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Energy and Climate Change Committee

The Future of Marine Renewables in the UK

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Additional written evidence

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The Energy and Climate Change Committee

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Contacts

All correspondence should be addressed to the Clerk of the Energy and Climate Change Committee, House of Commons, 7 Millbank, London SW1P 3JA. The telephone number for general enquiries is 020 7219 2569; the Committee's email address is ecc@parliament.uk

List of additional written evidence

Written evidence

Memorandum submitted by University of Edinburgh: Innovation and Policy group for marine renewables

It is important to clarify here that the term "marine renewables" is taken to encompass only the wave and tidal stream energy sectors. Other energy conversion technologies such as tidal barrage, offshore wind, and ocean thermal energy conversion (OTEC) will not be considered in this response.

1. *What are the potential benefits that marine renewables could bring to the UK and should Government be supporting the development of these particular technologies*?

If the right facilitating policies are put in place, the benefits that marine renewables could bring to the UK are threefold:

— Emissions reductions;

— Increased security of supply; and

— Economic benefits including job creation and inward investment.

The benefits from emissions reductions and increased security of supply are principally benefits from marine renewable energy deployments in the UK, irrespective of where the supply chain is developed. In comparison to this, the economic benefits are principally benefits from developing the sector and the supply chain in the UK.

Emissions reductions and Increased security of supply:

The UK has committed to a legally binding target of achieving 80% emissions reductions (1990 baseline) by 2050.[1] In addition, the EU Renewable Energy Directive[2] sets the UK a legally binding target of producing 15% of UK energy consumption from renewable sources by 2020. Both of these targets are highly ambitious and will require a swift and efficient transition to low carbon energy sources.

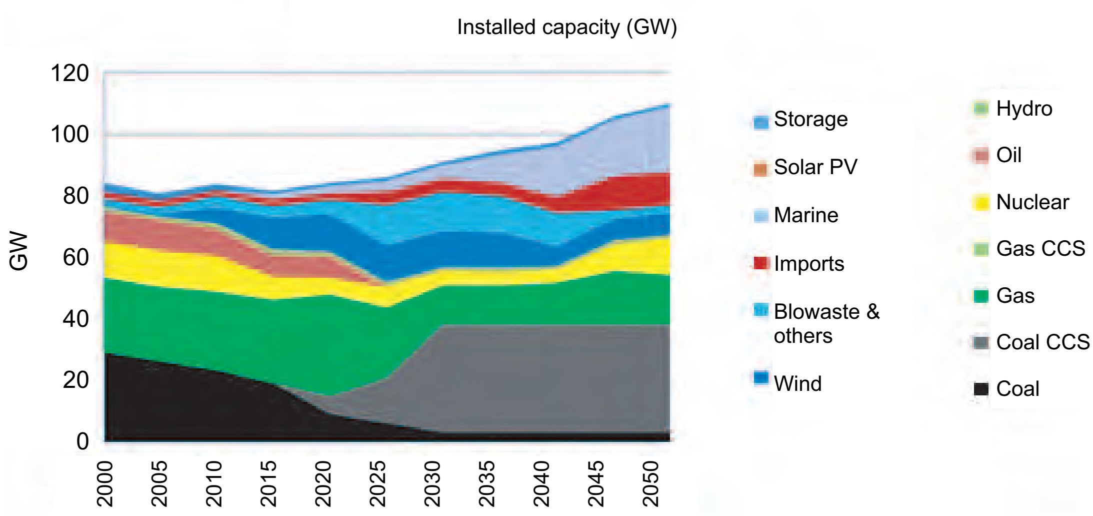
The Carbon Trust estimate that, with devices currently under development, the wave energy sector in the UK could practically and economically capture around 50 TWh/yr and the tidal stream sector around 20 TWh/yr. Combined, the two sectors could therefore capture a maximum of 70 TWh/yr,[3] around 20% of current UK electricity demand which was 379 TWh in 2009.[4]

Achieving the UK's ambitious target of 80% emissions reductions by 2050 whilst the overall electricity demand is projected to rise over the same period (to an estimated 600 TWh/yr),[5] illustrates the fundamental changes in the emissions intensity of the electricity sector which will be required. A wide and diverse range of low carbon technologies will be required if the targets are to be met, and marine renewables could make a large contribution. There are a myriad of different scenarios for how the UK's growing demand and ambitious emissions reduction targets could be met. One such scenario, under which all low carbon technologies are accelerated, is shown in figure 1 below which illustrates the large potential role for the marine energy sector, contributing in excess of 70GW of installed capacity by 2050.

1 UK Climate Change Act (2008).
2 Directive 2009/28/EC of the European Parliament (23 April 2009).
3 Carbon Trust (2011) Accelerating Marine Energy report.
4 DUKES (2011)—Chapter 5, electricity.
5 Elders et al. (2005) Electricity Network Scenarios for Great Britain in 2050.

Figure 1

GRAPH SHOWING THE CONTRIBUTION THAT MARINE RENEWABLES COULD MAKE IN THE UK IN 2050 UNDER A SCENARIO IN WHICH 80% EMISSIONS REDUCTIONS ARE ACHIEVED BY 2050 AND IN WHICH ALL LOW CARBON TECHNOLOGIES ARE ACCELERATED

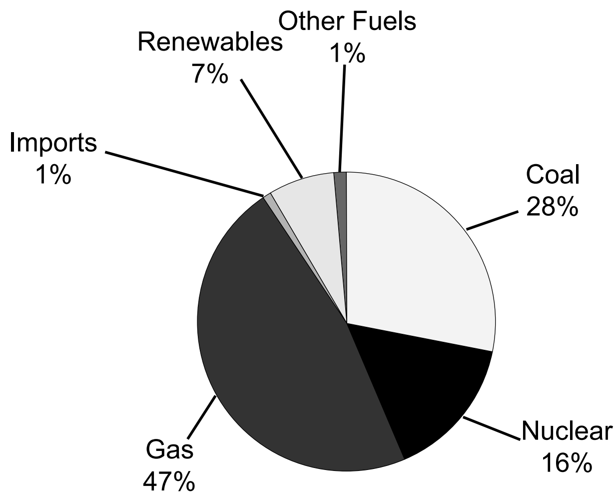


(*Source*: UKERC 2050 Project).

As can be seen in figure 2 below, UK electricity generation is highly dependent on generation types such as gas. In 2010, ~38% of the natural gas used in the UK was imported,[6] illustrative of how exposed the UK electricity generation is to price volatilities which are largely controlled by factors outside of the UK. The above estimate that the marine renewables sector could contribute 70 TWh/yr[7] to the UK electricity system is in excess of the contribution that nuclear energy made to the UK net electricity supplied in 2010. Clearly the scale of this potential contribution is significant to the UK's energy security as marine renewables exploit a completely domestic resource.

Figure 2

GRAPH SHOWING THE BREAKDOWN BY FUEL INPUT OF THE UK NET ELECTRICITY SUPPLIED IN 2010



(*Source*: DUKES 2011).

Economic benefits:

The Carbon Trust estimate that the global market for marine energy could be worth up to £460 billion in the period 2010–50, reaching up to £40 billion/year by 2050. They estimate that around 75% of this is potentially accessible to UK based businesses, and that the UK (given present strengths) could capture ~£76

[6] DUKES (2011)—Chapter 4, natural gas.
[7] Carbon Trust (2011) Accelerating Marine Energy report.

billion (22%) of this accessible market, contributing ~£15 billion to UK GDP over 2010–50 and potentially creating over 68,000 UK jobs by 2050**.** It is important to highlight that a substantial portion of these UK jobs (over 70%) are estimated to be generated by exports, both within Europe and beyond.[8]

Should government be supporting the development of these particular technologies?

At present, the UK is seen as the world leader in marine renewables, and many of the leading technologies and companies in the sector are located in the UK. This is largely due to the support which the UK government has provided to the sector. If this support is withdrawn, the developments and investments in the sector will still take place, but they are unlikely to be in the UK, and therefore many of the benefits outlined above will not be realised for the UK.

2. *How effective have existing Government policies and initiatives on marine renewables been in supporting the development and deployment of these technologies?*

The UK government have implemented a wide range of policies to support marine renewables, complemented by policies enacted by the Scottish Government which has gone even further to support the sector.

Government support mechanisms to successfully support any emerging sector will require:

— Technology-push/capital grant support;

— Market-pull/revenue support;

— Support for test centres; and

— Support for underpinning research.

In this vein, five important UK government policies on marine renewables will be considered:

1. EMEC (The European Marine Energy Centre):

   In the first five years after its establishment in 2003 EMEC only hosted two devices. However, establishing EMEC can be considered as a long term strategic decision to support the sector and ensure that the UK remains at the forefront of the industry. There is now a strong demand for the centre's testing facilities, which are currently being extended. The strategic "leap of faith" made in establishing EMEC in 2003 has positively impacted on the collective ability of the sector to develop and, ultimately, commercialise its technologies. The strong demand for EMEC's testing births and technical assistance has established EMEC—and by extension the UK—as the international market leader in marine device testing, and other institutions globally are looking to emulate EMEC's success.

2. The MRDF (The Marine Renewables Deployment Fund):

   The MRDF's establishment in 2004 was premature for the industry, and no devices achieved the eligibility criteria before the scheme was terminated in 2011. The MRDF is widely regarded as a failure, but this fails to take account of the fact that the scheme was well designed to effectively support pre-commercial, multi-device deployments. The principal failure of the scheme was that it was implemented too early and therefore no projects were able to qualify for the scheme. The fact that no devices were able to satisfy the eligibility criteria for the MRDF is testament to the fact that no devices were ready for multi device, pre-commercial deployments, rather than the fact that the scheme was badly designed.

3. The RO (Renewables Obligation) and the RO Scotland:

   Despite the fact that only a very small number of marine renewable projects have qualified to receive ROCs (despite enhanced ROC banding for marine renewables in both Scotland and the rest of the UK), and the fact that ultimately no projects achieved MSO[9] eligibility before it was superseded, none of these policies should be regarded as a failure. These mechanisms send out a long term market signal that the UK and Scottish governments are committed to the sector and provide the certainty needed by investors and developers. Importantly, these measures have also contributed to incentivising large utility and engineering companies (with significant energy engineering expertise and experience of international energy markets) to enter the sector, which was previously almost entirely made up of SMEs.

4. The MRPF (The Marine Renewables Proving Fund):

   The MRPF (announced in 2009) has been largely successful—aimed at supporting full scale prototype testing—and a number of projects have already been supported.[10] The relative successes of the MRDF and the MRPF illustrate the importance of policies being realistic as to the stage of development of the sector. The MRDF overestimated the sector's stage of development, but the

[8] Carbon Trust (2011) Marine Renewables Green Growth Paper.

[9] The Marine Supply Obligation (MSO) created a protected market in Scotland for the ROCs from marine renewable energy projects.

[10] Carbon Trust (2011) Accelerating Marine Energy report.

MRPF was much better suited to the sectors' stage of development, and it has consequently been successful.

5. The SUPERGEN Marine Consortium:

   Since being founded in 2003, the SUPERGEN marine consortium has successfully provided underpinning research to support the development of the marine energy sector, and is now going into its 3rd phase. The success of this initiative, fostering collaboration between industry and academic institutions alike to accelerate the development of the sector, is illustrated by the fact that many countries are trying to emulate the strong collaboration it has achieved.

3. *What lessons can be learnt from experiences within the UK and from other countries to date in supporting the development and deployment of marine renewables?*

Due to the world leading position the UK currently holds in both the wave and tidal stream energy sectors there limited opportunities to learn lessons from other countries. However, an important example from Canada will be highlighted.

Lessons from Canada:

In 2008, the Fundy Ocean Research Centre for Energy (FORCE) was set up in Canada, an important example of a government supported test centre for marine renewables outside the UK. The centre currently has three berths for testing tidal stream devices, but is in the process of installing subsea cables which will give it the largest offshore transmission capacity of any tidal stream energy site in the world,[11] with capacity of over 60 MW to allow for growth at the site. The UK can learn from this strategic decision to invest in extra capacity to allow for growth and to further reinforce the market signal which is sent out to developers and investors. Although the UK has a significant first mover advantage in the marine renewables sector, other countries, such as Canada are well positioned to capitalise on the opportunities presented by the sector if the UK is hesitant.

Lessons from the UK:

In the UK, the funding landscape for marine renewables may be too crowded. Efficiency may be affected by the large number of bodies responsible for administering government funding opportunities in the sector, including:

- EPSRC (Engineering and Physical Sciences Research Council);
- TSB (Technology Strategy Board);
- ETI (Energy Technologies Institute);
- The Carbon Trust;
- Scottish Entreprise/Scottish Government; and
- DECC (Department for Energy and Climate Change).

It must be considered that overlap between the funding bodies could lead to inefficiencies:

1. Inefficiencies due to the fact that projects have to apply to multiple funding schemes with high requirements in terms of developing proposals.
2. Inefficiencies due to the high administrative requirements of running so many quasi governmental organisations.

Care must be taken to ensure that the system is as efficient as possible. There are clear benefits to creating a more streamlined system, resulting in a more coherent and efficient funding mechanism at the UK level, reducing both the inefficiencies associated with administering the funding mechanisms and the inefficiencies associates with the burden on applicants having to submit bids/proposals to multiple schemes. The streamlining of the funding system in the UK would be a long term goal, to develop a system more akin to that in the USA where all government funding in the energy sector is administered by a single organisation, the Department of Energy (DoE).

4. *Is publicly provided innovation funding necessary for the development of marine technologies and if so, why?*

Innovation funding is of critical importance to the marine renewables sector and at present the conditions do not exist for this innovation to be privately funded, therefore there are large benefits to be gained from maintaining publicly funded innovation funding in the UK. The principal reason that this innovation funding cannot be provided from private financial sources at present is due to the fact that the timescale for achieving a return on these innovation investments is too long to be borne by the private companies in the sector, and the uncertainties surrounding this return on investment are too large, due to the nascent and emerging status of the sector. A long term strategic approach is required, and at this time, this can only be provided by government.

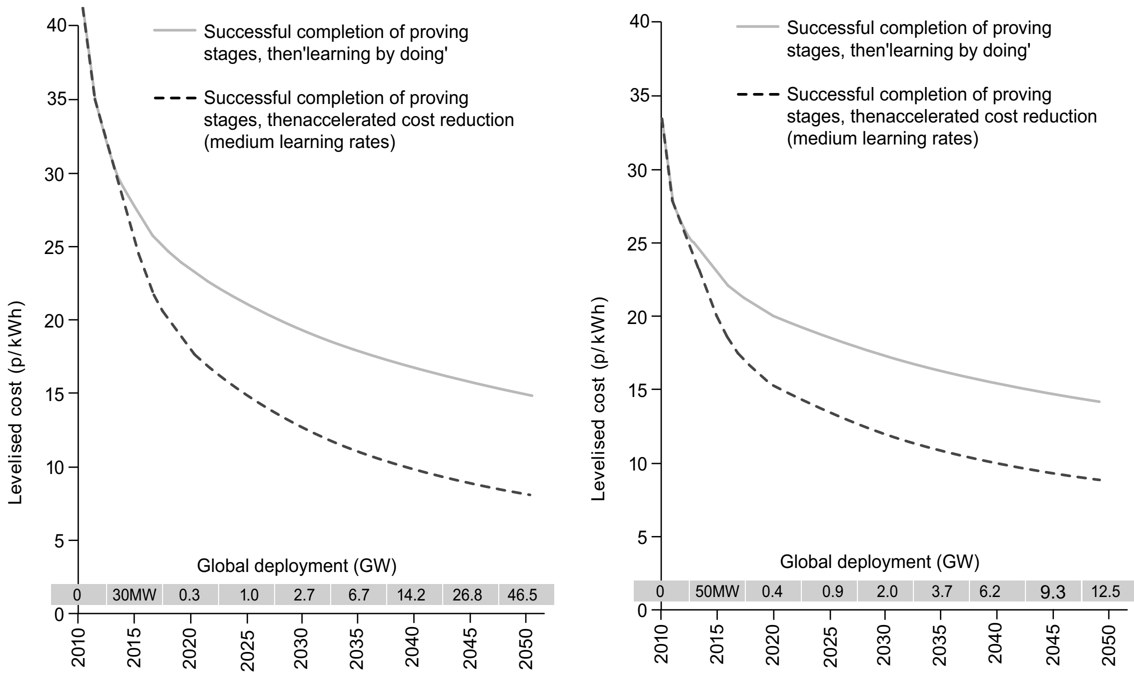
[11] www.fundyforce.ca

Why is innovation funding necessary?

The graphs in figure 3 below show projected cost curves for the wave and tidal stream energy sectors. The Purple lines illustrate how the projected cost curves are affected by innovation funding to accelerate cost reductions. It is clear that over the long term, innovation and underpinning R&D funding is important to ensure the cost reductions necessary to make marine renewables competitive with other forms of generation happen rapidly enough and in a financially efficiently manner.

Figure 3

GRAPHS SHOWING POSSIBLE COST REDUCTION PATHWAYS FOR THE WAVE AND TIDAL ENERGY SECTORS UNDER TWO DIFFERENT SCENARIOS



Note: Two proving stages exist, one at full-scale prototype, and one at first array stage.

(*Source*: Carbon trust (2011) accelerating marine energy report).

Why must this innovation be funded by the government?

In the longer term, when marine renewables are in the commercial stages of development, this innovation is likely to be funded privately by companies active in the sector. However, there are two principal reasons for the government to support innovation funding in the short term when privately funded innovation is not possible:

- To ensure that innovation continues to take place, ensuring that there is a market for marine renewables by making them increasingly cost competitive.
- To ensure that the innovation and the supply chain which is established for marine renewables both occur in the UK. If the government does not support innovation in the sector, it is likely that it will still take place, just not in the UK.

5. *What non-financial barriers are there to the development of marine renewables?*

Four important non-financial barriers to the development of the sector will be discussed here:

- **Public perception.** At present, there are no commercial scale multi device deployments in operation, and therefore public perception is not a major issue. However, when the sector reaches large scale deployments, if not properly managed, public perception could present a significant barrier. Therefore work is required to further research the public perception impacts on the sector and how to manage these appropriately.
- The **consenting process.** Scotland has implemented, in Marine Scotland, "one stop shop" consenting for marine renewable energy projects. Further research is required to evaluate this system and determine whether a similar system should be implemented in the rest of the UK.

— **Insurance risk.** The first commercial deployments and the first multi device deployments will be subject to such a large amount of uncertainty and therefore the costs of insurance will be high. Over the long term, these costs will come down as the risks in the sector become better understood and better managed and the uncertainty in the sector is reduced due to available data from the first generation of projects. The government can help to reduce the impacts of high insurance costs on the sector by taking actions such as government underwriting of some project risk.

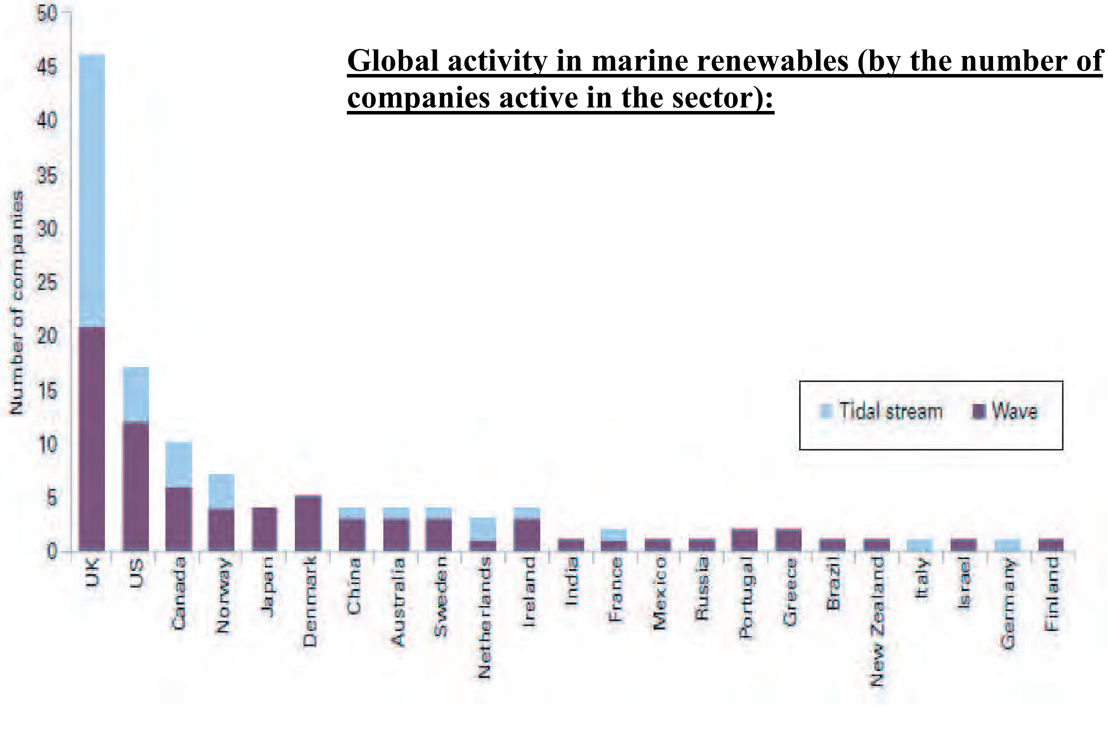
— **Grid access**. Given that many resource locations are in locations with weak grids, it is important to ensure that strategic investments in grid infrastructure are made to facilitate developments in the sector. Therefore it is important to ensure that Ofgem's objectives don't hinder these strategic investments in the national interest.

6. *To what extent is the supply chain for marine renewables based in the UK and how does Government policy effect the development of these industries?*

The UK is currently the world leader in the sector and as a result, a large amount of the supply chain for device development is based in the UK. Figure 4 below illustrates how much of the global supply chain (in terms of technology development companies) is based in the UK. It is clear that the UK is currently the world leader, but it is important that the UK government continues and advances the policy and funding landscape to ensure that this first mover advantage is maintained. As described above, there are other countries also striving to become the world leaders in this emerging sector and to realise the associated benefits.

Figure 4

GRAPH SHOWING THE LEVEL OF ACTIVITY IN THE WAVE AND TIDAL STREAM ENERGY SECTORS ACROSS THE WORLD



(*Source*: Carbon trust).[12]

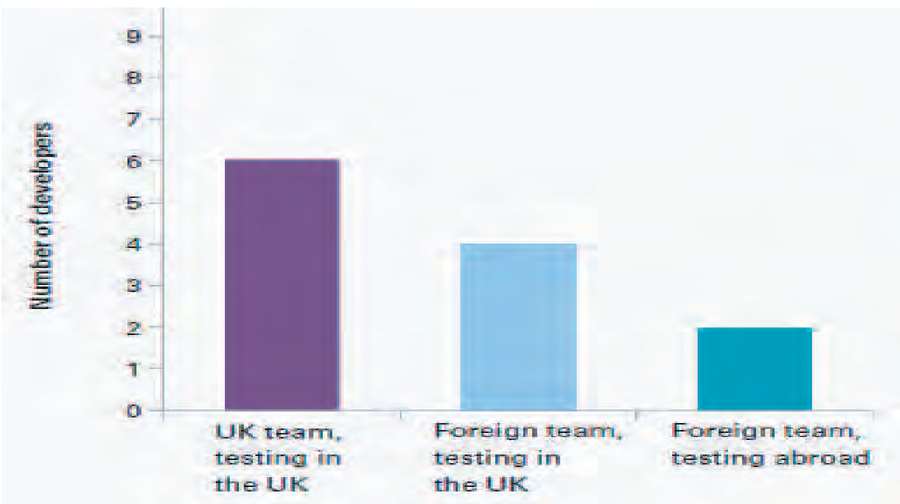
Figure 5 below illustrates the distribution of marine renewable energy devices which are currently undergoing large scale sea tests. Of the 12 devices which are currently at this stage of development, 10 are being tested in the UK, and 6 of these are being developed by UK companies, illustrating the strong policy and funding landscape currently in place in the UK.

[12] Carbon Trust (2011) Accelerating Marine Energy report.

Figure 5

GRAPH SHOWING THE PROPORTION OF MARINE ENERGY TECHNOLOGIES CURRENTLY UNDER LARGE SCALE SEA-TESTING THAT ARE BEING DEVELOPED OR TESTED IN THE UK

<u>Proportion of wave and tidal technologies at large scale sea-testing stage that are being developed or tested in the UK:</u>



(*Source*: Carbon Trust).[13]

As highlighted by figures 4 and 5 above, a significant proportion of the device development supply chain for the sector is based in the UK. However, it is also important to ensure that the component supply chain (components used to build the devices) is also based in the UK.

Creating and maintaining the conditions to develop the marine renewable energy supply chain in the UK presents a significant and immediate opportunity, and this should not be neglected. Due to the early stage of development of the sector, it is very much all to play for with respect to where the supply chain is developed. If government policy fails to put the necessary policies in place to maintain the UK's first mover advantage and attract investment, the supply chain will be developed in another country with more favourable conditions for investment in the sector. This would result in a large portion of the potential benefits outlined above not being realised in the UK.

7. *What approach should Government take to supporting marine renewables in the future?*

This analysis is focussed on one particular approach which has gained much coverage in the last year: that of Marine Energy Parks (MEPs). The clustering of test centres, developers, and supply chain companies has been shown to create efficiencies in other sectors. However, while the benefits of clustering are not disputed, there are risks associated with the MEP approach and it is important that these are considered.

The MEP approach risks dividing and fragmenting stakeholders within the UK as they compete to attract the funding and opportunity associated with hosting the MEP. This risks losing sight of the bigger picture: what is of utmost importance is that the supply chain for the sector is developed in the UK, not whether it is developed in the South West, Scotland or elsewhere. Care must be taken for the sector not to become divided and distracted by focussing on where in the UK an MEP should be developed which would significantly detract from the UK's international position in the sector.

All other UK government policies for this sector are implemented on a national basis. The Crown Estate leasing rounds, market support mechanisms such as the RO, financial support mechanisms such as the MRPF. Therefore, following the MEP approach, and readjusting to focus on one particular area which is designated as an MEP, is a discontinuous approach.

In large countries, such as the USA, where Silicon Valley is often used to champion the benefits of clustering, incentives for clustering are increased by the otherwise wide spread of developments. However, the UK is relatively small with only one time zone and where it is relatively easy for stakeholders to travel and collaborate. Therefore, it is recommended that the MEP approach is modified so that the UK is the MEP, not a single region. Given that the area of California where Silicon Valley is located is larger than the entire UK, this approach is justified. This will allow attention to remain focussed on how the conditions can be put in place to ensure that the supply chain for the sector is developed in the UK.

[13] Carbon Trust (2011) Accelerating Marine Energy report.

Summary:

It is important to reiterate that the market for marine renewables is an international one. Therefore the UK needs to strive to maintain a strong national offering in this international market, and not get distracted by focussing on where the developments within the UK should be located. The UK needs to ensure that it is seen internationally as the best place for investments in the sector. The UK cannot afford to lose its first mover advantage as the world leader in the sector. If this were to occur, it is likely that the supply chain for the sector would develop outside the UK and a large portion of the benefits outlined above would no longer be realised in the UK. Increasing fragmentation and competition within the UK by focussing the MEP approach on specific areas within the UK will reduce the UK's effectiveness on the world stage, competing with other countries to maintain its competitive advantage. The UK's current first mover advantage in the sector is far from secure from encroachment by other countries and the UK Government need to remain committed to supporting the sector if the large potential benefits the sector poses are to be realised in the UK.

September 2011

Memorandum submitted by Parsons Brinckerhoff Ltd

Executive Summary

1. Peter Kydd of Parsons Brinckerhoff Ltd led the consortium of consultants employed by DECC to assist them on the Severn Tidal Power Feasibility Study between 2008 and 2010. He also acted as technical advisor to DECC for the Severn Embryonic Technologies Scheme (SETS) in 2009 and led the Duddon Estuary Tidal Power Feasibility Study for Britain's Energy Coast—West Cumbria in 2010. Prior to this he led the research effort that resulted in the development of the Shoots Barrage concept subsequently submitted as evidence to the 2006 White Paper.

2. This submission builds on the experience that Parsons Brinckerhoff has gained in the development of tidal power in the UK and makes six key points:

- (i) Tidal power is an indigenous, dense and predictable resource—irrespective of whether tidal range or tidal stream technologies are utilised. Back-up requirements are therefore less onerous than other less predictable forms of renewable power;
- (ii) Any abstraction of energy from tidal waters (whether tidal range or tidal stream technologies are used) will change the adjacent environment, irrespective of technology type—use of this natural resource therefore requires that stakeholders make a choice about the amount of energy taken from the marine environment, its associated impact and how that impact may be mitigated;
- (iii) Tidal range projects have a number of advantages over other near and offshore technologies in that they use existing proven technology and have long asset lives—a tidal barrage or lagoon project is capable of operating for more than 120 years for example. The total energy produced (and thus carbon dioxide emissions avoided) by a tidal range project over its lifetime is much larger than shorter life projects of similar capital cost;
- (iv) The long term benefits of long-life projects with high capital costs and low running costs (such as tidal range) are not reflected in levelised cost analyses which are commonly used for comparing the energy cost of different generation technologies. The 10% discount rate used in DECC's analysis of generation costs since 2010 effectively eliminates any energy or costs after 35 years.
- (v) Tidal range power projects, because of their long-life, offer a genuine method of reducing long term energy costs. It is not reliant on future technology development or commercialisation to achieve this. It is a function of that fact that once the financing period (typically 30 years) required to fund construction is over, there is no further call on capital budgets for the remaining 90 years of the project life and annual operational costs are relatively small in relation to revenues. The effect of this is that whilst a relatively high tariff would be required during the financing period—potentially between £200 to £350/MWh depending upon the specific project—this rate falls to below £55/MWh for the subsequent 90 year period, enabling funds to be returned to the tax payer/consumer. It could also exert downward pressure on future electricity prices.
- (vi) Tidal Stream technologies could, in the long term, result in lower energy costs than offshore wind given its current early stage of current development. Factors contributing to future lower costs include the predictable nature of the available energy resource and potentially higher load factors when compared with wind. However, because they are largely inaccessible and with higher physical loadings relative to wind, tidal stream technologies will need to be robust in design with low maintenance demands. Research and development investment that focuses on the commercial benefits of improving durability, reliability and cost by incentivising more durable solutions, albeit at higher initial cost, will help deliver this. Such an approach may result in greater availability performance than is currently forecast with the associated economic benefit.

3. Parsons Brinckerhoff supports the development of all forms of renewable and low carbon power generation and believes that with the increase in electricity demand required to meet the UK's 2050 carbon emissions requirement, a combination of many different technologies will be required, including tidal stream, tidal range

and wave power. The main purpose of this submission, however, is to highlight the long term benefits of tidal range projects and the contribution that they could make to the long term reduction of energy costs.

Benefits and Impacts of Tidal Power

4. Tidal power is a predictable indigenous long term energy resource. The UK's western coast is one of the richest seams of tidal power in the world—for both tidal technologies—tidal stream (utilising the tidal currents) and tidal range (exploiting the level difference created by tides). The predictable nature of tidal energy, compared with wind, means less back-up capacity is required (1.35GW less for 12TWh of annual energy according to DECC's Impact Assessment for the Severn Tidal Power Feasibility Study.)[14]

5. The tidal stream resource is typically located offshore and therefore requires significant offshore transmission links like offshore wind. There are some nearshore sites for tidal stream and development work continues on tidal stream devices that can operate in shallow waters. Tidal stream devices would be expected to have operating lives similar to offshore wind turbines—of the order of 20 to 25 years.

6. Tidal stream technologies generally have less environmental impact than a tidal range scheme in the same location but this is primarily due to the much lower power densities meaning that much less energy is abstracted. The lower energy abstraction results in relatively higher energy costs as the physical infrastructure required is not proportionately lower.

7. Tidal range sites (comprising barrages and lagoons) are located adjacent to the shoreline and consequently have much shorter transmission routes. However, their environmental impact is relatively high. A number of the best tidal range sites, such as the Severn and on the North West England coastline, are also designated as Natura 2000 sites protected by the Habitats Directive. Tidal range projects also, inter alia, impact fish, change the estuary geomorphology and water quality and can affect commercial users of the estuary, which, alongside other environmental and social effects, all have to be understood and appropriately avoided, mitigated or compensated. Tidal Barrages (which connect two opposite shorelines via an embankment) and Tidal Lagoons (which use a long embankment to create an impoundment on the same shoreline) share some impacts but not all.

8. Whilst past and recent studies on tidal power have understandably focused on the immediate issues of affordability, financial viability, technical feasibility and environmental and socio-economic impacts, the cross technology comparisons have tended to ignore the longer term benefits which, by the time they are discounted using net present value analysis, make little contribution to the levelised costs of energy, the measure generally used for comparing costs between different generation technologies.

9. This submission seeks to provide new evidence of the value of the longer term benefit of high capital cost, low running cost, long-life projects such as tidal range. These do not apply to tidal stream, wave, offshore wind or other renewable technologies (other than hydropower) which typically have much shorter lives and have less significant residual value after 20 to 25 years of operation. It also seeks to highlight the value arising from the predictability of the tidal resource and suggests this should be an important consideration in guiding future research and development, particularly for emerging tidal stream technologies.

Tidal Range Long Term Benefits

10. The cost of electricity is forecast to rise[15] over the foreseeable future as the UK seeks security of supply and achievement of 80% reduction in carbon dioxide emissions by 2050. Most, if not all, new low carbon generation technologies will themselves contribute to this rise. However, the effective asset lives of renewable technologies such as wind are little longer than the period required to finance their initial construction and to extend their life beyond this requires wholesale replacement of the wind turbine itself which accounts for the majority of the overall cost. As a consequence the long term cost of fully commercialised offshore wind is similar to its initial cost, amortised over the financing period. A similar case applies to tidal stream technologies.

11. However, tidal range technologies are biased much more towards civil engineering components and their correspondingly longer life. 120 years is taken as the industry standard for reinforced concrete structures and rockfill embankments, for example, although the reality is that, if properly designed and well maintained, much longer lives are possible. The only items that need refurbishment are mechanical items such as turbines, gates etc where 40 to 60 years life can be expected (the technology is well established and used throughout the world) and electrical components such cabling, controls and switchgear which have a life of typically 20 but up to 40 years. As the mechanical and electrical components represent a smaller percentage of the overall investment than the civil engineering works and because they are not due for replacement until the initial financing period is over, their replacement cost can be met from revenues generated by the project.

12. Much of this is disregarded when calculating levelised costs, particularly for higher discount rates which render costs and revenues after 30 to 40 years as having little worth. As a consequence tidal range projects often emerge as more expensive than other technologies, even though their effective life may be significantly longer.

[14] Paragraph 142 (p39), Severn Tidal Power Feasibility Study Impact Assessment, DECC, October 2010.

[15] Planning our electric future: a White Paper for secure, affordable and low—carbon electricity, DECC, July 2011

13. It is helpful to look at this in terms of carbon dioxide emissions over the operating life (that is the anticipated life of the initial construction investment) which are not generally discounted or reduced to a net present value as shown in the table below.

Technology Type	*Operating Life*	*Annual Energy per MW*	*Total Lifetime CO_2 emissions saved*
Offshore Wind	25 years	3066MWh/yr	30,320t
Tidal Stream	25 years	3504MWh/yr	34,650t
Tidal Range	120 years	2014MWh/yr	100,500t

Assumptions:
Load Factors: 35% for offshore wind, 40% for tidal stream and 23% for tidal range applied to 1MW
CO_2 emissions: 0.43t per MWh and 2 year carbon dioxide in construction payback period

14. The conclusion from this is that the initial investment in 1MW of tidal range generation achieves a threefold improvement in saved emissions by virtue of its longer life. A similar situation exists when considering the post financing period performance of tidal range projects in cost terms.

15. PB's latest update of levelised electricity costs (Powering the Nation)[16] shows tidal power levelised costs ranging from £160 to £240/MWh and offshore wind ranging from £150 to £200/MWh. Taking the central points of these estimates would give £200/MWh for tidal power and £175/MWh for offshore wind. These are discounted at 10% to reflect private sector implementation. These figures represent First of a Kind (FOAK) estimates reflecting the initial costs of constructing a new technology. The Government is hoping to drive down offshore wind costs to £100/MWh for 'Nth of a Kind (NOAK) projects. Tidal Range FOAK and NOAK costs are the same as such projects are not modular and already use existing established construction methods and technologies.

16. The table below shows a comparison of costs for 1MW of tidal range vs 1MW of offshore wind over the same 120 year life with offshore wind installations being replaced every 25 years using NOAK costs and the tidal range project being split into four 30 year phases. Each phase is treated as a separate entity and has its own levelised cost assessment. In the case of tidal range, this could replicate a Public Private Partnership arrangement where Government owned the asset but appointed an organisation to Design, Build, Finance and Operate (DBFO) it under a concession arrangement before it was transferred back to Government who would then let a second concession for the next 30 years and so on.

Years:	*1–25*	*26–50*	*51–75*	*76–100*	*101–120*
Offshore Wind	£175/MWh	£100/MWh	£100/MWh	£100/MWh	£100/MWh
Tidal Range	£200/MWh	£55/MWh	£55/MWh		£55/MWh

17. The £55/MWh over 90 years for tidal range is less than the current electricity price and therefore has a downward influence on future electricity prices if passed directly to the consumer. It is also largely inflation proofed given the dominance of the revenues over costs post financing—in fact inflation will enhance the cost savings achieved between the market price and the actual cost from tidal range over this period. This saving does not rely on future technology development and continuing efficiencies in construction as it is using the original infrastructure. It includes the cost of refurbishment, replacement, maintenance, operation and the necessary contributions to a sinking fund to pay fro decommissioning the works at the end of the 120 year period (although in practice it is likely that the facility could continue beyond that).

18. An alternative approach would be to separate the basic infrastructure elements into the civil engineering works with its life of 120 years and the electrical mechanical plant with its associated much shorter life. If Government retained ownership of the civil engineering works following its transfer back after the initial DBFO concession, it could then lease this asset to operators under a concession arrangement who would then replace/refurbish the shorter life plant as appropriate to maximise their return. The value of the lease would be based on the cash flows that would be generated but would effectively comprise a return of equity to the taxpayer through the income from the lease.

19. The table below shows the cash flows (in today's terms) for the first post financing period (year 31 to 60) for a 750MW tidal range project, generating 1.4TWh/a with revenues set at £100/MWh. It includes a major refurbishment programme in year 40 which, as can be seen, is funded through income rather than debt. At the end of the thirty year period, a cash balance of some £2.3 billion has been established, distributed between owner (Government) and operator. This example ignores interest that might be earned on the accrued cash balance as it is designed to illustrate the direct earning power of tidal range projects in this and subsequent phases compared with offshore wind. Revenues could be further reduced, reducing the cash balance but resulting in lower energy costs, assuming the savings were passed back to the electricity consumer, helping to offset higher cost generation technologies over this period.

[16] Powering the Nation Update, Parsons Brinckerhoff 2010

Year	*Capital Cost*	*Finance Charge*	*Revenue*	*O&M costs*	*Sinking Fund*	*Net Revenue*	*Cum.Cash*
31	0	0	140	30	4.5	105.5	106
32	0	0	140	30	4.5	105.5	211
33	0	0	140	30	4.5	105.5	317
34	0	0	140	30	4.5	105.5	422
35	0	0	140	30	4.5	105.5	528
36	0	0	140	30	4.5	105.5	633
37	0	0	140	30	4.5	105.5	739
38	0	0	140	30	4.5	105.5	844
39	0	0	140	30	4.5	105.5	950
40	0	0	140	30	4.5	105.5	1,055
41	0	0	140	30	4.5	105.5	1,161
42	750	0	0	30	4.5	-34.5	376
43	0	0	140	30	4.5	105.5	482
44	0	0	140	30	4.5	105.5	587
45	0	0	140	30	4.5	105.5	693
46	0	0	140	30	4.5	105.5	798
47	0	0	140	30	4.5	105.5	904
48	0	0	140	30	4.5	105.5	1,009
49	0	0	140	30	4.5	105.5	1,115
50	0	0	140	30	4.5	105.5	1,220
51	0	0	140	30	4.5	105.5	1,326
52	0	0	140	30	4.5	105.5	1,431
53	0	0	140	30	4.5	105.5	1,537
54	0	0	140	30	4.5	105.5	1,642
55	0	0	140	30	4.5	105.5	1,748
56	0	0	140	30	4.5	105.5	1,853
57	0	0	140	30	4.5	105.5	1,959
58	0	0	140	30	4.5	105.5	2,064
59	0	0	140	30	4.5	105.5	2,170
60	0	0	140	30	4.5	105.5	2,275

Cash Flows for a 750MW Tidal Range Installation after the Conclusion of the Financing Period (all costs in £m)

20. In conclusion, previous studies have shown that tidal range projects are more expensive than offshore wind projects over the design/build/finance/operate phase which last between 25 and 30 years depending upon the technology. However, there has been little consideration of the post financing period for tidal range projects in spite of their 120 year projected life. The majority of infrastructure for an offshore wind farm requires replacement after 25 years and the expectation is that replacement costs will benefit from the scale and technology advances with unit costs dropping to £100/MWh. Tidal range infrastructure on the other hand should require little attention after the initial 30 year financing period.

21. Some good examples of long life projects which were relatively expensive when first built but which are now amongst the least expensive in the world are the hydropower projects built in Scotland after the war and La Rance Tidal Barrage in Brittany, France.

Tidal Stream Technology Development

22. Tidal range opportunities are significant (more than 10GW) but the number of sites are limited in the UK and are generally located in sensitive environments. UK Tidal stream sites are more remote but also more abundant although the potential in GW is less than for tidal range. Alongside tidal range, tidal stream technologies offer a predictable source of indigenous energy to the UK and it is important that this resource is exploited where it makes sense economically. Tidal stream resource potential also exists around the world and there is a reasonable export market as a consequence—particularly to North America and South East Asia.

23. The UK is currently the world leader in tidal stream technology development but the technology is not yet at a commercially exploitable level with costs per MW still far in excess of tidal range or offshore wind technologies. Given the predictability/extent of the tidal stream resource and the tentative progress to date, there is considerable scope to reduce costs per MW of installed capacity with further potential savings if common landing points and land based infrastructure can be used for offshore cable connections. However, the biggest issue, aside from reduction in manufacturing and installation costs, is the achievement of proven durability and reliability.

24. Rather than focus on incremental cost savings at this stage of marine turbine development, it is proposed instead that innovation funds should be aimed at rewarding device developers (and their supply chains) who are able to achieve long periods of operation without extensive maintenance. This would encourage a more

resilient approach to device development and could be incentivised through the award of a specific top-up payment(s) for example after a device has achieved a particular reliability milestone(s). Whilst this may mean higher initial capital cost, a robust low maintenance design, once proven, is more likely to recoup its costs through reduced maintenance costs and longer periods of availability both in terms of day to day generation and longer life.

25. Finally, although comparisons in cost have been made with offshore wind, the timing and difficulties in exploiting the full tidal power potential in the UK, suggest that tidal power development should not be seen as a competitor to offshore wind but an additional resource that will be needed to satisfy increased electricity demand from 2020 to 2050.

September 2011

Memorandum submitted by the Whale and Dolphin Conservation Society

1. WDCS, the Whale and Dolphin Conservation Society, welcomes the commitments from the Scottish and UK Governments to renewable energy generation, particularly noting the potential adverse consequences of climate change for cetaceans (whales, dolphins and porpoises). Climate change is an issue that WDCS has been working on for some time.[17] However, we have serious concerns about the possible negative impacts that marine renewable developments may have on cetaceans in Scottish and UK waters if not developed with appropriate consideration.

Understanding Cetaceans Habitat Requirements

2. The waters surrounding the UK offer a range of rich cetacean habitats with more than 20 species being recorded here, and many routinely encountered in coastal waters. However, large gaps still remain in our knowledge of the cetaceans which live year round or migrate through UK waters. No clear picture exists of their abundance and distribution in most areas, so the location of important cetacean habitats is still largely unknown and this is increasingly true as you go further offshore.

3. Therefore, as a minimum, we believe that all possible marine renewable developments should assess the level of baseline data that exists for cetaceans, and ensure that at least two years baseline monitoring data exists to inform appropriate decision making—primarily around siting of a development but also, later, to inform effective mitigation measures. In-field monitoring should continue during development and post-development so that potential impacts can be assessed and adaptive management applied.

4. Baseline data should be collected to inform population abundances, trends and structures, distributions and movements, foraging and reproduction patterns and social structures. Local scale studies are required in the area of each development. Broader studies are also required to understand any combined impacts of a number of developments within a region.

Understanding Potential Impacts

5. As the Scottish and UK governments strive to meet their greenhouse gas emission targets and renewable energy commitments, we anticipate that renewable developments will continue at a rapid pace. Vast areas of the seas surrounding the UK have already been set aside for marine renewable development and, in addition to habitat loss caused by the presence of these structures, WDCS is concerned about the potential for cetaceans to be disturbed and displaced, including by the noise introduced into their environment. Noise will be produced throughout the life of the development, including construction, operational and decommissioning phases, and from associated vessel traffic. Noise pollution has the potential to displace animals and populations, interfere with normal behaviour and, at very high intensities, may be physically damaging. We are particularly concerned about the intense impulsive noise caused by the pile-driving that is likely to be used to anchor marine wind farms and other renewable devices to the seabed and may disrupt the behaviour of marine mammals at distances of many kilometres, with hearing potentially impaired at closer range. Pile driving is one of the loudest sources of underwater noise and the construction of large wind farms, made up of lots of turbines, can generate noise for months on end. Placing turbines into the seabed will go on for decades in order to put in place the number of devices planned. Quieter and more benign alternatives to pile-driving are therefore an important and essential objective and governments should be making funding available to develop these alternatives. Similarly, there may be methods that can be used to limit noise. This is likely to become more of an issue as wind turbines and farms both become larger.

6. However, in addition to pile-driving concerns, we have little information about how cetaceans will interact with other new renewable structures being placed in the water column and therefore other significant impacts may still come to light as the industry develops. Collisions with tidal and wave devices can be envisaged, and particularly as more devices are placed in the water, to become arrays that cover large areas and along particular stretches of coastline. These impacts may only be able to be monitored if strandings occur as a result.

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[17] See, for example, Whales in Hot Water available at www.wdcs.org

7. Whilst some limited data exists that documents the potential negative impacts of renewable devices on harbour porpoises in Europe, including the UK (MASTS, 2010), very little or no data exists for a number of other cetacean species that we can expect to be impacted by such developments, including minke whales, white-beaked dolphins, Risso's dolphins and bottlenose dolphins.

8. We acknowledge that it has been suggested that there could be positive impacts of renewable developments for cetaceans such as the establishment of fisheries no-go zones around devices, although there is little evidence to support this at the moment. Such data are also required.

9. As the marine renewable industry is a relatively new one, a lack of detailed information about the potential impacts of devices, or arrays of devices, on cetaceans and other marine life means that a highly precautionary approach is required in the development of this industry. Data gaps have been acknowledged and some efforts are underway to fill these, for example, through the Scottish Marine Energy Spatial Planning Group (MESPG). Further, existing data points to very site specific (beneficial and adverse) impacts (Lindeboom et al, 2011).

Understanding Cumulative Impacts

10. The combined effects of these developments with other industries operating in the marine environment, such as shipping and oil and gas exploration, are also largely unknown. Yet it is important that cumulative and in-combination impacts be adequately considered as our understanding develops.

An Adaptive Approach to Development

11. We feel it essential that appropriate marine environmental impact assessments and adequate baseline monitoring surveys are conducted before construction begins for the proposed areas of development to allow for properly informed decision making. Once a decision has been made, that development can safely proceed without impact on the marine environment, monitoring should then continue during development to understand and to minimise the effects on cetacean populations.

12. Effective management strategies should include adequate mitigation, monitoring and adaptive management. Important considerations include:

- What mitigation measures are available.
- What measures have been validated and how well they work.
- What uncertainties and gaps remain in mitigation strategies.
- What development activities are needed to address those uncertainties and gaps.
- How might monitoring data be better collected, stored, and analyzed to provide insights into developing new and effective mitigation approaches.
- How might monitoring data be used to assess mitigation efficacy over large temporal and spatial scales.
- How will the results of these studies be fed back into the decision making process to further develop future mitigation and management decisions.

Recommendations

13. Detailed environmental guidance should be provided to industry at the earliest opportunity. Guidance should be science-based and where this is lacking should be precautionary. Guidance should include detailed locational guidance, being mindful of Natura sites, other potential and designated Marine Protected Areas (MPAs)/Marine Conservation Zones (MCZs) and European Protected Species (EPS) generally.

14. Marine renewable energy developments should avoid sensitive habitats, including but not limited to MPAs, at least until their impacts on cetaceans and their habitats are better understood and can be eliminated.

15. At least two years of baseline data should be collected at all potential development sites to inform siting of devices and Scoping Reports and Environmental Impact Assessments (EIAs). Data should be publicly available and in an appropriate format so that they can be included in the JNCC Joint Cetacean Protocol.

16. Given that impacts are so site specific, species impact monitoring should continue throughout the life of each project until lack of impacts are demonstrated for a range of habitats and species. An adaptive management approach is critical, where data inform whether or not further development of sites that are scaled up is appropriate, as well as the potential development of sites in other areas.

17. JNCC should provide an annual and publicly available review of all collected baseline and impact data as it currently does with seismic survey data. This data can be fed back in to government processes to inform future plans through an adaptive approach.

18. Investigations into impacts should be conducted and they should be comprehensive, independent and transparent. Effective mitigation measures should be properly monitored, tested and in place.

19. The industry should seek immediately to reduce its noise emissions, especially but not limited to alternatives to pile driving, particularly in important habitats for cetaceans.

20. Data gaps have been identified and efforts are underway to fill these. COWRIE research fund should be continued and should focus on evaluating the potential positive and negative impacts of wave and tidal energy.

September 2011

Additional Resources

European Cetacean Society. 2007. Offshore wind farms and marine mammals: Impacts and methodologies for assessing impacts. Held at the European Cetacean Society's 21st Annual Conference, The Aquarium, San Sebastian, Spain, 21st April 2007. Available online at:
http://www.wdcs.org/submissions_bin/wind_farm_workshop.pdf

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http://www.scotlink.org/files/publication/LINKReports/LINK_ACME_Report0610web.pdf

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Memorandum submitted by the Seabed Users and Developers Group

The Seabed User & Developer Group comprises some of the key marine industries. The SUDG understands that the sea around our shores is a sensitive environment that needs to be valued and protected, but it is also a working environment that makes a substantial contribution to all our lives. From energy to aggregates and from ports to cables and leisure boating, the industries of the sea make an essential contribution to our land-based society and represent 4.2% of gross domestic product supporting c.900,000 jobs.

We are an informal grouping whose participants have a common interest and commitment to sustainable development within the UK's marine environment. We believe that sustainable win-win solutions are possible from what are sometimes seen as competing needs. We are committed to working with Government, the MMO and other stakeholders to ensure that new regulation (including the Marine and Coastal Access Act) makes a significant contribution to cost-effective regulation and marine management that benefits both business and the environment. Our website www.sudg.org.uk sets out more information about the group and our priorities which are summarised as:

- A future for our seas based on sustainable development.
- Clear objectives which cover economic and social, as well as environmental needs.
- An integrated approach to planning, management and protection.
- Cost-effective regulation and management.
- Planning decisions based on science and knowledge.
- Robust mechanisms for high level resolution of problems.
- Consistency from the devolved administrations.
- Transitional arrangements while any new framework or legislation is put in place.

SUDG members include the Renewable Energy Association (REA) and Renewables UK (RUK) as well as the Carbon Capture and Storage Association (CCSA) all of whom are significant if the UK is to have any chance of meeting its commitments to climate change mitigation. These industries are still in their emergence and therefore emphasis must be placed on both the development of new technologies as well as their implementation. This is reflected in the very small number of wave and tidal energy projects currently in place, but also in the difficulties that have been experienced in gaining the necessary approvals for the projects to be constructed. SUDG has worked closely with regulators since the implementation of the M and CA Act, but continues to be very concerned that as more information is revealed about the way the regulations will be implemented, the more arduous will be the task of trying to gain the necessary approvals for development. While SUDG accepts and agrees that there is a commitment to environmental protection, SUDG also believes that there is a lack of real and tangible evidence of the Government's commitment to cost effective and risk based assessment of projects. In addition, while we are seeing considerable evidence of the development of environmental guidance to project appraisal, much of this guidance appears to be making the approval harder to achieve and there is little evidence of how socio-economic consideration will be determined or how it will be built into the decision making process. Marine renewable energy is also dependent on other marine industries such as ports and shipping which have the same requirements for development to support marine energy work and therefore the same concerns regarding the growth and implementation of regulation.

What are the potential benefits that marine renewables could bring to the UK and should Government be supporting the development of these particular technologies?

In addition to the opportunity for marine renewable to help deliver Government policy on climate change mitigation, all marine industries, including renewable, create important economic growth and job opportunities at a time when the country especially needs them. For both these reasons it is important that Government not only support the development of new technologies, but also assist with their implementation. It should be emphasised that this economic growth is not confined to marine renewable industries which also require underwater cables, port facilities, construction materials, transport and land based facilities as well as a comprehensive range of science and engineering skills.

How effective have existing Government policies and initiatives on marine renewables been in supporting the development and deployment of these technologies?

SUDG has no view on the Government policies in relation to the development of marine renewable technology and will rely on the views expressed to the Committee by the REA and Renewables UK. However, while Government policies on the deployment of these technologies remains clear and constructive, there is considerable growing concern about the way in which the policies are implemented through the project appraisal and licensing processes. The details of these concerns are given in answers to the questions below.

What lessons can be learnt from experiences within the UK and from other countries to date in supporting the development and deployment of marine renewables?

SUDG feel that this question is best answered by REA and Renewables UK.

Is publicly provided innovation funding necessary for the development of marine technologies and if so, why?

SUDG feel that this question is best answered by REA and Renewables UK.

What non-financial barriers are there to the development of marine renewables?

