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Morlais Project

Proof of Evidence
Dr James Orme – Project Witness

Applicant: Menter Môn Morlais Limited
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Proof of Evidence: Project Characteristics

1. Introduction

1.1 My name is Dr James Orme and I am a project witness for the Morlais Tidal Array. I have a BEng Honours (1st) Degree in Engineering from Swansea University a PhD in hydrodynamic modelling of tidal stream turbines.

1.2 I have over 20 years of experience in tidal stream energy development, including technology development, project development, consenting and financial analysis.

1.3 I am the Consenting Lead for the Morlais project and have been involved with the project since 2012 with involvement in a broad range of activities.

1.4 The topic of evidence is Project Characteristics in terms of location and scale and the requirement for the broad Project Design Envelope approach.

1.5 This proof of evidence should be read in conjunction with the Proof concerning Navigation, SLVIA, Mammals, Ornithology and Planning.

1.6 The evidence addresses:

- The requirement for the proximity of the project to the Anglesey coast.
- The requirement for the project to be at the scale proposed, both in the first phase and the ultimate full deployment.
- The requirement to use a broad Project Design Envelope.

1.7 This proof of evidence represents my professional opinion, based on my knowledge and experience.

1.8 A full summary of evidence is given in Section 8.

1.9 Key documents in support of the marine mammal proof of evidence are outlined in **Table 1**.

2. Table 1: Key Documents

Reference	Core Documents
MDZ/I3	HRW Wallingford Flow Model Report
MDZ/M1 to MDZ/M6	Developer letters
MDZ/A25.4	ES Chapter 4
MDZ/A28.1	ES Chapter 4 Figures
MDZ/A28.25	PDE matrix
Reference	Key representations
REP005	Natural Resources Wales
MDZ/N9	Natural Resources Wales
MDZ/N2	RYA
FEI-OBJ014	RSPB
OBJ072	Kudelska, T
Reference	Other Relevant Documents and Reports
MDZ/P9	Planning POE
MDZ/P2	Mammals POE
MDZ/P7	Navigation POE
MDZ/P5	SLVIA POE
MDZ/P1	Ornithology POE
MDZ/P9	Carbon reduction policy / climate emergency
MDZ/D11	WG Declaration of climate emergency
MDZ/D13	UK Wave and Tidal Demonstration Zone Workshop 2015
MDZ/D14	Planning Inspectorate Advice Note Nine – Rochdale Envelope

3. Structure of Evidence

3.1 Section 3 - Factual Background

3.2 Section 4 - Relevant legislation, policy and guidance to the subject matter

3.3 Section 5 - Other relevant constraints

3.4 Section 6 - Matters for the Inquiry - The Project's Response

3.5 Section 7 - Addressing representations made by interested parties and how the Project has responded to the concerns raised

3.6 Section 8 - Summary and Conclusions

4. Factual Background

4.1 The Morlais Demonstration Zone (MDZ) covers an area of 35km^2 of seabed to the west of Holy Island, Anglesey, Wales. The area is shown in Figure 1.

4.2 It is a total of c.8.3km north to south and at its widest point is 5.4km east to west. Following consultation, the eastern MDZ boundary has been designed to allow an inshore navigation channel which averages 1.9km in breadth between the coast and the nearest surface emergent tidal devices. At its narrowest points at South Stack and Penrhyn Mawr there are short sections where the breadth of this channel is limited to 1km. The MDZ boundary itself runs 500m closer to shore, with any tidal devices within this area constrained in size to allow a minimum under keel clearance of 8m (Restricted Area Blue). Similarly in the northern most part of the zone, around the west and also to the south, there is an area which allows for 20m of under keel clearance (Restricted Area Purple). In addition, in the area to the west and north of South Stack, no visually prominent devices are permitted (Restricted Area Gold).

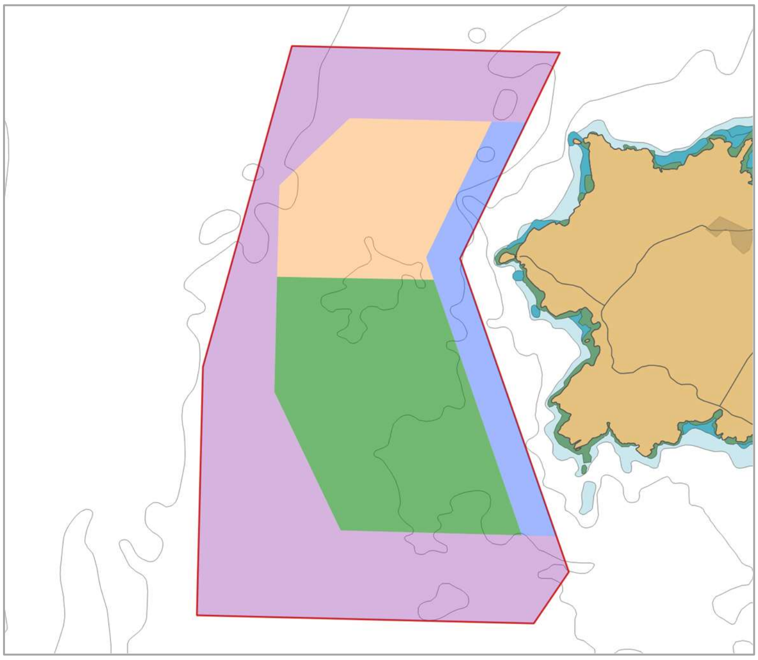

Figure 1 - MDZ Plan

4.3 The project is proposed to accommodate a maximum of 240MW of tidal stream generation, which allows for the commercial demonstration of 8 x 30MW arrays of different technology types. Tidal stream technology is a pioneering new form of renewable energy that offers distinct advantages as part of the low carbon energy mix. It is therefore acknowledged by all involved that it is inevitable that some data gaps remain at the current time. Owing to this uncertainty with respect to the potential for impacts on marine biodiversity, a phased approach is proposed. An Environmental Monitoring and Mitigation Plan (EMMP) controls the size of the phases such that they are not expected to cause a significant adverse effect on marine biodiversity under the Habitats Regulations (See MDZ/P4). The scale of the first phase is expected to be limited by the constraint of potential impacts on bottlenose dolphin. Only if and when it can be demonstrated to Welsh

Government under the TWAO and NRW under the Marine Licence that subsequent, larger phases are not expected to cause a significant adverse effects on marine biodiversity, will these subsequent phases be installed. The scale of the first phase is defined in terms of its predicted impact, in that it will be of a scale currently predicted to result in less than 0.7 bottlenose dolphin collisions per year. As different tidal technologies have different collision rates per MW installed, it is not possible to define the first phase in terms of MW output, however it is expected that this would be no larger than c.12MW [MMC141]. Similarly, subsequent phases are not defined in terms of MW, but they would be constrained to a scale that is not predicted to have a significant adverse effect on biodiversity.

4.4 The Project Design Envelope (PDE) is defined in Chapter 4 of the ES [MDZ/A25.4] where each of the limitations on parameters is defined. Individual array deployments will be confirmed to fit within the PDE prior to installation. Technologies that do not sit within the envelope will not be permitted to be installed. This approach was successfully employed at the PTEC project to consent a tidal stream energy project at the Isle of Wight[1]

4.5 Site selection and refinement

4.6 In 2012, The Crown Estate (TCE) identified Key Resource Areas for wave and tidal energy around the UK. TCE engaged with the industry to determine requirements and key factors in site selection.

4.7 In 2013, The West Anglesey Demonstration Zone (WADZ, now known as the MDZ) was defined by TCE in consultation with Stakeholders with reference to the Marine Renewable Energy Strategic Framework (MRESF) for Wales.

