



SCOTTISH EXECUTIVE

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E1 Introduction

The primary question which has been addressed in this SEA is ***can wave and tidal stream energy contribute towards helping the Scottish Executive achieve its target for producing 40% of its electricity from renewable sources by 2020 without significant impacts on the environment, and if so, how can this best be achieved?***

As a guide, the SEA has used the Marine Energy Group (MEG) estimate of 1300MW of marine renewable energy generating capacity in Scottish Waters by 2020. The results of the SEA show that it may be possible to meet MEG's proposed target of 1,300MW of marine renewable energy generating capacity with, **generally**, minor effects on the environment, although there are notable gaps in our knowledge. There are important exceptions to this general conclusion and the likelihood of more significant effects occurring is dependent on the particular characteristics of the projects being developed, in combination with the locations where they are being deployed (as summarised in Section C: Level 1 Assessment and Section D: Energy Resource Assessment of this report).

Consequently, a key issue for the future development of marine renewable energy is how to promote wave and tidal stream power in a manner which minimises environmental effects. Indeed, informing project-level decision-making and the future development of guidance for marine developers are key objectives of this SEA (see Section A, Chapter A1: Introduction).

This section of the Environmental Report identifies the key issues that require consideration in the development of the Scottish Executive's strategy to support the development of marine energy and the planning of individual projects.

E2 Informing the Future Development of Marine Renewable Energy

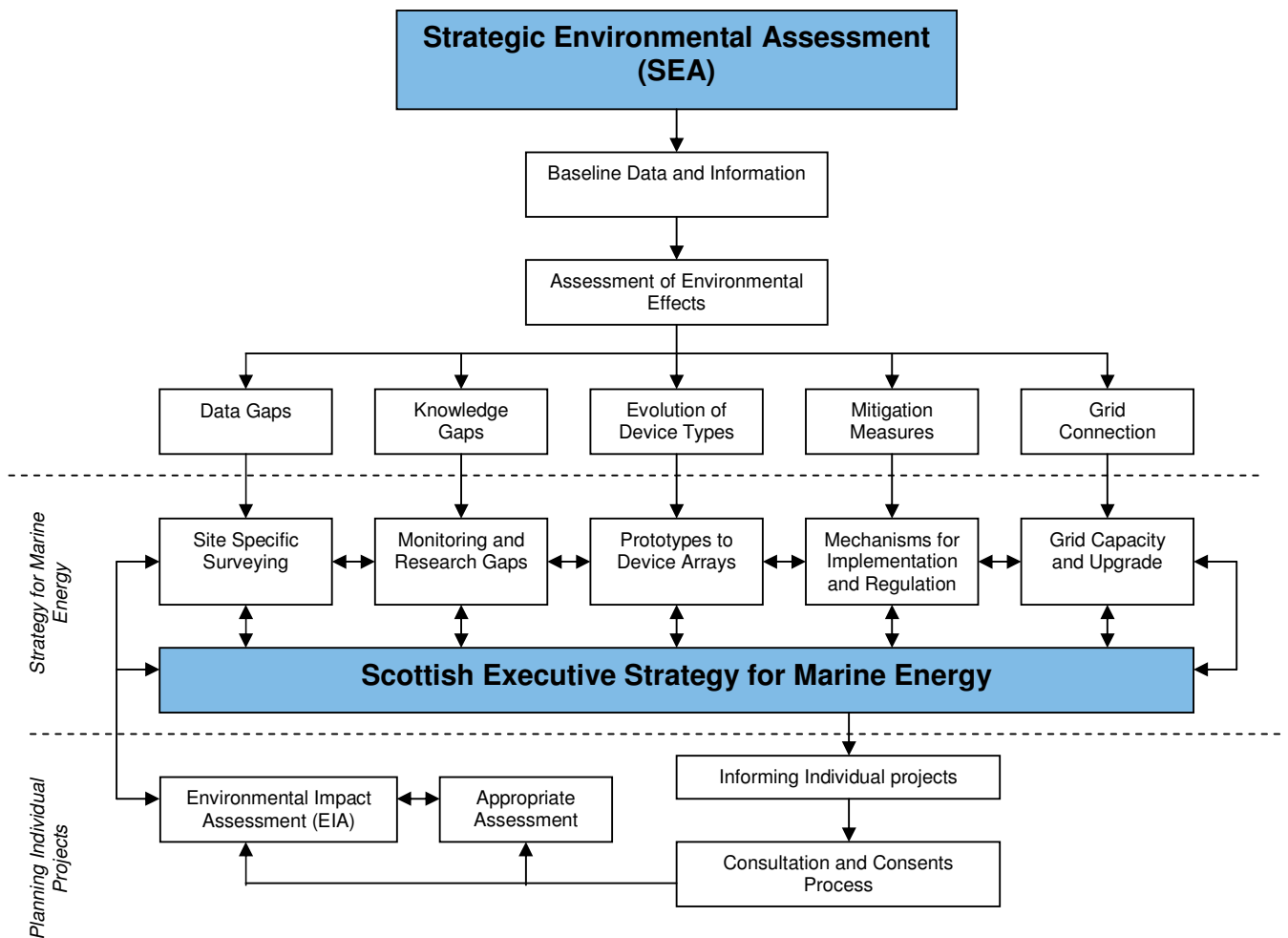
E2.1 Introduction

The SEA identifies a number of inter-related issues which influence the future development of marine renewable energy and the environmental impacts which result. These issues will require consideration in the development of the Scottish Executive's strategy to support marine energy to ensure that it is focused on achieving maximum energy generation with minimal environmental effects. They should also be considered by all those concerned with the planning and development of individual marine energy projects.

E2.2 Key Issues Influencing the Future Development of Marine Renewable Energy

As identified in the introduction (Section A, Chapter A1), the information obtained from the SEA will be used by the Scottish Executive to inform development of its strategy to support marine energy. It has been possible to identify from this SEA a number of key issues that will require consideration in the development of the Executive's strategy. Figure E2.1 below illustrates the key issues identified from the SEA and how they feed into that strategy:

Figure E2.1: Key Issues Influencing the Future Development of Marine Renewable Energy



The following is a discussion of the key elements identified above. It is important to note that the issues will also influence site selection at a project level, and therefore also need to be taken into account by developers and decision makers.