In line with most marine industry, marine renewable energy organisations are concerned that increased legislation is making it considerably more difficult to gain necessary approvals for projects to proceed. SUDG and the renewable industries are agreed that the environment needs protection and that new regulation should help to ensure that the environment is properly protected. Industry was promised a more streamlined, proportionate and risk based approach to regulation and that concerns about the environment would need to be supported by good evidence held by the regulators. However, Government commitments to a more streamlined approach to regulation do not seem to be manifesting as the detail of new regulations are developed and SUDG can produce significant evidence to support this statement. For example, new guidance from JNCC and Natural England to the Marine Management Organisation strongly advises that industry will need to provide information to supplement regulators' views and that the precautionary approach must be applied comprehensively with little or no account of risk assessment. This guidance also states that it is likely that the burden of environmental assessment will be greater than that which currently exists [see annex].

Consequently, Government commitments to a more streamlined approach to regulation do not seem to be manifesting as the detail of new regulations are developed and SUDG is greatly concerned that this will have a significant and detrimental impact on the appetite for investment and development of new technologies. There is already considerable concern that the way that environmental regulation is implemented makes it increasingly difficult for investors; with clear statements from NE that this situation should become yet more cautionary, this will only serve to further reduce investor confidence.

To what extent is the supply chain for marine renewables based in the UK and how does Government policy affect the development of these industries?

SUDG will rely on REA and Renewable UK to answer the first part of this question, but as with the question above, emphasis needs to be placed upon regulatory authorities to ensure that Government policies are delivered in cost effective ways.

What approach should Government take to supporting marine renewables in the future?

These are emerging technologies critical to meeting UK policy on climate change mitigation and therefore it is essential that Government supports the development of new and better technologies as well as ensuring that these technologies can be implemented in cost effective ways. The Government will be relying on private sector investment to develop and construct these new technologies and against a background of growing concern about the difficulties of gaining all the necessary approvals, Government will need to find ways of ensuring that investor confidence is not lost or simply shipped abroad, where the understanding of industry is that the regulatory approach is less demanding, more risk based and more amenable to development.

Are there any other issues relating to the future of marine renewables in the UK that you think the Committee should be aware of?

As stated above it is important to remember that marine industries are often closely interrelated and that marine renewable are reliant on shipping and port facilities for construction and maintenance and that underwater cabling is essential for the transmission of energy created by the new technologies. All these elements of marine industry are not so much concerned by the growth of regulatory control but by the apparent inability of the regulators to ensure that it is implemented in cost effective ways which reflect the need for socio-economic consideration as well as that of the environment.

The SUDG would be happy to provide further comment and evidence to support these views. In the meantime we thank you for the opportunity to present views to the Committee.

September 2011

Memorandum submitted by Shawater

Executive Summary

We welcome the Committee's decision to investigate the potential of the marine sector to contribute to the UK's renewable energy and emissions targets. We address the issues which the Committee is seeking to assess in the context of the reasonable scope open to Government to call upon marine energy. We believe the Committee's initiative will enhance international appreciation of the lead position held by UK companies in the commercial development of relevant technologies and will further both their prospects and the UK's interests.

1. The Committee is aware of the strategic and social employment implications of energy projects in general and of maritime opportunities in particular. The sea about us is a good neighbour; its riches still hold immense potential.

2. Although the Tennessee Valley is far from any US coastline, the energy (hydro) based Authority (TVA) set up in 1933 is a resilient example of imaginative infrastructure planning by central government. The kernel of our submission reflects the ethos of that lasting memorial to strategic thinking at a time, like now, of need for investment in greater domestic dependence. A Severn Estuary Authority to promote the hugely valuable Severn Barrage tidal power (hydro) project would bear just initials.

3. Marine energy is not new to the UK. My company has contributed to the technical development of sea wave energy projects since the 1970s and tidal range (barrage) schemes since 1960s. We were amongst the pioneers of the former but not the latter; plans for a Severn Barrage date back a clear century, to a Frenchman in 1911.

4. Our commitment to realising these projects has included attention to their "non-energy" implications, eg, for shipping, fisheries and the environment in general; power stations must integrate with all communities which they affect.

5. The technical challenge of harnessing sea wave energy has always been clear to us. This induced us to balance engineering simplicity against hydrodynamic efficiency; device performance was duly confirmed at laboratory size with Government funding. Further progress was sidelined in the 1980s when sea wave energy lost central UK support; thankfully it now has a reprieve.

6. In comparison, tide ("gravity") driven power has a long history, much of it in N W Europe at tide mills for which records go back a millennium. Not until 1966, however, was the full potential of tidal power demonstrated—at the La Rance tidal river Barrage in northern Brittany (referred to here as "Rance"); built for Electricite de France, its justification was to bolster supply to the then less-well served electricity customers in that part of France, also to act as a demonstration for a much larger but technically similar project off that coastline.

7. Our association (as professional observers!) with the Rance project dates from its construction and this has continued through technical and ecological associations. The success of that project over nearly 50 years speaks for its conception, design and realisation. Whereas many power stations are built and decommissioned well within that period, "Rance" continues to use its original 24 turbines and generators; not even the turbine blades have been changed since commissioning, resisting both the rigour of tens of thousands of hours of operation in sea water, also pressure from designers offering more efficient equipment—technology does not stand still.

8. The technical success of Rance is well demonstrated by the fact that the 18 year (approx) solar cycle which governs variations in tidal energy potential (the Sun and Moon are only two of the contributing forces) is evident in the records of its annual electrical output; its operation extends beyond two such cycles, proof indeed of celestial influence on our seas.

9. This Committee's "marine energy" ambitions are further served by a unique feature of the Rance Barrage, namely that the design of its turbines and generators permits these to "double-up" in reverse as efficient motors and pumps, allowing them to perform pumping duties to extend their "generating" function beyond what the

tides alone permit. The Committee may view reference to pumping as implying that "Rance" is some form of pumped-storage scheme—which it is, though in this case one spectacularly boosted in terms of efficiency by tidal power. Whereas standard pumped storage schemes return 70–75% of the electricity consumed in pumping, by selecting when in the tidal rhythm pumping is done, a significant *mark-up* in energy output is achieved. Thanks to the solar rhythm, opportunities occur regularly and predictably. Gravity is not generally seen as an energy source; in this case it is.

10. Designing to maximise value goes unsaid. Incorporating flexibility into generation offers much if scope to realise future value is built in. Barrages must harness this marine source to the full and include pumping for maximum value. The optimum mix will not remain static—designs must anticipate such contrasting moving targets as sea level change and consumer demands.

11. Notwithstanding its success as a hydro scheme, the Rance Barrage also performs a vital role in the infrastructure of the St. Malo area by providing a four-lane road, shortening cross-estuary travel, assisting commercial and recreational water transport by maintaining navigable depths and incorporating a ship lock, and bolstering adjacent land values. The taxation regime relating to the commercial value of the area confirms these changes. Small wonder that councillors and politicians in Cardiff, Newport, Weston-super-Mare and Bridgwater are interested.

12. Contrary to "popular" views of the environmental effects of barrages, the ecology of the Rance Estuary is judged by the French Government-owned Natural History Laboratory located close to where the barrage now is (set up in 1892, 70+ years to prepare the ground) that the changes resulting from the modified tide regime have resulted in significantly increased marine productivity. Whereas species balances have changed, none have been lost. Water clarity has improved and the fisheries resource multiplied, measures confirmed by comparing the ecological history of the Rance Estuary (before and with barrage) to the unmodified regimes of nearby estuaries along the "Emerald Coast". For this to be repeated with a Severn Barrage would permit the project to contribute further to counteracting global warming.

13. We are not saying that experiences at Rance will be mirrored in any estuary in which a barrage is built. There are examples where for project-specific reasons this has not followed. However, Rance exists and has been monitored and analysed in great detail (Ref. 1); it is a prime source of basic evidence and by being on our doorstep its natural history has much in common with the conditions which prevail in the Severn Estuary and can be expected should a similar project be developed there. An individual who saw little of the scheme when *en passage* is the sailor who inadvertently went through an operating turbine and emerged unscathed—unlike his boat! Shoals of fish migrate daily though the turbines without providing a resource for the seagulls which occupy this estuary for what must be other reasons.

14. The close scientific links which have sprung up between scientists in France and the UK because of our attraction to "Rance" technology and experience have resulted in many rewarding developments (Ref. 1); earlier this year this professional Paper was awarded a top premium prize by the UK's Institution of Civil Engineers.

15. French interest in the tides of the Severn Estuary is not new (3 above). Its realisation since 1911 has as yet not taken longer than it took Napoleon's concept for a Channel Tunnel (to invade England) to reach fruition!

16. The UK Government has also been active. Early studies reported in 1926, 1933 and 1945 were followed by the Select Committee on Science and Technology's concern about the supply and cost of oil (in 1974)—the latter encouraging Government to look again (in 1980) and fund further investigations which reported in 1990 and 2001. The most comprehensive assessment is the most recent, 2010 (Ref. 2); its findings endorsed the findings of the 2001 and earlier studies. Although the 2010 report points a clear way forward, there remains much for Government to do.

17. Tidal power barrages (often designated "tidal range" projects to distinguish them from those which only take energy from currents) have a powerful and valuable pedigree in conventional hydro-electric technology. The Rance barrage exemplifies this; its early energy productivity estimates are fully confirmed, the machinery is ultra-reliable, and using seawater has not proved life-limiting.

18. Sea wave energy does not have this background. That the energy exists and will continue to arrive off our shores is not in doubt. Hydro-power technology took world interest and a world market to reach maturity. Sea wave energy is a new industry, hindered by its location. Reliability is essential to credibility; tidal power has achieved that, thanks in large measure to Electricite de France—though in his launching ceremonial speech in 1966, General de Gaulle did not give it the full vote of support which time has bestowed on it; nuclear power was more on his mind. Without French national support for Rance, tidal power would be an infinitely weaker prospect today; its success is there for the benefit of all.

19. Marine energy comes in many contrasting forms. Wave energy is wind-driven and diffuse, hence irregular and expensive to capture. In contrast, tidal range is predictable and concentrated. The UK is readily able to call upon the latter to meet some of its energy demands, and in time doubtless also the former. Reliability is the key when it comes to public supplies; gravity won't let us down, the Sun and Moon will be with us for much longer than it will take us to work out how best to capture all forms of marine energy.

20. The density of water gives it an immediate advantage over air ("wind") as an energy source. Larger wind turbines have power ratings of 3–5 megawatts (MW), and 10MW machines are envisaged. In comparison,

each turbine envisaged for a Severn Barrage would generate up to 40MW, there would be over 200 of them, and they and their electrical generators would be out of sight, in the ducts supplying them with water (as for all hydro schemes).

21. The annual energy output of a Severn Barrage incorporating pumping would be about 20 billion units (20,000 GWh, or 20TWh). The present annual electricity consumption of the UK is under 400TWh, the barrage would meet 5% of this, close to the demands of Wales or South-West England—which a Severn Barrage would connect. This project would supply the national network. Its supply would be ultra-predictable, not lifetime limited and flexible in operation according to demand, maximising its value. That value could be quantified by the much vaunted Feed-In Tariff system or via a project-specific pricing mechanism recognising its true system values. Its inherent flexibility will be used according to the circumstances anticipated on any day. Although demonstrated both at Rance and by us, it can only be quantified and valued with reference to actual network operation.

22. The energy output of a Severn Barrage is less than 50% of what could be generated in this way from UK coastal waters, ie, it could meet over 10% of national electricity demand. This aligns with the Carbon Trust's estimate that the UK's marine sources could supply 15–20% of demand, tidal power forming the lion's share.

23. Although there is much "non-energy" R&D to be done ahead of constructing any barrage project, this relating to its wider community opportunities—about which the political future of many infrastructure projects depends.

24. Some of the generating capacity of a Severn Barrage would be available before it is fully commissioned; it could supply progressively more electricity annually over a four-year period from 2020. This will allow its full potential to be integrated smoothly into an evolving national supply structure. A "building" programme over ten years with equipment installation between years 5–9 to progressively increase pumping and generating capacities is envisaged by us (Ref. 3).

25. The construction task comprises repetitive engineering operations extending over this period, these including forming concrete or steel floated-in caisson units ("Mulberry Harbour" style but on a larger scale, Ref. 4) and fabricating and installing over 150 identical turbine/generator units and their supporting services. Much of the "civils" element of this task is suited to many now-largely redundant construction yards in Scotland and the North of England developed to support the 1970/80s North Sea oil & gas production programme. The "floated-in, ballasted-down" procedure used for those units is suited to barrages, the machinery following when secured to the bed of the estuary and to each other—"Lego" style in all but scale.

26. Although caisson construction could be carried out in coastal Scottish yards, the turbines and electrical generators would be assembled in special production facilities located close to electrical and mechanical engineering industries spread across the UK. The Glasgow area is a strong candidate, also Merseyside, the Midlands, North and South Wales, Northern Ireland and the Bristol area. All have active affiliations with relevant technologies, also Derby for turbine technology. Whilst expertise from outside the UK could be called upon to assist turbine design, manufacturing and assembly could be UK-based; this is project suited to the whole of UK Ltd.

27. The national scale of this operation might obscure its energy value. The needs of the project's components have been translated into "energy to produce and install" terms, summed and related to the energy output of the project. The procedure followed is that advocated by an earlier Select Committee of this House, and the results have been published by the UK's Institution of Water and Environmental Management (Ref. 5). The answer works out to be about ten months of the energy potential of the scheme, closely in line with the information published by that Select Committee for "water power" schemes in general and confirmed by us.

28. Like icebergs, tidal power barrages are mostly under water, a precondition for them to exist. Their small visible element comprises items of infrastructure, eg, that for the transport corridors which the caissons are well suited to support. Government would do service to this project by instituting a "non-energy" assessment of its potential, not only for its generally supportive neighbours in South Wales and South-West England but for the UK as a whole. This is truly a national project.

29. Despite attention from the DECC, the capital cost of a Severn Barrage is open to debate. Detailed professional analysis put this at under £10 billion in 1990 (Ref 4), but it is now said to have risen to over £25 billion (Ref 2). Competitive tendering has yet to be encouraged, including pricing from outside the UK. £25 billion for an 8+GW (=8000+MW) power station indicates a simple unit price of some £3000/kW of generating capacity, which is less than some quoted prices for offshore wind turbine installations for which energy productivities per kilowatt are similar but maintenance is less convenient. The issue of lifetime is highlighted by Rance and hydro-power generally; should decommissioning be contemplated, "refurbishment" will be preferred. How could Severnside fare without what will by then be its focal point?

30. Operating costs for marine renewable energy sources favour shore-connected tidal power barrages. An investment of £25 billion which produces 20 terrawatt-hours annually from a project with a lifetime which, based on experience at Rance suggests a unit operating price of about 12p/unit for a 15-year payback, in keeping with "Feed-In Tariff" and renewable energy investor expectations, *and which ignores all other resulting public and commercial values including taxation.*

31. The value of the project to UK Ltd beyond its contribution to meeting renewable energy targets will be immense. Reference to this for the Rance Barrage was made in 11 above. Currently much is being said here about the capital cost of HS2, not least that it is being encouraged by Government without justification of its value to the communities served. It has been said that a Severn Barrage should be promoted for its community benefits, and that its turbines will have the added merit of paying for it by producing renewable energy. Many water engineering projects face this dichotomy—they are promoted on one pretext but come to serve others. The Thames Barrier could be cited, also many water-storage reservoirs—and our network of historic canals is a profound infrastructure asset without which the coherence of important parts of our society would be much depleted.

32. The "non-energy" value of a Severn Barrage has not been quantified; perhaps this scheme would be of greater national value if it produced less energy and did more by way of flood protection and assist commercial navigation? Detailed studies have been made of the construction procedure needed to cause least disruption to the natural and commercial "ecosystems" of the Severn Estuary (Ref 4). Some disruption is inevitable but it need not extend beyond one year of its construction period.

33. Gravity is probably our most secure form of energy supply; Earth's interaction with mainly the Sun and the Moon has permitted us to harness this by tide mills and more recently by tidal barrage projects—of which more are in train. This clean and secure worldwide energy resource has been wasted in the past and again today. Present and foreseeable markets give no reason for us to go on being so profligate, especially in the UK facing the Atlantic's prime, uninterruptable tidal surge.

34. Power stations have to fit into their local and often not so local infrastructures. When so much other than energy production is involved with promoting a barrage (as La Rance has shown), a "Big Society" approach is needed to ensure not only that national interests are recognised but also that the diverse implications for local communities are taken on-board. There's a job for Government to do; all that's needed to bring this major marine energy source to fruition is a dose of strategic planning, a task for Government's new infrastructure planning machine.

35. Two not-so-fringe issues warrant our last words. We have referred to the intermittent generation from renewable energy sources. We believe that the advent of "smart technology" will deal with this efficiently when the time comes, as it will when a barrage on the scale of the "Severn" scheme is built. By then, electric traction could be the norm. Petrol stations could give way to dual purpose petrol/battery stations at which fully tide-charged batteries to standard formats will be available. Domestic premises as well as streets will be equipped with charging points, overnight replenishment providing an ideal off-peak outlet for the fully predictable but controllable link between tidal power and battery-powered users.

36. Then there is protection against sea level rise, both predicted in the long-term and imposed without warning! Estuary barrages can resist surges; the tidal surge of 1607 in the Severn Estuary engulfed low-lying parts of the South Wales coastline. The proposed Severn Barrage would have provided protection against that event and would do so against events yet to come.

Harnessing the tides involves proven technology. A robust shore-connected structure ensures that crucial issues of access for maintenance and connection to the electricity network are as for conventional power stations. This form of marine energy is secure, reliable and predictable, and it is not a generator of carbon. The wider environmental implications of a Severn Barrage are well researched and predictable. What remains to specify, again to national advantage (and why not?), are its "non-energy" social and economic implications—TVA-style.

Marine energy offers the UK security of supply based on use of indigenous and currently wasted resources, at prices and degrees of technical reliability which vary with device design and energy source. So-called "tidal range" schemes (involving barrages) are basically conventional hydro power projects and have well demonstrated credentials. Tidal current energy is likely to involve many relatively small isolated units to accumulate significant amounts of energy, these being mounted on the sea bed, inter-linked electrically and connected sub-sea to coasts and hence to consumers via the grid. Sea wave energy will also involve many electrically inter-linked units, tethered and either floating or located within the water column; connection to consumers being as for tidal current devices. We have not referred to offshore wind energy; this is not a marine energy source *per se*.

There are no over-riding reasons why UK industry cannot fully support the development of all of our marine energy sources, subject only to commercial considerations. A Severn Barrage, by virtue of the high energy density of tidal power compared with that of the other marine sources, might be viewed as beyond the in-house scale for attainment; however, if formed of floated-in concrete caissons, this supply could come via Scotland's now little used coastal construction yards developed, the turbines would bear on the machinery used in other "energy" centres of expertise close to Glasgow, Manchester, Derby and Bristol (to name but a few), and the electrical generating equipment would require quantity production for which this sector is well versed. Co-ordination and incentives must prevail. Tidal barrages may be the easiest to promote because they interact less with established infrastructure; by comparison the truly offshore renewables affect interests less accustomed to newcomers and which have established traditions!

The employment potential of a Severn Barrage would therefore be nationwide, and it would be a low-carbon renewable energy asset involving proven technology and worthy of international standing (Ref. 4).

Being water engineers we veer towards gravity (it won't let you down) and the persuasion of the inspirational Rance project. But the marine sector as a whole offers enormous prospects as well as enormous challenges. But when it is on our door-step, why ignore it? The sea already provides us with diverse resources and opportunities, none of which need be compromised by it also being used as an energy source; the Rance Barrage demonstrates the scope for multi-disciplinary harmony, and we face the same tides and hence opportunities. "Vive La Rance!"

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September 2011

Memorandum submitted by EMEC

1. Executive Summary

2. The UK is leading the world in the race to develop and deploy wave and tidal energy converters. The scale of activity is envied elsewhere and real progress is being made due, in no small part, to consistent non-partisan support by government over a number of years. Marine energy will deliver on climate change, economic growth and sustainable energy policy objectives provided it continues to receive the necessary support.

3. The lead is, however, assailable.

4. This consultation response is broadly in support of past governmental support and urges maintenance of the direction and an increase in quantity of support.

What are the potential benefits that marine renewables could bring to the UK and should Government be supporting the development of these particular technologies?

5. The UK economy needs energy. Without a secure, stable, affordable supply of energy there can be no economy. The UK saw the benefits of North Sea Oil, not just in terms of the revenues from the product itself, but in the invisible earnings it continues to see from the learning and IP the activity generated. Indigenous energy also recycles the energy value within the economy and prevents the haemorrhage of funds overseas.

6. In the case of marine energy the UK has an absolute world lead. To retain this lead requires vision and determination and comparatively little public money. To regain it after losing it would be prohibitively expensive and would see the value of the industry move overseas and fail to see the income that will be achievable.

7. The UK oil industry is a world leader in drilling and exploitation technology and is establishing itself as the leader in decommissioning. However, there are only a limited number of opportunities to expand the extraction of oil. Diversification into more sustainable energy supply systems is comparatively simple at the moment as the markets have yet to be developed. Restrictions on the colonisation of this space are therefore limited only by ambition rather than confinement by pre-existing players. It represents a potential new fertile resource to be exploited and will work well as the successor to offshore wind as this development achieves maturity.

8. Should government support the development of these technologies? Absolutely. Yes. The benefits of developing a new industry and selling it to the world are huge. The costs of staying in this industry at this early stage are comparatively small.

How effective have existing Government policies and initiatives on marine renewables been in supporting the development and deployment of these technologies?

9. To date it would be EMEC's view that policies have been 'moderately' successful in helping to develop this nascent industry. This is evidenced by the level of activity in the UK and the fact that a significant number of the leaders in the field are actively seeking to get involved in the UK.

10. From EMEC's perspective the following table of its customers is illuminating in that it shows that only four of the 15 companies planning to install full scale devices are British. 11 companies from other nations have chosen to come to the UK to install.

11. Tide

Company	*Nationality*	*Status*	*Next Steps*
Openhydro	Irish	Installed & testing. Now on Mk 6	Canada, France, Scotland
TGL	British	Installed Mk1 working on Mk 2	
Atlantis	Singapore	Installed	
Voith	German	Foundation installed	
Scotrenewables	British	Initial installation	
Hammerfest Strom	Norwegian	Preparing to install	
Confidential	Japanese	Contracted	
Confidential	Dutch	Contracted	

12. Wave

Company	*Nationality*	*Status*	*Next Steps*
Pelamis (P1)	British	Testing complete	
AW Ocean Energy	Finnish	Testing complete	Installing in Portugal
Aquamarine	British	Mk 1 testing complete, Mk to installing	
EON	German	P2 machine on test	
Scottish Power	Spanish	Testing to start imminently	
Wello	Finnish	Testing to start imminently	
Seatricity	Antiguan	Preparing for installation	

13. It is EMEC's firm opinion that these installations would not have taken place in Orkney, let alone the UK, without the leadership and vision shown by government in setting up EMEC and then seeking to provide sufficient support to get developers to use the facilities.

14. EMEC has seen that the UK's leadership in the sector is regarded by device developers as something they must engage with. The feeling that the UK is where it is all happening is palpable. The appetite to join in is demonstrable. EMEC has presented on its work all over the world and without exception we see the audiences showered by other speakers with references to what the UK is doing and the need for their own governments to follow the UK's lead. In many jurisdictions these messages have been heard and movements are afoot to come after us.

15. Developers are, however, still driven by where the support is. The UK saw the focus of wave energy shift from Orkney to Portugal when their tariffs and other mechanisms were better than the UK. Initiatives by Scotland wrested that back to the UK where it has stayed for the moment. However anecdotally developers are paying particular attention to other administrations and will follow the money if that is more attractive. The UK needs to decide to stay "in the game" if it is to see the win it envisages.

16. The economic benefits of this activity are still small at present. The machines are experimental and the outputs intermittent, but developers have stated their expenditure in the local area of around £1 million/installation and £0.5 million per annum thereafter. EMEC's annual spend is generally £1.8 million of which 45% is within the Orkney, almost 80% within the UK.

17. EMEC has seen a direct correlation between the levels of interest in using its sites and the public money available to support projects. Developers have stated that they have attracted between £3–£5 of private finance for every £1 of public money.

18. EMEC does not have direct experience of the funding models of its customers, however it can attest to the increasing pace of interest. Indeed it is now hosting two developers who have provided some of the infrastructure they require themselves. In doing so EMEC is seeing some private finance begin to flow into the works that will support the developers' projects rather than just the devices themselves.

19. EMEC's initial construction was funded exclusively by the UK public sector. This covered the initial wave energy test site. EMEC's expansion to cover the tidal site was eligible for some ERDF funding. Expansion of the wave site shore infrastructure was subsequently funded by Scottish Government through the WATES

funds. A more recent phase of expansion was undertaken using economic stimulus money (Approximately 75% of which was spent with UK companies) through DECC.

20. In between these assorted capital initiatives EMEC had to rely on revenue support through its local Development Agency (Highlands & Islands Enterprise—HIE) & The Carbon Trust (initially). It is important to realise that without the unstinting support of HIE that the entire EMEC project would have failed, and without the Carbon Trust funding the quality of the offering would not have been sufficient to attract the developers.

21. EMEC was not directly involved in the MRDF (and would not have been eligible for it), however EMEC's opinion is that it was a very useful signal that the UK was seriously interested in seeing success in the sector. It was unfortunate that it was not accessed, however this should not detract from the fact that it was widely seen (particularly by those looking to make inward investments to the UK) as a demonstration of the UK's determination to succeed.

22. The Scottish Saltire Prize is a similar signal. Whether it is won or not is of less value than the clear message it sends that Scotland wants to see this industry happen and is willing to be imaginative in how it helps this come about.

What lessons can be learnt from experiences within the UK and from other countries to date in supporting the development and deployment of marine renewables?

23. Consistency and long term view is important to attract in the industrial players. This has worked to data and needs to be further developed if the UK is to realise its potential and secure the economic benefit of its lead and its resources.

24. The willingness of funding bodies to change and adapt to the needs of the technology developers as situations alter has been important. It will continue to be important and aids development.

25. Allocating enough money to make a project a success is paramount, notably at large scale. Poorly funded projects do not work eg FP6. Well-funded projects, with some degree of time pressure to get on with it, do work eg MRPF.

Is publicly provided innovation funding necessary for the development of marine technologies and if so, why?

26. Yes. At this stage it is necessary on several levels:

26.1 It reduces the cost burden on individual projects and allows the full benefits of the economic activity to be realised.

26.2 Removal of some items from the project makes the private money available able to go further and therefore cover the main project costs.

26.3 It provides a good signal to investors that this is something serious. The public support by Government increases investor confidence.

26.4 It provides a good signal to regulators/policy makers that this is something Government wishes to see developed & helps dictate their general approach to proposals. The public support by Government is a clear policy signal of itself.

27. Over time the momentum of the industry will develop and the need for most of these drivers will reduce, however by then the industry will be looking to achieve more and the focus for innovation will shift from proving THAT it works onto making it work WELL.

28. EMEC does not itself commission cost reduction work and rather than regurgitate the work of others on probable reductions in cost it will restrict itself to some lessons it has learnt from what it has seen happen on its sites.

29. *Resource sharing*—The creation of a marine renewables cluster has been achieved in Orkney, largely through the work of EMEC and its suppliers. As a result developers and their contractors have brought vessel assets to the area for use in their projects. On several occasions EMEC has seen these assets cross hired to other developers when they are under-utilised. As a result projects have progressed more easily/cheaper than would otherwise have been the case if each developer had had to provide all the assets. An extension of this is now that two private companies have each bought vessels. These are multimillion pound investments they would not have made had the activity not been taking place.

30. *Background Monitoring*—The regulatory authorities have no experience or precedence for the licensing of these devices. As a result, not only is there regulatory uncertainty, but the measurement systems for monitoring may not always exist. EMEC has worked with the regulators as something of a "half way house" between the private and public sectors and helped both parties understand the issues at stake. Through developing this understanding it has proved possible for the regulators to seek public funding to develop the methods and tools necessary to regulate the industry in ways that have worked for the developers too. EMEC has been able to be used as a test bed for the processes and has been able to obtain the confidence of the regulators and also the data they require. This in turn has led to developers finding it easier to obtain the consents to deploy at EMEC (so saving cost), they have been able to get in earlier (realising the benefits earlier).

31. In addition the regulators have been able to learn from the process and better, simpler, quicker regulatory processes are now being used. This saves the regulators, developer and associated consultant time and money.

32. *Learning by Doing*—EMEC has seen that the more practice developers get, the faster they become and the smaller assets they need to use. In addition they are able to innovate once the processes have been shown to work at all.

33. This latter point being particularly important: It is necessary to succeed to enable cost reduction to occur. Failing tends to lead to a cessation of progress and consequent loss of momentum. If there is an excessive focus on premature cost reduction and this leads to failure then the overall costs go up as work is repeated.

34. EMEC firmly believes that developers need to be sufficiently funded to undertake work the first time. This leads to there being a second time and that the second time it will be cheaper than the first. Cost is saved through the experience of *doing* and excessive focus on theoretical cost reductions can be obstructive to progress in both the short and long run. "Saving the ha'peth of tar".

35. *"This isn't rocket science"*—No in some respects it is harder. Rockets do not have to work for tens of years. Space is not a corrosive electrolyte as seawater is. Space contains less grit and as far as we know it is not likely to contain life that will foul and damage the installations. Marine energy devices will, however, need to obtain similar levels of reliability to spacecraft and whilst they will not entirely be "fire and forget", they will need to operate autonomously for extended periods. Such performance is not cheap.

36. In order to get to these levels of performance it is necessary to either perform extensive testing at full scale over prolonged periods, or else deploy in massive numbers. In either scenario the costs are not insubstantial running to many £10s of millions if not £100s.

37. However the benefits of a sustainable energy source over which the UK has sovereignty powering the homes and businesses of the UK are clear. This technology will be ready at times when the rest of the world are chasing increasingly rare carbon sources of energy. At this point they will also be looking to purchase robust reliable products from those with strong home markets. This will be the niche the UK will be able to exploit ruthlessly.

What non-financial barriers are there to the development of marine renewables?

38. The main barrier to deploying now is that we didn't start this 20 years ago. If we had done so then we would know more about how to make this all happen and be ready to deploy this now that the drivers have all come into alignment. We now need Marine Energy for energy security, carbon reduction, economic activity, employment reasons. Unfortunately we still have an amount of preparation work to do before we can deliver.

39. Notwithstanding this, the resource is enduring so there is no risk of it disappearing, but the competition is waking up and the UK runs the risk of failing to capitalise on its lead.

40. Improvements are being made to peripheral activities such as consenting, but as yet none of the technologies has been deployed long enough to be ready for the mass roll out required. Acquiring this time at sea and learning from it remains the single biggest requirement for successful deployment.

41. Other non-financial barriers include:

- 41.1 *Grid rules*—The present inability to fully socialise the costs of electrical connections, particularly for demonstration devices and arrays. The present rules governing grid connection cost allocations are not helpful to this nascent and potentially important energy source. They need to be re-aligned to provide positive encouragement.
- 41.2 *Political support*—could be a barrier if the unanimity for the technology is not maintained. At present this is not a barrier, but similarly it is one that should not be erected.
- 41.3 *Public Perception*—There is not much public awareness of the effort being deployed & opportunities presented set amongst a background of general engineering ignorance. As a consequence there is a risk that uninformed opposition to the projects may arise. It is critical that the proper context of this industry is set out and Government has a role to play in this. At present the industry is too small to effect sufficient influence on the general public.

To what extent is the supply chain for marine renewables based in the UK and how does Government policy affect the development of these industries?

42. The UK has delivered significant proportions of the activity around EMEC. However this has tended to relate to services and small-scale activities (consultancy, survey, observation, civil engineering). The heavy engineering end (cables, switchgear) have generally been provided from overseas.

43. Of the work done on site during installation of developers' devices then this generally centres around vessels and a similar picture emerges. Foreign vessels are increasingly being used when big equipment is needed. This is surprising given the UK's ability to operate in the North Sea and may be the result of a lack of incentive to get fully and strategically engaged.

44. It is always a surprise when travelling to Aberdeen to see the numbers of vessels in the harbour waiting, when in Orkney we have a dearth of such vessels. It will clearly be necessary to re-centre vessel operations around the new resource areas (ie moving from oil to renewables) and opportunities to produce incentives for vessels to move early could be examined.

45. Skills: It is of particular concern that the UK is chronically short of skilled engineering personnel and consequently it is hard to see how the UK will fully benefit from the work about to be created. Well trained electrical, mechanical and marine technical staff do not grow on trees and the UK is not seeing the ramp up of effort needed to be ready in time. Whilst there are numerous Higher Education courses around the UK, there do not seem to be many in Further Education. We will have Graduates, Masters and Doctors, but we will not have the skilled 'artisan' workforce they need to lead to actually do the job. Excellent examples such as the initiative by North Highland College in Thurso to re-establish apprenticeships based around the decline in decommissioning work at Dounreay are commendable, but are not yet main-stream. When these practical skills are seen as an imperative for UK plc they will not have to struggle for support in the way they are at present. This needs to change.

What approach should Government take to supporting marine renewables in the future?

46. It is essential that industry is sufficiently confident that it is important enough to the nation that Government is going to support it sufficiently. As detailed above this support comprises several forms:

46.1 *Clear and unwavering policy* drivers to form the push from Government irrespective of who is in power.

46.2 *A sufficiently attractive price plan* to encourage involvement of the sector to move from initial experimental machines onwards through small arrays and onto mass deployment. This will comprise different levels of encouragement at different points.

46.3 *Continued and active engagement* with/by industry to understand the respective pressures along with a passion to keep this moving.

46.4 *Patience*. This will take a while to ramp up and it is beginning to do so. However it will take longer than people want, but it is strategically important for the UK in the longer term. This cannot afford to be rushed, but similarly it cannot afford to dawdle. Being in a state of "demanding patience" will provide the optimal mix of push and understanding.

46.5 *Publicity of progress.* It is critical that all relevant parts of Government understand the project and that they are tasked with finding ways to assist. See below for an example:

Joining up policy: VAT cash flow:

EMEC was awarded £8 million in grant funding to build further cables and infrastructure for the benefit of UK plc. The grant was exclusive of VAT. The materials and services EMEC procured attracted VAT and as a result it was necessary for EMEC to be ready to stand the cash-flow pressures of being out of pocket by the amount of the VAT for several weeks. Fortunately on this occasion it was able to phase the expenditure and dip into its cash account to cover these pinch points until the tax was refunded. In no small part was this made possible by HMCR who were unfailingly helpful as were the DECC officials monitoring the contract. They all helped EMEC survive this cash flow problem.

However, the problem was that EMEC as a small company had to fund the government for the period until the VAT claim was paid. This seems an unnecessarily perilous financial arrangement for us and other small companies to bear and one that government could easily resolve if it chose to. To ask EMEC in Orkney to resolve differences of approach between DECC and Treasury seems inappropriate. This is probably risk/pain experienced by others too and merits resolution.

September 2011

Memorandum submitted by Atlantis Recourses Corporation

Executive Summary

The benefits for the UK from developing a marine renewables industry are multifaceted. The natural resource within the UK could produce 20% of UK electricity consumption, save £1 billion per annum through balancing of grid benefits, create thousands of jobs and significantly contribute to the UK's revenue generation.

Atlantis Resources Corporation is a tidal technology developer. The deployment of the AR1000, a 1MW 18m rotor diameter tidal turbine, was originally planned for Australian waters. However, the excellent testing infrastructure and attractive well placed capital grants made the UK the natural place to relocate deployment of the AR1000. As a result of the excellent supply chain capabilities and companies within the UK, 77% of the value of the AR1000 was secured by UK companies.

The capital support mechanisms have provided a huge level of support for the sector over the past 18 to 24 months. However, it is essential that lessons are learnt from the development of the Danish wind energy industry, which was based upon long-term stable support.

The industry is at a crucial stage of development and marine energy is a global opportunity. As such Atlantis is actively reviewing the most favourable development opportunities. In particular countries in North America and Asia are attracting our attention.

Atlantis concurs with the industry consensus view developed via the Marine Energy Programme Board; a Renewables Obligation banding of five ROCs for wave and tidal energy across the whole of the UK, combined with capital support, is required to secure this global opportunity. The UK Government should also seek to maximise the support of the European Commission for the sector, notably by ensuring inclusion of marine renewables within the Strategic Energy Technology Plan.

1. *What are the potential benefits that marine renewables could bring to the UK and should Government be supporting the development of these particular technologies?*

1.1 The benefits for the UK from developing a marine renewables industry are multifaceted. Not only could the UK's wave and tidal energy resource potentially produce 20% of the UK's electricity demand, it could also prove to be a corner stone of the UK's low carbon green growth agenda.

1.2 Being able to produce 20% of the country's electricity requirements from marine energy would insulate the future cost of energy within the UK, protecting from inevitable long term increase in the price of fossil fuels, securing future energy supply and negate the need for the UK to become a net importer of energy. Further to this it is reported that encouraging the correct mix of marine energy with the UK electricity system could reduce the overall cost of electricity by close to £1 billion per annum.[18]

1.3 The Danish wind industry was accredited with contributing some €6 billion to the Danish economy in 2009 and employing thousands of individuals. A number of recent reports outline that the that current global lead that the UK has in marine energy could result in revenue generation of in the region of £4.5 billion per annum and employ 10,000 individuals directly in 2020 and over 20,000 individuals when the industry reaches maturity.[19]

1.4 Notably as many sections of wave and tidal energy devices are high value and light weight, therefore easy and cheap to transport, the UK could secure a lucrative export market. Not only for the rest of Europe but also to countries such as the USA, Canada, Korea, Japan, Australia, Chile and Brazil. All of which are actively seeking the development of marine energy in their bid to reduce carbon emissions.

1.5 It is clearly a justified position to question how much of this domestic and export market the UK could realistically capture. However, with established high value supply chains developed around both the maritime and Oil and Gas sector, along with the rapidly developing offshore wind industry, it is evident that UK companies possess the skills and expertise required to make the UK the future global hub of marine renewable energy development.

1.6 Atlantis Resources Corporation originally planned to deploy the world largest tidal turbine, the 1MW AR1000 with an 18m rotor diameter, within Australian waters. However, due to the favourable support mechanisms within the UK and the proactive approach having been adopted by the UK Government to date, Atlantis changed their deployment plans to base their operations within the UK.

1.7 The deployment of the AR1000 generated many millions of pounds investment into the UK. Internal analysis identifies that in the region of 77% of the expenditure for the fabrication and deployment of the AR1000 was within the UK. The recent RenewableUK report "Channelling the Energy" outlines an average cost to deploy a full scale prototype tidal turbine to be in excess of £20 million. Based on this figure the deployment of the AR1000 would have contributed £16 million investment into UK plc.

1.8 However, the deployment of signal devices will not provide adequate pay back for the investment and effort which have been allocated to the industry to date. Industrialisation with production of hundreds of devices will be required to realise the socioeconomic benefits outlined above. As a comparison between the development of the Danish and UK onshore wind industries has outlined, this can only be achieved through stable long term political support.[20]

1.9 For the UK to realise a globally significant industry it is vital that the UK Government continues to support the industry and encourage companies with a global remit, such as Atlantis, to select the UK as their preferred place of business.

[18] RenewableUK, The Benefits of Marine Renewables on the Future Energy Mix, 2009.
[19] RenewableUK, Channelling the Energy, 2010.
[20] IBID

2. *How effective have existing Government policies and initiatives on marine renewables been in supporting the development and deployment of these technologies?*

2.1 One only has to look at how advanced the UK's plans for development and deployment, combined with the fact that the capacity of marine energy currently undergoing real sea testing (3.4MW) is greater than the rest of Europe combined, to see how effective the UK Governments actions in supporting the sector have been to date.[21]

2.2 Atlantis believes that the UK has without doubt the most advanced suite of testing infrastructure anywhere in the world. The existence of the European Marine Energy Centre was a significant factor in the decision to relocate the deployment of the AR1000 from Australia to the North of Scotland.

2.3 A number of capital grant schemes to support the development and deployment of prototype devices has also been a critical stepping stone to move the marine renewables industry in the UK to where it is today.

2.4 Atlantis successfully secured funding from the Technology Strategy Board and the Carbon Trust's Marine Renewables Proving Fund to support the deployment of the AR1000 at EMEC. Both of these funds were well targeted at the types of projects Atlantis and the wider industry were seeking to develop. The same can also be said to be true of funding which has been allocated by Scottish Enterprise and the Energy Technologies Institute.

2.5 The well-defined scope and objectives of the above funds which aimed to facilitate the development, design and deployment for prototype marine energy devices was expertly positioned, as attracting the sums of private finance required to complete open sea testing is well recognised as being a major hurdle for the industry.

2.6 The administration of these funds was also well executed, ensuring in most cases that the funding allocated was utilised efficiently. Notably if the scope of the project changed due to external circumstances the funding organisations had an open mind to the revision of the scope of work. Another very important aspect of the funding is that it was allocated on a use-it-or-lose-it basis. Ensuring that Government funds were not tied up with organisations which were not using it to leverage private investment and further the industry.

2.7 Atlantis believes it is a fair appraisal that had the Government not provided the capital support it did during the past 24 months, a time in which private investment has been particularly difficult to source within the UK, many wave and tidal energy companies would have relocated operations.

2.8 The Marine Renewables Deployment Fund (MRDF) was well positioned for the stage at which the industry is currently at and would have been instrumental in facilitating the deployment of the first multi device marine energy arrays. The replacement, £20 million from the DECC's low carbon innovation fund, represents less than half the total amount of the MRDF. This could be seen as a reduction in Government ambition for the sector which could impact the percentage of the domestic and export market which could be secured by UK plc.

2.9 A key supplement to this capital support outlined above has been the higher ROC banding for marine energy within Scotland, which has delivered a project pipeline of 1.6GW. In comparison the lower ROC banding in the rest of the UK has delivered no project pipeline. This long term revenue incentive is essential in attracting finance into the sector, right from the early stages, as it allows investors to view a return on their investment.

3. *What lessons can be learnt from experiences within the UK and from other countries to date in supporting the development and deployment of marine renewables?*

3.1 When looking for lessons to be learnt for supporting the development and deployment of marine energy it is clear that Governments which articulate a consistent message and hold a long term view for development of emerging renewable energy technologies via the policy they implement is hugely influential.

3.2 The following is an extract form the RenewableUK report "Channelling the Energy"—Even though both Governments (Danish and UK) invested similar sums of money into R&D activities (Danish—£122 million, UK—£141 million), the Danish Government awarded grants from 1976 to 1981, five years earlier than those which occurred in the UK, providing the Danes with an essential early mover advantage. This was swiftly followed by the establishment of premium revenue incentives and a holistic policy package.

3.3 As outlined in paragraphs 2.3–2.7 of this response. The UK has awarded a number of capital grants which have been essential at moving the sector to the stage it is at now. However, if the lessons which can be learnt from the development of the Danish wind industry cannot be incorporated in to current UK policy for marine energy a global business opportunity could be lost.

3.4 Due to the higher cost of the initial marine energy farms, it will be essential for the whole of the UK to establish a five ROC banding for wave and tidal energy, as Scotland has already provided for wave energy.

3.5 With regard to the allocation of capital grants within the UK a key lesson which can be learnt is that initial development of marine energy technology is costly in comparison to developing onshore renewable

[21] RenewableUK, Wave and Tidal Energy in the UK—State of the Industry, 2011.

energy technologies. This is due to the fact that marine renewables operate offshore in extremely harsh environments, which are difficult to realistically simulate onshore due to scaling.

3.6 The funding bodies have taken a positive approach of utilising extensive screening methodologies, but allocating sufficient funding to successful candidates, facilitating the attraction of private finance and completion of projects. The allocation of some FP6 projects is often cited as a case example where allocation of insufficient funding resulted in companies sitting on grant funding and not utilising it. This is unhelpful and can be avoided by clearly understanding the size of the funding gap which cannot be filled by private finance and ideally allocating sufficient funding to move the sector to a point where it is supported by private finance alone.

4. *Is publicly provided innovation funding necessary for the development of marine technologies and if so, why?*

4.1 As outlined in paragraph 3.5 the testing of marine renewable energy devices cannot be achieved via onshore testing. Simply moving offshore is costly for individual activities and for the most part deployment of these devices is planned for the world's harshest marine environments. The trade body RenewableUK has outlined an initial cost of deploying a full scale prototype to be in excess of £20 million.

4.2 The combination of the payback period for any private investment (in excess of five years) and the significant level of risk associated with any such investment results in the majority of private investors (VC, Bank, Angle investor) writing the sector of as an attractive opportunity. As such the majority of private finance secured by wave and tidal technology developers to date has come either from utilities or original equipment manufacturers (OEMs), both of which take a long term view on investment, but generally seek investment opportunities with a lower risk profile than wave and tidal energy. The provision of government capital support is the optimum approach to de-risk early marine energy technology and stimulate further investment from utilities and OEMs.

4.3 As outlined in both the carbon trust report "accelerating marine energy" and the RenewableUK report "channelling the energy" continued Government support will continue to leverage investment into the sector. A coherent long term view is critical to this with provision of revenue support at five ROCs and 25% capital support for the initial 8–10MW arrays.

4.4 Atlantis plans to undertake an advanced R&D programme to significantly drive down the cost of marine energy. Atlantis believes the continued provision of capital support to UK suppliers across the marine energy value chain will lead to the development of a world leading export market.

5. *What non-financial barriers are there to the development of marine renewables?*

5.1 Atlantis views the following non-financial issues a key to the development of the UK marine renewables sector:

5.1.1 Consenting—Currently the costing authorities request arduous environmental monitoring programmes for early stage demonstration devices which could be eased.

5.1.2 Grid Availability—Whilst some grid connections have been secured by the sector for their projects. The 1.6GW of project planned in the Pentland Firth and Orkney waters require urgent grid upgrades in order to connect.

5.1.3 Grid Charging—Currently the charges being applied by the grid operators within the North of Scotland is considerably higher than the rest of the UK. Applying an additional financial burden to projects within these locations.

6. *To what extent is the supply chain for marine renewables based in the UK and how does Government policy affect the development of these industries?*

6.1 As mentioned in paragraph 1.7, 77% of the spend for fabrication and deployment of the AR1000 was allocated to UK based companies. This is because these companies are well suited to provide the services and supplies required by the marine energy industry.

6.2 As an indication of where these costs lie the most expensive section of the development, deployment and installation of the AR1000 were the cost associated with vessels, the turbine structure, the blades and the foundations; all of which were sourced within the UK and accounted for over 70% of expenditure.

6.3 The clear leadership which the UK Government has shown in previous years, notably be providing a target deployment of 1.3GW of marine energy by 2020 in the 2009 Renewable Energy Strategy, provides faith to technology developers (tier 1 suppliers) that the UK will create the correct market conditions, via policy development, to facilitate marine energy commercialization. This in turn also provides comfort to tier 2 and tier 3 suppliers of subsystems and components that a market will emerge. Hence it is worthwhile for them to invest in early projects and establish, as the UK has already achieved within the sector as a whole, a strong early mover advantage.

6.4 The recent revision of the 2020 target in the 2011 renewable energy roadmap to a 300MW scenario is obviously disappointing as it outlines a significant reduction in ambition for the sector. However, there has been insufficient time to assess how much impact this will have upon the market. What is clear is that industry reacts to Government ambitions and with this nascent developing industry, strong leadership is required.

6.5 Leadership can most notably be provided by providing adequate revenue incentives to leverage private capital into early stages of development which are high risk, stating specific future targets for deployment of marine energy deployment and facilitating a manageable consenting system.

7. *What approach should Government take to supporting marine renewables in the future?*

7.1 The current engagement process with the sector via the Marine Energy Programme Board provides direct visualisation of policy development and allows the sector to provide a concise and direct message to the UK Government. This has been welcome by the industry and Atlantis has played an active role in developing industry agreed positions to aid policy makers enact a strategy that will de-risk the UK Governments approach to supporting the marine renewables sector.

7.2 As the industry seeks to take the next step towards commercialisation, deployment of 5–10MW arrays, it is of paramount importance that the Governments learns from the lessons of the development of the wind industry and creates a demand pull through establishment of significant revenue support mechanism.

7.3 The costs of the first commercial scale tidal array are estimated to be in the region of £50–80 million for a 5–10MW.[22] A capital grant of at least 20–25% combined with five ROC's for each MWh of generation are conditions precedent to attracting the balance of private sector investment. As such the capital support announced by the Government is welcomed and will stimulate a maximum of 2–3 projects. Industry has clearly articulated that 3–4 technologies for wave and tidal energy, totalling 6–8, will be required to secure a significant proportion of the market share. As such a combined approach from DECC, BIS and HMT should be considered encouraged to continue to support the sector.

7.4 Atlantis supports the industries unified position that in order to provide a suitable risk reward ratio, a banding of five ROCs for marine energy should be established across the entire of the UK for the next Renewables Obligation banding review period 1 April 2013 to the 31 of Mach 2017.

7.5 This increased revenue incentive will stimulate investment, increase deployment and drive cost reduction. Further to this Atlantis believes that cooperation between the industry and the UK Government should be encouraged to clearly understand the path to cost reduction and decreasing revenue incentive in line with reduced costs.

8. *Are there any other issues relating to the future of marine renewables in the UK that you think the Committee should be aware of?*

8.1 The marine energy industry has the potential to become a corner stone of the UK's low carbon green growth agenda.

8.2 With developments within the European Commission of the New Entrants Reserve 300, Framework Programme 7 and future funding mechanisms, the UK Government should actively support the sector and encourage its development at a European level. Notably through support for marine energy through the SET plan.

8.3 However, marine energy is a global opportunity as such the leading developers are exploring all opportunities. Notably within Asia and Northern America which are developing coherent support frameworks to attract the experience and knowhow which has been developed within the UK and at the expense of the UK Government.

8.4 The time scale for the next stage of industry development is two-three years and the UK Government has a central role. Provision of strong leadership can be achieved by clear a commitment to establish a global lead in the marine renewables industry.

8.5 The UK can capitalise upon its natural domestic resource, existing supply chain capabilities, world leading testing infrastructure and investment made to date if the UK Government enacts policy to deliver a coherent suite of revenue support and capital support mechanisms.

September 2011

[22] RenewableUK, Channeling the Energy, 2010.

Memorandum submitted by AMEC

AMEC's people design, deliver and maintain strategic assets for our customers, offering services which extend from environmental and front end engineering design services before the start of a project, to decommissioning at the end of an asset's life. We operate in some 40 countries, working for customers ranging from blue chip companies to national and local governments and supporting assets such as oil and gas production facilities and nuclear power stations. Our engineers, project managers and consultants use their skills and expertise to deliver successful projects for our customers, so building long-term relationships with them.

Response to Consultation

1. *What are the potential benefits that marine renewables could bring to the UK and should Government be supporting the development of these particular technologies?*

1.1 We agree with the Carbon Trust that the UK marine energy resource is of the order of 50 TWh/y of wave energy and 21 TWh/y of tidal stream (Carbon Trust 2011). This equates to ~18% of current UK electricity demand.

1.2 The technology is applicable in many different electricity markets around the world and so has excellent export potential. There are emerging tidal markets in Canada, USA, Korea and New Zealand for example. There is interest in wave energy in North and South America, Australia and New Zealand. There are many other countries that have marine energy resources and energy demands that would benefit from this new technology.

1.3 All marine energy projects require many complementary services, such as offshore surveying and contracting and environmental management. These are specialist skills that will be developed in the UK as the technology develops here and will be exported. Global organisations like AMEC will bring in skills from around the world when the market conditions are right.

1.4 AMEC has already taken lead innovative roles in offshore wind energy with our construction of the Blyth offshore wind farm, the first in the UK, and our development of the deepwater foundation design used on the Beatrice offshore wind demonstration project. AMEC wishes to bring its skills and knowledge in environmental impact assessment, electrical integration and structural engineering to the marine energy market. However we would like to see continues commitment and support from the government to secure the long-term marine energy market.

2. *How effective have existing Government policies and initiatives on marine renewables been in supporting the development and deployment of these technologies?*

2.1 The revenue support in Scotland, combined with its high levels of marine energy resource, has clearly attracted interest from around the world with companies such as Voith, Ocean Power Technologies, Hammerfest Strøm and Open Hydro setting up there. Portugal also attracted interest when they announced a support mechanism. This demonstrates the effectiveness of a realistic and long-term market signal.

2.2 The European Marine Energy Centre in Orkney is a very valuable asset and has attracted many parties to the UK. The UK has benefitted greatly from this European project.

2.3 The early engagement of the Crown Estate in this sector, and its setting of an ambitious goal has stimulated interest. The Crown Estate's leasing round in the Pentland Firth was made possible by the completion of a Strategic Environmental Assessment by the Scottish Government. This demonstrates to us the importance of a clear strategic direction and early facilitation.

2.4 The Marine Renewables Deployment Fund was an appropriate support mechanism. Its entry requirements, including three months of real-sea testing, were appropriate. However, there was insufficient funding from any sector to pay for the testing required to qualify.

2.5 The Marine Renewables Proving Fund was helpful. It provided strong stimulation because it was short term, competitive and focussed. We are concerned that whatever advancements are made, these may be lost if the new technologies cannot continue to be developed.

2.6 The UK support policies for marine energy have historically been inconsistent and fragmented over a very long period. Funding has been sporadic and has been directed through a number of different bodies. There have been significant differences between the countries in the United Kingdom too, such as the availability of 3–5 ROCs[23] in Scotland and two ROCs in England and Wales.

2.7 We recognise that there will always be calls for more funding for new technology. However, unless the quantum of support is sufficient the investment will be ineffective. We wish to ensure that once the available funding is allocated it is still at a meaningful level to enable projects. This requires that finite resources are not spread too thinly over otherwise eligible projects.

2.8 We welcome the allocation of £20m from the DECC low-carbon technologies budget to marine energy. We recognise that this is from a limited source. We also recognise that it represents match funding for maybe

[23] 3 ROC/MWh for tidal and 5 ROC/MWh for wave energy.

less than 10MW of projects. We wish to ensure that it is invested wisely and for maximum impact. We do not wish to see the money diluted by investing too widely.

3. *What lessons can be learnt from experiences within the UK and from other countries to date in supporting the development and deployment of marine renewables?*

3.1 We believe that marine energy technologies are currently expensive, but that their costs will come down as more are built and the technology efficiency improves. We also believe that if there are temporal breaks in the technology development then the industry learning will be reversed and costs will rise again. This will be because of a loss of key staff and knowledge and through business failure.

