to the proposed project location and consequently should be identified.

Information on the location of unexploded ordnance (i.e. bombs, mines, etc) should also be collected as this might pose a significant hazard for any operation in the area.

5.4.5 Other sea users and infrastructure

The proposed marine power project will share the sea space with a number of existing and established sea users and infrastructure. The project should be located in an area that will cause minimum disturbance to other users in order to minimize the risk of a navigational incident and to prevent the project infrastructure from being damaged. The indicative presence and relevance of the following sea users and sub-sea infrastructure should be identified from existing literature and consultation with local stakeholders:

- fishing;
- commercial navigation;
- recreational navigation and other activities (e.g. diving, surfing);
- Ministry of Defence (MOD) activities;

- existing sub-sea cables and pipelines;
- the mining of aggregate from the sea bed.

5.4.6 Consultation

Key statutory consultees should be identified and approached in order to initiate informal discussions on their views on the proposed project based on their local knowledge and expertise. Early discussions with consultees will help to highlight potential constraints and issues affecting the development of the project, as well as identifying mitigation measures.

The relevant coastal planning authority should also be approached to assess their views and seek their early support to the project. Early discussions with the planning authority should provide additional information on current and future policies relevant to the project.

A consultees/stakeholders engagement plan should be drafted at this stage and reviewed at the different stages of the project development. The plan should not only identify the stakeholders and parties with an interest in the project, but set the procedures on how and when to engage with the different stakeholders and manage their expectations at different stages of the project. It should establish appropriate communication channels and protocols throughout the whole project life.

5.5 Health and Safety considerations

At this stage any relevant site-related Health and Safety (H&S) hazards highlighted from the screening exercise should be logged for detailed assessment and consideration in the later project stages.

5.6 Site screening checklist

- Confirmation of SEA in the area of interest.
- Identification of existing data sets, understanding their validity and accuracy.
- Identification of additional data requirements.
- Assessment of constraints and alternative schemes.
- Shortlist of candidate site(s).
- Identification and initial discussions with key consultees.
- Initial discussions with electrical network operator.
- Preparation of consultees/stakeholders engagement plan.
- Record and audit.

6 Stage 2 – Project feasibility

6.1 General

Based on the outcome of the site screening, the project development process should progress to this stage provided that one or more potential sites have been identified for the project development.

During the feasibility phase more detailed investigations should be undertaken.

NOTE 1 The objectives of the feasibility assessment are to refine the site selection and key constraints. This will allow the preparation of the scoping of potential environmental impacts and the selection of a suitable marine energy converter technology (provided that the project is not being developed based on a preselected technology).

Based on this a conceptual and technical specification should be prepared, which will inform a budget costing, initial financial assessment and outline programme for the project life cycle.

NOTE 2 A positive outcome from this stage will be used in developing the business case for the project and will set the basis for the preparation of a detailed Project Execution Plan.

Key milestones

- Selection of marine energy converter technology.
- Conceptual design.
- Confirmation of availability of suitable grid connection.
- Appointment of Construction and Design Management (CDM) Coordinator (or equivalent subject to national requirements).
- Financial assessment to confirm economic feasibility.
- Project Execution Plan (including risk register, project budget and project programme).
- Formal scoping opinion from consenting authorities (or equivalent subject to national requirements).
- Environmental scoping study (or equivalent subject to national requirements).

6.2 Technology selection

As part of the feasibility assessment the project development process should identify the marine energy converter technology that will best fit the project objectives, provided that the developer does not have a preferred preselected technology for the project.

The technology selection should be based on the following factors:

- site technical and physical constraints;
- available marine climate;
- environmental performance;
- safety performance;
- technical performance and efficiency;
- costs [both capital and operation and maintenance (O&M)];
- degree of development;
- reliability, maintainability and survivability;
- operability.

NOTE Further information on marine energy converters technical and design issues can be found in the following documents:

- *Assessment of Performance of Wave Energy Conversion Systems*
- *Assessment of Performance of Tidal Energy Conversion Systems*
- *Guidelines for Marine Energy Converter Certification Schemes*
- *Guidelines for Design Basis of Marine Energy Conversion Systems*
- *Guidelines for Reliability, Maintainability and Survivability of Marine Energy Conversion Systems*
- *Guidelines for Grid Connection of Marine Energy Conversion Systems*
- *Tank Testing of Wave Energy Conversion Systems*
- *Guidelines for Manufacturing, Assembly and Testing of Marine Energy Conversion Systems*

From a preliminary assessment, one or more technologies should be initially shortlisted based on the technical, physical and environmental characteristics of the identified site(s). The final selection should be based on the financial assessment of the different options.

6.3 Feasibility assessment

6.3.1 General

The project development process should assess the available data and their suitability to inform the initial feasibility of the project. Any data gaps and their relevance should be highlighted in order to identify, define and prioritize the requirements for further and more detailed surveys.

Existing data should be used where possible as this is the most cost-effective option. When data limitations are critical for the successful completion of the feasibility phase, physical surveys should be undertaken at the appropriate level of detail.

6.3.2 Technical and physical considerations

- Marine resource assessment – in order to confirm the existing marine climate and the associated power availability at the identified location(s), the local ocean resource should be monitored for a sufficient period of time. The *Assessment of Wave Energy Resource* and *Assessment of Tidal Energy Resource* guides should be referred to for guidance on the recommended equipment, methodology and duration of this resource monitoring.
- The interaction of available wave or tidal energy resources between existing and potential future developments in the same area should be investigated to quantify the potential impact that other developments, whether existing or planned, might have on the resource available for the project being developed, and hence affect the economic case for the project.
- Offshore geophysical and geotechnical conditions – existing bathymetry and seabed geomorphology in the area should be investigated further to refine the location and extent of the deployment area, assess the fixing and mooring requirements and outline a corridor for the cable route.

NOTE If the existing information does not provide the required level of detail, geophysical and geotechnical surveys might need to be undertaken.

- **NOTE** The geomorphology of the sea-bed can also provide an indication of the likely benthic habitats in the area. This data can inform the requirements for the subsequent environmental studies.
- Onshore ground conditions – landfall characteristics and onshore geotechnical conditions should be assessed in order to identify the likely technical requirements for the onshore works and the installation of the onshore section of the cable.

6.3.3 Electrical connection

The availability of a suitable grid connection with sufficient capacity to connect the proposed development is critical for the success of the project.

Discussions with the operator of the network to identify opportunities for connection shall be initiated at an early stage. Technical and contractual arrangements for connection shall be identified and possible connection layouts and indicative costs assessed, including required standard of security.