4.8 The TCE process for identification of tidal stream demonstration zones initially sought areas with no minimum distance from shore. TCE then consulted with Navigational Stakeholders as part of MDZ identification, including existing marine users which resulted in minimum distances for the tidal demo zones:

- West Anglesey Demo Zone is 1km from shore
- North Devon Demo Zone is 0.5km from shore
- Isle of Islay Demo Zone 1km from shore

4.9 In parallel, Menter Môn also consulted with key stakeholders for a project off Holy Island and the feedback included advice that under keel clearance be used to mitigate effect on navigation and that recreational use be considered when assessing impacts on Navigation.

4.10 TCE, as competent authority, identified the need for a HRA to be undertaken for the 2013/14 wave and tidal leasing plan as a requirement of the Habitats Regulations and the Offshore Habitats Regulations. This assessment was undertaken in parallel with the leasing round. The MDZ was incorporated into this plan-level HRA. As a highlevel, strategic document, there was still some uncertainty about the final locations of the demonstration zones and so, to address this uncertainty and retain flexibility within the

[1] The application (ref: MLA/2014/000563) can be accessed via the MMO Public Register.

plan, 'Areas of Interest' were defined as an approximately 10km buffer zone around the demonstration zones. These Areas of Interest provided the definition of the spatial extent of the plan against which impacts were assessed in the HRA. As part of this process TCE consulted with the Statutory Nature Conservation Bodies (SNCBs) and other stakeholders to ensure a consistent approach to undertaking plan-level HRA. The Appropriate Assessment was completed in 2014 concluding no adverse effect on the integrity of European sites as a result of the plan, at which point TCE were able to finalise the leasing process and sign seabed agreements. It was also assumed that each zone and project would undertake project-level HRAs as part of its subsequent consent application.

4.11 In 2014, Menter Mon successfully bid for the lease to manage the MDZ on behalf of Crown Estate and began to undertake further work on understanding the project potential.

4.12 In 2015, higher definition flow modelling indicated that the area of tidal stream resource required for tidal energy project is further north and east than the original WADZ boundary as defined by TCE. Menter Môn prepared to propose a boundary change to TCE.

4.13 Publicly available AIS data was used to assess marine traffic density. The northern ferry route was avoided and the high density inshore route was also avoided by allowing a 500m inshore channel which is aligned with many other tidal energy sites around the UK. Note that 70% of all tidal stream energy sites in the UK are 500m or less from the coast. 83% are within 1,000m[2].

4.14 The boundary change was proposed to stakeholders, on the basis that any resulting project would be subject to full consent application and NRA. Concerns were raised about the 500m breadth by Navigational Stakeholders and a preference to maintain the 1km distance was noted [MDZ/I5]. It was also acknowledged by Stakeholders that much of the inshore traffic was inshore of the proposed boundary change and hence would not be affected.

4.15 On the basis that any resulting project would be subject to full NRA and EIA, TCE approved the boundary change and the WADZ location was moved to its current location.

4.16 Subsequently, through further consultation with Navigational and Landscape stakeholders the current proposals for mitigations in the form of Restricted Areas (which restrict the allowable types of turbine) as shown in Figure 1 were developed. More detail on this process of refinement is given in the Navigation Proof of Evidence [MDZ/P7] and the SLVIA Proof of Evidence [MDZ/P5].

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[2] TCE Crown Estate Tidal Stream Leases GIS dataset 2015

5. Legislation Context

5.1 The Habitats Regulations (MDZ/B6) as described in the Policy POE (MDZ/P9).

5.2 Carbon reduction policy / climate emergency as described in Policy POE (MDZ/P9).

6. Other constraints

6.1 Planning Inspectorate Advice Note Nine – Rochdale Envelope (MDZ/D14) as described in Policy POE (MDZ/P9).

6.2 As discussed below in Section 7, the project has a fundamental requirement to be located in the area of high tidal stream energy.

7. Matters for the Inquiry - The Project's Response

7.1 It is my understanding the key objections and outstanding issues related to this proof are:

7.2 Project location

7.2.1 The proximity of the project to the Anglesey coast and the potential for this proximity to impact on the Holy Island AONB and also potentially cause associated negative socioeconomic effects.

7.2.2 The proximity of the project to the Anglesey coast and the potential for this proximity to impact on the safety of the inshore navigation route for small boats and unpowered craft, and also the potential for associated negative socioeconomic effects.

7.3 Project scale

7.3.1 Whether the scale of the first phase of deployment is expected to cause a significant adverse affect on protected marine mammal species.

7.3.2 Whether the scale of the overall project is appropriate to be consented now and controlled by phasing in the EMMP, or whether a smaller project should be brought forward instead.

7.4 Project design envelope

7.4.1 Whether it is appropriate to use a broad Project Design Envelope for a tidal energy project of this scale and whether this allows a robust Environmental Impact Assessment and a Navigational Risk Assessment to be undertaken.

7.5 The project's response is set out below.

7.6 Project Response - The location of the project

7.6.1 The location of energy in tidal streams is unlike wind or solar energy in that the resource is not evenly distributed across wide areas, it is concentrated in specific locations created by geographical features. It is not possible to move the project away from these areas of tidal stream energy, as adequate energy resource is a fundamental requirement of the project.

7.6.2 To allow an understanding of the physical constraints, the effect of the gravity of the moon is to pull the body of water in the ocean around the planet which causes the daily rise and fall of the tides. As a result of this pull, water must move from place to place, resulting in flows that are called tidal streams. Tidal stream energy generation is the conversion of this kinetic energy into electricity and relies upon high velocities that are created by restrictions such as channels or as is the case at Morlais, promontories. It is the presence of the headlands at the east of Holy Island that causes the acceleration in flow in this area and creates the opportunity for energy generation.

7.6.3 Whilst different tidal energy technologies may be designed for different tidal stream environments, there are fundamental physical and engineering drivers that govern the viable operation of tidal stream energy systems. In exactly the same way that a wind turbine requires adequate wind velocities, tidal stream turbines require adequate tidal stream velocities in order to be viable.

7.6.4 The generation output of a tidal stream turbine is very sensitive to flow speed and is governed by a mathematical relationship whereby the power generated is proportional to the cube (u^3) of the flow velocity. By this token, doubling the flow speed results in eight times the power output. Or with a less extreme example, a 20% increase in flow velocity results in 73% additional power output. Given that the cost of installation, ships and associated infrastructure will be similar regardless of the flow speed, the location of a tidal energy project and the associated flow speeds are fundamental to project viability.

7.6.5 The Welsh Government commissioned Marine Renewable Energy Strategic Framework Marine Energy in 2011 states that tidal energy developers tend to need a minimum of 2-2.5m/s Mean Peak Spring Current (MPSC) for project viability.

7.6.6 “Generally, a minimum tidal stream of 2m/s mean peak spring was identified by the majority of developers as a requirement for a viable tidal stream device deployment; however some stakeholders suggested lower levels should be included i.e. 1.5m/s as a minimum, with some developers indicating a minimum of 2.5m/s or higher.”

7.6.7 In Morlais’ own consultation with potential tenants for the project in 2016, the average minimum flow speed require was stated by developers to be 2.48m/s mean spring peak velocity. Others expressed the requirement differently in terms of a requirement for an average flow speed of c.1.4m/s. A subsequent process to make initial allocations of subzones to individual tenants demonstrated that almost all tenants had a preference for the fastest areas of the MDZ.