3.2 Lessons can be learnt from the UK wind industry. We agree with many other commentators that the lack of a home market for wind energy in its early years hindered the development of the technology in the UK. By the time that a home market emerged (at the time of the NFFO[24]), there was stiff competition from abroad, notably Denmark. UK companies competing at this time were faced with having to export their technologies to other countries. This required stretching their resources to many new regions as they solve the technology challenges with their new products. Then, once the market mechanism was in place there was a disjoint between the market pull and the consenting process. The consenting process did not support the need for wide deployment of renewable energy many schemes were delayed at great expense.

3.3 Marine energy should face a different future. A clear market signal should be provided that secures investment in the UK and the development and deployment of technologies here. The consenting regime is already receptive to the new technologies, and the main consenting bodies are already coordinating their activities to provide a consistent planning process for new farms. We believe that the UK is already the home to the greatest levels of activity in this emerging sector and that it can achieve what Denmark did in wind energy.

4. *Is publicly provided innovation funding necessary for the development of marine technologies and if so, why?*

4.1 In addition to the technology uncertainties there are many other risks. These include uncertainties in the long-term revenue system, the availability of infrastructure (such as electricity grid) and in consenting.

4.2 The private sector is used to taking technology risks, but we do so only where we can see a viable market. Whilst the electricity market is already established it is locked into existing technologies, such as gas and coal. The current market price does not reflect the value of low carbon energy. This means that an additional market signal is required to attract the investment needed. That signal will comprise a market support mechanism. This will enable us to concentrate on addressing the risks we are best able to control.

4.3 The nature and longevity of the support mechanism, the efficiency of the consenting process and the availability of infrastructure are in the control of government—or their appointed regulators. They therefore present a political risk to investors in novel low-carbon technology. We believe therefore that it is reasonable for some investment from public sources is required to balance this risk.

4.4 We believe also that public money is valued for other reasons too. If administered by respected and knowledgeable bodies it can signal the credibility of an idea, and so attract and lever private money. Our experience of working with the Carbon Trust and Energy Technologies Institute has shown how valuable this can be. Positive support from the Carbon Trust has helped secure wider investment from private sources.

5. *What non-financial barriers are there to the development of marine renewables?*

5.1 Whatever finances are available to develop the industry, these will be ineffective if there are pauses or breaks in the development the knowledge acquired will be dispersed. These can result in the loss of skilled staff, knowledge, links with the supply chain or even entire companies and their intellectual property. Thus, we believe that whatever resources there are available they are allocated with a view to maintaining steady investment and an increasingly long-term market for the technology.

5.2 Many technology developers are also taking a role as project or site developers. This is because their new technology is often strongly dependent on the deployment location, and also because they are best able to understand the behaviour of their devices in these new places. This means that they are unable to concentrate solely on their core capabilities in product development. The industry will benefit greatly when the technology providers can be separated from the project developers, and that will happen once the technologies are proven. In the meantime the essential consenting processes, which we fully support, will distract from the development of the core technology. Since the consenting processes are essential, we would like to see support provided to help ease the consenting burden on technology developers. This would require facilitating frank and open dialog between regulators and industry.

5.3 The wind industry in the UK has always been affected by inconsistencies in the planning and consenting process. This has hindered growth and now is making the UK less attractive to investors. (Ernst and Young 2011). Marine energy farms would benefit greatly from strategic and coordinated consenting process that is

[24] Non Fossil Fuel Obligation.

balanced and consistent. We recognise and value the role the Crown Estate has played in this so far. We hope that the MMO and Marine Scotland will also help achieve this level of consistency.

Lessons from Lewis wind farm:

5.4 AMEC is developing the 150 MW Stornoway Wind Farm on Lewis in a joint venture with EdF. This wind farm has access to one of the highest levels of wind resource in the UK. It might produce 480 GWh/y of energy, enough to meet the needs of 100,000 homes, more than ten times the population of the island. The Atlantic waters west of Lewis contain at least 2000 GWh/y more energy. The grid connection between these vast resources and the centres of industry is essential for the near-term wind farm development and longer-term marine energy development.

5.5 There are significant numbers of consented wind turbines on Lewis that are reliant on the provision of a new link to the mainland. None of these has sufficient resources to underwrite the development of the £393m link required. However, with the coordinated development of larger projects, such as the Stornoway Wind Farm, the resources to underwrite the link are more likely to be found.

5.6 In the case of Lewis a new link will also enable access to the massive marine energy resources in the area, which are some of the best in the World. It will also make Lewis more attractive as a centre of manufacture—the Arnish shipyard has already produced tube sections for Pelamis, the support structure for Hammerfest Strøm and the entire Oyster 800 device.

5.7 We believe that similar circumstances will arise in other places. It is only by coordinating the activities of many developers and infrastructure operators within a region that we can bring the required infrastructure needed for all to benefit.

6. *To what extent is the supply chain for marine renewables based in the UK and how does Government policy affect the development of these industries?*

6.1 In our view the supply chain will not develop until it is clear that there is a long-term market for the industry. A clear vision of the market support mechanism is required for this.

6.2 AMEC has many skills in the oil and gas sector and wind farming on which to draw. We are experienced in electrical grid connections, offshore structures—including the novel deepwater foundations for Beatrice offshore wind farm—as well as weather forecasting and offshore access systems.

6.3 As part of the emerging supply chain, we watch the industry with interest, and we play a strong role in the industry with our work for the various funding agencies and our vice-chairmanship of the RenewableUK marine energy steering group. Nevertheless we are unlikely to invest significantly until we can see a viable long-term market for our services.

7. *What approach should Government take to supporting marine renewables in the future?*

7.1 The government should demonstrate that there is a long-term market signal for marine energy projects. This would deliver a clear and secure revenue stream for efficient and competitive marine energy technology projects. We believe that ultimately this should be a competitive system that encourages the best technologies to improve and reduce costs. It should be success-based and reward the generation of low carbon electricity.

7.2 However, we believe that until projects are of commercial scale and can benefit from positioning in higher levels of resource, with economies of scale in production, farm size, consenting and management, they will need continued investment at realistic levels.

7.3 We believe that there is a need to provide a clear long-term market signal for the technology, through a revenue support mechanism and also provide a capital support mechanism until projects are able to make use of the market support. There should be a transition from capital support to revenue support as the technologies prove themselves.

7.4 The government should stimulate all relevant research activities, and not only those that are core to the development of the technology itself. This includes environmental research into the effects of marine energy devices, collation of health and safety information, and investment or underwriting of grid infrastructure projects.

8. *Are there any other issues relating to the future of marine renewables in the UK that you think the Committee should be aware of?*

8.1 We commend the Renewable Energy Roadmap (DECC 2011i) and the recent energy white paper (DECC 2011ii) as excellent sources of background information. AMEC supports the submission by RenewableUK and Scottish Renewables Forum.

September 2011

Carbon Trust 2011, Accelerating Marine Energy, The potential for cost reduction—insights from the Carbon Trust Marine Energy Accelerator 1
DECC 2011i, UK Renewable Energy Roadmap 5
DECC 2011ii, Planning our electric future: a White Paper for secure, affordable and low-carbon electricity 5
Ernst and Young 2011, Renewable energy country attractiveness indices, Issue 29 4

Memorandum submitted by Pulse Tidal Ltd.

Pulse Tidal has developed a cost-effective technology for generating clean, renewable electricity from the ocean tides. The Sheffield-based company has been in operation since 2007, and the team of 5 has over 2 years operating experience with a grid-connected generator in the Humber estuary. Building on this success, Pulse received €8 million from the EU in 2009—the largest contribution ever to an ocean energy project—and is currently developing a commercial scale generator.

Pulse is currently an independent SME, which does not yet have the backing of large established engineering firms. As such, I believe we can offer a rounded perspective to the inquiry, spanning early stage development, through offshore operation and working with the EU funding system. We are currently coming to the close of a 2-year fund-raising program, during which we have gained extensive experience of financing environment, and we are members of the Government's Marine Energy Programme Board.

Executive Summary:

The United Kingdom has a global lead in the marine renewables market, drawing on an extensive skills base, developed supply chain and some of the best wave and tidal resources in the world. However, domination of this potentially global industry is fragile, and decisive action is needed to cement the UK's position and maintain its lead over other nations developing interests in the sector.

Pulse Tidal Ltd. is an example of one of the leading tidal power developers. The Sheffield-based company was formed in 2007, and the team of 5 has over 2 years operating experience with a larger-scale, grid-connected generator in the Humber estuary. Building on this success, Pulse received €8 million from the EU in 2009—the largest contribution ever to an ocean energy project—and is currently working with 7 major international companies to develop a commercial scale generator.

The key constraint on development for Pulse, and for its peers, is investment funding. Investors are nervous about the expense required to develop a commercial marine power solution, and unsure of whether there will be a market for that solution when it emerges. This situation is limiting the pace of technology development and risks destroying the UK marine industry. If the opportunity for secure green power, jobs and economic activity is to be captured, Government must intervene now, both to increase confidence in the market, and to provide direct capital support.

DECC are working very effectively with industry through RenewableUK and the Marine Energy Programme Board. At Pulse, we believe that the DECC marine team understand the needs of the industry. However, we have not yet seen the most important outcome of this year's work—the ROC banding review. This review must provide 5 ROCS for wave and tidal developments across the UK, so that there is an effective market for marine power technology. Alongside this, capital support must be available, at the level of 25%, to small-scale commercial projects. There must be sufficient support to enable 3–4 technologies in each of wave and tidal to deploy in small arrays, thereby generating a vibrant, competitive industry. This is estimated to require £120 million of capital support over the CSR period.

1. *What are the potential benefits that marine renewables could bring to the UK and should Government be supporting the development of these particular technologies?*

1.1 The existing offshore wind and oil and gas industries have developed a supply chain that could be enhanced by the marine renewables industry. The UK is home to majority of the sector leaders, and there is significant potential export value from technology sales and electricity revenue.

1.2 Marine energy would contribute to increasing security of supply as a significant component of a balanced energy portfolio, mitigating issues such as intermittency. Marine energy has highly forecastable resource characteristics which complement those of other renewables such as wind, and therefore will allow maximum total penetration of renewables on our electricity system.

1.3 As an example of the economic benefits from marine technology, Pulse Tidal is today employing 5 people directly, along with around 15 part-time consultants in the UK and around 10 overseas. The Company will add more permanent employees to the team as funding allows. Construction and installation of our technology demonstration in the Humber brought over £1 million of work to the Yorkshire area, involving companies such as Corus, Humber Work Boats, Briggs Marine and CIC Omec. With a base in Sheffield, we are now developing our river power device using local firms.

1.4 Pulse is planning to deploy a 1.2MW tidal power machine in Kyle Rhea in Scotland, commissioning in 2013. This machine will cost around £20 million to build and install, much of which will flow to UK companies. The local community in the area has been deeply involved in the development of the deployment plans and will benefit from the project.

1.5 With the right political and economic environment, Pulse aims to deploy tidal power arrays in the UK that will produce over 250MW of clean, green and entirely predictable power by the turn of the decade. The construction and installation of these arrays will see around £500 million flow to UK companies.

2. *How effective have existing Government policies and initiatives on marine renewables been in supporting the development and deployment of these technologies?*

2.1 Pulse Tidal began as a tiny enterprise in 2007, built from the work of one entrepreneur. Government support, through Yorkshire Forward, and the Viking Fund, were crucial in allowing the company to grow beyond the initial idea, enabling Pulse to attract IT Power as an engineering partner. IT Power assisted Pulse in gaining access to a £0.9 million grant, from the then DTI. This enabled Pulse to construct a large-scale (100kW) grid-connected prototype, which has been operating in the Humber estuary since 2009. Pulse has received £1.3 million of grant support in total and this has attracted £2 million of private funding. This finance has enabled Pulse to develop a brand new technology and bring it to the attention of customers, Government and the wider industry.

2.2 Pulse is now engaged in the challenging process of scaling up to a commercially attractive size for utility-scale power generation. The company was awarded an €8 million grant from the EU FP7 programme, and this will leverage in over £12 million of private finance.

2.3 Without Government support, Pulse could not have reached its present stage of development. This is because tidal power technology is expensive and time consuming to develop relative to other new technologies. Private investors are not willing to take the entire capital risk in companies such as Pulse Tidal, and grants serve as a way to reduce that risk to a more manageable level.

2.4 As a developer of tidal power technology, the single largest risk that Pulse Tidal faces is that it will run out of money before it can generate revenues from its products. Private Funders provide the investment to keep the company going, and they have many choices about how to invest their money. A key part of their decision-making is to ensure that there is ultimately going to be a market for the technology they are backing, and this can be an issue with renewable power, as discussed below.

2.5 Whilst there is clearly a demand for clean, green, predictable power, the energy markets do not effectively price these benefits—with the result that renewable power appears more expensive than “traditional” sources of generation. This market failure means that Governments must intervene in the market if they want renewable power to be deployed at scale. In the UK, this intervention has been through the ROC, and, in future, the EMR.

2.6 Because Government intervention is required in order to create the market, investors pay a great deal of attention to the signals sent by Government regarding its support for tidal power. Recent Government finance provided through WATERS, WATES, MRPF and, indirectly, through the ETI, offer powerful signals, which have enabled a number of companies to make significant progress thus far. However, the most important signal, the ROC support level, and now the EMR support level, has been weak. Confused and non-committal messages around ROC support and the EMR are today a significant barrier to further development for Pulse Tidal, and for the sector as a whole.

2.7 In Scotland, the completion of the Strategic Environmental Assessment, and the subsequent leasing round in the Pentland Firth has been extremely helpful in creating market pull for tidal technology. The centralised control of seabed by the Crown Estate, along with centralisation of permitting under Marine Scotland, is also a good model, though still somewhat bureaucratic. In contrast, the delays to the SEA in England and Wales are preventing progress there.

3. *What lessons can be learnt from experiences within the UK and from other countries to date in supporting the development and deployment of marine renewables?*

3.1 We have some experience of the major growth in Solar PV following the introduction of feed-in-tariffs and grant support in Germany. Up until that point, Solar PV was an expensive and unreliable technology, limited to just a few companies and deployed at scale only in Japan (where feed in tariffs were already in place). When Germany introduced the incentive mechanism, it created a step-change in the demand for Solar, which stimulated a massive evolution in the supply-chain, lowering prices and encouraging other countries to follow suit. The virtuous circle of “high support level—increasing deployment volume—lowering prices—lower support level” seen in the Solar PV business is an excellent model for the development of the marine sector. The one area where it has failed for Germany is in keeping large numbers of manufacturing jobs in the country.

3.2 As Solar PV revenue incentives are introduced into new countries, a huge network of installers and re-sellers springs up to support the fragmented demand created by domestic customers. This creates some economic activity at one end of the value chain. However, the largest manufacturers of Solar equipment are now in China. This is because the product is a relatively simple piece of equipment that is easily shipped around the world. China is not only about manufacturing efficiency, and we are now starting to see significant technology development from Chinese solar players—showing that once the manufacturing moves overseas, there is a risk that all the industry value will follow.

3.3 A key lesson for the UK is in how to develop the marine industry whilst avoiding the future loss of manufacturing, and ultimately the loss of technical leadership.

3.4 The Solar industry was created by revenue support schemes—whether in Japan, Germany, Italy or elsewhere, all of the volume deployment has been in areas where revenue support is clear and uncomplicated. The UK has seen a similar increase in Solar activity on introduction of its own FIT. Adequate revenue support is critical if marine power is to be deployed at scale in the UK.

3.5 However, revenue support must be accompanied by other mechanisms if a large portion of the marine power supply chain is to be captured for the UK. Testing facilities, University engagement, dock and manufacturing facilities must all be developed in parallel with the market in order to maintain the UK as the place to be in marine power. But most of all, the market must be conducive to deployment. Seabed leasing, consenting, grid connection and other potential barriers must be addressed so that the UK continues to be the premier marine power deployment site in the world. Unlike solar modules, tidal power machines are not easy to transport in volume. Volume deployment in the UK will ensure that the world's leading companies continue to be based here, building a strength that will prevent overseas competition from gaining a foothold.

4. *Is publicly provided innovation funding necessary for the development of marine technologies and if so, why?*

4.1 Public funding is essential for the growth of the sector, both in terms of revenue support and capital support. The private sector has demonstrated clearly that it is not willing to invest in companies that do not have substantial Government support, so without the support, investment will dwindle and progress will cease.

4.2 Specifically, the public funding needs over the next few years are:

- Market support at 5 ROCs for both wave and tidal power.
- Grant support at 25% of capital cost for the first small arrays.
- Continued grant support at 40% for prototype testing, to bring forward sufficient concepts to ensure the best ideas make it through to commercialisation.
- Additional early-stage funding on commercial terms, to stimulate the VC industry so that private investment continues to flow into new marine energy technology development.

4.3 This funding level is required because marine technologies are still pre-commercial. At the scale of a few MW deployed industry-wide, marine power is in the very earliest stages of development. At this stage, with each machine manufactured as a one-off, very high design safety factors and one-off installation and grid-connection costs, Pulse machines cost almost twice as much as an equivalent offshore wind turbine.

4.4 Costs will fall as volumes increase, partly because projects get more efficient as they get larger, and partly because machine costs will fall as manufacturing volumes increase. Pulse expects to match the cost of offshore wind after deploying less than 100 machines.

4.5 Thus, a differentiated level of Government support is required only for a few hundred MW deployed, to enable the industry to drive down costs.

5. *What non-financial barriers are there to the development of marine renewables?*

This section is very well covered in the RenewableUK submission, which Pulse Tidal supports. We have nothing to add.

6. *To what extent is the supply chain for marine renewables based in the UK and how does Government policy affect the development of these industries?*

6.1 The UK is well endowed with the skills and capabilities needed to develop and deploy tidal power machines like Pulse Tidal's device. All of the components for the Pulse large-scale demonstration machine in the Humber were sourced from UK suppliers, and a large part of the commercial machine now in development will also be sourced from the UK—particularly the installation components and process.

6.2 However, Pulse is involved in a European Union project, which insists that some of the work takes place outside the UK. For this reason, much of the machine assembly will take place in the Netherlands.

6.3 This is an example of Government policy affecting the supply chain. Pulse could have sourced the majority of its needs from the UK, but is being pushed overseas because that choice brings grant funding.

6.4 In general, our experience to date is that the supply chain is not a constraint on development in the UK. However, some strain may begin to appear as the rate of construction and deployment of tidal power machines increases. Dock facilities, installation vessels and steel-working capability all have potential to become bottlenecks.

6.5 The most powerful method of developing the supply-chain is to let the market work. If there is a thriving market for tidal power machines, the supply chain will react by increasing capability. Any uncertainty in the market will similarly be reflected in reluctance to invest and an industry constrained by supply-chain inefficiency.

6.6 Government intervention should be focused on creating the market for tidal power devices and also on removing structural disadvantages for UK suppliers—assisting them to control labour costs and access skilled workers for example. The key is that supply-chains take a long time to develop and are built on confidence—Government must provide clear, determined interventions that remain stable over long periods.

7. *What approach should Government take to supporting marine renewables in the future?*

7.1 By far the most important Government intervention is the provision of revenue support, at the level of 5 ROCS for wave and tidal projects across the UK. This is a vital market signal that will accelerate progress. The converse is that anything less will bring progress rapidly to a halt.

7.2 The next intervention is to provide capital support in 3 areas:

(A) Small projects, in the 8—10MW range, which require capital support to reduce the risk for customers in the event of non-performance (since the machines are still relatively unproven). These projects require 25% capital support.

(B) Single full-scale prototype machines should be supported to the maximum level allowable—typically around 40%. This is R&D funding, but at a sizeable scale because marine power tests are expensive. The private sector will not currently fund 100% of these demonstration tests.

(C) Early-stage development of new technologies that have potential to change the cost-structure of the industry. These ideas and companies would previously have been funded by Venture Capital, but that is currently not available. Ignoring this part of the industry today will slow down cost reduction in the future.

7.3 The final financial intervention should be through the GIB or similar; providing funds on a commercial basis to stimulate the VC sector, and to stimulate the debt sector. The former would require dedicated renewable energy technology development investment, and the latter could be a range of products which would bridge the gap between customer balance sheet funding (which can fund one or two small projects only) and the commercial debt funding required for projects in the 100's of MW.

7.4 In addition, Government should continue to engage with industry through the MEPB to understand the sector's needs.

7.5 The industry has estimated that capital support of £120 million is required to build a thriving marine renewables industry. While the £20 million funding provided by the DECC Low Carbon Innovation Fund is a welcome signal, it can effectively support only 2 projects, which is not sufficient to develop the strong industry that will provide jobs and secure, renewable power into the future.

7.6 Government should work closely with the existing oil and gas supply chain, and the developing offshore wind supply chain, to understand what interventions are required to encourage these companies to become involved in wave & tidal activity. The experience in these companies will be a critical driver of cost reduction in the marine sector.

8. *Are there any other issues relating to the future of marine renewables in the UK that you think the Committee should be aware of?*

8.1 No further comments.

September 2011

Memorandum submitted by the Highlands and Islands Enterprise

Highlands and Islands Enterprise (HIE), the economic and community development agency for the north and west of Scotland is, in line with the Scottish Government's Economic Strategy, responsible for generating sustainable economic growth in every part of the Highlands and Islands. Energy, and in particular renewable energy, is a key priority for HIE recognising the comparative advantages of the region, not least in the area of marine energy. We very much welcome the opportunity to respond to this consultation, given the relative importance of this new emerging industry to our region and the potential we believe it has to contribute significantly to economic growth.

The Highlands and Islands is leading the world in the development of this new industry, being home to the European Marine Energy Centre (EMEC) in Orkney (the world's first UKAS accredited grid connected wave and tidal test facility) and to the first commercial scale wave and tidal leasing programme in the Pentland Firth and Orkney waters area. HIE is fully committed to maximising the economic potential from marine energy and determined to build upon the recent momentum in the industry as demonstrated by the demand for testing berths at EMEC, the consenting of Scottish Power Renewables and Hammerfest Strom's 10 MW tidal array near Islay–the largest of its kind in the world—the confirmed applications for the Scottish Government's £10 million Saltire Prize and the 1.6GW lease awards in the Pentland Firth and Orkney Waters.

1. *What are the potential benefits that marine renewables could bring to the UK and should Government be supporting the development of these particular technologies?*

1.1 Highlands and Islands Enterprise (HIE) is the Scottish Government's economic development agency for the north and west of Scotland and the Islands, and its core purpose is generating sustainable economic growth. Given the extensive natural resources of the region (including wave and tidal), combined with decades of oil and gas experience in offshore environments, leading-edge manufacturing and engineering capabilities, and current favourable financial incentives; HIE believes that this region is well-placed to benefit significantly from the emerging marine energy industry, and indeed argues that this region has and will continue to be instrumental in the development of this new industry across the UK and beyond. The establishment of the European Marine Energy Centre (EMEC) in Orkney—the world's first UKAS accredited, grid connected wave and tidal test facility—is alone testament to that claim.

1.2 Marine energy has the potential to significantly contribute towards the UK and Scottish Government's ambitious renewable targets and therefore make a substantial contribution to tackling carbon emissions and security of our energy supply. Whilst offshore wind represents major opportunities for the UK in terms of meeting renewable energy targets, marine energy offers that and a once in a generation opportunity to lead the creation of a new self sustaining, global industry.

1.3 It is the economic growth prospects which largely interest HIE and even at this early stage in the industry's life, economic benefits are being derived. In Orkney, significant business is being generated in supporting EMEC and the technology developers currently attracted to the facility; and investment in supporting infrastructure is generating wider business benefits. Work is underway to determine the economic impact of the £35 million public sector investment in EMEC and we will be happy to share the findings once complete. However, work undertaken by the Scottish Government's Marine Energy Group in 2009 estimated that over 10,000 jobs could be supported by the marine energy sector, assuming deployment of 2GW. More recently, the Pentland Firth and Orkney Waters Build Out Story predicted an investment of £6bn to enable the anticipated 1.6GW to be deployed under the world's first commercial scale leasing round for wave and tidal development. HIE, with other public and private sector partners, is leading work to ensure that the maximum economic benefits from these major investments accrue to the region, Scotland and the rest of the UK. The UK is also home to a number of technology developers, with a strong contingent within Scotland, but all leading the way in technological research and development, innovation and entrepreneurship, essentially flying the flag for the industry and the UK.

1.4` Therefore, the UK is already benefitting from the marine energy industry in terms of research and development, knowledge transfer, intellectual property and in manufacturing and testing early devices. Such leading edge activity has attracted international interest, with investments being secured in indigenous developers including Voith Hydro in Wavegen, and Alstom in AWS.

1.5 In summary, progress to date, combined with Scotland's enviable wave and tidal energy resource (representing a quarter of Europe's tidal stream and 10% of its wave energy potential) means that the UK is well placed to derive substantial economic and carbon reduction benefits from a marine renewables industry helping both the Scottish and UK Governments to reach their ambitious energy targets through various renewable energy sources by 2020.

1.6 In order to achieve these targets and derive the projected economic growth from the marine energy industry, it is imperative that Scottish and UK Governments continue to support the development of the marine energy sector, recognising its relative infancy and its huge potential. Reducing costs is absolutely vital in helping the sector become commercially viable, thus requiring up front grant aid in R&D, supported testing facilities, and market pull in terms of enhanced financial incentives. The need for ongoing Government support is vital to ensure the sector continues to progress through the stages of technology proving and deployment, moving from full-scale demonstration through to the deployment of the first pre-commercial arrays, and then onwards to commercial development. This will be seen in the Pentland Firth and Orkney Waters where the first large scale wave and tidal commercial arrays are due to be deployed commencing 2014 through to 2020, as well as at those sites leased to developers competing for the Saltire Prize.

2. *How effective have existing Government policies and initiatives on marine renewables been in supporting the development and deployment of these technologies?*

2.1 The introduction of enhanced levels of support for wave and tidal generation through the Marine Supply Obligation (MSO) in 2007, followed by the enhanced Renewables Obligation Certificates—wave 5 ROC's and tidal 3 ROCS—in 2009, combined with significant grant funding for Research, Development and Demonstration within Scotland has resulted in significant progress being made by the marine energy industry.

2.2 Current deployments include Voith Hydro Wavegen's 500kW Limpet on Islay, currently in its 11th year of successful operation; Pelamis P2 750kW machine (commissioned by EON), OpenHydro 250kW tidal turbine, Tidal Generation Ltd 500kW turbine, Atlantis 1 MW AR1000 tidal turbine, and Scotrenewables 250kW tidal generator all deployed at EMEC. A further 5 devices are scheduled for deployment at EMEC during 2011.

2.3 During 2010, Scottish Government awarded £13 million to five projects through the WATERS fund to support technology development and deployment, which when added to the earlier £13 million WATES scheme and investment in EMEC's facility in Orkney takes Scottish Government's support for the sector over the past 10 years to more than £30 million. In addition DECC support for EMEC has exceeded £10 million, and has enabled EMEC to develop nursery sites in response to industry demand. These schemes have been instrumental in the ongoing development of EMEC and in building the pipeline of full scale prototypes to be deployed over the coming year. This activity tangibly demonstrates the real progress being made by the industry.

2.4 In addition three confirmed applications for the Scottish Government's £10 million Saltire Prize along with utility investments in technology developers, further signal that Government support and incentives have helped to stimulate significant private sector investment in this emerging industry.

2.5 Examples of less effective policies and initiatives include the lack of priority attached to marine renewables at an EU level (which we are addressing via support for the Scottish European Green Energy Centre) and in the £42 million Marine Renewables Deployment Fund (MRDF), which failed to support industry due to being ahead of its time and not reflecting industry needs. That said, the subsequent Marine Renewables Proving Fund, administered by the Carbon Trust was successful in allocating all £22.5 million to six projects (all of which are testing, or are scheduled to test at EMEC).

3. *What lessons can be learnt from experiences within the UK and from other countries to date in supporting the development and deployment of marine renewables?*

3.1 Ensure that future support for the industry closely reflects the needs and current state of the industry. For example, HIE is working with Scottish Enterprise and the Technology Strategy Board, in partnership with industry, to develop a joint industry project for investment in research and development that will seek to address common challenges in the industry, such as tidal array cabling, moorings, installation techniques etc. Schemes need to be flexible and responsive to industry needs and allow scope for projects to develop and evolve in different ways, based on the innovation and learning taking place. There are still only a relatively small number of full scale devices at demonstration stage, despite the progress being made over recent years, so ongoing technological support remains critical in order to prove the technology and move the industry to a commercially viable stage.

3.2 Ensure that the market mechanisms in play deliver the right level of support as well as a clear signal that this support will be available in the long term, driving deployment and reducing costs. The future of the RO and any replacement mechanism will be critical in determining future private sector investment in the industry. Developers continue to identify development opportunities out with the UK and whilst resource is a key factor in location decisions, so too are market mechanisms, with countries such as Canada proving attractive. The UK must therefore ensure that it maintains its competitive position at this early stage.

3.3 Further; to increase the rate of deployment for devices, the consenting process should be streamlined, building upon the approach adopted by Marine Scotland and the provision of planning advice and guidance tools. Emphasis on project scoping, by promoting partnership working between developers and stakeholders should lead to comprehensive pre-application engagement and ultimately swifter consents. Ongoing efforts in this area to identify simplified planning policy and monitoring the planning processes adopted by competitor countries is recommended.

4. *Is publicly provided innovation funding necessary for the development of marine technologies and if so, why?*

4.1 In order for the sector to continue to develop, innovation support is imperative. Coherent and co-ordinated action to address issues related to device reliability, survivability, installation techniques, inter-connection and anchoring can play a crucial role in reducing early project costs, therefore R&D funding support needs to be available to developers. Driving down costs is absolutely essential if the sector is able to make the leap from single device development and demonstration to commercial scale production and deployment, and to attract the necessary private sector finance to enable this to happen.

5. *What non-financial barriers are there to the development of marine renewables?*

5.1 The deployment of marine renewables depends on a number of complex and interdependent factors. The main challenges to the development of the sector are:

(a) Planning and Regulation—it is imperative that the challenges faced in onshore wind regarding planning are avoided where possible, to ensure that momentum is built up and maintained and that the UK supply chain is stimulated. In Scotland there is the need to build on the work currently being undertaken by Marine Scotland on developing planning advice and guidance tools.

(b) Secure Grid Access—lack of grid access in areas of high resource is still a huge issue, and more of a challenge for marine energy developers with a limited project portfolio to spread their risk. Key influence in this area lies in the outcome of Project TransmiT and a more sensible approach to grid investment and charging issues.

(c) Supply Chain Development—it is critical that development keeps pace with and enables marine renewables deployment and that Scottish businesses are in a position to support and benefit from this sector and its huge potential. The supply chain is also critical in helping drive innovation up and costs down, but as mentioned above, will only be sufficiently stimulated to invest if there is confidence in the scale of the market.

(d) Skills—Scotland needs to continue to develop a highly skilled workforce to continue to attract our share of investment in marine energy for Scotland. The Skills Investment Plan for the Energy Sector, commissioned by the Energy Advisory Board, published March 2011 by Skills Development Scotland, details the skills required for the key energy sectors to 2020. The plan identifies at least 40,000 job opportunities in the renewables sector. Collaboration and development across the education and training sectors is required to ensure that our people have the opportunity to take advantage of the employment opportunities that will arise, and also to offer a solid skills foundation supporting inward investment. Funding should be allocated to achieve these aims. The competition for such skills will also be significant, with offshore wind and more traditional energy industries, seeking a growing skilled workforce.

(e) Innovation/R&D—need for ongoing technology support is critical, and goes beyond finance. Knowledge transfer and networking opportunities will be equally important in helping the sector drive down costs.

(f) Public Engagement—support for the sector and its association with planning and consenting and community benefit, will be a key factor in the development of this new industry, and the strength of public opinion should not be underestimated.

(g) Proving the technology—much more work is required on testing and demonstration, both of individual devices and also of arrays. If the technology cannot be proven to be successful and deliver reliable energy and a competitive cost, the industry will find it increasingly difficult to compete with other sectors.

6. *To what extent is the supply chain for marine renewables based in the UK and how does Government policy affect the development of these industries?*

6.1 A maintained focus must be on supply chain development arising from lease awards and planned activity in Scottish Waters and beyond. The UK is exceptionally well placed to develop a strong supply chain to support the marine energy industry, with well developed supply chains in the North East of England, Aberdeen and the Inner Moray Firth active in the oil and gas market. It is recognised, however, that at this stage, the industry is focussed on reliability, with component parts being sourced globally. Until momentum builds and there is a scale which merits indigenous companies investing in such parts, it is likely that a significant proportion of the supply chain will be out with the UK.

6.2 The Highlands and Islands is, however, already witnessing significant activity with prototype devices being manufactured and assembled in locations such as Invergordon, Nigg, and Arnish before being towed to EMEC, and a range of engineering companies already active in the industry.

6.3 At a very local level, Orkney represents a strong business and academic cluster supporting the marine industry, with businesses developing a range of services covering project planning, environmental impact assessments, and marine services.

6.4 Government policies towards the marine energy industry are of critical importance to stimulating the supply chain, as is the supply chain to addressing cost reduction. The two cannot be viewed in isolation. Market signals are extremely important in providing industry confidence, as are consented projects. Therefore efforts to ensure that changes under the EMR result in sustained if not improved incentives for the wave and tidal sector, combined with demonstrable progress in consenting of projects will be critical in stimulating the supply chain. At this early stage, it is important to facilitate, where possible, local content in device manufacture and development.

7. *What approach should Government take to supporting marine renewables in the future?*

7.1 Overall, support for the marine renewables sector must be sustained, responsive to industry needs, and demonstrate long term commitment. Instilling confidence in the industry and the wider supply chain is critical to driving down costs and leading to commercialisation of the sector.

7.2 It is widely acknowledged within the sector that the next phase of development—the deployment of small arrays at the 5–10 MW scale—will not take place without significant capital grant support, potentially of the order of around £20 million per project. This will require additional resources to supplement Government funding including support from the EU and the Green Investment Bank, which in turn is needed to lever additional private sector finance into the sector.

7.3 In addition market pull through incentives will continue to be required. Scotland has led the world in recent years through enhanced levels of support for wave and tidal stream generation through the Renewables Obligation (RO). The bandings are currently under review, however any proposals for change must combine to deliver a coherent and effective level of support, and a system which is capable of bringing these technologies through to commercial development and to a competitive and commercial cost basis. Scottish Government's 2007 introduction of the MSO and then enhanced ROCs have driven activity in marine renewables in Scotland which has been of strategic importance to the UK. The fact that UK Government is now considering parity in revenue support for marine renewables across the UK supports the conclusion that the decision to provide higher support in Scotland was driven by industry needs rather than geographic ambitions. It is therefore extremely important that the ability to modify any future support mechanism is retained by the devolved administrations if they do not agree with UK Government's assessment of industry requirements. This autonomy is currently threatened by proposals in DECC's EMR white paper.

7.4 Government should also address the grid access and charging issues that currently act as a barrier to growth of the marine energy industry in the UK, particularly in the Highlands and Islands where the marine energy resource is greatest. The grid transmission charging and underwriting issues require to be tackled effectively through Project TransmiT as the existing charging regime currently acts as a barrier to development. A satisfactory and timely resolution will play a vital role in developing the sector.

7.5 Finally, we would urge Government to consider the concept of Marine Energy Park status in key strategic locations, such as that of the Pentland Firth and Orkney Waters area, with a view to accelerating business growth and inward investment in the sector. Consideration of business benefits akin to Enteprise Zone status would in our view further stimulate the supply chain in support of the sector and secure economic development close to key wave and tidal development zones. This would build upon research and development, design, testing, manufacturing and construction, operations and maintenance, and support the development of a strong, coherent, cluster of activity. Such an approach would support the transition of the industry from research and development through to full scale commercialisation. HIE working with Scottish Government plans to discuss this with DECC and present options on Marine Energy Park status in the near future, and support for this would be welcome.

8. *Are there any other issues relating to the future of marine renewables in the UK that you think the Committee should be aware of?*

8.1 The pivotal role of EMEC in developing this industry should not be underestimated, and whilst currently in a strong position, it is imperative that we join efforts to capitalise upon the major public sector investment to date, and ensure that as a key UK asset, its future is secured.

8.2 The Highlands and Islands of Scotland is leading the UK's efforts on marine energy, and it is already generating economic growth in the region. It is vital that this momentum is maintained to ensure that Scotland and the UK can legitimately lead the world in the development of the sector. The Saltire Prize, further demonstration sites and the Pentland Firth and Orkney Waters leasing rounds represent the largest share of marine energy activity in the UK and success in these will be critical for the industry as a whole.

8.3 The current debate on the The Crown Estate and its revenues generated by offshore renewables is of direct relevance to the industry, with developers facing considerable charges for access to the seabed. The Select Committee is encouraged to refer to the Scottish Affairs Committee Inquiry into The Crown Estate in Scotland.

September 2011

Memorandum submitted by the Marine Energy Group, Edinburgh University

CONTEXT

1. The Institute for Energy Systems[25] (IES) is a research institute within the School of Engineering,[26] in the College of Science and Engineering at the University of Edinburgh. There are three research groups in the Institute: Marine Energy; Machines & Networks and Innovation & Policy. IES has been prominent in marine energy research and development since 1974[27] and for the last eight years has led Phases 1 & 2 of the EPSRC SuperGen Marine Energy Programmes[28] and, in a third phase beginning in October, is establishing the UK Centre for Marine Energy Research (UKCMER) that includes Queens University Belfast, The University of Exeter and Strathclyde University. UKCMER also includes seven affiliate universities active in marine energy research: Plymouth; Southampton; Oxford; Manchester; Swansea; Heriot-Watt and Lancaster. The Doctoral Training Programme in the Centre will train 15 PhD students. IES has been a Phase 1&2 partner in the UK Energy Research Centre with specific responsibility for technology foresighting and roadmapping in marine

25 http://www.see.ed.ac.uk/research/IES/
26 http://www.see.ed.ac.uk/drupal/
27 http://www.mech.ed.ac.uk/research/wavepower/
28 http://www.supergen-marine.org.uk/drupal/

energy.[29] It is a partner in several NERC marine energy research programmes[30] and ETI technology development programmes.[31] IES hosts the European Energy Research Alliance in Marine Energy[32] and leads or is a partner in several European Framework Programme 7 projects. IES is building a unique world-leading All-Waters Current and Wave Test Tank as a national facility jointly supported by EPSRC and the University of Edinburgh.[33] Most recently it has been supported to train, with and for the marine industry, 50 EngD students in the ETI:EPSRC Industry Doctoral Training Centre in Offshore Renewable Energy[34] with Exeter and Strathclyde Universities, Hydraulics Research Wallingford[35] and the Scottish Association for Marine Science in Oban,[36] part of the University of Highlands & Islands.

The views expressed in this response are solely from those submitting it, but relate to some of the response from the Innovation and Policy Group within IES.

Executive Summary

2. The UK leads the world in terms of prior investment and progress towards array-scale deployment of wave and tidal generating technologies. It has the most extensive and dedicated research and development facilities and the best test and demonstration infrastructure. There are more marine generators supplying electricity to the UK network than anywhere else in the world. It has set the most ambitious deployment targets for 2020 and established the most extensive set of seabed leases for marine installation anywhere. Built on a heritage of shipbuilding and the manufacture, operation and support of offshore oil and gas assets the UK has opportunity to capitalise on this unique position and capture a substantial share of the market for these new technologies to establish, by 2050, the world's leading and largest skills base and supply chain. This will require continued pride, faith, patience and measured support from Government to deliver the visions that have led to its prior investment giving the UK this unique opportunity.

Response

What are the potential benefits that marine renewables could bring to the UK and should Government be supporting the development of these particular technologies?

3. Potential benefits that could arise from the establishment of a marine renewable energy technology sector in the UK include, but are not limited to:

- Consolidation of the worldwide R&D and technology market leads that the UK has, as evidenced by the many prototype wave and tidal generators that have been developed and tested by UK based companies, to establish a new, high value, indigenous manufacturing industry, positioned to exploit the export market in the USA, Canada, Europe and Far East.
- Further development of human capacity across depth and breadth of skills range, from post-graduate, through professional to technician training and across the full technology development, OEM and equipment supply chain.
- Job creation, financial and social regeneration in declining coastal and maritime communities, including re-use of the infrastructure and skills base from the shipbuilding and offshore oil and gas industries. EMEC, NaREC and the WaveHub are prime examples.
- Creating another forecastable and predictable low carbon energy source to contribute to the 2020 and 2050 energy mix in the UK, with attendant increase in system resilience and security of supply. The wave resource is time-displaced from wind and the tidal resource is driven by predictable gravitational cycles rather than by weather.

For these reasons alone the government should continue to support the development of wave and tidal technologies and the infrastructure that will establish the sector and industry.

How effective have existing Government policies and initiatives on marine renewables been in supporting the development and deployment of these technologies?

4. The United Kingdom has some of the best wave and tidal energy resources in the world.[37,38] It leads the world by example with its investment in collaborative research and development programmes and test facilities across the range of scales from 1/100th scale in university test tanks[39] through 1/10th scale test facilities at the National Renewable Energy Centre at Blyth in Northumberland[40] to the open-sea test sites at

[29] http://www.see.ed.ac.uk/research/IES/ukerc/
[30] http://www.nerc.ac.uk/research/programmes/mre/
[31] http://www.energytechnologies.co.uk/Home/Technology-Programmes/marine.aspx
[32] http://www.ukerc.ac.uk/support/tiki-read_article.php?articleId=1119
[33] http://www.flowavett.co.uk/
[34] http://www.idcore.ac.uk/
[35] http://www.hrwallingford.com/site/
[36] http://www.sams.ac.uk/
[37] http://www.carbontrust.co.uk/Publications/pages/PublicationDetail.aspx?id=CTC797
[38] http://www.carbontrust.co.uk/Publications/pages/publicationdetail.aspx?id=CTC799
[39] http://ukerc.rl.ac.uk/Roadmaps/Marine/Tech_roadmap_summary%20HJMWMM.pdf
[40] http://www.narec.co.uk/

EMEC in Orkney[41] and at the WaveHub in Cornwall.[42] Full-scale first-generation prototype wave generators have been deployed singly and have been generating electricity into the onshore electricity network for some years.[43,44,45] Similarly, full-scale single prototype tidal current generators have also been deployed singly and have been generating electricity into the network over the last two years.[46,47,48,49] Second-generation wave devices, such as Pelamis P2 and Oyster 2 are now being deployed singly in preparation for array installation.

5. The Crown Estates seabed leases make provision for 1600 MW of new wave and tidal capacity towards meeting the target of 2000 MW of installed capacity by 2020.[50,51] This deployment will be in arrays, clusters and farms and will require significant up-scaling of manufacture and installation of first- and second-generation marine energy technologies to align with the expectations of the targets set.

6. SuperGen and other UK researchers are regularly called upon to inform and advise the development of research programmes around the world, including: USA; Canada; Chile; South Africa; Taiwan, China, and Korea. There is a very heavy presence of UK researchers in European Funded projects including: Equimar and EERA (UK led); Marinet; Marina and TROPOS. UKCMER researchers are recruited to and active on every policy advisory group and marine energy conference steering group, such as ICOE and EWTEC. Their publications record and contribution to roadmaps, protocols and standards for the sector leads knowledge transfer in the sector.

The progress described in 4–6 above is sound evidence that policies have been very effective.

What lessons can be learnt from experiences within the UK and from other countries to date in supporting the development and deployment of marine renewables?

7. Collaborative research programmes like the UK SuperGen Marine and the EU FP7 programmes have enabled and brought together the research, training and industrial communities. Balanced with technology specific R&D funding, this has established a mix of generic fundamental research capacity and, through device specific applied research, proved and established designs like Oyster and new concepts such as Anaconda.[52] Many countries, including USA, Canada and Taiwan are emulating this form of research funding and capacity building.

8. Clear, consistent, stable and patient financial and regulatory support is necessary to ensure that technologies develop through a coherent and long-lasting framework. The sector and investors need confidence in prospective funding and uncertainty on the lifespan of revenue support reduces this confidence, as does uncertainty on eligibility for and access to future funding. Eligibility should be determined by regular and fair appraisal of fitness by equitable and consistent technology evaluations from concept to grave, such as those established in the EQUIMAR programme.

9. The Marine Renewables Deployment Fund and the Marine Renewables Proving Fund[53,54] are both well-designed schemes that, based on technology readiness, would have been much more effective if introduced in reverse order, with proving leading deployment.

10. There are many actors in the UK arena, both along the technology innovation chain and on a region by region basis. While it is a highly activated sector it might benefit by becoming more streamlined and single-minded to develop the whole-UK position. In Ireland there is a well co-ordinated innovation, demonstration, test and deployment pipeline that reduces the possibility of funding voids or overlaps. In the USA, marine kinetic energy devices are funded through much of their development cycle by single sources, not disconnected multi-departmental contribution. This is perceived to increase the sense of ownership and responsibility for the device, allows clearer monitoring of appropriate continuation funding and better secures the future for successful devices.

11. It is a feature of the highly energised arena in the UK that there are both national and regional funding initiatives and investments. It might be observed that there is a danger of regional investments becoming provincial, inward facing, competitive and divisive of the coherent effort that the UK is reputed to have around the world. It will be important to establish and operate a conjoined and synchronised UK effort that ensures maximum return on its investment.

[41] http://www.emec.org.uk/
[42] http://www.wavehub.co.uk/
[43] http://www.wavegen.co.uk/what_we_offer_limpet.htm
[44] http://www.pelamiswave.com/
[45] http://www.aquamarinepower.com/
[46] http://www.seageneration.co.uk/
[47] http://www.atlantisresourcescorporation.com
[48] http://www.openhydro.com
[49] http://www.pulsetidal.com/
[50] http://www.thecrownestate.co.uk/newscontent/92-round-1-pentland-firth.htm
[51] http://www.scotland.gov.uk/Resource/Doc/281865/0085187.pdf
[52] http://www.checkmateseaenergy.com/
[53] http://www.berr.gov.uk/energy/environment/etf/marine/page19419.html/
[54] http://www.carbontrust.co.uk/emerging-technologies/current-focus-areas/marine-renewables-proving-fund/pages/default.aspx

7–11 above identify some of the lessons learned in reaching today's position.

Is publicly provided innovation funding necessary for the development of marine technologies and if so, why?

12. Yes. Establishment of a Technology Innovation Centre would significantly accelerate the development of marine technologies. This is necessary because commercial investors of the scale required are accustomed to seeking more mature technologies and opportunities for rapid and measured return on investment. The gestation period on all successful technology deployments so far has been around 10 years. While every major developer is now revising their technology for improved manufacture, installation and operation, the market for marine technologies itself has not matured to the extent that competition for market share is forcing more extensive innovation.

13. At present it is not obvious to investors that the cost of deployment can be reduced sufficiently quickly enough for them to develop business plans based purely on commercial funding. Public funding needs to provide a confidence bridge.

What non-financial barriers are there to the development of marine renewables?

14. Non-financial barriers that need to be lowered to allow deployment to accelerate, include:

- Strategic Environmental Assessment processes need to be streamlined within given single sea areas for generically similar technologies.
- Marine Spatial Planning processes need to be faster, more transparent and conducive to development.
- Test sites need high level environmental approval-in principle for testing generically similar devices.
- Network access for initial deployments needs to be more easily and cheaply obtained to stimulate growth and gain experience of operational effects on supply quality and network effects on machine performance, before array deployments predicate perhaps un-necessary and costly reinforcement.
- Increasing public scepticism for support arguments based upon climate change, as can be seen in the letters pages of UK newspapers.

To what extent is the supply chain for marine renewables based in the UK and how does Government policy affect the development of these industries?

15. It has been estimated that the market for marine generation technologies could aggregate to approach £500 billion over the next 40 years. Three-quarters of this market is assumed to be available to UK businesses that, on the basis of a 22% market share could stimulate around £75 billion of new indigenous and export trade. This trade could be taken up by companies established in the mature offshore oil&gas and declining shipbuilding industries, and grown to develop the offshore wind sector. By 2050 this transition and expansion could employ around 70,000 staff in companies largely trading in the export market.[55] At this stage of its development policy can profoundly affect the sector and its industry.

What approach should Government take to supporting marine renewables in the future?

16. There is still a need to support fundamental and applied research that will de-risk technology development, its installation at sea and its operation and maintenance. This must continue to define the agendas across councils within RCUK, recognising the needs of the emerging sector and the mandate for coherence and linkage across the stakeholders down the innovation chain—including NERC, EPSRC, TSB, ETI, Carbon Trust and UK Agencies and Departments. The nature and scale of interaction with the marine natural environment will rapidly increase. Fundamental and applied research, including background and foreground monitoring, must continue to ensure that impact assessment and consenting can be accelerated but remains vigilant, consistent, scientifically robust and fair. It will remain important to ensure appropriate balance of R& D; technology development and revenue support, which takes timeliness into account.

17. A clear and stable long-term financial and performance-proving mechanism is required to encourage and ensure pull through of large-scale prototypes to full-scale test in the sea. Innovation funding should be made available to bridge the gap between technology push and market pull, across the mid-range TRLs 4–6. This should be intended to broaden the gene pool of technology concepts with new designs for deeper water, farther offshore, made more manufacture-ready and easier to install.

18. The short term imperative is to ensure greater and longer experience of existing machines operating in arrays. The equipment and logistics for installation and seabed-fixing are known to be among the most expensive cost centres. Targeted funding should continue to be made available to ensure that worthy designs, fully proved across the range of scales and established to be viable can make the transition into the sea and gain experience and market-confidence.

[55] Carbon Trust (2011) Marine Renewables Green Growth Paper.

19. Survival and long-term energy yield will be the ultimate drivers of market confidence. Premature attempts to drive down the costs of structures and internal technology will be masked by the less-controllable costs of installation and maintenance, and could lead to false-economies and failure. Once the market-leading technologies begin to establish their market shares and as their volumes of manufacture rise, there will be cost reductions through economies of scale and learning-by-doing as experience and tooling grows. Measured, monitored and stable government support should be made available to propagate the growth of this experience and market over an appropriately long period, given that it is to establish a new industry manufacturing a new technology.

20. The longer term aim should be to create a financial, consenting and regulatory regime where winning technologies and companies can be identified earlier by investors who will fund the technology towards maturity rather than waiting on the off-chance that it will mature by other means.

19 and 20 commend a phased approach to the measures adopted and expectations of them, reflecting the progressive and developing nature of the sector and its technologies.

21. The rate at which funding is made available, and its intended area of application should be carefully considered and monitored for effectiveness to ensure adequate support to sustain progress but not excessive support leading to mismanaged expectations and disappointment.

Are there any other issues relating to the future of marine renewables in the UK that you think the Committee should be aware of?

22. The UK has a significant first-move lead in the eyes of the world in the wave and tidal energy sector. Continued pride, faith and support at a prudent rate are necessary to establish fully this advantage and create the intellectual, social and financial wealth available. The timing of funding is important, to synchronise support becoming available as demand for it arises. This requires accurate foresighting, that will be delivered by ongoing research.

23. There is a valuable role to be played by a real, physical Technology Innovation Centre at the heart of sectoral activity, facilities and investment in offshore renewable energy in the UK. It could connect, align and synchronise the use of all available and applicable intellectual, physical and financial assets to stimulate innovation and grow the sector to realise these challenging ambitions. Building on and between prior public investment in the universities, test houses and proving sites it must bridge the identified void between TRLs 3 and 6 to prove concepts at meaningful scale, develop devices and OEM technology and translate this into demonstration and on towards market pickup. It should innovate new device and supply chain technology and methodologies for manufacture, installation, operation, maintenance and recovery to de-risk, accelerate and sustain growth of the market and sector.

September 2011

Memorandum submitted by Trident Energy

We welcome the opportunity to submit evidence to the Energy and Climate Change Select Committee. Trident Energy is an independent developer of enabling technology for the marine energy sector. Unlike other developers our energy generator is designed to work across a range of devices to improve conversion levels and reduce the cost of power generation for offshore wind and wave farms.

Executive Summary

Marine Renewables represent a global economic opportunity for UK companies as well as an opportunity for a secure domestic supply of clean energy. The UK industry is at a high risk stage in its development and requires stable long term policy support as well as funding to fully capitalise on the opportunity. Obtaining consent for deployment remains a key issue, particularly for developers looking to reduce costs and optimise power extraction by co-locating wind and wave generation. The high costs of technology development within the industry are due in part to a proliferation of bespoke systems. Generic components and consolidation of the currently complex supply chain are required to reduce costs. Manufacturing set-up costs are a major barrier to deployment of a wider range of concepts. Support for the industry would ensure skills and experience become anchored in the UK.

What are the potential benefits that marine renewables could bring to the UK and should Government be supporting the development of these particular technologies?

1. The UK's marine environment provides an opportunity for a secure supply of sustainable, clean energy. A strong UK based marine renewables industry is the optimal means of exploiting these natural resources. However, marine renewables is also a global business opportunity for a range of UK organisations throughout the supply chain. This fledgling industry is at a high risk stage in its development and Government support is essential to ensure UK companies capitalise on the opportunity to become and remain global market leaders in this new technology area.

How effective have existing Government policies and initiatives on marine renewables been in supporting the development and deployment of these technologies?

2.1 Government policies and funding initiatives have been effective in promoting the start-up and early stage growth of a large number of small technology developers. They have been less effective in moving the majority of these companies on to the next stage of development, deployment and commercialisation due to the significantly larger funds required.

2.2 The Renewables Obligation (RO) scheme has created an attractive market for marine energy technologies, particularly in Scotland, and this has encouraged utilities to invest in technology developers and make the first purchases of marine energy devices.

What lessons can be learnt from experiences within the UK and from other countries to date in supporting the development and deployment of marine renewables?

3.1 An accurate assessment of the technology readiness level of devices by funding agencies is required in order to target funds appropriately. The failure of devices to qualify for the Marine Renewables Deployment Fund (MRDF) has since been remedied by the introduction of the Marine Renewables Proving Fund (MRPF) whose requirements are set at a more realistic and achievable level for current technologies.

3.2 Creating a long term attractive domestic market for marine renewables would give the UK industry a competitive advantage in the global export market. Lessons can be learnt from Denmark where government policy created a sustained domestic market for onshore wind. This incentivised the development of supply chains, quality control and a highly skilled workforce. In turn, these enabled Danish companies to go on to capture a large share of the world market.

Is publicly provided innovation funding necessary for the development of marine technologies and if so, why?

4. Yes, we believe that publicly provided innovation funding is necessary. Marine renewables are at an early stage of development and the sector is relatively unattractive to private investors. Issues include technology risk and economic viability as well as the small and fragmented nature of the sector. Many investors are looking for a financial return over shorter timescales than those associated with the development of marine renewables technologies. Public bodies are better able to take non-financial factors such as wider economic and environmental impacts into consideration and view the opportunity over longer timescales.

