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Introduction

Scope

Marine renewable energy is an emerging industry which has very considerable potential for economic growth and job creation. This can happen through the development, manufacture, deployment and operation of wave, tidal and offshore wind technologies and the creation of an indigenous supply chain in Ireland. Ireland can capitalise on its natural advantages in the area of marine renewable energy by following the Ocean Energy Strategy. The policy context for the ocean energy initiative and for addressing wave and tidal technologies is contained in the Programme for Government, the Sustainable Energy White Paper and in the Ocean Energy Strategy 2005 (Marine Institute and Sustainable Energy Authority of Ireland).The initiative, announced in early 2008, will help establish Ireland as a leader in ocean energy technologies and to develop facilities that will enable the commercialisation of ocean energy products and services.

As part of the Ocean Energy Strategy an offshore wave energy test site is proposed for the Belmullet area of County Mayo. The proposed test site will be called the Atlantic Marine Energy Test Site (AMETS). The test site will provide a grid-connected national test facility, to which full-scale wave energy converters could be coupled during their final stages of pre-commercial development. The test site is an integral component of Ireland's Ocean Energy Strategy and will facilitate testing and validation of various wave energy converters in an open ocean environment. It will be operational for a period of fifteen years and will be decommissioned thereafter.

An examination of the likely significant impacts of the project on the environment was carried out and the results are presented in this Environmental Impact Statement (EIS). The conclusions of the EIS are contained in this Non-Technical Summary.

Background

Since the adoption of the Kyoto Agreement in 1997 there has been increasing concern over the security of supply of energy from fossil fuels and a growing awareness of their impact on the environment and climate. Climate change impacts are one of the key concerns of the EU, and renewable sources of energy are seen as essential alternatives to fossil fuels, which are regarded as a major contributor to greenhouse gas emissions. In 2007 the EU agreed new climate and energy targets to be achieved by 2020. These targets are based on a 20% reduction in greenhouse gas emissions, the achievement of 20% improvement in energy efficiency and the production of 20% of the EU's energy consumption from renewable sources. Individual and legally binding targets have also been set for each member state under the EU Renewable Energy Directive 2009/28/EC to ensure that the 2020 targets are achieved.

Some 14.4% of electricity generated in Ireland in 2009 came from renewable sources, exceeding the EU 2010 interim target of 13.2% generation. Wind energy accounted for 10% of this. According to the Strategic Environmental Assessment (SEA) of the draft Offshore Renewable Energy Development Plan (OREDP, 2011) the potential amount of accessible[1] wave energy development is greater than 17,500MW, nearly three times the current generation capacity from all sources in Ireland. The wave energy resource available off the Irish coast is vast, accessible, and greatly exceeds that available to other EU states. This means that Ireland is in a unique position to harness this renewable resource and to develop this new industry.

The technology to harness the wave energy resource is still at development and testing stages and no commercial full scale wave energy device is in operation as of yet. On the critical path for proving technology is the requirement for testing and demonstration in an open ocean environment such at Belmullet. The test site will deliver this requirement and will also

support the delivery of Government and EU policy for implementation of the Ocean Energy strategy and job creation initiatives. Studies indicate that an Irish Ocean Energy industry could support 17,000-52,000 jobs and represent a net present value of around €4-10bn by 2030 (SQW 2011).

- It will facilitate the development of new technologies, thus supporting the Government's commitment to develop the smart economy.
- It will be the final test facility required by international industry to demonstrate and prove the commercial viability of ocean energy devices for deployment off the Irish coast. This will provide a focal point to develop and test ocean energy products and services in Ireland.
- It will provide a catalyst for new commercial opportunities to ensure Ireland and Irish companies are at the forefront of developments in ocean energy.
- It will enable important research into the development of ocean energy in the most extreme climates, helping justify investment in commercial projects that are more productive, but with more risk.
- It will provide a means to reduce dependence on fossil fuels, reduce emissions and develop an indigenous secure and renewable energy source.

The project

The site

The west coast of Ireland offers Europe's best resource in terms of wave energy potential. The marine site near Belmullet in Co. Mayo was selected following a rigorous assessment process to identify the most suitable location for a wave energy test facility on Ireland's western seaboard.. The assessment considered issues such as wave resource, technical feasibility, water depth, grid connectivity, seabed conditions, accessibility through ports and road networks and the need to minimise any potential for environmental impact.

The project comprises both onshore and offshore components. Offshore there will be two test areas: Test Area A at 100m water depth is located some 16km out from Belderra Strand; and Test Area B at 50m water depth is located 6km from the strand. Test Area A will be 6.9 km^2 (2.02 nautical square miles) and Test Area B will be 1.5 km^2 (0.44 nautical square miles). The onshore

[1] Accessible is defined as wave energy development potential in water depths of between 10m and 200m off the coast of Ireland

element comprises a small substation which will be constructed in the townland of Ballymacsherron, south of the L5233, which runs alongside Belderra Strand. The substation site will be 2 acres.

