1 Wind Technology

### SEA Topic

#### Areas

<table>
<thead>
<tr>
<th>Device Information</th>
<th>Wind technologies with gravity-base foundation devices</th>
<th>Wind technologies with monopile or multi-pile foundation devices</th>
<th>Wind technologies with tripod or steel jacket foundation devices</th>
<th>Wind technologies with mono or multi-caisson foundation devices</th>
<th>Floating wind turbines</th>
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<tr>
<td>• Involves the construction of gravity foundations directly on the seabed.</td>
<td>• Like typical oil and gas pile designs.</td>
<td>• Generally consist of turbines attached to multi-legged structures secured to a series of piles driven into the seabed.</td>
<td>• Consists of a structure or suction caisson resembling an upturning bucket placed on a pre-prepared levelled seabed.</td>
<td>• Have a variety of types being investigated, including: Spar and Tension Leg Platform (TLP) such as the ‘Hywind’ floating device equipped with a cement ballast (installed in Norway in 2009), and Windfloat – a 3 cornered pontoon (installed in Portugal in 2011).</td>
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<tr>
<td>• Gravity base foundations consist of concrete or steel structures, often internally ballasted to create a large mass on the seabed.</td>
<td>• Involves long steel tubes (monopiles) driven into the seabed using a hydraulic piling hammer, assisted by drilling where necessary.</td>
<td>• Jackets are mounted on a 3 or 4 legged steel lattice rising out of the sea.</td>
<td>• Placement is based on a pressure differential attachment to the seabed. The foundations weight combined with the hydrostatic pressure on the caisson when the internal water is pumped out of it provides the force to hold the bucket structure in place.</td>
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<tr>
<td>• May be suitable for depths of 30 – 60m of water.</td>
<td>• Generally suitable for turbines in shallower waters, although ongoing research into deeper applications (i.e. &gt;25m).</td>
<td>• Tripods have a single vertical column above the water, with diagonal braces attaching the turbine mast to a 3-legged structure below the water surface and attached to the seabed.</td>
<td>• Can involve use of single or multiple caisson attachments.</td>
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<td>• Able to be floated and towed out to windfarms and installed without specialist marine equipment with minimum seabed preparation.</td>
<td>• Considered likely to continue to be used in shallow waters in the short-term.</td>
<td>• Jackets in particular are very common in the oil and gas sector, with a number of variations available.</td>
<td>• Is generally considered a future technique.</td>
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<td>• Can incorporate scour protection, has low maintenance requirement and can be removed upon decommissioning.</td>
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### Biodiversity/Flora/Fauna

**Summary of key potential effects:**

- Physical disturbance during device installation and operation
- Habitat exclusion and species displacement due to device presence and operation
- Potential for creation of artificial habitats underwater and bird aggregation on surface-piercing structures
- Noise and vibration during construction (particularly piling) and from device operation
- Risk of bird collision with operating devices (e.g. foraging, migration)
- Increased suspended sediment/turbidity from seabed disturbance during device installation and cable trenching
- Substratum loss, caused by placement of devices and attaching support structures and cables on the seabed

**Key measures to prevent adverse effects may include:** avoidance of sensitive sites; avoidance of sensitive seasons during installation (e.g. breeding); protocols (such as use of Marine Mammal Observers) to ensure noise construction activities do not occur when marine mammals are in close proximity; effective device design and project-specific studies to help design appropriate mitigation; carry out detailed routing studies at project level in accordance with ‘Holford Rules’ best practice guidance on routing overhead transmission lines onshore.

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**Marine Mammals and fish**

- Underwater noise and vibration during installation has the potential to impact on marine fauna (i.e. seals, otters, cetaceans, basking sharks).
- There is also the potential for cumulative impacts from multiple noise sources audible to marine mammals and fish during installation and increased vessel disturbance.
- Potential displacement or disturbance of marine fauna through a combination of:
  - Underwater noise and vibration on marine mammals, seals and cetaceans during piling. There is also the potential for cumulative impacts from multiple noise sources audible to marine mammals and fish during installation of turbines, and increased vessel disturbance.
  - Potential displacement or disturbance of marine fauna.

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**Marine Mammals and fish**

- Underwater noise and vibration during installation and the placement of tripod/jacket structures, with potential impacts to marine fauna (i.e. seals, otters, cetaceans, basking sharks).
- There is also the potential for cumulative impacts from multiple noise sources audible to marine mammals and fish during installation and increased vessel disturbance.
- Potential displacement or disturbance of marine fauna.
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<td>factors including noise (and multiple noise sources), vibration, visual and light intensity changes, water quality changes, habitat disturbance or the presence of structures and vessels.</td>
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<td>Loss of seabed habitat from the placement of gravity foundation directly on/into the seabed, and potential for adverse impacts from sourcing of fill or dredged material for use in the gravity-based foundation (i.e. potential risk of impacts to marine fauna from dredging activities, turbidity, potential release of</td>
<td>Direct adverse impacts to benthic habitats, particularly sensitive habitats such as shellfish growing waters, from sediment dispersion and deposition in</td>
<td>Potential disturbance of diving bird foraging areas due to surface noise, visual and light intensity changes, water quality changes, habitat disturbance or the presence of structures and vessels.</td>
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<td>Potential for injury to marine mammals and impacts during installation period (i.e. risk of injury to curious seals and dolphins during placement of foundations).</td>
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<td>Potential for EMF impacts associated with cabling and grid connection infrastructure.</td>
<td>Cumulative impacts may occur, particularly affecting mammals and migratory fish, from an increased number of barriers affecting fish movement (i.e. device arrays, construction vessels/equipment, etc.).</td>
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## Environmental Statement

**SEA Topic Areas**

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<td>Contaminated materials, loss of habitat at source, etc.</td>
<td>the construction phase of works (i.e. east of Scotland (e.g. Bell Rock, Inch Cape, Neart na Gaoith and Forth Array) and west of Scotland (e.g. Argyll Array, Islay and Kintyre) where shellfish waters are prevalent.</td>
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<td>It is anticipated that many of the construction and decommissioning effects may be temporary and reversible (i.e. removal of the turbines with the monopile remaining insitu). However, some impacts on biodiversity experienced during operation of wind farms are likely to be permanent and irreversible.</td>
<td>It is anticipated that many of the construction and decommissioning effects may be temporary and reversible (i.e. removal of the turbines and support structures, and piles remaining insitu). However, some impacts on biodiversity experienced during operation of wind farms are likely to be permanent and irreversible.</td>
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### Population and Human Health

**Summary of Key Potential Effects on Population and Human Health:**

- Flicker and noise effects, particularly for near-shore devices
- Displacement of other marine activities (i.e. fishing, recreational, shipping, aquaculture)
- Reductions in the safety of navigation
- Risk of collision by other marine users with turbine structures and installation/maintenance vessels
- Requirement for the installation of new transmission infrastructure to connect the devices to the grid (i.e. cables on the seabed, terrestrial infrastructure)
- Requirement for upgrading of nearby port/harbour infrastructure to install and/or maintain turbines

Key measures to prevent adverse effects may include:

- Siting devices away from spatially constrained areas and areas with high vessel densities; siting devices in open water; making use of industry guidance on assessment of effects and use of aids to navigation; use of notifications such as ‘Notices to Mariners’, publicising information at marina, and Sailing Directions; and adhering to appropriate safety regulations.

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Potential issues with navigation, although it is noted that this may be managed through the selection of appropriate sites and the MCA to ensure that there are no hazards to shipping. Potential for commercial impacts on the fishing and shipping industries (i.e. loss of access to fishing areas, reduced catches in such areas from displacement of fish populations, collision risk).

Requirement for the installation of new transmission infrastructure to connect the devices to the grid (i.e. cables on the seabed, terrestrial infrastructure) could, in some circumstances, impact on recreational and commercial activities. Potential impacts, is likely to be site and development specific.

Potential for upgrading of nearby port/harbour infrastructure to install and/or maintain turbines.

These effects will likely be reversible. Potential issues with navigation, although it is noted that this may be managed through the selection of appropriate sites and the MCA to ensure that there are no hazards to shipping. Potential for commercial impacts on the fishing and shipping industries (i.e. loss of access to fishing areas, reduced catches in such areas from displacement of fish populations, collision risk).

Requirement for the installation of new transmission infrastructure to connect the devices to the grid (i.e. cables on the seabed, terrestrial infrastructure) could, in some circumstances, impact on recreational and commercial activities. Potential impacts, is likely to be site and development specific.

Potential for upgrading of nearby port/harbour infrastructure to install and/or maintain turbines.

Informed by: Halcrow (2007)

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<td>Effects are temporary and may be reversible. Potential for cross-contamination in the use of excavated fill material or dredging material as ballast in gravity-based foundations.</td>
<td>Benefits through contribution to decarbonisation of electricity generation through the long-term operation of the wind farms (i.e. displacement of non-renewable power generation).</td>
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**Climatic factors**

Benefits through contribution to decarbonisation of electricity generation through the long-term operation of the wind farms (i.e. displacement of non-renewable power generation).

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<tr>
<th>Marine geology and coastal processes</th>
<th>Summary of key potential effects on geology:</th>
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<tbody>
<tr>
<td>- Disturbance or damage to coastal Geological SSSIs and GCRs during installation works.</td>
<td></td>
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<tr>
<td>- Changes in coastal processes due to presence of devices in water column.</td>
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<tr>
<td>- Seabed contamination and water quality (including disposal areas) during installation works.</td>
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<td>Key measures to prevent adverse effects may include: siting devices away from sensitive and designated areas; using best practice methodologies and technologies to minimise potential impacts during installation; adoption of appropriate management planning in installation works.</td>
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**Direct adverse impacts to the seabed**

Potential for direct adverse impacts to the seabed during piling operations. Potential alteration of sediment dynamics and tidal flows/fluxes from the presence of gravity-based foundation structures on the seabed and presence of scour protection in the seabed.

Potential for direct adverse impacts to the seabed during piling operations. Potential alteration of sediment dynamics and tidal flows/fluxes from the presence of piles and turbine structures into the seabed and presence of turbine masts and support structures in the water column. Impacts such as scouring, deposition, abrasion (during installation of piles only) and vibration may also occur due to the installation and operation of the wind turbines. Impacts from construction and decommissioning works are likely to be temporary and are often reversible. Potential for direct adverse impacts to the seabed during piling operations. Potential alteration of sediment dynamics and tidal flows/fluxes from the presence of piles and turbine structures into the seabed and presence of turbine masts and support structures in the water column. Impacts such as scouring, deposition, abrasion (during installation of piles only) and vibration may also occur due to the installation and operation of the wind turbines. Impacts from construction and decommissioning works are likely to be temporary and are often reversible. Likely direct adverse impacts to the seabed from the preparation of seabed areas (i.e. dredging) and placement of caisson support structures directly on the seabed (e.g. turbidity, sediment disturbance, loss of geology, potential for release of contaminated materials bonded to sediments). Potential alteration of sediment dynamics and tidal flows/fluxes from the presence of gravity-based foundation structures on the seabed and presence of moorings in the water column. Impacts such as scouring, deposition and abrasion (particularly in the placement of mooring lines, if used) may also occur due to the foundation structures present at the seabed. However, it is assumed that scour protection would be used for such foundation structures and this may alleviate such risks. Impacts from construction and decommissioning works are likely to be temporary and are often reversible. Likely direct adverse impacts to the seabed from the preparation of seabed areas (i.e. dredging) and placement of caisson support structures directly on the seabed (e.g. turbidity, sediment disturbance, loss of geology, potential for release of contaminated materials bonded to sediments). Potential alteration of sediment dynamics and tidal flows/fluxes from the presence of gravity-based foundation structures on the seabed and presence of moorings in the water column. Impacts such as scouring, deposition and abrasion (particularly in the placement of mooring lines, if used) may also occur due to the foundation structures present at the seabed. However, it is assumed that scour protection would be used for such foundation structures. Impacts from construction and decommissioning works are likely to be temporary and are often reversible. However, impacts from seabed preparation works are likely to be permanent. **Potential for direct adverse impacts to the seabed from the placement of gravity concrete anchors and moorings directly on the seabed.**

**Potential for direct adverse impacts to the seabed from the preparation of seabed areas (i.e. dredging) and placement of caisson support structures directly on the seabed (e.g. turbidity, sediment disturbance, loss of geology, potential for release of contaminated materials bonded to sediments).**  
**Potential alteration of sediment dynamics and tidal flows/fluxes from the presence of gravity-based foundation structures on the seabed and presence of moorings in the water column.**  
**Impacts such as scouring, deposition and abrasion (particularly in the placement of mooring lines, if used) may also occur due to the foundation structures present at the seabed. However, it is assumed that scour protection would be used for such foundation structures. Impacts from construction and decommissioning works are likely to be temporary and are often reversible.**
### Historic Environment

#### Summary of key potential effects on marine and coastal historic environment include:

- Direct disturbance, damage, or destruction of submarine archaeological remains and wrecks during device installation and cable trenching.
- Disturbance, damage or loss of archaeological remains and sites during installation of cables and overhead lines and substation construction from onshore grid connections.

#### Key measures to prevent adverse effects may include:

- Avoid sites of interest and exclusion zones for protected sites; follow Crown Estates 2007 JNAPC Code of Practice for seabed development; carry out seabed surveys: loss of substrata or habitat if taken from suitable undisturbed areas; potential for release of contaminated materials bonded to dredged sediments; potential for cross-contamination from source areas to windfarm site, particularly if sourced from shipping lanes or harbours; potential impacts on hydrodynamics and water flows at the source location from the removal of sediments; reduced water quality and increased turbidity from sediment disturbance during dredging operations; and potential impacts for marine fauna and flora, including the disturbance and physical injury risk from dredging operations. If material is sourced from the terrestrial environment it will have effects associated with the removal of material and its transportation.