What non-financial barriers are there to the development of marine renewables?

5. Site consenting is a serious issue for marine renewables developers. This is being addressed by Strategic Environmental Assessments (SEA) and other initiatives to streamline the consenting process. Currently, these initiatives assume that offshore wind, wave and tidal devices will be installed in separate geographical areas. However, there are economic, environmental and health and safety benefits to be gained by co-locating offshore wind with wave or tidal generation. These opportunities are being explored by commercial organisations and academic collaborations such as the FP7 MARINA Platform Project. Trident Energy has developed a direct drive linear generator that can be deployed as part of a wave energy converter co-located on an offshore wind turbine structure. We believe that co-location with offshore wind will accelerate technology development of the marine renewables industry and reduce the timescales for commercially viable wave energy generation. Bringing forward time to market would open up the industry to a much wider range of private investors. Unless offshore wind sites are assessed at this stage for wave energy generation the consenting process will be unnecessarily extended for projects that combine wind with wave. It will therefore be difficult for companies to capitalise on co-location opportunities within UK waters.

To what extent is the supply chain for marine renewables based in the UK and how does Government policy affect the development of these industries?

6.1 Trident Energy is part of the marine renewables supply chain. We are developing a generic power take off solution for use in offshore wind, wave and some tidal energy generation devices. Trident is a UK company. It was founded in 2003 to develop a wave energy converter and repositioned in 2011 to focus on its core linear generator and the supply of this enabling technology to the marine renewables industry. We recently opened a Glasgow office with the support of a Regional Selective Assistance grant from Scottish Enterprise. The technology-dependent RO scheme strongly affects the attractiveness of marine energy and hence positively impacts on the UK market for our products.

6.2 Building a local supply chain is an integral part of our business plan and we are already engaged in discussions with potential suppliers. Manufacture of our products will require a new production line to be set up and the high costs incurred cause the manufacturer to take on significant financial risk by working with us. In order to ensure that the future marine supply chain is based in the UK policy support and funding initiatives need to be directed towards local manufacturing, for example, by reducing the financial risk of production line setup.

What approach should Government take to supporting marine renewables in the future?

7.1 It is critical that policies and incentive schemes remain consistent over the long term to create a stable market and inspire investor confidence. The RO scheme has succeeded in creating a more attractive market for marine energy technologies. Any reduction in the number of ROCs awarded would seriously impact investment in technology development and deployment. Only a handful of marine technology developers have received sufficient funding to move on to the next stages of technology development, deployment and commercialisation.

7.2 The high cost of technology development in the sector is in part due to the proliferation of bespoke systems. This has been encouraged by funding mechanisms which tend to support end-to-end solutions rather than the development of generic components. This can be traced back to the organisation of funding streams by industry sector leading to a situation where development of the underlying enabling technologies "falls through the gaps". Commoditisation of components and consolidation of the existing complex supply chain are necessary to drive down costs within the marine renewable sector. Funding the development of enabling technology components would benefit the industry as a whole and avoid the high risk strategy of using public funds to strongly back a few unproven complete solutions.

Are there any other issues relating to the future of marine renewables in the UK that you think the Committee should be aware of?

8.1 Marine renewables represents a significant opportunity for developing and inspiring the current and future UK workforce. The sector is made up of a large number of small technology start-ups whose staff are developing entrepreneurial skills and experience that in the future will easily be transferred to benefit other parts of the economy.

8.2 Marine renewables is a very attractive sector for young job seekers with its compelling combination of novel technology development and involvement in tackling one of the biggest issues of their generation, climate change. This attraction should be capitalised upon to encourage young people to study science and engineering. However, it is important that "renewables" is not promoted separately to the core subjects. The renewables industry, in common with the UK's other industrial sectors, needs graduates with a solid grounding in the core scientific and engineering disciplines.

September 2011

Memorandum submitted by Alstom

Summary

(i) Marine renewables bring a range of benefits to the UK and the Government should continue to support the development of the sector.

(ii) Governments' track record on funding marine technologies has not been perfect, but strategic investments have given the UK an advantage over other nations.

(iii) It is important that the UK maintains its lead and maximises economic benefits in the face of interest from other countries.

(iv) Marine technologies are now attractive to Original Equipment Manufacturers (OEMs), such as Alstom—an indicator of growing technology maturity and market confidence.

(v) Government financial support is still necessary to close the financial gap through capex support of first arrays and through the Renewables Obligation.

(vi) The UK Government should follow the lead of the Scottish Government and offer 5 ROCs for wave and tidal technologies.

(vii) A focus on the removal of non-financial barriers is also important (e.g lack of grid connections and uncertainties around consents process).

(viii) We welcomed the Government's Renewables Roadmap, though were disappointed by the ambition for marine technologies.

About Alstom

1. Alstom is a global leader in power generation, grid transmission and rail transport. We strongly support the UK Government's target of reducing emissions by 80% by 2050. We agree with the assessment that—in order to meet the 2050 target—the UK power sector needs to be largely decarbonised by 2030. This needs to be achieved by using the full portfolio of technologies, by increasing the efficiency of power generation, and by applying CCS to fossil fuel generation as speedily as practicable.

2. As the supplier of around 25% of the world's installed power generation capacity (and around 50% in the UK), Alstom Power has wide experience of power plant design and construction in over 70 countries. We offer technologies and services for all energy sources: gas, coal, oil, marine, geothermal, biomass, hydro, nuclear,

wind and solar. We have also engaged in 12 CCS projects around the world. Alstom Grid is one of the top three global players in electrical transmission and is helping today to develop the intelligent and green grids of tomorrow.

DETAIL

Q1. *What are the potential benefits that marine renewables could bring to the UK and should Government be supporting the development of these particular technologies?*

3. The benefits that marine energy brings to the UK include:

- Reducing CO2 emissions and helping to deliver the UK's CO2 reduction targets.
- Marine energy has a greater predictability than wind. This creates opportunities to plan and stabilise the grid.
- Marine energy is not subject to control by others and so offers a secure source of energy.
- Global pressure for oil and gas supplies is increasing volatility in the wholesale market, which is passed on to consumers. Renewable energy will help to stabilise prices following necessary cost reductions.
- UK has a clear and established lead in marine energy technology development, which can form the backbone of an export business opportunity.
- Marine energy devices are large structures that offer an opportunity to revive the UK's marine supply base in regions that have limited employment opportunities.
- UK has well-established marine skills developed over decades from shipbuilding, heavy engineering, oil & gas and offshore wind.
- Attracting investment, such as Alstom's in AWS Ocean.
- A number of overseas developers are making use of marine test centres (EMEC, NAREC and soon Wave Hub), while others are establishing offices, and design centres, and making use of UK suppliers to construct their devices.

4. A number of recent reports have concluded that the sector could deliver:

- 4.5GW by 2030 and up to 60GW by 2050 (Carbon Trust, 2011)
- Cost parity with nuclear and onshore wind by as early as 2025 (Carbon Trust, 2011)
- 10,000 jobs and revenues of nearly £4 billion per year by 2020 (RenewableUK, 2010)
- 68,000 jobs and £76 billion revenue to the UK economy by 2050 (Carbon Trust, 2011)

Q2. *How effective have existing Government policies and initiatives on marine renewables been in supporting the development and deployment of these technologies?*

5. The Government's track record on funding has not been perfect and we would agree with many of the points made in the recent Public Accounts Committee report "Funding the development of renewable technologies",[56] including:

- the need to manage budgets more effectively;
- concern about the lack of a clear strategy to deliver the 2020 target; and
- urgency in reviewing the Renewables Obligation banding.

6. However, we should not forget that it is Government funding and support which has been partly responsible for the UK becoming the world leader in marine technology, with six UK-based developers and four foreign developers attracted to the domestic market.[57]

7. The grants made available from a range of funding bodies (eg Carbon Trust, DECC, Energy Technologies Institute), together with the ROC programme, have allowed some developers to raise significant private finance. Their technologies have reached the point now where they are attractive to Original Equipment Manufacturers (OEMs) such as Alstom, which is a strong indication of technology maturity and market confidence.

8. The Marine Renewables Development Fund (MRDF) was clearly a failure. The announcement of £20 million of funding through the Department of Energy and Climate Change (DECC) Low Carbon Innovation Fund was welcomed by industry, yet it is less than half the funding previously offered through the Marine Energy Delivery Fund (MRDF).

9. The Marine Renewables Proving Fund (MRPF) is helping six beneficiaries to move their technologies forward. The Saltire Prize in Scotland continues to generate a huge amount of interest in the sector and the investment that has flowed from that is many times the £10 million prize.

[56] House of Commons Committee of Public Accounts report, "Funding the development of renewable energy technologies", 30 November 2010, HC538

[57] Full scale devices only

10. The Scottish Government's decision to award 5 ROCs for marine technologies has helped to give Scotland a strong leadership role in the sector. That leadership should be replicated throughout the UK by extending the 5 ROCs regime through the forthcoming Renewables Obligation Banding consultation exercise.

11. The establishment of the European Marine Energy Centre (EMEC) created a world-class test site where developers are fighting to take a berth to demonstrate their technology. NAREC has provided R&D resources, and test facilities, for early stage developers and Wave Hub offers a 20MW pre consented wave site for small arrays to be demonstrated. These strategic investments by Government have given the UK a unique advantage over other nations many of whom are only now starting to invest in similar infrastructure.

Q3. *What lessons can be learnt from experiences within the UK and from other countries to date in supporting the development and deployment of marine renewables?*

12. The UK is currently enjoying an unchallenged lead in the marine sector. However, other countries (e.g France, Canada, Ireland, USA, Portugal and Spain) are showing increased interest with the growing evidence that the sector is starting to deliver, demonstrated by the:

- number of full scale devices in the water;
- consolidation of tidal devices (horizontal axis, three blade turbines); and
- investments made by the world's leading power sector OEMs, including Alstom.

13. Canada has established a national tidal test facility in the Bay of Fundy that provides an easy consent process for four berths, one of which has been taken by Alstom. In addition to this facility, significant grants were also made available to developers. Canada is on the point of confirming a feed in tariff for 1MW tidal turbines of $490/MWh (£317). This follows the FIT recently announced for 500kW turbines of $652/MWh (£423). These are very attractive, especially as the tidal resource is greater than Pentland Firth.

14. France is now seeking to catch up with the UK, recognising that they have substantial tidal resource in the English Channel and wave opportunities on the western coast. France has a feed in tariff of €150/MWh (£132) for marine, which is expected to be increased to stimulate more activity. There are also substantial grants and soft loans available from both national and regional governments. Marine centres are also being established to concentrate marine energy R&D and skills to accelerate development. A tidal test berth is being installed at Piampol on the Brittany coast.

15. Spain, Portugal and Ireland are also investing in infrastructure projects to develop marine energy. The USA, while still at least 10 years behind the UK in its approach to marine energy, already makes significant grants available, but the industry is handicapped by a bureaucratic and inflexible consent process.

16. It is essential that the UK maintains the necessary level of support for the sector to consolidate its leading position. It would be tragic if, having made all the early investment, the UK failed to stay the distance and handed the fruits of success to others who are only now entering the arena. This is what happened with wind, which was developed in the UK thanks to government funding. That support was then withdrawn and the UK lost out to Germany and Denmark who dominate the global wind market. There are numerous other examples in the UK's past where an early technology lead was given away to others.

Q4. *Is publicly provided innovation funding necessary for the development of marine technologies and, if so, why?*

17. Many of the technologies that we take for granted have resulted from publicly funded R&D. Public money—be it from university grants, defence budgets, regional and national funds—have always supported innovative technology to a point where it has become attractive to industrial companies. Developers have survived over the last 10 years by a mixture of angel investors, venture capital and government support. This approach worked reasonably well while devices were at an early stage of R&D with modest costs.

18. But the lead technologies have now advanced to the point where they face a step change in costs as they move to full-scale deployment. To reach this stage, developers have typically invested £30 million to £50 million, but this is not the final hurdle and venture capital companies who made early investments in the sector have not seen the returns they had expected and appear unwilling, or unable, to make further investment. A few technologies have reached the point where they have accumulated sufficient evidence of performance and reliability that large industrial companies, and OEMs, can see an opportunity to diversify their business.

19. The involvement of the OEMs, particularly those whose core business is in the power sector, is critical to the success of marine energy. The utility customers and the banks, that will lend the money for projects, will only do business with companies who have the financial strength and credibility to offer the performance guarantees that are required.

20. However, at the entry point for the OEMs, the risks and costs of commercialising the technology are still very high and this has to be funded out of R&D budgets, which in the present financial climate are under severe pressure. A typical estimate for commercialisation of a marine device that has reached full-scale prototype stage is around £100 million. This is too much for an OEM to invest where the market is not clearly established.

21. Many of the utilities have invested in the developers and, while they are willing to relax their normal IRR requirements on first projects, the risks for them are also high. It is therefore necessary for government to close the financial gap through capex support of first arrays and 5 ROCs to ensure a strong market established to bring in the private finance that is essential.

22. Public funding can also be justified based on the contribution that the marine industry can make to the UK economy through the private finance attracted, the jobs and skills maintained and developed in the supply chain.

23. In the absence of public funding none of the wave and tidal companies based in the UK would exist and the investment that Alstom and others have made, and will continue to make in the sector in the UK, would not happen.

Q5. *What non-financial barriers are there to the development of marine renewables?*

24. Non-financial barriers include:

- Lack of grid connections. An example is Pentland Firth where grid will not be available until 2016 at the earliest.
- The consent process has improved significantly over the last 5 years but still introduces costs, delays and uncertainties.
- Technical challenges related to the interconnection of multiple devices and the use of high voltage transmission (66kV, 132kV) to shore.
- The cost and availability of the appropriate vessels for installation and maintenance that have more established relationships in the oil & gas and wind sector.

Q6. *To what extent is the supply chain for marine renewables based in the UK and how does Government policy affect the development of these industries?*

25. The UK's long involvement with shipbuilding and oil & gas has established both the skills and facilities necessary for marine related activities. The oil & gas sector has maintained many of skills required for marine energy and these are currently being exploited for offshore wind and can be expanded, and used, by wave and tidal. It is very important that we capitalise on these existing North Sea skills set before they disappear.

26. We believe that while some additional port capacity will be required, much of the basic infrastructure required to service wave and tidal already exists. Additional personnel will be required as wave and tidal deployments occur in the same time period as offshore wind, but the knowledge to do this already exists in the UK.

27. The majority of devices will be constructed from steel fabrications and there are still sufficient sites existing, shipyards, quayside fabricators or additional capacity that can be created to service the demand. The power take off system components of all devices make use of very similar equipment and these can be manufactured within the UK. Additional capacity may be required, but it is expected that key industrial suppliers will respond to the demand.

28. The crucial factor for the success of marine energy is the cost of power produced by the devices. While capex grants and ROCs can help support the generation of this new sector, the costs must be reduced substantially from where they are today. The supply chain must deliver competitive components and services, or inevitably device developers will be forced to reduce their costs by looking outside of the UK.

Q7. *What approach should Government take to supporting marine renewables in the future?*

29. The marine energy sector has been guilty in the past of over promising. These claims were perhaps an understandable result of smaller developers' enthusiasm for their technology and a need to attract venture capital. But the marine energy sector has changed dramatically over the last 2 years with the entry of the major power OEMs. It is now possible for a regular and meaningful dialogue between the OEMs, utilities and government. This can ensure that government is kept informed of both the progress and the needs of the sector, allowing targeted support where required. All the parties need to encourage private finance into the sector and we believe that this can be better achieved through the synchronised activities of government and industry.

30. Currently there are various sources of support available (e.g Carbon Trust, DECC, regional agencies, etc) and more value could be gained if there was an agreed and coordinated strategy.

Q8. *Are there any other issues relating to the future of marine renewables in the UK that you think the Committee should be aware of?*

31. We are concerned about the level of ambition for marine power described in the **Renewables Roadmap** issued by DECC in July. Overall, we thought that the Roadmap was a good quality piece of analysis and reached a number of helpful conclusions. However, on marine, we think that the central estimate (200–300MW by 2020) is too cautious.

32. We think it is important that the revised **UK 2050 Pathways Analysis**—to be published later this year—looks carefully at the long-term growth for marine power generation, including the policy framework required to go beyond the levels 1&2 scenarios.[58]

33. The **Green Investment Bank** could play an important role in enabling developers to access guaranteed debt for projects. As far as we aware, Government has not considered support for early-stage marine energy projects as being part of the Bank's potential remit and we believe that that position should be reconsidered.

Background on Alstom UK

34. Alstom UK employs around 6,500 people in the UK at around 30 locations and has an annual turnover of about £1 billion. We are responsible for the maintenance, refurbishment and operation of nearly half of the country's existing power plants, providing a full mix of power generation technologies, combining traditional and renewable energy sources with clean power solutions. In the UK, Alstom is responsible for the construction of four of the six new gas-fired power plants in the UK providing close to 6 GW of new electrical power. We are also delivering three onshore wind farms.

35. Alstom has taken a 40% equity share in Scottish renewable energy company AWS Ocean Energy. Alstom is a shareholder alongside Shell Technology Ventures and Scottish Enterprise. Created in 2004, AWS Ocean Energy is currently focusing on the development and delivery of its AWS-III wave energy generator, a floating device with a rated power output of 2.5MW. A 1:9 scale model of the AWS-III has already been tested in Loch Ness in 2010.

36. The AWS investment complements the existing activities of Alstom's Ocean Energy business in Nantes, France, where the company is developing its 1 MW commercial-scale tidal turbine prototype, the Beluga 9.

September 2011

Memorandum submitted by the Royal Institution of Chartered Surveyors

RICS—Royal Institution of Chartered Surveyors—is pleased to respond to the Select Committee's inquiry into the future of marine renewables.

RICS is the leading organisation of its kind in the world for professionals in property, construction, land and related environmental issues. As an independent and chartered organisation, RICS regulates and maintains the professional standards of over 91,000 qualified members (FRICS, MRICS and AssocRICS) and over 50,000 trainee and student members. It regulates and promotes the work of these property professionals throughout 146 countries and is governed by a Royal Charter approved by Parliament which requires it to act in the public interest.

General Comments

RICS believe that there is considerable potential to produce electricity from marine renewables in the UK. In addition to the deployment of devices in UK waters, to produce renewable electricity, there is also the potential to become the world leader in Offshore Renewables. This will lead to long term benefits for both export and for Operation and Maintenance.

The marine renewables industry has failed to live up to expectations for a number of reasons. The sector has been under development for nearly 40 years, with little to show in terms of commerciality. Some tidal devices are now producing electricity, which is connected to the grid, but the connection of wave devices to the grid on a commercial scale is probably five to 10 years away.

The creation of the Marine Energy Programme Board, to co-ordinate activity in the sector and the proposed Technology and Innovation Centre, which is being handled by the Technology Strategy Board, are both important for the future development of this nascent sector. Further innovation funding is required as the technologies are some way off market commercialisation.

What are the potential benefits that marine renewables could bring to the UK and should Government be supporting the development of these particular technologies?

RICS believe the potential benefits include:

- Long term energy security.
- Diversification of energy supply.
- Further development of the rich asset base in the UK.
- Providing facilities to encourage rapid deployment in UK waters now, and by helping to anchor the value chain in the UK will lead to export opportunities in the future.

[58] DECC 2050 Pathways Analysis, July 2010. Wave & tidal scenarios. *Level 1*: very gradual deployment; *Level 2*: slow growth initially, but speeding up in 2020s; *Level 3*: significant acceleration in commercialising technologies between 2015 and 2020; *Level 4*: "extremely ambitious" deployment with 1.3GW capacity in place by 2020.

- — Internalisation of externalities indicates that the real value to indigenous industry is significantly more than the value of the marine project itself.
- — Long term revenue from operation and maintenance activities.
- — Commercialisation of early stage design concepts from UK universities and technology companies.

How effective have existing Government policies and initiatives on marine renewables been in supporting the development and deployment of these technologies?

- — The Marine Action Plan, initiated by the previous Labour Government, was the start of the co-ordinated planning for this sector. That direction is largely still relevant under the present Government.
- — The Carbon Trust Offshore Wind accelerator has been a successful initiative and could be modified to enhance the development of wave and tidal technologies, though there are differences in the stage of market development.
- — The development of test centres has been moderately successful. Their remote location, (which is inevitable), has probably hindered their effectiveness. However, the proposed Technology and Innovation Centre has the capability to co-ordinate their activities and create synergies across the industry.

What lessons can be learnt from experiences within the UK and from other countries to date in supporting the development and deployment of marine renewables?

Several initiatives and test centres have already been launched. They include:

- — European Marine Energy Centre (EMEC).
- — Narec.
- — Wave Hub.
- — The Ocean Energy Development Unit (OEDU) at Sustainable Energy Authority of Ireland (SEAI).
- — Fundy Ocean Research Centre for Energy (FORCE).

The lessons learnt from these sites include:

- — Grid constraints can limit scale for small arrays. (EMEC)
- — No infrastructure was built until sufficient interest from credible developers was secured, which is a good way to mitigate risks of stranded investment in infrastructure. (FORCE)
- — Competitive tender approach to awarding berths promotes competition among developers. (FORCE)
- — Advisory committees ensure environmental and community stakeholders play an active role in the development of the project. (FORCE)
- — Disconnect between availability of facilities and technology readiness and incentives/funding, to enable companies to undertake demonstration projects using the facilities. (Wavehub)
- — Identify the gap in the wave energy sector and develop a test area for pre-commercial arrays. (Wavehub)
- — Regions can attract significant investment from both the private sector and R&D funding from the public sector—both from the UK and Europe. (Wavehub)
- — Provided Irish government and the Marine Institute/SEAI with a credible case study to promote at international conferences that has helped attract private sector investment into local businesses. (OEDU)

Is publicly provided innovation funding necessary for the development of marine technologies and if so, why?

RICS believes innovation funding is required for the following reasons:

- — There is good potential in UK waters for the production of electrical energy from both Wave and tidal sources.
- — The stage of development means that that if the technologies are to rely exclusively on “normal” tariff support such as ROCs, they will not be cost effective. This is particularly relevant to wave technology where there is a gap in the market, worldwide, for demonstration projects.
- — Private investors see Innovation Funding as proof of Governments policy commitment to supporting developing technologies.
- — Engagement at EU level could set the direction of calls from FP8.
- — Further funding from the New Entrants Reserve 300 (NER 300) is possible.
- — Government owned test and development facilities, such as Wavehub, are unlikely in the current financial environment. Innovation funding, to allow commercial partners to develop systems, is therefore more important.

What non-financial barriers are there to the development of marine renewables?

RICS believes there are a number of non-financial barriers to the development of marine renewables, including:

— The perception that waves and tidal energy projects have been under consideration for about 40 years, with little commercial success.

— The challenging marine environment, with technical difficulties related to working conditions, remote access, and the failure of many sub-sea anchoring and foundation systems.

— Environmental issues associated with marine ecology and benthic zones.

— Difficulty in reconciling new marine technologies with traditional marine users, and other marine sectors. (eg fishermen)

— The long development times from project inception, through design, scale testing, prototype proofing and deployment. It is still likely to be five-10 years before any significant commercial activity is likely in the Offshore marine renewables sector.

— Environmental Planning Legislation. To date, this has not been a significant factor in delaying Offshore Renewables. However, it has been, and continues to be, with regards to Onshore Wind Development, in some parts of the UK.

To what extent is the supply chain for marine renewables based in the UK and how does Government policy affect the development of these industries?

Supply Chain development is difficult but essential for an industry in a nascent condition.

Several organisations already exist to promote Supply Chain Development. The Global Maritime Alliance is Irish based, but has its headquarters in Northern Ireland and already operates in the UK market. NOF Energy, based in the NE of England has also been active in Offshore Renewables.

What approach should Government take to supporting marine renewables in the future?

RICS believes that future support should include, but not be limited to:

— The Offshore Renewable Technology and Innovation Centre, proposed by the Technology Strategy Board, is an important step in helping to support the future of Offshore Renewables in the UK.

— Continued implementation of the All Islands Strategy as proposed in June 2011 "The *All Islands Approach* to energy resources across the British Islands and Ireland aims to encourage and enable developers to exploit commercial opportunities for generation and transmission, facilitate the cost-effective exploitation of the renewable energy resources available, and increase integration of our markets and improves security of supply".

— The provision of data, to support further progress through stage gates.

— Innovative financing arrangements that manage the risk, without relying solely on core public funding.

— An integrated policy framework that recognises and takes account of environmental factors, without providing unnecessary impediments.

— Long term strategy planning and implementation. A lack of a transparent, long term strategy will adversely affect financing.

— The continuation of the Marine Energy Programme Board which was initiated in January 2011. It is an important part of the matrix of collaboration, to allow the marine renewables industry to develop in a coordinated way.

— There is a requirement at this time to describe how prototype arrays will be developed as they appear to be the next step beyond single devices

— Co-operation between technology companies is crucial at this stage of market development.

— There has been some talk about Marine Energy Parks but it is unclear what form they may take.

Please do not hesitate to contact me for further briefing or detail.

September 2011

Memorandum submitted by the Institute of Marine Engineering, Science and Technology

1. The Institute of Marine Engineering, Science and Technology (IMarEST) recognises that climate change is a most important threat facing the planet. The global community recognises that emissions of greenhouse gases and land use changes are resulting in significant warming of the atmosphere and the oceans. As a consequence, there is widespread acceptance of the need to mitigate global warming through control of emissions of greenhouse gases and to plan adaptation to the impacts of a changing climate. As an international professional body representing the marine sector, the IMarEST supports technically, economically and environmentally sound strategies and technologies for adaptation to the consequences of climate change. In addition the IMarEST is committed to:

- Encouraging recognition that human activities are contributing to global climate change, and that regional changes are likely to be significant;
- Fostering a responsible and knowledgeable attitude to climate change matters;
- Contributing to the climate change debate through its representation at bodies such as the International Maritime Organization, the Intergovernmental Panel on Climate Change, and the Intergovernmental Oceanographic Commission of UNESCO;
- Providing objective and independent expert advice to governments and intergovernmental bodies on marine aspects of climate change and climate change impacts;
- Supporting marine engineering and technological solutions with significant potential to achieve long-term reductions in anthropogenic greenhouse gas emissions; and
- Showing leadership in support of the development and deployment of clean marine energy technologies and energy efficiency.

The IMarEST firmly supports the continuing development and deployment of marine renewable energy technologies as a key initiative to help mitigate and adapt to the effects of climate change.

2. In this context, the IMarEST has established a Special Expert Group, governed by a Committee drawn from its members and overseen by the Institute's Technical Leadership Board, with a view to providing advice and supporting its membership in the rapidly growing field of Offshore Renewable Energy.

3. Pursuant to the request by the Select Committee for Energy and Climate Change, the IMarEST is pleased to respond to the Committee's questions regarding the development of marine renewables as set out below. This response has been prepared by members of IMarEST's Offshore Renewables Expert Group and reviewed by the Institute's Technical Leadership Board. The response represents their views and not necessarily those of all the members of IMarEST. Please also note that with regard to the financial aspects of the questions posed, the IMarEST, as a professional learned society and registered charity, chooses not to respond.

What are the potential benefits that marine renewables could bring to the UK and should Government be supporting the development of these particular technologies?

The headline benefits may be summarised as:

4. Marine renewable energy can provide a significant contribution to the renewable energy portfolio in the UK and thereby assist delivery of renewable energy targets. Government-commissioned studies (such as those by the Carbon Trust) have assessed the accessible resource for wave energy, tidal stream and tidal barrage schemes, and estimated that some 20% of the UK's electricity demand could be sourced accordingly. Provided that it can be demonstrated that the cost of delivery is affordable and competitive with other renewable sources, then the opportunity for marine renewables must be fully explored. The naturally occurring certainty of the tidal cycle offers an additional advantage because of its inherent predictability, therefore being a potential valuable provider of base-load generation capacity.

5. As a renewable energy source, marine energy will assist achievement of CO_2 emission reduction targets.

6. Similarly, marine energy will enhance strategic energy policy initiatives for security of supply through self-generation with no import requirements.

7. The UK is fortunate to possess an inherent maritime and marine capability, established through a long history of seafaring. In 2008, the Crown Estate published a report on the socio-economic indicators of marine-related activities in the UK economy across the complete marine industrial portfolio, including, for example, shipbuilding, maritime operations, ports, and oil and gas. This report states that in 2005–06 direct marine-related activities comprised 4.2% of the total UK GDP, at basic prices, to a value of £46 billion. It estimated that 890,000 jobs were marine-related (2.9% of the total), thereby constituting an overall contribution to the UK economy of between 6.0 and 6.8%. A marine renewable industry can clearly build on this expertise, preserve it, and indeed create a new sub-sector of competence, thus providing economic added value beyond the more immediate energy-generation benefits.

How effective have existing Government policies and initiatives been in supporting the development and deployment of these technologies?

8. By and large this is an early-stage industry in transition from R&D to commercial scale. The industry is following a classic pattern from the roots of entrepreneurial enterprise and academic research, to demonstration testing of prototype technology solutions and onwards to commercial development. A number of technology developers are at the testing stage of full-scale prototypes, and their next most significant step will be the demonstration of multiple devices in a small-scale array, which will then become the foundation for full commercial development. Demonstration arrays should begin to appear around 2015, setting the scene for commercial realisation by the end of the decade. The pace of development has been strongly influenced by the challenges presented by the harsh working environment, wherein the potential environmental impact is not yet understood.

9. Against this background, whilst government-led policies and strategies have clearly been well-intentioned, there is mixed success to report. At the front end of R&D, initiatives channelled through academic institutions and the Technology Strategy Board have provided entrepreneurial encouragement so that full-scale prototype test units are materialising. It is recognized that the challenge extends beyond simply the technology of a particular device, investigating the wider holistic aspects of device installation, operation and maintenance issues, including infrastructure studies. The onward transition to commercial status remains a challenge. For the longer term, encouragement for a market place is essential. There exists uncertainty in market conditions for future investor confidence.

10. The industry is at a significant transition phase. The majority of development has to date been on the devices themselves and has been undertaken by device developers (as happened with wind turbines at the start of the wind industry). What is now required is the take up of the devices by project developers (mostly energy generators). Project developers wish to buy a number of devices for their project "off the shelf", so to speak. They are not generally comfortable in contributing to the development of the devices themselves. Following the successful individual device-testing phase (the stage many devices are currently at), the industry will move quickly into Demonstration Arrays (commercialisation proving grounds) being taken forward by project developers (not device developers). These "test" arrays need to be commercially viable if they are to be attractive to project developers.

What lessons can be learnt from experiences within the UK and from other countries to date in supporting the development and deployment of marine renewables?

11. Within the UK the speed of development has been inconsistent; it depends on the approach and ambition of devolved authorities. Notably, the Scottish Parliament has forged a determined and leading path so that Scotland has currently gained recognition as the focal point for commercial opportunity. Key elements of its success in this regard include:

- Creation of areas for commercial exploitation, and associated licence awards for their development.
- An efficient regulating regime for their operation and environmental oversight.
- The presence of the European Marine Engineering Centre (EMEC) as the primary test centre for technology developers to prove their concepts.

12. Around the world where wave and tidal resources are prevalent too, eg, in the Americas, the Far East/ Pacific Rim, and Australasia, marine renewable energy development is progressing. The UK seems to have attracted the greatest levels of activity in recent years.

Is publicly provided innovation funding necessary for the development of marine technologies and if so, why?

13. As stated in our introduction to this response, with regard to the financial aspects of the questions posed, the IMarEST, as a professional learned society and registered charity, chooses not to respond.

What non-financial barriers are there in the development of marine renewables?

14. The marine renewable industry will face infrastructure challenges, especially with regard to grid, ports, and assembly and maintenance facilities. The industry has not yet gone through a sufficient device-proving phase to give project developers and investors confidence in moving to commercial pilot arrays. Device-testing centres are costly and not readily available. Efficient consenting and licensing is necessary too. Again the process is disparate and inconsistent depending on where jurisdiction lies, with the central UK government or with the devolved authorities.

15. There are concerns relating to the availability of qualified engineers, scientists, and technologists. The ERFF/NERC Skills Need Review (2010) (available from www.nerc.ac.uk) identified Renewable Energy Technology as one of its areas that has a "critical" shortage of postgraduate skills (one of only 23 areas out of 220).

To what extent is the supply chain for marine renewables based in the UK and how does Government policy affect the development of these industries?

16. It is clear that the supply chain could be wholly UK-sourced. The capability is here in the inherent marine and maritime expertise for design, for manufacture, deployment, and Operation and Maintenance, with transferable know-how from existing industries, including, for example, shipbuilding and oil and gas.

17. Government policy is crucial in its power of influence. Perhaps most importantly, if Government facilitated the right market conditions as a part of its total energy strategy, then industry would respond as it would naturally for attractive business opportunities.

What approach should Government take to supporting marine renewables in the future?

18. There remains scope for early stage development, for companies at pre-demonstration phase, but crucially now it is necessary to create the right market conditions for commercial deployments and to enable the transition from prototype stage to pre-commercial level. The industry is on the cusp of transition. The industry is at an "in-between" state where some prototype technologies have been demonstrated to give confidence that wave and tidal stream energy generation is feasible. The technology case still must prove that array-scale production can be achieved, and the commercial case is some way from competitive verification. However, for all this to happen, there are key aspects of policy and approach for which Government can provide leadership:

- At the top level, create a market scenario which gives the whole industry, and those who may invest in it, long-term confidence for its future.
- There is a fragmented and inconsistent approach to marine renewable energy in the government authorities in the UK. This manifests itself in, eg, uneven consenting processes.
- Bolster and support developing solutions and mechanisms to create a firm foundation and platform for the industry.
- Recognise the stage of development where the industry is currently at and the additional support this requires with the clear view of creating a global manufacturing base.
- Seek to establish whether a skills and resources gap can be bridged and catered for.

Are there any other issues relating to the future of marine renewables in the UK that you think the Committee should be aware of?

The IMarEST has nothing further to add to the above.

September 2011

Memorandum submitted by the Scottish Government

1. Scotland's wave and tidal energy resource is almost unparalleled, representing a quarter of Europe's tidal stream and 10% of its wave energy potential.

2. The wave and tidal energy sector is still at an early stage; however, it has made remarkable progress over the past three years. Wave testing started in Orkney in 2004 and tidal in 2007, and all EMEC's berths are scheduled to be full by 2012, and further demand is strong for the newly developed nursery sites. There are also firm plans in place for pre-commercial and commercial arrays of wave and tidal machines from 2014 through to 2020. Much of the scale-up activity will take place within the Pentland Firth and Orkney Waters Strategic Area following on from the award of commercial leases in the area. These leases, the first of their kind in the world, amount to 1.6 GW of potential capacity which could be built out by 2020.

3. These technologies can make a huge contribution to Scotland's and the UK's longer term renewable energy and carbon reduction targets. However, reducing costs will be absolutely crucial in terms of helping the sector become commercially competitive; this heightens the importance attached to the learning effects that will be a product of the prototype and pre-commercial plans currently being taken forward. This means that the next few years will be crucial for this sector, and why it is so important that the policies that are put in place continue to accelerate progress and incentivise investment as well as tackle the non-financial barriers that could threaten the future development of this vitally important sector.

What are the potential benefits that marine renewables could bring to the UK and should Government be supporting the development of these particular technologies?

4. Marine renewable energy deployment offers significant benefits to the UK and can make a significant contribution to future targets for renewable energy and carbon emissions. Independent research has shown that Scotland's wave and tidal stream energy resource could be as much as 33GW and it is estimated that Scotland is home to 10% of Europe's wave energy and 25% of its tidal energy resource. Even taking load factors into account, this represents the potential for close to 100 TWh per year—more than twice Scotland's current demand for electricity. It is now clear that the marine sector is now moving nearer commercial reality with 11

projects offering potential capacity of 1.6GW awarded leases as part of the 2010 Pentland Firth and Orkney Waters leasing round. These projects are now being taken forward through the planning and licensing process.

5. It is critical that Government continues to provide the appropriate support for these technologies. The marine energy industry does acknowledge that progress to commercial deployment has been slower than anticipated, primarily due to technical and financial constraints. However, the sector has made enormous strides over the past three to five years and the support that Government has put in place in terms of grant funding for technology, infrastructure for device testing and revenue support has been fundamental to this progress. It is essential that this momentum is maintained and that further progress is made in vital areas, including the deployment of the first early commercial arrays. The experience gained for the deployment of the first 5–10MW device arrays will be key to reducing costs, enhancing confidence in the technologies and creating a sector that is competitive with other sources of renewable energy. However, it is clear that the risk profile is still high and ongoing Government support is essential in order that we create the conditions that can support continued private sector investment.

How effective have existing Government policies and initiatives on marine renewables been in supporting the development and deployment of these technologies?

6. Scotland has led the UK, and indeed the world in recent years, through its introduction of enhanced levels of support for wave and tidal stream generation to the Renewables Obligation Scotland (ROS). Those bands are presently being reviewed, but in the context of Electricity Market Reform proposals from the UK Government which propose that the RO should be replaced from 2017. These reviews and proposals must combine to deliver a coherent and effective level of support and a system which is capable of bringing these technologies to a competitive and commercial cost basis. The Scottish Government would also wish to retain its existing responsibilities in setting the appropriate levels of support for the sector, which to date has been successful in attracting marine renewable projects to Scotland.

7. The Orkney based European Marine Energy Centre (EMEC) is the global leader for the testing of wave and tidal devices, and is still the world's only grid connected test centre for both the wave and tidal industry. From 2003, a public sector investment of £35 million has delivered a test centre that is now scheduled to be fully occupied with 11 full-scale prototype demonstrators in place during 2012. EMEC is recognised by industry and government as a global centre for research, testing and deployment of prototype marine energy devices and is a good example of extremely effective Scottish and UK Government intervention that has supported the deployment of these technologies.

8. Technology support provided through the Scottish Government Wave and Tidal Energy Support (WATES) and the subsequent support provided through the WATERS programme have also been successful in leveraging private sector investment and accelerating technological progress. Other UK measures including the Marine Energy Proving Fund and Marine Energy Accelerator have also been instrumental and effective in stimulating progress.

9. The Scottish Government has also launched the Saltire Prize, the £10 million marine energy challenge to the world. To date this initiative has been successful in raising the profile and potential benefits of the sector across the world. In fact, since its launch in 2008, 153 expressions of interest in the Prize have been received from across the globe.

10. With a view to supporting and driving forward projects in the Pentland Firth and Orkney Waters strategic area, the Scottish Government is working in partnership with The Crown Estate, Highlands and Islands Enterprise, Orkney Islands Council, Highland Council and industry, through the Pentland Firth and Orkney Waters Leadership Forum. This collaborative approach is proving successful in identifying challenges and finding solutions for projects within this strategic area which is also benefitting the wider industry as a whole.

What lessons can be learnt from experiences within the UK and from other countries to date in supporting the development and deployment of marine renewables?

11. It is important that international experiences are shared in this emerging sector as valuable lessons are being learnt with each deployment that is taking place. However, it is important to recognise the UK's lead in this area—for example, the scale of device deployment taking place at EMEC are unparalleled in comparison with any other area of the world. EMEC has been invited to form a strategic alliance with the Bay of Fundy FORCE facility in Canada and it has also been assisting the New Zealand authorities with plans for the emerging New Zealand Marine Energy Centre. It is clear that experience within the UK, and Scotland in particular, will be invaluable in informing future activity across the world and in assisting development of Government policy.

12. Valuable lessons have already been learned within the UK. For example, the marine Renewable Deployment Fund was created on the basis of over ambitious projections from the sector and was subsequently not drawn down. This demonstrates that Government intervention needs careful consideration and must be developed in close collaboration with industry and in full view of the realities of the sector. This is the approach that Scotland's economic development agencies are taking in conjunction with the Technology Strategy Board in developing a joint-industry project support model aimed at tackling some of the key challenges associated with array deployment.

Is publicly provided innovation funding necessary for the development of marine technologies and if so, why?

13. Immediate and ongoing technology support for device development and deployment is the most critical issue facing the industry at present. Although there has been extremely good progress in taking devices through to full demonstration scale, future development towards commercial array deployment will require significant levels of innovation in may vital areas—all absolutely critical in helping the industry to move down the cost curve. Continued public sector support aimed at focused R&D, across all aspects of the sector is essential. This view has been clearly articulated by industry through the recent report published by RenewablesUK which highlights the ongoing need for significant capital and revenue support. Coherent and co-ordinated action to address issues related to device reliability, survivability, installation techniques, inter-connection and anchoring can play a crucial role in reducing early project costs. Government needs to continue its collaborative discussions with public sector partners and agencies to ensure that R&D support is available, targeted and effective.

What non-financial barriers are there to the development of marine renewables?

14. There are several non-financial barriers to the development of marine renewables which include the following:

— Grid transmission charging and underwriting issues identified must be tackled effectively through Project TransmiT. The existing charging regime is a barrier to development and satisfactory and timely resolution will play a vital role in developing the sector. It is clear that the areas of richest marine resource lie adjacent to some of the weakest grid infrastructure. It is vital that grid charging mechanisms do not act as a disincentive to investment in marine renewables.

— Developing marine renewables in a manner that supports environmental sustainability is an important factor for project developers and a number of barriers can potentially impact development. The Scottish Government, through Marine Scotland has made some progress in this area to streamline and simplify the process for those seeking licenses to deploy devices. Marine Scotland has created a one-stop-shop for all marine license applications in Scottish seas with the aim being a consistent and co-operative approach to working with developers and a simplification of the process. Work is also underway to update the draft marine renewables licensing manual published last year. Marine Scotland is undertaking Locational guidance for marine renewables through a Sectoral Plan, Regional Locational Guidance and a sea bed mapping project, all assisting developers by guiding development to the right places thereby reducing costs to industry. However, more work is needed and more progress with regulatory bodies, including the Crown Estate Commissioners, and it is vital that the requirements on industry for expensive baseline surveying activity should be commensurate with the scale of the planned deployment. It is important not to deter or prevent SMEs from being able to pursue the opportunities which marine presents. This will require highly effective survey, deploy and monitor protocols which are currently being developed in Scotland.

— Appropriate infrastructure to support the manufacture, assembly, deployment and operations and maintenance of marine renewable energy devices is also a key constraint. The Scottish Government and its economic development agencies have developed a National Renewables Infrastructure Plan which takes a strategic and Scotland-wide approach to the development of appropriate infrastructure and good progress is being made.

— Skills and work-force development is a key issue for the sector. While this represents a huge opportunity, it is important that the mechanisms are put in place to address the future needs of the marine energy sector which is progressing in parallel with significant developments relating to offshore wind.

15. To explore in detail the issues facing the marine renewables sector, the Scottish Government established the Marine Energy Group (MEG). This group consisted of technology developers, utility companies, academia, EMEC, National Grid and the key public sector bodies. This group published its Marine Energy Road Map in 2009 which set out in detail the barriers facing the sector, and recommendations for overcoming these barriers. This Road Map can be found at the following link: http://scotland.gov.uk/Publications/2009/08/14094700/0

To what extent is the supply chain for marine renewables based in the UK and how does Government policy affect the development of these industries?

16. The fabrication and deployment of marine renewable energy prototype devices has already created opportunities for existing UK based supply chain organisations. For example, BiFab Ltd with bases in Fife and Arnish have been engaged in the construction of devices for Aquamarine Power Ltd and Hammerfest Strom. In addition, the Atlantis tidal turbine was constructed and transported to EMEC from the Isleburn facility in Nigg.

17. Government policy and action can influence the development of these industries and the associated supply chain opportunities. The National Renewables Infrastructure Plan that is currently being taken forward in Scotland is an example of this. Highlands and Islands Enterprise (HIE) is also piloting a technology specific supply chain analysis to assist Pelamis Wave Power (PWP) develop their manufacturing strategy for projects

in the Pentland Firth and Orkney Waters. HIE will use this information to inform infrastructure investment, influence production decisions, inform industry of opportunities and help support supply chain businesses grow into this emerging sector. If successful, this approach will be rolled out to marine developers with agreements for lease with potential funding input from SE and the Crown Estate.

What approach should Government take to supporting marine renewables in the future?

18. The future decisions surrounding RO banding levels and the revenue support that will be made available through EMR is of the utmost importance. It is critical that support levels are maintained at a level that will continue to stimulate and incentivise private sector investment. Leading wave and tidal companies in Scotland have secured significant investment multi-national companies including Alstom and ABB. However, it is clear that much more of this investment will be needed and this will only happen if the appropriate support landscape is created and maintained.

19. The sector has stated that the next phase of development—the deployment of small arrays on the 5–10 MW—will not take place without significant capital grant support, potentially on the scale of around £20 million per project. Identifying resources to support and enable this from within Government, the European Commission, potentially the Green Investment Bank as well as more investment leveraged from private sector capital remains a key factor.

20. The Scottish Government has also made very clear representations for the full and immediate release of the Fossil Fuel Levy funds that currently reside in an Ofgem bank account. These funds are now in excess of £200 million and breaking the current impasse could play a pivotal role in accelerating marine renewable energy, and other renewable technologies—with significant potential benefits for the UK and Scottish economies.

Are there any other issues relating to the future of marine renewables in the UK that you think the Committee should be aware of?

21. The Scottish Government fully supports ongoing activity to further promote the case for increased support for marine renewables within the EU. This is a primary focus of the British Irish Council Marine Energy Group (chaired by the Scottish Government) which is working in consort with the European Ocean energy association to make the case for marine energy to be adopted on the EU's Strategic Energy Technology Plan. The significant funding that can potentially be made available from the EU to support commercial deployment will be a critical factor in supporting the industry to maturity.

September 2011

Additional memorandum submitted by the Scottish Government

Marine Renewables Commercialisation Fund

- The £18 million Marine Renewables Commercialisation Fund will help develop Scotland's first commercial wave and tidal power arrays in Pentland Firth, Orkney Waters and elsewhere in Scotland.
- Scottish Government will consult directly with industry about the nature of the projects to be supported by the fund, through the re-convened Marine Energy Group (MEG), which will meet for the first time on 15 December 2011.
- This fund is part of the £35 million that Scottish Government and its enterprise agencies will provide for the marine renewables sector over the next three years to improve capability and infrastructure, as well as helping to fund technology solutions and the roll-out of marine arrays.
- This is Scottish Government's biggest financial commitment to the sector to date, highlighting its ongoing commitment to the industry as it strives to reduce costs and reach a level of commercial competitiveness with other renewable sectors.

Fossil Fuel Levy

- The Fossil Fuel Levy (FFL) surplus, currently worth £207 million, is money raised in Scotland to support the development of the Scottish renewables industry.
- In November 2011, the UK Government agreed to increase the Scottish Government's DEL cover by £103 million in 2012–13. The remaining FFL surplus is being made available to the UK Government towards the capitalisation of the Green Investment Bank.
- The FFL surplus will be used to promote renewable energy in Scotland and to help exploit its unparalleled natural resources. Key areas include; offshore renewables, community and local renewable energy, investment in district heating and developing the skills base that these growing sectors will need.
- In the recent Spending Review, Scottish Government has already proposed to provide over £200 million on renewables over the next three years. The additional funds will significantly strengthen current commitments and play a vital role in creating a longer term renewables legacy for Scotland.

- — Scottish Government will build on continued discussions with stakeholders, to ensure the funding is appropriately targeted and put to the best possible use.
- — Any future FFL surpluses will be split equally between the Scottish and UK Governments.

Notwithstanding these announcements, Scottish Government also believes there is still a need for considerable and ongoing levels of funding to be invested in marine renewables over the coming years.

December 2011

Memorandum submitted by RWE Npower Renewables Limited

1. *What are the potential benefits that marine renewables could bring to the UK and should Government be supporting the development of these particular technologies?*

The benefits of a diverse generation portfolio, incorporating a range of renewable energy technologies is already widely debated and documented. It makes sound and sustainable business sense to be investigating emerging renewable energy technologies, since it will not be possible to meet the UK's carbon emissions reduction targets through wind technology alone. However, it is not as simple as just adopting marine renewables as a commercially viable renewable energy resource and developing projects immediately, the sector is not mature enough for that stage of delivery. The sector has a number of significant challenges to overcome if it is to succeed in deploying genuinely viable arrays of wave or tidal devices.

In order to gain the benefits of marine renewables, industry and Government need to continue to build on the constructive relationships already established through the DECC Marine Energy Programme. Focus should be placed on making it happen by delivering the technologies rather than endlessly debating the risks. It is our belief that seeing functioning equipment in the water will bolster confidence across the development and investor communities, ultimately making it easier to achieve a bought-in utility sector, and a functional OEM sector presence in the market.

Economically, the UK stands to benefit from an opportunity to secure a domestically grown engineering and knowledge capability with significant global export potential. On this basis, it is appropriate that the Government supports the development of marine renewables via financial, policy and organisational means.

2. *How effective have existing Government policies and initiatives on marine renewables been in supporting the development and deployment of these technologies?*

Engagement with Government on the matter of committing public finances to the support of emerging technologies is a vital component of the process of commercialising innovation. The UK Government has formed a constructive working relationship with the marine renewables industry in the past few years, and by working closely with the developers and technology companies who are driving forward the projects that will deliver future renewable energy supply, effective and appropriate policy can be made which will support the industry to commercial scale.

It is reasonable to state that previous Government policies since 2002 have been ineffective in supporting the growth of the marine renewables sector, both in terms of generating investor interest and confidence, and in enabling developers to progress their plans for demonstration projects. One of the key reasons for this failing has been the issue of timing. The Marine Renewables Deployment Fund was arguably the right support mechanism at the wrong time. The 'market signal' generated a lot of excitement and activity in technology companies and their utility backers which whilst genuinely intentioned was naïve in its expectation of how much it would cost and how long it would take to deliver qualifying projects.

The existence of a specific support mechanism for marine renewables has benefited the industry by increasing investor interest in the sector, and encouraging project developers to progress with plans which may have previously not been considered. In this respect, the Marine Renewables Development Fund policy intervention was successful in drawing in developer interest. This success, albeit limited by developer inability to meet qualification criteria, does signal that appropriate policy and funding interventions genuinely does spur on interest and motivate organisations to embark upon development. The Marine Renewables Proving Fund has proven to be very successful in this respect, supporting several technology developers in the proving of their prototype devices.

3. *What lessons can be learnt from experiences within the UK and from other countries to date in supporting the development and deployment of marine renewables?*

The UK is leading the way for marine renewable energy projects. As such it doesn't have the immediate luxury of learning from other countries' efforts to commercialise marine energy technologies.

It is also important to note that the marine renewable energy resources native to the UK are the most significant in Europe, and more geographically concentrated than in other countries, hence this opportunity is a domestic one which can bring real, direct value to the UK economy. The UK wind turbine industry of the

70's was not lost to the Danish and others through failure to develop good technology but through failure to deliver a domestic market.

Within the UK Scotland has established a leading role in the policies promoting marine renewables with 5ROCs/MWh and 3 ROCs/MWh for wave and tidal stream respectively plus additional grant funding. The presence of the European Marine Energy Centre and the award of 1,600MW of seabed leases has created a hub of activity in northern Scotland as technology development and project development opportunities are relatively attractive. Improvements in the ROC banding for marine are needed in the rest of the UK to stimulate this sort of interest.

Elsewhere, the UK has a highly successful and well developed offshore industry borne out of the oil and gas sector. We are already seeing that vessels and personnel from the offshore industry are being called upon for their expertise and capabilities in the marine environment. At the same time, there is a growing base of offshore capability developing in support of the burgeoning offshore wind industry.

Whilst there is crossover with both of these more mature sectors, many of the key learnings are not immediately applicable to wave and tidal projects given the peculiar challenges of deploying technology in these highly aggressive and energetic environments.

4. *Is publicly provided innovation funding necessary for the development of marine technologies and if so, why?*

Public funding for innovation is an essential component of the financing package required to take devices from prototype to fully commercial, warrantied and marketable machines. The pre-commercial phase of technology development heavily relies upon the existence of either R&D budgets within large scale industrial organisations, or the development of technology by SMEs. We are seeing the latter case in the UK, with most of the major advances in the production of commercial marine energy devices coming from small to medium sized technology companies,. Government needs to continue to support innovation through its appointed public bodies since this support maximises the opportunity to accelerate the deployment of new technology.

The need for public innovation funding is in part to address the risks of investing in new technology, but it is also an important signal to the market that they will be making future investments into a sector which has the buy-in of Government, and is therefore considered likely to enjoy the certainty of future policies to support the growth of the market. Private funding from either utilities, industrials or from financial institutions is intrinsically linked to public financial support, as is the case with all existing forms of electricity generation, which are supported via revenue incentives. It has also been shown the first commercial demonstration projects (5–10MW) require multiple ROCs and capital grants to get the funding from private business's, based on the returns such investors expect.

5. *What non-financial barriers are there to the development of marine renewables?*

There are a large number of non-financial barriers which developers need to overcome in order to successfully develop and deploy marine renewable energy projects, but very few of these are insurmountable. The focus of the industry should be on removing barriers rather than being constrained by them. This can only be done through collaborative working with Government and wider stakeholders who can facilitate the removal of barriers through agreed measures of mitigation. Some of the key non-financial issues which developers need to consider are explored below:

> *Consenting*—Since marine renewables are in their infancy, the overall understanding of device interaction with the natural environment is still developing. Some interactions are more studied and better understood than others, but the consequence of this lack of extensive baseline data has led to an expectation by consenting bodies and NGOs that developers must fund and conduct lengthy surveys in order to be able to satisfy consent conditions. In organisations with limited development budgets, this can be difficult to achieve, especially when considering the economic case for pre-commercial demonstration projects where a return on investment is likely to be modest at best.
>
> *Technology & engineering*—There is not yet a single device which holds all the answers to tidal energy extraction, and we believe that this is even truer in the case of wave. These technological challenges can only be met with experience, and to do this, devices must be deployed, tested, and operated for a suitable length of time to prove their viability. It is only once the initially high capital deployment costs have been overcome that efficiencies can be accessed and the technology can move down the cost curve towards parity with existing, mature renewable energy technologies.
>
> There is an inextricable link between deployment and delivering cost efficiency. If there is insufficient support both in terms of policy and finance, the industry will remain stalled at the point of pre-commerciality.
>
> *Grid capacity*—the main resource locations within the UK are in the extremities. In particular in Scotland this presents a major problem in being able to export power from these locations to the demand centres. Investment in grid infrastructure and a fair charging regime is needed to ensure these projects can be connected affordably.

