

Key issue 17 - The potential wider or secondary effects on protected or sensitive sub-littoral seabed communities due to installation and operation of wave and tidal energy converters and associated moorings or support structures

What are the relevant technologies and support structures?

The following technologies and support structures were identified during the assessment process to have the potential to significantly affect seabed habitats and species and should therefore, be subject to further investigation on a project specific basis.

As shown, different technologies give rise to different impact mechanisms i.e. changes in sediment dynamics, smothering, deposition and scour. This should be considered within the project specific EIA.

Relevant technologies and support structures	Relevant features, components or activities	Phase
Gravity / deadweight anchor and mooring lines Gravity base structure Monopile	Change in sediment dynamics Structures may create a shadow, reduce flows or change turbulence resulting in the deposition of mobile sediments	Operation
Oscillating wave surge converter Submerged pressure differential Oscillating water column (shoreline) Overtopping device (shoreline)	Sediment accumulated in device may be entrained into outflow Change in shoreline profile may lead to localised changes to flows or changes in turbulence affecting sediment movement	
Gravity / deadweight anchor and mooring lines Gravity base structure Monopile Drag embedment anchor and mooring lines Oscillating water column (shoreline) Overtopping device (shoreline) Oscillating wave surge converter Submerged pressure differential	Smothering Placement of structures / materials on the seabed / shoreline or changes in sediment dynamics due to these structures / materials may result in smothering	Installation
Gravity / deadweight anchor and mooring lines Gravity base structure Monopile Oscillating wave surge converter Point absorber Submerged pressure differential	Deposition Structure may create a shadow, reduce flows or change turbulence resulting in the deposition of mobile sediments	Operation
Gravity / deadweight anchor and mooring lines Gravity base structure Monopile Rock anchors and mooring lines Drag embedment anchor and mooring lines Overtopping device (shoreline) Oscillating wave surge converter	Scour Localised changes due to accelerated flows and turbulence induced by structures on or near the seabed	Operation

Relevant technologies and support structures	Relevant features, components or activities	Phase
Gravity / deadweight anchor and mooring lines Gravity base structure Monopile	Change in tidal flows and fluxes Tidal energy devices extract energy extracted from the water column resulting in localised changes	Operation
Horizontal axis turbine Vertical axis turbine Reciprocating hydrofoils	Anchors and wave devices may create a shadow, reduce flows or change turbulence resulting in the deposition of mobile sediments	
Oscillating wave surge converter Submerged pressure differential		
Oscillating water column (offshore) Overtopping device (offshore) Attenuator Oscillating wave surge converter Point absorber	Dissipation of wave energy Presence of structures and extraction of wave energy may cause wave shadow effects	Operation

What species / groups may be vulnerable?

The following species were identified during the assessment process as being particularly sensitive to changes in sediment dynamics, smothering, deposition, scour, changes in tidal flows and fluxes and wave energy dissipation and should therefore, be considered further on a project specific basis.

Relevant species / groups ¹	Possible consequences
A3.1 : Atlantic and Mediterranean high energy infralittoral rock A3.2 : Atlantic and Mediterranean moderate energy infralittoral rock A4.1 : Atlantic and Mediterranean high energy circalittoral rock A4.2 : Atlantic and Mediterranean moderate energy circalittoral rock A4.7 : Features of circalittoral rock A5.1 : Sublittoral coarse sediment A5.2 : Sublittoral sand A5.4 : Sublittoral mixed sediments A5.5 : Sublittoral macrophyte- dominated sediment A5.6 : Sublittoral biogenic reefs	<p>Change in sediment dynamics</p> <p>Some of these habitats are defined by rocky substrata, so if seabed sediments moved into these areas, the entire habitat and associated species would change.</p> <p>Some habitats are defined by their sediments, so if variation to sediment dynamics caused a shift in grain-size of sediment, the entire habitat and associated species could change.</p> <p>Change in sediment dynamics may alter the grain-size composition, thus influencing the habitat and associated species.</p> <p>Sediment dynamics may affect availability of suspended sediments which are important to some species.</p> <p>Smothering</p> <p>Smothering can inhibit respiration, feeding and growth of some species</p> <p>Photosynthesis by algae will be compromised or prevented by smothering.</p> <p>Smothering by deposition of sediment will affect juvenile stages and settlement of propagules in particular.</p> <p>Hard substrata may be covered by sediment, possibly changing the entire character of the environment.</p>

¹ Species or habitats of conservation interest (e.g. Habitats directive, BAP habitat, OSPAR, CITES) or limited distribution found within the following Eunis habitats (see assessment for details):