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<td>Sourcing of fill or dredged material for gravity foundations, and potential impacts of taking fill from other areas. If terrestrial fill or dredged material is used, potential impacts at the source may include: loss of substrata or habitat if taken from suitable undisturbed areas; Potential for release of contaminated materials bonded to dredged sediments; potential for cross-contamination from source areas to windfarm site, particularly if sourced from shipping lanes or harbours; potential impacts on hydrodynamics and water flows at the source location from the removal of sediments; reduced water quality and increased turbidity from sediment disturbance during dredging operations; and potential impacts for marine fauna and flora, including the disturbance and physical injury risk from dredging operations. If material is sourced from the terrestrial environment it will have effects associated with the removal of material and its transportation.</td>
<td>Potential for placement of gravity-based foundations and scour protection on known and designated historic sites and their exclusion zones, WHS, coastal listed buildings such as lighthouses, scheduled monuments and other unknown, submerged or non-designated archaeological assets features or paleo-landscapes to create adverse impacts. The potential scouring, silting and deposition around these important sites located in the vicinity of such devices or arrays may also occur. However, adverse effects are likely to be avoided through careful siting of individual device foundations and arrays,</td>
<td>Potential for piling operations on or close to known and designated historic sites and their exclusion zones, WHS, coastal listed buildings such as lighthouses, scheduled monuments and other unknown, submerged or non-designated archaeological assets features or paleo-landscapes to create adverse impacts. Adverse effects are likely to be avoided through careful siting of device monopiles and arrays.</td>
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<td>Potential for placement of foundations and caisson structures directly on the seabed in the vicinity of known and designated historic sites and their exclusion zones, WHS, coastal listed buildings such as lighthouses, scheduled monuments and other unknown, submerged or non-designated archaeological assets features or paleo-landscapes to create adverse impacts. The potential scouring, silting and deposition around these important sites located in the vicinity of such devices or arrays may also occur. However, adverse effects are likely to be avoided through careful siting of floating wind turbines.</td>
<td>Potential for placement of concrete gravity anchors directly on the seabed, and installation of mooring lines in the vicinity of known and designated historic sites and their exclusion zones, WHS, coastal listed buildings such as lighthouses, scheduled monuments and other unknown, submerged or non-designated archaeological assets features or paleo-landscapes to create adverse impacts. The potential scouring, silting and deposition around these important sites located in the vicinity of such anchors may also occur. However, adverse effects are likely to be avoided through careful siting of floating wind turbines.</td>
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Landscape/Seascape

Summary of key potential effects on land/seascape include:
- Devices likely to be visible at distances of 26 miles (42 km) in daytime and 24 miles (39 km) in night-time views.
- Devices may be a focus of visual attention at distances of up to 10 miles (16 km).
- Landscape and visual intrusion from offshore turbine devices, and onshore substations, overhead lines and grid connections.

Key measures to prevent adverse effects may include: maximising the distance of devices from shore; reducing the height of devices above the water surface; reducing the area of sea occupied by the devices; and modifying the position and layout of devices to suit characteristics of the local seascape; carry out detailed routing studies at project level in accordance with ‘Holford Rules’ best practice guidance on routing overhead transmission lines; provide screening for substations.

Potential for turbines and supporting infrastructure (i.e. additional platforms, construction, maintenance or decommissioning vessels and equipment) to adversely impact on valued receptors (i.e. designated or valued landscapes/seascapes). In general, greater impacts are likely for near-shore devices than those located further offshore.

Field observations of offshore wind facilities in the United Kingdom revealed that the facilities may be visible at distances of 26 miles (42 km) in daytime and 24 miles (39 km) in night-time views. They may be a focus of visual attention at distances of up to 10 miles (16 km).

Potential onshore impacts from supporting grid infrastructure and interconnectors with terrestrial grid, although these will likely depend on siting and surroundings (i.e. proximity to valued or sensitive landscapes/seascapes).

The potential for landscape impacts at the source of excavated terrestrial fill material, or from dredging areas for use as ballast in gravity-based foundations has also been identified.

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### Wave technology

#### SEA Topic Areas

<table>
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<tr>
<th>Device Information</th>
<th>Point Absorbers and Rotating Mass Devices</th>
<th>Attenuators and Buoy Wave Devices</th>
<th>Oscillating Wave Surge Converters</th>
<th>Submerged Pressure Differential</th>
<th>Oscillating Water Column (Offshore and Shoreline)</th>
<th>Overtopping Device (Offshore and Shoreline)</th>
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<tr>
<td>Consist of floating structures that absorb energy in all directions through their movements at the water surface, or by device rotation created by wave movements.</td>
<td>Consist of elongated devices floating on the water surface with associated support structures or moorings.</td>
<td>Consist of large elongated structures made up of several floating parts with moving joints (e.g. Attenuators such as Pelamis) or flexible devices floating on the water surface (e.g. Buoy wave devices).</td>
<td>Consist of a surface or near-surface paddle device, mounted on a fixed base on the seabed, oscillating with passing waves (e.g. Oyster devices).</td>
<td>Consists of near-surface but submerged device located offshore and fixed to the seabed.</td>
<td>Consists of a partially submerged hollow structure located offshore, or as a shoreline-based structure.</td>
<td>Consists of a floating structure with large catchment area (offshore) or located onshore at the shoreline, typically with a breakwater (shoreline).</td>
</tr>
<tr>
<td>Are located at the water surface with above water or near surface components (i.e. the spar and float that houses generation equipment).</td>
<td>Are likely to be anchored and moored to the seabed (i.e. embedded, gravity/deadweight or rock anchors) with mooring lines spanning the full depth of the water column.</td>
<td>The device(s) floating on the surface, typically staggered in rows, and likely have a shallow draft.</td>
<td>Is likely to be fixed to seabed with a gravity base (i.e. rock anchors/pins).</td>
<td>The device floats within the water column, moving up and down with wave systems.</td>
<td>Offshore devices are likely to be moored by anchors (gravity, deadweight or embedded) with associated mooring lines present in the full depth of the water column.</td>
<td>Offshore devices are positively buoyant and are likely to be moored by anchors with mooring lines.</td>
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<td>Marker buoys and lighting are likely to be used for offshore awareness and navigation.</td>
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<td>Likely to be moored by anchors on the seabed (i.e. embedded, gravity/deadweight or rock) and have associated mooring lines spanning the full depth of the water column. Support structures may also be present.</td>
<td>Energy generation equipment (i.e. pistons and joints) are located within the water column.</td>
<td>There is the possibility that the device will also involve pipelines to shore for pumping water.</td>
<td>Marker buoys are likely to be used for offshore awareness and navigation.</td>
<td>Energy generation equipment is housed above the water surface in the floating component (offshore) or housed within an onshore structure (shoreline).</td>
</tr>
<tr>
<td>Biodiversity/ flora/fauna 1, 2</td>
<td>Summary of key potential effects:</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Noise during construction (particularly piling) and from device operation.</td>
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<td>Accidental contamination from device failures, vessel collisions and storm damage.</td>
<td>Habitats exclusion and species displacement due to device presence and operation.</td>
<td>Barriers to movement – due to avoidance reactions to noise and risk of collision.</td>
<td>Increased suspended sediment/turbidity from seabed disturbance during device installation and cable trenching.</td>
<td>Changes in tidal flow and wave regime due to device presence and operation.</td>
<td>Key measures to prevent adverse effects may include: avoidance of sensitive sites; avoidance of sensitive seasons (e.g. breeding) during installation; use of devices with attachments that cause smaller seabed</td>
<td></td>
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### Disturbance

Disturbance, such as anchors and clumps weights protocols (such as use of HF happily) do not occur when marine mammals are in close proximity, effective device design, and project-specific studies to help design appropriate mitigation; carry out detailed routing at project level in accordance with ‘Holford Rules’ best practice guidance on routine overhead transmission lines.

### Fauna:

- **Attraction of Fauna**
  - Bird aggregation utilising above water infrastructure may occur, particularly during calm water periods (if any) and if located in foraging waters.
  - Noise
  - Potential for underwater noise impacts on marine fauna, from drilling/installation works (i.e. anchoring works, etc.) or from machinery housing in floating or subsurface structures. As such, there is the potential for behavioural impacts to seals and otters (typically near shoreline), and cetaceans and basking sharks (offshore) possibly avoiding these locations during installation and operation. But there are significant unknowns on disturbance effects as they are likely to be site-specific, and also regarding actual noise levels generated by this technology. In summary, acute effects to these receptors are considered unlikely, with impacts likely to be most significant during piling and drilling activities (if undertaken).

- **Shock Waves**
  - The potential for disturbance impacts to marine fauna (i.e. seals, otters) from above surface noise has been identified, particularly during installation works (i.e. machinery, vessels) and where floating device structures house noise-generating equipment (expected to be most devices of this type). This disturbance may be greater for those devices near to the shoreline, however, this will likely be site specific given the significant unknowns on the specific effects of such disturbance and likely receptors.

- **EMF**
  - While no EMF impacts have been identified from the devices, there is the potential for EMF impacts from underwater cabling and grid connections. Further information is required to determine the potential susceptibility of marine fauna and likely effects associated with this issue.

- **Physical Barrier**
  - The physical presence of these devices in the water column and mounted on the seabed may disrupt movements or migration of marine fauna. There are unknowns over known movements and migration routes.
SEA Topic

The physical presence of new structures in the water column may disrupt movements or migration of marine fauna, particularly for groups of devices. Given the mobility of these species, any impacts are likely to be site specific. There are unknowns over movements and migration routes (i.e. basking sharks), patterns of movement of other species (i.e. seals, otters), and also over whether these devices and their moorings may exist, although there are nearshore devices may restrict movement more than offshore (e.g. potentially greater alternatives for movement around offshore). The potential for collisions between marine fauna and these devices and their moorings has been identified, particularly for those with moving parts, and those with large footprints (i.e. Pelamis, Buoy wave devices). However, this will be largely dependent on the actual size and design of the device, the location of the device (i.e. proximity to seal haul out zones, etc.) and the response of the marine fauna involved. Avoidance is likely for many species (i.e. fish), but impact could also be fatal in some instances if it were to occur (i.e. seals, otters, cetaceans, basking shark). Collision with or entanglement in mooring lines associated with offshore devices is considered possible, particularly for larger marine fauna and migration routes (i.e. basking sharks), patterns of movement of other species (i.e. seals, otters), whether moorings and devices will be perceived or if they will simply alter their movement accordingly. Nearshore devices may restrict movement more than offshore (e.g. potentially greater alternatives for movement around devices offshore).

Physical Barrier

While no EMF impacts have been identified from the devices, there is the potential for EMF impacts from underwater cabling and grid connections. Further information is required to determine the potential susceptibility of marine fauna and likely effects associated with this issue.

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Oscillating Wave Surge Converters

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Oscillating Water Column (Offshore and Shoreline)

While no EMF impacts have been identified from the devices, there is the potential for EMF impacts from underwater cabling and grid connections. Further information is required to determine the potential susceptibility of marine fauna and likely effects associated with this issue.

Overtopping Device (Offshore and Shoreline)

While no EMF impacts have been identified from the devices, there is the potential for EMF impacts from underwater cabling and grid connections. Further information is required to determine the potential susceptibility of marine fauna and likely effects associated with this issue.

Physical Barrier

Introduction of new structures at, or close to, the shoreline could disrupt movement of marine fauna. Unknowns over movements and migration routes (i.e. basking sharks), patterns of movement of other species (i.e. seals, otters), whether any moorings or device components will be perceived or if EMF will simply alter their movement accordingly. Nearshore or shallowline could disrupt routes to/from feeding grounds. Similarly, the physical presence of new structures in the upper water column may disrupt movements or migration of marine fauna. Unknowns over movements and migration routes (i.e. basking sharks), patterns of movement of other species (i.e. seals, otters), whether any moorings or device components will be perceived or if EMF will simply alter their movement accordingly.

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<td>Gelatex, basking shark.</td>
<td>Species (i.e. minke whales which are more prone to entanglement than other odontocetes/toothed whales) with a particular focus on complex arrays of devices and their multiple mooring lines (e.g. likely multiple point mooring systems). However, whether this is significant is not presently known, although it is noted that if it did occur, it may result in serious injury or fatality. <strong>Displacement</strong> In general terms, the potential displacement of species from the presence of devices or associated structures, disturbance during installation, operation or decommissioning (i.e. noise, turbulence, vibration, displacement of prey, etc.) is likely to be site-specific and would likely depend on a range of other factors (suitable alternative sites, importance of habitat, etc.). Any impacts would also likely depend on what activities are being displaced and their importance (e.g. Basking sharks avoiding of structures or installation/servicing vessel activities may lead to the displacement of foraging activities or courtship behaviour).</td>
<td>Activities may lead to the displacement of foraging activities or courtship behaviour. In placement of these devices on the seabed, or on supports placed on the seabed, some loss of benthic habitat will occur.</td>
<td>Structures or installation/servicing vessel activities may lead to the displacement of foraging activities or courtship behaviour. In placement of support structures for these devices on the seabed, some loss of benthic habitat will occur.</td>
<td>Activities may lead to entanglement of other odontocetes/toothed whales) and larger devices with several mooring lines. The potential for entrapment of marine fauna within the chamber/reservoir of devices such as the water column device (likely offshore for larger fauna, shoreline for smaller marine fauna) may also exist. However, whether either could actually occur and its significance is unknown. It is noted that while it may result in injury or fatality, such occurrences are considered unlikely. <strong>Displacement</strong> The potential displacement of shoreline habitats with the installation of shoreline devices (i.e. device footprint and infrastructure) will likely lead to displacement of fauna, particularly seals, otters, birds, etc. In most cases, the impact of this is likely to be site-specific and dependant on the availability of alternative habitats, siting options, activities displaced (i.e. haul out, breeding areas), etc.</td>
<td>Activities may lead to entanglement (i.e. seals, otters, cetaceans, basking shark). Collision with or entanglement in mooring lines associated with offshore devices is considered possible, particularly for larger species (i.e. minke whales which are more prone to entanglement than other odontocetes/toothed whales) with a particular focus on complex arrays of devices and their multiple mooring lines (e.g. likely 3-point mooring systems). However, whether this is significant is not presently known, although it is noted that if it did occur, it may result in serious injury or fatality.</td>
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Birds:
Collison
No collision risk identified in relation to wave devices for diving birds. The potential may exist for the aggregation of some seabirds on the top of surface-piercing devices (e.g. Penguins), particularly during calmer conditions.

Noise
Potential risk of underwater noise during installation, operation and decommissioning works of offshore devices has been identified. Increased noise levels are likely in drilling activities and installation of rock anchors if used. However, there are significant unknowns around the magnitude of the impacts from installation and operation of these devices on diving bird populations, although it could potentially be damaging and create sufficient disturbance for displacement.

Potential for noise impacts from generators and machinery located above the water surface. While high energy environments are likely to have high levels of background noise, this could create disturbances if located near coastal breeding sites. Noise within devices is likely to be low and constant and the effects are unknown, as effects of increased/alterned noise levels are not known for birds at present (displacement/avoidance, impacts to foraging success, etc.).

It is noted that the levels of underwater noise from the presence and operation of this device in offshore areas, is not currently known. Further the importance of hearing underwater for birds, threshold levels and the likelihood of any impacts are also unknown. Potential impacts may include displacement, avoidance, reduction in foraging success, no

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**Disturbance and Displacement**

Potential for displacement of birds during installation and operation. This is likely to be dependent on other factors (i.e. sensitivity of habitats, availability of suitable alternative habitats) and may only be temporary (e.g. birds may become accustomed to devices). Likely dependent on site-specific conditions, including the sensitivity of species and the activities displaced (i.e. breeding, foraging, mouling, etc.).