In the UK the relevant statutory framework for the connection of a distributed generator is set out in:

- Local distribution network operator Licence , which include a number of clauses (conditions 4, 4A and 4B) that specify the obligations of the network operator in relation to connection of new customers (including generators).
- Distribution Code for Great Britain (Sections DPC5, DPC6 and DPC7), which requires users of distribution networks (i.e. generators) to provide certain information about new loads and generator installations. It also specifies arrangements for the design of connections to the distribution networks, as well as requirements for the control and protection of distributed generators.

6.3.4 Environmental scoping study

Based on the highlighted environmental issues during the site screening and on continuous discussions with consultees, an environmental scoping study should be prepared. This should define the content and extent of the environmental studies to submit to the consenting authorities. The main elements of an environmental scoping review should include (but not be limited to):

- review of existing environmental conditions and constraints, based on baseline data collected;
- compilation of issues raised by consultees and stakeholders throughout consultation;
- identification of data gaps and assessment of the need and scope for further baseline data;
- identification and assessment of key potential environmental impacts, as well as associated benefits of the proposed project;
- requirements for mitigation measures and monitoring;
- scope for further studies.

In the UK the findings of the environmental scoping study should be compiled in an Environmental Scoping Report. The report should be submitted to the statutory consultees for their review and to the consenting authorities for a formal scoping opinion.

6.3.5 Other considerations

The developer should identify and initiate contacts with the relevant consenting authorities to confirm the consents likely to be required for the project.

Requirements for the lease agreement with the organization(s) with ownership rights over the seabed (e.g. The Crown Estate (CE) in the UK) and other onshore landowners should also be identified at this stage.

6.4 Conceptual design

The objective of this task is the selection of a design option for the project infrastructure and the development of a preferred concept. The concept design should provide sufficient level of detail to allow the preparation of a cost estimate and to identify key issues and programme constraints for the installation and operation of the project. The evaluation of the different design options and the outline of the selected design should use preset criteria including the following:

- functionality;
- flexibility;
- operability;
- costs (capital, O&M and decommissioning);
- proven performance;
- safety issues;
- environmental and socio-economic impacts;
- ease of installation;
- project risks, including logistics, supply chain and novel features;
- reliability, maintainability and survivability, taking into account both adverse conditions and long-term effects.

These issues should be addressed at the early stages through careful design to help minimize project risks and uncertainty during installation and operation, resulting in time and financial savings.

Some of the elements to take into account in concept design should include:

- Type and number of marine energy converters and layout design, which will depend on the size and orientation of the deployment area, seabed characteristics, potential environmental impacts, sea take of each marine energy converter and recommended separation between them.
- Mooring and foundation requirements, which will be based on the marine energy converted technology and associated offshore infrastructure, the geomorphology of the seabed and the potential environmental impacts.
- Main sub-sea cable and other offshore connecting cables. This will include the cable electrical specification, based on the total generating capacity; indicative route, based on the geomorphology of the seabed; and cable protective measures, based on the seabed characteristics and the potential environmental impacts.

- Electrical design, including offshore and onshore electrical infrastructure (i.e. transformer, switchgear, connectors, etc), grid connection requirements and power conditioning.
- Connection to the grid (*Guidelines for Grid Connection of Marine Energy Conversion Systems* should be referred to).
- Onshore infrastructure and auxiliary equipment.

A preliminary development and installation programme should be drafted based on the concept design. This should include key design activities, development milestones and decision gateways throughout the process.

6.5 Health and Safety considerations

In the UK provisions for Health and Safety offshore construction work within UK territorial waters are defined in the Construction and Design Management (CDM) Regulations 2007 (CDM 2007). CDM 2007 specifies the duties towards H&S of all the parties involved in the design, planning and execution of the installation work.

The project development process should ensure that appropriate H&S measures are in place and maintained through the life of the project, as well as to ensure the competence in terms of H&S of all the parties involved in the project (designers, CDM Coordinator, contractors, suppliers, etc).

At the feasibility stage the project development process should appoint a competent designer (or team of designers), noting the wide definition of 'designer' in the Regulations. Designers should avoid foreseeable H&S risks So Far As Is Reasonably Practicable (SFARP) from an early design stage, without compromising other key design criteria.

Under CDM 2007 it is a requirement that the project developer appoints a competent CDM Coordinator as soon as significant design commences. The CDM Coordinator should advise and assist the project developer to carry out their duties towards H&S, ensure that H&S is properly managed and facilitate effective coordination and communication between the parties involved in the project.

A H&S Management Plan should be drafted at this stage, including:

- hazard identification and logging;
- risk assessment, to be reviewed as project progresses;
- identification of risk controls to reduce risks to acceptable levels;
- ownership and responsibility to manage risks;
- review of risk management performance;
- auditing to ensure that risks are mitigated;
- certification.

The H&S risk management should be reviewed and updated accordingly throughout the project development and should be communicated between all parties involved in the project development.

Special attention should be paid to the H&S risks directly related with the nature and severe conditions of offshore operations.

Further information on H&S for a marine power project can be found in *Guidelines for Health and Safety in the Marine Energy Industry*.

6.6 Financial assessment

An initial financial assessment will identify the selection options of the marine energy converter technology and the preferred design. This should be a critical consideration in the decision to proceed with the development of the project.

The main elements that should be taken into consideration in the financial assessment include:

- indicative energy yield prediction based on the estimated marine power resource and the marine energy converter technology;
- overview of current and projected national renewable electricity market and revenue streams applicable to the project;
- identification of funding options applicable to the project;
- indicative installed costs based on the conceptual design;
- indicative O&M costs based on the conceptual design;
- project life costing and calculation of rate of return; and
- identification and appraisal of project financial risks, possibly through a sensitivity analysis.

A realistic cost estimate should be developed at this stage with sensitivity analysis, understanding cost uncertainties and allowing for potential cost fluctuations. The level and likely assignment of financial risk should be included.

6.7 Consultation

Following initial scoping discussions with key consultees and the local planning authority, a comprehensive list of consultees and stakeholders should be prepared.

NOTE An indicative list of key consultees is included in Annex A. It should be noted that this list is only indicative and is not exclusive.

Local stakeholders should be identified and these will vary depending on the location and type of development.

Formal consultation and discussions with the identified stakeholders and local planning authority should be initiated and maintained through the feasibility stage in keeping with the Stakeholder Engagement Plan. Their local and specialist knowledge will assist in the identification of potential constraints and possible control measures to remove any 'showstoppers'. This will then inform the environmental scoping study.

Contact with the consenting authorities should be initiated for a formal scoping opinion and confirmation of consent requirements.

Preliminary contact and discussions with the relevant body which has ownership over the seabed on-site leasing agreement or licence requirements should be initiated, as well as with any other onshore landowners identified.

Engagement with the local community to inform them of the proposed project and its likely impacts (both positive and negative) and gather their opinion and concerns on the proposal should be initiated in the form of public exhibitions and presentations.