7.6.8 HRWallingford was commissioned by Morlais to create a detailed hydrodynamic model of the MDZ, validated against real world data from tidal height and current monitoring stations. The original graph is in [MDZ/I3] however the colouring on the below Figure 2 has been adjusted clearly show the areas of flow above 2m/s and then those above 2.4m/s.

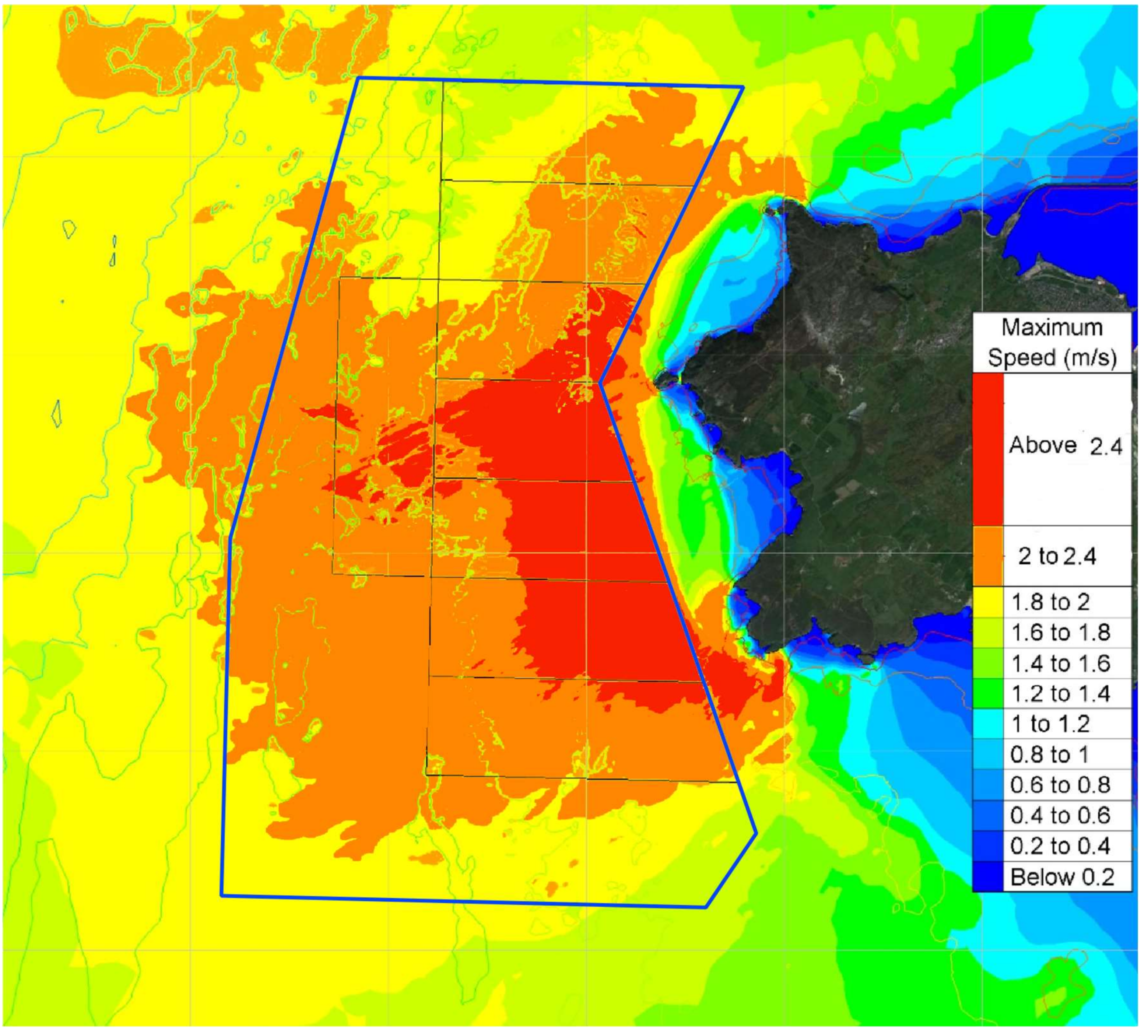

Figure 2 - Maximum mean spring current velocities

7.6.9 Similarly the HRW Report Figure 3 shows the average flow speed area of c. 1.4m/s in green.

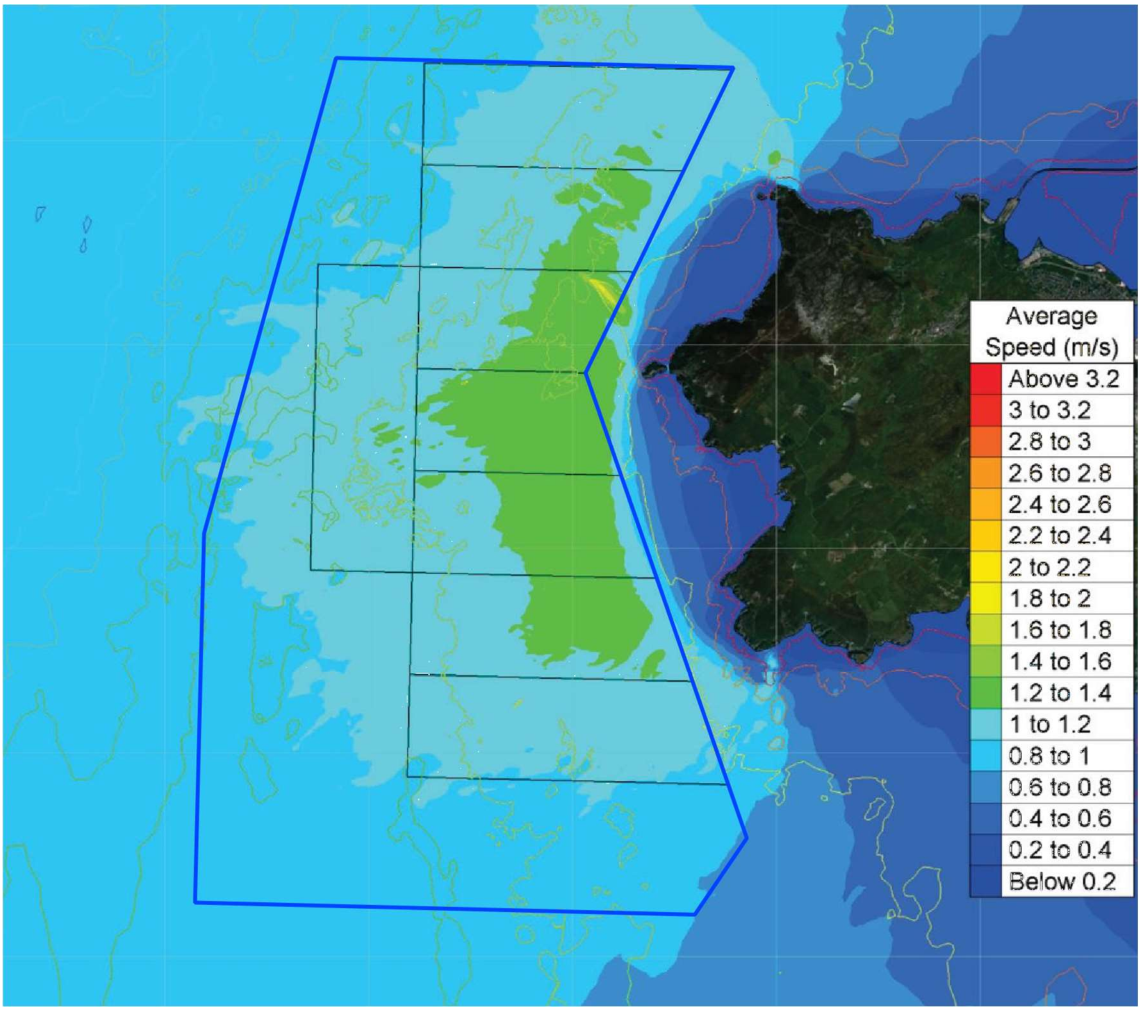

Figure 3 - Average flow velocities

7.6.10 Note that whilst the green and light blue areas in Figure 3 differs slightly in extent to the red and orange in Figure 2 above owing to difference in the way that different locations experience tidal streams over the tidal cycle, the general pattern is the same, with the areas of highest flow adjacent to the coast at between 0.5km and 3km offshore (0.3 - 1.6 nautical miles).