E2.3 Key Elements in Developing a Strategy to Support Marine Energy

E2.3.1 Data Gaps/Site Specific Surveys

As part of the SEA a comprehensive review was undertaken of available baseline data. Additional, detailed desk based studies were also commissioned. This information provides a reference source for future project specific studies and research. It is recognised that the assessment of effects was limited for some of the SEA topics due to gaps in the baseline data. Only very small parts of the study area have actually been surveyed in detail, and most of these are in coastal areas which are much more accessible. Information relating to offshore areas is very limited.

The Environmental Report identifies where baseline data gaps affected the overall confidence of the assessment of effect significance. The data gaps also affected the accuracy by which the SEA was able to use the information obtained from the Level 1 Assessment (SEA topics) to assess the energy resource that could be developed within the study area with minimal environmental effects. This was mainly due to most of the data gaps being associated with the distribution and abundance of key receptors e.g. the location hotspots for foraging and loafing for seabirds, or the location of key benthic habitats.

However, the SEA has identified a number of opportunities for filling these baseline data gaps through site specific surveys or area based surveys, depending upon the level of detail required and the area of interest. Details of these sites specific surveys are provided in Chapter E3.

Most of the site specific surveys identified are likely to be required to inform individual projects and to satisfy consenting requirements and procedures e.g. Environmental Impact Assessment and Appropriate Assessment. The information obtained from the project level site specific surveys can be fed back into the SEA and the strategy to support marine renewables to improve the accuracy and confidence of assessment.

E2.3.2 Knowledge Gaps/Monitoring

The SEA also identified a number of gaps in the understanding of how marine energy devices and arrays interact with the marine environment and how key receptors respond to the devices and arrays. The main reasons for these knowledge gaps include:

- Marine energy (wave and tidal) is a relatively 'new' industry
- To date only a limited number of devices have been deployed in the water
- Currently there are a wide range of different device types and characteristics, with designs evolving all the time. This effects the range of interactions that may occur with the marine environment
- To date, due to the industry being relatively new, there has been limited opportunities for the monitoring of marine devices and key receptor responses to these devices

These knowledge gaps are recognised in the Environmental Report and confidence levels have been assigned to the assessment of effect significance. For some SEA topics it was not possible to determine effect significance, resulting in unknown effects. These gaps have been noted as being of particularly importance where the responses of key receptors to devices or device characteristics are unknown. For example, limitations in the understanding of how marine mammals and seabirds respond to the potential risk of collision with devices meant that these effects were assessed as being of 'unknown' significance. Also, due to a general lack of monitoring, and the currently large variations in device types, there are limitations in the understanding of how much noise would be generated from operational devices. This meant that the potential significance of the effects of operational noise on key receptors also had to be assessed as unknown.

The SEA has identified a number of opportunities for filling these knowledge gaps through the monitoring of individual projects and research studies. These opportunities are presented in the monitoring framework set out in Chapter E4.

E2.3.3 Device Characteristics

The method used in this SEA involved identifying:

- The device and project characteristics which result in environmental effects
- The sensitivity of receptors to these characteristics,
- The potential environmental effects of device characteristics and at what phase in the development they would occur

Chapters C1 to C21 provide the results of the assessment and identify the characteristics of devices which are likely to have the greatest environmental effects. This information should be taken into account when considering device types and designs. In some instances, it may be possible to alter the characteristics of a device, or to select a particular type of device, to avoid or reduce impacts.

E2.3.4 Mitigation Measures

The SEA initially assessed the potential effects that may occur without mitigation and then identified measures that could be implemented to reduce the potential effects. In terms of mitigation, the aim is to inform all those involved in the planning and consenting of marine energy projects by suggesting where mitigation could be used to prevent or reduce significant effects. The measures also inform the Scottish Executive's strategy to support marine energy on how to regulate or promote appropriate implementation of mitigation at the project level.

It is important to note that whilst a range of mitigation measures have been recommended as part of the assessment of effects, at this strategic level the implementation of these measures cannot be guaranteed. If the mitigation measures identified in the assessment chapters (C1 to C21) are not implemented at the project level then it is likely that for some SEA topics the effects of marine energy developments could potentially be of moderate to major significance. This is of particular importance where the predicted effects are unknown.

Whilst it cannot be guaranteed that the mitigation measures identified as part of the Level 1 Assessment will be implemented, the results of the assessment do give an indication of what could be achieved if appropriate mitigation is used. The main objective of this SEA was to identify whether it is possible for marine energy to contribute towards the Scottish Executive's target for producing 40% electricity for renewable sources by 2020 with minimal environmental effects. The results from the Level 1 Assessment and resource assessment have indicated that this could be possible, providing that the mitigation measures identified in the SEA, and other project specific mitigation measures, are implemented appropriately.

E2.3.5 Connecting to the Electricity Grid

Much of the available wave and tidal energy is located in the remote northern and western isles. The report *Harnessing Scotland's Marine Energy Potential* (MEG, 2004) identified the capacity of the Scottish electricity grid as a significant constraint to the future development of marine renewables. In fact, the current transmission capacity of the electricity grid in Scotland acts as a significant constraint upon the development of all forms of renewables. In the absence of investment in, and building of, new capacity, the development of marine renewables may not progress significantly beyond the demonstration stage.

Although grid capacity and connections are reserved matters, the Scottish Executive is fully involved in discussions between stakeholders from the renewables sector and other relevant players, such as the grid owners and operators, industry regulator Ofgem, and the Department for Trade and Industry (DTI).

The potential environmental effects associated with connecting marine devices into the onshore network are considered by the SEA (see Section C, Chapter C20: Onshore Grid Connection). In addition, there is the potential for developments to cluster around locations where grid connections are available and this could lead to cumulative impacts.