Potential for visual disturbance if surface-piercing components are present, with potential for greater impacts if located near-shore and close to coastal breeding and mouling sites, or offshore near foraging areas. However, the likelihood of impacts is presently unknown.

In such instances, birds in flight may operate in a broadly similar way and use similar avoidance tactics to those employed when encountering other natural and man-made obstructions (i.e. by taking alternative flight routes, avoiding obstructions to a greater degree at night, etc.).

**Predation**

The 2007 Marine Renewables SEA raised the potential risk of increased mink colonisation of offshore islands due to the creation of islet chains between Scotland’s western isles from the placement of devices with surface structures. Impacts such as increased predation on ground-nestling birds were identified. However, it is noted that there is no documented evidence indicating the likelihood of this occurring.

Unlikely. Potential impacts may include displacement, avoidance, reduction in foraging success, no effect, etc.

**Oscillating Wave Surge Converters**

- Level and the likelihood of any impacts are also unknown. Potential impacts may include displacement, avoidance, reduction in foraging success, no effect, etc.
- Disturbance and Displacement
  - Potential for displacement during installation and operation, but dependent on other factors (i.e. sensitivity of habitats, availability of suitable alternative habitats) and may only be temporary as fauna become accustomed to the devices. They are likely to be dependent on site-specific including the sensitivity of species and the activities displaced (i.e. breeding, foraging, mouling, etc.).
  - Potential for visual disturbance if surface-piercing components are present, with potential for greater impacts if close to coastal breeding and mouling sites, or offshore near foraging areas. The likelihood of impacts is unknown. In such instances, birds may operate in a broadly similar way and use similar avoidance tactics to those employed when encountering other natural and man-made obstructions (i.e. by taking alternative flight routes, avoiding obstructions to a greater degree at night).

**Submerged Pressure Differentiation**

- Level and the likelihood of any impacts are also unknown. Potential impacts may include displacement, avoidance, reduction in foraging success, no effect, etc.
- Disturbance and Displacement
  - Potential for displacement during installation and operation, but dependent on other factors (i.e. sensitivity of habitats, availability of suitable alternative habitats) and may only be temporary as fauna become accustomed to the devices. This is likely dependent on site-specific including the sensitivity of species and the activities displaced (i.e. breeding, foraging, mouling, etc.).

No surface-piercing components are identified, and hence no visual disturbance impacts are considered likely.

**Overtopping Device (Offshore and Shoreline)**

- Underwater noise from the presence and operation of this device in offshore areas, is not currently known. Furthermore, the importance of hearing underwater for birds, threshold levels and the likelihood of any impacts are also unknown. Potential impacts may include displacement, avoidance, reduction in foraging success, no effect, etc.

**Overtopping Device (Shoreline)**

- The 2007 Marine Renewables SEA raised the potential risk of increased mink colonisation of offshore islands due to the creation of islet chains between Scotland’s western isles from the placement of devices with surface structures (offshore only). Impacts such as increased predation on

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<td>Benthic Habitats and Water Column: Habitat Changes</td>
<td>The presence of these devices in the water column and their seabed moorings have the potential to contribute to habitat changes in a number of ways. In general, impacts on seabed habitats from the devices themselves are likely limited to wave energy dissipation, tidal flows and fluxes changes and deposition due in large to the presence of structures in the water column. These potential indirect impacts are likely to affect both benthic habitats and their species. Other impacts, such as scouring, deposition, abrasion, smothering and the potential for loss of habitat from placement of anchors on the seabed and mooring lines in the water column have also been identified. These may also occur due to wave and coastal process changes. Direct seabed impacts such as scouring and deposition/siltation have the potential to affect benthic habitats in a range of ways including the introduction of variations and shifts in grain size of sediments affecting habitat character and species distribution; shading or smothering of benthic areas changes in species distribution via interference with</td>
<td>Benthic Habitats and Water Column: Habitat Changes</td>
<td>The presence of these devices near the water surface and their support structure mounted on the seabed has the potential to contribute to habitat changes in a number of ways. In general, impacts on seabed habitats from the devices and their supports may include changes in sediment dynamics, scouring, deposition/siltation and vibration. Additional impacts such as wave energy dissipation, potential effects of placement in or near a mixing zone, changes in tidal flows and fluxes, and changes in turbulence due to installation and operation may also occur. Direct seabed impacts such as scouring and deposition/siltation, and in-direct impacts from wave and tidal changes, have the potential to cause a range of adverse benthic impacts. These may include the introduction of variations and shifts in grain size of sediments, which can alter habitat character and species distribution; shading or smothering of benthic areas changes in species distribution via interference with filter feeders, inhibiting their respiration and reproduction; and secondary Benthic Habitats and Water Column: Habitat Changes</td>
<td>The presence of these devices and their moorings has the potential to contribute to habitat changes in a number of ways. In summary, changes to sediment dynamics (shoreline), wave energy dissipation (offshore) and changes to coastal processes (shoreline) can create adverse impacts to benthic and shoreline habitats and species. These may have direct impacts to altered sediment movement and changes in coastal character and profile which have the potential for a range of adverse impacts to these habitats. (i.e. scouring, increased intensity of wave energy and potential for dissipation from sub-surface devices are unclear at present. In general, these changes to sediment dynamics and coastal processes can create adverse impacts to benthic habitats and their species. This may include direct impacts such as the introduction of variations and shifts in grain size of sediments, which can alter habitat character and species distribution; shading or smothering of benthic areas with sediments and the presence of the device itself; changes in species distribution via interference with filter feeders, Benthic Habitats and Water Column: Habitat Changes</td>
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<td>Oscillating Wave Surge Converters</td>
<td>Submerged Pressure Differentials</td>
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Areas

SEA Topic

Mass Devices

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Changes in sediment
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sediment (including BAP

habitat blue mussel beds) due
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wave action may adversely

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Changes in sediment dynamics in Sublittoral mixed sediments (including BAP habitats) may adversely impact filter feeders (i.e. A. fragilis) through reduced food supplies and siltation. While impacts are unlikely, there may be the potential for impacts for A. fragilis, E. timida or A. sarsi if present.

Changes in sediment dynamics in Sublittoral macrophyte-dominated sediment (including BAP habitats) may influence scouring, deposition and smothering. Wave dissipation may also affect species competition (i.e. seaweeds and filter feeders with reductions in exposure and food supplies) and BAP changes in sediment dynamics. While impacts are unlikely, there may be the potential for impacts for A. fragilis, C. cruoraiformis, D. Montagnei, P. calcareum, L. coralloides, horse mussel beds or blue mussel beds or maerl beds present.

Changes in sediment dynamics in Sublittoral biogenic reefs (including BAP habitats) may also affect species competition (i.e. seaweeds and filter feeders with reductions in exposure and food supplies) and BAP changes in sediment dynamics. While impacts are unlikely, there may be the potential for impacts for A. fragilis, C. cruoraiformis, D. Montagnei, P. calcareum, L. coralloides, horse mussel beds or blue mussel beds or maerl beds present.
Potential impacts for habitat Tidal Swept modiomus beds due to moorings. This may influence scouring, deposition and smothering. Wave dissipation also has the potential to impact filter feeders (i.e. reduced food supplies, siltation, migration of some species to shallower water depths) thus potentially affecting the overall habitat. While impacts are unlikely, there may be the potential to affect horse mussel beds, cold coral reefs or blue mussel beds if present.

Changes in sediment dynamics in Atlantic and Mediterranean high energy circalittoral rock (including BAP habitat Tidal Swept Channels) due to moorings. Potential impacts for habitat and S. pallida as it is nationally scarce.

Changes in sediment dynamics in Atlantic and Mediterranean moderate energy circalittoral rock due to moorings. Potentials for impacts due to device and support structures (offshore). Potential impacts for S. pallida and S. spinulosa as it as nationally scarce.

Changes in sediment dynamics in Atlantic and Mediterranean moderate energy circalittoral rock due to moorings. Potential impacts for S. pallida and S. spinulosa due to device and support structures (offshore). Impacts unlikely for small arrays (10MW) but potential impacts may exist for S. pallida and S. spinulosa.

Changes in sediment dynamics in Atlantic and Mediterranean high energy circalittoral rock (including BAP habitat Tidal Swept Channels) due to device (offshore) or moorings (offshore). Potential impacts for S. pallida and S. spinulosa as it is nationally scarce.

Changes in sediment dynamics in Atlantic and Mediterranean moderate energy circalittoral rock (including BAP habitat Tidal Swept Channels) due to device (offshore) or moorings (offshore). Potential impacts for S. pallida and S. spinulosa as it is nationally scarce.

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Changes in the overall habitat, through changing grain size in sediments may also occur. While many species are present in a variety of tidal flow conditions, impacts are unlikely. However, the potential may exist for impacts if C. crurieaformis, D. Montagnei, E. timida, A. sarsi or horse mussel beds are present.

- Changes in tidal flows and fluxes in Sublittoral sand (including BAP habitat subtidal sands and gravel, blue mussel beds) due to moorings (offshore). Impacts are not considered likely, but included due to potential as this habitat is seldom recorded.
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Chances in tidal flows and fluxes in Sublittoral macrophyte-dominated sediment (including BAP habitats maerl beds, tidal water coral reefs and blue mussel beds) due to moorings (offshore), on filter feeders (i.e. M. modiolus, A. digitatum and A. fragilis) from reduced food supplies and siltation. Strong flows may detach weakly attached organisms. Changes in the overall habitat, through changing grain size in sediments may also occur. While many species are present in a variety of tidal flow conditions, impacts are unlikely. However, the potential may exist for impacts if A. fragilis, E. timida, A. sarsi and horse mussel beds or file shell beds are present.

Changes in tidal flows and fluxes in Sublittoral macrophyte-dominated sediment (including BAP habitats maerl beds, tidal water coral reefs, horse mussel beds, blue mussel beds) due to moorings (offshore), on filter feeders (i.e. M. modiolus, A. digitatum and A. fragilis) from reduced food supplies and siltation. Strong flows may detach weakly attached organisms. Changes in the overall habitat, through changing grain size in sediments may also occur. While many species are present in a variety of tidal flow conditions, impacts are unlikely. However, the potential may exist for impacts if A. fragilis, E. timida, A. sarsi or blue mussel beds are present.

Changes in tidal flows and fluxes in Sublittoral macrophyte-dominated sediment (including BAP habitats maerl beds, tidal water coral reefs, horse mussel beds, blue mussel beds) due to moorings (offshore), on filter feeders (i.e. M. modiolus, A. digitatum and A. fragilis) from reduced food supplies and siltation. Strong flows may detach weakly attached organisms. Changes in the overall habitat, through changing grain size in sediments may also occur. While many species are present in a variety of tidal flow conditions, impacts are unlikely. However, the potential may exist for impacts if A. fragilis, E. timida, A. sarsi or blue mussel beds are present.

Changes in tidal flows and fluxes in Sublittoral macrophyte-dominated sediment (including BAP habitats maerl beds, tidal water coral reefs, horse mussel beds, blue mussel beds) due to moorings (offshore), on filter feeders (i.e. M. modiolus, A. digitatum and A. fragilis) from reduced food supplies and siltation. Strong flows may detach weakly attached organisms. Changes in the overall habitat, through changing grain size in sediments may also occur. While many species are present in a variety of tidal flow conditions, impacts are unlikely. However, the potential may exist for impacts if A. fragilis, E. timida, A. sarsi or blue mussel beds are present. Potential deposition of sediment from device and moorings in littoral biogenic reefs (including BAP habitat blue mussel beds) due to moorings (offshore), on filter feeders (i.e. M. modiolus, A. digitatum and A. fragilis) from reduced food supplies and siltation. Strong flows may detach weakly attached organisms. Changes in the overall habitat, through changing grain size in sediments may also occur. While many species are present in a variety of tidal flow conditions, impacts are unlikely. However, the potential may exist for impacts if A. fragilis, E. timida, A. sarsi or blue mussel beds are present.

Changes in tidal flows and fluxes in Sublittoral macrophyte-dominated sediment (including BAP habitats maerl beds, tidal water coral reefs, horse mussel beds, blue mussel beds) due to moorings (offshore), on filter feeders (i.e. M. modiolus, A. digitatum and A. fragilis) from reduced food supplies and siltation. Strong flows may detach weakly attached organisms. Changes in the overall habitat, through changing grain size in sediments may also occur. While many species are present in a variety of tidal flow conditions, impacts are unlikely. However, the potential may exist for impacts if A. fragilis, E. timida, A. sarsi or blue mussel beds are present.
present a potential risk to BAP species such as mussel beds, M. edulis, and filter feeders, with secondary impacts up the food chain (i.e. affecting predatory species that feed on them). The potential for scouring in a range of BAP habitats has been identified for offshore devices:

- Increased scour and potential for deposition of sediment (i.e. smothering, inhibiting respiration, feeding and growth) in sublittoral coarse sediment (including BAP habitats subtidal sands and gravel, blue mussel beds) if A. fragilis, C. cruoriaeformis, D. Montagnei, E. timida or horse mussel beds are present.
- Increased scour and deposition of sediment (i.e. smothering, inhibiting respiration, feeding and growth) in Sublittoral sand (including BAP habitat subtidal sands and gravel, blue mussel beds) if A. fragilis, E. timida, A sarsi or blue mussel beds are present.
- Increased scour and deposition of sediment (i.e. smothering, inhibiting respiration, feeding and growth) in Sublittoral mixed sediments (including BAP habitat Horse mussel beds, file shell beds). Considered unlikely but has potential for impacts if A. fragilis, D. Montagnei, E. timida, A sarsi, horse mussel beds or file shell beds are present.
- Increased scour and deposition of sediment (i.e. smothering, inhibiting respiration, feeding and growth) in Sublittoral macrophyte-dominated sediment (including BAP habitats maerl beds, tidal swept channels, horse mussel beds, blue mussel beds). Considered unlikely, but noted as a potential impact particularly if C. Montagnei.