Project design

The proposed development will involve deploying wave energy converters (WECs) such as those of Wavebob, Pelamis, Ocean Energy Limited and Ocean Power Technologies in deep water (as described in **4.3.7 Wave energy converters** below). WECs will be anchored within the designated test areas and will be connected to the distribution electricity grid onshore via submarine electricity cables installed between the test areas and the proposed onshore electricity substation. The project will have the following components:

- Offshore test areas: two areas delineated by cardinal marker and other buoys –Test Area A with 100m water depth and Test Area B with 50m water depth.
- Offshore submarine electricity cables in the subtidal environment (associated with Test Areas A and B).
- Cable landfall in the intertidal environment (associated with Test Areas A and B) at Belderra Strand – four submarine electricity cables, two from each Test Area, will be landed at this location.
- For wave resource assessment purposes, oceanographic monitoring equipment will be located as follows:
    - A Met Ocean buoy is moored at present at Test Area A to record the waves and other data such as wind, atmospheric pressure and direction. In addition, an Acoustic Doppler Current Profiler (ADCP) is located on the seabed adjacent to the weather buoy.
    - At present at Test Area B a Waverider buoy is moored to measure the wave resource at this location. It is intended to deploy a second Waverider here, and a further ADCP on the seabed.
    - In order to help prevent collision damage to these oceanographic buoys, each of the two test areas has a large special mark buoy moored close by. The special mark buoys warn passing vessels to keep their distance. The special mark at Test Area B can be seen from the adjacent mainland on a clear day.
    - At 20m water depth one ADCP may be deployed on the seabed to measure currents and wave resource.
- Land-side cable transition joint bay located underground adjacent to Belderra Strand to allow connection of the submarine electricity cables to land-side electricity cables.
- Land-side electricity underground cables from the transition joint bay to the substation.
- Land-side substation and access road with connection to the distribution electricity network using wooden poles and 10/20kV overhead line located outside the cSAC area near Belderra Strand.
- Office and workshop base in Belmullet.
- Wave energy converters (WECs) will be deployed within the test areas once these have been established.

Construction of the project will involve initial preparatory works offshore in the marine environment and construction of the land-side elements of the project.

To ensure safety in the offshore environment, the test areas will be marked using both cardinal marker buoys and special markers and a Notice to Mariners provided giving the coordinates of the test areas. The submarine electricity cables will be laid on the seabed by a special cable-laying vessel. This vessel will be large and slow-moving and is likely to be accompanied by guard vessels and other ancillary craft. The cables will be buried to an optimum depth of 1 metre in the seabed. The cables have to cross a rocky seabed, for a distance of some 4 km starting about 6 km from shore. Here they will be protected by placing rock armour on top or using other suitable means of protection.

The final stretch of cables will be floated in to Belderra Strand with the assistance of small boats and divers. The submarine electricity cables will be ducted through Belderra Strand via cable ducts, which will be installed beneath the beach area prior to the cable laying operations. The cable will be pulled through these ducts to a specially built cable interface joint bay. This will be located beneath the existing small car park. At this location the submarine electricity cable will be joined to landside cables. The land cables will be buried beneath the road (L5233) and their route will be through the field to the substation location just 200 metres from the cable joint bay. The cable deployment and landing operation is expected to take about six weeks.

The substation building will have standard electrical equipment and additional space for developers of wave energy technology to monitor the performance of their devices. The substation will not be manned permanently and will be used by developers occasionally. Its construction will involve site preparation works, earth moving, materials and equipment delivery and landscaping and will take approximately six months to construct. Most of the excavated material will be used to form an external berm around the substation to minimise its visibility. The substation will have an overhead line connection to the national grid. This will be 20kV single pole line and will be similar to existing lines in the area.

The substation will have high speed communications to transmit data received from the wave energy test areas and devices to a proposed office in Belmullet, from where activities will be monitored remotely.

During the operational phase WECs will be anchored at the test areas and connected to the submarine electricity cables. WECs will be towed or shipped to site using tug boats and barges. Special anchor handling tugs will be used to deploy the anchoring system and attach the WECs . The maximum number that can be accommodated at test area A is 10 WEC units. The maximum number at Test Area B is two WEC units. The maximum output of electricity from the site will be 10MW.

It is likely that small numbers of WECs will be deployed for short test periods and then recovered for design modification before being re-deployed. This will give rise to occasional vessel activity offshore.

Decommissioning of the test site will be subject to discussion with the Department of Environment, Community & Local Government and Mayo County Council. It may involve removal of the WEC anchoring systems, removal of the cardinal and other special marker buoys, removal of the submarine electricity cables, demolition of the substation and reinstatement of the site.

Alternatives

Alternatives to the project

Other potential sources of renewable energy could be developed to achieve the EU's agreed 2020 targets – for example, onshore and offshore wind, biomass, solar, geothermal or hydro power for example. These sources are limited either by resource and/or potential issues such as:

- Considerable loss of potential economic benefits from the development of a new industrial sector
- Increased pressure on aquatic environments and potential loss of status under the Water Framework Directive
- Increased pressure on sensitive habitats such as moorlands
- Increased adverse effects on landscape character and visual amenity
- Increased cumulative effects on birds, bats and other wildlife through habitat loss and disturbance
- Limitations relating to intermittency of electricity supply from onshore wind; by contrast, wave energy is much more consistent
- Security of supply and increased portfolio diversity.

Alternative locations

The location of the AMETS was identified following a rigorous assessment of seven locations on the west coast of Ireland. The assessment included the available wave resource to generate electricity, seabed conditions, environmental constraints, possibility of a grid connection, available infrastructure to support the development and suitable water depths reasonably adjacent to shore. Of the seven locations examined in detail, the site off Belmullet was identified as the best location to site the test areas.

An assessment of options for cable landing in the vicinity of Annagh Bay was also carried out and five landing locations were identified, Annagh Head, the beach at Annagh Head (Port Mór), Emlybeg beach, Belderra Strand and Cross Point. Preliminary cultural heritage and ecological surveys were carried out to identify any constraints in these areas. The overall assessment, which included technical feasibility, environmental and cultural heritage constraints identified Belderra Strand as the optimum landing location. The cable route to Belderra Strand offered a sandy seabed to a sandy beach which would facilitate cable burial. The cable could be ducted through the beach area with minimal impact on the dune system, which is a protected area under the Habitats Directive.