6.8 Commercial

6.8.1 General

Commercial aspects shall be considered; this is essential from project inception through to completion, whether this is sale of the project or decommissioning. Commercial aspects should be considered in the context of the developer's business and the project development strategy.

NOTE The development of the project feasibility study and project life costing is key to developing the business case for the project and presenting it to potential investors.

Other commercial aspects such as starting negotiations with electricity suppliers should also be addressed at this stage.

6.8.2 Business case and financial model

The form of the business model should be specific to the business which is undertaking the project and to the project objectives.

NOTE A key factor will be the balance of risk and reward. The available resource, the status of the selected technology and particularly performance of previous marine projects using comparable technologies will have a strong influence on the required rate of return from the project.

A business cash flow model for project development, operation, any replanting, and decommissioning should be derived from the project life costing. This should include Return on Investment (RoI) for investors from the project at the various stages of development, handover and operation, comparing the different development and ownership routes, and different sources of finance.

A key factor in determining bankability, which should be considered, will be the firmness of commitment to long-term economic support, which will depend on the different support mechanisms offered by the various national governments.

6.8.3 Financing options

Once the project feasibility has been confirmed the project development process should research what financing options are available, what their requirements are and what the most appropriate sources of funding are for the specific project.

NOTE There are a number of financing options for capital investment in power projects. The suitability of a financing option for a particular project will depend on a number of factors, including the type and scale of the project being developed, the associated risks, partners involved in the project and the availability of market incentives.

In order to select the right financing option for the proposed project the project objective(s) shall be well defined, the project feasibility shall be confirmed, the project risks shall be understood and a risk mitigation strategy shall be designed. Clear and comprehensive information on these aspects (project objectives, project feasibility, project risks and risk mitigation strategy) should be provided to potential financers as soon as they become available.

6.8.4 Power Purchase Agreement

Risk sharing options and the effect they have on project economics should be considered, particularly the Power Purchase Agreement (PPA) options.

NOTE Through a PPA a long-term commitment is obtained from electricity suppliers to purchase electricity generated by the project at certain rates. Combined with validated energy yield predictions a PPA provides visible and bankable predictions of revenue which are necessary to obtain investment in the project.

Different forms of PPA should include (but are not limited to):

- Fixed price contracts, in which electricity is purchased at fixed rates, hence reducing the risk to the generator from falls in electricity prices. However, the fixed rates will be substantially lower than projected electricity prices.
- Floor price contracts, in which electricity is purchased at variable rates following the market price, with a lower floor threshold to provide a safety net to the generator. It can be expected that the variable rate would be above a fixed rate for most of the time and that a floor price contract would give greater revenue. However, the floor price is usually lower than the fixed price, and hence there is greater risk to the generator from falls in electricity prices.

NOTE Hence PPAs enable risk sharing between the generator and the electricity supplier. In general, the more predictable the resource the more favourable PPA the project development process can obtain.

6.8.5 Insurance

The project development process should clarify the extent of the required insurance during the construction phase covered by plant suppliers, construction and installation contractors, as well as during the operating phase. Insurance costs should be included in the project life costing estimates. The full costs of potential weather delays are likely to be difficult to insure, and potential programme delays and additional cost contingencies should be allowed for in the project risk assessment, project programme, costing and sensitivity analysis.

6.8.6 Taxes

The project development process should ensure that applicable taxes are included in the business cash-flow model.

6.9 Project feasibility checklist

- Identification of requirements for further studies and physical surveys to understand the local environment and key project development issues.
- Setting the appropriate criteria for the conceptual design taking into consideration the issues related to offshore operations and the associated adverse environment.
- Selection of a marine energy converter technology.
- Confirmation of grid connection availability with adequate capacity.
- Assessment of all the potential design options.
- Appointment a competent designer.
- Appointment of a competent CDM Coordinator (or equivalent subject to national H&S legal requirements).
- Preparation of a H&S Risk Management Plan.
- Initial contacts with the relevant consenting authorities to outline consent requirements.
- Initial discussions with relevant stakeholders to gather their views/expertise and assist in the preparation of the Environmental Scoping Study (or equivalent document).
- Preparation of an Environmental Scoping Study (or equivalent document) for distribution to the relevant stakeholders and consenting authorities for feedback.

- Identification of site ownership and lease agreement requirements.
- Development of a realistic initial cost estimate with sensitive analysis, understanding cost uncertainties and allowing for contingency to cover potential cost fluctuations and risks.
- Commence discussions on a Power Purchase Agreement.
- Arrange project insurance.

7 Stage 3 – Project design and development

7.1 General

The project developer should progress to this stage only if the outcome from the feasibility assessment still meets the project objectives and has not identified any major potential environmental impacts.

A key element of this phase should be to gain consent from the consenting authorities to enable the implementation of the project. The results from the detailed environmental studies to be undertaken as part of the consent application process should inform the project design, which should be refined according to those findings. Similarly, as design progresses, technical information should be fed back into the environmental studies for consent application.

During this stage, and based on the project design, the project development process should define a procurement strategy for the project fabrication and installation that best fits the overall project objectives and priorities.

Key milestones

- Preparation of Environmental Impact Assessment (EIA) or equivalent studies for consent application.
- Consent determination.
- Lease agreement.
- Refined project design.
- Preparation of procurement strategy.

7.2 Environmental Impact Assessment

7.2.1 Consent application route

Under current UK legislation there are a number of consents required for offshore energy generation which are applicable to marine power projects. Some of these consents are site and project dependent so their relevance will need to be assessed on an individual basis.

The two most common (UK) consent routes that currently apply to any marine power project are:

a) Electricity Act consent route, which includes:

- Consent from the Department of Business, Enterprise and Regulatory Reform (BERR) under the Electricity Act (EA) 1989 – Section 36 for generating station over 1 MW capacity within adjacent waters to England, Wales and Scotland (similar provisions exist for Northern Ireland) and any Renewable Energy Zone (designated by the UK Government outside territorial waters under the Energy Act 2004). Under Section 36 of the Electricity Act, conditions for the associated onshore works are attached to a deemed planning permission under Section 90 of the Town and Country Planning Act 1990 and enforceable by the relevant local planning authority.

  Projects with a generating capacity below 1 MW are exempt from consent under Section 36 of the Electricity Act.

- Licence from the Department for the Environment, Food and Rural Affairs (DEFRA) under the Food and Environment Protection Act (FEPA) 1985 (Part II) – Section 5 for the placement of materials or structures in the sea/tidal waters below mean high water on spring tides (MHWS) within UK territorial waters and the UK continental shelf. The purpose of this licence is to protect the marine habitats and human environment and to minimize interference with other sea users.