6. *To what extent is the supply chain for marine renewables based in the UK and how does Government policy affect the development of these industries?*

The UK supply chain is still in the early stages of developing to support the emerging wave and tidal sector. In many cases, this has already resulted in components and offshore services being procured by developers from overseas markets, including Europe and the Far East. This overseas procurement spans across a number of sectors, from raw materials to very specific gearbox components and complex steelwork fabrications. In short, there appears to be a lack of domestic capacity at present, to provide the emerging marine renewables industry with a supply chain capable of pushing forward deployment at a pace and cost which will enable deployment targets to be met.

There is a need for localised supply chains to support the growth of this sector, and we are seeing this begin to occur in the Pentland Firth and Orkney Waters region, supported extensively by the work of The Crown Estate. However, an issue which continues to be problematic is that of cost. Overseas markets which have more established supply chains are being looked to by project developers to reduce the cost of their projects. Some markets, principally China, are said to be capable of up to halving the cost of fabricating machinery and foundations. In light of this, a great deal of work needs to be done in order to build a domestic supply chain that can compete on cost and retain the value in the UK economy.

Some technology companies are already talking of carrying out fabrication in Asian markets for UK based projects—so the opportunity to address this is already beginning to shrink if we do not collectively act now.

7. *What approach should Government take to supporting marine renewables in the future?*

The UK Government has the opportunity to make a real difference to the rate of progress of the emerging marine renewables industry. This can be achieved in part by expressing support publicly for innovation, and by acknowledging the role of low carbon technology diversity in energy security.

Government should also adopt a position of leadership of the marine renewable agenda by being a visible sponsor. Investor confidence, along with corporate confidence is underpinned by long-term certainty, which can in part be achieved through straightforward, appropriate policy interventions, and clear messaging from Government around the real strategic importance of investing in new energy technologies.

By continuing to work closely in collaboration with marine renewable industry players, UK Government can design and agree an effective framework of co-operation which meets industrial and political needs. The sector now needs full engagement from all stakeholders, not just the observatory interest which we have largely seen to date.

Government should also continue to support the concept of Marine Energy Parks. There is a strong case for drawing together the appropriate companies to deliver marine renewable energy projects, as it is our view that the sector will never achieve its potential if left to individual organisations to pursue their own agendas. The development of Marine Energy Parks, in close collaboration with industry, will allow the development of a fit-for-purpose set of business conditions to enable the sector to grow. Emphasis should be placed on learning, management of knowledge, and ensuring that the focus is firmly placed upon delivering realistic projects to a sensible and achievable programme.

8. *Are there any other issues relating to the future of marine renewables in the UK that you think the Committee should be aware of?*

From our experience gained in the past five years, a two-tier information system appears to operate within the marine renewables industry. This has emerged because developers have often felt it necessary to present exaggerated claims about their technology to attract attention. Sometimes this has been deliberate, but it is also a symptom of an industry in the learning zone, where information may be thought to be correct, only later to be proven inaccurate. The consequence of this mixed-messaging is that when exploratory discussions begin to take place between developers and industrials, interrogative modelling reveals where these claims are unfounded, and decision making can suffer as a result.

The existence of Climate Change sceptics has led to dangerous undercurrents of scepticism towards emerging marine technologies. These undercurrents are damaging towards the credibility of the sector amongst potential investors, potential developers and the UK Government. Whilst a healthy level of scepticism is appropriate in some cases to moderate the occasionally inaccurate claims made by inexperienced developers, the more sinister sceptics are actually contributing to the problem of developing credible business confidence in the sector.

A recommended course of action to deal with this is a more co-ordinated approach by industry to establish credible, accurate and deliverable claims about the potential benefits of marine renewables, and educating key stakeholders and the media about this potential. In doing so, a shared knowledge base can be established and developer, investor, Government and public awareness and confidence can be increased. A feature which highlights the need for an expert panel for Marine Renewables within Government is the incongruity of many of the reports commissioned by DECC in recent years from various consultancies. These reports draw uncertain conclusions and serve to destabilise confidence by presenting different facts and figures, when really what is needed is a definitive account of the industry and its potential.

September 2011

Memorandum submitted by Wave Hub

1. Summary

1.1 Marine renewables has the potential to make a significant contribution to UK GDP and to future energy requirements. The UK currently leads the world in this emerging area. However, there are many challenges and achieving this will require sustained effort from both the private and public sectors. Developing the technology is costly and the time needed to adequately prove reliability and performance is long. These combine to make early stage projects hard to finance and the technology developers relatively unattractive for venture capital. Alongside of this, there are a number of non-financial barriers that add to investors' perceptions of risk. The Government's role in leading a strategic approach to the development of this nascent industry and providing the right market signals for the long term is absolutely critical.

2. *What are the potential benefits that marine renewables could bring to the UK and should Government be supporting the development of these particular technologies?*

2.1 The sector currently employs 800 full time employees in the UK. There are various estimates of the marine energy sector's long term potential to contribute to economic growth and renewable energy targets. The most recent are those from Renewable UK in their 2011 publication Wave and Tidal Energy in the UK: State of the Industry Report. This suggested that the sector could employ 10,000 people directly, draw investment of £3.7 billion per annum and provide GVA of £530 million per annum by 2020. By 2035 this could increase to an industry worth £6 billion per annum, directly employing as many as 19,500 people and contributing GVA to the UK economy in the region of £800 million per annum by 2035. By 2050, the sector could be worth £15 billion to the UK economy.

2.2 These potential economic benefits are obviously partly predicated on the contribution marine renewables can make to the UK's renewable energy needs. Renewable UK has estimated that there is developer appetite for 1.6GW of wave and tidal stream capacity to be in operation by 2020, with DECC's Renewable Energy National Action Plan including a target of 1.3GW for marine energy installation. As identified in DECC's UK Renewable Energy Roadmap, published in July 2011, this could increase significantly by 2050 with some 27 GW of potential capacity in the UK.

2.3 In 2010, the South West RDA commissioned the Offshore Renewables Resource Assessment and Development (ORRAD) project to deliver a broad scale, strategic assessment of South West England's potential to support the development of offshore renewable energy projects up to and beyond 2030. Specifically, the study identified areas of potential deployment for wave, tidal steam and offshore wind; it estimated the potential installed capacity by 2030; and produced a high level economic assessment. The study concluded that the marine renewable resource suitable for commercial utilisation in the South West is capable of delivering a total of 2.3GW of capacity by 2030, 1.2GW of wave and 1.1GW tidal stream. This study also concluded that this marine energy generation could deliver 2,500 jobs by 2030. This report is available on the South West RDA website at www.southwestrda.org.uk

2.4 Many of these economic benefits could be realised from the development of technology, production of devices, offshore installation, ongoing operation and maintenance, and the expertise in developing and financing projects worldwide. While this is a relatively new sector, many of the job opportunities can readily be developed from the UK's existing strengths in maritime and offshore engineering, consultancy and marine services. In addition, there is a significant opportunity for the marine energy sector to capitalise on the growth in offshore wind given many of the skill sets are the same.

2.5 However, these economic benefits will only be realised if the correct market signals are provided by Government and supportive actions taken over the long term to develop the UK marine energy industry.

2.6 Without doubt, the UK is the world leader in wave and tidal stream technologies and the global focalpoint for their development. Other countries are making progress in some areas but they lack the breadth of technology, testing facilities, research capability, technical know-how, and government support that combine to create the preferred location in which to develop the industry.

2.7 The UK is well positioned to retain this leadership position. We have around 50% of the available European marine energy resource—a prerequisite. We have a strong R&D base, the public sector having made strategic investments in testing facilities such as Wave Hub, EMEC and Narec, and in research capacity and equipment that is accessible to industry in institutions such as the Peninsula Research Institute for Marine Renewable Energy (PRIMaRE) in South West England. Government has provided critical funding to device developers through technology programmes such as Collaborative R&D run by the TSB and the Marine Energy Challenge run by the Carbon Trust. We also have experience in a range of relevant industries, such as oil and gas, offshore wind and marine operations. It is the combination of all of these ingredients that has enabled the UK to establish itself as the world leader in marine energy.

2.8 But other countries are targeting this sector and making relatively good progress. If Government genuinely wants to realise the potential economic benefits and ensure that its investments to date deliver for the UK economy, it must reinforce its long term commitment to the sector.

3. *How effective have existing Government policies and initiatives on marine renewables been in supporting the development and deployment of marine renewables?*

3.1 Over the past 20 years, the public sector has provided substantial support to the marine energy sector, investment that can be justified given the UK's position as the global leader in marine renewables. There has been a relatively strong national policy framework in recent years, through policies such as the 2007 Energy White Paper, the UK Renewable Energy Strategy and Low Carbon Industrial Strategy published by DECC and BIS respectively in 2009, and the Marine Energy Action Plan published by DECC in 2010.

3.2 More recently, DECC has established a UK Marine Energy Programme to put in place a coherent set of policies across Government to enable the marine energy sector to move from prototype testing to commercial deployment over the coming five years. Advice on this programme is provided by industry and key stakeholders through the Marine Energy Programme Board, which also provides a direct link with DECC Ministers. All of this is a welcome long term commitment to the sector but only if it is backed up by action.

3.3 Both the South West RDA and One North East have provided substantial support to the industry during their existence, both leading the development of, and investing in, vital testing facilities at Narec in Blyth and Wave Hub in Cornwall. Recognising the significant role universities had to play in developing the sector, the South West RDA also enabled a new research institute to be established, PRIMaRE, which is a partnership between the Universities of Exeter and Plymouth and offers significant research capacity and unique capital equipment. Other areas of focus for the South West RDA have included supply chain development, skills, workspace provision and inward investment.

3.4 With the England RDAs closing in March 2012, there is a concern that the level of expertise and investment provided by these Agencies to support the development of this industry will not be matched by local partners. The emerging Marine Energy Park in the South West, led by Cornwall and Plymouth City Councils, will hopefully be able to fill the gap.

3.5 There have been two successful policy initiatives in Scotland that have actually created a barrier to the development of marine energy in South West England. There is evidence that The Crown Estate's licensing in the Pentland Firth coupled with the availability of five Renewable Obligation Certificates (ROCs) for marine renewables in Scotland, compared with two ROCs in England, have distorted the market somewhat. It is hoped that the outcome of the Government's current ROC review will help to redress this balance.

4. *What lessons can be learnt from experiences within the UK and from other countries to date in supporting the development and deployment of marine renewables?*

4.1 Experience in Scotland demonstrates that investment in testing facilities, a strong R&D base, good financial support mechanisms and long term planning for the deployment of marine energy technology in the form of a licensing round provide exactly the right signals to the market. It is recommended that Government learns from this experience and, where appropriate, applies the same approach in England and Wales.

4.2 Experience in South West England also demonstrates that a comprehensive approach to the development of a nascent industry is essential. The South West RDA recognised there were several key ingredients to developing the marine energy industry in the region:

- Technology demonstration—the Wave Hub test facility for arrays
- Research—new research capacity and equipment through PRIMaRE
- Industrial acceleration—supply chain, skills and technology grant funding
- Workspace—business premises and targeting science and innovation centres
- Infrastructure—appropriate port facilities and grid capacity
- Strong home market—planning framework, licensing and ROCs
- Marketing—ensuring the region's offer is marketed internally

4.3 This programme of work was effectively delivered by a multi-disciplined team of marine energy, economic development, environment and planning experts, backed up by the leadership and investment commitment from the South West RDA Board. But, without extensive engagement and support from the industry and research community, the success to date in developing the industry in South West England would not have been possible. Partnership working across the public and private sectors is critical.

5. *Is publically provided innovation funding necessary for the development of marine technologies and if so, why?*

5.1 The potential benefits of owning a successful technology are clear but, from an investor's perspective, the diversity of marine energy technology is such that picking a winner is extremely difficult. Along with this, investors recognise the high cost and length of time it takes before the technology can achieve consistent positive cash flows. Financing the technology is therefore a significant challenge and one that is unlikely to be overcome without a willingness from Government to share the costs for several years to come.

5.2 Individual projects can sometimes attract support from utility companies seeking to build their expertise in the marine energy sector. However, the Government's electricity market reforms could actually reduce this interest since the utilities will no longer face the pressure from the Renewables Obligation. But, on the other hand, the changes could encourage other players, such as infrastructure funds, to get involved.

5.3 The aim for all technology companies should be to reach the stage where their machines can be utilised in large numbers without any direct or indirect public sector subsidy other than a level of tariff support. This will require considerable time and expense.

5.4 The Marine Energy Industry Forum (MEF), established by the South West RDA to oversee implementation of the region's designation in 2009 as the UK's Low Carbon Economic Area for marine energy, published a report in March 2011 called the Marine Energy Route to Commercialisation (MERC). The analysis in this report was based on a maturity model framework that was originally developed by Ocean Electric Power. This model illustrates clearly the entire development process for marine energy technology from concept to commercial viability and importantly, the timeframes and investment required at each level. The levels are:

1. Concept definition
2. Scale model testing
3. Functional engineering prototype devices
4. Validation prototypes
5. Commercial sales

5.5 Using this model, the MERC report made a number of observations and drew a number of conclusions in relation to financing which were based on MEF member's experience and perspectives. The report is attached for information but the main findings and conclusions were as follows:

- The transition from Level 2 to Level 3 requires a step change in financing as well as engineering and managerial skills, with the costs at Level 3 in the order of £20 million for a single device.
- The UK only has one indigenous industrial group with existing interests in developing and selling power generation systems. In addition, there are a small number of companies with a corporate venturing-type involvement in financing technology development. This means that the default position for technology developers in the UK is to rely on financing from a combination of government schemes and the finance markets.
- Technology development from Level 3 to Level 5 is incompatible with venture capital (VC) funding; the VC return requirements (at around 40% per annum) are too high and the proposition, particularly at Level 3, is too far from technology sales revenues.
- The length of time required to design, build, deploy and test sub-systems as well as full-scale prototypes means the period of cash burn is too long and the costs too high for all but industrial companies with lower costs of capital to consider. Even then, there is an assumption of some government support in the business plans of most industrial companies.
- The financing of companies at Level 4 may be possible using private equity, provided there is a supportive combination of capital grants and/or enhanced revenues; a supportive policy and market framework; and a strong likelihood that there will be market pull in the form of customers for the systems. This is principally because of the timescales involved; private equity rarely supports ventures that are three to four years away from technology sales revenues.
- Investment decisions by the large industrial companies and utilities need to satisfy the same criteria as their other investments. Policy measures are therefore required to create confidence that investments now have a strong chance of being rewarded in the future.
- Some large industrial players have expressed an interest in investing significantly in the sector once technologies are further advanced; they will not participate in "technology betting". Others have become involved at earlier stages, however competition within the large industrial companies for R&D capital is strong.
- Utilities want to purchase proven technology; their businesses are not rewarded for picking winners, particularly when there is no commercial benefit.
- Utilities want to buy from OEMs who are able to support and warrant their products in order to support their own financing.

5.6 Looking outside of the sector for experience elsewhere, research by Professor Joseph Lassiter at Harvard Business School (HBS Working Knowledge, Oct 2010) established that the requirements for the development of new clean-tech industries is very different from those in fields such as IT. He concluded that they require continuing active government involvement throughout each of the stages of the development of infant clean-tech industries, and that the future tariff levels and grant support are highly important to investors at all stages of technology development.

5.7 Further public funding is therefore undoubtedly required but care is needed to use these limited funds to gain the greatest benefit. On the one hand, very few devices can now envisage a multiple device project within the next few years. But there are some very promising designs at slightly earlier stages and it would be a mistake to allocate all the funds to the most advanced. The programmes of the TSB seek to bring together partnerships with industry and this does attract major UK companies into the sector as well as addressing some of the industry-wide issues of installation and development of components. This should continue. As designs become more advanced, it should be possible for government to develop more rigorous criteria for support including demonstrating whether, in the future, the technology can expect to become competitive with other renewables.

5.8 The timing of Government funding is also critical. With hindsight, the Marine Renewables Deployment Fund was way ahead of its time since the industry was nowhere near ready for a scheme based on multiple device projects. It is important that Government avoids repeating this mistake. In contrast, the Marine Energy Challenge that the Carbon Trust ran and also the Marine Renewables Proving Fund were both appropriate funding programmes for the stage the sector was at. Government has also provided useful funding support for the industry through the TSB, ETI and the various Research Councils. Helpful funding has also been provided at a sub national level, through the devolved administrations in Scotland, Wales and Northern Ireland and the English RDAs. Unfortunately, this delivery mechanism for England is now being withdrawn with the closure of the RDAs and it is not yet clear what will be able to match the delivery capacity and investment levels that RDAs provided the regions.

6. *What non financial barriers are there to the development of marine renewables?*

6.1 Any potential investor will look beyond the technology and ask whether governments around the world will be receptive to adopting this technology. The UK should do all it can to continue to signal its willingness to do so and encourage other nations to do the same.

6.2 Investors will be interested in the process by which the country makes areas of sea available for commercial projects and how consents are processed. The UK is well ahead of most other countries in terms of consents but the process for allocating commercial sites is unclear. This is in the remit of The Crown Estate which has allocated sites in the north of Scotland well ahead of suitable technology, or grid connection becoming available, and opportunities in Northern Ireland are now being offered. This is not a problem in so far as it encourages participation in the industry but it leaves uncertainty whether possibly more readily developable sites in Wales and England are, or are not, potentially available. All that is required is a statement from The Crown Estate that they will consider approaches for sites as and when the intended developers can show a business plan capable of being financed within a foreseeable timeframe.

6.3 The electricity grid is a second barrier. The UK grid system was built around coal, gas and nuclear generation in the central areas of the country with transmission and distribution networks to move the power to consumers. The grid is not configured to accept generation from the remote areas where the renewable marine resources are located. It is clearly unrealistic to expect significant investment in the grid until such time as the technology can show it has apart to play in the future energy mix. In the meantime, we will need to make the best use of whatever grid capacity is available and seek to benefit from improvements being made to connect offshore wind or the new nuclear programme.

6.4 A third area of some concern is the system for granting consents. To make an application for anything larger than a small single device requires an Environmental Impact Assessment. This is a highly detailed process of determining the baseline for many for many environmental factors at sea, in the intertidal zone and on land for the electrical cable. This is very costly but probably cannot be reduced, at least for a time. An equal concern is the amount of post-installation monitoring that can be required. This is understandable for early stage projects with new technology but there is concern amongst developers that not all monitoring is always strictly justified. There are two actions government could take, and to a degree some of this is already happening. Academic greater research funding could be more targeted to answering the challenges facing the industry. This is an important aspect of the Wave Hub project in Cornwall, enabling technology and its potential environmental impact to be demonstrated. This would reduce costs to developers and allow a rigorous, independent evaluation of the impacts of the devices. Secondly, the regulatory bodies could be encouraged to work with academia to build an increasing knowledge of what effect could be of concern and which, as time goes on, can be taken as being insignificant.

6.5 A further area is dividing up the sea. This is potentially contentious as the greater part of our coastline is intensively utilised. Clearly, major shipping routes must be safeguarded. There is every indication that shipping is, maybe with some reluctance, willing to accept the creation of tightly defined corridors around the coast provided safety is not put in jeopardy. At the same time pressures for protection and enhancement of marine biodiversity could so constrain the development of renewables as to make otherwise valuable resources undevelopable. A further major difficulty is likely to be how to achieve a sustainable fishing industry while also closing significant areas of sea to the fleet. It is intuitive to say that these closed areas will act as nurseries for commercial species but this is not yet proven. There is no quick answer to these questions and much may depend on the pressures facing future generations in terms of these possibly competing objectives.

6.6 Work by the South West RDA and the Regional Employment and Skills Partnership identified the likely demands on the workforce of future offshore wind, wave and tidal developments in the South West. Meeting this demand will require some new programmes at FE level and continuation of existing HE programmes. But the work also pointed to the national issue of insufficient bright people following careers in scientific disciplines.

6.7 Finally, port infrastructure needs to be considered. Marine renewables involves deep water ports with sufficient wharfage, lay down areas and handing equipment. These facilities are not universally available in proximity to all of the high energy sea areas. The immediate priority of meeting the needs of offshore wind may only meet this need to a limited extent and future plans for marine energy deployment should be factored in now.

7. *To what extent is the supply chain for marine renewables based in the UK and how does Government policy affect the development of these industries?*

7.1 The UK supply chain content for marine renewables is relatively high compared to, for example, offshore wind. This is due to several factors. Firstly, the industry is at an early stage and predominantly UK based, providing opportunities for UK companies to get in at the early stage of development and develop specific capabilities and IP. There is also close collaboration between technology developers, research institutions and supply chain companies as a result of successful programmes such as the TSB's Marine Energy Collaborative R&D call (co-funded by the South West RDA) and initiatives like PRIMaRE. The strength in depth the UK has in marine operations, subsea and marine engineering is also a clear advantage, with the manufacturing content of marine renewables being largely based in the UK. Finally the spend on consultancy and services has also been predominantly in the UK.

7.2 The strong UK supply chain indicates that the economic development strategy for marine energy has been working. We are seeing technology developers putting down roots in the UK; close collaboration between technology developers, academia and supply chain companies, which is creating a knowledge based industry; and we are seeing the beginnings of a manufacturing base. With funding from the South West RDA, a Marine Energy Supply Chain Directory has been developed and maintained by Regen SW and this is available on their website www.regensw.co.uk

7.3 A lot of work has been done by organisations like Renewable UK and Regen SW to encourage SME's into the marine energy supply chain. This has been very successful, the vibrant supply chain in South West England evidence of this. As the industry develops it will be equally important to encourage larger UK based companies to provide leadership in the industry. This is beginning to happen with companies such as Rolls Royce, Babcocks and A&P already actively looking for investment opportunities. But the Government priorities have a significant influence on where UK industry invests. It is therefore essential that the Government sets a very clear direction in support of marine energy and provides consistent long term backing for the industry. The clear lesson from the wind sector is that to sustain economic growth and secure a long term industry requires the development of a strong home market. Technology development without a strong home market will inevitably mean that the industry supply chain will gravitate to overseas markets as the industry matures.

7.4 The Government also needs to address the gap that has been created in England by the closure of the RDAs, otherwise the ongoing supply chain activity in Scotland, Wales and Northern Ireland will have a detrimental effect on England and result in displacement and even leakage to other countries.

8. *What approach should Government take to supporting marine renewables in the future?*

8.1 The Government needs to build on its strategic approach to developing the marine energy industry in recent years and step up its focus on addressing the challenges to deployment. The UK Marine Energy Programme provides a useful mechanism for doing just this, under the welcome leadership of the DECC Minister of State, Greg Barker MP.

8.2 Further targeted delivery capacity will be provided by the new Offshore Renewable Energy Technology and Innovation Centre (TIC), being established with the support of the TSB. This will hopefully be centred around the UK's testing facilities at Narec, EMEC and Wave Hub, and enable knowledge and expertise in offshore energy to be pooled and targeted research programmes to be developed across wave, tidal and offshore wind. As a matter of priority, the TIC should also provide a means of coordinating public funding and thereby avoiding the duplication of provision that is already available.

8.3 DECC's policy initiative of establishing a network of Marine Energy Parks will also help deliver this programme as it will help to pull the technology through to commercialisation through enabling deployment at a commercial scale, facilitating the development of clusters of connected companies and skills, and securing economic and other benefits for localities. Together the Offshore Renewable Energy TIC and the Marine Energy Parks should substantially enhance the comprehensive UK offer.

8.4 In addition to this strategic approach to delivering the UK's marine energy industry, Government also needs to:

- Introduce a five ROC incentive for both wave and tidal projects across the UK, addressing the current imbalance and therefore the distortion in the market. Whilst technologies remain experimental, a significantly enhanced level of price support is essential. The UK currently has a two-tier market under which a unit of wave power generated in Scotland can be sold for twice the price available in England and Wales. This market distortion inevitably signals investors to move north and if the country is to move ahead as one and make the best use of its available assets, grid capacity and limited public funds, it is essential that the whole country is put onto an equal footing.
- Continue to provide capital grants targeted at demonstration and early commercial scale projects.
- Proactively encourage investment in technology commercialisation by, for example, encouraging utilities to provide more funding for technology demonstration projects. The Green Investment Bank could also have an important role to channel finance into early commercial scale projects and provide a strong market signal to other investors.
- Support the ongoing development of a marine energy supply chain in England.
- Together with The Crown Estate and Marine Management Organisation (MMO), a clear commercial roadmap should be established to enable the deployment of commercial scale projects.

September 2011

Memorandum submitted by the Wildlife Trusts

Introduction

1. In principle, The Wildlife Trusts support the development of the marine renewables industry. However, The Wildlife Trusts believe that uncertainties exist regarding the levels of impacts of these technologies on the UK's marine biodiversity and therefore a precautionary approach needs to be applied to their development. To ensure the precautionary approach is applied, an assessment of environmental sustainability of the development should be undertaken which takes account of the:

- Risk of damage to marine ecosystems from development.
- Risk of damage to ecosystems as a result of unmitigated climate change.
- The net carbon impact of development.
- Any environmental benefits from development.

2. The Wildlife Trusts believe that the most environmentally sustainable approach for marine renewable developments is likely to be one that delivers a net reduction in carbon emissions while maintaining the integrity and function of marine ecosystems and avoiding damage to nationally and internationally important features. Nationally important marine features (including both species and habitats) are currently not adequately considered during the planning and deployment of marine renewables.

Positive Environmental Impacts of Marine Renewables

3. Marine renewables have a key role to play in meeting the UK's commitment of generating 15% of its energy needs from renewables by 2020, thereby helping to reduce the effects of climate change on biodiversity.

Negative Environmental Impacts of Marine Renewables

4. Different technologies have different potential impacts and therefore it is vital for the right technology to be developed in the right place.

5. The main sources of potential damage from wave and tidal devices are believed to be disturbance or displacement of key species during construction, and habitat loss beneath and adjacent to the installed devices. During operation the main risks are from injury and mortality through collision with moving components, disturbance due to operational noise, barrier effects, and changes to benthic habitats and loss of foraging areas.

6. For wind turbines the main sources of potential damage during the construction phase are similar, with a particular concern over the noise impacts of pile driving. Barrier effects, potential changes to benthic habitats and foraging areas are also considered important.

7. The risk of damage to ecosystem integrity and function from marine renewables has not been studied in detail. It is generally acknowledged that greater understanding is needed of a whole range of ecosystem components, including water column ecology and processes and the role of benthos and fish within wider ecosystems[59] to be able to adequately assess the impacts of marine renewables.

[59] UK Energy Research Centre, 2009, Spatial planning for marine renewable energy arrays workshops

THE FUTURE

8. The Wildlife Trusts believe that marine renewables can play a key role in reducing the UK's carbon emissions, thereby helping to reduce climate change impacts on biodiversity. However, The Wildlife Trusts recognises there is also uncertainty over the relative level of impact of such devices on our unique and internationally important marine biodiversity.

9. All developments must be subject to full environmental impact assessment and that where unacceptable impacts are predicted, alternative sites should be selected. The environmental impact assessment should also identify the most appropriate 'end use' where the appropriate level of decommissioning is identified which causes the minimal disturbance to the marine environment and allows restoration of habitats if needed.

10. Licence and consent agreements for marine renewable energy installations should include conditions requiring ongoing development and management of the site to be responsive to best practice recommendations emerging from research and monitoring programmes.

11. The Marine and Coastal Access Act (2009) which has established a new marine planning and licensing system and is establishing an ecologically coherent network of marine protected areas, must be fully implemented in order to ensure that marine renewables can contribute fully to sustainable marine development.

12. The Marine Strategy Framework Directive should be used as a tool to help direct marine renewable developers and the licensing authorities towards marine sustainability.

13. The current strong policy driver for maximising the potential of marine renewables could, if not informed by sound science, in the long term damage the sustainable development of the sector. We recommend that greater focus on the following areas would benefit both the marine renewables industry and the natural environment:

— **Cross-sectoral co-ordination—**greater co-ordination and shared objective-setting across the energy, climate change, biodiversity and marine sectors of government is required.

— **Precautionary principle—**economic and political drivers and the imperative for the rapid deployment of renewables to cut carbon emissions have resulted in the timing of developments pre-empting strategic consideration of their potential environmental impact. This is not an ideal situation and the precautionary principle should be used if there are uncertainties over the potential environmental impacts from a given development.

— **Protection of the functioning of the marine ecosystem—**Although efforts are being made to minimize risk to the environment, environmental sustainability and the Ecosystem Approach[60] are not at the heart of strategic decision-making. There is currently an over-reliance on mitigation rather than avoidance of sensitive areas. The important role of healthy marine ecosystems in natural carbon storage and in ensuring resilience to climate change needs to be promoted more. Design of devices to benefit marine biodiversity, which could be delivered at minimal cost, should also be prioritised.

— **Protection of nationally important marine features—**while the EU Habitats Directive ensures that a limited number of protected sites and species are taken into account in development decisions, there is still a concern that nationally important marine biodiversity is not adequately considered in decision making due in part to the urgency of marine renewables deployment.

— **Environmental data—**baseline data and understanding of impacts on habitats, species and ecosystems, although growing, is still lagging significantly behind development.

— **Cumulative impacts—**while the Habitats Directive allows, in principle, for the cumulative and in-combination impacts of development to be considered in respect of some marine habitats and species, speed of development and lack of baseline data will make such impacts difficult to assess. There is no mechanism for considering such impacts for nationally important marine features or, crucially, for ecosystem function.

— **Setting upper thresholds for development and adaptive management—**while the Habitats Directive allows, in principle, for developments to be scaled-back to reduce impacts on some marine habitats and species, there is no such legislative mechanism for nationally important features or ecosystem function. In the absence of sufficient baseline data to provide the necessary evidence, setting upper thresholds for development and scaling back or amending development will be difficult to implement.

— **Carbon impacts—**while initial estimates indicate that marine renewables will deliver a net carbon benefit, there should be a requirement to calculate and minimise adverse carbon impacts either as part of strategic development decisions or at project level.

[60] See Annex I for the Convention on Biological Diversity principles of the ecosystem-based approach to conservation

— **Community and other stakeholder engagement—**there is currently no independent expert scrutiny of key environmental documents, for example Strategic Environmental Assessment (SEA). Non-statutory stakeholder groups, for example communities and environmental non-governmental organisations, should be brought within the decision making process.

September 2011

Memorandum submitted by Campaign to Protect Rural England

Introduction and Summary

1. We welcome the opportunity to submit evidence to the Energy and Climate Change Committee on the future of marine renewables in the UK. As a leading environmental charity, the Campaign to Protect Rural England (CPRE) has worked to promote and protect the beauty, tranquillity and diversity of rural England by encouraging the sustainable use of land, coast and sea since our formation in 1926. We are concerned to ensure that development of marine renewables produces appropriate technologies and associated infrastructure while ensuring least cost to the environment. Our comments are therefore focused primarily on the environmental impact of marine renewables development. In order to maintain and enhance the beauty, tranquillity and diversity of England's land, coast and sea, we believe that a co-ordinated and strategic spatial planning approach should be adopted as marine renewables and associated infrastructure develop in the future.

General Comments

2. CPRE supports action to tackle climate change recognising the threat it poses to the character and quality of England's rural environment. We believe that promoting and improving energy efficiency while reducing overall energy demand are the first measures that should be adopted. We are aware, however, that energy efficiency and reduction alone will not achieve the ambitious greenhouse gas emissions reduction targets set by the Government. As such, we recognise the need to invest in, develop and exploit the potential of a diverse range of renewable energy sources, including marine renewables, to provide energy security and meet the Government's target of an 80% reduction in greenhouse gas emissions by 2050.

3. We are concerned to ensure that development of marine renewables and associated infrastructure does not threaten the beauty, tranquillity and diversity of England's seascapes. Seascapes[61] are defined as "an area, as perceived by people, of sea, coastline and land whose character results from actions and interactions of land with sea by natural and/or human factors." England has some of the most varied and interesting natural, cultural and historical seascapes in the world. They are a key component of our national heritage, valued for their natural beauty, for their habitats, their contribution to tranquillity and for recreation. They are critically important to our health and well-being, and contribute to national and local economies. CPRE strongly believes, therefore, that seascapes constitute a key aspect of the marine environment and should be an important part of a framework to underpin a sustainable approach to its planning and management.

4. The development of marine renewable energy and associated infrastructure is one of many threats to the marine and coastal environment. Other pressures include port development, increased volumes of recreation and tourism, and sea level rise which is also increasing the frequency and impact of flooding and erosion. It is imperative, therefore, that development of marine renewables and associated infrastructure are positively managed, to ensure we tackle climate change whilst conserving and enhancing our seascapes for the benefit of current and future generations.

5. Adopting a co-ordinated and strategic spatial planning approach will be crucial to ensuring that the infrastructure development, which will need to take place to support marine renewables, is taken forward in an environmentally sensitive way so that potential conflict over the public acceptability of such infrastructure is minimised. Developing marine renewables and associated infrastructure in a strategic and environmentally sensitive way will curtail unnecessary environmental and visual intrusion of the land-coast-sea continuum. This will require the consideration of alternative and appropriate sighting of new technologies, burying transmission lines underground or under the sea and using existing substations to keep levels of clutter and light pollution to a minimum.

6. CPRE is concerned that the existing regulatory framework, and wider market reforms designed to incentivise the development of offshore and marine renewables, are setting a pace which could undermine a co-ordinated planning approach. This could obscure the wider value of a strategically planned system that reduces the need for new infrastructure over the coming decades.

Conclusion

7. Development of marine renewables and associated infrastructure will be necessary if we are to meet the challenge of providing energy security, tackling climate change and protecting the environment. CPRE broadly supports the development of marine renewables as a low impact option if developed using a co-ordinated and strategic spatial planning approach which minimises their impact on the environment, and particularly on

[61] See "a manifesto for coasts and seascapes" (http://www.europarc-ai.org/Seascapes%20manifesto_A4.pdf) Last accessed 06.09.2011.

seascapes. Development of marine renewables and associated infrastructure needs to be pursued in the wider context of market reform and should go hand-in-hand with measures to improve energy efficiency and reduce overall energy demand.

September 2011

Memorandum submitted by the Countryside Council for Wales

Introduction

The Countryside Council for Wales champions the environment and landscapes of Wales and its coastal waters as sources of natural and cultural riches, as a foundation for economic and social activity, and as a place for leisure and learning opportunities. We aim to make the environment a valued part of everyone's life in Wales.

Thank you for giving CCW the opportunity to submit evidence to this inquiry. Our comments are made in the context of CCW's role as an advisor to government on policy and planning as far as that relates to the natural heritage of Wales and as a statutory advisor to licensing authorities responsible for the development of marine renewable energy.

The Terms of Reference for the inquiry invite comments on a number of matters and our submission focuses primarily on the approaches we believe Government should adopt to support marine renewables in the future, in so far as this relates to the natural heritage of Wales.

Summary

(i) CCW is Government's statutory advisor on nature conservation, landscape and recreational matters throughout Wales and in Welsh waters out to 12 nautical miles of the coast.

(ii) CCW supports initiatives which expand generation from low carbon sources while minimising unnecessary impacts on natural heritage, and works proactively with Government and industry to help deliver renewable energy development

(iii) Marine renewable energy developments (wave, tidal stream, tidal range) represent potential risks to natural heritage and therefore project consenting. However, the risk of impacts may be avoided or mitigated by careful siting of deployments or through operational controls. Furthermore, experience from the early deployment of offshore windfarms has shown that strategic planning can help to avoid significant impacts provided it is based on rigorous assessment supported by good evidence and robust research.

(iv) Marine Planning, to be implemented under the requirements of the Marine & Coastal Access Act 2009, will be an important process for guiding the future development of marine renewables. The publication of locational guidance and environmental criteria for assessing marine renewables proposals would also help to guide appropriate technologies to suitable locations.

(v) The Offshore Energy SEA and Welsh Government's Marine Renewable Energy Strategic Framework are valuable strategic assessments that will help reduce the consenting risks to individual projects however, gaps in the evidence base remain. More information is needed about the habitats and species that are likely to be affected by marine renewables and the consequences of interactions between the environment and these technologies. Whilst allowing a better understanding of the environmental risks of projects, improving the evidence base would facilitate assessment of projects by developers and therefore support more efficient decision-making.

(vi) Considerable research into the potential effects of offshore renewable energy (wind, wave and tidal) is already underway; some of this is focused specifically on marine renewables (wave and tidal) and some of the research into the effects of offshore wind has relevance to marine renewables. However, coordination, prioritisation and a better sharing of information is needed to avoid duplication and ensure the necessary focus on key issues.

(vii) Opportunities for coordinating the collection of environmental information by industry with that gathered by Government for wider assessment purposes should be explored.

(viii) The growth of marine renewables and other areas of priority marine work has significant resource implications for statutory advisors and additional funds are likely to be needed to ensure that advice can be delivered to decision-makers in a timely and efficient manner.

Background to CCW's Interest in Marine Renewables

1. The Countryside Council for Wales champions the environment and landscapes of Wales and its coastal waters as sources of natural and cultural riches, as a foundation for economic and social activity, and as a place for leisure and learning opportunities. We aim to make the environment a valued part of everyone's life in Wales.

2. CCW is the Government's statutory advisor on sustaining natural beauty, wildlife and the opportunity for outdoor enjoyment in Wales. CCW was created by the Environment Protection Act 1990 to provide advice on

nature conservation, landscape and recreational matters (natural heritage) throughout Wales and in Welsh waters out to 12 nautical miles of the coast. Our comments are made in the context of CCW's role as an advisor to government on policy and planning as far as that relates to the environment and as a statutory advisor to planning and licensing authorities responsible for the development of renewable energy.

3. CCW was a member of the group convened by DECC to develop the Marine Energy Action Plan and examined barriers to the development of the wave and tidal technologies and is a member of the Offshore Renewable Energy Licensing Group hosted by the Marine Management Organisation. CCW also contributed significantly to the DECC-run Severn Tidal Power Feasibility Study set up to enable Government to decide whether it could support a tidal power scheme in the Severn Estuary.

4. CCW has provided advice to the National Assembly for Wales Environment and Sustainability Committee inquiry into Carbon Reduction and Energy Generation in Wales in 2008[62] and will also be submitting advice to the forthcoming inquiry by the same committee into Energy Policy and Planning in Wales. These inquiries address some issues that are similar to those of the current DECC inquiry and copies of CCW's submissions can be provided upon request.

CCW's Approach to Renewables

5. CCW's interest in energy stems from the fact that its generation, in all its forms, leads to environmental impacts. Generating energy from fossil fuels releases carbon dioxide and other greenhouse gases, contributing to climate change. Acidification, and increasingly eutrophication, as a result of fossil fuel burning remains a major concern. Renewable energy sources, while not creating such pollution, can lead to other environmental impacts which, depending on the technology involved, can take the form of changes to the landscape, seascape and biodiversity.

6. In a position statement on Energy and Natural Heritage,[63] CCW set out its support for initiatives which expand generation from lower carbon sources while minimising unnecessary impacts on natural heritage. To accommodate this imperative, it will often be necessary to reconcile the need to accept some local impacts on our natural heritage in the short term in order to secure a lowering of emissions from energy generation, whilst ensuring that the legal requirements to protect the environment are upheld.

7. In the context of energy generation, CCW's role is to provide independent, evidence based advice to Government, regulators and developers on the potential impact of strategic policy, plans and programmes and individual developments on natural heritage. In practice CCW believes that Government and other decision–makers, with the support of their advisors, should aim to steer the right kind of development to the right place.

8. CCW works proactively to help deliver renewable energy development and achieve low carbon energy goals. CCW works at a strategic level with government, regulators and developers to share knowledge and experience, and to develop research and consenting procedures. The statutory nature conservation agencies also work collaboratively to ensure a joined up approach to environmental advice across the UK. CCW also encourages early engagement with developers at a project level to identify, mitigate and resolve environmental issues.

Marine Renewables and Natural Heritage

9. Many of the high energy areas identified as suitable for the deployment of marine renewable energy technologies also support biodiversity and habitats that are of nature conservation importance and are protected by legislation which requires that significant damage or disturbance is avoided. Some of these areas will also have significant landscape and recreational value which may also be sensitive.

10. There is therefore significant potential for damage to natural heritage from deployments of marine renewable energy infrastructure. Uncertainty about some impacts and the level of precaution required by some environmental legislation are also challenges to decision-makers. However, experience from the early deployment of offshore windfarms has shown that planning can help to avoid significant impacts provided it is based on strategic assessment supported by good spatial evidence and robust research.

11. Furthermore, despite the considerable uncertainty about the environmental impacts of wave and tidal devices it is possible to deploy in sensitive areas under some circumstances. Evidence for this comes from the recent approval for a tidal stream device in an area off the West Wales coast that is of high importance to species and habitats protected under the Habitats Directive. By adopting an adaptive management approach to deployment that also incorporated robust safeguards for the local wildlife and habitats it was possible to mitigate the potential effects of deployment.

12. However, because marine renewable technologies are new and evolving, questions remain about the potential implications for the environment especially where deployments are at a large scale. We have identified below a number of key issues that CCW considers should be addressed to support robust and timely planning

[62] National Assembly for Wales Sustainability Committee Inquiry into Carbon Reduction in Wales: Energy Generation Large Scale Renewable Energy Developments 13th November 2008

[63] Energy & Natural Heritage. CCW Position Statement. 2008.

and consenting of deployments. In doing so we have highlighted a number of approaches that should be beneficial to the future planning, consenting and assessment of marine renewable energy developments.

Planning for Marine Renewables

13. Recent publication of the UK Renewable Energy Roadmap and publication by Welsh Government of its Energy Statement "A Low carbon Revolution" in 2010 has helped to clarify Government's desire to see marine renewable technologies as part of the overall energy generation mix. However, Government could further clarify what processes will now be developed to promote marine renewables and how advisors and other stakeholders might become involved to help ensure deployment in line with the principles of Sustainable Development.

14. Planning for marine renewables needs to be integrated with the requirements of other activities and uses, and within a planning framework that addresses both the requirements of energy policy and the needs of the environment. Planning for marine renewables should therefore take place within the emerging Marine Planning framework which will allow decisions to be taken in line with the wider marine policy context. Marine Plans are now under development and Government should consider how the development of the sector should be promoted within this new system of planning.

15. Large scale marine renewable energy development will require corresponding development of the electricity transmission network both on and offshore. New transmission infrastructure requires careful planning at a strategic level, taking account of the potential implications for natural heritage, to avoid difficulties at the project level in deploying individual parts of the network. The publication of the Offshore Development Information Statement (ODIS) by National Grid is an important and positive step towards the development of a more strategic and coordinated view of the deployment of future transmission infrastructure.

Assessment of Environmental Impacts at a Strategic Level

16. All developments will be assessed at the project level but CCW believes that the ability to consider environmental effects more strategically can help to significantly reduce environmental and consenting risk. CCW therefore places great importance on strategic assessments such as Appraisal of Sustainability and Strategic Environmental Assessment as rigorous, structured and open evaluations of the effects of development plans and programmes.

17. Although it is possible to manage the effects of marine renewable development on the environment, in some circumstances it may be necessary to avoid developing in areas that support sensitive natural heritage. CCW believes that this is best achieved through planning and assessment at a strategic level and considers that the development of locational guidance—based on both spatial information about sensitive resources and criteria for detailed site specific assessment—is critical to ensure that the right development is located in the right place.

18. In 2005, the DTI published guidance on consenting arrangements for pre-commercial demonstration phase wave and tidal stream devices[64]. CCW were supportive of the guidance as it clearly set out the consenting and assessment requirements of the decision-making process for developers. However, changes to legislation and responsibilities for consenting mean that these guidelines are in need of updating. In doing so Government could also provide developers with guidance on the key criteria (eg choice of location, impacts that should be avoided and approaches to EIA and mitigation) by which projects will be assessed and might usefully draw on approaches underway in Wales and Scotland designed to support the renewables sector in developing individual proposals.

19. In particular, CCW would draw the inquiry's attention to the Marine Renewable Energy Strategic Framework (MRESF)[65] recently published by Welsh Government to identify the location of development opportunities alongside the potential for consenting risk as a guide to industry and policymakers. This study is an important example of the information that will be needed to support the development of the marine renewables industry in a way that allows robust consideration of the risks to the environment.

20. Critical to the success of the MRESF approach has been the ability to predict potential conflicts between marine renewable energy devices, natural heritage and other users of the marine environment. The MRESF has used what information there currently is about the natural heritage that is likely to be affected by deployments, but there are gaps in this information. There is also an absence of empirical observations of the interactions between devices and wildlife (such as diving birds and mammals). To overcome this, the MRESF has utilised novel work by CCW to derive predictions about the likely impacts[66]. The development of such work is at an early stage and further refinement would contribute significantly to the development of the wider evidence base needed to support future decisions about marine renewable energy.

[64] Guidance on Consenting Arrangements in England and Wales for a Pre-commercial demonstration phase for Wave and Tidal Stream Energy Devices (Marine Renewables). DTI 2005.

[65] Marine Renewable Energy Strategic Framework. Approach to Sustainable Development. Report by RPS to the Welsh Assembly Government. 2011.

[66] Natural Heritage Evidence to Support Planning for Marine Renewable Energy. CCW Policy Research Report No. 11/3. 2011.

Developing the Evidence Base

21. As described above, marine renewable energy developments involve new technologies and modes of operation and there is currently considerable uncertainty about whether their construction and operation will result in significant damage or disturbance to important habitats and species.

22. The ongoing process of Strategic Environmental Assessment (SEA) for offshore energy has proved invaluable as a process for reviewing evidence and guiding future research in relation to oil and gas and more recently offshore wind. CCW responded to consultation on the Environmental Report from the latest Offshore Energy SEA and highlighted the lack of detail about what research and development is needed to support planning and consenting of marine renewables. In publishing the Offshore Energy SEA it will be important for Government to confirm the priorities for future research into the effects of marine renewables and how that might be funded.

23. To better understand the environmental risks associated with marine renewables CCW believes there is a need to:

(i) develop a strategic and coordinated programme of environmental research similar to that established for early offshore wind farm development under the COWRIE programme (see our comments below in relation to the recently established Offshore Renewable Energy Licensing Group);

(ii) maximise and make widely available the learning from deployed demonstrator scale projects to help confirm or eliminate potential impacts and begin to address issues associated with larger scale wave and tidal stream arrays;

(iii) support the assessment of wave and tidal technologies (and offshore wind) by improving the baseline data that characterises inshore natural heritage resources that are most likely to be at risk from marine renewables developments and, for tidal stream technologies in particular, develop ways of assessing the risks of collision and disturbance to mobile marine species;

(iv) in the case of tidal range, draw on the extensive evidence base gathered for the Severn Tidal Power Feasibility Study to more comprehensively identify and understand key generic impacts and information gaps for tidal range technologies (eg implications of habitat loss, changes to coastal processes, effects on fish migration and the success of mitigation).

24. A wide range of important research is already underway but it is important that information about research programmes is shared to develop the evidence base as quickly and cost effectively as possible. The Crown Estate, through their "Strategic Workstreams" programme and work underway in a number of academic and technical institutions is undertaking research to improve understanding about the environmental effects of offshore renewables. Much of this is focused on improving our understanding of the effects of offshore wind but there are synergies with the development of the evidence base for marine renewables.

25. Significant programmes of research into the effects of marine renewables are underway in Wales and Scotland and a number of testing centres have been established that, in addition to technological development, are also an opportunity for environmental research and monitoring.

26. The establishment of the MMO-led Offshore Renewables Energy Licensing Group (ORELG) has been a useful step in coordinating regular discussions about the priorities for supporting the consenting of offshore renewable energy projects. The work of the ORELG is essential to maintain an overview of the planning and consenting issues facing marine renewables and, although not necessarily responsible for carrying out research itself, should help to target future research effort.

27. The information needed by the marine renewables industry to support planning and consenting decisions and the evidence needed by government to inform wider assessments of the state of the marine environment often overlap. For instance, long term data about the marine environment is needed to contextualise the effects of development before a decision can be taken, and projects can be delayed whilst this information is collected. One of the aims of the UK Marine Science Strategy[67] is to bring about better coordination of policy priorities, research programmes and funding. Potential synergies between government and industry processes for gathering information about the marine environment should be explored.

Implications for Statutory Advisors

28. The growth of marine renewables has significant resource implications for those who advise Government and other regulators about the effects of development, including the statutory nature conservation bodies.

29. CCW is already under significant resource pressure in providing advice to a wide range of renewable energy projects on and offshore, and the advice requirements for other energy infrastructure (eg grid, nuclear) has also grown significantly. In addition, CCW's wider marine work is expanding significantly to accommodate priority government work (for example implementation of Marine Spatial Planning, the Marine Strategy Framework Directive, and securing a well managed ecologically coherent network of marine protected areas).

[67] UK Marine Science Strategy. Shaping, supporting, co-ordinating and enabling the delivery of world class marine science for the UK. 2010–25.

30. CCW, along with other statutory advisors and regulators, is in discussion with DECC about the need to ensure that the work of statutory advisors on offshore renewable energy is adequately resourced. We would advise that without an increase in resource from Government or from developers (either directly or indirectly), the ability of CCW and other statutory advisors to deliver advice in an efficient and timely manner is likely to be impaired.

September 2011

Memorandum submitted by Low Carbon Developers

Introduction to Low Carbon Developers

Low Carbon Developers is a development business which encompasses Low Carbon Solar, Low Carbon Wind and Low Carbon Tidal, founded in 2010.

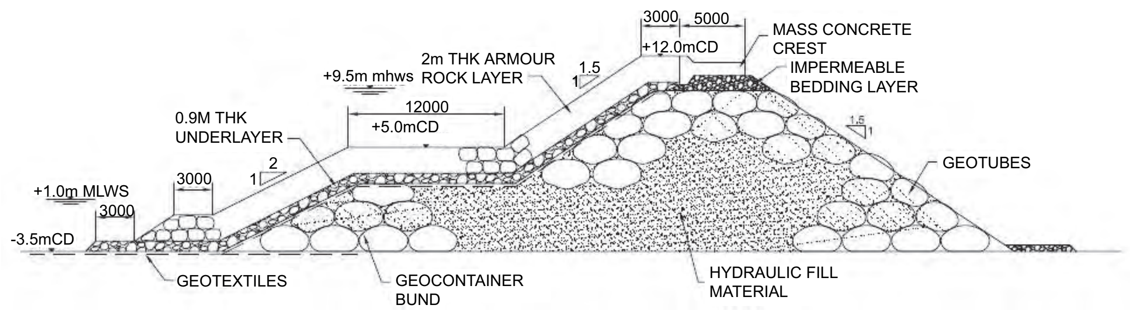
Our company ethos and ambition is to join individuals to renewable energy at scale by offering investment into renewable energy projects from our home-grown development teams. We are focussed on changing the energy mix to large scale, lower cost renewable energy technologies with a particular preference for tidal lagoon, tidal stream, small and large scale wind and solar (both solar thermal and solar pv).

In 2010–11 Low Carbon Solar has so far developed and funded the deployment of £70 million of solar energy, totalling 26MW and Low Carbon Wind is currently organising the build out of a 16MW wind farm.

Low Carbon Tidal will seek to harness the predictable renewable energy from UK tides through the deployment of both tidal lagoon and tidal stream projects. Our ambition is to enable the UK to realise its natural potential to be a world leader in tidal energy, whilst creating an export industry and large scale employer. At scale we believe tidal energy can provide lowest cost green energy to the consumer.

Tidal Lagoons

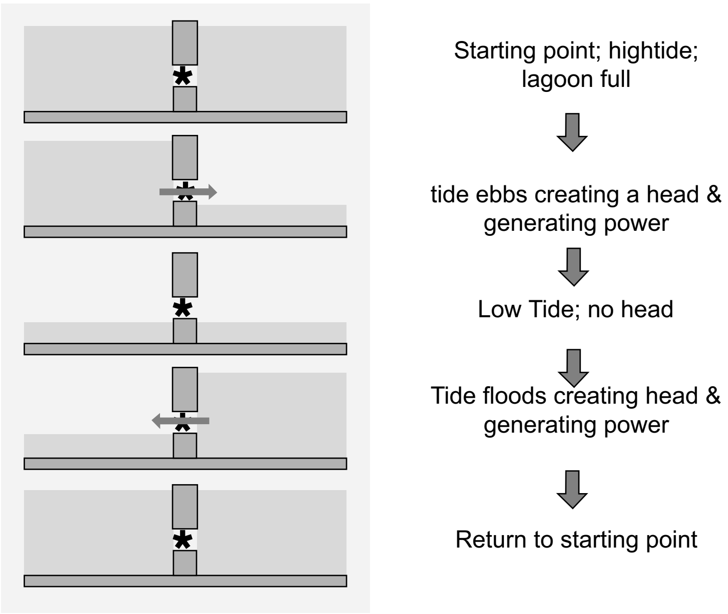
We have commenced our tidal activities by pursuing tidal range developments using a technology referred to as tidal lagoon or impoundment. A tidal lagoon is a manmade structure in the sea that harnesses the natural rise and fall of the tides to generate power through "low-head" hydro power turbines. Tidal lagoons can generate electricity four times a day as there are two flood and two ebb tides every 25 hours. The times of the tides are known and predictable, so the energy can be supplied to the grid consistently and reliably, or stored and released in accordance with instant demand needs. The tidal lagoon impoundment wall is constructed using dredged sand from the sea bed which is compacted and encapsulated in geotubes. On top of the geotubes are small rocks and then larger rock armour.



Tidal lagoons generate hydroelectric power using conventional marine construction technologies such as Kaplan or bulb turbines and proven methods and materials. Our proposal is to adopt geo tube marine construction technologies, widely used in Asia and southern USA but to date not deployed in any scale in the UK, which will enable us to pursue tidal lagoon projects that are cost effective.

Tidal lagoons offer the UK a source of clean, reliable power able to be deployed at scale over the next five years and beyond; a significant opportunity in today's political and environmental climate. The development of highly-efficient bi-directional turbines will also stimulate and drive British design and manufacturing.

How a Tidel Lagoon Works



Response to Specific Committee Questions

What are the potential benefits that marine renewables could bring to the UK and should Government be supporting the development of these particular technologies?

The UK has the second largest tidal range in the world, second only to the Bay of Fundy in Canada. As water accelerates over the 200 mile continental shelf to the West of the United Kingdom a large body of water enters a relatively shallow pool to bring with it wave energy and tidal range.