7.6.11 It is clear that to enable viable projects at the MDZ, it is these areas which need to be used. It is this factor that has driven the project's requirement to be in this location. Whilst significant compromises have been made in limiting certain types of devices to certain areas to reduce predicted impacts, there is a fundamental necessity for the project to be located in the areas of fastest flow as demonstrated.

7.7 Project Response - The requirement for project scale

7.7.1 Economy of Scale

7.7.1.1 The Morlais project is intended to serve as a commercial demonstration with the objective of reducing the cost of energy generated. A key factor in this is being able to install a project that uses the 'economies of scale' to enable cost reduction.

7.7.1.2 There are a number of ways that economies of scale are used to reduce the cost of energy generation. This is the economic situation where cost per unit of output decreases with increasing scale. Key drivers for tidal stream energy economies of scale are:

7.7.1.3 Economies of volume - This is intuitive and clearly observable from other industries through bulk order discounts, reduced production cost per unit and standardisation of common components.

7.7.1.4 Economies of generator size – For each turbine unit, many costs do not scale linearly with size. For example, design, project management, installation and material costs. As being illustrated by offshore wind energy, larger turbines are able to significantly reduce the cost of generation.

7.7.1.5 Economy of project size – A small project incurs costs that are proportionally much greater than those for a large project. For example a small project requires consent, survey, a cable and infrastructure connection and finance in much the same way as a large project however the costs are proportionately much greater for a smaller project as they do not scale linearly.

7.7.1.6 A larger project benefits from accelerated learning in that cost reduction learning in design and manufacturing happen more quickly owing the number of opportunities for learning being greater. This brings costs down faster which reduces cost of development overall and hence cost of generation[3].

7.7.2 Climate emergency

7.7.2.1 The global climate challenge is enormous and urgent as demonstrated by the declaration of a climate emergency by UK and Welsh Government [MDZ/D11]. The implications and costs for communities and society are commensurately large. Similarly, the expected widespread mass extinction of many species of wildlife owing to climate change are implicitly irreversible and will have permanent effects on the ecology of the planet into the future.

7.7.2.2 The scale of the requirement for carbon reduction is so large that it requires immediate deployment of all types of renewable energy production alongside step changes in energy use and behaviours. The timing of this carbon reduction requirement is also critical, as climate change is occurring now and the carbon reduction needs to happen immediately.

7.7.2.3 To allow the Morlais project to fulfil its potential and play a significant part in the reduction of carbon emissions, it needs to progress at a scale that is as large as possible whilst being acceptable in terms of environmental impact.

7.7.3 Developer business growth

[3] TIDAL STREAM AND WAVE ENERGY COST REDUCTION AND INDUSTRIAL BENEFIT – Offshore Energy Catapult 2018

7.7.3.1 The companies that are developing the technology needed to generate tidal stream energy are at an early stage and operate primarily on investment capital. Significant financial reserves are required to fund this pre-revenue stage with the objective of progressing to production of units at a meaningful scale as quickly as possible.

7.7.3.2 Without a rapid route to market, there is an increased risk that businesses will fail before reaching the sales volumes required to become sustainable in the long term. This will reduce and delay the ability of the industry to produce technology to reduce carbon emissions and create new employment in coastal communities. It is likely that the industry capacity will be lost to other developers abroad. Representation from Developers are given in [MDZ/M1 to MDZ/M6]

7.7.4 Whole array avoidance

7.7.4.1 Improving the scientific understanding of the ability of marine animals to avoid tidal stream turbines is critical to enable the subsequent phases of deployment at Morlais and for the industry as a whole and achieving its carbon reduction potential. The only way to demonstrate this effect is to install multiple devices in an array, and hence the first phase of deployment must be large enough to allow this to be monitored, ie multiple rows and multiple columns in the array. This is described in the Mammals POE [MDZ/P2]

7.7.5 In summary, there is a requirement for the project to be of significant scale to achieve:

- Economy of scale, and reduction in cost of energy.
- Urgently addressing the climate emergency
- Sustaining developer business growth
- Demonstrating whole array avoidance

7.8 Project Response - Requirement for a broad Project Design Envelope

7.8.1 Tidal stream energy is a relatively new form of energy generation. Much the same as was found in the wind energy industry in the 1970s and many other technology industries in history, there are a variety of design concepts in development in the early stages. This is a result of designs being created from first principles, and different design teams using learning from different related industries. Over time, much the same as wind turbine designs have generally converged on a 3 bladed tower mounted machine over the past 50 years, it is expected that tidal stream devices will converge in future. However, at present, and with the more diverse design environment underwater, a number of distinctly different devices are being developed in the industry and it is not clear which will be most successful at achieving the most effective tidal stream energy generation in the long term.

7.8.2 There is yet to be convergence in mooring methods, generation platform or device scale in the industry, however firm design principles are emerging and maximum dimensions and quantities are able to be determined, to be able to define a specific and quantifiable Project Design Envelope with which to undertake the EIA.

7.8.3 A Front-End Engineering Design (FEED) study was undertaken by ITP Energised (ITPE) on behalf of Menter Môn in 2018, to provide the proposed design of the project necessary to inform the EIA project description (**Appendix 4.1, Volume III [MDZ/A27.1]**). Further to a revision of proposed installed project capacity to 240 MW, an addendum to the study was undertaken for the MDZ elements (**Appendix 4.2, Volume III [MDZ/A27.1]**), also by ITPE. In parallel, Black & Veatch Ltd. (B&V) have been responsible for further design of, and updates to, the onshore infrastructure.

7.8.4 Consent for a broad PDE is sought, to ensure maximum flexibility in the tidal technology types consented for deployment by the Project. This approach allows for deployment of a variety of currently available technologies, whilst also allowing for evolution of the designs of tidal devices over time.

7.8.5 However, the range and flexibility sought within the consent application has been limited by careful consideration of development scenarios designed to rationalise the likely approach to development and to set workable limits on potential impacts. The PDE approach used in this ES, has been tested in planning law and is often referred to as the 'Rochdale Envelope' approach (see **Chapter 2, Policy and Legislation**).

7.8.6 The Project Design Envelope has been defined in accordance with Planning Inspectorate Advice Note 9- Rochdale Envelope [MDZ/D14] and the recommendations of the UK Wave and Tidal Demonstration Zone Workshop 2015 [MDZ/D13] in that:

7.8.6.1 Morlais communicated with and learned from the PTEC project that successfully use a broad PDE approach to consenting a tidal demonstration zone on the Isle of Wight[4].

7.8.6.2 The PDE approach has been clearly explained in the consultation phase in Chapter 6 Consultation, including meetings with key stakeholders [MDZ/A25.6]

7.8.6.3 The requirement for flexibility is clearly identified in Chapter 4 [MDZ/A25.4]

7.8.6.4 Worst case parameters are clearly defined in Chapter 4 and set out to demonstrate consistency in the PDE Matrix [MDZ/A28.25]. These were defined by using experienced specialists to consider sensitivities of specific receptors.