E2.4 Key Issues for Consideration in Planning Individual Projects

E2.4.1 Site Location

The choice of site is likely to be the most important factor in determining the environmental effects of a project. It was not the aim of this SEA to identify specific locations considered favourable or unfavourable for development primarily because:

- There are limitations with available baseline environmental information – the suitability of any precise location depends on site specific issues which can only be established by more detailed baseline studies and surveys. The data collected for the SEA is suitable for the assessment of effects at a strategic level but it is not sufficiently detailed to make precise decisions on where development should be located.
- There is a wide variety of device types – environmental effects will vary depending device and project specific characteristics. The suitability of locations will therefore also vary and giving specific information on locations would be misleading. The results of an assessment setting out locations based on device types could also be interpreted as favouring some device types over others and this was not the intention of the SEA.
- There are uncertainties with the significance of environmental effects – because of uncertainties over the significance of certain environmental effects (e.g. collision risk to seals, birds, fish etc) it is not possible to promote or exclude areas until future evidence is available.
- Information could become outdated – over the study period to 2020 new information on environmental effects (as a result of monitoring) will become available. In addition, technologies are likely to change. As the SEA has been undertaken using available information, any advice given in 2007 on specific locations may become outdated overtime.

However, the study does assist in the site selection process in a number of ways, as summarised in Table E2.1 below:

Table E2.1: Informing Site Selection

Key factors affecting site selection	The Environmental Report provides the following to assist with site selection:	Where information can be found
Baseline Information and data collection	The Environmental Report provides baseline information and data sources which can be used as a starting point for the desk studies which will inform the site selection process. For information on site surveys see the following chapter (Chapter E3)	Chapters C1 to C21. Each chapter contains a summary of baseline information, data sources and references
Environmental effects	The Environmental Report provides a comprehensive review of the key environmental issues which need to be considered both generally and in each of the Development Areas. The potential environmental effects are described for a wide range of device characteristics. Developers should consider these potential effects in relation to their device and project characteristics in making locational decisions.	This is the purpose of the Level 1 Assessment Chapters C1 to C21. The results for each of the development areas are presented in Tables D2.4 to D2.11.
Recommendations on areas to avoid	The Environmental Report identifies areas which, in most circumstances, should be avoided. These are referred to as physical constraints and include shellfish farms, fin fish farms, protected wrecks, other wrecks, cables, pipelines, munitions contamination sites, MOD firing ranges, MOD danger areas, MOD byelaw areas, disposal sites and shipping routes.	See Chapter D2 to D3 and Figures D3.1 to D3.8 for information on physical constraints
Mitigation measures	The Environmental Report identifies measures that should be considered to mitigate potential environmental effects. The residual significance of effects of developments will depend on the successful implementation of mitigation measures.	Section C1 to C21 contain a description of appropriate mitigation measures. Mitigation measures are discussed in more detail in the following chapters (Chapter E5)

E2.4.2 Current Licensing and Consents Process and Environmental Considerations

The SEA does not specifically address the process of gaining consent for individual projects but it does identify important environmental issues which are likely to influence the success of an application. The current licensing and consents process for marine energy developments in Scottish Waters is outlined below.

The deployment of marine energy developments within territorial waters requires two forms of consent/licence:

- Development consent/licence
- Site lease consent/licence

For any marine energy installation greater than 1MW, a development consent/licence must be obtained from the Scottish Executive under Section 36 of the Electricity Act 1989. Licences must also be obtained, for all marine developments, in respect of their impact/effect on the sea bed, under Section 5 of the Food and Environment Protection Act (FEPA) 1985 and Section 34 of the Coast Protection Act (CPA) 1949. In Scotland, both FEPA and CPA licences are determined by, and obtained from, the Scottish Executive.

In Scotland consent for onshore works must be obtained under Section 57 of the Town and Country Planning (Scotland) Act 1997 either from the Scottish Executive, via deemed planning permission under Section 36 of the Electricity Act 1989, or from the relevant Local Planning Authority (LPA). Maritime safety matters are not devolved, and licensing authorities will consult with the national maritime safety administration – the Maritime and Coastguard Agency (MCA), for the appropriate types of assessment.

The environmental effects of all proposals for consent under Section 36 of the Electricity Act must be assessed under the Electricity Works (Environmental Impact Assessment) Regulations 2000, and the required and agreed level of information presented in the form of an Environmental Statement (ES). LPAs can also request an ES for non-Section 36 proposals.

When considering Section 36 consent applications, the Scottish Executive must also take into consideration the effects of a marine development on European Sites of Nature Conservation Importance (Natura 2000 Sites) in territorial waters under the Conservation (Natural Habitats, &c.) Regulations 1994. Where a marine energy development could potentially have significant effects on the conservation objectives of Natura 2000 sites, an Appropriate Assessment may be required.

E3 Site Specific Surveys

E3.1 Site Specific Surveys and Studies

Whether or not the effects described in this SEA will occur will largely depend on the environment in which development is proposed in combination with the device/array characteristics. There are a number of limitations with the baseline environmental information available for the SEA and developers will still need to undertake project-specific surveys and studies to accurately determine the environmental characteristics of their proposed site. Surveys will be required to obtain consent to construct and operate (and in time decommission) a project. The specific requirements will vary from project to project and should be defined in consultation with environmental regulators and responsible consenting authorities. Table E3.1 below summarises the types of survey that may be required.