The average incoming power of lunar tides around the West coast of the UK has been measured to be 250GW. If we were able to extract just 10% of this energy there would be potential for 25GW of power to be generated around the UK using tidal technology, with many of the best sites offering large tidal ranges close to population centres, requiring minimal transmission of the energy generated.

The two main locations for large tidal lagoons in Britain are the Wash on the east coast, and the waters off Blackpool on the west coast. Smaller facilities can be built in north Wales, southwest Wales, Lincolnshire and east Sussex. The tidal time differences between these locations would also allow for constant generation, contributing to the UK base-load demand as well as enabling peak demand response.

Essential and fringe benefits of tidal generation are as follows:

1. Home grown, inexhaustible and predictable energy supply.
2. Can deliver 24 hour baseload, with tidal incidence varying around the UK coast.
3. Peak power with long term potential to be the lowest cost to consumer.
4. A source of large scale marine energy storage.
5. Enhanced security of supply.
6. Encourage manufacturing and services, including production facilities near marine plant locations, resulting in job creation.
7. Coastal defence protecting coastal villages and coastal-based power stations. Designs will work in climate change adaptation to lessen the impact of future sea level rise, providing an opportunity to protect our cultural and marine heritage through an industrial revolution mark II.
8. Enclosed and sheltered water can create a new space for many kinds of water sports, enhancing local amenities.
9. Position the UK as a global centre of excellence for marine energy.
10. Tidal generation will enable us to provide a global example of low carbon living.

11. Highly carbon-efficient power generation; tidal lagoon carbon lifecycle assessment is estimated to be in the region of 1.6–2.4gCO_2/kWh; lower than wind, solar and nuclear. Recent studies on the Severn Barrage suggest carbon payback could be in the region of 5–8 months.[68]
12. Contribute to the Treasury's Coastal Communities Fund—marine energy developments offer a significant source of revenue to bolster this fund and create a virtuous circle of coastal regeneration and climate adaptation. Licensing fees from tidal lagoons would significantly enhance Crown Estate marine revenues and result in additional revenue to coastal communities for regeneration and developing renewable energy.

In summary, tidal generation would not just deliver a low carbon power source, but set in motion a series of coastal developments that will bring together multiple benefits to materially help create a sustainable UK.

How effective have existing Government policies and initiatives on marine renewables been in supporting the development and deployment of these technologies?

Following the previous Administration's Marine Action Plan and the subsequent election of last year, there has been a hiatus in activity. We understand however that a Marine Energy Action Programme Board has been established to address this, which has so far held 2 meetings, but defined membership of the board or its remit are yet to be determined. (NB we are not currently involved in this group but are seeking a position within it as a developer).

There is strong support for the commercialisation and development of marine technology across the UK administrations, however, we would argue that this rhetoric is not reflected in current policy and funding developments:

— Recent announcement of £20 million for Marine technology innovation is very much at the lower end of what is required, with it being anticipated that only two projects will be funded from this at a demo scale of 3–5MW.

— Focus on tidal stream technologies may prove ambitious vis a vis our energy needs in the next five years, as they require extensive research and development capital and time in the water, as well as considerably higher costs to achieve the scale of generation we need to develop UK energy security. All of which is expensive and which needs a larger government impetus.

— We believe tidal stream plants cannot come on line prior to 2016 at anything more than sub 20MW scale, with 100MW+ scale around 2020, assuming government offers enough support to the market for those initial deployments. To note and for reference Korea and Canada both have good tidal ranges and strong stimulus packages for tidal stream and are set to dominate the market.

— The Electricity Market Reform (EMR) White paper only refers to tidal technology once as an example of renewable technology required for our longer term energy mix (deployment only minimal to 2030), as opposed to our analysis which we believe points to the potential for excess 4000MW of tidal lagoon installed by 2020 and a circa 800MW of tidal stream (the latter requiring more investment in technologies now).

— No clear future roadmap for industry—no industrial strategy to make Britain the world leader has been championed.

There is however an opportunity in the forthcoming ROC banding review for tidal lagoons and tidal stream to be profiled and appropriately supported, and we welcome the review that is aimed at enabling greater transparency of financial incentives. For information, we are trying to make all economics work for tidal lagoon sites at existing 2 ROC tariff levels, but will, in all probability need some form of grant, Treasury investment or a 3 ROC tariff for the initial two prototype lagoons to be able to secure their all equity funding. The initial prototype sites are Swansea Bay and Colwyn Bay.

Our challenge within the policy context is to prove both economic and technical viability, specifically of tidal lagoons, which are currently overlooked by those shaping policy, despite potential capacity factors of over 35% and costs per MW that could rival offshore wind farms.[69]

What lessons can be learnt from experiences within the UK and from other countries to date in supporting the development and deployment of marine renewables?

The UK can be the tidal and wave powerhouse of the world as Japan and Germany became for the solar industry. To do that we do need to have an industrial strategy with the ambition of building a home-grown industry, which develops UK marine engineering talent (transfer offshore oil and gas skills to the marine economy) and establishes an export industry. A key element will be to provide certainty for the deployment of the initial 500MW–1000MW of marine renewables in the UK, mapping out clear incentive levels per amounts of deployment with clear derogations to tariffs once those levels have been reached, and thus create a market.

[68] http://www.intechopen.com/source/pdfs/15834/InTechTidal_power_in_the_uk_and_worldwide_to_reduce_greenhouse_gas_emissions.pdf, David Mackay, 2011

[69] http://social.tidaltoday.com/industry-insight/tidal-cost-competitive-offshore-wind-five-years
http://www.openhydro.com/techEconomics.html

EXAMPLES

- — Japan and Germany for example offered very good subsidies for initial solar roof programmes (75,000 and 100,000 roofs respectively) creating a local market for their fledgling solar industries to sell into. As the solar market grew internationally so Germany and Japan took the lion's share of panel exports, inward investment and EPC contracts.
- — An example of forward looking success in the tidal industry would be France's La Rance, now providing lowest cost of power for the French nation based on tidal range innovation from the 1960's, which is now generating at €0.02/kWh (only using ebb generation). It also attracts 300,000 visitors a year and has been operational for 60 years without turbine fault (though undergoing a maintenance programme).
- — La Rance suffered alternator burnout when attempting (at the start) to use their turbines for bi-directional generation—they had to replace all their alternators. The mechanism was not designed to work in both directions and, rather than engineer a solution, they accepted ebb generation only. The UK can take this lesson and deliver a British turbine to achieve genuine bi-directional turbine solutions for hydroelectric power.
- — OpenHydro is currently installing the first of four 2MW tidal turbines off the North coast of France, a major scale tidal pilot, at the cost of €40m, made possible due to support of local government (Brittany), French State and Eur Comm. Government support has attracted inward investment from French submarine & nuclear tech group DCNS as well as London-based Pershing International Nominees (aff. of Bank of New York) and Davycrest Nominees. The UK Government needs to show long-term commitment now to ensure continued interest in UK waters for innovative tidal tech.
- — The Koreans, the French, the Canadians are all offering strong capital investment incentives and subsidy regimes to lure talented engineering companies to their countries. These are nations that announce an intention to act and have followed up with capital.

Is publicly provided innovation funding necessary for the development of marine technologies and if so, why?

There is a distinction to be made between tidal lagoons, tidal stream and wave.

(a) Tidal Lagoons with a Treasury Grant or initial granting of 3 ROCs for an initial 200MW of projects will generate enough investor certainty in turbine performance and impoundment wall building speeds and costs, to then only need 2 ROCs going forward as it will be possible to debt finance them thereafter . Tidal impoundment construction is well understood; secure financial support for the initial prototype installations is vital in creating market certainty allowing infrastructure funds and banks to invest in the roll out of this renewable generation.

Tidal lagoons will need a bespoke ebb and flood turbine capable of pumping to maintain artificially high flood tides during neaps. The cost of the development of a bespoke bulb or Kaplan turbine will be excess £50 million. The value to the State once this turbine is developed can be as much as 7GW of operating tidal lagoons, the associated lower cost of power, and taxable revenues for the engineering company concerned. Thus a one off grant into a large marine engineering firm to aid the development of a bespoke Kaplan or bulb turbine should be the total cost to the Government for tidal lagoons and should be considered an immediate priority.

(b) Tidal stream and wave technology require more support for longer, but again we advocate the prize of cheap, local power that lasts for decades and creates an export industry is worth supporting in its five year infancy (2012–17). We believe capital funding for technologies and a banded, degrading tariff regime is required. For example the first 500MW of tidal and wave could attract a level of payment for 20 years, the following 500MW could attract a reduced level of payment for 20 years and so on.

At the cost levels of early innovation and given the relatively small number of investment funds, many of whom are largely fully invested and who mostly have a per investment cap of around £10 million, wave and tidal innovation will be departing these shores without strong government intervention.

The funding of renewable technologies at the beginning stages of development is crucial to securing long term deployment. In a report in May of this year the Carbon Trust identified the marine sector as capable of generating around £76 billion for UK plc by 2050with the UK leading the innovation, however success will only be realised if there is sufficient support for development now.

Initial calculations show the cost to develop a 60MW–120MW tidal lagoon pilot project, including debt, interest, operations and maintenance, is approximately £150–300 million, from which initial estimates suggest 4,000kWh of clean power would be produced per annum, creating the potential to power 50,000 homes.

What non-financial barriers are there to the development of marine renewables?

The following non-financial issues contribute to the speed of tidal energy deployment in the UK. As a nascent industry, support, understanding and intervention where appropriate from governments could assist in moving projects forward in a timelier manner, without expediting important processes:

1. EU competition law in Crown Estate leasing shores—the paradigm, in which they work, aligned to the Utilities needs addressing.
2. Planning consents and licences.
3. Ensuring local stakeholders are supportive.
4. Grid capacity and the upgrade of the national network.
5. Aggregates sourcing—a licence is required to dredge suitable sand to fill geotubes in construction which has to come from licenced marine borrow areas.
6. Ancillary policies such as marine conservation and coastal defence.

To what extent is the supply chain for marine renewables based in the UK and how does Government policy affect the development of these industries?

This is a question that should be asked again in 2017—and to which the answer has to be a resounding yes.

Next year Enercon are going to open a tower manufacturing plant in Sweden for wind farms. They are doing that in response to clear Swedish government push for 10,000MW of wind by 2020. If we see strong UK government intent in the form of capital investment and appropriately sized tariff bands, the supply chain will show an interest in the UK marine sector.

At present large scale renewable projects source much of the supply chain required for development from outside the UK, based on existing expertise. For example, all major turbine manufacturers other than Rolls Royce are abroad, with many of the leading global marine construction companies being non-UK.

Without government support directed towards marine renewables it is unlikely that expertise and growth in the supply chain will be stimulated, we therefore need to create a home market and look to export once this develops. We are working with UK based engineering companies on turbine development, design and construction. We are also seeking to create a level of demand within the UK market that facilitates local manufacturing capability from geo-textiles to rock armour. We plan to create a leading market within the UK with a global reputation for high quality, pioneering low carbon development. In addition, just as there are significant cost savings to be gained in sourcing stone from local quarries, there are opportunities to develop a local manufacturing expertise in geotextiles manufacturing which could produce fabric supply to a large variety of global, multi-million pound construction projects.

What approach should Government take to supporting marine renewables in the future?

The government need to demonstrate sufficient and unswerving support to enable the expansion of the marine renewables industry that will enable them to achieve the commitment to long term goals of 1.5GW of renewable energy generation by 2020.

The EMR also has an opportunity to provide support for marine renewables. In our response to the EMR consultation earlier in the year, we supported a premium FiT scheme for new marine energy deployment, which would allow us to demonstrate to potential investors that the prize of taking the risk on early stage technology and projects is a sufficient and dependable tariff. Specifically, we sought a premium FiT banding for tidal lagoons and tidal stream which applies in each of the first 1,000MW of projects that are constructed, with a digression in tariff for the next 1,000MW and then a return thereafter to a FiT tied to the offshore wind price.

We do not believe that the proposed FiT with a Contract for Difference will engage the investment community at the levels required post 2017 when new projects will no longer be eligible for ROCs. There would at the very least need to be a CfD for each technology on a site by site basis to allow for variance in capacity factors and development costs, otherwise the proposed 2-way FiT will prove to be a disincentive for those pioneering for renewable projects at scale such as tidal lagoons.

September 2011

Memorandum submitted by Hales Energy Ltd

The eight sections of this document cover eight different, but closely related, aspects of the Marine Energy industry, as indicated by the following questions that were provided with the invitation to submit a document.

SUMMARY

The UK has a long history of using the energy contained in its surrounding waters. The tides remain as predictable and sustainable as they have ever been and their exploitation can create not only abundant electricity but also meaningful employment.

The Government cannot justifiably deny the industry its wholehearted support. Its efforts so far have often been hampered by procedural complications and burdensome bureaucracy. Such an unproductive situation needs to be rectified as soon as possible, otherwise the UK will fall even further behind other nations.

Public funding for innovative ventures would enable small-scale developers to compete with wealthy, established companies. As a result, the most efficient systems and equipment would be more likely to come to the industry's attention. Assistance with patents would also be possible.

The two greatest non-financial barriers to Marine Energy development are the lack of locations and facilities for testing first-stage prototypes and the sheer volume of bureaucracy involved in organising such trials and development.

The large-scale deployment of suitable off-shore systems will require the appropriate specialised infrastructure and equipment, both of which are lacking at present. Similar problems already exist in connecting off-shore systems to the National Grid.

To deal efficiently with all aspects of the industry, the Government needs to directly employ people with a greater knowledge of the marine environment in general coupled with their expertise in the generation of energy off-shore.

Using the power generated off-shore, hydrogen could be extracted from the water there and transported and stored until needed. The Government must try to ensure that the EU does not gain control over the UK's off-shore energy supplies.

Q1. *What are the potential benefits that marine renewables could bring to the UK and should Government be supporting the development of these particular technologies?*

1. The great industrial revolution of the nineteenth century (which started in the UK) was powered, not by gas-fired or coal-fired power stations, nuclear reactors or hydro dams, but by water power. Low-head and run-of-the-river waterwheels, combined with tidal capture systems (many of them in the city of London), provided the primary energy that turned the layshafts in the cotton mills etc. until the invention of steam-powered rotational systems enabled mills and factories to be located further away from the rivers.

2. Tidal power is predictable. In other words, it is possible to forecast (to within an accuracy of one or 2%) how much energy will be available for harvesting at any particular time on any chosen future date from any section of the English Channel or the UK-controlled areas of the continental shelf. With the possible exception of geothermal, no other source of renewable energy can match this predictability of supply. Furthermore, there is enough energy in those thousands of square miles of tidal flows to not only satisfy the whole of the UK's energy demands but also leave a surplus that could be exported to Europe. In fact, having sovereignty over the largest area of the continental shelf, the Republic of Ireland could quite feasibly become the most prosperous nation in the EU.

3. Everyone involved in harnessing Marine Energy understands that the amount of kinetic energy contained in moving water increases in direct proportion to the FLOW-SPEED CUBED. For example, a column of water having a cross-section area of one square metre produces approximately 500 watts of power when it flows at one metre per second, whereas it produces approximately four kilowatts of power when it flows at two metres per second.

4. Therefore, the logical deduction is that we should harvest as much energy as possible from areas containing flow-speeds of two metres per second or greater (which limits us, unfortunately, to a few well-known areas around the UK), whilst also harvesting the thousands of gigawatts contained within the slower, average tidal flows around the UK and over the continental shelf.

5. Can that actually be achieved in practice? The answer is an unequivocal YES. Development and research being carried out by companies such as Hales Energy Ltd. and by several universities are focused on producing tidal-stream turbine designs that are effective in those slower tidal flows and can be scaled up to megawatt-generating size and deployed in large numbers—providing both energy and employment for the UK and its people.

6. Consequently, if the Government sincerely intends to eventually see this country become independent again in the field of energy supplies, then it really must support and advance tidal energy research and deployment without any reservations.

Q2. *How effective have existing Government policies and initiatives on marine renewables been in supporting the development and deployment of these technologies?*

7. The appropriation of the UK Government's former Marine Renewable Deployment Fund (MRDF) provided a prime illustration of why the supply of R&D funding has failed to advance the development of marine renewable energy. The qualifying criteria for that particular fund were so inflexible that only two major R&D companies (having sufficient financial and human resources to complete such complicated paperwork) made any attempt to access the fund—and both of them failed.

8. One of the directors of Hales Energy Ltd. (a privately-funded tidal turbine developer) has attended several renewable energy R&D funding workshops that have been organised by the former DTI and the more recent version of that organisation. During one of those sessions, he asked the following questions of the administration's main speaker.

"Suppose that an application for R&D funding was made and the panel of experts who vetted the applications all agreed that a particular new and patented system or design had immense potential and could greatly benefit the UK. If, however, they then found that one of the boxes had obviously been ticked incorrectly on the very complicated application form, would they choose to overlook that minor error temporarily and allow it to be corrected later? Alternatively, would they notify the applicant of the error in the paperwork and advise him to reapply?"

The answer to both of those questions was NO—the application would be rejected out of hand and the applicant would not be told why. The explanation given for such an unhelpful attitude was that they were dealing with public money and, therefore, were not allowed to deviate from the stipulated procedure. It seemed to be not so much a question of their working for the good of the country, but more a case of petty regulations and self-preservation.

Q3. *What lessons can be learnt from experiences within the UK and from other countries to date in supporting the development and deployment of marine renewables?*

9. When viewed against the present backdrop of spiralling increases in the prices of fossil fuels and the public's dislike of unsightly wind turbines and risky nuclear power, the very slow progress made so far in the development of tidal and wave energy is surely a clear indication that financial support for research into our marine resources has been highly inadequate and that the amounts provided have been misdirected.

10. The large number of e-mail enquiries that our company receives from around the world seems to suggest that other nations are becoming aware of the potential of marine energy a great deal faster than the UK Government is doing. The French scheme on La Rance Estuary has been operational for almost fifty years and a very small tidal turbine prototype has recently been undergoing trials at the University of Massachusetts in the USA. In fact, in almost every developed country that has either coastal waters or large rivers, there is now an increasing eagerness to investigate the possibilities that are offered by such a powerful and valuable resource as flowing water.

Q4. *Is publicly provided innovation funding necessary for the development of marine technologies and if so, why?*

11. For the development of marine technologies, publicly provided innovation funding is needed desperately. Without it, inventors and creative designers are unable to make much (if any) initial progress with the implementation of their ideas unless they have sufficient capital themselves or financial support from the private sector. Consequently, some very useful ideas might remain completely unknown to the industry, whereas some very inefficient designs and systems might become large-scale commercial applications simply owing to the ability of wealthy or established developers to produce and successfully market equipment that is actually of a relatively low standard. After all, the desire to gain financially is the motivating force behind the majority of such undertakings.

12. It would be very useful if some public funding was directed towards linking colleges and universities with the large number of first-time and early-stage turbine and generator developers in both tidal and wave power. The Government could supply small predetermined amounts of such funding to enable both parties to quickly investigate the possibilities and the potential benefits of linking up with each other. In addition, there could be a national database on which early-stage developers could list themselves so that academic bodies and specialised companies could view their details and then link up with them if they so wished. Furthermore, free and independent assistance could be given to any interested developer, not only with the initial registration with the relevant Government department, but also with Intellectual Property (IP) protection and possibly with the database listing.

13. The strategy outlined above would not only bring forward a larger number of useful designs but would also introduce more college and university students to marine renewables and, as a result, to various related fields of engineering. The Government's "Patent Box" initiative provides a great incentive to companies to work in the field of renewable energy, but that particular benefit comes a long way down the developmental road, whereas much more needs to be done to encourage new enthusiasts to dip their toes into the water for the first time.

Q5. *What non-financial barriers are there to the development of marine renewables?*

14. In order to develop a new form of wind turbine, the procedure is very simple—build a small prototype in a garage and take it to the top of Beachy Head (or a similar high hill) on a windy day. With some inexpensive hand-held instruments and a strong roof-rack on the car, one can easily (and relatively quickly) verify a concept and improve a design.

15. In complete contrast, with a tidal or run-of-the-river turbine or similar device, one has to have access to either a flowing river or a boat large enough to anchor offshore. In addition, the equipment needed for measuring the water's flow-speed (even remotely accurately) is very expensive, even to hire, and electronic boat meters give very poor readings at the lower end of the speed scale.

16. The two greatest non-financial barriers to Marine Energy development are:

(a) The multitude of Governmental agencies (both local and national) that have to be contacted and negotiated with, even to conduct primary or early-stage trials and development.

(b) The total lack of locations and facilities at which first-time tidal and wave developers can test a first-stage prototype in a confidential manner.

17. (a) Institutions and organisations such as the Environment Agency, the Crown Estates, the Coast Guard and Local Planning Departments may all require notification in advance of any trials that could possibly cause pollution, flooding or (in their opinion) any other environmental problem. That wide range of bureaucracy needs to be taken into consideration even before one builds a prototype that will survive in the water.

18. Those difficulties could be significantly reduced if there was a specific Government office or department for all matters relating to Marine Energy. It could have a section that had complete control, by means of a licence, over the testing of any particular wave or tidal device for a fixed period of (for example) one month. That department would have its own engineers who could confidentially monitor the device's progress and inspect it to make sure that it would not cause any environmental damage.

19. (b) Places such as EMEC and NAREC and the few tow-tank facilities around the country can cost developers thousands of pounds to hire and they are often totally unsuitable for the trials that are required. Hales Energy Ltd. has already tried once to build a small specialised test tank, not only for the development of the company's own tidal turbine but also to be hired by other early-stage developers. However, a six-month delay in obtaining even a morsel of advice from the local planning department resulted in the withdrawal of the proposal.

20. To facilitate testing, a new department of Marine Energy could provide access to chartered boat hire for some wave and tidal devices and to stretches of river that would be suitable, having made prior arrangements with the concerned landowners to allow this early-stage development to take place.

Q6. *To what extent is the supply chain for marine renewables based in the UK and how does Government policy affect the development of these industries?*

21. When the industry begins the general deployment of systems that are based on "slow flow with high power", suitable harbours and docking areas will be required, together with specialised craft and tugs etc. (similar to the situation in the off-shore wind industry). In addition, the manufacturing and the maintenance of such energy-harvesting machinery can be undertaken only at those locations that have dry docks or heavy lifting equipment. Unfortunately, very few facilities of that nature have remained operational in the UK—other than those that service the North Sea oil and gas industries. Consequently, unless the Government can find a way to encourage UK industry to focus some of its attention on that aspect of the development of Tidal Energy, foreign companies will need to be employed (as is the case with the off-shore wind industry).

22. In the licensing of energy farms, whether they be wind, wave or tidal, the Crown Estate controls all aspects of work on the seabed and has recently commissioned a survey of the costs and challenges involved in connecting the raft of new off-shore wind farms to the National Grid transmission system. The major items highlighted in that report are the high costs, the long delays due to planning problems and environmental considerations, and the UK's inability to manufacture the special undersea cables and equipment that are needed.

23. Owing to the likelihood of large variations in output from off-shore wind farms, the Grid's designers have great difficulty in choosing adequate capacity for the transmission cables without wasting money by overestimating the requirement. Obviously, the same problem will arise from the intermittent nature of the power that is produced by systems of wave farms. Tidal energy, however, does not pose such a problem. The output can be determined in advance, owing to the fact that, within a few kilometres of the UK's coast, the flow patterns of the tides can be accurately predicted. As a result, maximum output loads can be delivered—with supplementary power being drawn from other sources in order to achieve parity with the total demand.

Q7. *What approach should Government take to supporting marine renewables in the future?*

24. If this or any future Government wishes to secure major supplies of energy from marine sources (either tidal or wave), it needs to employ people who understand not only the basic challenges of deploying enormous

energy systems off-shore but also the marine environment and the requirements and concerns of those who earn their livelihoods from it, such as fishermen and the like. With sufficiently knowledgeable people involved in the Government's major decision-making, creative engineering solutions could be implemented in order to make our marine environment an aid to the generation of energy instead of always seeming to be an obstacle.

25. The "Patent Box" scheme that encourages companies to use renewable energy patents is undoubtedly very useful, but it could be expanded even further. For example, more production might be kept in the UK if there was sufficient assistance with the costs of worldwide patents and their renewals and with the protection of patents and IP.

Q8 *Are there any other issues relating to the future of marine renewables in the UK that you think the Committee should be aware of?*

26. The Government should give serious consideration to the promotion of research into the off-shore extraction of hydrogen from water, using the power generated there by any of the available technologies. Furthermore, encouragement should be given to the development of efficient methods of storage and transportation of that hydrogen so that the UK might lead the way forward in providing future generations with a plentiful supply of accessible power.

27. The UK has the largest Marine Energy potential of all the countries in Europe. As the rapid decline in fossil-fuel supplies accelerates and the corresponding cost of energy rises, the EU will attempt to consolidate and control this untapped resource. Failure to secure it and retain it would amount to a significant loss of control and sovereignty.

September 2011

Memorandum submitted by Peel Energy Ltd

1. *What are the potential benefits that marine renewables could bring to the UK and should Government be supporting the development of these particular technologies?*

1.1 The UK is an island nation with immediate access to one of the world's best tidal range and tidal stream resources. This resource has the potential to provide a significant amount of secure, predictable renewable electricity for the next century thereby reducing our dependence on imported fossil fuels and associated storage infrastructure, and our susceptibility to global increases in fuel prices.

1.2 Businesses across the UK have a proven track record in successfully developing emerging technologies and exporting this expertise around the world. Marine energy presents an opportunity to develop a new vibrant and valuable export sector of the economy supporting thousands of new jobs.

1.3 Approximately half of the UK population live in major coastal conurbations. Marine energy projects, located close to centres of population reduce the need for expensive new grid infrastructures. Furthermore, with smart grid technologies, the fluctuations in the supply and demand for energy can be managed locally.

1.4 The UK Sustainable Development Commission (SDC) highlighted the role of tidal energy and that up to 10% of the UK's energy needs could be met by this renewable source. The SDC also indicated that the consideration of marine renewable energy was a cross-government department issue. The consideration of renewable energy, environmental protections and the climate change targets set the focus within the Department for Energy and Climate Change but there are also benefits to HM Treasury, Department for Business and Skills, Department for Environment and Rural Affairs and the Department for Communities and Local Government.

1.5 Marine renewable energy projects, in particular tidal range (and tidal fence) schemes, lead to the creation of significant numbers of new jobs and support under-utilised infrastructure in maritime construction sectors. They also bring investment to peripheral regions of the UK and create a focus of attention that stimulates local business in the leisure (hotel) and retail sectors. Marine energy projects stimulate supply chains and promote business growth in engineering and manufacturing sectors. For example, the Mersey Tidal Power Feasibility Study estimated that 3–4,000 direct jobs would be created/supported, plus a further 2–3,000 indirect jobs supported, during a five year construction window; contributing £1.7–2.2 billion GVA to the UK economy.

1.6 The development of innovative marine energy projects will promote the services of UK businesses. This will support further development in research and development activities within the academic sector who will in turn respond to the demand for professional services. Whilst the supporting structures of tidal range schemes last over 120 years the energy generating technology and management systems (approximately 25% of the initial capital cost) are expected be replaced every 25–40 years. The scope for research and development into new turbines and management systems will drive system replacement and enhancement, which in turn can be exported. There is the scope within tidal range projects to have research and development test facilities incorporated into the scheme to exploit the infrastructure in this way. This may support the development of new technologies being developed by UK companies such as Rolls Royce's Contra Rotating Turbine and VerdErg's Spectral Marine Energy Converter.

2. *How effective have existing Government policies and initiatives on marine renewables been in supporting the development and deployment of these technologies?*

2.1 The Mersey Tidal Power Feasibility Study concluded that a technically feasible scheme is available but the cost of energy would require a level of financial support beyond that which is currently available from the Government. The planning policies also require further development, in particular the introduction of a specific National Policy Statement on tidal power, in order to give the promoter sufficient confidence to progress a scheme through to consent.

2.2 As mentioned above, tidal range power schemes encompass many cross government issues including energy, transport, environment, tourism and the economy. As such marine energy should be considered on a platform with other major infrastructure projects in the UK, where the benefits of the scheme are considered in their entirety in order to derive an appropriate support mechanism. For example, large scale road and rail projects are promoted on their ability to deliver economic benefits by reducing congestion and improving business connectivity and productivity. Such schemes are funded through government instruments which value these benefits across Government over the medium to long term.

2.3 The costs and benefits of long term and large scale marine energy projects should be considered over the whole life of the scheme. At the moment there is an imbalance in the discussion as the costs are viewed over a 25 year period, with the benefits accruing over 120 years. The new Feed-in-Tariff mechanism proposed in the Electricity Market Reform may provide an opportunity to achieve this, however capital grants may also need to be considered to mitigate some of the developer/investor risks.

2.4 Lord Hunt launched a Marine Energy Action Plan, which was prepared by a partnership of private and public sector stakeholders with Peel Energy leading on contributions to the tidal range chapter. The Marine Energy Action Plan aimed to understand the obstacles to developing marine renewable energy and set out a plan and justification for addressing them. The aim of the Plan at that time was to inform the conversation in relation to the National Policy Statement for Renewable Energy. Since the plan's launch there has been no discernable progress in relation to tidal range technology despite the conclusion of the Severn Feasibility Study and the Mersey Tidal Power Feasibility Study.

2.5 The National Policy Statement for Renewable Energy has only a mention of marine energy which states, "It is expected that tidal range schemes may be the subject of applications to the IPC within the near future. Government is, therefore, considering the need for either a revision to this NPS or a separate NPS to provide the primary basis for decision-making under the Planning Act on such schemes. When it appears that other renewables technologies will be economically and technically viable over 50MW, the Government will further consider either revisions to this NPS or separate NPSs to cover such technologies."

2.6 The Mersey Tidal Power scheme is a technically viable 700MW scheme. The scheme could be economically viable with sufficient support from Government. The lack of planning and financial certainty means that schemes such as the Mersey Tidal Power scheme cannot be taken through the detailed planning and consenting phase.

3. *What lessons can be learnt from experiences within the UK and from other countries to date in supporting the development and deployment of marine renewables?*

3.1 La Rance Tidal Power scheme (240MW) was delivered in France by EDF in the 1960's and has many lessons of relevance to the Mersey, largely in terms of the modes of operation and methods of construction but there are also significant lessons in terms of the environmental impact and wider socio-economic benefits. Forty years on it is a great asset providing approximately 550GWh of electricity per year.

3.2 Last month the world's largest tidal range power scheme (254MW) came on stream at Sihwa, South Korea. Two other sites are also being considered in South Korea at Garolim (480MW) and Incheon Bay (1GW). Their Government's energy policies appear to be broadly aligned with ours in reducing dependence on imported fossil fuels but they appear to have embraced longer term solutions.

4. *Is publicly provided innovation funding necessary for the development of marine technologies and if so, why?*

4.1 Tidal Range schemes are able to be delivered with existing proven technologies such as the bulb turbine. To achieve short term renewable energy and carbon reduction targets funding is required to facilitate the delivery of schemes rather than technology development. In the medium to long term, funding for development of new technologies would provide opportunities for replacement plant when refurbishing schemes, or developing future schemes, either in the UK or abroad.

5. *What non-financial barriers are there to the development of marine renewables?*

5.1 As stated above, there is significant uncertainty in relation to the National Policy Statement for Renewable Energy. Many of the best estuaries and coastal locations for marine energy are also environmentally protected as Special Protection Areas, designated as RAMSAR or as Sites of Special Scientific Interest, and protected under the Water Framework Directive. Therefore satisfying the regulators and Government that the environmental impact is appropriately mitigated or compensated for is a key part of the development of tidal range power schemes. In relation to the Mersey Tidal Power project the studies demonstrated a route through the consenting process and consideration of alternatives for the purpose of Habitats Directive and Water Framework Directive assessments.

6. *To what extent is the supply chain for marine renewables based in the UK and how does Government policy affect the development of these industries?*

6.1 Given the scale of a tidal range project it is likely that the procurement of the scheme would be advertised in accordance with EU Procurement Regulations.

6.2 The principle benefit in terms of the project's supply chain is in relation to the construction and fabrication of the scheme utilising local port infrastructure and local labour markets. It is also anticipated that local suppliers and labour will be sourced for the operation and maintenance phase.

6.3 The current suppliers of turbines for tidal range applications are not UK companies however Rolls Royce and Verderg are developing technologies for this application. In the context of the Mersey Tidal Power Project, the power generation technology only accounts for 24% of the initial capital cost.

7. *What approach should Government take to supporting marine renewables in the future?*

7.1 Peel Energy would welcome the return of a public/private partnership, led by Government to continue the work of the Marine Energy Action Plan. Peel is aware of the work currently underway in relation to tidal stream devices. Indeed the issues affecting tidal range are significantly different to those affecting tidal stream and warrants a different approach. This work should develop a clear NPS for Marine Energy considering carefully the important role of tidal range technologies and their location. This work would then require a Strategic Environmental Assessment on the appropriate and preferred locations for tidal range deployment in the UK.

7.2 Government should support the exploration and development of new funding instruments akin to those utilised for other forms of major UK infrastructure, including long term bonds and tax increment finance.

8. *Are there any other issues relating to the future of marine renewables in the UK that you think the Committee should be aware of?*

8.1 Tidal range projects cannot be delivered by the private sector alone and clear leadership is required by Government to support the private sector in the planning development and deployment of this nationally significant energy infrastructure.

September 2011

Memorandum submitted by Tyndall Centre

EXECUTIVE SUMMARY

The UK is widely presented in government, industry and academic discourse as a world leader in marine energy technology. However, particularly due to slower than expected progress in deploying small arrays, this position is now under serious threat from other nations. The UK Marine Sector faces tougher international competition than ever before and there is much discussion in the industry about the UK losing its leading position and having to "buy-back" marine technology in the future. The sector offers the possibility to both assist in the decarbonisation of the UK's electricity sector and develop a supply chain that could export technology and expertise across the world.

The evidence presented here draws on the findings from a Tyndall Centre study of stakeholder assessments of the opportunities and barriers for UK Tidal Energy.[70] For this study approximately 20 individuals from a range of organisations were interviewed including: trade associations, academic research projects, testing facilities, regional and national government, utilities, funding bodies, regulators, and technology developers. Industry respondents certainly presented Government funding as a necessity for the development of the UK marine sector. Particularly given the current economic climate, it was felt that attracting private investment was very challenging. In addition, technology developers and industry bodies tended to believe that more significant amounts of funding were required if deployment in line with previous government analysis (eg the Renewable Energy Strategy) is to be achieved. The concept of banding ROCs was widely supported but disagreement remains of the "right" levels of banding. There was praise for the responsive nature of particular previous funding schemes which had been seen to meet the evolving needs of the sector. Other, non financial issues for the sector include: stages of testing being "jumped", grid connection, consenting timeline delays and establishing environmental impacts.

[70] McLachlan, C. 2010, Tidal Stream Energy in the UK: a stakeholder perceptions study, Tyndall Centre Working Paper, http://www.tyndall.ac.uk/publications/working-paper/2010/tidal-stream-energy-uk-stakeholder-perceptions-study

What are the potential benefits that marine renewables could bring to the UK and should Government be supporting the development of these particular technologies?

1. The marine sector offers the combined benefit of decarbonising our electricity supply and developing a supply chain which could export technology and expertise across the world. Particularly given the current economic climate, private investment alone is not thought to be at a sufficient level to bring this technology to market. Therefore, if Government believe that the UK should play a significant role in an established global marine energy sector, Government funding must be available.

What lessons can be learnt from experiences within the UK and from other countries to date in supporting the development and deployment of marine renewables?

2. The current level of UK funding was argued by technology developers and trade body representatives to be too low to really drive the industry forward on the sort of timescales identified, for example, in the Renewable Energy Strategy (ie an important contribution by 2020 and mass roll out beyond that). Whilst through the Marine Action Plan, the previous Government had expressed a willingness to "continue" to fund marine energy through existing bodies at the time of the research, some respondents stressed that continuation at that funding level was simply not high enough to rapidly move to commercialisation. Since this research was conducted, the Marine Renewables Deployment Fund (£42 million) has been dropped, although £20 million has been made available through the Low Carbon Innovation Fund. Industry bodies such as RenewableUK have welcomed this recent announcement of funding but continue to stress the need for further funding if the potential of the sector is to be realised. Although the potential for marine energy for the UK energy mix is generally presented primarily as a post 2020 contribution, a number of stakeholders stressed the urgency of action required if these longer term targets are to be met and concern that longer term targets mask the need for immediate action.

3. The policy issue that was the "hottest topic" in the research (conducted in 2010) was the banding of ROCs and the difference between ROCs in Scotland and the rest of the UK. The concept of banding ROCs was been widely supported in the industry but the exact level of banding and the justification of a difference between wave and tidal in Scotland was the source of much more controversy. There were many calls for wave and tidal to be treated equally at this stage until more is known about their performance in real sea conditions.

4. There was much praise amongst interviewees for the Carbon Trust's Marine Renewable Proving Fund (MRPF). This was felt to have been a timely response to address the issue that the Marine Renewables Deployment Fund (MRDF) was aimed at too advanced a stage. Funding awarded by DECC which will allow development of nursery sites at EMEC and a rotary test rig at NaREC through the Renewable Energy Strategy was also praised for being responsive to the needs of the sector as they emerged. Whilst the recent announcement of £20 million from the Innovation fund was welcomed by industry bodies, the loss of the £42 million earmarked for the MRDF is a significant blow for the industry and clearly, industry will now be hoping that additional funds will be made available to make up the difference.

5. The Scottish Government's Forum for Renewable Energy Development in Scotland (FREDS), have supported a "use it or lose it" (UIOLI) approach so that funding is not "tied up" by a developer without leading to developments in the field whilst other developers find that there is no new money to apply for. This approach had a mixed reaction from industry stakeholders with some arguing that the very nature of these projects means that as much flexibility as possible is required in terms of funding timescales.

6. Another major issue discussed by respondents was the potential to unsettle investors in the marine energy sector and the need for a stable policy environment. Therefore the potential benefits of changes in policy must be carefully weighed against the potential impact they may have on private investment.

Is publicly provided innovation funding necessary for the development of marine technologies and if so, why?

7. Stakeholders widely agreed that the current economic climate made attracting investment difficult for the sector. In addition, the profile of costs in the sector (ie high levels of investment to deploy, test and prove a device) makes attracting private investment challenging. Government funding was seen as being required if the UK is to establish itself as a significant player in an established global marine energy industry.

What non-financial barriers are there to the development of marine renewables?

8. There are a number of issues that stakeholders identified in addition to specific funding concerns including.

9. **Testing facilities**: Testing facilities in the UK were seen as being world class. However, there were concerns expressed over the cost of accessing these facilities and some developers "jumping" stages of testing leading to "preventable" failures in the field. Clearly this issue relates to available funding for testing.

10. **Grid**: As with many renewables, connecting to the grid was widely seen as a potentially major barrier. Concerns over availability of connection and the cost of that connection were discussed. There were calls for the Government to underwrite grid connection for the industry, giving tidal developments guaranteed and prioritised grid connection when they required it. An alternative suggestion was for developers to form consortia to apply collectively for grid connection in certain areas. Whilst seen as a significant barrier, many

respondents stressed that transmission companies were now much more engaged with the sector and a sense of optimism that the issue could be dealt with satisfactorily was evident across the range of stakeholders.

11. **Overpromising**: Many respondents from technology developers to Government officials felt that the sector had previously been guilty of "overpromising" what it could deliver in terms of the speed of technology development and deployment. There was some concern that if claims continued not to be met, government support, private investment and public enthusiasm may wane.

12. **Consenting timetables**: There were calls from respondents for leasing rounds and timetables to be set more "realistically" with device developers stressing the difficulty in managing costs and investor confidence if delays occurred.

13. **Intra-national policy differences**: The more favourable ROC regime, the early undertaking of an SEA, the significance of marine energy as a part of Scotland's energy needs and political will, were seen by a range of stakeholders to have given Scotland a significant advantage over the rest of the UK. For some interviewees the wealth of marine energy resource in Scotland made this an entirely reasonable situation, for others there was a strong sense that steps must be taken so that the rest of the UK is not "left behind".

14. **International Position**: Whilst the UK Government and UK stakeholders generally saw the UK as being the "world leader" in tidal stream and marine energy more generally, this position was felt by many respondents to more "at threat" from international competition than it had ever been before. China, Portugal, France, Canada, Spain, Korea were noted among the key competitors. Deployment of arrays of devices was seen as a key step in protecting the UK position as was establishing a UK based supply chain to service the world market.

15. **Environmental Impact and the precautionary principle**: The degree to which the precautionary principle should be applied was contested and it was argued by many respondents that some of the environmental monitoring costs would need to be covered by the public purse. Whilst some presented the technologies as "benign" others stressed that impacts were unavoidable and that the concern must be how best to deal with these. Some argued that by imposing strict conditions on early stage devices such as switching off when marine mammals where in the vicinity, meant that opportunities for collecting valuable data were being missed. A clear sense of what terms such as "deploy and monitor" mean in practice for the sector would help to manage the expectations of both developers and stakeholders.

16. **Networks and collaboration**: Despite the need to protect intellectual property, there was enthusiasm across a number of organisations for collaboration on areas such as: baseline environmental data collection, environmental monitoring, establishing standards and a publicly funded deployment vessel.

Are there any other issues relating to the future of marine renewables in the UK that you think the Committee should be aware of?

17. Public perceptions and engagement are starting to be discussed by the industry but there is still a dominance of a sense of the technologies being "out of sight out of mind" and "benign". As more developments are planned and deployed, the processes of consultation with local stakeholders (including the public) require careful consideration. As found in a case study of the UK's Wave Hub, local interpretations of marine energy can differ unexpectedly from those proposing a development and developers' claims of "benign" devices may not be accepted by all.[71] Developers and government should take the opportunity to learn from consultation practice (successful and unsuccessful) in the wind sector, avoiding unproductive "name-calling" (NIMBYism) and engaging with the substance of any stakeholder and public concerns.

September 2011

Memorandum submitted by the Renewable Energy Association

The Renewable Energy Association (REA) welcomes the opportunity to contribute to the Select Committee enquiry into the future of marine renewables in the UK. The Association represents British renewable energy producers and promotes the use of sustainable energy in the UK. The membership is active across the whole spectrum of renewables, including wave and tidal, electric power, heat and transport fuels. Members range in size from major multinationals to sole traders. There are over 800 corporate members of the REA, making it the largest renewable energy trade association in the UK.

The REA's main objective is to secure the best legislative and regulatory framework for expanding renewable energy production in the UK. The Association undertakes policy development and provides input to government departments, agencies, regulators and NGOs.

In order to cover sector-specific issues, a number of so-called "Resource Groups" have been set up. The Ocean Energy Resource Group, comprising more than 100 individuals, covers wave energy and tidal stream energy. The primary focus of the Group is the progress of energy conversion device and array development to prove the capability and survivability of full-scale projects, and the legislative measures required to support and finance projects in order to bring them to commercial fruition.

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[71] Mclachlan, C., 2009, "You don't do a chemistry experiment in your best china": symbolic interpretations of of place and technology in a wave energy case, Energy Plolicy, 37(12), 5342–5350.

The REA believes that the UK's marine energy resource provides a unique opportunity, in terms of a clean, totally renewable source of electricity generation, provision of a new industry with job creation and export potential and a major contribution to security of energy supply. We urge the UK government to exploit this opportunity through continued support of the sector.

General Comments

The REA believes that there is potential for wave and tidal energy to overtake and undercut the cost of offshore wind as it matures and achieves economies of scale. This will be a game-changing scenario through creation of a new UK industry.

The UK's leading marine energy developers represent a vast amount of innovation and IP knowledge, and have achieved a number of accomplishments and world firsts. They have:

- Overcome technical hurdles to generate electricity from marine renewables.
- Built key relationships with major industrial companies such as Siemens, GE, ABB and with utilities, such as SSE, E.ON, ScottishPower Renewables, EDF, Vattenfall, EDP, ESBI, RWE Npower and Statkraft.

Full scale machines are currently built or in the process of being built, to a total of 8MW. One of the most striking characteristics of the industry is that over the past decade, £33 million of public funding (of which approximately half was in the last year) has stimulated private sector investment of £189 million in the four leading wave and tidal energy companies. Much of that has been raised overseas and much has been spent here in the UK and hence contributed to tax receipts

This is a crucial time to accelerate first multi-machine projects, as a stepping stone to larger commercial projects that can be built without need for further capital support. The marine energy supply chain needs to see evidence of government's vision on marine energy and the market needs both short term push and long term pull. The REA believes this will best be achieved through:

- Banding of 5 ROCS for wave and tidal electricity generation in the period 2013–17 alongside a clear, consistent and transparent mechanism for market support through the EMR Contract for Difference.
- Capital grants to meet the funding gap for new deployment.
- Innovative thinking by government over other support in addition to grants and market pull, such as loans through the Green Investment Bank, tax breaks and government-backed loans.

If this occurs, a clear signal will be given to investors, a major UK industry will evolve, jobs will be created and exports will follow. The total cost of subsidy will be recycled into the UK economy through jobs and taxes.

Specific Comments and Responses to Consultation Questions

1. *What are the potential benefits that marine renewables could bring to the UK and should Government be supporting the development of these particular technologies?*

1.1 The UK possesses a rich natural resource in marine renewable energy, amounting to 50% of Europe's tidal resource and 30% of Europe's wave resource. Exploitation of this clean and renewable resource will contribute to the government's achievement of its mandatory renewables targets (to a small extent by 2020 but with a growing contribution thereafter). It has been estimated[72] that marine renewables could provide up to 20% of the UK electricity demand, with an extractable resource of 36 GW.[73]

1.2 In a world where our oil and gas deposits are depleting and reliance on imported energy has major political and financial implications, marine renewables will also contribute to the UK's security of energy supply. They provide a portfolio of resources: tidal stream, tidal head, inshore wave and offshore wave energy. Unlike wind energy, tidal energy is totally predictable and the time of maximum generation potential is phased along the coast, with financial benefits to the electricity consumer through system balancing and reduction in the necessity for back-up capacity.[74] As a form of stored wind energy, waves have greater longevity than the wind which generates them, appearing on our shores before the wind arrives and lasting after the wind has died down.

1.3 The UK is currently the acknowledged leader in marine renewables, due both to the supportive government policies and to the creative minds of our engineers. If the industry develops, RUK estimates that marine renewables could create 19,500 jobs by 2035 and draw investment of about £6.2 billion, with a Gross Value Added contribution of £800 million.[75] The benefits of exporting UK technologies should not be underestimated.

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72 Carbon Trust, "Future Marine Energy", 2006.
73 Public Interest Group, "The Offshore Valuation Report", 2010.
74 Redpoint Energy Ltd, "The benefits of marine technologies within a diversified renewables mix", 2009.
75 RUK "Wave and Tidal Energy in the UK", 2011.

1.4 There has been much public opposition (justified or otherwise) to the building of onshore wind farms. This has been overcome to an extent by moving the wind farms offshore and hence out of sight of the land-locked public, but the presence of huge swathes of wind turbines across our seas is equally unacceptable to those who use the marine space for work and leisure. Because water is 800 times denser than air, marine energy generators are much smaller than wind turbines (taking up less space on the seabed) and either floating or seabed–mounted, they are less visually intrusive and therefore more socially acceptable.

2. *How effective have existing Government policies and initiatives on marine renewables been in supporting the development and deployment of these technologies?*

2.1 Overall

2.1.1 In general, the level of support through Government policies and initiatives to date has been good and effective (albeit small in relation to public investment in nuclear energy R&D, which amounted to £1 billion over the 25 years to 1998). Over the past decade £33 million of public funding has stimulated private sector investment of £189 million in four leading marine energy companies (MCT, Pelamis Wave, Aquamarine Power and Atlantis Corporation).[76] Much of that has been raised overseas and much has been spent here in the UK, hence contributing to tax receipts.

2.1.2 These lead companies are now making the cash-burning transition from development and demonstration to full commercial scale operation. Unless public support continues, all the benefits of previous initiatives will be wasted, as companies fail to secure sufficient private investment to capitalise on the current position.

2.1.3 Government support has taken many forms and we consider the various initiatives separately below:

2.2 Market Mechanisms

2.2.1 The Government banding of Renewable Obligation Certificates (ROCs) for emerging technologies is a move in the right direction, but REA believes that the past and current level of ROC banding for wave and tidal energy in England and Wales (2 ROCs/MWh) is still too low. Based on the real costs incurred undertaking the 1.2MW SeaGen tidal turbine in Northern Ireland, REA member company Marine Current Turbines Ltd (MCT) produced an estimate of the economics for the next tidal array.[77] MCT's calculations indicate that even with 5 ROC's and MRDF support of £9 million, the first array would only produce a return of around 6%, which is insufficient to secure investment. The typical investment hurdle rate that is being applied by utility companies to this type of project is the creation of a positive Net Present Value at a discount rate of 15%.

2.2.2 The REA strongly believes that there should be a coherent level of support for marine renewable energy generation across the whole of the UK. Therefore we have lobbied the Westminster Government during the current banding review to increase the ROC banding for both wave and tidal wave energy to five, in line with the Scottish ROCs for wave energy.

2.2.3 In 2017, the new system of Contract for Difference (CfD) introduced through the Electricity Market Reform (EMR) will replace the present system of ROCs. The unfortunate drawback of the new system for marine energy (and indeed for all renewable energy technologies) is that it removes the obligation on electricity suppliers to source power from renewable generators.

2.2.4 The details of the CfD system have yet to be announced, hence there is nothing to encourage investment in marine renewables for projects planned beyond 2017. At present there is no confidence that the strike price for CfDs will be in line with the banding of ROCs that the REA believes is necessary to support marine renewables.

2.3 Capital Grants

2.3.1 The overall message for the marine renewables industry is that there is not much available at the present time, or in the foreseeable future.

2.3.2 The Technology Strategy Board (formerly DTI) grants for early stage devices have been (and continue to be) helpful, although there are certain issues regarding competition with other technologies and standards of assessment for applications.

2.3.3 Since 50% of its funds come from member companies, the Energy Technologies Institute can provide up to 100% of project costs without contravening EU law. This is most helpful for companies struggling to find match funding for other grants. However, lack of transparency with regard to project selection and issues with ownership of IPR make the ETI grants less attractive.

2.3.4 The Marine Renewables Deployment Fund (MRDF) was premature and was withdrawn before any companies had achieved the stipulated qualification of three months continuous operation.

[76] M Carcas, presentation to DECC, Jan 2011.
[77] REA response to the DETI Consultation on Incentivisation for offshore renewable energy generation. 2010.

2.3.5 The Marine Renewables Proving Fund (MRPF) has been described as "The right money at the right time". Targeting the more advanced developers, to assist them in deployment of commercial-scale demonstrators, such initiatives are most welcome.

2.3.6 Some early-stage developers benefited from local initiatives offered by Regional Development Agencies (RDAs). Accessibility and level of support was variable (depending on Region in question), but funding generally appeared easier to access than national grants. RDAs have now been abolished and all their funds are administered through BIS.

2.3.7 The recent announcement of £20 million earmarked for deployment of arrays of marine energy devices from the Low Carbon Innovation Fund is most welcome, but the REA is disappointed that the available funding is less than half of the value of the withdrawn MRDF. The criteria for awards under this initiative are not known and there are concerns that it will be insufficient to support the sector's anticipated deployment for 10 MW arrays.

2.3.8 The fund is time-limited to 2015. The REA hopes that the government will focus on spending the £20M wisely and then build on the success of this public investment, by providing further funding to develop commercial-scale deployment.

2.4 Government Renewable Energy Targets

2.4.1 The mandatory UK target of 15% renewable energy by 2020 imposed by the EU has been particularly helpful to the renewables industry overall, in that it focuses the UK government towards its achievement. As already stated, exploitation of marine renewables will contribute to this target, to a small extent by 2020 but with a growing contribution thereafter.

2.4.2 UK national targets tend to be volatile and confusing. The government often refers to "aspirations" rather than targets. Firm and fixed targets beyond 2020 are needed for marine renewable energy.

2.5 Marine and Coastal Access Act

2.5.1 The passage of the Marine and Coastal Access Act (MCAA) through parliament and the granting of Royal Assent in November 2009 heralded the onset of many changes in the marine regulatory regime which impact on the marine renewables sector.

2.5.2 With regard to licensing, the REA's first impression is that the new system will be more costly and time-consuming. Despite combining FEPA and CPA, the promised "streamlining" of the licensing process is not taking place and extra regulation is appearing.

2.5.3 The creation of a network of Marine Conservation Zones (MCZs) in UK waters is a continual worry because of the associated monitoring requirements and limitations on activities in (or near) MCZs. The REA continues to work closely with Defra throughout the MCZ designation process and we are lobbying for MCZ management measures that will not present barriers to the deployment and operation of marine energy projects.

2.5.4 A new system of marine planning has been initiated by the Marine Management Organisation (the body set up under the MCAA to manage activities in the marine space). The REA has concerns that marine energy projects will be under-represented as the planning regime develops, since the industry does not have an established presence in UK waters.

2.6 National Test Facilities

2.6.1 The UK national facilities at EMEC, NaREC and Wavehub are the envy of other countries—they act as a focus for expertise and a centre for environmental impact monitoring, while reducing the burden on developers for the consenting process and the cost of cabling.

2.7 Marine Energy Action Plan

2.7.1 Under the previous government, DECC initiated the Marine Energy Action Plan (MEAP), which promised to deliver major benefits to the marine energy sector. The Plan was intended to set out an agreed vision for the marine energy sector to 2030. The summary document for the Plan outlines the actions required by both private and public sectors to facilitate the development and deployment of marine energy technology.[78] It covers finance, infrastructure, planning and technology, and the document was developed with unprecedented input from industry, whereby companies gave unstintingly of their employees' time to participate in working groups. Sadly, we have seen very little action following publication of the document.

2.7.2 The MEAP has been replaced by the Marine Energy Programme Board. Again, we have seen little action. The government should capitalise on the free "consultancy" that they receive from industry via such initiatives, through provision of positive action to support the marine energy sector.

[78] HM Government: Marine Energy Action Plan 2010—Executive Summary and Recommendations.

2.8 Grid Connection

2.8.1 The lack of available grid capacity at locations of good marine energy resource (eg the Orkneys and Pentland Firth) has been highlighted as a major barrier to the development of marine renewables.[79] Initiatives for a marine interconnector (eg work commissioned by The Crown Estate) are critical—utility companies will not invest in marine renewables unless they can export and sell the electricity.

2.8.2 There are current discussions underway through the EMR about "capacity payments" for marine renewable developers. If introduced, this will constitute an additional cost to exploitation of the marine energy resource.