Scouring and Deposition
While likely site specific, the presence of mooring systems associated with these devices may present a potential risk to BAP species such as mussel beds, M. edulis, and filter feeders, with secondary impacts up the food chain (i.e. affecting predatory species that feed on them). The potential for scouring in a range of BAP habitats has been identified:

- Increased scour in sublittoral coarse sediment (including BAP habitats subtidal sands and gravel, blue mussel beds) if A. fragilis, C. cruoriaeformis, D. Montagnei, E. timida or horse mussel beds are present. Also potential for deposition of sediment due to moorings was raised due to the potential presence of these species.
- Scouring in Sublittoral sand (including BAP habitat subtidal sands and gravel, blue mussel beds) if A. fragilis, E. timida, A sarsi or blue mussel beds are present. Also potential for deposition of sediment due to moorings was raised due to the potential presence of these species.
- Scouring in Sublittoral mixed sediments (including BAP habitat Horse mussel beds, file shell beds) if A. fragilis, D. Montagnei, E. timida, A sarsi, horse mussel beds or file shell beds are present. Also potential for deposition of sediment due to moorings was raised due to the potential presence of these species.
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- Scouring in Sublittoral mixed sediments (including BAP habitat Horse mussel beds, file shell beds) if A. fragilis, D. Montagnei, E. timida, A sarsi, horse mussel beds or file shell beds are present. Also potential for deposition of sediment due to moorings was raised due to the potential presence of these species.
- Scouring in Sublittoral mixed sediments (including BAP habitat Horse mussel beds, file shell beds) if A. fragilis, D. Montagnei, E. timida, A sarsi, horse mussel beds or file shell beds are present. Also potential for deposition of sediment due to moorings was raised due to the potential presence of these species.
- Scouring in Sublittoral mixed sediments (including BAP habitat Horse mussel beds, file shell beds) if A. fragilis, D. Montagnei, E. timida, A sarsi, horse mussel beds or file shell beds are present. Also potential for deposition of sediment due to moorings was raised due to the potential presence of these species.
- Scouring in Sublittoral mixed sediments (including BAP habitat Horse mussel beds, file shell beds) if A. fragilis, D. Montagnei, E. timida, A sarsi, horse mussel beds or file shell beds are present. Also potential for deposition of sediment due to moorings was raised due to the potential presence of these species.
- Scouring in Sublittoral mixed sediments (including BAP habitat Horse mussel beds, file shell beds) if A. fragilis, D. Montagnei, E. timida, A sarsi, horse mussel beds or file shell beds are present. Also potential for deposition of sediment due to moorings was raised due to the potential presence of these species.
- Scouring in Sublittoral mixed sediments (including BAP habitat Horse mussel beds, file shell beds) if A. fragilis, D. Montagnei, E. timida, A sarsi, horse mussel beds or file shell beds are present. Also potential for deposition of sediment due to moorings was raised due to the potential presence of these species.

Submerged Pressure Differences
Deposition of sediment (i.e. smothering, inhibiting respiration, feeding and growth) in sublittoral coarse sediment (including BAP habitats subtidal sands and gravel, blue mussel beds) if A. fragilis, C. cruoriaeformis, D. Montagnei, E. timida or horse mussel beds present.

Potential for increased scouring and deposition of sediment (i.e. smothering, inhibiting respiration, feeding and growth) in Sublittoral sand (including BAP habitat subtidal sands and gravel, blue mussel beds) if A. fragilis, E. timida, A sarsi or blue mussel beds are present.

Potential for increased scouring and deposition of sediment (i.e. smothering, inhibiting respiration, feeding and growth) in Sublittoral sand (including BAP habitat subtidal sands and gravel, blue mussel beds) if A. fragilis, E. timida, A sarsi or blue mussel beds are present.

Potential for increased scouring and deposition of sediment (i.e. smothering, inhibiting respiration, feeding and growth) in Sublittoral sand (including BAP habitat subtidal sands and gravel, blue mussel beds) if A. fragilis, E. timida, A sarsi or blue mussel beds are present.

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Potential for increased scouring and deposition of sediment (i.e. smothering, inhibiting respiration, feeding and growth) in Sublittoral sand (including BAP habitat subtidal sands and gravel, blue mussel beds) if A. fragilis, E. timida, A sarsi or blue mussel beds are present.

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Potential for increased scouring and deposition of sediment (i.e. smothering, inhibiting respiration, feeding and growth) in Sublittoral sand (including BAP habitat subtidal sands and gravel, blue mussel beds) if A. fragilis, E. timida, A sarsi or blue mussel beds are present.

Potential for increased scouring and deposition of sediment (i.e. smothering, inhibiting respiration, feeding and growth) in Sublittoral sand (including BAP habitat subtidal sands and gravel, blue mussel beds) if A. fragilis, E. timida, A sarsi or blue mussel beds are present.

Potential for increased scouring and deposition of sediment (i.e. smothering, inhibiting respiration, feeding and growth) in Sublittoral sand (including BAP habitat subtidal sands and gravel, blue mussel beds) if A. fragilis, E. timida, A sarsi or blue mussel beds are present.

Potential for increased scouring and deposition of sediment (i.e. smothering, inhibiting respiration, feeding and growth) in Sublittoral sand (including BAP habitat subtidal sands and gravel, blue mussel beds) if A. fragilis, E. timida, A sarsi or blue mussel beds are present.
The placement of offshore or near-shore devices, and/or their moorings on seabed can result in damage to benthic habitats, or their loss in extreme instances (e.g. seabed structures, piling, drilling and anchoring, subsea cable placement).

This could also include additional damage such as the abrasion of benthic areas by mooring lines in the placement process. The potential for abrasion of marine habitats and sessile/sedentary species (i.e. BAP species such as mussel and file shell beds) from the installation of infrastructure

### Potential for Scouring

- Scouring in Sublittoral biogenic reefs (including BAP habitat blue mussel beds) if blue mussel beds are present. While deposition unlikely in high-energy environments, raised as potential issue due to presence of BAP habitats.
- Potential for deposition of sediment in features of littoral sediment (including BAP habitat blue mussel beds) if blue mussel beds are present. May impact on habitat character.
- Potential for deposition of sediment on filter feeders in circalittoral rock features. Potential for deposition of sediment from device and potential deposition of sediment due to moorings was raised due to the potential presence of these species.
- Scouring in Sublittoral biogenic reefs (including BAP habitats horse mussel beds, cold-water coral reefs and blue mussel beds) if horse mussel beds, cold water coral reefs or blue mussel beds are present. Also potential for deposition of sediment due to moorings was raised due to the potential presence of these species.
- Potential for deposition of sediments at moorings in littoral biogenic reefs (including BAP habitat blue mussel beds) if blue mussel beds are present. While deposition unlikely in high-energy environments, raised as potential issue due to presence of BAP habitats.
- Potential for deposition of sediments due to moorings in littoral biogenic reefs (including BAP habitat blue mussel beds) if blue mussel beds are present. While deposition unlikely in high-energy environments, raised as potential issue due to presence of BAP habitats.
- Potential for deposition of sediment due to moorings in features of littoral sediment (including BAP habitat blue mussel beds) if blue mussel beds are present. May impact on habitat character.

### Loss of Habitat/Abrasion

The placement of moorings on the seabed can result in damage to macrophyte-dominated sediment (including BAP habitats maerl beds, tidal swift channels, horse mussel beds, blue mussel beds) if C. cruroideaformis, D. Montagnei, P. calcareaum, L. corallioideas, horse mussel beds or maerl beds are present.

- Increased scour at high tide, and deposition of sediment on algal frond surfaces in high energy littoral reef (including BAP habitat Tidal Swept Channels) if horse mussel beds are present. Increased scouring and deposition at high tide in features of littoral sediment (including BAP habitats horse mussel beds, cold-water coral reefs and blue mussel beds) if horse mussel beds are present. Increased scouring and deposition of sediments in high energy littoral reef (including BAP habitat Tidal Swept Channels) if horse mussel beds are present.
- Potential for deposition of sediment on filter feeders in circalittoral rock features. Increased scour and deposition of sediment due to moorings was raised due to the potential presence of these species.
- Scouring in Sublittoral biogenic reefs (including BAP habitats horse mussel beds, cold-water coral reefs and blue mussel beds) if horse mussel beds, cold water coral reefs or blue mussel beds are present. Also potential for deposition of sediment due to moorings was raised due to the potential presence of these species.
- Potential for deposition of sediments at moorings in littoral biogenic reefs (including BAP habitat blue mussel beds) if blue mussel beds are present. While deposition unlikely in high-energy environments, raised as potential issue due to presence of BAP habitats.
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- Potential for deposition of sediment due to moorings in littoral biogenic reefs (including BAP habitat blue mussel beds) if blue mussel beds are present. While deposition unlikely in high-energy environments, raised as potential issue due to presence of BAP habitats.

### Potential for Deposition of Sediment

- Increased scour at high tide, and deposition of sediment on algal frond surfaces in high energy littoral reef (including BAP habitat Tidal Swept Channels) if horse mussel beds are present. Increased scouring and deposition of sediment in Sublittoral biogenic reefs (including BAP habitats horse mussel beds, cold-water coral reefs and blue mussel beds) if horse mussel beds are present. Increased scouring and deposition of sediment in Sublittoral biogenic reefs (including BAP habitats horse mussel beds, cold-water coral reefs and blue mussel beds) if horse mussel beds are present. Increased scouring and deposition of sediment in Sublittoral biogenic reefs (including BAP habitats horse mussel beds, cold-water coral reefs and blue mussel beds) if horse mussel beds are present. Increased scouring and deposition of sediment in Sublittoral biogenic reefs (including BAP habitats horse mussel beds, cold-water coral reefs and blue mussel beds) if horse mussel beds are present. Increased scouring and deposition of sediment in Sublittoral biogenic reefs (including BAP habitats horse mussel beds, cold-water coral reefs and blue mussel beds) if horse mussel beds are present. Increased scouring and deposition of sediment in Sublittoral biogenic reefs (including BAP habitats horse mussel beds, cold-water coral reefs and blue mussel beds) if horse mussel beds are present. Increased scouring and deposition of sediment in Sublittoral biogenic reefs (including BAP habitats horse mussel beds, cold-water coral reefs and blue mussel beds) if horse mussel beds are present. Increased scouring and deposition of sediment in Sublittoral biogenic reefs (including BAP habitats horse mussel beds, cold-water coral reefs and blue mussel beds) if horse mussel beds are present. Increased scouring and deposition of sediment in Sublittoral biogenic reefs (including BAP habitats horse mussel beds, cold-water coral reefs and blue mussel beds) if horse mussel beds are present. Increased scouring and deposition of sediment in Sublittoral biogenic reefs (including BAP habitats horse mussel beds, cold-water coral reefs and blue mussel beds) if horse mussel beds are present. Increased scouring and deposition of sediment in Sublittoral biogenic reefs (including BAP habitats horse mussel beds, cold-water coral reefs and blue mussel beds) if horse mussel beds are present. Increased scouring and deposition of sediment in Sublittoral biogenic reefs (including BAP habitats horse mussel beds, cold-water coral reefs and blue mussel beds) if horse mussel beds are present. Increased scouring and deposition of sediment in Sublittoral biogenic reefs (including BAP habitats horse mussel beds, cold-water coral reefs and blue mussel beds) if horse mussel beds are present. Increased scouring and deposition of sediment in Sublittoral biogenic reefs (including BAP habitats horse mussel beds, cold-water coral reefs and blue mussel beds) if horse mussel beds are present. Increased scouring and deposition of sediment in Sublittoral biogenic reefs (including BAP habitats horse mussel beds, cold-water coral reefs and blue mussel beds) if horse mussel beds are present. Increased scouring and deposition of sediment in Sublittoral biogenic reefs (including BAP habitats horse mussel beds, cold-water coral reefs and blue mussel beds) if horse mussel beds are present. Increased scouring and deposition of sediment in Sublittoral biogenic reefs (including BAP habitats horse mussel beds, cold-water coral reefs and blue mussel beds) if horse mussel beds are present. Increased scouring and deposition of sediment in Sublittoral biogenic reefs (including BAP habitats horse mussel beds, cold-water coral reefs and blue mussel beds) if horse mussel beds are present. Increased scouring and deposition of sediment in Sublittoral biogenic reefs (including BAP habitats horse mussel beds, cold-water coral reefs and blue mussel beds) if horse mussel beds are present. Increased scouring and deposition of sediment in Sublittoral biogenic reefs (including BAP habitats horse mussel beds, cold-water coral reefs and blue mussel beds) if horse mussel beds are present. Increased scouring and deposition of sediment in Sublittoral biogenic reefs (including BAP habitats horse mussel beds, cold-water coral reefs and blue mussel beds) if horse mussel beds are present. Increased scouring and deposition of sediment in Sublittoral biogenic reefs (including BAP habitats horse mussel beds, cold-water coral reefs and blue mussel beds) if horse mussel beds are present. Increased scouring and deposition of sediment in Sublittoral biogenic reefs (including BAP habitats horse mussel beds, cold-water coral reefs and blue mussel beds) if horse mussel beds are present. Increased scouring and deposition of sediment in Sublittoral biogenic reefs (including BAP habitats horse mussel beds, cold-water coral reefs and blue mussel beds) if horse mussel beds are present.
Offshore devices, can result in damage to benthic habitats, and in some instances lead to the loss of habitat (e.g. the placement of shoreline devices, seabed structures including gravity base structures, piling, drilling and anchoring, subsea cable placement). This can also include additional damage such as the abrasion of benthic areas by mooring lines in the installation process. The potential for abrasion of marine habitats and sessile/sedentary species (i.e. BAP species such as mussel and file shell beds) from the installation of infrastructure (i.e. mooring cables dragging during installation) and subsea cabling (i.e. placement and dragging during installation and operation) has been identified at:

- Atlantic and Mediterranean high energy circalittoral rock
- Sublittoral coarse sediment (including BAP habitats horse mussel beds, file shell beds)
- Sublittoral macrophyte-dominated sediment (including BAP habitats horse mussel beds, file shell beds)
- Sublittoral biogenic reefs (including BAP habitats horse mussel beds, cold-water coral reefs and blue mussel beds)

Benthic habitats, and in some instances, their loss (e.g. seabed structures, piling, drilling and anchoring, subsea cable placement). This can also include additional damage such as the abrasion of benthic areas by mooring lines in the installation process. The potential for abrasion of marine habitats and sessile/sedentary species (i.e. BAP species such as mussel and file shell beds) from the installation of infrastructure (i.e. mooring cables dragging during installation) and subsea cabling (i.e. placement and dragging during installation and operation) has been identified at:

- Atlantic and Mediterranean high energy circalittoral rock
- Sublittoral coarse sediment (including BAP habitats horse mussel beds, file shell beds)
- Sublittoral macrophyte-dominated sediment (including BAP habitats horse mussel beds, file shell beds)
- Sublittoral biogenic reefs (including BAP habitats horse mussel beds, cold-water coral reefs and blue mussel beds)

Increased scouring and deposition of sediment (i.e. smothering, inhibiting respiration, feeding and growth) in Sublittoral coarse sediment (including BAP habitats subtidal sands and gravel, horse mussel beds). Sublittoral sand (including BAP habitat subtidal sands and gravel, blue mussel beds). Sublittoral mixed sediments (including BAP habitat Horse mussel beds, file shell beds). Sublittoral macrophyte-dominated sediment (including BAP habitats maerl beds, tidal sweep channels, horse mussel beds, blue mussel beds). Sublittoral biogenic reefs (including BAP habitats horse mussel beds, cold-water coral reefs and blue mussel beds).