Table E3.1: Summary of Site Specific Surveys That May be required at the Project Level

Topic (Chapter Reference)	Type of survey that may be required
Chapter C1: Bathymetry	<ul style="list-style-type: none"> Bathymetric survey will be routinely carried out as part of site investigation for individual projects.
Chapter C2: Geology and Sediment Processes	<ul style="list-style-type: none"> Geophysical and geotechnical surveys will be routinely carried out to establish the suitability of the seabed for the proposed seabed attachment method. Surveys to establish the nature of the seabed sediment to inform the assessment of impacts from sediment resuspension, sediment transport and disturbance of any contaminated sediments if present. Surveys at project level to identify whether any geologically important features are present in development area/could be affected by development.
Chapter C3: Marine and Coastal Processes	<ul style="list-style-type: none"> Refer to Chapter C2
Chapter C4: Sediment Contamination and Water Quality	<ul style="list-style-type: none"> Surveys to determine location and composition of contamination may be required if developments are proposed within close proximity to contaminated sites.
Chapter C5: Protected Sites and Species	<ul style="list-style-type: none"> Ecological surveys are likely to be required for any development within, or which may affect the features of, a protected site to help assess environmental effects and aid site selection and configuration. Surveys to determine distribution and abundance of protected species may also be required in certain locations. For other site specific surveys relating to protected sites and species see references to Chapters C6, C7, C8 and C9.
Chapter C6: Benthic and Intertidal Ecology	<ul style="list-style-type: none"> Site specific benthic surveys to determine whether sensitive and/or important benthic habitats and species are present in the proposed development area or may be affected by a marine development.
Chapter C7: Fish and Shellfish	<ul style="list-style-type: none"> The need for site specific surveys to determine whether key fish and shellfish species are present in the proposed development area or could be affected by the development will need to be determined in consultation with regulators. Should development be proposed within a potential herring spawning area, site specific survey work is likely to be required to determine the local distribution of herring spawning activities.
Chapter C8: Marine Birds	<ul style="list-style-type: none"> The need for site specific surveys to determine the ecological importance of a development site for bird species will need to be determined in consultation with regulators.
Chapter C9: Marine Mammals	<ul style="list-style-type: none"> The need for site specific surveying to identify whether populations of marine mammals are present in the proposed development area or could be affected by the development due to its location will need to be determined in consultation with the regulators

Topic (Chapter Reference)	Type of survey that may be required
Chapter C10: Commercial Fisheries and Mariculture	<ul style="list-style-type: none"> ▪ Consultation with the fishing industry will be required to establish spatial extent and location of fishing grounds and the sensitivity of the fishing activities to development. ▪ For receptor focused surveying, refer to Chapters C6 and C7.
Chapter C11: Marine and Coastal Historic Environment Chapter C11: Marine and coastal historic environment	<ul style="list-style-type: none"> ▪ In certain locations archaeological analysis of the site geophysical and geotechnical survey data (described for Section C2) may be required to determine the presence of archaeological features such as wrecks, submarine pre-historic remains, unidentified important coastal archaeological remains and submerged historic landscapes. Archaeological assessment is more likely to be required in areas identified as having high archaeological and historical interest e.g. presence of Scheduled Monuments and sites and features recorded on the National Monuments Record for Scotland (NMRS).
Chapter C12: Cables and Pipelines	<ul style="list-style-type: none"> ▪ The site specific geophysical surveys (described for Section C2) will need to determine the precise locations of any cables or pipelines in close proximity (i.e. within 500 m) to an array or its cables.
Chapter C13: Military Exercise Areas	<ul style="list-style-type: none"> ▪ No survey has been recommended. ▪ Consultation with the Ministry of Defence will be required at the project level to determine whether there are any military exercise areas/areas of potential conflict within the proposed development area or along cable routes.
Chapter C14: Disposal Areas	<ul style="list-style-type: none"> ▪ No survey has been recommended. ▪ Consultation with the Fisheries Research Service will be required at the project level to determine whether there are any disposal areas within the proposed development area or along cable routes.
Chapter C15: Shipping and Navigation	<ul style="list-style-type: none"> ▪ Detailed review of shipping activities and consultation with local port and harbour authorities, the MCA and the Northern Lighthouse board be conducted as part of site selection for any project development. ▪ Site specific detailed surveys should be conducted in accordance with DTI guidance and MGN 275 (MCA) in order to determine risks and impacts. ▪ Detailed surveying has not yet been conducted with regard to the effects of marine renewable energy devices on journey times, distances, trade and supplies. These factors are highly dependant on location. Site specific surveying of local routes and the vessels using them is recommended to assign greater confidence to the potential effect significance of these impacts.
Chapter C16: Recreation and Tourism	<ul style="list-style-type: none"> ▪ It is recommended that assessment be conducted, upon identification of sites, in order to increase confidence in data regarding identification of relationships between particular types of tourism/tourist attractions and specific sites. This is particularly important in increasing understanding of the effects on unregulated activities such as wildlife watching, the spatial distribution of which is poorly documented due to the nature of the industry. ▪ Further assessment of recreational shipping movements is recommended at project level to raise confidence in the assessment of potential effects and account for localised movements and variations. Refer to the proposed monitoring for C15. ▪ Repeated surveying of identified potential areas should be conducted in order to account for seasonal and spatial variations in tourism and recreation activities. ▪ Incorporation into broader tourism surveys of surveying regarding developments, in the longer term, may offer increased insight into their effects on public opinion of specific areas.
Chapter C17: Noise	<ul style="list-style-type: none"> ▪ As part of project specific investigations detailed consideration is likely to be required of noise impacts. This could be expected to involve investigation and modelling of noise levels (emitted from devices and ambient) and propagation of sound during installation and device specific operation noise measurements and analysis.
Chapter C18: Electric and Magnetic Fields (EMF)	<ul style="list-style-type: none"> ▪ No project surveying as been recommended at this time. The COWRIE programme (www.offshorewind.co.uk) is currently undertaking studies into EMF and it is expected that this information will also inform the marine renewable energy industry.
Chapter C19: Seascape	<ul style="list-style-type: none"> ▪ Due to variations in device type and design it is recommended that detailed Seascape Assessments are undertaken at the project level to determine effect significance
Chapter C20: Connections to the Grid	<ul style="list-style-type: none"> ▪ Routeing studies should be carried out at the project level to assess potential onshore effects of connecting devices into the national grid network. These routeing studies should incorporate 'Holford Rules'. A variety of surveys will be required including landscape and visual and ecology.
Chapter C21: Decommissioning	<ul style="list-style-type: none"> ▪ No surveying has been recommended. See Table E3.1 for recommended monitoring.