3. *What lessons can be learnt from experiences within the UK and from other countries to date in supporting the development and deployment of marine renewables?*

3.1 There are strong parallels between wind energy and marine renewables. Denmark is the undisputed leader of the modern wind energy industry and lessons must be learned from this success if the UK is to capitalise on its current stronghold in marine renewable energy. Early political vision in Denmark, including consistent financial support mechanisms and priority grid access, provided security for private investors to develop wind energy on a commercial basis. The early technological support and experience in large-scale commercial wind installations provided Danish manufacturers with a first-mover advantage over competing manufacturers in other countries. Through the 1980s Danish companies formed an international reputation for innovation, efficiency and reliability, which continues to this day.[80] With similar vision and structured political support, the potential of this industry could be captured in the UK.

3.2 A clear and long-term framework of consistent financial support must be provided by the government, if the marine energy industry is to grow. The recent government turn-around on FITs for solar power has introduced additional uncertainty, discouraging private investment across the entire renewables sector.

3.3 Collaboration brings faster results. One example is the collaboration between Atlantis Corporation and SMD, which accelerated the deployment of the Atlantis AR1000 tidal generator.

3.4 Action not words! Other countries, particularly the USA and China, champion new ideas and projects. For example, in 2000, China generated only small amounts of solar energy; now, every other solar cell is made in China.[81] The UK spends too much time consulting and discussing drawbacks.

4. *Is publicly provided innovation funding necessary for the development of marine technologies and if so, why?*

4.1 Yes, as for all new technologies in a market dominated by mature technologies, public funding is necessary. Marine energy projects require heavy financial investment up-front and the fixed costs for wave and tidal developments are too high to permit small arrays of say 10MW to be financially viable without additional support. The risk is too high for private finance alone, or for debt finance, thus without public funding, marine energy demonstration projects and device arrays will not be deployed and the industry will fail.

4.2 As the technologies for wave and tidal stream energy extraction mature, a supply chain for the sector becomes established and economies of scale are achieved, the REA believes that the costs of "wet" marine renewables will reduce, to a point where they are competitive with offshore wind. Once the size of arrays increase to 50 or 100 MW (reducing the proportion of fixed costs per MW installed), the industry will eventually survive without additional support.

4.3 As described in paragraph 2.1.1, public investment in the sector already pays dividends through the leveraging of private investment that is spent in the UK and contributes to tax receipts.

5. *What non-financial barriers are there to the development of marine renewables?*

5.1 Grid connection and transmission charging

5.1.1 As stated in para 2.3.1 above, the lack of available grid capacity at locations of good marine energy resource is a major barrier to the development of marine renewables. The areas of most abundant resource tend to be remote from onshore distribution and transmission networks, or in locations where the network capacity is limited. A new transmission infrastructure, planned to accept levels of increasing capacity at the peripheries, will be required to avoid substantial delays in development of the marine renewables sector. The REA hopes that Ofgem's project Transmit will offer a solution to enable the commissioning of upgrades by 2015.

5.1.2 The current transmission charging regime, which levies high charges on generators furthest from the market, acts as a major deterrent to the growth of marine renewables projects in remote locations, by raising the barrier to entry for investors.

[79] Xero Energy, Pentland Firth Tidal Energy Project Grid Options Study, Jan 2009.

[80] Kyle Smith "The Danish wind industry 1980–2010: Lessons for the British marine energy industry". International Journal of the Society for Underwater Technology, Vol 30, Sept 2011.

[81] Jeremy Leggett, The Telegraph 5 Sept 2011.

5.2 Disproportionate environmental monitoring demands for licensing and consents

5.2.1 The REA believes that protection of the marine environment is very important, but monitoring costs on the level experienced by MCT's Seagen tidal generator at Strangford Lough (approximately £2 million for a project with an initial budget of £10 million) could potentially destroy the UK's wave and tidal energy sector. In projects for typical public or private sectors—be they engineering, university research or commercial developments—there is a project budget that must be adhered to and activities are tailored to suit. With environmental monitoring for wave and tidal energy projects, developers have the impression that the monitoring requirements are driven by what is specified by the environmental sector, with no limit or consideration of cost.

5.2.2 Specious arguments are often put forward by the environmental lobby, demanding disproportionate monitoring to feed research projects. There should be stringent guidelines which environmental bodies must adhere to, to justify demands for studies included within the licensing conditions. The demands should clarify the value and usefulness of the study outcomes. The REA notes with concern that there is zero cost to the stakeholders who make such demands.

5.2.3 We would like the Government to formalise an upper limit for monitoring costs attributable to the developer at say 5% of the project budget, with any additional costs to be found from the public purse. This can be justified for monitoring that is considered meritorious, since marine renewable energy is a strategic resource for this country.

5.3 Inflexibility of/opposition from other marine stakeholders

5.3.1 Marine renewable developments are sometimes opposed by more traditional marine industries, such as the fisheries and shipping sectors, who might argue that they potentially lose historic perceived first right of use at sites that contain a good energy resource.

6. *To what extent is the supply chain for marine renewables based in the UK and how does Government policy affect the development of these industries?*

6.1 Significant amounts of expenditure will always be incurred locally, where the marine energy generators are deployed. Tasks conducted in the vicinity of the deployment site include assembly and test, commissioning, and operation and maintenance. In order to avoid transportation costs, local fabrication will often be the most economic option.

6.2 Over 75%, by value, of the SeaGen turbine in Strangford Lough was sourced from UK suppliers and all of the design work was carried out in the UK. The Pelamis wave energy device was constructed in Leith, employing about 70 staff.

6.3 Government policies and renewable energy targets will provide supply chain companies with confidence that the marine energy industry will grow, encouraging them to self-invest in the appropriate skills and equipment.

6.4 The current government initiatives to develop ports for the offshore wind industry should be extended to ports for wave and tidal energy projects. The needs of the two sectors overlap to some extent, although they are not identical.

6.5 A viable home market for marine renewable energy, developed through government support at this crucial time for the industry, will encourage the supply chain to expand.

6.6 A shortage of relevant skills is cited as one of the barriers to rapid deployment of offshore wind farms and this is likely to be true for the marine energy industry as it matures. Government should set in motion initiatives to:

- Encourage transferable skills from the declining offshore oil and gas industry.
- Encourage training by providing confidence—through policies and targets—that in the future there will be a marine energy industry to provide work.

6.7 The REA believes that apprenticeships and skills transfer may be more effective in filling the skills gaps than increasing the number of academic courses.

7. *What approach should Government take to supporting marine renewables in the future?*

7.1 The REA believes that the No 1 priority is for investors to see devices in the ocean and delivering power to the grid—market mechanisms and public capital support are required. The benefits of this expenditure (which will be relatively small since few developers are in a position to exploit it) will be the development of a major new UK industry and the leveraging of private investment.

7.2 The No 2 priority is for full-scale demonstration of device arrays, to allay concerns about device interactions—again market mechanisms and public capital support will be required.

7.3 Government should put in place initiatives to facilitate:

- Provision of grid connections where the marine resource is located.
- Fulfilment of the promise to streamline licensing.
- Access to finance for marine energy projects through the Green Investment Bank, tax incentives etc.
- Completion of the offshore energy SEA for England and Wales.
- A coordinated approach to the understanding of environmental impacts.
- A coordinated approach to resolution of cross-industry problems and challenges.

7.4 The REA would like to see positive action from the Marine Energy Programme now.

7.5 If Marine Energy Parks are developed, government should ensure that the benefits to developers are tangible and significant.

7.6 The REA strongly recommends that the monitoring costs for new marine energy projects should be capped, in proportion to the size of the development

8. *Are there any other issues relating to the future of marine renewables in the UK that you think the Committee should be aware of?*

8.1 Time is of the essence for small companies in the marine energy sector, struggling to survive. There has been a hiatus in both public and private investment since the coalition government announced the CSR and we are already seeing the lead developers retrench and lose key members of staff. The REA does not believe this situation is tenable.

8.2 Since the turn-around of government policy for large-scale solar electricity generation, the concept of "Sovereign risk" has been introduced into the investment sector. This triggered a lack of confidence in the stability of government policy regime, which acts as a disincentive to invest in renewable projects generally.

8.2 The REA would welcome some action from "Action plans", rather than more consultations, such as the proposal to re-consult on National Policy Statements for major infrastructure.

September 2011

Memorandum submitted by Engineering the Future Alliance

RESPONSE FROM THE *ENGINEERING THE FUTURE* ALLIANCE TO THE ENERGY AND CLIMATE CHANGE COMMITTEE

The response has been prepared by the following institutions:

- The Royal Academy of Engineering.
- The Institution of Engineering and Technology.
- The Institution of Civil Engineering.

It is also supported by the following institutions:

- The Institution of Chemical Engineering.
- The Engineering Council.

September 2011

Engineering the Future is pleased to have the opportunity to input into the Committee's inquiry into the future of marine renewables. As the alliance of the UK professional engineering institutions, *Engineering the Future* can draw upon a wide range of expertise in the energy field. The UK has a large resource of marine energy that it could potentially exploit, contributing significantly to a secure and low-carbon future energy system as well as a successful UK supply chain. There are, however, many challenges to overcome before full commercialisation of any of the various technologies is realised. The engineering realities of large-scale adoption of new technologies should not be underestimated and it is hoped that this response will help bring to light some of the relevant issues.

Executive Summary

- There are large potential resources of marine renewable energy available to the UK. In this, we are better placed than any other European country so, if any country is likely to make a success of marine renewables, it is the UK and we should therefore take the initiative. This is not the case for other renewables such as solar PV where countries such as Spain and Germany already have a lead.
- There is the possibility of a large and successful UK supply chain, as there is in the oil and gas sector, but it will not happen without a clear, integrated plan and the relevant support for it.

— None of the various marine technologies will be cheap when measured on a £/MWh basis. However those based on tidal motion have the benefit of predictability and in the future this may be more important than the price per unit of electricity that has been used in most of the assessments up to now.

— Tidal barrages have far lower technical uncertainties than for other marine renewables and they supply power predictably, but at a higher cost per MWh than can be obtained from a wind turbine. Proposed barrage structures also often encounter public opposition due to their impact on the local region adding extra risks and costs, as evidenced by the Severn Estuary proposals. However, as the UK is so favourably placed in terms of tidal range resource the government should continue to research developments in this technology, targeting more flexible generation over both ebb and flow tides, and multi-use options such as bridges or flood defences, along with lower costs and less environmental impact.

— Tidal flow turbines have been demonstrated in prototype numbers and represent a promising technology that is applicable to certain areas of coastline, particularly around Scotland. They are visually unobtrusive and unlikely to be damaged by storms. We strongly recommend support for further demonstration and development projects.

— Wave energy is at an early stage of development. There are challenging technical and logistical problems to be solved and, at this stage of development, it is not clear that these can be overcome at an acceptable price. Wave energy converters are, by necessity, massive structures at the sea surface where they would impact commercial and recreational use of the sea and would be subject to the full force of storms.

— Overall, the development of marine renewables will be challenging and, because of the need to test large machines in inhospitable conditions far from urban centres, will be expensive. However, they include some of the very few renewable technologies that have the potential to provide predictable power that is not dependent on the weather. To meet the targets of the 2008 Climate Change Act, marine renewables are likely to become an important ingredient in the generation mix. As with all the low-carbon energy options, there are technical and political risks in deployment—and some may fail. It is, therefore, vital to carry forward a range of potential choices.

— We would urge that a systems view of marine renewables is taken in evaluating costs and benefits versus other options. This is vital as the future energy system will be a complex network made up of many interdependent parts. No single technology should be assessed in isolation.

1. *What are the potential benefits that marine renewables could bring to the UK and should Government be supporting the development of these particular technologies?*

The main aims for the future UK energy system are security of supply, affordability and reduced emissions of greenhouse (mainly CO_2) gases. Marine energy could potentially benefit in two of these areas:

(a) Energy security

Marine renewables could help meet peak electricity demands in an energy system relying heavily on renewable energy from wind:

— Tidal energy has the benefit that it is predictable. It is possible to predict the output of a tidal energy device decades in advance. The timing of tides also varies at different locations meaning a smoother supply from devices if distributed around the coast. In this, it is quite unlike wind energy that can sink to almost zero for a week or more during a settled anticyclone, such as has occurred in the last two winters.

— Wave energy is less predictable than tidal energy and also suffers from being, to some extent, correlated with wind energy. Waves tend to be larger during storms, when the wind is also strong, and to be of lower amplitude during calm weather (although in some conditions strong winds many hundreds of miles away can result in large waves on a calm day).

(b) Contribution to UK CO_2 emission reduction

This will depend on the level of deployment of marine energy but has the potential to make a significant contribution. The figure of 61Mt of CO_2 from wave and tidal stream by 2050 given in the Marine Energy Action Plan appears to be a reasonable estimate.

Marine energy could also potentially help in the following areas:

(c) Industrial opportunities

It is estimated that Britain has access to a third of Europe's wave and half of Europe's tidal power resources[82]. Because our natural resources are so suitable, we are well placed to be a first-mover, bringing industrial export opportunities should we be successful and others follow.

First-mover advantage and technological leadership are not sufficient, however. There is still a long way to go in terms of commercial realisation. Different technologies are at different stages. Tidal barrage technology is essentially mature but at least one major UK company has a new turbine design that may reduce costs and environmental impacts. Tidal stream technology is less mature but devices are now being refined by world class major companies in the UK and elsewhere. Wave energy is the least mature, but Scotland appears to be well advanced in terms of construction and testing at full scale.

[82] Atlas of UK Marine Renewable Resources, DTI, Dec 2004.

(d) Public acceptance

Given the widely-reported public resistance to deployment of wind turbines (envisaged as the largest source of renewable energy in the next 10 to 15 years), it may prove that much less visible tidal stream and wave devices will encounter fewer objections when going through the planning application process. Although this remains to be tested (and large scale marine power will often still require unpopular onshore infrastructure), a smoother passage through planning applications should reduce the financial risks for prospective investors. Tidal barrage projects have more major public acceptance issues because they involve building large civil engineering structures in river estuaries, however they can generate local public benefit, for example from new river crossings and associated economic regeneration opportunities.

Marine renewables have been estimated to offer a contribution to the UK's electricity supply of 15 to 20%[83] (excluding contributions from tidal range which could provide a similar amount). However, this is probably the upper bound and would not be realised until around 2050 as the technology is largely at prototype and proving stage. In the more foreseeable future—to 2020—when the UK needs to achieve around one-third of its electricity supply from renewables, it is not expected that marine power will make a significant contribution. However, if the government continues to pursue an 80% reduction in CO_2 emissions by 2050, a balanced portfolio of low-carbon technologies will be needed and that will include marine energy. Anything which has peak output at different times to wind power could make a valuable contribution to the generation mix and reduce demand for peaking plant that is less environmentally sound.

These benefits will not happen without public support because marine is an emerging technology and the initial costs and risks are too high. However, the experience in Scotland demonstrates that with the right form of government support for initial stages, the transition from cottage industry scale to "initial mature" industry is possible for leading designs.

The engineering realities of achieving significant levels of marine technology should not be underestimated. In the case of tidal barrages, the technology is not new but its development to reduce costs and environmental impact is, and the risks of mass manufacture and deployment into one of the very large potential projects such as the Severn Barrage may be beyond the private sector alone. Tidal stream power devices are becoming more robustly engineered, with more effort needed on deployment, anchoring and maintenance recovery.

For wave power, devices fall into two categories—resonant devices that float on the surface and extract energy from a narrow frequency of waves or stationary structures anchored to the seabed or shoreline that funnel energy from all waves into a turbine or hydraulic mechanism. The floating devices are subject to all the rigours of a marine environment and hundreds of kilometres of plant would be needed to replace the equivalent of large thermal power plants. Stationary wave devices have high levels of embedded energy, are visually intrusive and are yet to demonstrate a favourable return of energy.

The engineering challenge to build, install, connect, operate and maintain, and ultimately replace—all at a scale that would contribute significantly to the UK's electricity supply—is considerable. If the government is to push these technologies it would be advisable to carry out a serious engineering appraisal of the risks and costs associated with a long-term, large-scale marine renewable industry, considering the different challenges of tidal barrage, tidal stream and wave energy separately. A market appraisal, including comparison with alternatives and consideration of overseas commercial opportunities, is also required.

2. *How effective have existing Government policies and initiatives on marine renewables been in supporting the development and deployment of these technologies?*

Scotland has so far been markedly more effective than the rest of the UK in supporting the development and deployment of marine renewables. The Scottish Renewables Obligation rules give a higher subsidy to marine renewables than the equivalent UK system, recognising the fact that the technology is worthwhile but at early stage.

Policy in Scotland has also been more effective in encouraging private industry to become involved. For example, the Wave Hub project in Exeter is only attracting very small scale investment from private industry at a "cottage industry" level, whereas in Scotland the greater government support has encouraged significant levels of investment and a local supply chain to develop. In addition, the Scottish Government's £10 million Saltire Prize for technological advances in wave and tidal energy is one of the biggest international innovation prizes in existence.

Government policies in England and Wales have been much less effective in supporting development of these technologies. The level of public sector resources being devoted to the development of marine power (eg the recently announced £20 million DECC fund) seems rather modest. Only a small number of projects are being supported, and the level of central direct support is much less than was available via the Marine Renewables Deployment Fund which has been discontinued.

[83] The Path to Power, BWEA, June 2006.

The reasons for the inadequate UK-wide support for marine energy include:

(a) UK policy has tended to see marine as a relatively small contributor to national annual energy needs rather than more appropriately seeing it as the solution of choice for particular coastal regions both in the UK and abroad.

(b) The planning and regulatory regimes for marine renewables have been complex and uncertain, with conservation and community obligations and priorities not always reconciled with power generation ambitions. The Scottish Government and others have identified issues about the cost of connection to the national electrical transmission system as having potentially perverse incentives. We are aware that work is underway to address conservation and grid issues but the final outcomes remain to be assessed.

(c) There has been a policy over the years of evaluating renewable energy in terms of price per MWh without a proper assessment of the predictability of the output. If one takes a systems view of energy, the requirement of the electricity supply system is not to provide so many units of electrical energy over the course of a year but to provide particular power loads minute by minute. Viewed from this perspective, predictable energy, such as provided by tidal power devices, is more valuable than intermittent bulk energy units and should be evaluated against other predictable renewable options such as biofuels, electrical storage or demand control.

While R&D financing in the UK has produced a plethora of experimental designs, the funding has not been available for consolidation to take place.

Testing at scale is a vital but expensive part of the R&D phase because small scale tank-based water experiments do not provide a guide to the behaviour of the marine environment. The commitment to undertake large scale trials and deployment has until recently been lacking.

Support for the development of marine renewables could be argued to be "too little, too late". The UK government is committed to massive investment in (particularly offshore) wind in order to meet European 2020 renewable energy targets. Insufficient development to date means that marine power is unlikely to contribute much towards these targets. With a fleet of new nuclear power stations also being planned in England, and a number of gas fired facilities also in planning or delivery, it is unclear how much demand there is likely to be for marine energy in the 2020s. One clear window of opportunity has been missed, the next is uncertain and that is not a good basis for confidence and long-term investment. However the challenge of decarbonising energy is massive and some currently promising options may fall by the wayside, meaning that having a range of choices is important. It is hoped that the current Electricity Market Reform will provide sufficient incentive to potential investors in marine renewables alongside other low-carbon technologies.

3. *What lessons can be learnt from experiences within the UK and from other countries to date in supporting the development and deployment of marine renewables?*

UK government (particularly England and Wales) support for marine R&D has been too short-term, too fragmented and too focused on pre-commercialisation research. For example, the recent EPSRC-funded SuperGen Marine 2 wave energy research programme is valued at £5.5 million over four years and is divided between four universities. This will enable some theoretical studies and testing at 1:100 scale in wave tanks. It will not enable building and testing of working machines, even at one quarter full-scale. Unless a serious intention to reach full commercialisation is shown and the technology development and additional sectoral requirements are driven forward, the sector can stagnate and nascent companies struggle to stay afloat.

Future public funding should concentrate on development and demonstration. The route to full commercialisation of any new technology is long, expensive and high risk, so there is no point starting if there is no clear strategy to reach the end.

The UK government's latest energy Whiter Paper[84] on Electricity Market Reform moves policy closer to the Scottish model for technology-banded ROCs, which is a good move, but Scotland fears a lowest common denominator outcome and wishes to retain the right to set its own levels for ROCs.

Many of the lessons for marine renewables grid connection and transmission are similar to those faced by offshore wind. Some of the anchorage issues faced by offshore wind turbines may also have lessons for marine power, although devices that are floating freely rather than anchored to a foundation may present additional technical difficulties as is the case for some wave and tidal stream devices.

Other countries may offer generic lessons in industrial development, particularly in how best to develop good ideas into national industrial strengths. Denmark and Germany may be specifically relevant for their development of strong wind power industries and Portugal has invested in marine energy test beds.

There are other marine energy concepts that could be explored which may be of interest. For example the Dutch 'Energy Island' that offers bulk storage.[85] This has been developed with government support in The Netherlands through basic feasibility stages.

[84] http://www.decc.gov.uk/en/content/cms/legislation/white_papers/emr_wp_2011/emr_wp_2011.aspx

[85] http://www.kema.com/services/consulting/utility-future/energy-storage/large-scale-storage.aspx

4. *Is publicly provided innovation funding necessary for the development of marine technologies and if so, why?*

Public funding will be needed if tidal stream and wave energy at least are to be commercialised because they are high-risk developments that require large (and expensive) trials. For water-based technologies, results from small scale prototypes cannot be scaled up on paper. The physical properties of water mean that small-scale prototypes in tanks do not behave in the same way as larger prototypes or full-scale models at sea.

For this reason we support the Marine Energy Action Plan's recommendation to provide funding for first and second generation sea trials. Also, government needs to appreciate that some publicly funded projects will result in failure. It cannot be assumed that potential failures have already been weeded out at this stage.

For wave and tidal stream devices, it is important to research the effectiveness of arrays of multiple units not just single examples. This is because:

- Any such device placed in the water creates waves of interference which affect the power and direction of waves reaching nearby devices. By utilising multiple technology types it is possible to increase the efficiency of an array because different types of devices capture different forms of wave.
- If different types of device are placed in the same array, systemic problems may arise in part, or all, of the array that were not observed in individual devices.
- It is necessary to test a range of different mooring methods with different strains on them in order to find optimal solutions for different areas of seabed which vary widely in composition and angle.

5. *What non-financial barriers are there to the development of marine renewables?*

Reputation—there has been a great deal of progress on wave power in the last five years. In Scotland, wave energy has now reached a stage in its development where mainstream commercial companies such as SSE and ABB are sufficiently confident to invest. Despite this, it is difficult to shake off the received wisdom that wave energy research has been around since the 1960s (eg Salter's Duck) and we are little nearer now to a workable and economically viable device than we were then. The key to this reappraisal lies in seeing successful marine power designs as the solution of choice in particular locations in the UK where there is a natural resource at a suitable scale for either local distributed use or to be fed into the national electrical transmission system.

Technical challenges—there are technical issues that still require solutions, although this is to be expected for any developing technology. Many of the issues relate to installing and operating machinery in a hostile environment and include mooring techniques, durability and maintenance. Grid connections represent a serious challenge although this is also being dealt with in offshore wind.

Regulatory—governments have, in the past, changed policy and programmes at short notice, without always fully considering the implications. The recent changes (regardless of whether they were right or wrong) to solar feed-in tariffs is a case in point. The uncertainty created makes private investment and commitment more difficult to secure. The current reform of the electricity market is a chance to provide stability and certainty and, as such, is critical to give investors the confidence to engage with marine energy.

Planning—the UK's spatial planning and conservation regimes should ensure pro-active and co-ordinated planning of energy infrastructure. Marine power priorities must be clearly considered alongside shipping and conservation issues, while onshore planning also needs to be made more certain and efficient. The proposed approach of the new Marine Management Organisation is encouraging in this respect, promising detailed analyses underpinning its off-shore planning and integration with associated on-shore planning, as well as coordination with Scottish and Welsh processes. However, it has not yet completed its first plans so its ability to deliver remains to be demonstrated. Smaller on-shore developments, such as substations and other overhead lines, can also be difficult to secure permission for—the more so as renewable energy is often generated in areas which have not previously had generating facilities (the same issues apply to wind power).

Skills—the UK renewable energy industry faces a general shortage of suitably skilled workers in both technical and commercial disciplines and faces stiff competition for talent with other industries, particularly offshore oil and gas and other major construction sectors. Relying on talent from those sectors or importing labour from abroad will not be sufficient.

Port capacity—major port facilities and related infrastructure will be required if marine renewables are to be installed at sufficient levels to contribute meaningfully to the UK's low-carbon electricity supplies. Serious thought needs to be given to these issues and not simply the offshore structures, particularly with regard to how they will interact with the growing offshore wind industry.

Environmental impact—whilst this is probably modest for tidal stream and wave energy (though impact on marine life would need to be studied) it is significant for tidal barrage schemes. More work is needed to maximise the potential of new technology to minimise this.

Other—there is the possibility of difficulties arising from other industries and services that will share the same space as marine renewables such as fishing, marine conservation, shipping and leisure services.

6. *To what extent is the supply chain for marine renewables based in the UK and how does Government policy affect the development of these industries?*

The marine renewables sector is currently too immature for a sustainable UK supply chain. Currently, the focus is on test units with no integrated plans to develop the full system that is required to deliver the technology to the seabed and the power to the land. However, compared with the wind sector, there is a much stronger element of UK ownership and control in the nascent marine renewables industry. Plus, a lot of what would be needed does exist in UK but it is not recognised as a marine energy supply chain. There is the possibility of a large and successful UK supply chain, as there is in the oil and gas sector, but it will not happen without a clear, integrated plan and the relevant support for it.

There are a number of successful examples in the UK and abroad, such as:

— In Scotland companies such as Aquamarine (a Dundee firm which built the Oyster 2 prototype) have diversified from the oil and gas industry. Aquamarine has a policy of investing in local capacity and building up the local supply chain, for example the European Marine Energy Centre (EMEC) testing facility in Orkney, and local consultancy firms for the purpose of obtaining the necessary consents.

— Norwegian tidal-power developer Hammerfest Strøm has placed contracts worth £4 million to construct the first of their advanced HS1000 tidal turbines in Scotland using Fife-based Burntisland Fabrication Limited (BiFab) for the fabrication of the sub-structure. These will also be tested at EMEC.

Civil servants are naturally cautious and require a track record of success in order to minimise risk. In marine energy research this is a barrier because it is not until a model is scaled up to full size that its behaviour in a marine environment can really be tested. It is an iterative process since, as explained above, results at a small scale will not accurately predict how a device will interact with the marine environment at a larger scale.

However, capability has increased rapidly in the last five years, to the extent that commercial investors are now putting money into certain marine renewables. The situation in Europe has also improved with the EU Strategic Energy Technology Plan being amended to include marine renewables and calls for funding applications are being made.

It is important that the UK takes advantage of these opportunities for investment and follows the examples of best practice in order to develop a successful national supply chain and gain the maximum economic benefit from any potential marine renewables industry.

7. *What approach should Government take to supporting marine renewables in the future?*

The general approach from government towards marine renewables, as laid out in the Marine Energy Action Plan 2010 is sound. There is, however, a concern that the plan is good on intentions and aspirations but light on concrete actions. For example, it highlights the multiple stakeholders in the area but simply calling for better synergies across these bodies will not necessarily achieve that aim.

There is clearly a need to review the plan. A review was due to be completed by DECC in spring 2011 but is yet to be published. However, in the time since the original plan was completed a number of the stakeholder bodies, such as the RDAs, have been closed down. Some of the more important recommendations have also not been followed. The Marine Renewables Deployment Fund, which the plan called on to be extended, has now been withdrawn. As noted in the answer to question 2, this has reduced the amount of funding available and will undermine attempts to implement the rest of the plan's recommendations.

Government should be bolder in the delivery of support for marine renewables. Policy should focus on creating critical mass not widespread subsidies. What is needed is a plan to deliver a certain amount of installed capacity by a set date and to put the right incentives in place to make it happen. This could include paying or part paying for development of robust test units and port infrastructure (which may also have benefits for offshore wind). We would not encourage increasing public support for research into new designs of marine device as this would merely add to the plethora of untested models.

Subsidy is required to de-risk the demonstration at scale stage for the most promising designs. A sliding scale of subsidy is needed over a number of years which is high initially then decreases over time.

8. *Are there any other issues relating to the future of marine renewables in the UK that you think the Committee should be aware of?*

The current Electricity Market Reform process will be vital in setting out the future incentives for renewable energy. Appropriate arrangements to supersede the current Renewables Obligations will be vital if the UK is to realise the full potential of its renewables opportunities. Marine power is perhaps not at the level of maturity where mainstream support through Contract for Difference feed-in tariffs are the most appropriate mechanism—government support is still needed but must be mindful of the transition between the types of support when developing and reviewing bandings.

On a more general level it may be worth reviewing the overall risk/cost/benefit profile to see which marine renewables are viable technologies, taking into account the future costs of other technologies and constraints on the availability of other renewable and non-renewable resources. Wave resource might ultimately give a total of 3GW, and tidal stream the same, so roughly 10% of today's peak electricity demand. This is not negligible, but equally only 10%, and by our earlier estimate perhaps 15% of total renewable energy. Tidal range technologies could provide equivalent amounts of energy but this will depend on which of only a small number of potential sites are developed. This analysis should consider costs and timelines to reach deployment at scale, and the costs and contributions (eg MWh, predictability) in a future energy world including smart grids and sophisticated demand management, possibly electric vehicles and a wide portfolio of renewable, nuclear and low-carbon fossil fuel sources.

September 2011

Memorandum submitted by the National Renewable Energy Centre

Background to Narec

1.1 The National Renewable Energy Centre (Narec) is the UK's national centre for accelerating grid integration of renewable energy systems and catalysing the development and deployment of offshore wind, wave and tidal energy generation technologies.

1.2 Narec is a not-for-profit organisation. Our primary purpose is to secure economic, social and environmental returns for our public and private sector clients by undertaking research, development and deployment projects in the field of renewable energy technology.

1.3 Narec's highly experienced, multidisciplinary team of 100 scientists and engineers operate some of Europe's largest translational research and testing facilities for electrical networks, offshore wind, wave and tidal power generation technologies. Our clients range from large multi-national companies, to technology start-ups, local authorities and major investors in renewable energy projects.

1.4 In addition to our technical role, we play an important role in supporting delivery of the government's policy objectives and attracting and anchoring internationally mobile investment to the UK. We also participate actively in key stakeholder groups such as DECC's Renewables Advisory Board (chair marine subgroup), RenewableUK's Marine Strategy Group, international Standards Committees etc.

1.5 Narec undertakes mission-oriented research, development and demonstration projects between Technology Readiness Levels 3 and 8, the range between proof-of-concept and system test and demonstration. We adopt an open access model and collaborate very closely with a global network of universities, businesses and governments to secure breakthroughs in the design, deployment and commercialisation of renewable energy technologies.

1.6 Our technical assets are sized to address the problems and issues faced by companies seeking to develop and demonstrate technologies at large scale. Key facilities include: a new 3MW marine drive train development and testing facility; a 100MW offshore wind turbine demonstration site; 1/10th scale wave and tidal test facilities and three large dry docks for marine device development. We are working with the Energy Technologies Institute to develop the world's largest wind turbine drive train testing facility rated at 15MW. In our 8 years of operation we have supported the development and testing of 18 wave and tidal devices and taken 4 devices on to open sea trials and demonstration.

2.0 Consultation Response

2.1 *What are the potential benefits that marine renewables could bring to the UK and should Government be supporting the development of these particular technologies?*

- Marine renewable energy technologies are at a very early stage of their lifecycle and still some way from large scale commercial deployment. They have considerable potential as a large and reliable source of low carbon energy and are the focus for a significant amount of research and development effort and government investment around the world. The Carbon Trust estimates that some 15–20% of UK electricity demand could potentially be met by marine renewables.
- The UK is firmly placed amongst the leaders in marine energy research. The combination of abundant marine resource and a supportive policy environment has encouraged the growth of a robust research base and a vigorous community of technology developers, supported by a strong technical infrastructure for prototyping, testing and trialling technologies at all scales.
- The principal benefits to the UK from marine renewables are economic, environmental and social. These benefits will be maximised if the UK's technological lead is transformed into commercial advantage through the development of a dynamic indigenous marine renewable industry, with a strong local market and significant global exports. Benefits include economic growth, greater security of energy supply, cleaner and low carbon energy production, employment opportunities etc.

— As the industry is still in its infancy, government support will be required to assist with the translation of UK technological leadership to commercial opportunities. This is particularly important in the current economic environment as companies are finding it difficult to secure private capital to develop their devices. Investors are reluctant to accept the risks associated with projects that propose to generate revenue from unproven energy technologies, operating reliably for many years in the harsh marine environment.

— There is already growing international competition from countries such as the USA, Canada, EU member states and Korea that are implementing policies aimed at encouraging the formation of a domestic industry. If the UK government does not demonstrate its ongoing commitment to the industry, it is likely that companies will invest elsewhere.

— Econometric modelling undertaken by the UK Energy Research Centre and others suggests that early investment to develop technologies will bring forward commercial deployment of marine energy technologies by 15–20 years. It is our view, from discussions with our customers and key industry groups that the level of investment required is unlikely to materialise without government intervention.

2.2 *How effective have existing Government policies and initiatives on marine renewables been in supporting the development and deployment of these technologies?*

— Government policies and initiatives have in the main been successful in supporting the development and deployment of marine renewable technologies.

— The £50 million Marine Renewable Deployment Fund (MRDF) is possibly the best example of a measure that did not perform as initially anticipated. Despite high expectations, it was not utilised due to eligibility requirements which were beyond the capabilities of industry at the time. Narec's CEO led the Renewables Advisory Board team that reviewed the reasons for limited success of this initiative.

— Other initiatives, including those supported by the Research Councils, Technology Strategy Board, Carbon Trust, Energy Technologies Institute, Regional Development Agencies and Devolved Administrations have been more closely aligned with the needs of specific user groups. They have helped build substantial UK expertise and capability by supporting a diverse range of projects and establishing world leading research, development and demonstration infrastructure at universities and facilities like EMEC and Wave Hub.

— Narec has been involved in:

  — 18 prototype development and testing projects for companies that have been partly funded by the Carbon Trust, TSB or Regional Development Agencies. Including high profile projects such as the design, build and testing of an innovative power take-off system for Aquamarine's highly successful Oyster device; design, build and testing of a novel direct drive generator for Swan Turbine's Cygnet Stage 1.

  — Project Nautilus, development and construction of a 3MW drive train development facility, supported by the Strategic Investment Fund, to de-risk the introduction of new marine devices by undertaking reliability and performance appraisal and providing device certification.

2.3 *What lessons can be learnt from experiences within the UK and from other countries to date in supporting the development and deployment of marine renewables?*

— Clear, consistent government policy coupled with sustained and carefully targeted support is a key enabler for the growth and development of new industries. All the countries at the leading edge of the marine renewable industry have implemented policies that specifically address its needs.

— The UK provides an attractive environment for marine renewable technology development. It has incentivised and encouraged research and development and the creation of a robust network of facilities to assist with commercialisation of the technology. This in turn has encouraged the growth of a vibrant marine energy community, including many foreign technology developers that have established a presence in the UK.

— Large-scale demonstration facilities such as those at EMEC and Wave Hub are a key differentiator for the UK but competitors are striving to close the gap. EMEC has been a major attraction for foreign device developers—11 of 15 device manufacturers planning to install full-scale devices are from outside the UK.

— Closer working between EMEC, Wave Hub and Narec and the completion of complementary testing and development facilities such as EMEC's "nursery" and Narec's Marine Blade Test and 3MW Nautilus marine drive train facility will be important in maintaining the UK's leading position. The proposed Offshore Renewable Energy Technology Innovation Centre will further assist by enhancing the profile of the UK's marine renewable offer and by helping to ensure that all aspects of the innovation system are appropriately aligned.

— Financial incentives are important but careful consideration needs to be given to how they are structured. The problems experienced by the MRDF provide a valuable lesson. Further learning comes from the tendency of financiers to utilise milestones that encourage speed of deployment at the expense of robust testing and development. Moving immature technologies into the harsh marine environment too early has led to a series of costly failures which have placed individual projects in jeopardy and damaged market confidence. Even the highly acclaimed Renewable Obligation Certificates (ROCs) programme has had its problems—the offer of at least 2 ROCs per MWh to marine technologies has not been sufficient to incentivise investment in this early stage and high risk industry.

— Deployment of marine renewables is still at a very early stage and considerable effort will be required to scale-up devices and obtain operating experience at scales relevant to utility level energy generation.

— Areas of high marine energy resource are often remote. Addressing the issue of grid accessibility at reasonable cost will be material to development of the industry.

2.4 *Is publicly provided innovation funding necessary for the development of marine technologies and if so, why?*

— The marine renewable sector is at an early stage of its lifecycle. The technology is largely unproven at utility scale and lacks the track record of other more established forms of power generation. In the current economic environment, it is unlikely that the private sector would be willing to accept the inherent financial and technological risks associated with developing and operating new energy technology, particularly given its harsh working environment. Public support will therefore be required to support technical and financial de-risking and encourage private sector investment.

— The growing involvement of multi-national organisations in the sector is an encouraging sign. Of particular interest is the innovative combination of financial and engineering engagement used by companies such as Siemens, Voith, Rolls Royce and Alstom. These companies are unlikely to shoulder the full commercial risk of building out marine renewable capacity and some public funding will be required to encourage their continued involvement and to assist with developing a critical mass of activity.

— The availability and framing of UK public funds and support will be important with respect to the development of an indigenous industry with a high UK content in terms of components, technologies and skills.

2.5 *What non-financial barriers are there to the development of marine renewables?*

— The precautionary principle favoured by the consenting regime places a significant burden on this embryonic sector. For example the SEAGEN project (1.2MW tidal) successful developed by MCT in Strangford Lough (NI) incurred around £6m of cost attributed to environmental studies and environmental mitigation measures. It is understood that much of this cost was driven by the requirements of the regulatory framework.

— The geographically remote locations associated with the bulk of the marine renewable energy resource are often far from major centres of population and electrical power demand. This is likely to mean that there will be limited grid capacity available. There may also be competition for this limited grid capacity from other renewable generation sources, such as onshore wind.

2.6 *To what extent is the supply chain for marine renewables based in the UK and how does Government policy affects the development of these industries?*

— The marine renewable supply chain is embryonic with many devices still at the prototype or pre-commercial stage. That said, the UK has considerable potential to develop an indigenous supply chain building on complimentary expertise from sectors such as offshore oil and gas, subsea engineering and offshore wind. The importance of targeted government action can be seen in Scotland and the South West, where supply chain development activity by organisations such as the Southwest RDA and Scottish Enterprise is starting to have an impact.

2.7 *What approach should Government take to supporting marine renewables in the future?*

— Ensure the existence and availability of a support mechanism equivalent to 5 ROC's for at least the next five years. Beyond this period, introduce a clear, phased reduction in the support mechanism that dovetails with the sector's ability to reduce its costs.

— Take action to ensure that support mechanisms amongst the various Departments and Agencies (DECC, BIS, Carbon Trust, ETI, etc) are harmonised, complementary and address clearly articulated industry needs.

— Demonstrate a strong level of commitment to the industry and instil confidence in the investment community that the UK government will support development of the market.

— Exercise prudence in planning any further expansion in UK open sea testing facilities to avoid under-utilisation of existing capacity.

— Continue to support SME access to expertise and infrastructure in universities and development and demonstration facilities at Narec, Wave Hub and EMEC.

— Provide innovation funding to support development of generic technology solutions that may be adopted by a number of different devices. For example maritime vessels and subsea equipment tailored for efficient deployment of turbines in high energy tidal streams.

September 2011

Memorandum submitted by ScottishPower

Introduction

1. This evidence is provided on behalf of Scottish Power Limited (a major UK energy supply, networks and generation business), and ScottishPower Renewable Energy Limited (the UK's leading renewables developer). Both companies are subsidiaries of Iberdrola S.A. and references to "ScottishPower" and "we" are to either or both companies as the context requires.

2. Scottish Power Limited is an energy business that provides electricity transmission and distribution services to more than 3 million customers, supplies over 5 million electricity and gas services to homes and businesses across Great Britain (GB), and operates electricity generation, gas storage facilities and associated energy management activities in the UK. ScottishPower Renewable Energy Limited is part of Iberdrola's Renewables business, which is the largest developer of renewables globally.

3. ScottishPower Renewable Energy Limited is leading various marine projects within the UK, including the development of a tidal array in Islay and a wave project in West Orkney.

4. This memorandum provides a summary of our views in response to the Energy and Climate Change Committee (ECCC) Inquiry into the future of marine renewable electricity in the UK.

What are the potential benefits that marine renewables could bring to the UK and should Government be supporting the development of these particular technologies?

5. The UK has substantial, and in some regards world-leading resources of both wave and tidal energy around our coastline. This provides the potential for a range of benefits as follows:

— Substantial contribution to UK renewables and low-carbon targets, helping us to meet our international obligations regarding climate change.

— Improved fuel security by reducing the need for imported energy.

— Realistic prospects for a major new industry employing 68,000 people and worth £76 billion to the UK economy (Marine Renewables Growth Paper, Carbon Trust, May 2011).

— This new marine energy industry has significant export potential in relation to fabrication, manufacturing, engineering and technical services.

— Particular economic benefit for coastal communities supplementing other income sources, some of which are declining (eg. fishing).

— Resource and productions characteristics which complement those of other renewables such as wind, and therefore will allow maximum total penetration of renewables and other low carbon forms of production on our electricity system.

6. All of these benefits can be substantially enhanced by early action to stimulate and accelerate growth of the sector in the UK. Government support through these early stages is essential for the benefits to be realised.

How effective have existing Government policies and initiatives on marine renewables been in supporting the development and deployment of these technologies?

7. Experience has been mixed. For example, the MRDF scheme failed to support early projects with the key reason being that marine technology had not at the time reached the stage of development where it could meet the scheme criteria and progress to small arrays. However, other schemes such as MRPF (supporting prototype demonstration and testing) and WATES/WATERS have been much more successful, with a range of technologies either in the water or about to be installed.

8. We can reference two positive examples of Government support: one is our Orcadian Wave Project, using Pelamis Wave Technology, which has benefitted from £3 million grant support from the Scottish Government's WATES scheme. Another is the £4 million support which our tidal technology partner, Hammerfest Strøm, has received from the MRPF scheme administered by Carbon Trust. In both these instances, the funding has been critical for the go ahead of the projects.

9. Across the UK, the result of this progress is that some technologies are now approaching readiness for array application. This critical phase needs to be the focus of future Government support.

10. Other initiatives such as The Crown Estate's leasing rounds have been helpful in stimulating the sector, in particular by demonstrating a route to commercialisation for those companies and technologies which are successful at the testing stage.

What lessons can be learnt from experiences within the UK and from other countries to date in supporting the development and deployment of marine renewables?

11. Within the marine renewables sector we can be confident that the UK currently leads the world, albeit that lead is being challenged. Perhaps the best way to learn lessons is from other similar sectors such as wind which have already gone through this process.

12. In the case of wind power, comparing experience from countries such as the UK and Denmark, has shown very clearly that success requires action on a number of fronts, as follows:

— Strong and stable market support mechanism, allowing volume production to get underway and investments to be made with confidence.

— Direct funding support for testing and demonstration, ensuring that world-leading projects are built on home soil.

— Institutional and policy support in areas such as planning and grid, reducing risks and cutting down timescales.

— Academic support for universities and research programmes to boost industrial developments and embed technology developers and manufacturers nearby.

— Direct support for manufacturing including supply chain initiatives to help local companies get onto the supply chain ladder.

— Maximum use of existing expertise and synergies (in the case of marine renewables in the UK, this will mean our Oil & Gas and Shipping industries).

— Support for infrastructure development (for marine renewables this will mean ports and installation facilities).

13. The UK currently leads the world in marine renewables, however, we cannot afford to be complacent as other countries are working hard to steal that lead. All of the above factors need continual revision to ensure maximum effectiveness. In the case of funding support, the needs of the sector have evolved and it is now very clear what is required to maintain momentum (see below).

Is publicly provided innovation funding necessary for the development of marine technologies and if so, why?

14. Public funding is essential for the growth of the sector, and to leverage more private funding. The particular public funding needs over the next few years are as follows:

— Market support at 5ROCs for both wave and tidal power. This is needed to kick-start development of the first arrays, by signalling long-term commitment to the sector, and to underpin the large upfront investments needed. The industry as a whole has been very clear on this requirement and we have submitted solid evidence to back this up.

— Grant support at 25% of capital cost for the very first small arrays (5MW to 10MW). This is essential to help address the diseconomies of scale affecting such projects. The recently announced £20 million support funding is extremely welcome and could support two small arrays. It is not enough on its own however to support a viable sector, which is why additional support of this type is still needed, whether from the UK, Scottish or EU Governments.

— Continued grant support at 40% for prototype testing, to bring forward sufficient concepts to ensure the best ideas make it through to commercialisation.

15. It is important to point out that this support is only needed to start the sector. Once development gets underway we expect costs to reduce both due to economies of scale, and to learning rates as designs are optimised, manufacturing techniques advance and risk premiums reduce.

16. Over time we expect the grant requirements to be replaced by private financing from the market. Long-term market support (ie 5ROCs or equivalent) will also reduce for future generations of projects and the required support levels should be carefully assessed as part of the administrative process under the Renewables Obligation (RO) and Electricity Market Reform (EMR).

What non-financial barriers are there to the development of marine renewables?

17. As discussed above, the success of the sector depends on progress across a range of fronts. The non-financial barriers are as follows:

— Planning in marine environment—procedures need to be clearly understood, and efficient.

- — Alternatives uses for marine environment—dialogue and initiatives needed to ensure marine renewables co-exist successfully with users such as shipping and fishing.
- — Ecological issues and benthic zone environments—ensuring sensible provisions which also allow for the environmental and economic credentials of marine renewables.
- — Development of supply chain—see below.
- — Suitable testing locations—EMEC has a pivotal role to play but is running out of space.
- — Public understanding—need to ensure support at local and national levels.
- — Hazardous and hostile environments—all parties need to respect and allow for these environments which are amongst the most inhospitable on Earth.
- — Development of supportive grid connections and, where necessary, reinforcements.
- — A fair transmission charging regime that can enable marine energy projects that are sometimes in remote locations.

To what extent is the supply chain for marine renewables based in the UK and how does Government policy affect the development of these industries?

18. Much of the existing supply chain is in the UK. Some components cannot currently be sourced within the UK, this represents an opportunity to support supply chain development here. Those companies which are involved in the early UK projects will be far better positioned to win future work here, and to export abroad, therefore a premium should be attached to early initiatives.

19. Government policy can have a direct and strong bearing on supply chain prospects, through providing market confidence, and through enterprise initiatives which maximise the prospects of UK supply chain involvement. Maximum use should also be made of established expertise in sectors such as Oil & Gas—this is not always easy given this sector is currently highly focused on its own core business needs. Government encouragement could play a key role.

What approach should Government take to supporting marine renewables in the future?

20. Funding and institutional support as set out above. Again, a premium should be attached to early action which will have substantial leverage, and long-term payback.

Are there any other issues relating to the future of marine renewables in the UK that you think the Committee should be aware of?

21. No.

September 2011

Memorandum submitted by SSE

0.1 SSE welcomes the opportunity to provide views in response to the Committee's inquiry into the future of marine renewables in the UK. SSE believes that the marine renewables industry has vast potential for the UK with a practically extractable resource of 36GW, capable of providing 20% of the UK's electricity supply[86]. This would contribute to the decarbonisation of the UK electricity sector whilst providing socio-economic benefits and a potentially significant export industry for the UK.

0.2 SSE is a UK-owned FTSE 30 company with over 20,000 employees and a £1.6 billion annual investment programme until 2015. It is the largest renewable generator of electricity in the UK and is the second largest generator overall. It supplies over nine million customers in GB with electricity and gas through its Southern Electric, Scottish Hydro, SWALEC and Atlantic brands, and operates electricity and gas networks in the south of England and the north of Scotland. It also has interests in telecoms, water, and contracting services.

SSE's Marine Energy Experience

0.3 SSE maintains a diverse generation portfolio and has been involved in the development of marine renewables for over eight years, spending over £20 million in technology R&D and actively developing commercial sites. As a project developer SSE has secured an interest in four lease options areas, amounting to 800MW, in the Pentland Firth and Orkney Waters Strategic Area, part of the world's first commercial leasing programme for wave and tidal projects undertaken by the Crown Estate.

0.4 SSE has a significant shareholding in the leading wave energy technology developer Aquamarine Power, and has taken a lead in supporting the off-shore renewable energy supply chain, through investments such as Burntisland Fabrications (BiFab) in which it invested £11 million in 2010.

[86] RenewableUK (2011)—*Working for a Green Britain: Vol 2.*

Given appropriate levels of support to get through the current technology demonstration stage and realisation of early pre-commercial arrays, SSE believes marine renewables will be able to compete with other more established forms of generation once delivered in scale.

Summary of Views

0.5 **Vast potential**—The potential for marine renewables in the UK is vast. The industry is ready to invest and is in a healthy position currently as the world leader in the sector, with an established supply chain and the largest number of private companies[87] and academic institutions[88] focused on the marine energy sector anywhere in the world. The development and deployment of marine renewables in the UK could bring a number of benefits:

0.5.1 **Renewables target—**Marine renewables can assist the UK in meeting its ambitious renewable energy targets, with the UK having 1.6GW of marine renewables potentially installed by 2020[89].

0.5.2 **Security of supply—**Marine renewables can assist in maintaining security of supply as they are an indigenous source of energy which can insulate the UK from volatile international energy markets and assist with intermittency issues associated with the increased penetration of wind onto the grid, making the UK's energy system more robust.

0.5.3 **Socio-economic—**The industry has the potential to provide an additional 15,000 jobs by 2021[90], and could allow the UK by 2050 to capture up to 20% of a market expected to be worth £40 billon per annum in 2050[91].

0.6 **Support needed—**Experience shows that where governments have proactively provided the required support, new technologies have been able to develop. Marine renewables are currently in transition from R& D to commercialisation and subsequently the levels of support must reflect this. The private sector will respond with greater confidence and investment, if the Government shows leadership and long term policy certainty. Without this signal of intent the initial private sector investment will dry up and it will likely lead to the UK's lead in the sector being eroded. The three main areas where the UK Government should prioritise to ensure the UK marine renewables industry is developed to its full potential are:

0.6.1 **Establish a long term financial framework—**The industry requires long term support. SSE would recommend that marine renewables are supported both from the pull of the market through ROC harmonisation across the UK and the push through capital support, which at current levels is inadequate to stimulate the emerging industry.

0.6.2 **Provide clear leadership and political support—**The marine renewables industry in the UK is at a critical juncture. The next two years are critical to maintaining the UK's position as the world leader in the sector. Clear political leadership is needed to ensure the supply chain benefits are not lost abroad.

0.6.3 **Ensure non-financial barriers are addressed—**A number of non-financial barriers to the development of the marine renewables industry exist. Issues regarding policy uncertainty and marine planning need to be monitored. Also, crucially, like other renewable generation projects, marine renewables need an appropriate solution from Ofgem's Project TransmiT, otherwise under the current charging regime projects will struggle to be economically viable.

Responses to Questions

1. *What are the potential benefits that marine renewables could bring to the UK and should Government be supporting the development of these particular technologies?*

1.1 The development and deployment of marine renewables in the UK could bring a number of benefits:

1.2.1 **Renewables targets—**The Government has an EU obligation of supplying 15% of the UK's total energy needs from renewables by 2020, with subsequent targets for 2030 and 2050 requiring an increasing transition to low carbon energy supplies. This represents an enormous challenge, from the 3.3% supplied from renewables in 2010[92]. It is expected that at least 30% of electricity will need to come from renewable energy to meet this ambitious 2020 target alone. Alongside onshore and offshore wind, marine renewables can make a meaningful contribution to the 2020 target and a significant contribution to the subsequent targets.

1.2.2 The projected 300MW of marine energy capacity by 2020 published in the UK Renewable Energy Roadmap takes a pessimistic view of the potential deployment of marine energy[93], and falls well short of current industry development activity. RenewableUK have estimated that this

[87] Carbon Trust (2011)—*Accelerating marine energy: The potential for cost reduction—Insights from the Carbon Trust Marine Energy Accelerator.*

[88] Carbon Trust (2011)—*Marine Renewables Green Growth Paper.*

[89] Renewable UK (2011)—*Wave and Tidal Energy in the UK.*

[90] RenewableUK (2011)—*Working for a Green Britain: Vol 2*

[91] Carbon Trust (2011)—*Marine Renewables Green Growth Paper*

[92] DECC (2011)—*Digest of United Kingdom Energy Statistics 2011.*

[93] DECC (2011)—*UK Renewables Energy Roadmap.*

figure is achievable by 2017 and SSE alone expects to be commissioning 200MW projects around 2020. Under the RO installed onshore wind capacity has grown significantly, from 1GW in 2005 to some 4.3GW today, a fourfold increase in less than six years. Given the right support and incentive framework from Government rapid growth in the deployment of marine renewable can be expected.

1.3 **Security of supply—**The UK is becoming increasingly dependant on imported sources of energy, a reversal being from a net exporter pre-2004, and this trend is set to increase as domestic supplies from the UK continental shelf are depleted[94]. The UK is uniquely positioned, in terms of both having significant wave and tidal resource on its doorstep, and also vast maritime experience, particularly in recent years through its North Sea oil and gas sector. Exploiting a diverse portfolio of indigenous renewable generation will allow the UK energy system to become less reliant on imported fossil fuels and thus less susceptible to volatile world energy markets as well as becoming more robust against intermittency issues, allowing greater penetration of renewables onto the grid.

1.4 **Socio-economic—**There is significant private sector investment in marine renewables with a number of major industrials running £20 million plus R&D programmes. The UK is currently the world leader in marine renewable development, and is well positioned to deliver significant socio-economic benefits, particularly high value-added jobs in engineering and science. The scope for a significant UK based supply chain for marine energy is much greater than some other forms of power generation, such as nuclear, where the UK is likely to import much of the expertise needed to facilitate its development. Furthermore, there are promising export opportunities for a UK based supply chain. Current estimates show that approximately 250GW of marine energy could be deployed globally by 2050[95]. This would require global investment of around £40 billion per annum by 2050, and the Carbon Trust estimates that if the marine energy sector is developed then the UK could capture over 20% of this accessible global market[96].