Potential for increased scouring in Sublittoral biogenic reefs (including BAP habitats horse mussel beds, cold-water coral reefs and blue mussel beds) if horse mussel beds, cold water coral reefs or blue mussel beds are present. Potential for deposition of sediment associated with moorings on filter feeders in circalittoral rock features. Included due to potential for impacts (i.e. smothering) although this is considered unlikely for arrays up to 10MW.

Loss of Habitat/Abrasion

The placement of shoreline devices, and seabed moorings for offshore devices, can result in damage to benthic habitats, and in some instances lead to the loss of habitat (e.g. the placement of shorelines, seabed structures including gravity base structures, piling, drilling and anchoring, subsea cable placement). In such instances sessile or sedentary species would be affected, and even small amounts of lost habitat may diminish species populations, particularly rare or vulnerable populations. However, the extent of impacts would likely be site-specific.

The potential for abrasion of marine habitats and sessile/sedentary species (i.e. BAP species such as mussel and file shell beds) from the installation of infrastructure (i.e. mooring cables dragging during installation) and subsea cabling (i.e. placement and dragging during installation and operation) has been identified at:

- Atlantic and Mediterranean high energy circalittoral rock
- Sublittoral coarse sediment (including BAP habitats subtidal sands and gravel, horse mussel beds)
- Sublittoral sand (including BAP habitat subtidal sands and gravel, blue mussel beds)
- Sublittoral mixed sediments (including BAP habitat Horse mussel beds, file shell beds)
- Sublittoral macrophyte-dominated sediment (including BAP habitats maerl beds, tidal sweep channels, horse mussel beds, blue mussel beds).
- Sublittoral biogenic reefs (including BAP habitats horse mussel beds, cold-water coral reefs and blue mussel beds)

Potential for increased scouring in Sublittoral biogenic reefs (including BAP habitats horse mussel beds, cold-water coral reefs and blue mussel beds) if horse mussel beds, cold water coral reefs or blue mussel beds are present.
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*Loss of Habitat/Abrasion*

The placement of these devices, and their support structures on the seabed can result in damage to benthic habitats, and loss of habitat in extreme instances (e.g. seabed structures, piling, drilling and anchoring, subsea cable placement). This could also include additional damage such as the abrasion of benthic areas, particularly from support structure lines in the installation/placement process.

The potential for abrasion of marine habitats and sessile/sedentary species (i.e. BAP species such as mussel and file shell beds) from the installation of infrastructure (i.e. support structure cables dragging during installation) and subsea cabling (i.e. placement and dragging during installation and operation) has been identified at:

- Atlantic and Mediterranean high energy infralittoral rock (including BAP habitat Tidal Swept Channels).
- Atlantic and Mediterranean moderate energy infralittoral rock (including BAP habitat Tidal Swept Channels).
- Atlantic and Mediterranean high energy circalittoral rock.
- Atlantic and Mediterranean moderate energy circalittoral rock.
- Sublittoral coarse sediment (including BAP habitats subtidal sands and gravel, horse mussel beds).
- Sublittoral sand (including BAP habitat sub-tidal sands and gravel, horse mussel beds).
- Sublittoral macrophyte-dominated sediment.

Loss of Habitat/Abrasion

The placement of offshore, near-shore or shoreline devices, and/or their moorings on the seabed, can result in damage to benthic habitats, or in some instances lead to the loss of habitat (e.g. the placement of shoreline devices, seabed structures including gravity base structures, piling, drilling and anchoring, subsea cable placement). In such instances sessile or sedentary species would be affected, and even small amounts of lost habitat may diminish or displace species populations, particularly those that are rare or vulnerable. The extent of impacts would likely be site-specific.

The potential for abrasion of marine habitats and sessile/sedentary species (i.e. BAP species such as mussel and file shell beds) from the installation of infrastructure (i.e. mooring cables dragging during installation) and subsea cabling (i.e. placement and dragging during installation and operation) has been identified at:

- Atlantic and Mediterranean high energy circalittoral rock (including BAP habitat Tidal Swept Channels).
- Atlantic and Mediterranean moderate energy circalittoral rock.
- Sublittoral coarse sediment (including BAP habitats subtidal sands and gravel, horse mussel beds).
- Sublittoral sand (including BAP habitat sub-tidal sands and gravel, blue mussel beds).
- Sublittoral mixed sediments (including BAP habitat Horse mussel beds, file shell beds).
- Sublittoral macrophyte-dominated sediment.
### SEA Topic Areas

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<td>Sublittoral mixed sediments (including BAP habitat Horse mussel beds, file shell beds).</td>
<td>Sublittoral macrophyte-dominated sediment (including BAP habitats maerl beds, tidal swept channels, horse mussel beds, blue mussel beds).</td>
<td>Sublittoral biogenic reefs (including BAP habitats horse mussel beds, cold-water coral reefs and blue mussel beds).</td>
<td>Sublittoral macrophyte-dominated sediment (including BAP habitats maerl beds, tidal swept channels, horse mussel beds, blue mussel beds).</td>
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</tr>
</tbody>
</table>

### Population and human health

Summary of key potential effects on population and human health:
- Displaced/increased shipping density.
- Reductions in the safety of navigation.
- Risk of collision of recreational or commercial shipping with installation vessels and operational devices, particularly for devices and vessels that are low in the water and in high waves.
- Access restrictions – the presence of devices in the water may restrict or reduce access to key recreational sailing areas or other water sports.

Key measures to prevent adverse effects may include: siting devices away from spatially constrained areas and areas with high vessel densities; siting devices in open water; making use of industry guidance on assessment of effects and use of aids to navigation; use of notifications such as ‘Notices to Mariners’, publicising information at marina, and Sailing Directions; and adhering to appropriate safety regulations.

### Water and marine environment

Summary of key potential effects on water quality include:
- Disturbance of contaminated sediments during device installation, e.g. disposal sites (silt, sand, rock and gravel sites, fish wastes and sludge); munitions dumps, and weapons ranges.

### Potential for impacts from local changes in wave energy dissipation and deposition due to the presence of these devices in the water column, and for changes to sediment dynamics, scouring, and deposition

- Potential for impacts from local changes in wave energy dissipation, changes to sediment dynamics, scouring, deposition, tidal flows and fluxes, water turbidity and water turbulence
- Potential for impacts from local changes in water turbulence due to the presence of these devices and their moorings. The potential may also exist for changes to sediment dynamics, and changes to sediment dynamics


### SEA Topic Areas

<table>
<thead>
<tr>
<th>Point Absorbers and Rotating Mass Devices</th>
<th>Attenuators and Buoy Wave Devices</th>
<th>Oscillating Wave Surge Converters</th>
<th>Submerged Pressure Differential</th>
<th>Oscillating Water Column (Offshore and Shoreline)</th>
<th>Overtopping Device (Offshore and Shoreline)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contamination, tidal flows and fluxes and water turbulence associated with the presence of mooring cables and structures on the seabed.</td>
<td>Deposition, tidal flows and fluxes and water turbulence associated with the presence of mooring cables and structures on the seabed.</td>
<td>Associated with the presence of these devices and their support structures mounted on the seabed.</td>
<td>Scouring (associated with gravity based structures, if used), vibration, deposition, tidal flows and fluxes, water turbidity and water turbulence associated with the presence of these devices in the water column and their support structures mounted on the seabed.</td>
<td>(shoreline), scouring (shoreline associated with moorings, i.e. gravity based structures, etc.), dissipation of wave energy (offshore), water turbidity and water turbulence (both shoreline) associated with the presence of these devices and their support structures. The potential for installation impacts such as water turbidity and contamination risks associated with installation and operation (e.g. leakage from vessels or equipment).</td>
<td>(shoreline), scouring (shoreline associated with outflows, and offshore associated with moorings, i.e. gravity based structures, etc.), dissipation of wave energy (offshore), changes in coastal processes and profile (both shoreline and offshore), water turbidity and water turbulence (both shoreline) associated with the presence of these devices and their support structures. The potential for installation impacts such as water turbidity and contamination risks associated with installation and operation (e.g. leakage from vessels or equipment) was also identified.</td>
</tr>
</tbody>
</table>

### Climatic factors

- Potential for wave energy dissipation and, in some instances, may contribute to the protection of coast. The potential for wave energy dissipation and, in some instances, may contribute to the protection of coastlines susceptible to erosion (i.e. Firth of Clyde). Likely contribution to renewable energy generation and reduction in GHG emissions (i.e. displacement of energy generated from non-renewable sources). Potential for wave energy dissipation and, in some instances, may contribute to the protection of coastlines susceptible to erosion (i.e. Firth of Clyde). Likely contribution to renewable energy generation and reduction in GHG emissions (i.e. displacement of energy generated from non-renewable sources). Likely contribution to renewable energy generation and reduction in GHG emissions (i.e. displacement of energy generated from non-renewable sources). Potential for wave energy dissipation (offshore) and changes to coastal profile and character. The placement of shoreline devices may contribute to the protection of coastlines susceptible to erosion (i.e. Firth of Clyde). Likely contribution to renewable energy generation and reduction in GHG emissions (i.e. displacement of energy generated from non-renewable sources). Potential for wave energy dissipation (offshore), changes to coastal processes and character/profile. The placement of these devices, in some instances, may contribute to the protection of coastlines susceptible to erosion (i.e. Firth of Clyde). Likely contribution to renewable energy generation and reduction in GHG emissions (i.e. displacement of energy generated from non-renewable sources). |

### Marine geology and coastal processes

- Summary of key potential effects on geology:
  - Disturbance or damage to coastal Geological SSSIs and Geological Conservation Review sites (GCRs)
  - Changes in coastal processes due to energy extraction, seabed contamination and water quality (including disposal areas)
- Potential for impacts from local changes in wave energy dissipation and deposition due to the presence of these devices in the water column, and for changes to sediment dynamics, scouring, deposition, tidal flows and fluxes, potential for impacts from local changes in wave energy (i.e. dissipation) due to the presence of these devices and their support structures mounted on the seabed. Potential for changes to sediment dynamics, scouring, deposition, tidal flows and fluxes, water turbidity and water turbulence associated with the presence of these devices and their support structures mounted on the seabed. The potential may also exist for changes to sediment dynamics, scouring (associated with gravity based structures, if used), vibration, deposition, tidal flows and fluxes, water turbidity and water turbulence associated with the presence of these devices in the water column and their support structures mounted on the seabed. | Potential for impacts from local changes in wave energy (i.e. dissipation) due to the presence of these devices and their support structures mounted on the seabed. Potential for changes to sediment dynamics, scouring, deposition, tidal flows and fluxes, water turbidity and water turbulence associated with the presence of these devices and their support structures mounted on the seabed. 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### SEA Areas

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<thead>
<tr>
<th>Point Absorbers and Rotating Mass Devices</th>
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<th>Oscillating Water Column (Offshore and Shoreline)</th>
<th>Overtopping Device (Offshore and Shoreline)</th>
</tr>
</thead>
<tbody>
<tr>
<td>water turbulence and direct abrasion on the seabed associated with the presence of moorings cables and structures.</td>
<td>associated with the presence of moorings cables and structures.</td>
<td>the presence of these devices and their support structures mounted on the seabed.</td>
<td>based structures, if used, vibration, deposition, tidal flows and fluxes, water turbidity and water turbulence associated with the presence of these devices in the water column and their support structures mounted on the seabed.</td>
<td>increased scouring and from changes to coastal processes and profiles (shoreline devices), and for seabed or coastal habitat disturbance/loss during installation, and abrasion of marine geology in installation of mooring systems and subsea cabling.</td>
<td>increased scouring and from changes to coastal processes (i.e. sediment dynamics, wave dissipation and tidal fluxes) during operation, and for seabed disturbance during installation (i.e. loss of habitat) and abrasion of marine geology in installation of mooring systems and subsea cabling.</td>
</tr>
</tbody>
</table>

### Historic Environment

Summary of key potential effects on marine and coastal historic environment include:

- Direct disturbance, damage, or destruction of submarine archaeological remains and wrecks during device installation and cable trenching;
- Direct disturbance, damage or destruction of coastal archaeological remains during cable trenching (effects of grid connections are considered separately below);
- Disturbance, damage or loss of archaeological remains and species associated with installation and cable overhead lines and substation construction from onshore grid connections.

Key measures to prevent adverse effects may include: avoid sites of interest and exclusion zones for protected sites; follow Crown Estates 2007 JNAPC Code of Practice for seabed developers; carry out seabed surveys and walkover surveys prior to installation; carry out detailed routing studies at project level in accordance with 'Holford Rules' best practice guidance on routing overhead transmission lines.