7.8.6.5 The ES establishes the relevant worst case parameters for the assessment for each receptor. This establishes those parameters likely to result in the maximum adverse effect (worse case scenario) for that particular receptor. As explained in Section 7, the worst case parameters may vary by receptor, but will always be within the overarching PDE parameters definition.

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[4] The application (ref: MLA/2014/000563) can be accessed via the MMO Public Register.

8. Relevant representations

8.1 The following relevant representations have been made to the TWAO process:

8.1.1 RYA SOC001:

8.1.1.1 *"Until such time as the Eastern Boundary is redesigned or the MDZ relocated to provide the necessary offing and sea room (1 to 2 nautical miles depending on overfalls), the RYA considers the residual impact to be High Risk and will maintain an objection to the Order application."*

8.1.1.2 The project response to the impact on navigation and Navigational Risk is given in [MDZ/P7]. From the perspective of the project location, as demonstrated above the requirement for current flow speed is fundamental to project viability. Note that it is the presence of these required currents that contributes to the creation of the 'overfalls'. Figure 4 below shows buffers a minimum of 1 nautical mile and 2 nautical miles from the coast which encompass the vast majority of the available tidal energy resource.

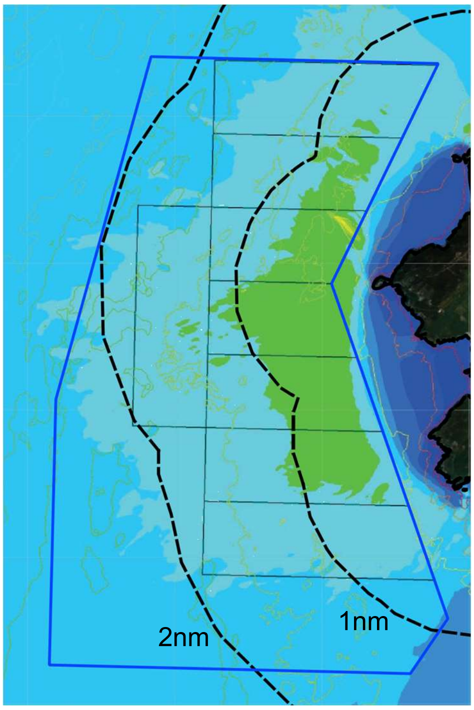

Figure 4 – Minimum 1nm and 2nm coastal buffers with tidal resource

8.1.1.1 Whilst RYA's requirements to remove their objection cannot be met owing to the location of the resource, Restricted Areas have been provided to ensure all Navigational Risks are mitigated to ALARP as described in [MDZ/P7].

8.1.1.2 *"The proposed Morlais site lies within a defined boating area with a high comparative intensity of use in relation to elsewhere along the Welsh coast."*

8.1.1.3 The RYA is referring to boating areas that it has itself defined as indicative ‘General Boating Areas’. In January 2020, RYA made a representation to Morlais under the Marine Licence process in which their General Boating Area did not encompass the MDZ [ML013]. It is understood that the General Boating Area has subsequently been altered to encompass the MDZ as shown in Figure 5. Of the c.350km section of coast from Liverpool along the entire North Wales down to Barmouth, c.80% is now defined as General Boating Area as shown in Figure 5. From the perspective of the project location, as demonstrated above the requirement for current flow speed is fundamental to project viability and it cannot be moved offshore to avoid the RYAs General Boating Area for this reason. However, the inshore channel has be widened through the process of NRA and Restricted Areas have been provided to mitigate all Navigational Risks to ALARP as described in [MDZ/P7]

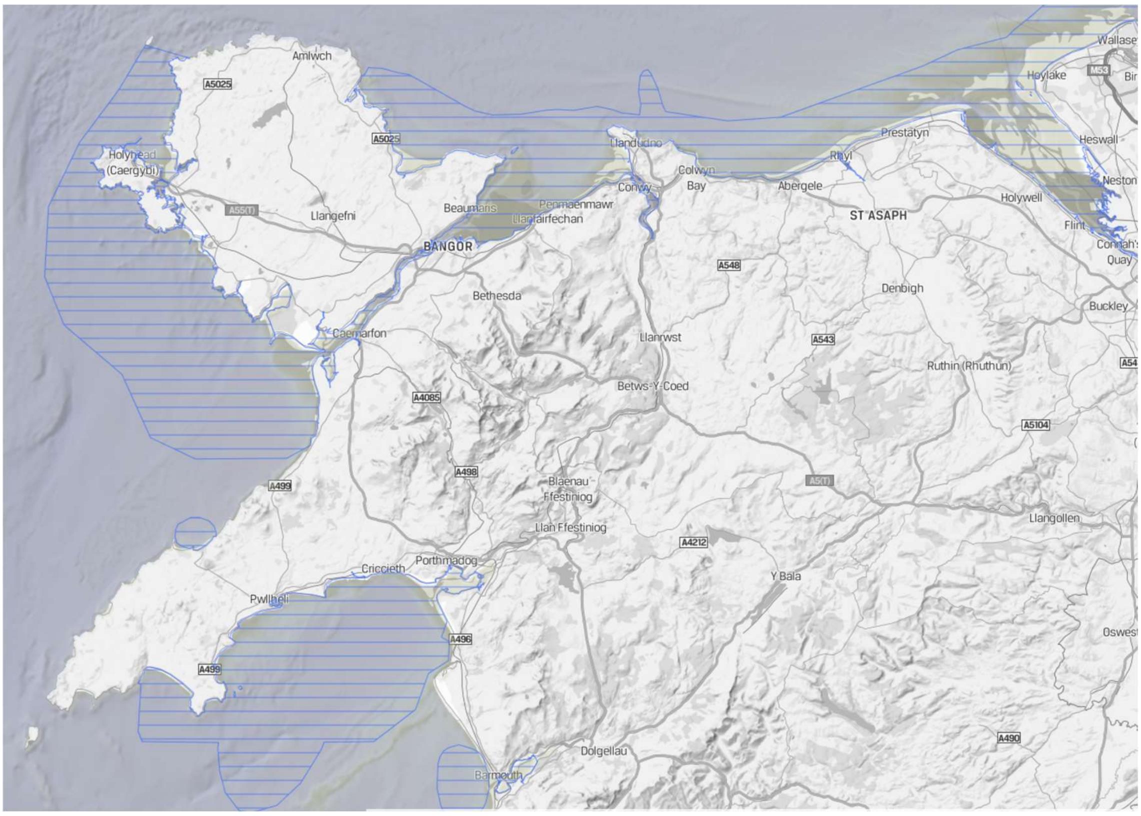

Figure 5 - RYA 'General Boating Areas' as defined in the RYA Coastal Atlas

8.1.1.4 “The RYA would have no objection, subject to review of a revised NRA and ES, if the area were used to site submerged devices and arrays with UKC of 8m or greater depth.”

8.1.1.5 Owing to the requirement to consent a broad Project Design Envelope as described in Section 7, it is not possible for the project to exclude surface emergent devices from the scope of the consent and maintain UKC>8m across the entire project. In the original consultation with RYA in 2015 with respect to the Boundary Change, 37km^2 of area was proposed to be able to include surface emergent devices. The broadening of the inshore route (now averaging c.1.9km) and the provision of the Restricted Areas as mitigation, has reduced the area of the project with surface emergent devices to 15.3km^2, a reduction of c.60%. In addition, as shown in

MMC171, there will to be channels between arrays of surface emergent devices to improve navigation through the project area.