Policy Context

Over the past decade, energy and environment policies have been adopted and realigned to reflect new concerns at national and international levels, to address the new realities in respect of climate change and energy, and to provide a focus for future actions. More significantly, Ireland can maximise the benefit from the development of its marine renewable resources and become an exporter of electricity. in this context, meeting the 2020 targets should be seen as a start towards much greater levels of renewable electricity generation in the EU.

The new EU targets for 2050 require greenhouse gas emissions to be reduced by 80–95% below 1990 levels. Overall, the EU objective for 2050 foresees a low-carbon 2050 strategy which will be a framework for longer-term action in energy and related sectors

As part of its short-term steps to achieving reduced emissions levels, the EU agreed in 2007 to climate and energy targets to be achieved by 2020. These targets are based on a 20% reduction in greenhouse gas emissions, the achievement of 20% improvement in energy efficiency and 20% of the EU's energy consumption from renewable sources. Individual and legally binding targets have also been set for each member state under the EU Renewable Energy Directive 2009/28/EC to ensure that the 2020 targets are achieved.

Under Directive 2009/28/EC each member state submits to the EU a National Renewable Energy Action Plan (NREAP) setting out how it plans to reach its individual target. Ireland's NREAP sets out a target of 16% of energy from renewable sources across the electricity, heat and transport sectors by 2020. This is made up from a 12% share of heat from renewable sources (RES-H), 10% share of transport from renewable sources (RES-T) and 42.5% share of electricity from renewable sources (RES-E).

With regard to the targets set out in the NREAP, the Government has identified offshore renewable energy (offshore wind, wave and tidal energy)to make a significant contribution to the RES-E element of Ireland's overall renewable energy target, highlighting the Government's target of 500MW for ocean energy (wave and tidal) by 2020 as set out in the Government's White Paper on Energy Policy (March 2007).

The Government's support for offshore renewable energy in Ireland is both technical and strategic.

At the technical level the Government has been actively supporting the delivery of the Ocean Energy Strategy for Ireland, which was adopted as Government policy in 2005. Its main focus is to introduce ocean energy into the wider portfolio of renewable energy and to develop an ocean energy sector. Currently, a number of Irish companies are developing different ocean energy technology concepts. For example, two (Wavebob and Ocean Energy) use wave energy, and one (Open Hydro) uses tidal energy. Both Wavebob and Ocean Energy have deployed prototype devices at the Galway Bay quarter-scale test site, and Open Hydro has successfully deployed in a number of countries.

The Ocean Energy Development Unit (OEDU) of SEAI was established to implement the Government's decision to accelerate the development of ocean energy (wave and tidal) in Ireland. The objectives of OEDU are:

- The creation in Ireland of a centre of excellence in ocean energy technology
- The stimulation of a world-class industry cluster through such initiatives as the enhancement of research facilities, development of test sites and support for industry development
- The connection of 500MW of ocean energy by 2020

Complementing the OE Strategy, in 2007 the Government adopted the strategy outlined in the Marine Institute's *Sea Change: A Marine Knowledge Research and Innovation Strategy for Ireland 2007-2013*. This strategy aims to drive the development of the marine sector in Ireland by:

- Strengthening competitiveness and sustainability of the marine sector
- Promoting economic stimulation and diversification
- Increasing research capacity
- Promoting regional development and North–South cooperation
- Improving public service
- Introducing improvements in environmental quality and management.

Mayo County Development Plan

The Mayo County Development Plan (2008–2014) encourages the production of energy from renewable sources under reference TI-RE 2, with a specific reference to wave and tidal among other sources. It recognises that natural resources are a vital element of the county's resource base and that they have not been developed to their full potential. The development of renewable resources is specifically addressed as part of the county's overall strategy for transport and infrastructure developments. In this it aims to optimise the development of appropriate renewable energy sources that make use of the natural resources of the area concerned in an environmentally acceptable and sustainable manner. The project sits within the area for marine renewable energy as identified in the Mayo County Development Plan.

Significant impacts of the development

The possible impacts of the development were examined. This was done by assessing the environment in terms of the existing conditions, the impact of the proposed development, and the measures taken to mitigate these impacts.

Human beings

The proposed development contains no residential component and will not have any significant direct impact on the composition of the population in the immediate area. However, through the provision of some local employment, it will help sustain the existing population and help prevent decline in the population of the area.

The installation of the proposed submarine electricity cable will not have a significant impact on employment, either at the construction stage or otherwise. The construction of the substation, access roads and cable ducts, however, will generate short-term employment for up to six months.

There is also potential for short-term employment on guard vessels and small boats during the cable-laying and landing operations. The impact during construction is expected to be positive but of short duration.

During the operational lifetime of the development (up to 15 years), the project has the potential to make Erris a hub of ocean energy development, and this could, in turn, give rise to spin-off projects. This trend has already been observed in the case of the Orkney Islands, which hosts the European Marine Energy Centre (EMEC) test site at Billia Croo, where approximately 200 people provide a range of services to the renewables sector including wave and tidal test site activities. It is likely therefore that a cluster of specialised services to the ocean energy sector will become established in the Belmullet area. These could include, for example, services in the following areas:

- Marine contracting
- Fabrication
- Design
- Performance verification
- Environmental surveying and impact assessment

There is potential for the creation of up to 12 jobs during the operation of the test site – between operational staff and those employed directly by wave energy device developers. This potential was identified based on experience at the EMEC site in Orkney.

Additionally, wave energy converters will require workboat services for operation and maintenance – including crew boats, guard vessels and boats with cranes/winches.