<table>
<thead>
<tr>
<th>Potential Effects</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>There is the potential for placement of device moorings (i.e. gravity-base, anchors, etc.) on known and designated historic sites, and on unknown sites (i.e. wrecks). The potential may also exist for adverse effects on historic sites located nearby or downstream during operation (i.e. scouring, deposition/siltation or abrasion from moorings; deposition/siltation from the presence of devices).</td>
<td>Adverse effects are likely to be avoided through careful siting of individual device moorings, although this may be more difficult for larger gravity bases or arrays of bases. Pre-construction impacts can result from intrusive site investigation. Construction effects as a result of device installation, in particular from moorings, chains and cables. In particular as a result of piling and preparation of the seabed disturbing historic features. Secondary effects from construction might arise from vessels anchoring and from temporary visual impacts on the seabed.</td>
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<td>There is the potential for placement of device support structures on known and designated historic sites, and on unknown sites (i.e. wrecks). The potential may also exist for adverse effects on historic sites located nearby or downstream during operation (i.e. scouring, deposition/siltation or abrasion from moorings). Adverse effects are likely to be avoided through careful siting of individual device support structures, although this may be more difficult for larger seabed-mounted structures or groups of structures. Pre-construction impacts can result from intrusive site investigation. Construction effects as a result of device installation, in particular from moorings, chains and cables. In particular as a result of piling and preparation of the seabed disturbing historic features. Secondary effects from construction might arise from vessels anchoring and from temporary visual impacts on the seabed.</td>
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<tr>
<td>There is the potential for placement of offshore mooring structures or shoreline devices on known and designated historic sites, and on unknown sites (i.e. wrecks). The potential may also exist for adverse effects on historic sites located nearby or downstream during operation (i.e. scouring, deposition/siltation or abrasion from offshore support structures). Adverse effects are likely to be avoided through careful siting of individual device support structures, although this may be more difficult for larger gravity bases or arrays of bases. Pre-construction impacts can result from intrusive site investigation. Construction effects as a result of device installation, in particular from moorings, chains and cables. In particular as a result of piling and preparation of the seabed disturbing historic features. Secondary effects from construction might arise from vessels anchoring and from temporary visual impacts on the seabed.</td>
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<tr>
<td></td>
<td>Setting of historic features</td>
<td>Associated cables and grid could directly impact on archaeological features on the seabed.</td>
<td>Operational effects are more limited Mooring requires lengthy chains and cables that rest on the sea bed and these can cause damage to heritage assets. Changes to sediment processes and associated coastal erosion might cause impacts on some resources but may also help to reduce energy reaching shore and some erosion related heritage impacts. Visual impacts for the setting of historic features during operation, construction and decommissioning.</td>
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<td>Despite having a low profile comprising units on or above the water surface (i.e. Pelamis, bulge wave devices), these devices may have the potential to alter the aesthetic character of the coastline if placed in near-shore areas, particularly if surface-piercing support structures are also present. In general terms, effects may the low profile of surface-piercing structures above the water surface may have the potential to alter the aesthetic character of the coastline, particularly if navigational lighting is used (i.e. noise and visual impacts). No surface-piercing components, therefore no impacts identified during operation. There may potentially be temporary impacts during installation or decommissioning.</td>
<td>The presence of surface-piercing devices, structures and marker buoys (e.g. lights for navigation) may have the potential to alter the aesthetic character of the coastline, particularly if located near-shore and in large numbers. In general terms, 8 out of the 10 seascape types are of high sensitivity to point structures such as the surface-piercing structures on the seabed.</td>
<td>Vessels anchoring and from temporary visual impacts on the setting of historic features Associated cables and grid could directly impact on archaeological features on the seabed. Operational effects are more limited Mooring requires lengthy chains and cables that rest on the sea bed and these can cause damage to heritage assets. Changes to sediment processes and associated coastal erosion might cause impacts on some resources but may also help to reduce energy reaching shore and some erosion related heritage impacts. Visual impacts for the setting of historic features during operation, construction and decommissioning.</td>
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</tr>
<tr>
<td>Summary of key potential effects on land/seascape include:</td>
<td>For linear structures, with devices at 0-5km from the coastline, effects may occur for all seascape types. The further from the coast, the less the effect becomes, and beyond 10km the effects are typically minor. For point structures, 8 out of the 10 seascape types are of high sensitivity to these types of device, with potential effects occurring at 0-10km from coastline. Moderate effects may also occur at distances over 10km. Submerged structures are likely to have negligible effects on seascape (although marker buoys and lighting may be required) Fixed coastal structures may have moderate effects depending on their design and location. Landscape and visual intrusion from substations and overhead lines as onshore grid connections. Key measures to prevent adverse effects may include: maximising the distance of devices from shore; reducing the height of devices above the surface; reducing the area of sea occupied by the devices; and modifying the position and layout of devices to suit characteristics of the local seascape; carry out detailed routing studies at project level in accordance with ‘Holford Rules’ best practice guidance on routing overhead transmission lines; avoid sensitive sites and areas; provide screening (substations).</td>
<td>The profile of surface-piercing structures above the water surface (offshore) or on the shoreline (shoreline) may have the potential to alter the aesthetic character of the coastline (i.e. noise and visual impacts). The profile of surface-piercing structures above the water surface (offshore) or on the shoreline (shoreline) may have the potential to alter the aesthetic character of the coastline (i.e. noise and visual impacts).</td>
<td>In general, 8 out of the 10 seascape types are of high sensitivity to point structures such as the surface-piercing structures on the seabed. Despite having a low profile comprising units on or above the water surface (i.e. Pelamis, bulge wave devices), these devices may have the potential to alter the aesthetic character of the coastline if placed in near-shore areas, particularly if surface-piercing support structures are also present. In general terms, effects may the low profile of surface-piercing structures above the water surface may have the potential to alter the aesthetic character of the coastline, particularly if navigational lighting is used (i.e. noise and visual impacts). No surface-piercing components, therefore no impacts identified during operation. There may potentially be temporary impacts during installation or decommissioning.</td>
<td>The presence of surface-piercing devices, structures and marker buoys (e.g. lights for navigation) may have the potential to alter the aesthetic character of the coastline, particularly if located near-shore and in large numbers. In general terms, 8 out of the 10 seascape types are of high sensitivity to point structures such as the surface-piercing structures on the seabed. Despite having a low profile comprising units on or above the water surface (i.e. Pelamis, bulge wave devices), these devices may have the potential to alter the aesthetic character of the coastline if placed in near-shore areas, particularly if surface-piercing support structures are also present. In general terms, effects may the low profile of surface-piercing structures above the water surface may have the potential to alter the aesthetic character of the coastline, particularly if navigational lighting is used (i.e. noise and visual impacts). No surface-piercing components, therefore no impacts identified during operation. There may potentially be temporary impacts during installation or decommissioning.</td>
<td>The profile of surface-piercing structures above the water surface (offshore) or on the shoreline (shoreline) may have the potential to alter the aesthetic character of the coastline (i.e. noise and visual impacts).</td>
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<tr>
<th>SEA Topic Areas</th>
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</tr>
</thead>
<tbody>
<tr>
<td>this device, with the potential for effects occurring at 0-10km from coastline. Moderate effects may also occur at distances over 10km.</td>
<td>occur for all seascape types with the presence of linear surface-piercing structures on devices less than 5km from the coastline. The further from the coast, the less the effect becomes, and beyond 10km the effects are typically minor.</td>
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### Tidal technology

#### SEA Topic Areas

<table>
<thead>
<tr>
<th>Horizontal Axis Turbines</th>
<th>Vertical Axis Turbines</th>
<th>Reciprocating Hydrofoils</th>
<th>Emerging Technologies*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Device Information</strong>11</td>
<td><strong>Moving blades.</strong></td>
<td><strong>Moving blades.</strong></td>
<td><strong>Includes other emerging tidal technologies such as Venturi Effect or Enclosed Tip devices, Archimedes Screw and Tidal kite devices.</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Can be suspended as part of a floating array (i.e. with moorings), or mounted directly on the seabed (i.e. monopiles).</strong></td>
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<tr>
<td></td>
<td><strong>Support structure/moorings may include gravity/deadweight anchors, monopole, rock anchors or even gravity-base structures.</strong></td>
<td><strong>Support structure/moorings may include gravity/deadweight anchors, monopole, rock anchors or even gravity-base structures.</strong></td>
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<tr>
<td></td>
<td><strong>Potentially with surface-piercing components (i.e. monopole or pontoon support structures).</strong></td>
<td><strong>Potentially with surface-piercing components (i.e. pontoon support structures).</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Generating equipment housed in support structure.</strong></td>
<td><strong>Generating equipment housed in support structure.</strong></td>
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<tr>
<td></td>
<td><strong>Marker buoys and other navigational aids are likely required.</strong></td>
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</tr>
</tbody>
</table>

#### Biodiversity/flora/ fauna19

**Summary of key potential effects:**

- **Physical disturbance during device installation**
- **Noise during construction (particularly piling) and from device operation**
- **Risk of collision with operating devices during foraging and feeding/travel (e.g. migration)**
- **Accidental contamination from device failures, vessel collisions and storm damage**
- **Habitat exclusion and species displacement due to device presence and operation**
- **Increased mink predation due to the creation of islet chains between islands**
- **Barriers to movement – due to avoidance reactions to noise and risk of collision**
- **Increased suspended sediment/turbidity from seabed disturbance due to device installation and cable trenching**
- **Smothering from seabed disturbance during device installation and cable trenching**
- **Changes in tidal flow and wave regime due to device presence and operation**
- **Substratum loss, caused by attaching devices to the seabed**
- **Habitat and species loss/disturbance during installation of cables and overhead lines and substation construction from onshore grid connections**

**Key measures to prevent adverse effects may include:**

- Avoidance of sensitive sites; avoidance of sensitive seasons (e.g. breeding) during installation; use of devices with attachments that cause smaller seabed disturbance such as anchors and clump weights; protocols (such as use of Marine Mammal Observers) to ensure noisy construction activities do not occur when marine mammals are in close proximity; effective device design; and project-specific studies to help design appropriate mitigation; carry out detailed routing studies at project level in accordance with ‘Holford Rules’ best practice guidance on routing overhead transmission lines; avoid sensitive sites and areas; provide screening (substations).

#### Fauna:

<table>
<thead>
<tr>
<th></th>
<th><strong>Fauna:</strong></th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>Noise</strong></td>
<td><strong>Attraction of Fauna</strong></td>
<td><strong>Potential for fish aggregation during shutdown periods or slack water (i.e. turbines not moving).</strong></td>
<td><strong>With similarities in infrastructure and the overall presence of devices in within the water column to that of turbine and hydrofoil devices, many of the potential impacts identified in the columns to</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Potential for underwater noise impacts on marine fauna during drilling/installation works and operation has been identified. There may be potential for underwater noise impacts on marine fauna, particularly during drilling/installation works. Potential for</strong></td>
<td><strong>There may be a potential risk of physical injury</strong></td>
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</tbody>
</table>

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11 For some tidal technologies, the potential effects specific to an individual technology may be less well known due, in part, to technologies still being in development. Whilst they may provide solutions for development within draft plan options, any potential impacts for commercial scale deployment may not have been fully ascertained through approved research. In these instances professional judgement has been used to consider whether the effects of similar technologies would also be applicable.


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**References:**

be the potential for behavioural impacts to marine fauna (i.e. seals, cetaceans, otter, basking shark), but there are significant unknowns on disturbance effects (likely site-specific), and noise levels that are actually generated. Acute effects are considered unlikely.

The potential for impacts from above surface noise was identified for marine fauna, during installation works and where floating structures house noise-generating equipment. This potential impact relates to disturbance of species such as seals and otters, and these may be greater for devices located near to the shoreline. There are significant unknowns on disturbance effects (likely site-specific).

**Shock Waves**

The potential for shock waves was identified from the installation of monopiles and from waves hitting the side of high-profile surface-piercing structures. Hence, this is only applicable for devices with high-profile surface-piercing components. The likely magnitude of any impacts and their effects on these species is unknown, however, the potential for impacts to seals, cetaceans, otter and basking shark has been identified.

Those with low-profile components (i.e. floating structures) are unlikely to create shock waves.

**EMF**

While no EMF impacts have been identified from the devices, there is the potential for EMF impacts from underwater cabling and grid connections. Further information is required to determine the potential susceptibility of marine fauna and likely effects associated with this issue.

**Physical Barrier**

The introduction of new structures in the water column, potentially the whole water column with support structures in place, may disrupt movements or migration of marine fauna. Unknowns over movements and migration routes (i.e. cetaceans, basking sharks), patterns of movement of other species (i.e. seals, otters), whether moorings and devices will be perceived or if they will simply alter their movement accordingly. Near-shore devices may restrict movement more than offshore (e.g. potentially greater alternatives for movement around devices offshore).

Potential for fatal collisions for marine fauna with devices and moorings, particularly with moving turbine blades. Avoidance is likely for some species during periods of start-up (i.e. when the blades start moving), due to this aggregation.

**Noise**

Potential for underwater noise impacts on marine fauna, particularly during drilling/installation works. Potential for behavioural impacts to seals, cetaceans, otter and basking shark. But there are significant unknowns on disturbance effects (likely site-specific), and noise levels that are actually generated. Acute effects are considered unlikely.

The potential for impacts from above surface noise was identified for marine fauna, particularly during drilling/piling/installation works and where floating structures house noise-generating equipment. The potential relates to disturbance of species such as seals and otters, and these may be greater for devices near to the shoreline. There are significant unknowns on disturbance effects (likely site-specific).