8.1.1.6 *"The applicant's HRWallingford Coastal Process Report sets out the worst case scenarios for the Morlais project's impacts on tidal flows and waves.*

The tidal flows "worst case scenario" consists of:
• 620 seabed-mounted devices ….. and includes the following:
• 112 electrical seabed hubs;
• 8 surface piercing electrical hubs, each of 6 m diameter;
• Rock bag protection along 9 cable routes." (HR Wallingford Morlais Demonstration
Zone Coastal Processes Report p 5.)

The wave "worst case scenario" consists of:
• 60 floating devices;
• 310 seabed-mounted devices;
• 60 electrical seabed hubs;
• 8 surface piercing hubs." (HR Wallingford Morlais Demonstration Zone Coastal Processes Report p 7.)

This information was not included as a worst case scenario within the NRA, with the NRA indicating, that "a finalised device specific layout was not available for the assessment" (Morlais NRA, p14). This demonstrates there is not a consistency of approach across project documents.

There is also a lack of clarity between the worst case scenario set out in the HR Wallingford Coastal Processes Report and Chapter 4 of the ES with the NRA. This demonstrates that planning advice has not been followed.

Given the size of the proposed project (35km²) and the scale of the worst-case scenario, it is the RYAs view that the applicant is indeed treating the use of the Rochdale Envelope "as a blanket opportunity to allow for insufficient detail in the assessment".

8.1.1.7 The Project Design Envelope has been defined in accordance with Planning Inspectorate Advice Note 9- Rochdale Envelope [MDZ/D14] and the recommendations of the UK Wave and Tidal Demonstration Zone Workshop 2015 [MDZ/D13] as explained in Section 7.

8.1.1.8 In terms of consistency of PDE worst case scenarios, the difference between the scenarios used for different receptors can be easily explained by an example of a theoretical project to construct a multistorey building on agricultural land. The PDE for that project includes three key parameter constraints with respect to the scale of the building; floor area (sqm), height (m) and footprint (sqm). For any given floor area, the building can either be tall and narrow or short and broad. The PDE includes both possibilities. For the receptor of aviation impacts, it is clear that the worst case needs to use the maximum height, which necessarily does not use the maximum footprint. Conversely for the receptor of agricultural land take, the worst case uses the maximum footprint, which necessarily is not the maximum height. By this token, whilst the PDE is fully defined by the constraints on the three parameters, the worst case scenario varies by the receptor being assessed.

8.1.1.9 This is the same situation with respect to the use of different worst case scenarios for different receptors in the Morlais ES. The PDE parameters are clearly set out in the ES as are the worst case scenarios used for each receptor.

8.1.1.10 In the case of the RYA's representation, it appears to be saying that the layouts used for hydrodynamic wave and tidal current effects would be appropriate to be used to provide a worst case scenario for the NRA, however this is not correct.

8.1.1.11 Indicative layouts are provided for both the coastal processes current and wave models and also for the landscape and visual assessment. Each provides an illustration of the 'worst case scenario' for a particular receptor. For tidal currents, waves and landscape and visual the worst case scenarios to be used have been discussed and determined in consultation with the Regulator. These are not inconsistent as they fall within the overall PDE as described within Chapter 4 and hence are in line with planning advice.

8.1.1.12 For the Navigational Risk Assessment, the worst case scenario for risk is assessed by using the assumption that any device type may be deployed within any zone in accordance with embedded required minimum UKC (Table 11-4 NRA Addendum). This is the worst case as it means that the risks associated with every permitted device type and every vessel type are considered together when scoring the hazards.

8.1.1.13 For example, anywhere in the Green area risks are assessed for floating, mid water and bottom mounted devices. In the Blue UKC8m area, the risks posed by floating devices are not included. By this mechanism a worst case scenario is assessed that appropriately corresponds to the navigational receptors.

8.1.2 NRW REP005:

8.1.2.1 "The ES confirms that the offshore development area would introduce significant effects to the seascape setting of the Isle of Anglesey AONB. We welcome the scheme amendments made prior to submitting the application, which means the worst-case scenario has avoided significant effects upon Gogarth Bay through the process of early stage iterative design. However, we still have concerns over the significant effects on the setting of South Stack and its lighthouse and the section of coastline southwards to Penrhyn Mawr."

8.1.2.2 Whilst the consideration of landscape and seascape effects is addressed in Simon Myers POE [MDZ/P5], with respect to the location and type of devices in proximity to South Stack and Penrhyn Mawr, owing to the location of the tidal energy resource and requirement to consent a broad Project Design Envelope as described in Section 7, it is not possible for the project to completely exclude surface emergent devices from the scope of the consent.

8.1.2.3 The broadening of the inshore route (now averaging c.1.9km) has increased the distance for onshore visual receptors. The provision of the Restricted Areas as mitigation has avoided the most sensitive landscape areas and has reduced the area of the project with visually prominent devices to 10km^2, a reduction of c.73% from the original PDE.

8.1.2.4 There are a number of representations that reference associated potential socioeconomic effects owing to impacts on the AONB which are addressed in Dr Edward Jones POE [MDZ/P6]. As above, the visual impact has been minimised as far as possible in the required location whilst maintaining project viability.

8.1.3 SOC008 – Natural Resources Wales

8.1.3.1 The applicant has presented an indicative first phase of deployment from calculating the maximum number of devices and megawattage (MW) for each device type that could be deployed with a collision risk below 0.7 bottlenose dolphin2 per year assuming an avoidance rate of 98%. NRW will argue that the assessment places an over-reliance on the outputs of the quantitative predictive collision risk modelling with very little appreciation of the uncertainties inherent in this approach. There remains a significant risk that unsustainable mortality of Annex II and IV marine mammal species could occur from the first phase alone (and that AEOSI cannot therefore be ruled out), and a precautionary reduction in scale of the first phase would reduce this risk.

8.1.3.2 Mammal effects are considered in Dr Jennifer Learmonth's POE [MDZ/P2. With respect to scale, as explained in Section 7 above, there is a requirement for the project to be of significant scale to achieve:

- Economy of scale, and reduction in cost of energy.
- Urgently addressing the climate emergency
- Sustaining developer business growth
- Demonstrating whole array avoidance

8.1.3.3 In terms of the scale of the first phase, this would ideally be larger than the proposed c.12MW maximum to improve economy of scale, address the climate emergency and sustain developer business growth. However the size of the first phase is only as large as possible whilst avoiding AEOSI for marine mammals. In terms of demonstration of whole array deployment, the only way to demonstrate this effect is to install multiple devices in an array, and hence the first phase of deployment must be large enough to allow this to be monitored, ie multiple rows and multiple columns in the array.

8.1.4 **OBJ014 – RSPB**

8.1.4.1 "the scale of the trial scheme is too large and the impacts too significant. We have expressed our preference to see a smaller scheme brought forward in the first *instance to allow the technology, monitoring and mitigation methods to be assessed thoroughly prior to the potential large-scale deployment of 620 devices."*

8.1.4.2 The requirements for ultimate project scale is set out in Section 7. There is no intention to build out to 240MW without agreed controls under the EMMP and the much smaller first phases. The initial phase of up to c.12MW will be brought forward in the first instance to allow the technology, monitoring and mitigation methods to be assessed thoroughly prior to larger subsequent phases.

8.1.4.3 "We question whether it is appropriate to apply adaptive management to such a large 'project design envelope' over such a long time period and involving multiple phases and whether such an approach enables a realistic environmental assessment of the full deployment of the scheme."