Relevant species / groups ¹	Possible consequences
	Sessile species are unlikely to be able to move up through smothering material.
<p>A4.7 : Features of circalittoral rock A5.1 : Sublittoral coarse sediment A5.2 : Sublittoral sand A5.4 : Sublittoral mixed sediments A5.5 : Sublittoral macrophyte-dominated sediment A5.6 : Sublittoral biogenic reefs</p>	<p>Deposition Deposition of sediment or other material can inhibit respiration, feeding and growth and in particular may hinder feeding by filter feeding species (but some could benefit from increased deposition of organic material).</p> <p>Smothering by deposition of sediment will affect juvenile stages and settlement of propagules in particular.</p> <p>Deposition of sediment will prevent or reduce photosynthesis by algae. Hard substrata may also be covered by sediment, possibly changing the entire character of the environment. Deposited material may change the nature of sediment habitats.</p>
<p>A5.1 : Sublittoral coarse sediment A5.2 : Sublittoral sand A5.4 : Sublittoral mixed sediments A5.5 : Sublittoral macrophyte-dominated sediment A5.6 : Sublittoral biogenic reefs</p>	<p>Scour Increased scour may interfere with feeding by filter</p> <p>Increased scour may affect settlement of reproductive propagules.</p> <p>Increased scour may affect settlement of reproductive propagules or cause physical damage to small or delicate species</p> <p>Change in tidal flows and fluxes Strong flows may detach weakly attached organisms.</p> <p>In the absence of moderate or strong wave action, decreases in tidal flows are likely to have an adverse effect on filter feeders because food supplies will be reduced and siltation may occur.</p> <p>Changes in tidal flow may cause changes in grain-size of sediments, thus potentially altering the overall habitat.</p> <p>Dissipation of wave energy In the absence of moderate or strong tidal streams, decreases in wave action may have an adverse effect on filter feeders because food supplies will be reduced and siltation may occur.</p> <p>Decreases in wave action may cause changes in grain-size of sediments, thus potentially altering the overall habitat.</p>

What species / groups are affected by which technologies and support structures

The following table provides a summary of the assessment results for each species or habitats in combination with each technology & Moorings/Support structures listed above.

Potentially significant at a 10MW scale	Unknown whether this will be significant at a 10 MW scale	Not Applicable	Assessed as not significant at a 10MW scale
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Change in sediment dynamics	Technology & Moorings and Support structures														
	Horizontal axis turbine & Gravity/deadweight anchor and mooring lines	Horizontal axis turbine & Gravity base structure	Horizontal axis turbine & Monopile	Vertical axis turbine & Gravity/deadweight anchor and mooring lines	Vertical axis turbine & Gravity base structure	Reciprocating hydrofoils & Gravity base structure	Reciprocating hydrofoils & Monopile	Oscillating water column (offshore) & Gravity/deadweight anchor and mooring lines	Oscillating water column (shoreline)	Overtopping device (offshore) & Gravity/deadweight anchor and mooring lines	Overtopping device (shoreline)	Attenuator & Gravity/deadweight anchor and mooring lines	Oscillating wave surge converter & Gravity base structure	Point absorber & Gravity/deadweight anchor and mooring lines	Submerged pressure differential & Gravity base structure
A3.1 : Atlantic and Mediterranean high energy infralittoral rock Including BAP Habitat "Tidal swept channels"															
A3.2 : Atlantic and Mediterranean moderate energy infralittoral rock Including BAP Habitat "Tidal swept channels", "Sabellaria spinulosa reefs"															
A4.1 : Atlantic and Mediterranean high energy circalittoral rock Including BAP Habitat "Tidal swept channels"															
A4.2 : Atlantic and Mediterranean moderate energy circalittoral rock															
A4.7 : Features of circalittoral rock															
A5.1 : Sublittoral coarse sediment Including BAP habitats "Subtidal sands and gravel", "Horse mussel beds"															
A5.2 : Sublittoral sand Including BAP habitat "Subtidal sands and gravel", "Blue mussel beds"															