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Potential for fatal collisions for marine fauna with devices and support structures/moorings. Collision with or entanglement in mooring lines is also considered possible for larger species (i.e. cetaceans and basking sharks), particularly in complex arrays. Avoidance is likely for many species (i.e. fish), but impact could be fatal for some species if it were to occur (i.e. seals, otters, cetaceans, basking shark). It is however, considered unlikely.
<table>
<thead>
<tr>
<th>Birds:</th>
<th>Collision</th>
<th>Potential collision risk with devices within the water column for shallow-diving birds. Collisions have the potential to be fatal for marine birds, which can dive to depths of up to 60m from the water surface (e.g. common guillermots, long-tailed ducks). This is likely to be of particular concern with the moving blades present on these devices.</th>
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<td>Impacts on foraging</td>
<td>Localised changes in turbulence from the presence and operation of devices (e.g. moving blades, presence of structures in the water column) may have the potential to affect the foraging success of marine birds. However, the potential effects are not currently known and may be difficult to identify a causal link between the two.</td>
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<tr>
<td>Noise</td>
<td>Potential noise risk, both above and below water surface, during installation and decommissioning works in particular (i.e. during piling, drilling for rock anchors, if used) and operation of blades below the water surface. Significant unknowns around the magnitude of impact, although it could potentially be</td>
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| Displacement | Displacement is likely to be site-specific and would depend on a range of other factors (suitable alternative sites, importance of habitat, etc.). Can be due to presence of devices or structures, or due to disturbance in installation, operation or decommissioning (i.e. noise, vibration, displacement of prey, etc.). Will also depend on what activities are being displaced (e.g. Basking sharks avoiding of structures or installation/servicing vessel activities may lead to the displacement of foraging activities or courtship behaviour). Others may simply choose alternative sites for foraging or as migratory routes if disturbed, if these are available. |
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<p>| Emerging Technologies* | Birds: With similarities in infrastructure and the overall presence of devices in within the water column to that of turbine and hydrofoil devices, many of the potential impacts identified in the columns to the left are likely to be associated with these emerging technologies. The potential for effects such as collision risk with devices and their associated structures (e.g. moorings), behavioural impacts (e.g. foraging) and disturbance from underwater noise on diving birds has been identified (see left). |</p>
<table>
<thead>
<tr>
<th>SEA Topic Areas</th>
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<td>Impact, although it has been identified as potentially damaging. Potential for noise impacts from generators within devices or their support structures for species, particularly for coastal breeding sites if devices are located in near-shore environment. Noise within devices is likely to be low and constant and the effects are unknown, as effects of increased/altered noise levels are not known for birds at present (displacement/avoidance, impacts to foraging success, etc.). It is noted that high energy environments are likely to have high levels of background noise. Underwater noise from the presence and operation of devices, the importance of hearing underwater for birds and their threshold levels is not currently known. As such the effects of altered underwater noise levels is not known, but potential impacts such as displacement, avoidance, reduction in foraging success, no effect, etc. have been identified.</td>
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<td><strong>Disturbance and Displacement</strong> Potential for displacement during installation and operation, but dependant on other factors (i.e. sensitivity of habitats, availability of suitable alternative habitats) and may only be temporary as fauna become accustomed to the devices. Likely dependant on site-specific including the sensitivity of species and the activities displaced (i.e. foraging, noise disturbance, etc.). Potential for visual disturbance if surface-piercing components are present, with potential for greater impacts if close to coastal breeding sites and moulting sites. In such instances, birds in flight may operate in a broadly similar way and use similar avoidance tactics to those employed when encountering other natural and man-made obstructions (i.e. by taking alternative flight routes, avoiding obstructions to a greater degree at night);</td>
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</tr>
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<td><strong>Benthic Habitats:</strong> Habitat Changes The presence of these devices in the water column and their supporting structures (i.e. moorings, monopole structures, etc.) has the potential to contribute to habitat changes in a number of ways. In general, impacts on seabed habitats from the devices themselves are likely limited to changes in tidal flows, fluxes and turbulence due to the presence of these devices and associated structures in the water column.</td>
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<td><strong>Benthic Habitats:</strong> Habitat Changes With the presence of tidal energy devices within the water column and the likelihood of seabed disturbance during installation, many of the potential impacts identified in the columns to the left are likely to be associated with these emerging technologies. In general terms, the potential for impacts on benthic habitats from the devices themselves is likely limited to loss of benthos from the installation of a device and its seabed mounting.</td>
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| water column. Other impacts, such as scouring, deposition/siltation, abrasion, smothering and the potential for loss of habitat are likely to be associated with the placement of supports (i.e. gravity and rock anchors, etc.) on the seabed and mooring lines in the water column. Direct seabed impacts such as changes in sediment dynamics, scouring, deposition/siltation and abrasion from supports and moorings have the potential to affect benthic habitats in a range of ways. These can include the introduction of variations and shifts in grain size of sediments affecting habitat character and species distribution; shading or smothering of benthic areas, changes in species distribution via interference with filter feeders (i.e. interference with feeding, inhibiting respiration, smothering, reproduction, loss of habitat, affecting species distribution, reducing food sources for other species, etc.), and leading to wider changes in ecosystem composition. In some instances, this may also result in changes to changing in coastal character/profile. 
Sediment Dynamics, Scour, deposition and Smothering Changes in sediment dynamics due to the presence of moorings for these devices (gravity anchors, gravity base structures, monopiles, rock anchors and mooring lines) may occur, with the potential for associated impacts such as scouring, deposition/siltation and abrasion. The potential for significant change to habitats has been identified. While likely site specific, this may present a potential risk to BAP species such as mussel beds, M. edulis, and filter feeders initially with secondary impacts up the food chain (i.e. affecting predatory species that feed on them). The potential for impacts in a range of BAP habitats has been identified:  
- Changes in sediment dynamics, increased scour and sediment deposition in High energy littoral rock (including BAP habitat Tidal Swep Channels) if F. distichus is present.  
- Changes in sediment dynamics, increased scour and the deposition of sediment during high tide in Moderate energy littoral (including BAP habitat Under boulder communities) if under boulder communities are present. Deposition may reduce photosynthesis for algae (i.e. F. serratus, F. vesticulosus, M. stellatula).  
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| (i.e. anchors, piling, etc.) to changes in tidal flows, fluxes and turbulence due to the presence of these devices and associated structures in the water column. The potential for associated effects (e.g. sediment deposition, scouring, smothering, abrasion, etc.) during the operational phase of a project has also been identified for a range of habitats (see left).
- Changes in sediment dynamics, increased scour, and deposition of sediment during high tide in Littoral biogenic reefs (including BAP habitat blue mussel beds) and interference with filter feeders (i.e. M. edulis, S. alveolata). Impacts are unlikely, but potential noted if blue mussel beds are present. Potential for changing the character of this habitat.

- Changes in sediment dynamics, increased scour and deposition of sediment in features of littoral sediment (including BAP habitat blue mussel beds) and interference with filter feeders (i.e. M. edulis). Impacts are unlikely, but potential noted if blue mussel beds are present. Potential for changing the character of this habitat.

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Although there may be the potential for interference with filter feeders (i.e. *M. modiolus*, *A. digitatum*, *M. edulis*, *A. fragilis*) and potential impacts have been identified if *A. fragilis*, *C. criouiaformis*, *D. Montagnei*, *P. calceareum*, *L. corallioides*, horse mussel beds, blue mussel beds of maerl beds are present

- Changes in sediment dynamics, and associated increased scour, deposition and smothering in Sublittoral biogenic reefs (i.e. BAP habitats horse mussel beds, cold-water coral reefs and blue mussel beds). Impacts are unlikely for a small array, although there may be the potential for interference with filter feeders (i.e. *M. modiolus*, *A. digitatum*, *M. edulis*, *A. fragilis*) and potential impacts have been identified if horse mussel beds, cold-water coral reefs or blue mussel beds are present.

- Changes in sediment dynamics in Atlantic and Mediterranean high energy infralittoral rock (including BAP habitat Tidal Swept Channels). Smothering may affect filter feeders (*S. pallida*, *U. feline*, *A. digitatum*, *B. schlosseri*, *H. panacea*) from feeding and growth, while photosynthesis by algae may be compromised. Potential for impacts on *S. pallida*, as even small impacts may have important influences on UK populations.

- Changes in sediment dynamics in Atlantic and Mediterranean high energy infralittoral rock (including BAP habitat Tidal Swept Channels). Smothering may affect filter feeders (*S. pallida*, *U. feline*, *A. digitatum*, *B. schlosseri*, *H. panacea*) from feeding and growth, while photosynthesis by algae may be compromised. Potential for impacts on *S. pallida*, as even small impacts may have important influences on UK populations.

- Changes in sediment dynamics in Atlantic and Mediterranean moderate energy infralittoral rock (including BAP habitat Tidal Swept Channels). Smothering may affect filter feeders (*S. pallida*, *U. feline*, *A. digitatum*, *B. schlosseri*, *H. panacea*) from feeding and growth, while photosynthesis by algae may be compromised. Potential for impacts on *A. dohrnii* and *S. pallida*, as even small impacts may have important influences on UK populations.

- Changes in sediment dynamics in Atlantic and Mediterranean moderate energy infralittoral rock (including BAP habitat Tidal Swept Channels). Smothering may affect filter feeders (*S. pallida*, *U. feline*, *A. digitatum*, *B. schlosseri*, *H. panacea*) from feeding and growth, while photosynthesis by algae may be compromised. Potential for impacts on *S. pallida*, as even small impacts may have important influences on UK populations.

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<tr>
<td>Changes in sediment dynamics and deposition in features of circalittoral rock may hinder filter feeders (i.e. respiration, feeding and growth). While characteristic species are common and widespread, potential for impact is noted since this habitat is seldom recorded. <strong>Loss of Habitat/Abrasion</strong> The direct placement of offshore or near-shore devices, and/or their moorings on the seabed can result in damage to benthic habitats, or their loss in extreme instances (e.g. seabed structures, piling, drilling and anchoring, subsea cable placement). This could also include additional damage such as the abrasion of marine habitats and sessile/sedentary species (i.e. BAP species such as mussel and file shell beds) from the installation of technology (i.e. mooring cables dragging during installation) and subsea cable deposition (i.e. placement and dragging during installation and operation). The potential for impacts in a range of BAP habitats has been identified:</td>
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<td><strong>loss of habitat and Abrasion from foundation/mooring systems in Atlantic and Mediterranean high energy infralittoral rock (including BAP habitat Tidal Swept Channels), particularly if S. pallida populations are present. Even small amounts of abrasion may impact on these populations.</strong></td>
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<td>**species are common and widespread, potential for impact is noted since this habitat is seldom recorded. <strong>Loss of Habitat/Abrasion</strong> The direct placement of offshore or near-shore devices, and/or their moorings on the seabed can result in damage to benthic habitats, or their loss in extreme instances (e.g. seabed structures, piling, drilling and anchoring, subsea cable placement). This could also include additional damage such as the abrasion of marine habitats and sessile/sedentary species (i.e. BAP species such as mussel and file shell beds) from the installation of technology (i.e. mooring cables dragging during installation) and subsea cable deposition (i.e. placement and dragging during installation and operation). The potential for impacts in a range of BAP habitats has been identified:</td>
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<td><strong>Loss of habitat and Abrasion from foundation/mooring systems in Atlantic and Mediterranean high energy infralittoral rock (including BAP habitat Tidal Swept Channels), particularly if S. pallida populations are present. Even small amounts of abrasion may impact on these populations.</strong></td>
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<td>rock, particularly if S. palida and A. dohrni populations are present. Even small amounts of abrasion may impact on these populations.</td>
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Change in Tidal Flows and Fluxes
Changes, predominantly decreases in tidal flows associated with device supports or mooring systems may have adverse effects on benthic areas, although these are largely expected to be site and habitat specific:

- Subtidal sands and gravel, horse mussel beds. Impacts are considered unlikely for small arrays, although the potential for effects on A. fragilis, C.cruoriformis, D. Montagnei, E. timida or horse mussel beds are present.
- Loss of habitat and abrasion from foundation/mooring systems in Sublittoral sand (including BAP habitat sub-tidal sands and gravel, blue mussel beds). Impacts are considered unlikely for small arrays, although the potential for effects on A. fragilis, E. timida, A. sarsi or blue mussel beds are present.
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### SEA Topic Areas

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**Notes:**
- BAP: Benthic Area of Particular Importance
- *A. digitatum*: Common horse mussel
- *A. fragilis*: Common blue mussel
- *A. sarsi*: Sarsella
- *C. crurioaformis*: Autumn shell
- *D. Montagnei*: Horse mussel
- *E. timida*: Common horse mussel
- *L. corallioides*: Common blue mussel
- *M. modiolus*: Common blue mussel
- *P. calcarea*: Common horse mussel

**Technologies:**
- *Technologies* indicate new or emerging technologies for addressing the impacts of tidal flows and fluxes in marine environments.
## SEA Topic Areas

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<tr>
<td>Summary of key potential effects on population and human health:</td>
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<td>- Displaced/increased shipping density.</td>
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<td>- Reductions in the safety of navigation.</td>
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<td>- Risk of collision of recreational or commercial shipping with installation vessels and operational devices, particularly for devices and vessels that are low in the water and in high waves.</td>
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<td>- Access restrictions – the presence of devices in the water may restrict or reduce access to key recreational sailing areas or other water sports.</td>
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<td>Key measures to prevent adverse effects may include: siting devices away from spatially constrained areas and areas with high vessel densities; siting devices in open water; making use of industry guidance on assessment of effects and use of aids to navigation; use of notifications such as ‘Notices to Mariners’, publishing information at marina, and Sailing Directions; and adhering to appropriate safety regulations. Consideration of device types that are fully submerged and allow shipping to pass over the top of them could reduce effects, but guidance would need to be sought on a case-by-case basis on the level of clearance required.</td>
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<td>The potential for vessel collisions with above water device components, or components at shallow depths in the water column, has been identified and may have the potential for serious injury.</td>
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Summarised key potential effects on water quality include:
- Disturbance of contaminated sediments during device installation, e.g. disposal sites (silt, sand, rock and gravel sites, fish wastes and sludge); munitions dumps, and weapons ranges.
- Potential for impacts from local changes in water quality during installation (i.e. turbulence, turbidity) and due to the presence of these devices in the water column (i.e. water turbulence, changes in tidal flows/fluxes) with localised impacts. Additional impacts (i.e. changes to sediment dynamics, scouring, deposition, smothering and water turbulence) may be associated with the installation and presence of support cables and structures on the seabed (i.e. gravity anchor and mooring).
- Potential for installation impacts such as water turbidity and contamination risks associated with installation and operation (e.g. leakage from vessels or equipment).

See Biodiversity section.

**Climatic factors**

- Contribution to renewable generation and reduction in GHG emissions (i.e. displacement of energy generated from non-renewable sources).

**Marine geology and coastal processes**

- Summary of key potential effects on geology:
  - Disturbance or damage to coastal Geological SSSIs and GCRs.
  - Changes in coastal processes due to energy extraction Seabed contamination and water quality (including disposal areas): key issues.

As detailed in biodiversity section, the potential may exist for changes to flows in the boundary layer, and localised reductions in tidal flows from the devices themselves.

Other impacts may occur from the placement of support structures or moorings for these devices on the seabed, including increased scouring, deposition/siltation from changes to coastal processes (i.e. sediment dynamics and tidal fluxes) associated with the installation, operation, benthic disturbance during installation (i.e. loss of habitat), abrasion of Vertical Axis Turbines. If impacts are likely to be required on such devices for navigational purposes.

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**Historic Environment**

Summary of key potential effects on marine and coastal historic environment include:

- Direct disturbance, damage, or destruction of submarine archaeological remains and wrecks during device installation and cable trenching.
- Direct disturbance, damage or destruction of coastal archaeological remains during cable trenching (effects of grid connections are considered separately below).
- Disturbance, damage or loss of archaeological remains and sites during installation of cables and overhead lines and substation construction from onshore grid connections.

Key measures to prevent adverse effects may include: avoid sites of interest and exclusion zones for protected sites; follow Crown Estates 2007 JNAPC Code of Practice for seabed developers; carry out seabed surveys and walkover surveys prior to installation; carry out detailed routing studies at project level in accordance with ‘Holford Rules’ best practice guidance on routing overhead transmission lines; avoid sensitive sites and areas; provide screening (substations).

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<td>There is the potential for placement of device moorings (i.e. gravity-base, anchors, etc.) on known and designated historic sites, and on unknown sites (i.e. wrecks). The potential may also exist for adverse effects on historic sites located nearby or downstream during operation (i.e. scouring, deposition/siltation or abrasion from moorings; deposition/siltation from the presence of devices).</td>
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</tr>
</tbody>
</table>

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Available at: http://www.eon-uk.com/generation/1309.aspx [accessed 26/03/2013].
<table>
<thead>
<tr>
<th>SEA Topic Areas</th>
<th>Horizontal Axis Turbines</th>
<th>Vertical Axis Turbines</th>
<th>Reciprocating Hydrofoils</th>
<th>Emerging Technologies*</th>
</tr>
</thead>
<tbody>
<tr>
<td>decommissioning</td>
<td>features during operation, construction and deconstruction</td>
<td>deconstruction</td>
<td>deconstruction</td>
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</tbody>
</table>

**Landscape/Seascape**
Summary of key potential effects on land/seascape include:

- For linear structures, with devices at up to 5km from the coastline, effects may occur for all seascape types. The further from the coast, the less the effect becomes, and beyond 10km the effects are typically minor.
- For point structures, 8 out of the 10 seascape types are of high sensitivity to these types of device, with potential effects occurring at 0-10km from coastline. Moderate effects may also occur at distances over 10km.
- Submerged structures are likely to have negligible effects on seascape (although marker buoys and lighting may be required).
- Fixed coastal structures may have moderate effects depending on their design and location.
- Landscape and visual intrusion from substations and overhead lines as onshore grid connections.