8.1.4.4 The PDE is thoroughly defined in terms of parameter constraints that allow the worst case for each receptor to be clearly set out. With the exception of a few, all of the parameters are consented for the full 240MW development as the potential impacts are assessed to be likely to be acceptable. The exception to this is those parameters associated with risks to biodiversity as set out in POE's [MDZ/P1 MDZ/P2 MDZ/P4]. These parameters are further constrained in the phases to reduce impacts to an acceptable level [MMC156].

8.1.5 OBJ072 - Kudelska, T

8.1.5.1 "The scale of the proposed development would enable new untested tidal devices to be installed at a large scale in the Environment."

8.1.5.2 The MDZ is intended for commercial demonstration, devices will have been tested elsewhere prior to deployment.

8.1.5.3 "The applicant is proposing that permission be granted for a broad consent envelope which would enable them to vary the location, number, deployment and type of tidal devices within certain parameters. The ES explores some of the devices which could realistically be tested in the area however it has not been possible for the applicant to identify which devices will be used, where they will be located, how they will be located etc.

The ES is therefore based on a snapshot of the devices which are currently in development. The uncertainty around the type, number, location and application of the devices makes it almost impossible to be able to assess the impact of this development alone and in combination and this is further compounded by the long-time scale of the development. The proposal allows any type of device be tested within the site so long as it meets a certain set of parameters however these parameters are quite broad, and I do not consider that the ES adequately assesses all of the impacts on the environment and wildlife that are likely to occur in future."

8.1.5.4 The parameters described in the PDE are firm constraints on the technology to be deployed and the locations allowable. Any technology that does not fall within this PDE will not be permitted to be deployed. A specific worst case scenario is assessed for each relevant receptor. Prior to deployment, each array of devices to be deployed will be demonstrated to be within the assessed parameters of the PDE.

8.1.5.5 "The need to make the barges visible to vessels and the proximity of them to the coast (1Km) will mean that they are clearly visible, and this will bring an industrial element to the landscape which will significantly detract from the wild beauty of the area. The landscape mitigation is unlikely to be able to address the impact that the development will have on the landscape and the wording of some of the landscape mitigation measures amount to vague intentions rather than actions and are open to interpretation (e.g. there will be 'preference' for seabed mounted or buoyant mid water tidal devices, there will be a 'preference' for deploying surface emergent devices in the south, they will minimise the visually prominent elements of the project as much as is 'practicable')."

8.1.5.6 Whilst the consideration of landscape and seascape effects is addressed in Simon Myers POE [Ref##], with respect to the location and type of devices, as discussed in Section 7 above, it is necessary for the project to include surface emergent devices, and it is necessary for these to be in the regions of high tidal flow. As a mitigation, these have been excluded from being immediately adjacent to the coast by the Restricted Area Blue, meaning they are on average 1.9km from the coast as described in the TWAO. The exclusions on visually prominent device from the Restricted Area Gold is also defined in the TWAO.

9. Summary and Conclusions

9.1 Introduction

9.1.1 My name is Dr James Orme and I am a project witness for the Morlais Tidal Array. I have a BEng Honours (1st) Degree in Engineering from Swansea University a PhD in hydrodynamic modelling of tidal stream turbines.

9.1.2 I have over 20 years of experience in tidal stream energy development, including technology development, project development, consenting and financial analysis.

9.1.3 I am the Consenting Lead for the Morlais project and have been involved with the project since 2012 with involvement in a broad range of activities.

9.1.4 This proof of evidence represents my professional opinion, based on my knowledge and experience.

9.1.5 The topic of evidence is Project Characteristics in terms of location and scale and the requirement for the broad Project Design Envelope approach.

9.1.6 This proof of evidence should be read in conjunction with the Proof concerning Navigation, SLVIA, Mammals, Ornithology and Policy.

9.1.7 Objections have been received by the TWAO process with respect to the project's proximity to the coast, the project scale and the breadth of project design envelope being used in the assessment.

9.1.8 The evidence addresses:

- The requirement for the proximity of the project to the Anglesey coast.
- The requirement for the project to be at the scale proposed, both in the first phase and the ultimate full deployment.
- The requirement to use a broad Project Design Envelope.

9.1.9 This evidence sets out the project's requirement for each of these factors and provides justification for why the project cannot entirely meet stakeholders requests with respect to re-locating, re-scaling or limiting the technology types considered in the PDE, EIA and NRA.

9.1.10 The project is required to be in a location of sufficient current flow speed as this is fundamental to its ability to viably generate electricity. It is required to be of a large enough scale to meet its economic, low carbon, business and environmental learning objectives, both in the initial phase and for full deployment. It is also required to be able to accommodate a range of technologies to reflect the diversity in this nascent industry and give the best possible opportunity to enable further reductions in the cost of energy generation.

9.1.11 The project cannot entirely meet stakeholder's requests for re-locating, re-scaling and reducing the breadth of the PDE owing to the requirements set out in this evidence. However, through consultation, the project has committed to additional mitigations for each of these factors and has introduced new constraints, such that they are mitigated as far as possible whilst maintaining project viability. In summary, these are:

9.1.11.1 The broadening of the inshore route (averaging c.1.9km) has increased the searoom for navigation and has increased the distance for onshore visual receptors.

9.1.11.2 The provision of the UKC>20m Restricted Area (Purple) has avoided maritime traffic in the north, west and south of the MDZ.

9.1.11.3 The introduction of and refinement of the two UKC restricted areas (Blue and Purple) has reduced the area able to accommodate surface emergent devices by c.60% (~20km^2) and hence allows for improved maritime navigation in these areas.

9.1.11.4 The provision of the Blue, Purple and Gold restricted Areas has avoided the most sensitive landscape areas and has reduced the area of the project with visually prominent devices to 10km^2, a reduction of c.73% (~25km^2) from the original proposal.

9.1.11.5 The reduction in size of the first phase of deployment to limit the predicted collision rate for bottlenose dolphin to <0.7 per year to avoid significant adverse effect, maximum c.12MW.

9.1.11.6 The commitment to subsequent phases to be of a scale to avoid significant adverse effect on marine biodiversity.

9.1.11.7 The clarification of worst case parameters used for each receptor [MDZ/A258.25]

9.2 Background

9.2.1 The Morlais Demonstration Zone (MDZ) covers an area of 35km^2 of seabed to the west of Holy Island, Anglesey, Wales. The area is shown in Figure 1.

9.2.2 It is a total of c.8.3km north to south and at its widest point is 5.4km east to west. Following consultation, the eastern MDZ boundary has been designed to allow an inshore navigation channel which averages 1.9km in breadth between the coast and the nearest surface emergent tidal devices.

9.2.3 The project is proposed to accommodate a maximum of 240MW of tidal stream generation, which allows for the commercial demonstration of 8 x 30MW arrays of different technology types. Tidal stream technology is a pioneering new form of renewable energy that offers distinct advantages as part of the low carbon energy mix. It is therefore acknowledged by all involved that it is inevitable that some data gaps remain at the current time. Owing to this uncertainty with respect to the potential for impacts on marine biodiversity, a phased approach is proposed. An Environmental Monitoring and Mitigation Plan (EMMP) controls the size of the phases such that they are not expected to cause a significant adverse effect on marine biodiversity under the Habitats Regulations (See POE MDZ/P4).