- Consent from DEFRA under the Coast Protection Act (CPA) 1949 – Section 34 for the construction of works under the seashore laying below MHWS in waters adjacent to England, Wales and Scotland, but not Northern Ireland.

- Other site and project specific consents for onshore and offshore elements as required.

b) The Transport and Works Act, which requires:

- Consent from BERR under the Transport and Works Act 1992 Order (TWA) for obtaining certain statutory rights for the development of an offshore project. It applies only to projects within the 12-nautical-mile limit around England and Wales, but TWA does not extend to Scotland or Northern Ireland.

- Consent from DEFRA under FEPA (Part II) 1985.
- Other site and project specific consents for onshore and offshore elements as required.

Application requirements are identical for all the consents. The project development process is only required to submit a joint consent application which under current legislative arrangements is coordinated by the Marine Consents and Environment Unit (MCEU) of BERR.

The legislation covering the marine environment and usage in Scotland is managed directly by the Scottish Government, while in Northern Ireland it is the responsibility of the Environment and Heritage Service.

Further information can be found at:

http://www.berr.gov.uk/energy/sources/renewables/planning/wave-tidal/page18874.html

http://www.mfa.gov.uk/environment/energy/energy.htm

http://www.scotland.gov.uk/Topics/Business-Industry/Energy/Energy-Consents/Guidance

In parallel to the consent application, a lease agreement for the use of the selected offshore site should be negotiated with the relevant organization having ownership rights over the seabed.

7.2.2 Requirement for an Environmental Impact Assessment

NOTE The most common requirement for consent application for marine power projects is the preparation of an Environmental Impact Assessment (EIA). This requirement, however, might vary from country to country depending on national legislation.

An EIA consists of a series of systematic and comprehensive studies aimed at assessing the potential environmental impacts of the project and proposed mitigation measures. The aim of the EIA is to inform consultees and the general public about the predicted effects of the project and to assist consenting authorities in the consent determination decision.

The provisions for an EIA are made under the EIA Directive (85/33/EEC as amended by 97/11/EC) and apply to projects that have or are likely to have a significant impact on the environment (as listed in the Directive's Annexes 1 and 2). Marine power projects are not specifically listed in the Directive's annexes. However, national legislation applying the EIA Directive might require the preparation of an EIA.

The project development process should confirm the consent application requirements with the relevant national authorities.

The regulations that implement the EIA Directive in the UK (i.e. the Electricity Works EIA Regulations (Reg 3) and the Harbour Works (Environmental Impact Assessment) Regulations 1999 (SI1999/3445)) require an EIA for all projects that need an application under Section 36 of the Electricity Act and the Coast Protection Act 1949. The same regulations specify the requirement for any application under those consents to be accompanied by an Environmental Statement (ES), which is a document that summarizes the results of the EIA.

In the UK there is by default a legal requirement to prepare an EIA for marine power projects, unless the proposed project is exempt from any of the consents mentioned above. In this case, the project development process should agree with the consenting authority the need for an EIA through a screening opinion, as well as the content and extent of the environmental studies required to gain consent.

7.2.3 Environmental Impact Assessment methodology

Although EIAs have basic requirements and common elements, each EIA should be both project and site specific. The extent and content of the EIA should have been defined in the Environmental Scoping Study as part of feasibility stage of the project development.

An EIA should consider the potential environmental impacts of the project through the installation, operation and decommissioning phases. The EIA should be a systematic and stepped process consisting of the following three stages:

1. Surveys and specialist investigations to determine current baselines for the different environmental receptors to be assessed. Data gathering should be undertaken to the standards stipulated in the scoping opinion.
2. Modelling and specialist studies to the standards specified in the scoping opinion to predict likely environmental impacts, evaluate their relevance, identify mitigation measures, identify uncertainty about the impact assessment, assess residual impacts and identify monitoring requirements to quantify those residual impacts.
3. Inputs from consultees from continued dialogue on scope of surveys and studies, likely impacts and mitigation measures.

NOTE Key environmental receptors that can be affected by a marine power project include (but are not limited to):

- coastal and sedimentary processes;
- marine ecology, including intertidal and benthic ecology, marine mammals, cetaceans, elasmobranches and other sensitive species;
- fish resources and commercial fisheries;
- marine navigation;

In the UK the potential impacts on navigation need to be assessed following the guidelines MGN 275: Proposed UK Offshore Renewable Energy Installations (OREI) - Guidance on Navigational Safety Issues (http://www.mcga.gov.uk/c4mca/mgn275-2.pdf). These guidelines have been developed by the Maritime and Coastguard Agency (MCA), who are responsible for the navigational safety and the search and rescue activities. Although these guidelines were initially developed for the assessment of the navigational impacts of offshore wind farms, they are being reviewed to cover all types of offshore renewable energy installations.

- cultural heritage and archaeology.

Other environmental parameters that should be assessed include:

- ornithology;
- terrestrial ecology;
- landscape and visual impact;
- road traffic and access;
- tourism and recreation;
- water, sediment and soil quality;
- noise and air quality;
- socio-economy.

In addition, the EIA should also take into account:

- Decommissioning – decommissioning plans should be outlined in the EIA.

  NOTE Current legislative provisions in the UK require the complete removal of the project infrastructure as far as is reasonably practicable to avoid any interference with other sea users and eliminate any environmental hazards.

- Cumulative impacts – the EIA should assess the cumulative impacts of the proposed project in relation to other existing and planned offshore projects in the wider area.

7.2.4 Environmental Statement

The results of the EIA should be summarized in an Environmental Statement (ES). If an EIA is required for consent, the ES should be submitted to the consenting authority together with the licence/consent application forms. The ES should demonstrate to the consenting authorities that all reasonable measures have been taken in the project design and method statements to minimize any impact on the environment.

The ES should include (but not be limited to):

- Project description, including its concept, design development, site screening and selected location, infrastructure, construction methodology, details of parties involved, operation and maintenance procedures and decommissioning activities.

- EIA process and methodology.
- Planning and policy framework, which should include information on the planning context of the region, statutory and non-statutory plans and policies at national, regional and local level of relevance to the study area.
- Summary of environmental assessment, covering various environmental parameters in terms of the baseline environmental conditions, impact assessments, mitigation measures and residual impacts.
- Monitoring requirements, providing an environmental programme aimed at gaining a better understanding of any unknown environmental impacts.

A Non-Technical Summary should be prepared for wider public distribution summarizing the key findings from the EIA.

NOTE The EIA process and consent determination is generally a lengthy process. Estimated timescales anticipated by BERR (former DTI) in the UK are illustrated in Table 1. These timescales can be longer depending on the specific project, location and local sensitivities. Despite being a long process, if well planned and managed the EIA will be crucial to understanding the environment of the proposed project, identify in advance any environmental issues and remove any 'showstoppers' to the project development.