Key measures to prevent adverse effects may include:
- Maximising the distance of devices from shore;
- Reducing the height of devices above the surface;
- Reducing the area of sea occupied by the devices; and
- Modifying the position and layout of devices to suit characteristics of the local seascape; carry out detailed routeing studies at project level in accordance with ‘Holford Rules’ best practice guidance on routeing overhead transmission lines; avoid sensitive sites and areas; provide screening (substations).

Potential for visual issues identified if surface-piercing structures are present and during installation and maintenance periods (i.e. monopiling equipment, etc.). This may result in an alteration of aesthetic character of the coastline, particularly if positioned near shore, which may be viewed by some as negative impacts.

No shore based infrastructure is anticipated, hence only impacts considered are those from devices in coastal waters.

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<tr>
<th><strong>SEA Topic Areas</strong></th>
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<tr>
<td><strong>Device Information</strong></td>
<td>Includes offshore AC substations and AC/DC substations.</td>
<td>Cables to transfer the power from the AC substation or the offshore AC/DC converter station to the shore.</td>
<td>Designed to bring the subsea cables to shore, and connect to buried onshore cables or overhead power lines.</td>
<td>Comprises buried onshore transmission cables and their connections from landfall or transition pit to onshore electricity network.</td>
<td>Installed to transmit electrical power on land via towers and cables.</td>
<td>Houses electrical equipment for switching and protection of the electrical system.</td>
<td>To convert from HVDC connection from the offshore wind farm to AC for connection to the onshore electricity system.</td>
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<tr>
<td></td>
<td>Common designs are based upon experience in offshore oil and gas industry.</td>
<td>Can be undertaken from a number of methods (e.g. Horizontal Directional Drilling (HDD), trenching) or a combination of them, using drilling rigs or trenching equipment.</td>
<td>Can be undertaken from a number of methods (e.g. Horizontal Directional Drilling (HDD), trenching) or a combination of them, using drilling rigs or trenching equipment.</td>
<td>Typically undertaken using standard civil engineering equipment excavating and installation foundations for the towers, and placement of infrastructure.</td>
<td>Typically undertaken using standard civil engineering equipment excavating and installation foundations for the towers, and placement of infrastructure.</td>
<td>In most cases it also steps up electrical voltages to connect to the onshore electricity transmission system.</td>
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<tr>
<td></td>
<td>Common designs consist of a ‘topside’ component housing the main equipment, and a foundation structure (e.g. steel jacket, monopile, gravity based structure).</td>
<td>Subsea piling, monopile, foundation structure (e.g. Horizontal Directional Drilling (HDD), trenching).</td>
<td>Comprising a subsea transition pit.</td>
<td>May require additional controls (e.g. traffic management, etc.) in some instances.</td>
<td>May require additional controls (e.g. traffic management, etc.) in some instances.</td>
<td>Involves standard civil engineering practices for drainage, foundations, buildings, fences and other structures.</td>
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</tbody>
</table>

**Biodiversity/flora/fauna**

| **Marine Mammals and fish** | Noise from construction from piling (e.g. behavioural response, lethal effects, displacement from natural habitat and possible feeding areas, physical injury to hearing organs). | Potential habitat loss or disturbance, especially to bottom dwelling species such as sand eels, which are important prey species for birds, marine mammals and fish. | Potential collision risk with submerged structures and associated cabling (if any). | Potential for increased suspended solids during construction and sediment deposition affecting respiration in bottom dwelling and spawning species (e.g. sand eel). | Potential for increased suspended solids and deposition, leading to potential increases to suspended solids and deposition, leading to | Potential for loss of prey species in offshore feeding grounds from installation activities. | Onshore Fauna | Potential loss or disturbance of protected or notable species, in particular, water vole, otter, badger, great crested newts, reptiles and breeding birds. | Onshore Fauna | Potential loss or disturbance of protected or notable species, in particular, water vole, otter. | Onshore Fauna | Potential loss or disturbance of protected or notable species (e.g. ponds, hedgerows, woodland, watercourses and grassland). |
| | **Potential habitat loss or disruption to seabed communities during installation.** | Potential temporary displacement to other areas and potential collision risk during installation. | Potential EMF from the cable distribution, and potential for impacts such as changes in behaviour and migratory patterns of some fish and mammal species. | | | Marine and Coastal Habitats | Potential loss of prey species in offshore feeding grounds from installation activities. | Marine and Coastal Habitats | Potential loss of prey species in feeding grounds. | Onshore Fauna | Potential collision risk of overhead lines to birds and bats, and disturbance during breeding from noise and light associated with maintenance activities. |
| | **Potential temporary displacement to other areas during installation.** | Potential temporary displacement to other areas during installation. | Potential EMF from the cable distribution, and potential for impacts such as changes in behaviour and migratory patterns of some fish and mammal species. | | | | | | | Onshore Fauna | Potential loss or disturbance of important habitats (e.g. ponds, hedgerows, woodland, watercourses and grassland). |
| | **Potential EMF from the cable distribution, and potential for impacts such as changes in behaviour and migratory patterns of some fish and mammal species.** | Potential adverse effects on designated (statutory and non-statutory) nature conservation sites. | | | | | | | | Onshore Fauna | Potential adverse effects on designated (statutory and non-statutory) nature conservation sites. |
| | **Seabirds** | Potential adverse effects on designated (statutory and non-statutory) nature conservation sites. | | | | | | | | Onshore Fauna | Additional landscape works and screening may provide habitats and opportunities for biodiversity enhancement. |
| | **Potential loss of prey species in offshore feeding grounds from installation activities.** | Reinstatement to land from previous condition can include enhancement measures. | | | | | | | | Onshore Fauna | Additional landscape works and screening may provide habitats and opportunities for biodiversity enhancement. |

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<td></td>
<td>Potential for EMF effects during operation as part of cable distribution.</td>
<td>Potential sedimentation of seabed communities.</td>
<td>Potential habitat loss or disruption to inshore seabed communities from installation activities.</td>
<td>Potential increase in suspended solids and smothering (deposition) during installation works.</td>
<td>Potential for dust arising from areas where vegetation has been removed, soils stored, and vehicle tracks, particularly in dry or windy conditions.</td>
<td>Potential for noise and vibration from construction traffic and equipment, especially at compounds and location towers.</td>
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<tr>
<td></td>
<td>Potential creation of artificial rocky habitats due to the presence of submerged infrastructure.</td>
<td>Potential habitat loss or disruption to benthic communities during installation.</td>
<td>Potential disruption to intertidal habitats and benthic species.</td>
<td>Potential noise and vibration from construction traffic and equipment, especially at compounds and location towers.</td>
<td>Potential for dust arising from areas where vegetation has been removed, soils stored, and vehicle tracks, particularly in dry or windy conditions.</td>
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<td>Seabirds</td>
<td>Potential habitat disturbance due to maintenance and repair activity.</td>
<td>Potential increase in suspended solids and smothering (deposition) during installation works.</td>
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<td>Potential displacement due to disturbance during construction from offshore feeding sites to other areas (e.g. herring gull, great cormorant, etc.).</td>
<td>Potential for increased suspended solids and sediment deposition associated with construction site, and associated effects for epibenthic species, especially filter feeders.</td>
<td>Potential disturbance to seabed and intertidal areas due to maintenance and repair activity.</td>
<td>Potential for dust arising from areas where vegetation has been removed, soils stored, and vehicle tracks, particularly in dry or windy conditions.</td>
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<td>Potential loss of feeding grounds for on- and off-structures (migrating) species due to presence of structures (e.g. dunlin, knot, etc.) and associated with loss of prey species (e.g. sand eel for migratory species such as Arctic Tern).</td>
<td>Potential for collision with cable excavation vessels in transit during construction.</td>
<td>Potential for displacement of previously contaminated land, potential transportation of contaminants (by physical movement, water and air) and the impact on human health and ecology.</td>
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<td>Marine and Coastal Habitats</td>
<td>Potential for collision with other marine users during construction and maintenance activities (e.g. shipping, recreation, etc.) and operation of work vessels (e.g. fishing activities with potential gear interactions with submerged structures, etc.).</td>
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<td>Potential loss or disturbance to especially sensitive/designated habitats from construction (e.g. reefs and associated species which may take time to recover).</td>
<td>Potential interference with navigation and displacement of other marine users (e.g. shipping, recreation, etc.) during construction and maintenance activities.</td>
<td>Potential for collision with cable excavation vessels in transit during construction.</td>
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<td>Potential for increased suspended solids and sediment deposition associated with construction site, and associated effects for epibenthic species, especially filter feeders.</td>
<td>Potential for collision with cable excavation vessels in transit during construction.</td>
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<td>Potential for displacement of other marine users (e.g. shipping, recreation, etc.) and operation of work vessels (e.g. fishing activities with potential gear interactions with submerged structures, etc.).</td>
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<td>Construction vessels and helicopter flights may cross other user’s transit routes (e.g. dredging, oil and gas operations and freight).</td>
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<td>Potential for increased collision risk, impacts for navigation and displacement of other marine users (e.g. shipping, recreation, etc.) during construction and maintenance activities.</td>
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<tr>
<td>Water and marine environment</td>
<td>Potential re-suspension of sediments and associated hazardous substances during construction. Potential for accidental spillage from construction vessels and structures during operation.</td>
<td>Potential re-suspension of sediments and hazardous substances due to excavation and release of construction activities during installation and during major repair activity. Potential for accidental spillage from construction equipment.</td>
<td>Potential contamination and associated risk to humans and riparian ecology from construction activities using oil, bentonite or other harmful substances. Potential sedimentation and increase in turbidity of watercourses from areas where vegetation has been cleared. Requirement for significant excavation and potentially piling may impact on groundwater quality and regimes. Requirement for de-watering and discharging of water may have potential impacts on water resources (e.g. abstractions). Potential increase in flood risk to facility itself and to others downstream from increase surface water run-off, especially from large areas of hard standing, for example access tracks and</td>
<td>Potential for accidental spillage from construction equipment entering water courses located near to sites.</td>
<td>Potential water contamination and the associated risks to humans and riparian ecology from construction activities using oil or other harmful substances. Potential sedimentation and increase in turbidity of watercourses from areas where vegetation has been cleared. Requirement for significant excavation and potentially piling may impact on groundwater quality and regimes. Requirement for de-watering and discharging of water may have potential impacts on water resources (e.g. abstractions) and riparian ecology. Potential increase in flood risk to facility itself and to others downstream from increase surface water run-off, especially from large areas of hard standing, for example access tracks and</td>
<td>Potential water contamination and the associated risks to humans and riparian ecology from construction activities using oil or other harmful substances.</td>
<td>Potential for noise from operation from the operation of the substation, in particular a ‘humming’ associated mainly with the operation of the cooling equipment, particularly in relation to transformers and reactors. Potential noise and vibration from operation and maintenance activities. Potential for loss of land to existing use (e.g. agricultural production).</td>
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<tr>
<td>Climatic factors</td>
<td>Construction vessel emissions have the potential to impact on air quality and contribute to greenhouse emissions.</td>
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<td>Marine geology and coastal processes / Onshore soils</td>
<td>Scour from seabed foundations (e.g. piles) and sediment deposition during construction and operation. Phases have the potential to alter physical processes and sediment structure.</td>
<td>Sediment disturbance during construction has the potential to alter physical processes and sediment structure.</td>
<td>Potential disturbance of previously contaminated land, potential transportation of contaminants (by physical movement, water and air) and the impact on human health and ecology.</td>
<td>Potential loss of land use during construction and operation. Phases at the tower base and along line routes (e.g. pylon or overhead lines may obstruct existing agricultural activities).</td>
<td>Potential degradation or loss of soil resource, and displacement of land use due to construction activities.</td>
<td>Potential soil heating from electrical cables at full rating, with potential secondary impacts (e.g. altered crop growth).</td>
<td>Potential disturbance of previously contaminated land, potential transportation of contaminants (by physical movement, water and air) and impact on human health and ecology.</td>
</tr>
<tr>
<td>Historic Environment</td>
<td>Potential loss of or damage to known and unknown buried heritage in construction activities.</td>
<td>Potential loss of or damage to known or unknown buried heritage due to corridor excavation by ploughing or trenching during installation.</td>
<td>Potential loss of or damage to known or unknown buried heritage due to corridor excavation by ploughing or trenching during installation.</td>
<td>Potential direct loss of or damage to known or unknown buried heritage.</td>
<td>Potential setting impacts on heritage assets and the historic landscape.</td>
<td>Potential direct loss of, or damage to, known and unknown buried archaeology.</td>
<td>Potential direct loss of, or damage to, designated assets or areas.</td>
</tr>
<tr>
<td>Landscape/ Seascapese</td>
<td>Potential for the seascape to change. Potential issues of temporary lighting during construction and operation.</td>
<td>Potential impacts to landscape/seascape during construction.</td>
<td>Reinstatement to land from previous condition can include enhancement</td>
<td>The construction of towers, poles and wire are more likely to have an impact on views and landscape character. Where existing features,</td>
<td>Potential change in the character of the landscape and on views particularly if situated within open countryside or residential areas (e.g. removal of</td>
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<td>measures. such as trees and woodland, are removed, e.g. trees and woodland, there is the potential for the landscape character to change. Screening may be used to mitigate impacts. Potential alteration and disruption of existing views from infrastructure, particularly if located in or near to designated landscape areas (e.g. AONB, NSAs, etc.).</td>
<td>existing ground features). During construction, areas will be needed for soil storage, site laydown areas, equipment storage, internal access tracks, etc. Potential for impacts from lighting of compounds. Potentially tall (e.g. overhead line gantries and switchgear) and bulky (e.g. transformers, buildings and converter sheds) equipment may effect landscape character and views of local area.</td>
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<td>Additional landscape works and screening may mitigate views of infrastructure.</td>
<td>existing ground features). During construction, areas will be needed for soil storage, site laydown areas, equipment storage, internal access tracks, etc. Potential for impacts from lighting of compounds. Potentially tall (e.g. overhead line gantries and switchgear) and bulky (e.g. transformers, buildings and converter sheds) equipment may effect landscape character and views of local area.</td>
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