9.2.4 The Project Design Envelope (PDE) is defined in Chapter 4 of the ES [MDZ/A25.4] where each of the limitations on parameters is defined. Individual array deployments will be confirmed to fit within the PDE prior to installation. Technologies that do not sit within the envelope will not be permitted to be installed. This approach was successfully employed at the PTEC project to consent a tidal stream energy project at the Isle of Wight[5]

9.3 Site selection and refinement

9.3.1 Crown Estate (TCE) identified Key Resource Areas for wave and tidal energy around the UK and engaged with the industry to determine requirements and key factors in site selection. TCE then consulted with navigational and other

[5] The application (ref: MLA/2014/000563) can be accessed via the MMO Public Register.

stakeholders as part of Demonstration Zone identification, including existing marine users which resulted in minimum distances for the tidal demo zones:

- West Anglesey Demo Zone is 1km from shore
- North Devon Demo Zone is 0.5km from shore
- Isle of Islay Demo Zone 1km from shore

9.3.2 In 2015, higher definition flow modelling indicated that the area of tidal stream resource required for tidal energy project is further north and east than the original WADZ boundary as defined by TCE. Menter Môn prepared to propose a boundary change to TCE.

9.3.3 Publicly available AIS data was used to assess marine traffic density. The northern ferry route was avoided and the high density inshore route was also avoided by allowing a 500m inshore channel which is aligned with many other tidal energy sites around the UK. Note that 70% of all tidal stream energy sites in the UK are 500m or less from the coast. 83% are within 1,000m[6].

9.3.4 The boundary change was proposed to stakeholders, on the basis that any resulting project would be subject to full consent application and NRA. On the basis that any resulting project would be subject to full NRA and EIA, TCE approved the boundary change and the WADZ location was moved to its current location.

9.3.5 Subsequently, through further consultation with Navigational and Landscape stakeholders the current proposals for mitigations in the form of Restricted Areas (which restrict the allowable types of turbine) as shown in Figure 1 were developed.

9.4 Key issues and summary responses with respect to this proof

9.4.1 Project location

9.4.1.1 (1) The proximity of the project to the Anglesey coast and the potential for this proximity to impact on the Holy Island AONB and also potentially cause negative socioeconomic effects.

9.4.1.2 (2) The proximity of the project to the Anglesey coast and the potential for this proximity to impact on the safety of the inshore navigation route for small boats and unpowered craft, and also the potential for associated negative socioeconomic effects.

9.4.1.3 Response on the requirement for the project location:

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[6] TCE Crown Estate Tidal Stream Leases GIS dataset 2015

9.4.1.4 The location of energy in tidal streams is unlike wind or solar energy in that the resource is not evenly distributed across wide areas, it is concentrated in specific locations created by geographical features. It is not possible to move the project away from these areas of tidal stream energy, as adequate energy resource is a fundamental requirement of the project.

9.4.1.5 Tidal stream turbines require adequate tidal stream velocities in order to be viable.

9.4.1.6 The generation output of a tidal stream turbine is very sensitive to flow speed and is governed by a mathematical relationship whereby the power generated is proportional to the cube (u^3) of the flow velocity. By this token, a 20% increase in flow velocity results in 73% additional power output. A 2.48m/s mean spring peak velocity is required by turbine developers at current time.

9.4.1.7 HRWallingford was commissioned by Morlais to create a detailed hydrodynamic model of the MDZ, validated against real world data from tidal height and current monitoring stations. This demonstrates the high flow areas in the location of the project which need to be used. It is this factor that has driven the project's requirement to be in this location. Whilst significant compromises have been made in limiting certain types of devices to certain areas to reduce predicted impacts, there is a fundamental necessity for the project to be located in the areas of fastest flow as demonstrated.

9.4.2 Project scale

9.4.2.1 (1) Whether the scale of the first phase of deployment should be reduced.

9.4.2.2 (2) Whether the scale of the overall project is appropriate to be consented now and controlled by phasing in the EMMP, or whether a smaller project should be brought forward instead.

9.4.2.3 Response on the requirement for project scale:

9.4.2.4 With respect to **Economy of Scale,** the Morlais project is intended to serve as a commercial demonstration with an objective of reducing the cost of energy generated. A key factor in this is being able to install a project that uses the 'economies of scale' to enable cost reduction.

9.4.2.5 There are a number of ways that economies of scale are used to reduce the cost of energy generation. This is the economic situation where cost per unit of output decreases with increasing scale. Key drivers for tidal stream energy economies of scale are; economies of volume, economies of generator size, economy of project size and accelerated learning

9.4.2.6 With respect to **Climate emergency,** the global climate challenge is enormous and urgent as demonstrated by the declaration of a climate emergency by UK and Welsh Government [MDZ/D11].

9.4.2.7 To allow the Morlais project to fulfil its potential and play a significant part in the reduction of carbon emissions, it needs to progress at a scale that is as large as possible whilst being acceptable in terms of environmental impact.

9.4.2.8 With respect to **Developer business growth,** the companies that are developing the technology needed to generate tidal stream energy are at an early stage and operate primarily on investment capital. Without a rapid route to market, there is an increased risk that businesses will fail before reaching the sales volumes required to become sustainable in the long term.

9.4.2.9 With respect to **Whole array avoidance,** improving the scientific understanding of the ability of marine animals to avoid tidal stream turbines is critical to enable the subsequent phases of deployment at Morlais and for the industry as a whole and achieving its carbon reduction potential. The only way to demonstrate this effect is to install multiple devices in an array, and hence the first phase of deployment must be large enough to allow this to be monitored, ie multiple rows and multiple columns in the array. This is described in the Mammals POE [MDZ/P2]

9.4.3 Project design envelope

9.4.3.1 (1) Whether it is appropriate to use a broad Project Design Envelope for a tidal energy project of this scale and whether this allows a robust Environmental Impact Assessment and a Navigational Risk Assessment to be undertaken.

9.4.3.2 Response on the requirement for a broad Project Design Envelope:

9.4.3.3 Tidal stream energy is a relatively new form of energy generation. There is yet to be convergence in mooring methods, generation platform or device scale in the industry, however, firm design principles are emerging and maximum dimensions and quantities are able to be determined, to be able to define a specific and quantifiable Project Design Envelope with which to undertake the EIA.

9.4.3.4 Consent for a broad PDE is sought, to ensure maximum flexibility in the tidal technology types consented for deployment by the Project.

9.4.3.5 However, the range and flexibility sought within the consent application has been limited by careful consideration of development scenarios designed to rationalise the likely approach to development and to set workable limits on potential impacts. The PDE approach used in this ES, has been tested in planning law and is often referred to as the ‘Rochdale Envelope’ approach (see **Chapter 2, Policy and Legislation**).

9.4.3.6 The Project Design Envelope has been defined in accordance with Planning Inspectorate Advice Note 9- Rochdale Envelope [MDZ/D14] and the recommendations of the UK Wave and Tidal Demonstration Zone Workshop 2015 [MDZ/D13] .

9.4.3.7 The ES establishes the relevant worst case parameters for the assessment for each receptor. This establishes those parameters likely to result in the maximum adverse effect (worst case scenario) for that particular receptor. As explained in Section 7, the worst case parameters may vary by receptor, but will always be within the overarching PDE parameters definition.

9.5 Conclusion

9.5.1 To reiterate in conclusion, the project is required to be in a location of sufficient current flow speed as this is fundamental to its ability to viably generate electricity. It is required to be of a large enough scale to meet its economic, low carbon, business and environmental learning objectives, both in the initial phase and for full deployment. It is also required to be able to accommodate a range of technologies to reflect the diversity in this nascent industry and give the best possible opportunity to enable further reductions in the cost of energy generation.

9.5.2 The project cannot entirely meet stakeholder’s requests for re-locating, re-scaling and reducing the breadth of the PDE owing to the requirements set out in this evidence. However, through consultation, the project has committed to additional mitigations for each of these factors and has introduced new constraints, such that they are mitigated as far as possible whilst maintaining project viability