The ES should provide as detailed and accurate information about the project as possible (i.e. defined cable route, mooring and foundation requirements, method statements).

NOTE This will assist the statutory consultees to undertake the project specific environmental assessment in a more effective manner, reducing ambiguity, accelerating the consenting process and resulting in more pragmatic consent conditions. This will assist the efficient design of the project and will result in subsequent time and financial savings during installation and operation.

Table 1 — Estimated timescales for consent application in the UK

Phase	Description	Estimated timescales*
Pre-application	Project feasibility; EIA scoping; EIA studies	12–18 months
Application	Completion and submission of consent application	N/A
Post-application consultation	Feedback from consultees and stakeholders, interdepartmental discussions	3 months
Determination	Grant of consent by consenting authority	2–3 months

* Guidance notes – Offshore Windfarm Consent Process, DTI, January 2003

7.2.5 Consent determination

NOTE 1 Once the consent application is submitted the relevant consent authorities will make a decision on granting consent to the proposed marine power project. The consent determination process will vary between countries and will be subject to national legislative requirements.

In the UK the submission of the consent application, accompanied by the ES will be followed by a period of open consultation. The ES should be made available for general review to allow consultees and members of the public to comment on its contents and forward their views to the consenting authority. This will further assist the consenting authority in their final determination decision.

NOTE 2 If consent is granted, it is expected that the relevant consenting authorities will specify consent conditions and monitoring requirements necessary to effectively manage the residual environmental impacts of the project.

In the UK there is a legal requirement for the project development process to comply with the provisions made in the consent conditions. If it fails to do so, the consent authorities reserve the right to withdraw the consent and licence to operate the project. The consenting authorities also reserve the right to impose additional conditions or withdraw the consent if previously undetected or unpredicted adverse impacts are identified through the monitoring programme during installation or operation.

The type and extent of the consent conditions will be project and site specific and will vary from one proposal to another. Typical consent conditions that might apply to marine power projects should include (but are not limited to):

- Preparation of an Active Safety Management System (or equivalent) for installation, operation and decommissioning activities. This should include the requirements for a Safety Zone (or relevant routing measures and extinguished rights of navigation), Navigation Risk Assessment and Emergency Response Plan, which shall be agreed with the relevant statutory navigational consultees and the consenting authorities.
- Details of the final design and method statements for installation, operation, maintenance and decommissioning, as information becomes available if these were not included in the ES at the level of detail required. These shall be agreed with the consenting authorities.
- Decommissioning Plan (or equivalent) which shall be agreed with the consenting authorities, if this has not been included in the ES. The plan should specify the proposed methodology for the decommissioning activities and how the potential environmental impacts will be mitigated.
- Marine Pollution Management Plan (or equivalent) to cover installation, operation, maintenance and decommissioning activities to be agreed by the consenting authorities.

- Provisions to conduct and manage effective liaison with environmental stakeholders, commercial fisheries interests and other affected parties.
- Relevant mitigation plans to manage residual impacts on marine mammals, benthic ecology, ornithology, coastal processes or other environmental receptors, if any significant impacts have been identified during the EIA. These will be agreed by the consenting authorities as appropriate.
- Preparation of an archaeological Written Scheme of Investigation (or equivalent) for the installation, operation, maintenance and decommissioning activities, to be agreed with the relevant Heritage consultee and the consenting authorities.
- Provisions for an Environmental Monitoring Programme (or equivalent) during installation, operation and decommissioning and pre- and post-activity surveys to quantify the residual environmental impacts and scope suitable mitigation measures.

The mitigation measures proposed in the ES and all the provisions made in the consent conditions should be compiled in an Environmental Management Plan (or equivalent). The plan shall be sent to the consenting authorities and will be used to manage any residual environmental risks during installation, operation and decommissioning. It should define the roles and responsibilities towards environmental performance. The Environmental Management Plan should be communicated to all the parties involved in the project implementation that will have a legal obligation to comply with its provisions.

7.3 Project design

The project design should be developed in parallel to the EIA. The findings from the environmental studies should feed back into the design and technical specification as they become available, while any design variation should be assessed against its environmental performance.

The design development of the project should take into account and not compromise any of the key design criteria listed in 6.4.

NOTE Please note that the design needs to be developed in accordance with any relevant legislative requirements, international codes and standards, and any other relevant codes and standards.

The project design should set the basis for the preparation of a suitable procurement strategy and contract strategy. Technical specifications and drawings will assist in the drafting of the contract documents.

7.4 Procurement strategy

The procurement strategy should meet the project objectives and risks.

NOTE The selected strategy will depend on the nature and scope of the project, its complexity, degree of innovation and associated uncertainties, as well as on the type of project development.

According to best practice a suitable procurement strategy should be designed to select suppliers that provide value for money over the expected life of the project, while ensuring supplier competence and quality of service. In order to achieve this, project objectives, priorities and risks should be accurately identified and defined at the detailed design stage.

Some key factors to consider when designing a procurement strategy and a contract form should include:

- elements of the project to be procured;
- current market status and projected market trends;
- rules and procedures for procurement applicable to the project development;
- contract management experience of the project developer;
- pricing strategy;
- risk allocation and management;
- procurement process timescales and integration with the overall project programme.

When defining the procurement strategy for a marine power project special attention should be paid to the allocation of risks between the parties involved and the management of uncertainty.

NOTE This is due to the severe physical environment associated with offshore activities and the volatile nature of the offshore market.

7.5 Health and Safety considerations

Under CDM 2007 the project developer, advised by the CDM Coordinator, needs to ensure that H&S considerations are properly addressed through the detailed design process.

Designers should continue addressing any foreseeable risks through engineering design. Designers will also have a duty to provide clear and concise information (through specification, drawings, etc) about risks highlighted in the design stage and cooperate with other team members in the management and control of risks.

The CDM Coordinator should coordinate and review the aspects of the design, planning and preparation for installation relevant to H&S. The CDM Coordinator, on behalf of the contract, should agree the format and scope of the Construction Phase Plan and H&S File at this stage, which are to be completed during installation.

The H&S Risk Management Plan should be reviewed and updated accordingly as the design work and environmental studies progress.

Particular attention should be given to H&S issues related to offshore operation and working in a marine environment. Hazards to navigation should be clearly identified and effective risk control measures designed.

7.6 Consultation

Extensive consultation should be undertaken during the preparation of the EIA or equivalent studies. The views of the consultees and stakeholders, especially of those more likely to be affected by the project, i.e. commercial fisheries, should be sought in the preparation of the environmental studies and their inputs should be incorporated in the EIA.

Post-consent application consultation is also critical, as the consenting authorities will be asking consultees and the general public for their opinion on the proposed project. The consent application should be widely announced in the local and national press for a sufficient period of time (stipulated by the consenting authorities) and the ES distributed to the statutory consultees. Copies of the ES should also be made available to the general public for their review.