Maintenance of an assortment of oceanographic monitoring equipment will require regular service visits as will continuing scientific research. Frequent promotional visits to the test areas will also be required

As part of the AMETS development, SEAI, in conjunction with Mayo County Council, is proposing to enhance the pier facilities at Frenchport to allow for convenient access to the test site. This would involve the installation of a new slipway and the extension of the existing quay. Short-term employment opportunities in construction would result from this proposed upgrading. In the longer term the fishing community would benefit from the presence of enhanced facilities at Frenchport.

Flora and fauna

The flora and fauna of the area were characterised by diver, drop-down video and seabed sampling surveys (monthly at sea) and shore based surveys (marine mammals and birds) and intertidal core surveys (beach).

There are no designated cSAC, pNHA or SPA in the marine environment at the location of the test areas or along the cable route. The Mullet/Blacksod Bay Complex cSAC and pNHA (Site Code 000470) extends along the shoreline and in the general vicinity of the proposed substation location. The cables will pass through the cSAC area at Belderra Strand. There is protected habitat in the marine environment comprising of reefs in the near shore test area. Nearby designated sites include Special Protection Areas under the EU Birds Directive: Termoncarragh Lake, Cross Lough and Inishglora/Inishkerragh Islands; and also cSAC areas such as Inishkea, important for its birds and grey seal breeding population.

Subtidal

The general effects of the development on the reef habitats are likely to be a temporary increase in sediment displacement during the cable burial process and disturbance and change in habitat through the occlusion of areas of cobble beds by cable protection along the cable route and within sections of the two test areas. The communities present within the site are all characteristic of exposed communities already subject to extreme wave action. During the survey they all showed evidence of being subjected to the effects of sand scouring and sediment movement, and any sedimentation caused during the cable laying process is unlikely to have any more effect on these communities than a natural storm event would have.

The greatest potential for impact on subtidal benthos is the creation of artificial reefs which may fragment communities and provide habitat for predatory species leading to impact on benthic species. However, the extent of this will be small in the context of the total available habitat. Conversely, the reefs may serve to increase biodiversity in the area providing additional habitat which would result in a positive impact overall.

Intertidal

Intertidal area surveys indicated that the beach is typical of an exposed habitat open to the effect of Atlantic waves. The paucity of species in all cores was notable. The extremely low diversity of species and biomass at Belderra Strand is indicative of the particularly harsh environment at this site, where even the most robust species were lacking. The impact of the development will be low and of short duration over a minor proportion of the beach area. Full recovery would be expected within one year of construction.

Marine mammals

The waters off north-west Co. Mayo have a long association with marine mammals, especially cetaceans (whales, dolphins and porpoises), as it was the site of two whaling stations that operated at the beginning of the 20th century. Cetaceans were recorded throughout the year with common dolphin and harbour porpoise widespread and abundant, and bottlenose dolphins abundant during summer and autumn. Some species such as minke whale were only present in the summer. The AMETS is a relatively small area when considering mobile marine species such as marine mammals. Nevertheless, seven cetacean species, two seal species and two other marine megafauna species (sunfish and basking shark) were recorded within the general test site area and at three other locations adjacent to it.

The construction phase is generally regarded as being potentially the most disruptive to marine mammals. Increased boat traffic and noise during construction may create a disturbance and degradation of preferred habitats. Of the species recorded in the vicinity of the AMETS, porpoise are likely to be the most sensitive to disturbance, actively avoiding vessels because they are more sensitive to high frequency sounds than dolphins. The impact during construction will be temporary and will not be significant and mammals will return to the area once construction is completed.

Knowledge of interaction between wave energy converters and marine mammals is largely based on a limited number of reviews, inference from studies on other marine renewable energy projects (such as tidal energy and offshore wind) and on expert opinion. Assessment of potential impacts of marine renewable energy devices on marine mammals during the operational phase is largely based on such knowledge, on literature reviews and experience of other marine devices.

Until such time as full-size devices are deployed at sea and their effects can be monitored, predicting impacts is a speculative activity. International published literature recognises this fact and emphasises the important role of monitoring early deployments of wave devices to determine possible effects, followed by rapid publication of results to guide the management of subsequent developments.

Operational phase impacts that might affect marine mammals include the risk of collision with the WECs or their anchoring systems, disturbance from underwater noise, and effects associated with the electromagnetic field from the submarine electricity cables. The scale of the development is very small in terms of the open ocean environment where it will be located and the risk of collision with WECs or noise effects are very small and the impact will not be significant. Once the WECs are deployed, a comprehensive monitoring programme should be in place to guide the site management and inform future deployments. This programme should include continued onsite observations of marine mammals when devices are operational, and noise monitoring using up-to-date equipment and validated techniques.

Terrestrial

The terrestrial survey of Belderra Strand and the surrounding area indicated that it is an exposed, low-lying mosaic of improved agricultural grassland and dry calcareous grassland with smaller areas of marram dune, dune slack and machair. The vegetation recorded here was typical of the habitat and no rare or threatened species were recorded. The Irish hare was the only non-domestic animal recorded during the surveys. The principal impact will be the loss of semi-improved agricultural grassland. Although this will be of long-term duration it is not of conservation interest. The extent of the habitat loss (2 acres) is very limited and the impact is not significant.

Avifauna

The Mullet peninsula and its nearby islands are protected for birds by a number of Special Protection Area (SPA) designations. These SPAs are nationally and internationally important for a range of breeding and wintering birds. Important species and species groups that use the shore habitats of the bay are wintering waders, common sandpiper and ringed plover. Use of shore habitats by flocks of roosting gulls and by waders during the summer months is also of note. Survey coverage of shore habitats and their use by birds was considered good. Counts of birds at Belderra Strand were consistently low. This may be due in part to disturbance by beach users, which was regularly recorded at this site. The inner bay is used year round by a range of birds, including wintering waterfowl, and foraging seabirds. Of note is the use of the bay by the Annex I species great northern diver and the occurrence of eider duck, which are part of a recently established, local breeding population. Long tailed duck regularly occur in nationally important numbers within the bay. Large rafts of Manx shearwater were also recorded in the bay.