E4 Monitoring Framework

E4.1 Introduction

It is a requirement of the SEA legislation that the responsible authority (in this case the Scottish Executive) monitors the significant effects of the implementation of the plan, programme or strategy for which it has carried out the assessment. Section 19(2) of the Act states that the responsible authority ‘shall do so in a manner...which enables the authority to (a) identify any unforeseen adverse effects at an early stage; and (b) undertake appropriate remedial action’. This chapter of the SEA sets out the proposed monitoring framework required as part of the overall SEA. Following consultation (see Chapter E5 below), the monitoring framework will be reviewed and finalised in the post-adoption SEA Statement.

E4.2 Approach to the Monitoring Framework

There are two types of monitoring that have been identified for this SEA:

- Monitoring the plan, strategy or programme that was subject to the SEA
- Project level monitoring and research gaps

E4.2.1 *Monitoring the Plan, Programme or Strategy that was Subject to the SEA*

The main focus of a monitoring framework is to set out measures that could be used by the Scottish Executive to monitor whether implementation of the plan, programme or strategy for which the SEA was undertaken has had the predicted effects on the environment.

As discussed in the introduction to this Environmental Report, Section A, Chapter A1, this SEA has been undertaken to identify, from the outset, the potential environmental implications that require consideration by the Scottish Executive in developing its strategy for support of marine energy.

In assisting the Scottish Executive in developing its future strategy to support marine energy, the SEA focused on addressing the question ‘**can wave and tidal stream energy contribute towards helping the Scottish Executive achieve its target for producing 40% of its electricity from renewable sources by 2020 without significant impacts on the environment, and if so, how can this best be achieved?**’

In answering this question the SEA has identified a number potential environmental effects associated with marine energy developments. These effects were identified for both individual marine energy devices and device arrays as well as the potential cumulative effects of developing a number of arrays within the SEA study area as part of the growth of the marine energy industry.

In terms of monitoring the implementation of a strategy of support for marine energy, the key focus is on the effects that the deployment of a number of marine energy devices would have on the marine environment. This is best interpreted as monitoring the ‘cumulative effects’ of marine energy developments.

However, it is important to note that in terms of this SEA the assessment of ‘cumulative’ effects was informed by the results of the assessment of individual device arrays. A key factor arising from the assessment of the individual device arrays was the levels of uncertainty associated with the assessment of how devices interact with the marine environment and certain receptors. This was primarily due to gaps in the understanding of how devices interact with the marine environmental and key receptors and gaps in the baseline data, particularly relating to the distribution, abundance and behavioural responses of key receptors that may be affected by marine energy developments.

These levels of uncertainty were scaled up in the assessment of cumulative effects, the result being that the confidence in the assessment of cumulative effects was much lower. This is a key point to recognise as it influences the focus of the monitoring framework set out in this Chapter.

The SEA has identified that in order to accurately determine the cumulative environmental effects of marine energy development, and therefore monitor them, there needs to be a greater understanding of the environmental effects that could occur at the project level. As identified previously there are two key areas where increased understanding would improve the accuracy and confidence of the assessment of effects. These include filling the gaps in the baseline data and improving our understanding of how marine devices interact with the environment. Some of the gaps in the baseline data can be filled through the site surveys as discussed in Chapter E3. Gaps in our understanding of how marine energy developments interact with the environment, and the behavioural and population responses of key receptors can be filled through the monitoring of specific projects and research studies. These are discussed below.

E4.2.2 Project Level Monitoring and Research Gaps

There is a need to undertake project level monitoring and specific research studies into key aspects of the marine environment to improve understanding of how marine developments interact with the environment. The benefits of this are three-fold:

Firstly, due to limitations in our understanding of how marine developments interact with the environment and gaps in the baseline data, a precautionary approach was taken towards the assessment of effects. The monitoring of individual devices and arrays and filling research gaps will help to increase understanding of potential effects. This will reduce the levels of uncertainty surrounding the assessment of the potential effects, which could potentially result in an increase the available energy resource area as the monitoring may identify that some of the potential effects identified may not be as significant as predicted or may not actually occur.

Secondly the monitoring of projects will help to identify any unforeseen effects as they arise. This is a significant point in that if monitoring is only carried out at the strategic level these unforeseen project specific effects may go unnoticed or may not be dealt with appropriately. Consequently these could lead to significant cumulative effects, which could reflect negatively on the future strategy for marine energy. Also identifying unforeseen effects at the project level means that mechanisms can be put in place to modify or review the overall strategy to ensure that these effects do not occur elsewhere e.g. by preventing development in similar locations or where the affected receptors are present.

Thirdly, and directly linked to the above, removing uncertainties will assist developers, consenting authorities and regulators in the planning of wave and tidal projects.

E4.2.3 Feedback Into the SEA Process

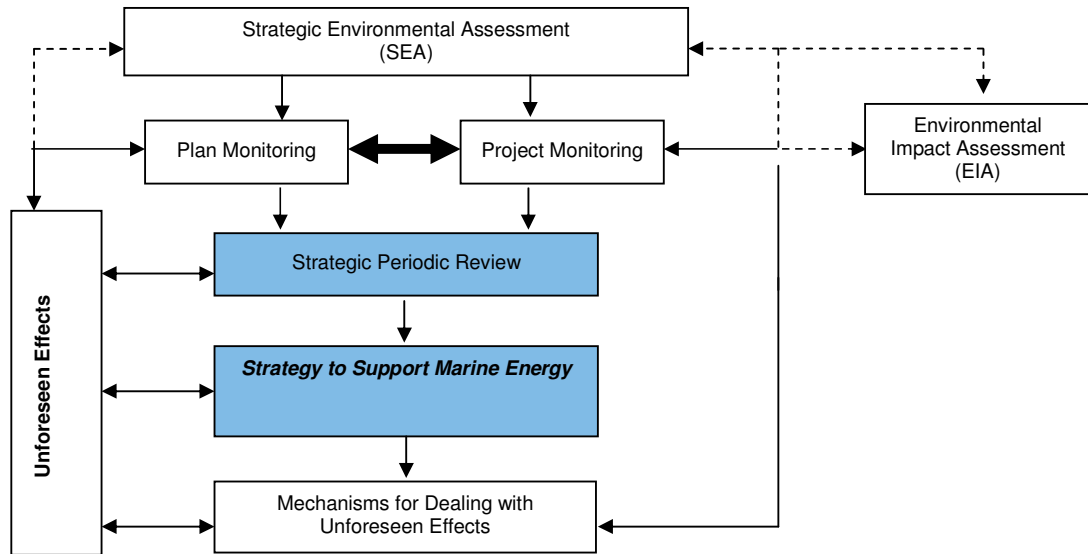
It is proposed that the monitoring framework be reviewed periodically (see subsection E4.4.1 below). As identified in the flow diagram below (Figure E3.1), the information obtained from monitoring the implementation of the Scottish Executive’s strategy for support for marine energy can be used to feedback into this monitoring framework which is set out as part of the SEA process. The framework can be used as a guidance tool and source of information for other similar strategic level assessments.