The project developer should address and formally respond to any queries and concerns raised by the consultees during post-consent application consultation and acknowledge any support given to the project.

NOTE It is good practice to organize formal meetings with the statutory consultees to discuss directly any significant issues that might be raised.

Engagement with the local community should continue throughout the EIA and post-consent application. Once the ES is submitted, a public exhibition and presentation to stakeholders should be organized to inform of the results of the EIA.

7.7 Project design and development checklist

- Definition of the consent route applicable to the proposed marine power project.
- Confirmation of the consent application requirements and need for an EIA (or equivalent studies).
- Preparation of the scope and specification for the different studies of the EIA (or equivalent studies) – according to the agreed Environmental Scoping Study.
- Preparation of an ES (if required) to summarize the findings from the EIA studies.
- Preparation of a Decommissioning Plan.
- Extensive consultation with stakeholders and the local community according to the Stakeholders Management Plan.
- Engagement with the local community to inform of the project development.
- Preparation of an Environmental Management Plan including the consent conditions.
- Development of the technical project design in parallel with environmental studies to meet the preset technical criteria and address H&S issues and environmental impacts.

- Development of a procurement strategy that meets the project's objectives.
- Review and update of the cost estimates, project risks and project programme to confirm that they are still applicable and match with project objectives.
- Review and update of the H&S Risk Management Plan.

8 Stage 4 – Project fabrication and installation

8.1 General

The project development process should proceed to the detailed design, project fabrication and installation stage only if the project has been granted consent by the consenting authority and the predicted technical and commercial performance of the project remains feasible and in line with the project objectives.

NOTE A key element of this phase is the implementation of the selected procurement strategy for the elements of the project to be contracted out. Until the appropriate fabrication and installation contract(s) is awarded with a price for the work fixed the implementation of the project cannot be assured. However, the required pre-contract processes can be completed up to contract signature stage. If European public procurement regulations are applicable [OJEU: Official Journal of the European Union] then the process can be lengthy and complex.

Key milestones

Preparation of contract strategy.

Project detailed design/fabrication/installation contract award(s).

Project detailed design and fabrication according to recognized standards and certifications.

Project installation.

Commissioning and operation handover.

8.2 Detailed design

The technical studies to be undertaken to refine the design of the project should include (but not be limited to):

- detailed design of electrical equipment and cables (sub-sea and onshore);
- detailed design of Supervisory Control and Data Acquisition (SCADA), communications and control equipment;

- detailed design of onshore facilities and auxiliary equipment;
- development of generation profiles and quality of generation based on the selected technology in order to inform the grid connection studies;
- specification of safety features, navigational marking and lighting;
- detailed review of the selected marine energy converter technology, including:
  - converter layout and mooring design;
  - converter electrical design and protection;
  - independent verification of energy yield and generation characteristics;
  - H&S and environmental performance.
- Failure Modes, Effects and Criticality Analysis (FMECA) to ensure the integrity and survivability of the project infrastructure and to optimize its reliability, availability and maintainability over the whole life cycle;
- review and refinement of cost estimates and programme;
- update of the design risk register.

The design should be developed in accordance with offshore standards developed by recognized classification societies and to available specific marine renewable energy standards. A Quality Plan should be prepared to specify the required standards for materials and components, procedures for assembly, inspection, test and commissioning, including acceptance criteria, responsibilities and methods for recording results, and defining the quality assurance and quality control procedures in place.

NOTE The detailed specifications and drawings are crucial for the drafting of the contract documents.

8.3 Contract strategy and tender process

In line with the selected procurement strategy the form of contract should meet the objectives and priorities of the project.

An initial pre-qualification stage could be included, if considered necessary, to assess the capability and willingness of potential interested suppliers. The pre-qualification phase should assist to shortlist candidate bidders and should promote competitive tendering.

Suitable conditions of contract should be selected in order to meet the requirements of the different elements to be procured. Published conditions of contract are available for different supply chains and these should be used when possible.

The tender document should define clearly the scope of work, conditions of contract, terms of payment and risk allocation. A tender document should include (but not be limited to):

- project description and requirements;
- technical specification – including quantities, drawings, relevant information and provisions for H&S and environmental performance, material and component standards;

- conditions of contract, including special conditions, financial, insurance and payment terms, guarantees and warranties.

A tender evaluation should be undertaken to assess the suitability of the tenders to meet the project objectives against predefined criteria.

8.4 Project fabrication and installation

8.4.1 Project fabrication

Once the contract(s) is awarded for the different elements of the project, the project developer should ensure that the project infrastructure is manufactured according to the standards, timescales and cost agreed in the contract(s).

Fabrication materials and components, procedures for assembly, inspection, test and commissioning should comply with the provisions made in the Quality Plan based on relevant industry standards. Design requirements to mitigate H&S risks and environmental impacts identified during the detailed design phase of the project should be incorporated. Factory Acceptance Testing should be carried out to ensure that the end products comply with the project specification. Please refer to the *Guidelines for Manufacturing, Assembly and Testing of Marine Energy Conversion Systems*.

NOTE If more than one contract is awarded for the fabrication of the different project infrastructure, coordination between suppliers and manufacturing programmes, as well as system integration, will be critical and will need to be carefully managed.

8.4.2 Project installation

If the installation contract is awarded to a single contractor, it will have responsibility to execute the work according to the approved methodology, specified standards and agreed timescales and cost. A representative should be appointed as part of the project development process to supervise the contractor activities.

Project developers should clarify the extent of insurance during the installation phase covered by plant suppliers, construction and installation contractors.

Installation methodologies shall be prepared in advance of any activity taking place.

NOTE Licence conditions will require their submission for approval in time for any required modifications to be included and accounted for.

Preparation of the licence conditions shall include suitable reference to hazard identification and mitigation.

The implementation of the environmental provisions during installation included in the Environmental Management Plan should be included in the installation contractor's Scope of Works. Environmental monitoring during installation should be undertaken during project development as stipulated in the Environmental Management Plan.

If a number of contractors are involved in the installation of the project infrastructure, during the project development process a Principal Contractor should be appointed (please refer to H&S box below), who will have responsibility for site management and for the installation according to the approved method statements, as well as for the implementation of all the environmental and H&S provisions for the overall installation work.

When programming installation activity it shall be done to ensure any items which could be considered a hazard to safe navigation will be correctly marked before they are deployed.

Once installation work, including commissioning is complete, appropriate testing shall be performed to ensure that the equipment has been installed without damage and is functioning correctly to the specification before it is accepted or ownership is taken by the operating organization.

NOTE This will include the full documentation required to operate and maintain the system. It is likely a certifying authority for insurance will witness and specify the level of test.