The Annex I species, Arctic tern, little tern and sandwich tern were recorded foraging in the bay during the breeding season. Gulls, shags and auk species also used the bay and breed locally.

The results of the Seabird at Sea Survey which covers the period of spring migration, the breeding season, and the start of autumn migration indicated that species that breed at nearby colonies were present during the breeding season, including auks, terns, gulls and fulmars. Storm petrels were identified on Inishglora. Passage migrants such as great skua and great and sooty shearwater were present during the autumn. Large rafts of Manx shearwaters are of note, and may be linked to the late arrival of non-breeding birds in Irish waters.

Little data exists on the environmental impacts of wave energy devices on avifauna. The potential impacts on birds may vary depending on nature, age and reproductive stage of the species. As with the marine mammals, the main potential for impacts comes from physical disturbance, risk of collision and noise disturbance. Entrapment of birds within the WEC structures is also a possibility. The potential impacts on birds will vary depending on the location of the installations and on the timing of construction activities. Careful planning and timing of activities will minimise any potential impact as will efficient construction and operation using the minimum footprint. It will be important to monitor bird populations in the study area, focusing on those species of note in terms of their conservation status and/or abundance and on any species that may be at particular risk, for whatever reason, due to their behaviour during the construction and operational phases.

Water quality

The main impacts on water quality will arise during the construction phase, when cable burial and anchoring operations will generate suspended sediment close to the cables. However, this will quickly settle and there will be only a temporary and insignificant impact on water quality. There is also a risk of accidental oil pollution from vessels should a collision occur. On-ship pollution plans will be put into operation in the event of such an occurrence, and the high energy nature of the location would rapidly disperse any residual contaminants.

During the substation construction there is a risk of silt entering the local drainage system which discharges across Belderra Strand. However, with good construction practices the risk will be minimised and impact will be low.

During the operational phase wastewater from the substation site could contaminate the nearby drainage system but this will be treated using a proprietary treatment system or tankered off site for disposal in accordance with legal practice.

The deployment and operation of the test site submarine electricity transmission cables in the seabed offshore and in the beach of Belderra Strand is not expected to present any significant risks to water quality during construction, operation or decommissioning.

Soils, geology and groundwater

The electricity transmission cables in the seabed offshore and in the beach of Belderra Strand are not anticipated to present any significant risks with respect to soil, sediment or geology during construction, operation or decommissioning. The construction of land-side project components (cable jointing bay, land cable and substation) present limited risks to receiving groundwaters during construction and lower risks during operation. These limited risks will be mitigated by the implementation of good construction practice and the provision of robust protection measures in the design of the substation.

The proposed development does not present any significant risks to soil or sediment, geology or groundwater during construction or subsequent operation.

Air quality and climate

Air quality in Ireland Is regarded as the highest in Europe, particularly in remoter western locations such as at Annagh Head. Emissions from vessels operating offshore during the construction and operational phases will contribute to background levels of sulphur dioxide, carbon dioxide and (to a small extent) nitrous oxides. Emissions from these offshore vessels constitute a small fraction of 1% of national air emissions. Emissions will also be of short duration, and during the operational phase will be offset to a small extent by renewable energy generation from the site. Considering the low levels of air pollutants in the receiving environment and the rapid dispersion in the area, the impact on air quality from emissions associated with construction, operation and decommissioning of the test site is expected to be negligible.

Emissions from onshore activities will principally arise from vehicles and equipment used during construction and decommissioning. Implementation of a management plan for these phases of the project and agreed mitigation measures will ensure that emissions are minimal and have negligible impact on receptors in the project area.

Overall, the impacts on air quality will be negligible, both in the national context and in the immediate receptor area.

Noise

Construction works that could give rise to off-site noise will effectively be limited to a small amount of earth moving, excavating and concreting. Noise levels resulting from construction of the substation were calculated for various distances from the site and it was concluded that noise levels will be well within the limits commonly imposed for construction sites.

Monitoring of noise was undertaken at the substation location and at three locations along the access route to the substation from the R313 regional road linking Belmullet and Blacksod. Measurement locations were chosen to be representative of the general area. The measurement locations are representative of the noise environment at the nearest residences likely to be impacted by this proposed development

The background noise levels in the Belderra area are typical of a rural area but can be elevated by natural sources such as surf noise. The noise levels measured at the junction near Belderra Strand were consistently higher than those measured on the proposed substation site due to

the proximity to the beach and local road network. There is, however, some natural screening at the proposed site.

A construction noise prediction model was prepared to deal with a worst-case scenario where a large bulldozer is engaged in site clearance works while (at the same time) trench excavation is taking place at three locations along the land cable route. The model predicted that at the nearest houses, the noise levels as a result of the construction works will be within the National Roads Authority's guideline figure for construction activity and not much greater than the baseline background noise measured for the area.

During operation, noise from within the substation due to switch gear and alarms are not foreseen to be a problem, as any such noise would be infrequent and of short duration. It is expected that noise generated by the transformer will be sufficiently attenuated outside the substation so as not to cause annoyance at neighbouring properties. In addition, the noise level will be further reduced by landscaping and the planting of the earthen berms around the substation perimeter.

Traffic noise will not increase significantly above background levels during all phases of the project. Overall the predicted noise impact from the development will be low and is not expected to give rise to complaints from local residents.