E4.2.4 Links to EIA Level Assessments

Project level monitoring carried out as part of this SEA will be important in informing future EIA's that will be required as part of the consenting process for marine energy developments. Initial monitoring work will help to improve the certainty over where data and knowledge gaps exist and how they can best be filled for the purpose of an EIA. This will improve the EIA process in the future as monitoring will help determine whether full scale assessments of certain interactions between the devices and the environment are actually required. Also, where there is a need for monitoring and survey work to be undertaken the methods that should be used will be much better established. This could reduce the economic costs and the potential risks associated with the development of marine renewables in the context of the environment.

The following flow diagram (Figure E4.1) illustrates the approach to the monitoring of the Scottish Executive's strategy for support for marine energy.

Figure E4.1: Approach to Monitoring Framework



E4.3 Environmental Change

It is important to note that the baseline environment in which the marine devices/arrays will be deployed is continuously changing due to other factors that are outside the direct influence of the marine energy industry. One of these key factors includes climate change.

The main driver behind this target is the Scottish Executive's commitment to making equitable contributions to the UK's commitments on climate change, set out in the Energy White Paper. The Energy White Paper sets out the UK Government's aims to achieve its long term goal to reduce UK carbon emissions by 60% by 2050, as these have been identified as significant contributors of global climate change.

Climate change is a naturally occurring process. The earth's climate is continuously changing. For example, the earth is presently in an interglacial period, where the climate is much warmer than the previous glacial period. There are also much smaller natural variations in global climate temperatures that occur within interglacial and glacial periods.

The temperature of the earth is maintained by greenhouse gases which are naturally present in the atmosphere. The sun warms the earth. Heat from the earth is then re-emitted into the atmosphere in the form of infrared rays. These infrared rays are trapped by the greenhouse gases that are naturally present in the atmosphere. This enables earth to maintain its 'warm' temperature, as without greenhouse gases earth would be approximately 30 degrees cooler.

In terms of the current 'climate change' debate, the main factor is that, through human activity we are emitting too many greenhouse gases into the atmosphere. As a result of this increase in greenhouse gases more of the heat emitted from the earth's surface is being trapped, leading to an increase in climate temperatures. Carbon dioxide, emitted from burning of fossil fuels to generate power and for transport, has been identified as one of the main greenhouse gases, hence the need to identify alternative sources of energy that do not produce carbon emissions e.g. wave and tidal power.

The actual effects of climate change are still under debate. However predicted effects include changes in seasonal rainfall patterns, storminess and sea level rises. In terms of the marine environment, the potential effects of climate change also include changes in sea temperatures. Over time this could affect the types of species and habitats that are present in the study area and their abundance. Some species may disappear from the study area; and may be replaced by other different species. It is therefore important for any long-term monitoring to identify that some of the changes that occur within the marine environment may not be as a result of the presence of marine devices but may be due to these other external factors.

E4.4 Monitoring Framework

It is a requirement of the SEA legislation that the responsible authority (in this case the Scottish Executive) monitors the significant effects of the implementation of plan for which it has carried out the assessment. Section 19(2) of the Act states that the responsible authority '*shall do so in a manner...which enables the authority to (a) identify any unforeseen adverse effects at an early stage; and (b) undertake appropriate remedial action*'.

E4.4.1 Method for Monitoring Implementation of the Strategy to Support Marine Energy

It is recommended that periodic strategic level reviews are used to monitor implementation of the Scottish Executive's strategy to support the development of marine energy. These strategic level reviews will be informed by the information obtained during the monitoring of individual marine energy projects and research studies.

The periodic reviews will:

- Check whether the effects identified during the SEA have occurred
- Identify the reasons why some effects identified during the SEA may have been less significant and or more significant than predicted
- Review unknown effects – based on information obtained from the project level monitoring and research studies
- Review cumulative effects – based on improved understanding obtained from the project level monitoring and research studies
- Review overall strategy of support for the development to marine energy to ensure that the growth of the wave and tidal energy industry is not having significant adverse effects on the environment
- Propose actions/strategy modifications to address any significant adverse effects that may have been identified through monitoring and to improve environmental conservation

There are four main types of effect that will be periodically reviewed as part of the monitoring of the SEA. These include:

- **Effects identified by the SEA where there are no specific requirements for project level monitoring or research studies**
 - Monitoring will identify if proposed mitigation has been successful in preventing significant effects
 - Where periodic review identifies that mitigation has not been successful in preventing significant effects there will be a requirement to review the strategy for marine energy development to understand why certain effects occurred, why mitigation was not implemented successfully and to identify mechanisms to ensure that any further potentially significant effects prevented

- **Effects identified by the SEA where there are specific requirements for project level monitoring and/or research studies to improve the confidence of the assessment**
 - Monitoring interactions between devices and the environment and key receptor behavioural responses to devices will improve the confidence of the assessment
 - Monitoring will identify if effects predicted during the SEA are accurate e.g. not as significant or more significant than predicted
 - Improved certainty of effect significance may identify that the effects are not a significant as predicted. This could have positive effects on the 'strategy' for marine energy development by increasing the potential energy resource that could be developed
 - Alternatively, if the significance of the effects increases there may be a requirement to review the strategy to address these effects and prevent them occurring in the future e.g. removing potential areas of energy resource