8.5 Health and Safety considerations

The project developer, advised by the CDM Coordinator, has the duty to prepare and issue the pre-construction information to the bidders/contractors in good time. This should contain all the relevant project-specific information on H&S that the bidders will require to prepare the tender documents or the appointed contractors to prepare work onsite.

A competent Principal Contractor should be appointed for the installation phase of the project. The Principal Contractor has the duty to coordinate and manage the installation work and to guarantee the health, safety and welfare of the workforce on site, as well as protecting the general public and other sea users during installation. The Principal Contractor is also responsible for preparing the Construction Phase Plan, as part as their H&S Management Plan.

During the tendering process the project development process should ensure that the selected bidder to become Principal Contractor will prepare and issue a H&S Management Plan for the installation work, which should include (but not be limited to):

- H&S policy and objectives;
- organizational structure and H&S responsibilities;
- proof of competency and training;
- H&S management (operating procedures, H&S risk management, Construction Phase Plan, etc);
- proof of H&S communications and cooperation;
- emergency procedures;
- incident reporting and investigation procedures;
- H&S performance monitoring.

Once the installation work starts the Principal Contractor is responsible for executing the installation work according to the provisions made in the H&S Management Plan and to review and update the plan as appropriate.

The Principal Contractor and other parties involved in the installation work should update the H&S File. This will be returned to the project developer at the end of the installation phase in order to record any residual risks to take into account in future work.

Some of the risk control measures specific to offshore operation during installation should include (but not be limited to):

- issue notices to mariners with all the relevant information about offshore work;
- have in place the appropriate marking and lighting of vessels and associated installation equipment used for offshore operation;
- have in place the appropriate routeing measures or safety zones to protect the offshore working area and minimize the risk of collision;
- have in place the appropriate H&S procedures for working in adverse weather conditions;
- have in place an incident reporting procedure and emergency response plan to effectively manage any incidents arising during installation. These emergency response procedures should be registered with the local emergency and rescue services.

For further information on H&S issues please refer to *Guidelines for Health and Safety in the Marine Energy Industry*.

8.6 Consultation

There shall be consultation and liaison during construction to ensure that the works, both onshore and offshore, will cause minimum disruption to residents, other sea users in the area and the local environment.

NOTE Consultation is also important to make sure that the installation works will not be affected by other activities undertaken in the area.

Adequate communication protocols and channels should be in place to inform different stakeholders of the nature, location, start date and planned duration of the different installation tasks.

A liaison officer(s) should be appointed to act as the project representative to facilitate the flow of information between the project and the local community and stakeholders, with special attention to those sectors more likely to be directly affected by the project activities, i.e. commercial fisheries. The liaison officer should also provide support and enable the dialogue between the affected parties in case an incident arises during installation.

Continuous liaison with the local planning authority should be maintained throughout the installation period as needed.

8.7 Project fabrication and installation checklist

- Confirmation of the elements of the project to be outsourced.
- Preparation of a contract strategy and tender process in line with the project's objectives.
- Provision of all the relevant information (including drawings, technical specification) in the tender document to define clearly the scope of the work, conditions of contract, payment conditions and risk allocation.
- Preparation of a detailed design in accordance with the preset technical criteria and following the relevant legislation and recognized standards and certifications.
- Preparation of a Quality Plan for the project design and fabrication specifying materials, components, procedures for assembly, inspection, test and commissioning and including acceptance criteria, responsibilities and methods.
- Factory Acceptance Testing.
- Appropriate H&S mitigation measures to be in place during installation.
- Appointment of a competent Principal Contractor (or equivalent).
- Preparation of a H&S File for the contractor to fill appropriately during installation.
- Ensurance that the installation activities are properly communicated to all affected parties and the general public and measures have been put in place to mitigate any adverse impacts.
- Appointment of a liaison officer as project representative to facilitate dissemination of information and provide support to affected parties should an incident arise during installation.
- Ensurance that an emergency response plan is in place and registered with the local emergency and rescue services.

9 Stage 5 – Operation and maintenance

9.1 General

Following the project infrastructure installation and commissioning, the project development process should ensure cost-effective and safe operation throughout the life of the project until decommissioning. Suitable maintenance should be scheduled to enable efficient performance and minimize environmental impacts. H&S risks should also be planned and implemented.

There should be technical support from the installation contractor, equipment supplier and technology developer at the early stages of operation in order to confirm the integrity and resolve any initial potential operational anomalies.

Operating procedures throughout the life of the project should be prepared in advance of commissioning.

Key milestones

- Safe and reliable operation of the marine power project.
- Appointment and management of support services.

9.2 Operation and maintenance

NOTE The structure of the operating organization and selected operating strategy will depend on the project objectives and priorities and the type of project development.

In order to monitor the operation of the project, acceptable performance parameters should be set over the operating life of the project.

An Operation and Management Plan (O&MP) should be prepared and reviewed over the life of the project in order to make provisions for:

- management structure, identifying roles and responsibilities of involved parties;
- emergency procedures, including an Active Safety Management Plan (or equivalent) and Emergency Response Plan (or equivalent);
- specification of subcontracting support services and their associated contractual arrangements;
- logistics and associated contingency;
- review, monitoring and auditing of technical performance;
- corrective measures (if project underperforms);
- grid disconnection during maintenance;
- planning and implementation of preventive maintenance;
- management of unplanned maintenance;
- availability of spare components;
- communication protocols between the parties involved in the operation and maintenance of the project;
- review, monitoring and auditing of environmental performance over the life of the project to ensure compliance with consent conditions;
- provision of information on environmental performance to stakeholders and consenting authority;
- application requirements for the renewal of FEPA licence over the life of the project;

- O&M cost estimates over the life of the project;
- generation revenue estimates over the life of the project;
- mandatory requirements (as applicable), e.g. COWIE reporting
- adequate allowance for insurance during the operating phase.

9.3 Health and Safety considerations

Normal operation, maintenance and repair activities are covered by CDM 2007. However, due to the anticipated short duration of such activities they might not qualify for notification under Part 3 of CDM. It might not be necessary therefore to notify the Health and Safety Executive (HSE).

Other regulations that apply include the Management of Health and Safety at Work Regulations and Electricity at Work Regulations.

For the operation and maintenance activities a H&S Management Plan should be prepared and implemented to ensure that hazards are identified and their associated risks mitigated effectively and should include:

- H&S policy and objectives;
- organizational structure and H&S responsibilities;
- proof of competency and training;
- H&S management (method statements, operating procedures, H&S risk management – to be reviewed and updated accordingly, etc);
- proof of H&S communications and cooperation;
- emergency procedures, including an Active Safety Management Plan and Emergency Response Plan;
- incident reporting and investigation procedures;
- H&S performance monitoring.