Roads and traffic

The substation site is located at Belderra Strand, which is on the west coast of the Mullet Peninsula in west County Mayo approximately 7km from Belmullet. Access to the site is by way of the R313 and L5233 from Belmullet and beyond. The site is connected to the L5233 via a local road. This road is unsurfaced between the junction with the L5233 and a point just southwest of the site area.

Traffic surveys were undertaken at three locations as agreed with Mayo County Council as part of the traffic and transport assessment for the site.

The volume of traffic movements associated with the construction phase of the AMETS substation and land works will be very low, adding just 8.2% to the baseline traffic in the area (on the L5233) and no specific mitigation is required with respect to traffic volume. There are sufficient passing bays along the local roads to facilitate passing and the project will not give rise to any traffic congestion in the area.

From the access and safety aspect, mitigation will be principally by design, and impacts will be minimised by ensuring good site access design and operating times designed to avoid peak school periods.

No significant impacts are predicted for any phase of the project.

Navigation risk assessment

Wave energy converters (WECs) will be placed in the test areas which in turn will be marked by cardinal marks and special buoys. Deep sea shipping, fishing vessels and pleasure craft routinely operate along the Irish west coast, and the marker buoys and WECs could constitute a hazard to vessels transiting or operating in the area.

The navigation risk assessment is primarily based on:

- An investigation of the existing environment.
- Consultations with stakeholders, users of the area and relevant national authorities.

- A semi-quantitative analysis of 28 days of data collected during specific radar surveys and vessel automatic identification system (AIS) data sourced from the Irish Coastguard. AIS data for the months of January and July 2010 was also obtained to supplement the analysis.

Consultations were carried out with all groups, organisations and agencies with a stake and/or interest in the waters off the west coast of Ireland, in particular the region off the Mayo coast. From these consultations it was concluded that some alteration to standard navigation routes may occur resulting from the presence of the test areas but this will not have a significant impact on navigation in the area. Search and rescue (SAR) response in the area will not be negatively impacted upon by the AMETS development. Consultees recommended adequate marking of the test areas and advanced notification of location.

The AMETS risk assessment indicated that the majority of the risks identified are 'broadly acceptable' provided the risk control measures are put in place. These risks require no further action. A small number of risks were determined to be 'tolerable with monitoring' and controls cited in relation to these risks should be periodically checked. A technical review by industry experts confirmed that the risk assessment is reasonable.

The construction and operational work will be planned and managed to ensure the safety of those involved and the safety of other maritime users in this area. This will include the selection of contractors and working vessels that are competent or capable of undertaking the works required, and that comply with offshore industry guidance and best practices.

Cultural heritage

The cultural heritage of the area was examined through archaeological, architectural and historical studies. The archaeological and architectural study involved a documentary search and field inspection of the area. Field inspections of the marine environment (geophysics and dive surveys) and walkover surveys on the intertidal and land areas were also undertaken.

Desktop and cartographic sources indicate that the area surrounding the subject site is of considerable archaeological and historical significance. Archaeological assessment provides indicative evidence for the continued and uninterrupted occupation of the area since neolithic times. Although there are a number of recorded archaeological monuments and finds in the vicinity, none will be directly impacted by the proposed development. Historical and cartographic records detail the more recent development and improvement of the area. They record the changing fortunes of the area, changes in ownership, and general improvements in living and working conditions.

The combined results of the desktop assessment and the field survey indicate that, although the subject site is one of considerable archaeological and historical significance, there is no evidence of archaeological material at the site of the proposed development. Notwithstanding this, there is potential that invasive ground works at the subject site may impact previously unrecorded archaeological material. Consequently a suitably qualified archaeologist will be required to be present during the construction and decommissioning phases of the project. The works should also be licensed appropriately.

Landscape and seascape

The *Mayo Landscape Appraisal* document identifies and describes the landscape character of each part of the county. The substation site is located on the western coast of Character Area B - North West Coastal Moorland. The wave energy converter sites are located off the western coastline of this same Area B. This character area is described as 'a complex of low lying islands

and peninsulas with varying topographical and land cover characteristics but unified by its proximity to the coast'.

Uninterrupted vistas across the water of bays and channels to opposing shorelines are abundant from public areas. The *Appraisal* states that 'the main concern for natural linear features such as coastlines and ridgelines is to avoid penetration by development that will interrupt and reduce the integrity of such elements'. In a low-lying and open environment, even low ridgelines are significant and it is important that development does not interrupt the integrity of primary ridgelines.

The greatest visual impacts during the construction stage would occur in the vicinity of the substation site and at the location of the underground cable. These impacts would be negative, but would be moderate and temporary.

The construction impacts associated with the proposed offshore test areas would largely occur at sea and, while these impacts would be negative, they will also be temporary.

The proposals will be new features in a landscape described in the *Mayo Landscape Appraisal* as 'vulnerable'; and 'sensitive'. However, good design and mitigation measures will result in landscape and visual impacts that will have low impact. Landscape, seascape and visual effects will generally be localised to the area between Annagh Head and Corraun Point.

In very clear atmospheric and good lighting conditions there will be slight visibility of Marine Energy Test Area B, and to a much lesser degree Marine Energy Test Area A. There would also be slight visibility of the roof of the proposed substation and visibility of the access road from a small number of localised views.

Material assets

Fishing industry

Inshore fishing activities within the project area consists mainly of brown crab and lobster fishing by members of the Erris Lobster Conservation and Restocking Association (ELCRA) and the Erris Inshore Fishermen's Association (EIFA), and trawling by members of the Killybegs Fishermen's Organisation (KFO).

During the construction and decommissioning phases, and during WEC deployment and recovery operations, the project's impacts on the fishing industry in the area will be temporary in nature and of low significance overall. During the operational phase, the test area locations will effectively constitute fishing exclusion zones. The impact on the crab and lobster fishing industry will, however, be low as Test Area A was redesigned following an extensive consultation process with the fishing community. Test Area B, at the 50m water depth, will not impact significantly on fishing activity in the area.