- **Unknown effects**
 - Monitoring interactions between devices and the environment and key receptor behavioural responses to devices will inform the accurate assessment of potential environment effects
 - The periodic review may identify that previously unknown effects are only of minor significance or negligible. This would have positive effects on the overall strategy for the development of marine energy by increasing the potential energy resource that could be developed
 - Alternatively, the periodic review may identify that previously unknown effects are of moderate to major significance. Consequently there may be a requirement to reduce the potential energy resource that could be developed and review the strategy of support for marine energy accordingly

- **Unforeseen effects**
 - The periodic review will be required to include contingency measures to enable the Scottish Executive to provide an immediate response to any major significant effects that are identified during the project level monitoring and research studies

E4.4.2

Review Period

Based on the information from this SEA it is suggested that a periodic review is carried out every 5 years following completion of this SEA. The findings from the periodic review should be presented in a formal report so that it can be made available to the public, as required under the SEA legislation. The timing of the period reviews is subject to agreement and may be amended to best meet the requirements of the Scottish Executive's objectives for their strategy.

E4.5 Project Level Monitoring and Research Gaps

The monitoring framework presented in Table E4.1 below identifies the key SEA topics where the assessment has identified a need for monitoring to be undertaken to improve understanding on how marine developments interact with the environment. It may not be necessary for all of the monitoring identified to be carried out either as part of the SEA or at a project level, as some of the suggested measures for monitoring will only be relevant in certain parts of the study area or where particular receptors are present.

E4.5.1 *Monitoring Priorities and Research Studies*

Based on information presented in Table E4.1 and results from the assessments presented in Chapters C1 to C21, the following monitoring requirements have been identified as a priority to improve understanding of how marine developments interact with the environment. These recommendations for monitoring are seen as a priority for informing the future development of the marine energy industry:

- Noise
 - Pre-installation assessment of ambient marine noise would produce information with which context could be given to the increase of noise levels due to marine device installation and operation.
 - Assessment/monitoring of noise from device installation, device operation and decommissioning. This would need to take account of device type, differing site conditions and bathymetry
 - Such assessments could be expected to inform any requirement for monitoring of effects on marine mammals, birds and fish and help inform ongoing monitoring and review of effects on these organisms.
- Collision Risk, Barriers to Movement and Habitat Exclusion
 - Ongoing monitoring is recommended of how fish, marine birds and marine mammals interact with operational devices in terms of collision risk, barriers to movement (disruption to migration routes and other transit pathways and noise (see above), habitat exclusion and species displacement
 - This monitoring will help to determine vulnerability to potential effects - e.g. collision risk, noise, and subsequent avoidance behaviour (including habitat exclusion)
 - Monitoring the effectiveness of mitigation measures used to reduce potential effects e.g. turbine spacing, increasing the visibility of devices
- Energy Extraction and Benthic and Intertidal Ecology
 - Monitor effects of arrays of devices upon wave and tidal regimes
 - Ongoing monitoring of benthic habitats and species responses to changes in tidal flow and wave energy regime may be required in certain locations. This monitoring work would need to be supported by ongoing monitoring into energy extraction (see Chapters C2 and C3) and the site specific surveys (Chapter D2) on the distribution on benthic habitats and species.

Table E4.1: Monitoring Framework for Development of Marine Energy Developments

SEA Topic	Recommendations for monitoring
Chapter C1: Bathymetry	<ul style="list-style-type: none"> Bathymetric monitoring may be required to confirm that cables have remained buried to the required depth and to assess the extent of any scouring or seabed sediment impacts.
Chapter C2: Geology and Sediment Processes	<ul style="list-style-type: none"> Post installation monitoring may be required to confirm that the level of environmental effect is in line with those predicted in the project Environmental Impact Assessment.
Chapter C3: Marine and Coastal Processes	<ul style="list-style-type: none"> Monitoring of the effects of wave energy extraction and associated sediment interactions (see proposed monitoring for Chapter C2 and C3) could improve understanding of natural variability and short-term dynamics and their influence on potential receptors such as coastal erosion and accretion, benthic ecology (Chapter C6), geology (Chapter C2), and fish and shellfish (Chapter C7). However, research is also required to determine the most appropriate techniques and methods for acquiring and analysing data and to ensure approaches are standardised to ensure comparability between monitoring periods and sites.
Chapter C4: Seabed Contamination and Water Quality	<ul style="list-style-type: none"> Monitoring for specific contaminants may be needed if a significant risk to water quality is identified at project planning stage. Monitoring of indicator species colonies for potential contaminants may be necessary where there are adjacent sensitive receptors such as shellfish waters (refer to the proposed monitoring for Chapters C7 and C10).
Chapter C5: Protected Sites and Species	<ul style="list-style-type: none"> Recommendations for monitoring with respect to the key features and species protected within the study area are discussed alongside monitoring proposals for their relevant chapters: Geology (refer to Chapter C2), benthic ecology (refer to Chapter C6), fish and shellfish (refer to Chapter C7), birds (refer to Chapter C8), marine mammals (refer to Chapter C9) and commercial fisheries and mariculture (refer to Chapters C7 and C6)
Chapter C6: Benthic Ecology	<ul style="list-style-type: none"> Monitoring will need to be undertaken to confirm predictions regarding potential effects on, and changes in habitats and species. Such data would assist in understanding the degree of change in wave or tidal energy (if any occur) together with the extent of change. The zones within which benthic monitoring is required will need to be determined based on the project specific modelling to estimate the extent of extraction of energy extraction impacts.
Chapter C7: Fish and Shellfish	<ul style="list-style-type: none"> Monitoring of benthic communities may be required to confirm predictions effects on shellfish (refer to the monitoring proposed in Chapter C7). Monitoring fish interactions with prototype devices operating at sea may be required to determine how fish interact with devices and provide further information to enable quantification of collision risk impacts. The use of video cameras, sonar equipment and surface observers can be used to monitor interactions as they occur, including the potential cues given out by the devices (sound, visibility, vibrations etc) and any environmental factors mediating the interactions such as turbidity, prey abundance, bubbles in the water column etc. Alternatively, the physical presence of the devices could be replaced with the cues alone to investigate avoidance responses.
C8: Birds	<ul style="list-style-type: none"> Once the baseline has been established, the programme of monitoring marine bird distributions in relation to the development and control sites, and assessment of demographic parameters and population size at local colonies, could continue during device installation and operation. Surveys such as this will establish the potential positive or negative impacts the scheme will have indirectly on the birds, by altering their foraging conditions and potentially their population size (further details of survey methods are given in chapter C6). Should monitoring direct effects of installation be required, the impact of collisions on marine birds should be monitored in a systematic fashion, for example using underwater cameras, to be deployed under the full range of diurnal and tidal conditions. The distribution of birds in relation to the magnitude and distribution of noise should also be monitored systematically. The presence of any contaminants such as oil resulting from the installation is likely to be monitored in an ad-hoc fashion immediately following the escape, so ideally contingency funds should be in place to carry out such a survey.
C9: Marine Mammals	<ul style="list-style-type: none"> The specifics of a programme to assess and mitigate impacts will depend greatly on the nature of the location, species involved and devices employed. It is suggested that monitoring surveys should be undertaken to collect the following data: <ul style="list-style-type: none"> Assessment of how animals interact with device(s) Re-evaluation of tidal, diurnal and seasonal use of site. Re-evaluation of species abundance and patterns of animal movement in and around site Measurement of underwater noise around the device