Change in sediment dynamics	Technology & Moorings and Support structures														
Habitat	Horizontal axis turbine & Gravity/deadweight anchor and mooring lines	Horizontal axis turbine & Gravity base structure	Horizontal axis turbine & Monopile	Vertical axis turbine & Gravity/deadweight anchor and mooring lines	Vertical axis turbine & Gravity base structure	Reciprocating hydrofoils & Gravity base structure	Reciprocating hydrofoils & Monopile	Oscillating water column (offshore) & Gravity/deadweight anchor and mooring lines	Oscillating water column (shoreline)	Overtopping device (offshore) & Gravity/deadweight anchor and mooring lines	Overtopping device (shoreline)	Attenuator & Gravity/deadweight anchor and mooring lines	Oscillating wave surge converter & Gravity base structure	Point absorber & Gravity/deadweight anchor and mooring lines	Submerged pressure differential & Gravity base structure
A5.4 : Sublittoral mixed sediments Including BAP Habitat "Horse mussel beds", "File Shell Beds"															
A5.5 : Sublittoral macrophyte-dominated sediment Including BAP habitats "Maerl beds", "Tidal swept channels", "Horse mussel beds", "Blue mussel beds"															
A5.6 : Sublittoral biogenic reefs Including BAP Habitats "Horse mussel beds", "Cold-water coral reefs", "Blue mussel beds"															

Smothering	Technology & Moorings and Support structures																			
Habitat	Horizontal axis turbine & Gravity/deadweight anchor and mooring lines	Horizontal axis turbine & Gravity base structure	Horizontal axis turbine & Monopile	Vertical axis turbine & Gravity/deadweight anchor and mooring lines	Vertical axis turbine & Gravity base structure	Reciprocating hydrofoils & Gravity base structure	Reciprocating hydrofoils & Monopile	Oscillating water column (offshore) & Gravity/deadweight anchor and mooring lines	Oscillating water column (offshore) & Drag embedment anchor and mooring lines	Oscillating water column (shoreline)	Overtopping device (offshore) & Gravity/deadweight anchor and mooring lines	Overtopping device (offshore) & Drag embedment anchor and mooring lines	Overtopping device (shoreline)	Attenuator & Gravity/deadweight anchor and mooring lines	Attenuator & Drag embedment anchor and mooring lines	Oscillating wave surge converter & Gravity base structure	Point absorber & Gravity/deadweight anchor and mooring lines	Point absorber & Drag embedment anchor and mooring lines	Submerged pressure differential & Gravity base structure	
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Deposition	Technology & Moorings and Support structures														
Habitat	Horizontal axis turbine & Gravity/deadweight anchor and mooring lines	Horizontal axis turbine & Gravity base structure	Horizontal axis turbine & Monopile	Vertical axis turbine & Gravity/deadweight anchor and mooring lines	Vertical axis turbine & Gravity base structure	Reciprocating hydrofoils & Gravity base structure	Reciprocating hydrofoils & Monopile	Oscillating water column (offshore) & Gravity/deadweight anchor and mooring lines	Overtopping device (offshore) & Gravity/deadweight anchor and mooring lines	Attenuator & Gravity/deadweight anchor and mooring lines	Oscillating wave surge converter & Gravity base structure	Point absorber & Gravity/deadweight anchor and mooring lines	Point absorber & Rock anchors and mooring lines	Point absorber & Drag embedment anchor and mooring lines	Submerged pressure differential & Gravity base structure
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Scour	Technology & Moorings and Support structures																							
Habitat	Horizontal axis turbine & Gravity/deadweight anchor and mooring lines	Horizontal axis turbine & Gravity base structure	Horizontal axis turbine & Monopile	Horizontal axis turbine & Rock anchors and mooring lines	Vertical axis turbine & Gravity/deadweight anchor and mooring lines	Vertical axis turbine & Gravity base structure	Vertical axis turbine & Rock anchors and mooring lines	Reciprocating hydrofoils & Gravity base structure	Reciprocating hydrofoils & Monopile	Oscillating water column (offshore) & Gravity/deadweight anchor and mooring lines	Oscillating water column (offshore) & Rock anchors and mooring lines	Oscillating water column (offshore) & Drag embedment anchor and mooring lines	Overtopping device (offshore) & Gravity/deadweight anchor and mooring lines	Overtopping device (offshore) & Rock anchors and mooring lines	Overtopping device (offshore) & Drag embedment anchor and mooring lines	Overtopping device (shoreline)	Attenuator & Gravity/deadweight anchor and mooring lines	Attenuator & Rock anchors and mooring lines	Attenuator & Drag embedment anchor and mooring lines	Oscillating wave surge converter & Gravity base structure	Point absorber & Gravity/deadweight anchor and mooring lines	Point absorber & Rock anchors and mooring lines	Point absorber & Drag embedment anchor and mooring lines	Submerged pressure differential & Gravity base structure
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Change in tidal flows and fluxes	Technology & Moorings and Support structures														
Habitat	Horizontal axis turbine & Gravity/deadweight anchor and mooring lines	Horizontal axis turbine & Gravity base structure	Horizontal axis turbine & Monopile	Horizontal axis turbine & Rock anchors and mooring lines	Vertical axis turbine & Gravity/deadweight anchor and mooring lines	Vertical axis turbine & Gravity base structure	Vertical axis turbine & Rock anchors and mooring lines	Reciprocating hydrofoils & Gravity base structure	Reciprocating hydrofoils & Monopile	Oscillating water column (offshore) & Gravity/deadweight anchor and mooring lines	Overtopping device (offshore) & Gravity/deadweight anchor and mooring lines	Attenuator & Gravity/deadweight anchor and mooring lines	Oscillating wave surge converter & Gravity base structure	Point absorber & Gravity/deadweight anchor and mooring lines	Submerged pressure differential & Gravity base structure
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Dissipation of wave energy	Technology & Moorings and Support structures												
Habitat	Oscillating water column (offshore) & Gravity/deadweight anchor and mooring lines	Oscillating water column (offshore) & Rock anchors and mooring lines	Oscillating water column (offshore) & Drag embedment anchor and mooring lines	Overtopping device (offshore) & Gravity/deadweight anchor and mooring lines	Overtopping device (offshore) & Rock anchors and mooring lines	Overtopping device (offshore) & Drag embedment anchor and mooring lines	Attenuator & Gravity/deadweight anchor and mooring lines	Attenuator & Rock anchors and mooring lines	Attenuator & Drag embedment anchor and mooring lines	Oscillating wave surge converter & Gravity base structure	Point absorber & Gravity/deadweight anchor and mooring lines	Point absorber & Rock anchors and mooring lines	Point absorber & Drag embedment anchor and mooring lines
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How could the issue be addressed on a project and site specific basis?