Trawling activity will also be impacted, with a reduction in access to the trawling ground adjacent to Test Area A of some 9%. However, this impact, although negative, can be considered as low, given that the area is one of five such areas fished in the region and the overall impact will be small.

Impacts can be further reduced through careful planning of all activities associated with the test site establishment, operation, maintenance and decommissioning, and through continuing engagement with key stakeholders in how operations are timed.

Economic losses to the fishing community could be offset by the effect of creating nursery areas through fishing exclusion at the test areas. The long-term influence of the test site in this

regard should be demonstrated through a specially funded project involving all key stakeholders.

Land use

The project will result in medium-term loss of two acres of pasture land at the substation site. It will also lead to temporary loss of use of the beach area at Belderra for a very short period during cable conduit installation. In addition there will be some local road closures of short duration during the land-side cable trenching and construction of the cable transition joint bay. The impact of these activities will not be significant. No additional impact is predicted during the operational phase and the site will be subject to a decommissioning plan.

Tourism

The Atlantic Marine Energy Test Site is not expected to have any negative impacts on tourism. Additional visitors may be attracted to the area during the submarine electricity cable laying operation and when the wave energy converters are deployed at the test site. This could also lead to increased marine tourism in the area.

Coastal processes

Coastal processes include the wave resource and its effects on sediment transport and coastal landform. Wave action is responsible for coastal land formation, including beaches. A change in wave action, resulting from the effects of wave energy converters taking energy from the resource, could result in changes to landform and sediment movements in the marine environment. Removing energy from the waves could also reduce wave height to an extent that it would impact on the surfing community. Modelling of the impact of wave energy converters on the wave resource, sediment transport and coastal landform was carried out by the Hydraulic and Maritime Research Centre in UCC.

The modelling indicated that the impact of the wave energy converters when deployed at the test area would be insignificant in comparison to the natural processes occurring in the bay. There will be no significant impacts on sediment transport, coastal landform or surfing waves.

Cumulative impacts, indirect impacts and interaction of impacts

There is potential for the Corrib Gas Project to have some limited cumulative impact together with the AMETS project. The assessment of cumulative impacts identified that navigation, traffic and human activity are the main areas where such impacts might potentially occur. The potential cumulative impacts that arise from the Corrib Gas project would be temporary, of short duration and insignificant in impact. A positive impact could arise for human activity in that there could be additional demand on local resources, accommodation and services, but this would depend on the implementation timing of AMETS.

The main indirect impacts associated with the AMETS include quarrying of materials for rock armour and construction. An estimated 32,000 m^3 of rock armour will be required for cable protection. There may be traffic and transport issues associated with the delivery of this material to a suitable harbour for transhipment to the AMETS site. There will also be a requirement for materials for the substation construction, but the quantities will be small and available from local quarries. The extraction and transport of materials required to construct the AMETS may also give rise to increased employment not directly associated with the AMETS construction. There might also be temporary economic benefits, additional income and temporary increased income to the area arising from the accommodation, transportation and general service requirements of WEC developers.

Bathymetry data collected as part of the seabed characterisation is available to the fishing community and potentially could be used to enhance overall fishing management.

Online data on the wave and climate characteristics is being provided through wave and climate scientific equipment located at the test areas. This online data will provide useful information to fishermen, surfers and other recreational users of the marine environment in the area – for example, by providing knowledge of suitable conditions for their specific activities.

The high bandwidth communication requirements of the test site will result in a communications infrastructure being put in place that will enhance broadband availability in the area generally.

Interaction of impacts does occur to some extent, but the level of such interaction does not significantly magnify the primary impacts as described.

Management and monitoring

An AMETS management organisation (such as a company limited by guarantee) will be established by SEAI to manage the construction and operation of AMETS. Once established, the AMETS Management Organisation's role will be to prepare, implement, review and monitor adequate operating procedures for AMETS, covering all aspects of the operation, appropriate for the detailed technical design and in line with best practice and consent constraints at that time.

The AMETS Management Organisation will be responsible for developing and implementing a robust but flexible Operational Management System to allow the broadest variety of operations to take place in a safe and controlled manner.

A working committee or similar structure for the AMETS project will also be established in parallel to the AMETS Management Organisation to ensure involvement of other relevant statutory bodies in the management and governance of the project.

While management of operations will be a considerable element of the AMETS Management Organisation's remit, environmental monitoring will also be a major responsibility. Critical to successful environmental monitoring will be the design and implementation of an Environmental Management System to ensure that environmental conditions (as characterised during the baseline studies), will be monitored on an ongoing basis, so that any negative impacts can be addressed at the earliest possible stage.

Conclusion

The main benefit from this project will be to enable WEC technology developers to test and modify their equipment in an open ocean grid-connected national test facility, thereby attracting developers to the site and encouraging the growth of an indigenous ocean energy industry in Ireland.

Proving WEC technology in such an environment is critical to the future development of the ocean renewable industry as a whole. It will give confidence to investors to proceed to full scale commercial development and in turn help to develop a new and comprehensive indigenous Irish ocean energy industry. This could also lead to the exploitation of the vast ocean renewable energy resource ultimately reducing Irish and global dependence on fossil fuels.

The test site is an integral component of Ireland's Ocean Energy Strategy and its development would trigger the growth of an indigenous marine renewable energy industry through spin off developments, in turn generating considerable job creation.

The equipment to be deployed at the test site will have gone through a rigorous assessment process and will have been deployed at other ocean energy test sites where its characteristics will be well documented.