SEA Topic	Recommendations for monitoring
C10: commercial Fisheries and Mariculture	<ul style="list-style-type: none"> For proposed monitoring regarding fisheries, refer to Chapter C7.
C11: Marine and Coastal Historic environment	<ul style="list-style-type: none"> No research gap to fill but there would need to be information collected to inform periodic review
C12: Cables and Pipelines	<ul style="list-style-type: none"> No issues have been identified for monitoring with regard to the issues presented in this chapter.
C13: Military Exercise Areas	<ul style="list-style-type: none"> No specific issues have been identified for monitoring
C14: Disposal Areas	<ul style="list-style-type: none"> No specific issues have been identified for monitoring
C15: Shipping and Navigation	<ul style="list-style-type: none"> Ongoing monitoring of navigation aids which mark devices should be conducted to ensure that they are operational
C16 Recreation and Tourism	<ul style="list-style-type: none"> No issues have been identified for monitoring. For proposed monitoring on related impacts (visual and noise related), refer to those identified in Chapters C19 and C17.
C17: Noise	<ul style="list-style-type: none"> Measurement of noise levels produced by operating devices will be required to further understanding of this issue, and this is discussed in Table E2.2. See Chapters C7: Fish and Shellfish, C8: Marine Birds and C9: Marine Mammals for recommended monitoring in relation to noise effects on these receptors.
C18: Electric and Magnetic Fields	<ul style="list-style-type: none"> Monitoring of the strength of electric and magnetic field while devices and cables are in operation would provide a better understanding of field strengths and their impacts especially the different impacts of induced fields with relation to array geometry of the cables. However, it is considered unlikely (based on current understanding and modelling) that fish, shellfish, benthic ecology or marine mammals will be significantly affected and therefore further monitoring may be of limited use.
C19: Seascape Assessment	<ul style="list-style-type: none"> Monitoring of seascape and visual effects is recommended through periodic, repeat collection of data in order to draw comparisons between the actual and predicted effects. Monitoring could also provide information on any effects on the perceived value of seascapes for different visual receptors (relates also to Chapter C16) Monitoring will be required to ensure that device array layout geometries respond to site specific locations and any future developments
C21: Onshore Grid Connection	<ul style="list-style-type: none"> Refer to monitoring requirements as recommended for Chapter C19: Seascape Assessment
C22: Decommissioning	<ul style="list-style-type: none"> Recommended ongoing monitoring of benthic, fish and shellfish, marine birds and marine mammals populations (size, reproductive rates, survival rates) during and following decommissioning.

E5 Next Steps

E5.1 Consultation

The Scottish Executive and their consultants will be undertaking wide ranging consultation to gain the views of all stakeholders on the results of the SEA. Consultation events will provide forums for all interested parties and individuals to express their views on how the development of planning guidance for marine energy development should be progressed. Consultation will focus on the following topics:

- The results of the Environmental Report
- How best to avoid, reduce or offset environmental effects
- Issues associated with identifying sites to locate projects
- Dealing with data and knowledge gaps
- The monitoring of the environmental effects to inform both project development and the strategy for marine energy
- The need for licensing rounds for wave and tidal stream energy projects

The consultation period for the SEA is 12 weeks. During this time the following activities are proposed:

- A public exhibition to be taken to selected locations in the study area: Orkney, Shetland, Western Isles, Argyll and Bute, and Dumfries. This would be combined with targeted meetings with council officers and other stakeholders in these areas.
- A developer, agency and stakeholder workshop.
- The continued involvement of the Steering Group

Table E5.1 sets out the programme for the next stages of the SEA.

Table E5.1: Forthcoming SEA Milestones

Expected Date	Milestone
30 March 2007	Publication of the Environmental Report. Consultation commences.
Late April/ Early May 2007	Road show of public exhibitions take place
May 2007	Workshop(s) with stakeholders to discuss the outputs of the SEA
20 June 2007	Final date for receiving comments on the Environmental Report
Late Summer	Publication of Post-Adoption SEA Statement, which will Highlight how the SEA and consultation responses have influenced the development of the Strategy State the framework for monitoring the environmental effects of the Strategy to (a) identify any unforeseen adverse effects at an early stage; and (b) undertake appropriate remedial action

E5.2 Further Information

Further information on the SEA can be found at:

www.seaenergyscotland.co.uk

or

www.scotland.gov.uk/enterprise/energy

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