The following tables provide a series of suggested activities and recommendations that may be taken forward to address the effects of *changes in sediment dynamics, smothering, deposition, scour, changes in tidal flows and fluxes and dissipation of wave energy* on seabed communities for those technologies and/or support structures, and species / habitats, assessed as significant in the assessment. This information is not prescriptive and should be used as a platform for discussion on a project and site specific basis in order to develop an appropriate impact assessment strategy and monitoring programme for the project.

Single test deployments

Preliminary desk based studies

Activity	Objective	Recommendation / comment
No activity recommended	N/A	N/A

Baseline characterisation surveys

Activity	Objective	Recommendation / comment
No activity recommended	N/A	N/A

Further desk based studies

Activity	Objective	Recommendation / comment
No activity recommended	N/A	N/A

Monitoring during and post installation

Activity	Objective	Recommendation / comment
No activity recommended	N/A	N/A

Demonstration arrays

Preliminary desk based studies

Activity	Objective	Recommendation / comment
Review of existing information regarding seabed conditions and communities in the proposed development area	To inform baseline survey plans and predict the presence / absence of any habitats and species identified as particularly vulnerable	This should be undertaken in all instances although data and information is likely to be largely generic and sparse in most unsurveyed areas.
Undertake impact assessment	To identify any particular areas of concern regarding the proposed development and to determine what/if further baseline characterisation is required (see below)	This should follow the normal project specific EIA procedures.

Baseline characterisation surveys

Activity	Objective	Recommendation / comment
Pre-installation baseline survey using swathe bathymetry with photo / video ground-truthing. If any sensitive species / habitats are found to be present, wider survey to establish distribution of that species in the wider area.	To determine the relative sensitivity of the proposed development area and to inform the impact assessment	This should be undertaken in all previously unsurveyed areas.

Further desk based studies

Activity	Objective	Recommendation / comment
Undertake impact assessment	To determine whether or not there are likely to be any potentially significant effects on the habitats and species identified	This should follow normal EIA procedures

Monitoring during and post installation

Activity	Objective	Recommendation / comment
Carry out repeated post-installation surveys using photo / video / quadrant studies to monitor effects	To monitor any changes in seabed communities, validate predictions, inform environmental monitoring and future site selection and project development work	This should only be undertaken where a development proceeds within a particularly sensitive area (as determined by the baseline characterisation work and the EIA). Long-term studies may be required to detect any change.
Measure the level and extent of changes in wave action and tidal flows and fluxes using appropriate equipment such as waverider buoys or Acoustic Doppler Current Profilers	To monitor any change in hydrographic conditions following installation	