Special consideration should be given to the emergency procedures during operation and maintenance as this has an impact on design. The Active Safety Management Plan needs to be designed through the design stage and developed in detail during installation.

9.4 Consultation

Continuous consultation and liaison should be maintained during the operating life of the project to ensure that the project activities, both planned and unplanned, will cause minimum disruption to other sea users in the area and the local environment and community. Consultation is also important to make sure that the operation of the project will not be affected by other activities undertaken in the area.

Adequate communication protocols and channels should be in place to inform different stakeholders of the nature, location, start date and planned duration of any planned maintenance programme. For unplanned maintenance and emergency events, effective emergency response procedures should be put in place. These procedures should have been previously discussed and agreed with the emergency and rescue services.

NOTE A liaison officer can be appointed by the project developer to act as the project representative in order to facilitate the flow of information between the project and the local community and stakeholders, with special attention to those sectors more likely to be directly affected by the project activities, e.g. commercial fisheries.

The liaison officer should also provide support and enable the dialogue between the affected parties in case an incident arises during operation and maintenance or concerns are raised by the public.

Any updated information on key environmental impacts resulting from the continuous monitoring programme should be disseminated among the consenting authority, stakeholders and other interested parties.

9.5 Operation and maintenance checklist

- Setting of acceptable performance parameters to monitor the performance of the project over its life cycle.
- Preparation and operation of a comprehensive O&M Plan.
- Preparation and operation of a H&S Management Plan.
- Appointment of a liaison officer for the operation and maintenance activities.

10 Stage 6 – Decommissioning

10.1 General

Once the project reaches the end of its operating life, it shall be decommissioned and the associated infrastructure removed according to mandatory and legislative requirements.

Key milestones

Decommissioning of the project infrastructure in a safe and environmentally sustainable manner at the end of the project's life.

10.2 Decommissioning

A Decommissioning Plan prepared as part of the consent conditions and revised over the life of the project should contain the provisions for the effective and safe removal of the project infrastructure, associated reinstatement work and disposal of the removed equipment.

A Decommissioning Fund or some other provision should be set aside over the life of the project to ensure that decommissioning and other associated reinstatement costs will be covered even in the event of insolvency.

The potential environmental impacts of the decommissioning activities need to be identified and properly mitigated. A number of site surveys shall be performed pre- and post-decommissioning to provide evidence of removal to an acceptable standard.

A safe and appropriate means of recovery, temporary storage and disposal of the recovered equipment shall be in place before the work commences. The requirements and procedures for the decommissioning work should be similar in depth of detail to those for project installation.

NOTE They are likely to include type and number of vessels, methodologies and timing.

Submission for approval before work commences shall be obtained.

In the UK current legislation requires all of the infrastructure to be completely removed and the site to be reinstated to its original condition as far as reasonably practical in terms of environmental impacts.

A procurement strategy and adequate contract form should be designed for the elements of the decommissioning work to be outsourced. Special attention should be paid to the uncertainty and risks associated with the severe working conditions of offshore projects and the logistical constraints that might result from the market volatility.

10.3 Health and Safety considerations

The same H&S requirements as during installation work shall apply.

10.4 Consultation

A similar consultation approach as during installation works applies.

Consultation with consenting authority, stakeholders and other interested parties is required to discuss and agree the decommissioning activities methodology in order to ensure that any potential environmental impacts are properly mitigated.

10.5 Decommissioning checklist

- Preparation of a Decommissioning Plan in consultation with the consenting authorities.
- Review and update the Decommissioning Plan over the project's life.
- Allocation of a Decommissioning Fund to ensure that decommissioning costs will be covered appropriately.
- Preparation of a suitable procurement strategy for the elements of the decommissioning work to be outsourced.

Annex A (Informative) List of key consultees

Abbreviation	Organization	Department / Officer
CEFAS	Centre for Environment, Fisheries and Aquaculture Science	Regulatory Assessments Team
FPO	Fish Producers Organizations	(Local and National)
MFA	Marine and Fisheries Agency	Marine Environment Team
		Offshore Renewable Consents Officer
BERR	BERR – Department for Business Enterprise and Regulatory Reform	Development Consents and Planning Reform
DC	District Council	Development Control
		Cornwall Sea Fisheries Committee
		Environmental Health Officer
		Historic Environmental Service
EA	Environment Agency	Planning Liaison
		Environmental Protection
		Waste Licensing
		Fisheries Recreation & Biodiversity
EH	English Heritage	(Or local equivalent)
RSPB	Royal Society for the Protection of Birds	
WWF	World Wildlife Fund	
IHO	International Hydrographic Organization	
JNCC	Joint Nature Conservation Committee	Renewable Energy Advisor
MCA	Maritime and Coastguard Agency	
NE	Natural England	Maritime Conservation Officer
TH	Trinity House	Director of Navigation Requirements
CoS	Chamber of Shipping	Nautical Consultant
RYA	Royal Yachting Association	Planning and Environmental Advisor
MOD	Ministry of Defence at RAF St Mawgan	Commanding Officer of nearby facilities
CE	Crown Estates	Head of Marine Estate
DOT	Department for Transport	
WPD	Western Power Distribution	
	National Grid	

Annex B (Informative) Guidance and useful legislation

- Consent – Department of Business, Enterprise and Regularotory Reform, BERR
  - Electricity Act (EA) 1989, Section 36
- Licence – Department for the Environment, Food and Rural Affairs, DEFRA
  - Food and Environment protection Act (FEPA) 1985 (part II), Section 5
- Consent – Department for the Environment, Food and Rural Affairs, DEFRA
  - Coast Protection Act (CPA) 1949, Section 34
- Crown Estates – Lease Agreement
- Environmental Impact Assessment, EIA
  - EIA Directive 85/33/ECC as amended by 97/11/EC

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Guidelines for Design Basis of Marine Energy Conversion Systems, EMEC, 2009

Guidelines for Health and Safety in the Marine Energy Industry, British Wind Energy Association, 2008

Guidelines for Manufacturing, Assembly and Testing of Marine Energy Conversion Systems, EMEC, 2009

Guidelines for Marine Energy Converter Certification Schemes, EMEC, 2009

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SI 1992 No. 2051, Management of Health and Safety at Work Regulations

SI 1994 No. 3140, Construction Design and Management (CDM) Regulations 2007

SI 1999 No. 3445, Harbour Works (Environmental Impact Assessment) Regulations 1999

SI 2004 No. 1633, The Environmental Assessment of Plans and Programmes Regulations 2004

Scottish SI 2004, No. 258, The Environmental Assessment of Plans and Programmes (Scotland) Regulations 2004

SR 2004 No. 280, The Environmental Assessment of Plans and Programmes Regulations (Northern Ireland) 2004

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