The most significant environmental impacts from the project have been examined and the best available mitigation has been applied in an integrated approach. As a consequence, there will be no significant adverse impacts on the environment arising from the development.

An AMETS Management Organisation will be established by SEAI to develop and implement adequate operating procedures to allow the broadest variety of operations to take place in a safe and controlled manner.

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Abbreviations and acronyms

A	Ampere or Amp
AADT	Annual Average Daily Traffic
AC	Alternating Current
ADCP	Acoustic Doppler Current Profiler
AHT	Anchor Handling Tug
AIS	Automatic Identification System
AMETS	Atlantic Marine Energy Test Site
ATCs	Automatic Traffic Counters
B field	Magnetic field
BIM	Bord Iascaigh Mhara (Irish Sea Fisheries Board)
CER	Commission for Energy Regulation
CIL	Commissioners of Irish Lights
CPODS	Self contained click detectors that log the echolocation clicks of porpoises and dolphins
cSAC	Candidate Special Area of Conservation
CSO	Central Statistics Office
CZMU	Coastal Zone Management Unit
DAFF	Department of Agriculture, Fisheries and Forestry
DAFOR	Dominant, Abundant, Frequent, Occasional, Rare
dB	decibels
dB(A)	sound as measured by meters with filters adapting the measured sound response to the human sense of sound
DC	Direct Current
DCENR	Department of Communications, Energy and Natural Resources
DEFRA	Department for Environment, Food and Rural Affairs (UK)
DEHLG	Department of Environment, Heritage and Local Government
Dir	Direction
DTI	Department of Trade and Industry (UK)
DTM	Digital Terrain Model DTM
E field	Electric field
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EIFA	Erris Inshore Fishermen's Association
EIS	Environmental Impact Statement
ELCRA	Erris Lobster Conservation and Restocking Association
EMEC	European Marine Energy Centre

EMF	Electromagnetic fields
EPA	Environmental Protection Agency
EPC	Engineer, Procure and Construct
EPIRB	Emergency Position Indicating Radio Beacon
EQR	Ecological Quality Ratio
ESB	Electricity Supply Board
ESBI	ESB International
EU	European Union
GHz	Gigahertz
GPS	Global Positioning System
GSI	Geological Survey of Ireland
GW	Gigawatt
H&S	Health and Safety
HDD	Horizontal Directional Drilling
Hmax	Maximum wave height
HMRC	Hydraulic and Maritime Research Centre
Hs	Significant wave height
HSE	Health, Safety and Environmental
HV	High Voltage
HVDC	High Voltage Direct Current
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
IBM	International Business Machines Corporation
ICES	International Council for the Exploration of the Seas
ICNIRP	International Commission on Non-Ionising Radiation Protection
iE field	induced Electric field
IEA	International Energy Agency
IFS	Irish Forest Soils survey programme
IMAR	Geophysical survey company
INFOMAR	Undersea geophysical survey of Irish territorial waters by the Marine Institute and Geological Survey of Ireland
IQI	Infaunal Quality Index
IWDG	Irish Whale and Dolphin Group
JCB	Tractor style digger with backhoe and wheels
KFO	Killybegs Fishermen's Organisation
kHz	kiloHertz
kV/m	kiloVolts per metre
kW	Kilowatt
L50	Noise level exceeded for 50% of the time
LA90	Background noise levels

LAeq	Equivalent Continuous Level (Noise)
mA	milli-Amp
MASTS	Marine Alliance for Science and Technology for Scotland
MCC	Mayo County Council
MI	Marine Institute
μT	microtesla
MMO	Marine Mammal Observers
MSO	Marine Survey Office
mT,	millitesla
mV/m	milli-Volts per metre
MW	Megawatt
NHA	Natural Heritage Area
NMBAQC	National Marine Biological Analytical Quality Control Scheme
NPWS	National Parks and Wildlife Service
NRA	Navigation Risk Assessment
NRA	National Roads Authority
NREAP	National Renewable Energy Action Plan
NUI	National University of Ireland
NYPSC	New York Public Service Commission
OE Buoy	Wave energy converter being developed by the Irish company, Ocean Energy Ltd
OEDU	Ocean Energy Development Unit
OPW	Office of Public Works
OREDP	Ocean Renewable Energy Development Plan
OS	Ordnance Survey
OSPAR	Oslo and Paris Convention Commission
OTD	Overtopping Device
OWC	Oscillating Water Column
PAH	Polycyclic Aromatic Hydrocarbons
pH	acidity/alkalinity scale
PLB	Post-lay Burial
pNHA	Proposed National Heritage Area
R&D	Research and Development
RBD	River Basin District
RBMP	River Basin Management Plan
RIB	Rigid Inflatable Boat
RMP	Record of Monuments and Places
RNLI	Royal National Lifeboat Institution
ROV	Remotely Operated Vehicle

RPA	Register of Protected Areas
RPS	Record of Protected Structures
RTDI	Research, technology, development & innovation
SAC	Special Area of Conservation
SAR	Search and Rescue
SEA	Strategic Environmental Assessment
SEAI	Sustainable Energy Authority of Ireland
SI	Statutory Instrument
SNH	Scottish Natural Heritage
SPA	Special Protection Area
Tp	Peak wave period
TTA	Traffic and Transport Assessment
Tz	Mean wave period
UCD	University College Dublin
UK DTI	UK Department of Trade & Industry's
V/m	Volts per metre
VHF	Very High Frequency (Radio)
WAB	Wave Activated Body
WEC	Wave Energy Converter
WFD	Water Framework Directive
WHO	World Health Organisation
WMU	Water Management Unit
WRBD	Western River Basin District
ZTV	Zone of Theoretical Visibility