1.5 In conclusion, the significance of these potential benefits should amply justify Government support for the development of the technologies and the wider sector.

2. *How effective have existing Government policies and initiatives on marine renewables been in supporting the development and deployment of these technologies?*

2.1 The Government can take some credit for the UK's current lead in marine energy through support for testing infrastructure, notably the European Marine Energy Centre (EMEC) in Orkney, which is seen as the home of most early full stage prototypes. This alongside the support made available to develop the National Renewable Energy Centre (NaREC) and Wave Hub, has meant that the UK has a world leading testing infrastructure. Government supported grant systems, such the Technology Support Board, and in Scotland, the WATES and WATERS funding rounds, coupled with enhanced ROC support, have also been important.

2.2 The UK Government's support through DECC's UK Marine Energy Programme initiative and the initial £20 million outlined in June this year, alongside the creation of a Green Investment Bank show the early stages of positive intent. The private sector will respond with greater confidence, and investment, if the Government shows further leadership and long term policy certainty. Without this signal of intent the sizeable private sector investment will dry up and it will likely lead to the UK's lead in the sector being eroded.

3. *What lessons can be learnt from experiences within the UK and from other countries to date in supporting the development and deployment of marine renewables?*

3.1 Demonstration projects of early marine devices have shown that the sector, as with most new technologies at the beginning of their development, is capital intensive and at times high risk. Capital may not always be channelled successfully initially, but it must be accepted that some developments may not come to commercial viability and developments must be allowed to fail, if a viable marine renewables industry is to be developed.

3.2 It is important that UK policy makers study how other renewables industries have developed. This would provide useful guidance in helping to shape policy intended to secure and develop the UK marine energy industry for both domestic growth and export markets. A case study the Government should look at closely is that of the Danish wind industry, which in 2010 was worth £6.5 billion (DKK55.3 billion) in exports[97]. A document which SSE would recommend to the Committee would be Aquamarine Power's analysis exploring the historical differences between the Danish and UK wind industries in the scope of how to develop a marine energy industry[98].

94 DECC (2011)—*Digest of United Kingdom Energy Statistics 2011.*
95 Carbon Trust (2011)—*Marine Renewables Green Growth Paper.*
96 Carbon Trust (2011)—*Marine Renewables Green Growth Paper.*
97 Danish Wind Energy Association (2011)—*New all time high record in exports—http://www.windpower.org/en/news/news.html#719*
98 Aquamarine Power (2010)—*The Danish wind industry 1980–2010: lessons for the British marine energy industry.*

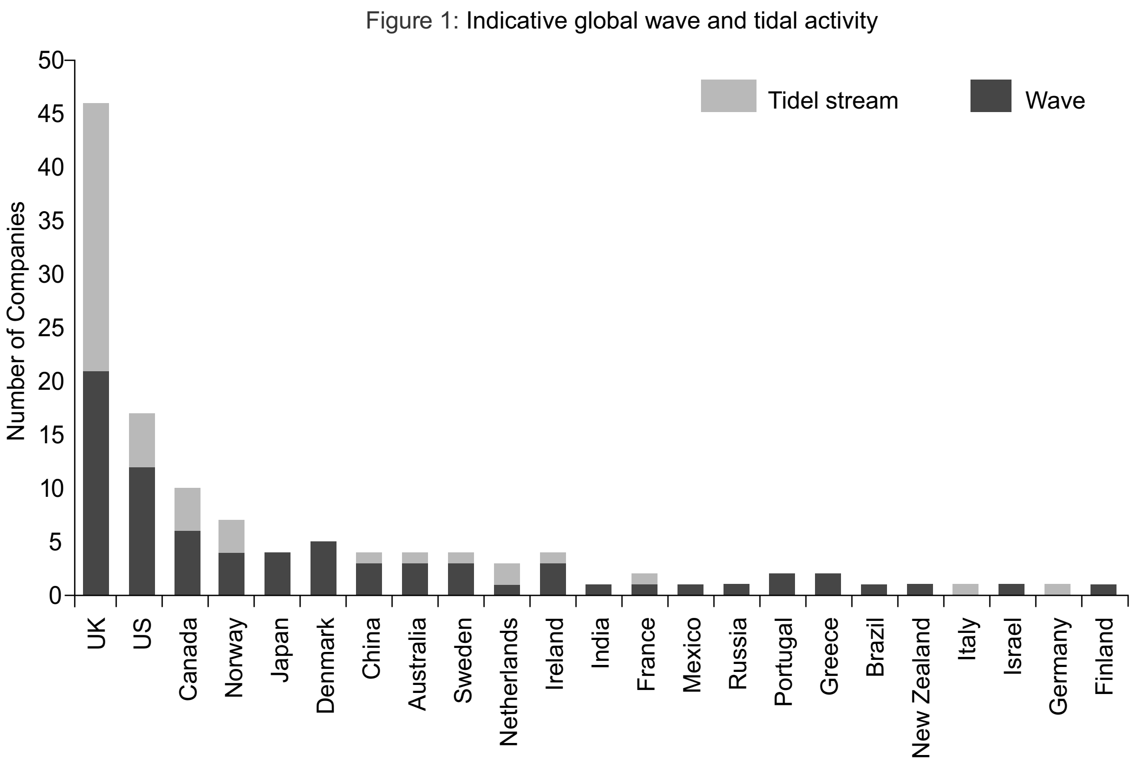
4. *Is publicly provided innovation funding necessary for the development of marine technologies and if so, why?*

4.1 In order to realise the potential benefits outlined in Q1, SSE believes that public innovation funding is fundamental to delivering a competitive advantage in an emerging industry in a global market. Again, the comparison with Denmark of support for an emerging wind industry is relevant. Denmark gave consistent support to the development of its wind industry whereas the UK support was inconsistent. Notably, when funding significantly increased for the wind developers under the RO this led to the rapid growth in deployment highlighted above (see question 1), but this market support was too late for UK manufacturing. In the 1970s the UK had a technical lead on turbine development, but pulled back support just as the wind industry was in transition from R&D to early pre-commercial projects. The marine industry in the UK is at a similar critical juncture. Today there are no UK based manufacturers, whilst the Danish wind industry accounts for 20% of global turbine manufacture[99].

4.2 The marine industry is at a critical juncture to develop the competitive advantage the UK has in the sector due to a strong research and development base, with 13 out of the 40 academic institutions focussing on marine energy based in the UK[100], a significant share of device developers (Figure 1), the existence of a strong oil & gas and the UK having the largest marine resource in Europe. Given these advantages the private sector will invest in the industry in the short term, but long term policy support needs to be given to the industry to fully develop its potential.

Figure 1

INDICATIVE GLOBAL WAVE AND TIDAL ACTIVITY[101]



4.3 Government must be aware that the benefits to the marine industry and the wider economy outweigh the costs to the public purse. RenewableUK calculates that for every £1 of public funding for the industry £5 is put into the sector from the private sector[102], whilst industry experience has shown it to be nearer £6. In relation to other public funding, the UK marine industry could be viewed to be in a better competitive position to lead the world market than CCS, given the amount of investment in CCS worldwide. The Government is committed to significant public investment in CCS, if it showed a similar commitment to the marine renewables industry it could have significant benefits to the UK economy.

4.4 Government should also ensure that funding support for marine renewables through the Low Carbon Innovation Group is better aligned and co-ordinated. Currently the Energy Technologies Institute (ETI), the Technology Strategy Board (TSB), the Carbon Trust and Research Councils SuperGen Marine Programme,

[99] Renewable UK (2011)—*Wave and Tidal Energy in the UK.*
[100] Carbon Trust (2011)—*Marine Renewables Green Growth Paper*
[101] Carbon Trust (2011)—*Accelerating marine energy: The potential for cost reduction—Insights from the Carbon Trust Marine Energy Accelerator.*
[102] Renewable UK (2011)—*Wave and Tidal Energy in the UK.*

appear to unnecessarily overlap in some areas. Government should look to encourage collaborative industry working to maximise efficient industry support.

5. *What non-financial barriers are there to the development of marine renewables?*

5.1 The non-financial barriers to marine energy development are similar if not the same as those that are encountered by other renewables, which are:

5.2 **Transmission charging—**As with other renewables, a significant proportion of the resource is located remote from centres of energy demand. Therefore the traditional transmission charging regime of locational pricing is not fit for purpose. Along with other renewables, CCS ready thermal plant and pumped storage in the north of Scotland, marine energy investment is dependent on a positive outcome from Ofgem's Project TransmiT.

5.3 **Planning—**The planning regime for marine renewables is uncertain due to the process being new and untried. So far there have been few significant issues with planning for individual devices, but as larger arrays begin to be rolled out around the UK coastline, the marine planning regime needs to be robust, and appropriately reflect the national need for renewable energy.

5.4 **Policy uncertainty—**The policy uncertainty surrounding renewables support is amplified for a high risk developing industry like marine. The marine industry understands that Government support will be "tapered" over time as the sector matures but the Government needs to ensure that the levels of support under the RO are transferred smoothly over to CfD's under the EMR proposals, to ensure that investments that are made post 2017 continue to receive adequate levels of market support.

6. *To what extent is the supply chain for marine renewables based in the UK and how does Government policy affect the development of these industries?*

6.1 Much of the supply chain needed to develop the marine industry in the UK already exists through the extensive experience in the North Sea and overseas from the oil & gas industry and the developing offshore wind industry. However, currently marine renewables struggles to attract the offshore expertise into the sector due to being unable to compete with lucrative oil & gas contracts. As the finite fossil fuel resources of the UK continental shelf are depleted, marine renewables and offshore wind will provide an attractive opportunity for employment and utilisation of a highly skilled and experienced supply chain, with marine renewables predicted to provide up to 15,000 jobs in the industry by 2021[103].

6.2 The Government's vision of creating Marine Energy Parks is a positive step, and SSE is supportive of focusing initial industry development in a limited number of strategic areas to allow integrated solutions to be developed, encourage supply chain development and shared learning and research programmes. A model to study, like the Scottish Government have in the past[104], would be the German port of Bremerhaven, where significant state investment in an area of high-unemployment resulted in large private sector investment in the wind supply chain, from which the UK now imports equipment.

6.3 Certainty from Government is fundamental to attracting the scale of investment needed in the sector. Large industrial manufacturing companies will be looking to continue to invest in the sector as it develops and maintaining the UK's lead is vital to secure inward investment opportunities in future from large international industrials.

7. *What approach should Government take to supporting marine renewables in the future?*

7.1 There are three main areas the UK Government should prioritise to ensure the lead that the UK has in the industry is developed to its full potential, these are:

7.2.1 **Establish a long term financial framework—**Economic viability is fundamental to investment in the sector. The private sector has demonstrated that it is prepared to invest in this relatively high risk industry because it believes the longer term "prize" is realisable. However appropriately structured market push and pull mechanism's need to be present, through a combination of initial capital (push) and revenue (pull) support.

7.2.2 The UK Government should harmonise the RO across the UK for marine renewables so that companies focus their investments in the most appropriate locations rather than focus decisions solely on financial incentives. It must be noted that market support mechanism such as the RO only cost the consumer once projects have been consented, built and become operational, supplying electricity to the grid. Up until this point to this point in a technology's development curve the private sector would have committed large amounts of capital.

7.2.3 To assist in attracting this initial private sector investment, the Government should also increase capital funding in the industry from the £20 million available under DECC's Low Carbon Energy Fund, to help deliver the early pre-commercial arrays. RenewableUK has estimated that

[103] RenewableUK (2011)—Working for a Green Britain: Vol 2.

[104] Scottish Government (2009)—German lessons for renewables infrastructure -http://www.scotland.gov.uk/News/Releases/2009/10/19103742

the industry needs £130 million cumulative spend for these early arrays by 2014[105]. Taking forward the six times multiple from experience to date, this could help secure up to £780 million of private sector funding, rather than the £120 million that would be stimulated under the current public capital support.

7.3 **Provide clear leadership and political support—**The industry is at a critical juncture; the next two years are critical to maintaining and consolidating the UK as the world leader in marine energy. Clear political leadership is required to reassure investors that there is a long term commitment to renewables. This leadership will assist the industry bring the 1.6GW[106] of projects in development to fruition by 2020 and move the marine energy sector much closer to economic parity with other forms of power generation. Swift, decisive, and supportive leadership will have significant positive effects on the industry. The recent FiT review and loss of investor confidence in the solar PV sector, highlights the importance of ensuring that Government provides long term certainty and stability.

7.4 **Ensure non-financial barriers are addressed—**The non-financial barriers of transmission charging, planning issues and policy uncertainty outlined in question five needs to be addressed. Of particular concern is the current regime of locational pricing for transmission charging. Constraints on the transmission network could stifle development of not only marine energy, but both onshore and offshore wind, CCS projects and importantly pumped storage, which will prove vital as more renewables come on to the system and issues with intermittency increase.

8. *Are there any other issues relating to the future of marine renewables in the UK that you think the Committee should be aware of?*

8.1 The Government should also look to be much more proactive in Europe in aiming to secure more funding for the marine industry given the UK's position as market leader and having the largest available resource. There is funding available for renewable energy from the EU, but the Government needs to ensure that marine energy is not overlooked by the EU, given the UK's current advantage in the sector.

8.2 Another aspect the Government could assist the industry with would be on a campaign to improve information on the current state and potential of the marine industry in the UK. Currently there is a perception in the media that wave and tidal stream technologies are already economically viable, but there needs to be an acknowledgement that, whilst offering huge potential marine renewables are not as advanced as other more mature renewable technologies, such as onshore wind, and therefore they need early public sector support. It is also important to communicate the large potential socio-economic benefits of "building an industry" in the UK.

8.3 SSE considers the UK marine industry to be in a similar position to Denmark wind industry in the late 1980s. Whilst we see the potential for 36GW of marine energy in the UK, the public should be aware that the industry will need more time and investment to develop before it can be deployed at similar levels to other renewables.

September 2011

Memorandum submitted by AWS Ocean Energy

1. Executive Summary

2. AWS Ocean Energy is a leading company in the wave energy industry. Headquartered in Inverness, Scotland. We have abundant natural resources on our doorstep. We have taken an honest and pragmatic market led approach to creating smart wave power solutions.

3. Our lead product—the AWS-III—is a multi-cell surface-floating wave power system and has evolved from our Mk 1 technology first deployed, tested and grid connected in Portugal in 2004. A single utility-scale device, measuring about 60m in diameter, will be capable of generating up to 2.5 MW of continuous power.

4. Wave energy will play a significant role in future energy supply, both in the UK and on a global basis. As the World Energy Council stated in 2003—ocean wave power has the potential to supply 10% of current global demand for energy.

5. However, significant public sector support is needed at the research and development stages and for the final stage before commercial deployment, to give private sector investors, such as our recent investor Alstom, the confidence they need that marine technology is seen as a key part of the UK's energy mix.

6. Alstom is a global leader in the world of power generation, power transmission and rail infrastructure and sets the benchmark for innovative and environmentally friendly technologies. Alstom builds the fastest train and the highest capacity automated metro in the world, provides turnkey integrated power plant solutions and associated services for a wide variety of energy sources, including hydro, nuclear, gas, coal and wind, and it

[105] Renewable UK (2011)—Wave and Tidal Energy *in the UK.*
[106] Renewable UK (2011)—*Wave and Tidal Energy in the UK.*

offers a wide range of solutions for power transmission, with a focus on smart grids. The Group employs 93,500 people in around 100 countries, and had sales of over € 20.9 billion in 2010–11.

7. In June 2011, Alstom agreed to take a 40% stake in AWS Ocean Energy. This investment will allow us to double our workforce to about 30 over the next 12 months in order to take forward and deploy our technology.

8. This is Alstom's, and indeed the industrial community's first major investment in wave technology should demonstrate to the UK Government that this sector is worth supporting and therefore ensure that funding sources and market mechanisms are as favourable as possible to marine energy.

9. We have attached more detailed responses to the specific questions raised by the Committee.

10. Response to Specific Select Committee Questions

11. *What are the potential benefits that marine renewables could bring to the UK and should Government be supporting the development of these particular technologies?*

12. Marine renewables present the UK with a unique three-fold opportunity for the UK , in terms of carbon reduction, energy sustainability, and long term economic development. The UK has the largest wave and tidal resource in Europe, and a unique wealth of indigenous technologies in development. In our view, just as the use of traditional fossil fuels were seen as the UK's primary energy source in the 19th and 20th centuries, so marine energy should now be considered as one of our greatest and most abundant energy resources in the 21st Century which can and should be harnessed.

13. Wave energy convertors have the potential to generate enough energy to power a quarter of the homes in the United Kingdom without producing CO_2 or harmful emissions. The industry would create 50,000 direct manufacturing jobs, and 5–10,000 high end research and management jobs. The two-fold balance of payments benefit, both from the reduction in import of fossil fuels in the future, and in the generation of technology and manufacturing led exports, has a significant contribution to economic redevelopment. That's what benefit marine technology offers. It is potentially worth £5 billion to the Scottish energy market alone by 2020.

14. However, the major challenge to any new technology is the research and development (R&D) stage as investors will not see a return for years to come. This is where government support is so influential and important. By providing public sector investment, and equally significantly commitment to stabilised future revenues, government sends out a positive signal to investors, like Alstom, that marine technology has a future in the UK energy mix. This process therefore has a domino effect and accelerates the R&D stage which in turn brings the commercial operation date forward, and therefore will assist in meeting the UK renewable targets and crucially to create a new industry for the UK, with all of the spin off economic benefits that entails.

15. The Renewable Energy Roadmap publication, alongside the Electricity Market Reform White Paper, is welcomed as it gave a direction of travel for Government thinking on renewables and the role it sees each renewable playing in the UK energy mix. However, in relation to marine energy, it underestimates its potential and undervalues the investment needed to achieve its targets.

16. The Roadmap also leaves a number of detailed decisions to be decided in the near and medium future. The sector yet again has to wait for these decisions to be made before taking the "leap" forward needed to unlock the great potential that marine energy offers.

17. *How effective have existing Government policies and initiatives on marine renewables been in supporting the development and deployment of these technologies?*

18. The UK and Scottish Governments have supported marine renewables through a mixture of market regulations and £160 million of public funding during the last decade (UK figure from the Renewables Advisory Board).

19. Public Funding

20. As with many developers, we consider the range of funding sources too complex and inconsistent. The Marine Renewables Deployment Fund, for example, was an initial failure because most of the technologies were not sufficiently developed to meet the criteria and no scheme successfully applied for years. Then when the technology began to reach the criteria, the current Government chose to close the Fund and DECC replaced it with a £20million funding allocation to support two projects to test prototypes in array formations—typically the final development stage for generating electricity from marine power prior to commercial roll out.

21. Whilst we welcome the announcement that some public funding will be available, it falls way short of what the sector requires to accelerate R&D and move into commercial operations in time to meet the Government's renewable targets. Dr Stephanie Merry, Head of Marine Renewables at the Renewable Energy Association (REA), warned this allocation is effectively a funding cut given the £42 million closure of the Marine Renewables Deployment Fund.

22. Market Regulation

23. As marine technologies are not yet as cost competitive as the primary costs of carbon fuel generation technologies, private sector investors require evidence of long term support through measures such as the Renewables Obligation (RO). However, the RO mechanism has changed since its inception when banding was introduced and yet again the RO is undergoing a banding review. Therefore, we welcome the introduction of a Feed-In-Tariff Contract for Difference, at similar support levels to those via the ROC banding scheme as a more stable replacement for the RO as it will increase investment security.

24. However, we believe the best mechanism for technology development funding and support to date has been the Scottish Wave and Tidal Energy Support Scheme (WATERS Scheme) as it has a more flexible approach as we explain below.

25. *What lessons can be learnt from experiences within the UK and from other countries to date in supporting the development and deployment of marine renewables?*

26. As mentioned above the best mechanism scheme so far has been the WATERS scheme, whereby earlier stage technologies have been supported by de-risking private investors' money with Government backed and Enterprise agency managed funds. The ability to attract private funds has multiplied this investment by at least 3:1. In our own case, the presence of WATERS funds has made it more attractive for Alstom to make the significant investment in our business. The fund, provided by the Scottish Government with some EC support, and managed by the enterprise agencies, was available to many different types of project, from the development of components crucial to deployment, to the support of pilot arrays.

27. The crucial lesson is: policy stability. It is hard enough for businesses like marine technology companies to sustain investment at the R&D and final stage up to commercial deployment, without having frequently to adjust to policy shifts. We are extremely disappointed that public investment has been cut in real terms, but whatever changes are made in the future it must be more "flexibility" and include increased investment where possible, and not further cuts and complex application processes. We urge more open calls, evaluated on techno-commercial merit.

28. *Is publicly provided innovation funding necessary for the development of marine technologies and if so, why?*

29. Publicly provided innovation funding is not only necessary, it is essential. As stated earlier, public financial support can generate three-fold increases in private sector funding. However, recognising that we live in times of austerity and significant pressures on public funds, we believe it is even more important for much needed Government spending to support the development of marine renewable to be concentrated in those areas around the UK and those marine renewable technologies which offer the greatest potential for success. Success could be measured in many ways, but one of the key factors is economic stimulus.

30. The need for a clustered approach, such as has the potential to exist in various Scottish locations, is seen. We would certainly be concerned that moves to spread government investment in the sector around the UK coastline or across too many different technologies would result in a dilution of the support needed to help the best technologies, in the most productive areas, get the support they need to achieve commercialisation. For example, in our opinion, there are currently too many locations around the UK coast looking for public funding to become established as centres of excellence for testing and evaluating marine renewable technologies. We believe the Government should, without extending timescales in any way, apply the most stringent performance criteria to those competing claims and use the intellectual, business and political assets at our disposal to back winners. This will help ensure that public funds deliver best value for the British taxpayer.

31. *What non-financial barriers are there to the development of marine renewables?*

32. Policy and Planning

33. Complex planning and licensing processes and policy uncertainty contribute to investment risk. For example, measures to protect the marine environment place complex burdens on developers like us and limit the level of development resource available. Pre-consented large scale nursery sites, developed in collaboration between public and private enterprises, would serve to de-risk and accelerate the learning and allow a speedier rollout of farms.

34. Reliability

35. Wave behaviour is less variable from hour-to-hour (placing fewer demands on the grid) but of course is dependent on a wave climate. However, it can be forecast fairly accurately several days in advance using modelling. Predictability is important as it allows the grid to adjust to ensure demand is met. Wave energy is well matched to current seasonal demand with around half of UK wave energy produced over the winter period when demand is high. It is also often out of phase with peak wind, such that the much reported "winter highs" can be offset by wave and tidal energy. Tidal energy is independent of weather, and extremely predictable.

36. Practicality

37. The focus with AWS Ocean Energy is to evolve wave energy convertors which meet the needs of the Utilities. These machines need to be easily deployed, quickly expanded into viable economical farms, easily accessed for maintenance, and above all, reliable. Whilst the industry is at an early stage, the technology is moving forward to achieve these requirements. AWS is now working on our third generation device, which has taken an objective look at utility requirements, rather than merely developed an invention. By following this route of meeting industry requirements, practical solutions will evolve quickly. Focus on this approach by the industry as a whole will yield further success.

38. Scale-Ability

39. The ability to expand wave farms in open water, well offshore, is well recognised. At 2.5–3MW per machine based on today's design, and with future plans to expand individual machine capacities, the AWS-III technology is recognised by the utilities to be at a scale that is readily deployed in farm arrays of greater than 100MW. Fabrication facilities exist today within the UK which would allow rollout, in the second half of the decade, of in excess of 250MW per year. Future rollout of 1GW per year is possible.

40. Grid Connection

41. Most UK marine resources are located off the north and west coasts of the British Isles. These areas are far from regions of high population density. Transmitting electricity from marine renewables located in these locations requires significant development of the grid network, which raises many issues such as public acceptability, cost, and the length of time the development would take. Delays in these areas disadvantage developers who may have to bear additional costs. The disproportionate loading of transmission costs onto marine renewables may well have a stifling effect.

42. *To what extent is the supply chain for marine renewables based in the UK and how does Government policy affect the development of these industries?*

43. The AWS-III supply chain, for the UK market, relies on technologies and fabrication facilities existing within the UK. Support for the development of port and quayside facilities via the Scottish Government's N-RIP will only serve to enhance this capability. The present support for the reopening of the Nigg facility, for example, will provide a significant fillip for the development of an indigenous industry, which as a major future exporter, will continue to create wealth for the UK economy as an exported product. THIS IS A MAJOR DIFFERENTIATOR FROM OTHER RENEWABLE TECHNOLOGIES.

44. *What approach should Government take to supporting marine renewables in the future?*

45. Back the technology winners with sufficient and easily accessible public funding for continued Research and innovation development . A scattergun approach to supporting viable technologies has resulted in over 100 technologies, each competing for investment and resources, and which in the view of industry experts are either just ridiculous or can never be commercially viable. We have the academic and entrepreneurial resources to apply rigorous viability tests to such devices, officials seem to prefer to leave such decisions to the market.

46. Apply future proposed support to whole farms of viable scale, rather than the tight constraints that are presently proposed, well beyond 2017. This when tied to sure backing of technology steps and technology winners will ensure a sensible glide path to parity with conventional generation.

47. Provide a softer entry to commercialisation. There are many opportunities here, including offering fiscal measures to support both developers and the critical supply chain.

48. Continue the ROC banding or equivalent scheme beyond 2017, at a scale which allows significant critical mass to develop, quickly to allow economies of scale to be achieved.

49. Provide pre-consented nursery farm opportunities for demonstration arrays.

50. Allow a pragmatic approach to planning, and work with the Crown Estate to streamline licensing, leasing and consenting in accordance with achieving aligned strategy objectives.

51. Ensure the recycling of unused WATERS and other funds, by means of open calls rather than ring-fenced single application schemes.

52. Support the development of clusters close to market ie in the north and west of Scotland, and the west of Northern Ireland.

53. Consider an "all isles" policy with ISLES grid connections.

54. Support the sensible transfer charging arrangements for getting the energy from the point of generation to the point of use.

55. Highlight the need for support of the industry as an exporter- support the differentiator.

56. Lead on developing other markets such as Chile and the US which have the resources but lag behind in the regulatory, policy, and mechanism approaches, particularly to wave energy. This creates an export market pull that doesn't yet exist, and accelerates the development of a sustainable long term industry.

57. *Are there any other issues relating to the future of marine renewables in the UK that you think the Committee should be aware of?*

58. This industry is still within the R&D phase. To date as an industry we have had the reputation of over-promising and under-delivering. The main driver for this is the need to appear attractive to investors. However this approach has heightened the risk-aversion of such investors. We need to work together to ensure that we stick to a culture of over-delivering and under-promising, as has been developed by the "under the radar" approach of AWS Ocean Energy. To achieve this, and to deliver the economic benefits promised, means that the risks need to be shared, by government and industry.

September 2011

Memorandum submitted by the Welsh Government

1. Thank you the opportunity to input into the above mentioned inquiry. The Welsh Government believes that with the right enabling framework marine energy can contribute significantly to domestic and UK renewable energy targets and move the UK closer towards a low carbon economy. The following submission highlights what the Welsh Government is doing to support the development of the sector.

Policy Framework

2. In March 2010, Wales published its Low Carbon Energy Statement which draws on the work of the Wales Climate Change Strategy, the National Energy Efficiency and Savings Plan and our Green Jobs Strategy. The Statement sets out the actions that will be taken to accelerate the transition to an efficient, low carbon energy based economy in Wales and the anticipated generation targets for each renewables sector. By 2025 we believe that Wales could be producing up to 48TWh, twice its current electricity consumption. With a relatively sheltered accessible resource, strategic port and grid access, the Welsh Government believe that marine energy in Wales will make a significant contribution to domestic and UK renewable energy targets. Wales is fortunate to have over 1,200 kilometres of coastline with significant marine-energy, extensive port facilities, a strong manufacturing and energy sector tradition. The Welsh Government is determined to maximise green energy and green jobs.

3. The Assembly Government recently published the findings of its three year project, the ***Marine Renewable Energy Strategic Framework*** (MRES). The MRES project has investigated the potential marine energy resource areas within Welsh Territorial Waters by device type, identified the associated constraints tied to those areas and considered potential scenarios for the sustainable development of the available resource. The MRESF is an aid to development, ensuring Wales gets the right device in the right place, providing developers with key information to inform EIAs and, by carrying out the constraints work, helping to reduce the consenting risk for developers. The findings show that even when the various environmental and technological constraints are taken into account, there is still the potential for Welsh waters to produce enough energy to power up to two million homes per year

4. The MRES acknowledges the current stages of the emerging technology and the need for further research. Given the difficulties of achieving consent when the level of scientific certainty is not high, the MRESF concluded that it is likely that a "deploy and monitor" approach may be required at least for early stage demonstrator devices. Such an approach would enable the industry to progress past the difficult stage it is currently in—essentially that a lack of certainty is hampering the consenting process and until devices are deployed and monitored, it is becoming increasingly difficult to increase the level of certainty. The MRESF study has shown the huge energy potential that lies within our seas and has provided some generally useful guidance that will aid our seas energy developers in their efforts to harness sea power.

5. Recently the Welsh Assembly & DECC announced the granting of the necessary consents for a 1.2MW tidal demonstrator device in Ramsey Sound off Pembrokeshire. This will be the first deployment of a marine device in Wales and the first in the UK to operate on a "deploy and monitor" approach, allowing the device to operate around the clock. The evidence collated from the demonstration will provide the much needed field data to move the industry forward.

6. In addition, there is a need for the data captured by early devices to be made public and not held onto by developers as part of their Intellectual Property. Using public money to fund environmental assessments and monitoring will release this information into the public domain and will only serve to move the industry forward.

Research & Development

7. ***The Low Carbon Research Institute*** (LCRI) has been set up to unite and promote energy research in Wales to help deliver a low carbon future. The Low Carbon Research Institute Marine consortium (LCRI Marine) is a partnership of Swansea, Aberystwyth, Bangor, Cardiff, Swansea Metropolitan Universities and Pembrokeshire College. Experts in each institution are collaborating in a multidisciplinary way to undertake £7 million of applied research and development.

8. Building on the outcomes of the MRESF, the current LCRI Marine research themes include:

- the interaction of tidal turbine rotor blades with combined tide, wave and turbulent flows;
- marine vessel survey of high energy wave and tidal sites;
- CFD modeling of wave machines, tidal turbines, arrays, wakes, scour and deposition;
- environmental impact analysis of wave and tidal energy sites.

9. The group has a strong role in the support of early stage device developers and the supply chain, together with public awareness and dissemination activities. Interestingly, many of the areas covered within LCRI Marine were identified as key research areas in the NERC sandpit.

10. In the Spring, the LCRI conducted a two week long field study exercise in and around Ramsey, off Pembrokeshire. A substantial amount of data was captured during the survey. LCRI, will be publishing reports and papers from the material gathered at Ramsey Sound in the forthcoming months.

11. Marine Energy Pembrokeshire is a local delivery group aimed at promoting Pembrokeshire as a hub for marine renewables. The Welsh Government co-fund the Group, along with other interested stakeholders. Later this month the Group will be hosting a workshop to establish a co-ordinated approach to marine research in Wales, increasing our understanding of the impacts of marine energy devices on the environment. This approach should help fast track consents of prototypes and pre-commercial arrays.

Grid and Infrastructure

12. Grid infrastructure is key to the delivery of a low carbon future. In Wales there is some capacity available to connect small-scale projects, but as the industry develops more grid capacity will need to be built. Eirgrid are in the first phase of constructing the subsea interconnector cable between Rush North Beach, Dublin and Barkby Beach, Prestatyn. The interconnector has the capability of carrying 500 megawatts of electricity in both directions, therefore opening up new connection capacity for marine renewable projects.

13. Building on the MRESF, the Welsh Government will shortly be announcing a Marine Energy Infrastructure Study with Halcrow Group Ltd. The Study will help define the foundations of an accelerated programme for development of a sustainable marine energy industry in Wales with a strong focus on providing benefits to the Welsh people and green jobs economy.

Financial Support

14. Costs for developing and proving marine technologies are high. The provision of capital support is therefore necessary to share the level of risk with the industry and help drive costs down, ensuring that marine energy can become competitive with other renewable technologies such as on and off-shore wind.

15. The outcome of the review of the ROCs technology banding will be an important step for the marine energy industry. At present there is very little incentive to move money into the marine energy sector when the ROC level for a proven technology is the same as that for a technology classed as "emerging". Consultation with industry confirms that a minimum of 5 ROC's is needed to kick-start this promising technology and send the right signals to the market.

16. The main source for large funding in Wales, both revenue and capital, is via the Convergence & Competitiveness Fund administered by the Welsh European Funding Office (WEFO) on behalf of the Welsh Government. Tidal Energy Limited is a beneficiary of the Fund, securing £6.4 million towards the manufacture and deployment of their 1.2MW tidal demonstrator device off Pembrokeshire.

17. We are in discussion with the EU Commission to consider a structural fund programme post 2013 and how it might support the sector.

18. The table at Annex A outlines the main funding awarded by the Welsh Government to support the emerging industry over the past three to four years

The Crown Estate

19. Using the MRESf work as the foundation, and building on the site assessment work with Halcrow, we will continue our discussions with The Crown Estate on moving towards a leasing round for commercial wave and tidal developments.

20. In March the Welsh Government signed a Letter of Intent with the Crown Estate which formalised our intention to work together to support Wales' capacity for marine energy manufacturing, ensuring that

deployment of marine renewable energy devices is not delayed by infrastructure requirements at ports in Wales. Furthermore, the Welsh Government will be signing a Memorandum of Understanding (MOU) with The Crown Estate to better develop mutual objectives in marine and rural environments.

Developer Interest

21. Despite difficult economic conditions, interest within the sector remains high with a good number of developer interest Wales.

22. Following the awarding of the necessary energy consents from The Department of Energy & Climate Change and the Welsh Government, along with the financial support mentioned above, Tidal Energy Limited's *Deltastream* project is at the forefront of developments in Wales. We consider the *Deltastream* deployment as a key project that will not only contribute towards our renewable targets, but provide much needed field data to move the industry forward. Looking further ahead, Marine Current Turbines Ltd have submitted an application to deploy a 10MW tidal demonstration array in waters off Anglesey know as the Skerries.

September 2011

Annex A

Project	*Funding*	*Period*	*Description*
Marine Renewable Energy Strategic Framework (MRESF)	£0.9m	2008–11	Study to analyse the available practical wave and tidal resource in Welsh TW. The project included research into key data gaps to help with the data confidence levels.
Low Carbon Research Institute Marine Programme (LCRI Marine)	£7m	2010–13	Marine LCRI has been funded from the Welsh European Funding Office (WEFO) to undertake significant multidisciplinary, pan-Wales research through the Wales Low Carbon Research Institute (LCRI). The £7m LCRI Marine Consortium aims to enable, support and help build a sustainable marine energy sector in Wales.
Deltastream Project	£7m	2 Awards; 1. £600k in 2009 2. £6.4m in 2011	Direct funding via the ERDF through the Welsh Government towards environmental research, modelling and manufacture of the Deltastream 1.2MW full scale tidal demonstrator.
Sustainable Expansion of the Applied Coastal and Marine Sectors (Seacams)	£12.6m	2010–13	Funded via ERDF through the Welsh Government, SEACAMS offers businesses with interests in the marine sector access to the research, expertise and knowledge base of universities in Wales.
Marine Energy Infrastructure Study	£0.1m	2011–12	Forthcoming study appraising marine energy infrastructure requirements to support the development of the marine energy industry and device deployment in Wales.

Memorandum submitted by the Northern Ireland Executive

1. The Department of Enterprise, Trade & Investment (DETI) welcomes the opportunity to contribute to the Energy and Climate Change Committee's inquiry into the Future of Marine Renewables (wave and tidal) in the UK. The Department for Energy and Climate Change has provided an overall UK wide response and this submission sets out the particular actions which the Northern Ireland Executive is taking to develop offshore renewables (offshore wind, wave and tidal).

2. Energy is a devolved matter (with the exception of nuclear policy) and is the responsibility of the NI Executive. This means that NI has similar but separate, and at times locally tailored, energy and renewable energy policy. DETI, however, works closely with DECC and the other Devolved Administrations and contributes to and benefits from overall UK wide policy approaches, where appropriate. Northern Ireland also participates fully in the British Irish Council Marine Energy Sectoral Group led by the Scottish Government.

3. DETI sees the development of offshore renewable energy as an essential element within its overall energy strategy for a more secure and sustainable energy system. It can deliver increased security and diversity, address

climate change, contribute to renewable energy targets and provide economic benefits and business/supply chain opportunities to NI companies. These business opportunities have been identified by Invest NI—Northern Ireland's economic development agency and part of DETI—which is working with Northern Ireland companies to access the benefits of this growing market.

Background

4. Northern Ireland has the highest levels of fuel poverty in the UK and is over reliant on imported fossil fuels which account for some 98% of our total energy needs. The development of our renewable energy resources is therefore critical to longer term sustainability. Over the last six years, however, through the support of the Northern Ireland Renewable Obligation (which operates in tandem with the Renewable Obligation in England and Wales and the Scottish Renewable Obligation), the level of renewable electricity has steadily increased to the current level of just under 10% (about 380MW), of which the majority is from onshore wind.

5. The Strategic Energy Framework (SEF), published in 2010, highlighted the need for much more of Northern Ireland's energy to come from renewable resources with the resulting economic opportunities fully exploited. The Northern Ireland Executive approved the challenging SEF target of 40% of electricity consumption to be met from renewable sources by 2020. This means that Northern Ireland will be punching considerably above its weight in terms of a contribution to the overall UK renewable electricity target. Northern Ireland has significant renewable resources in particular onshore and offshore wind and tidal. The possibility to "export" renewable electricity from Northern Ireland presents further opportunities in the longer term, but this is subject to further grid reinforcement.

6. While large scale onshore wind, as the current most cost effective means of renewable electricity generation, will continue to contribute strongly to this target in the short/medium term, there is a need for a diverse mix of renewables within NI's energy portfolio to 2020 and beyond as we seek to de-carbonise the NI grid. We are therefore looking to offshore renewables to contribute to that mix and are keen to maximise the economic benefits for Northern Ireland businesses in the developing offshore renewable energy market.

Development of the Offshore Renewable Energy Strategic Action Plan

7. Over the last two years, DETI has been leading a major programme of work to facilitate the development of offshore renewable energy in NI waters, leading to the current Crown Estate Offshore Renewable Energy Leasing Round process. Given the range of Departmental responsibilities within the marine environment, this has involved the establishment of a cross agency Project Steering Group, to oversee the commissioning and delivery of a Strategic Environmental Assessment (SEA) of DETI's draft Offshore Renewable Energy Strategic Action Plan (ORESAP) 2009–20.

8. Following approval from the NI Executive, the draft Plan and its associated SEA were the subject of a wide public consultation process in early 2010. A Post Consultation Report was prepared in September 2010 and these documents are on a dedicated website www.offshorenergyni.co.uk A Habitats Regulations Appraisal has since been completed on the draft ORESAP and the Plan is currently being finalised and will be submitted to the NI Executive for approval this Autumn 2011.

9. In addition to the recommendations flowing from the SEA, work has been ongoing on the range of actions identified in ORESAP to facilitate the sustainable development of offshore energy as follows:

- The establishment of the Offshore Renewable Energy Forum involving external stakeholders such as environmental NGOs, Invest NI, ports and harbours, renewable industry and fishing sectors to advise DETI on the implementation of the Plan;
- Working with NI Electricity and the Utility Regulator of Northern Ireland on a programme to strengthen the NI grid to accommodate higher levels of both onshore and offshore renewable electricity
- Promoting, with Invest NI, the business supply chain opportunities arising from this growing sector for local companies;
- Seeking agreement with the Republic of Ireland on a practical way forward for handling projects in adjacent territorial waters;
- Contributing to the Department of the Environment's marine environmental programme, the introduction of a NI Marine Bill following on from the UK Marine and Coastal Access Act 2009 and work to streamline the marine licensing and consenting process;
- Introducing an offshore energy production and decommissioning regime in NI waters similar to that in GB waters;
- In light of the EMR and UK RO Banding Review, establishing an appropriate support mechanism to incentivise offshore renewable energy in NI waters; and
- Ensuring that Northern Ireland benefits from the range of UK wide initiatives supporting research, development and deployment of offshore renewable energy.

NI's Offshore Renewable Energy Resources

10. On the basis of the SEA, it was concluded that up to 900MW from offshore wind and 300MW from tidal stream in NI waters could be developed by 2020 without significant adverse effects on the environment and other users. The map in **Annex A** shows the Resource Zones for offshore wind (North West and Eastern coasts) and tidal stream (the main resources on the North and North Eastern coasts).

11. It was identified that there was limited wave potential in NI waters (a small amount off the North West coast) but that it would not be considered for commercial scale development purposes. Likewise, three smaller tidal Resource Zones (Strangford Lough, the Maidens and the Copeland Island) were not considered suitable for commercial scale development opportunities, primarily due to environmental factors and other marine users. It was, however, considered that these smaller Zones could be considered for pre-commercial/demonstration purposes.

Current Offshore Renewable Activity

12. The world's first commercial scale grid connected demonstration tidal stream turbine, SeaGen, has been operating in Strangford Lough since 2008. Its 1.2GW twin turbines can produce renewable electricity to generate power for the equivalent of about 1,500 homes and so far has generated over 2,500 MW/h onto the grid. Generating predictable electricity in tides of 2.4m/s (at least) it has won awards for its owners Marine Current Turbines Ltd who are planning a number of other tidal projects in the UK and overseas.

13. Located in the highly environmentally sensitive Lough (Marine Nature Reserve, Special Protection Area, Special Area of Conservation, Ramsar site, Area of Outstanding Natural Beauty and Area of Special Scientific Interest) SeaGen has been subject to a very strict environmental monitoring regime as part of its deployment. This regime has been gradually eased with regard to operating times/procedures as the Northern Ireland Environment Agency and the independent Monitoring Group have been satisfied that its operation has not been to the detriment of the marine environment. Queen's University of Belfast (QUB) has been very closed involved in this environmental monitoring regime for MCT.

14. QUB also supports world-class innovation and interdisciplinary collaboration between research and education. Offering first class testing facilities and industry knowledge, the University has two wave tanks, a 10th scale tidal energy test site, a 10th scale wave energy test site and a new wave tank test facility at its Marine Laboratory in Portaferry.

15. Government support for SeaGen has come from UK wide funding for marine renewables eg the Marine Renewable Proving Fund. This funding has enabled the development and deployment of this world first and world class technology in UK waters and provided universities and companies with operational experience which they have been able to develop and market. It has also enabled MCT to attract further private sector funding with its principal corporate shareholders including BankInvest, Carbon Trust Investments, EDF Energy, ESB International, Guernsey Electricity, High Tide and Siemens Energy.

16. In addition to this Government support, SeaGen is an officially accredited UK generating station and Renewable Obligation Certificates are issued for its generated electricity.

17. To date DETI has spent just under £400,000 in relation to the Offshore Renewable Energy SEA and associated studies which have included offshore wind and marine renewable energy.

The Northern Ireland Offshore Renewable Energy Leasing Round 2011

18. The Crown Estate's Northern Ireland Offshore Renewable Energy Leasing Round was launched in March 2011. This was followed by an Industry Design Discussion Stage to enable the sector to submit views on how the opportunities could be offered to maximise market interest and benefits to Northern Ireland. To facilitate this Leasing Round, DETI just published Regional Locational Guidance for Northern Ireland waters to inform developers, regulators and all stakeholders.

19. It is planned that Expressions of Interest will be sought from potential developers in Autumn 2011. With regard to tidal development and its current stage of development, it will be important to balance the need to develop and test small array demonstration projects with the ambition to optimise the commercial potential of the resource. It is considered that there could be opportunities for demonstration and commercial development within the Northern Ireland Leasing Round.

20. Following assessment of bids, development rights would be offered by The Crown Estate by Spring/ Summer 2012. At that stage, successful projects would then undertake an Environmental Impact Assessment of their projects to secure the necessary marine licence and electricity generating consents when full leases are agreed. Initiation stages for actual project development would be from 2016 onwards for these offshore projects to contribute to the 40% renewable electricity target by 2020 and beyond.

Development of Marine Renewable Energy/Tidal Stream Energy

21. The UK is considered as a world leader in the research, development and deployment of marine renewable technologies, due to the high level of resource, skilled expertise in universities/research

establishments, long established maritime and engineering companies and excellent onshore and offshore testing facilities. Many of the leading device manufacturers are from the UK.

22. Northern Ireland's own experience with the development, licensing and monitoring of SeaGen and also the experiences of the Scottish Government and The Crown Estate in the development of the Pentland Firth and Orkney Waters marine leasing round have been very instructive in how Northern Ireland is taking forward its current marine renewable proposals.

23. DETI is a member of the DECC led Marine Energy Programme Board which was established in early 2011 and involves the industry, technology developers and utilities as well as Government. The Board has been considering the key issues of funding, planning and consenting and knowledge sharing. It has also been considering how the concept of Marine Energy Parks could be taken forward.

24. Marine renewable energy can contribute to energy diversity and security, low-carbon/renewable targets and economic benefits. The UK as a whole and Northern Ireland in particular, has the opportunity to capture potentially significant economic benefits from this emerging sector along the supply chain from research and development; device manufacture and assembly; installation/engineering through to operation and maintenance services.

25. Other existing marine sectors such as the ports/harbours can also benefit from offshore renewable developments. An example of this is the programme of actions being taken by the Belfast Harbour Commission (BHC) to market its resources as a key location for offshore renewable developments in Northern Ireland. The announcement by Dong Energy earlier this year of its plans to develop a £40 million logistics hub at Belfast Harbour as a base for its Irish Sea developments will kick start further development at the site. BHC is also pursuing plans to develop a Marine Energy Park to build on the Dong developments. The proposed park, close to the Dong site and the world class facilities and engineering expertise of Harland & Wolff, could provide a hub at which to co-locate further R&D facilities, manufacturing operations which would integrate with local companies developing their capability in the supply chain. DETI considers that the marine renewable sector can not only contribute to our renewable energy and climate change targets but can bring economic benefits and employment opportunities to Northern Ireland businesses.

26. The recent publication by The Crown Estate on the Pentland Firth supply chain opportunities showing how the projects there might be built out has been very useful in identifying the potential supply chain opportunities. Annex B sets out the extensive work underway by Invest NI to build capability within Northern Ireland companies to secure business from this growing sector.

27. There are, however, a number of challenges facing the sector's development; the full technical potential of devices has yet to be proven and this next stage in the development of the sector—small scale arrays—will be critical to realising this potential. The availability of targeted funding for this essential stage, within the constraints of Government spending and value for money, is required to enable these emerging technologies to move beyond the current prototypes to commercial scale delivery with its associated efficiency savings. While this would mean a higher level of support than for more mature technologies (which have already come down the learning and cost curve), this is necessary to allow the sector to prove its longer term value and contribution not only in terms of energy and but also wider economic benefits in the 2020–30 period and beyond.

28. DETI is currently considering the position with regard to potential levels of support under the NIRO in light of the DECC UK Banding Review and the Electricity Market Reform report indicating possible future support mechanisms post 2017. It would be vital that UK wide market reform should not result in a negative impact on the opportunities open to Northern Ireland.

It is critically important therefore, at this key stage in the sector's development, that positive signals are sent to developers and investors of support at a UK level to help the sector move to commercial scale development, with the associated cost reductions of a more developed supply chain.

29. Other challenges include issues around the overall environmental planning and consenting of novel and innovative devices and the importance of moving forward on a "deploy and monitor" approach. This was first proposed with regard to the Pentland Firth development and Northern Ireland will consider this emerging approach as it is developed further by Marine Scotland. It will be very important to ensure a balance between the necessary safeguarding of the marine environment, while enabling the economic and environmental benefits of the sustainable development of the marine renewable energy to be realised within the framework of the UK Marine Policy Statement.

30. DETI is working with the Northern Ireland Environment Agency, as the marine licensing authority and the Department of the Environment Planning Service to streamline the process for the necessary marine and electricity consents for the benefit of developers, stakeholders and regulators. It is planned to issue guidance on the process in early 2012. Northern Ireland is also a member of the UK Offshore Renewable Energy Licensing Group.

31. Of particular importance in the development of this sector is the need for ongoing engagement with the other existing marine stakeholders such as ports/harbours and the fishing sector to ensure their issues are fully considered and, in turn, they understand how the offshore development plans are being taken forward. In Northern Ireland, this is being taken forward through the Offshore Renewable Energy Forum and tailored local

engagement with the different sectors. In addition, DETI is a member of the UK wide Fishing Liaison with Offshore Wind and Wet Renewables Group. There are also economic opportunities for these other marine sectors and Invest NI has been working with a number of groups to identify these opportunities.

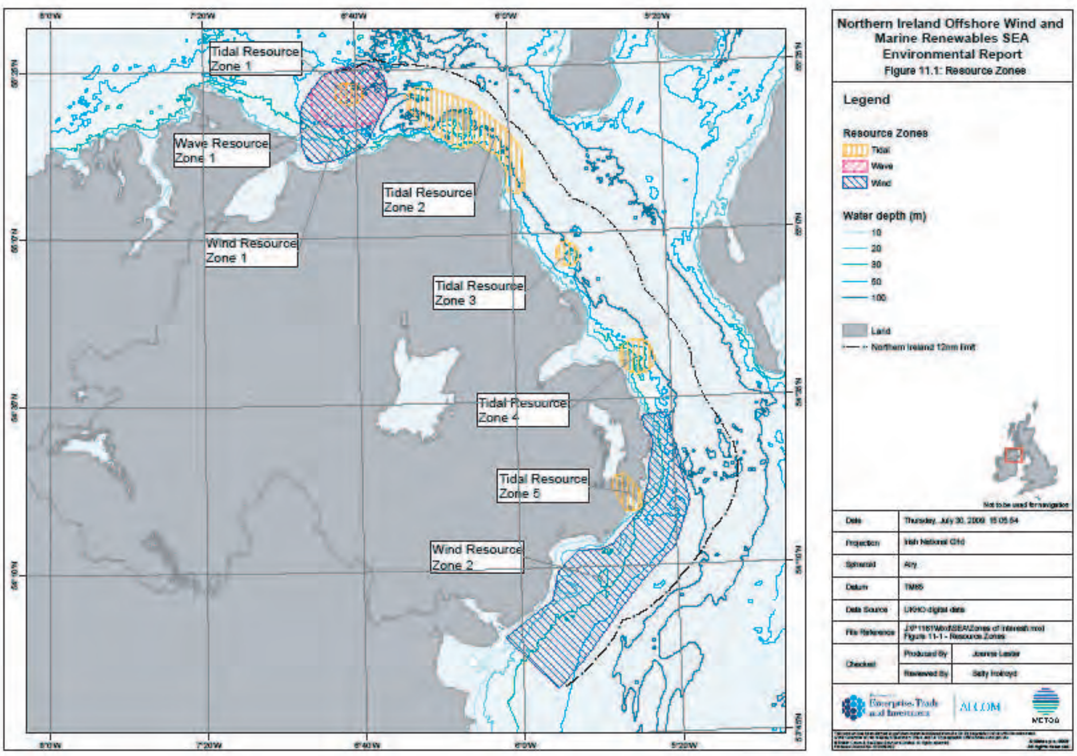
Conclusion

32. This next stage in the development of the sector is critical to help it to reach commercial scale deployment. This will bring increased knowledge of interactions with the environment and other sectors and reduced costs at all stages of the deployment. DETI believes strongly that offshore renewable energy, wind and tidal, can play an important role in the overall energy mix for Northern Ireland by 2020 and beyond and can deliver valuable benefits to Northern Ireland companies and communities. The range of integrated actions being taken forward through the Offshore Renewable Energy Strategic Action Plan in support of The Crown Estate's Leasing Round in Northern Ireland waters has been developed to support the delivery of these benefits.

September 2011

Annex A

RESOURCE ZONES FOR OFFSHORE WIND AND TIDAL STREAM



Annex B

INVEST NI BUSINESS SUPPLY CHAIN ACTIVITIES

1. Invest NI has developed a range of support activities to promote and develop business opportunities associated with development and deployment of renewable energy technologies. Marine energy is one of four main renewable energy sectors that Invest NI has concentrated on to develop supply chain capability over the last three years.

2. After a comprehensive survey, Invest NI published a report in 2009 that highlighted Northern Ireland's business and research capabilities in the renewable energy sector. The report entitled "Maximising Business Opportunities in the Sustainable Energy Sector" is a reference guide for the sector going forward in the short term. One of the technology areas highlighted for potential development in this report was offshore energy—including wind and marine energy.

3. Invest NI continues to commission, research and publish reports about and related to offshore energy including marine energy, to stimulate interest amongst Northern Ireland businesses in developing market opportunities. Examples of these reports published so far include:

- Offshore Wind Energy Supply Chain opportunities.
- Northern Ireland Ports Prospectus.

— Ocean Energy opportunities (a joint report with the Sustainable Energy Authority for Ireland—SEAI).

4. Invest NI is planning to publish two further reports in September 2011—Northern Ireland Marine Test Site Feasibility study and Supply Chain Opportunities for Northern Ireland Businesses in the Scottish Marine Energy Supply Chain. Two further studies are currently underway to assist companies to access marine industry supply chains—Supply chain information study and Supply chain categorization.

5. Through its financial support for Carbon Trust's activities in Northern Ireland, Invest NI has funded development of some of the more novel and emerging marine energy technologies and devices through Carbon Trust's applied research grants.

6. Invest NI has also funded other capability development projects within the marine energy sector that will accelerate the development of technologies and local business participation in marine energy supply chains. Support has been offered to an industrially based network—the "Global Maritime Alliance" (GMA). The aim of the GMA is to have the island of Ireland recognised as the centre of excellence for the Ocean Energy sector. The GMA has both indigenous and international members and is already engaged with a number of multinational developers to target the supply chains in marine energy developments.

7. Some 200+ SMEs are either already engaged or interested in targeting the offshore sector. Engagement with SMEs is a key factor in successfully developing supply chain opportunities and through the networks it has established, Invest NI has been able to put forward a funding bid for an SME focused offshore energy supply chain initiative that will embrace marine energy. An Interreg IVA project has been proposed with partners in Highland & Islands Enterprise and in Enterprise Ireland.

8. It has a strong track record of success in facilitating SME engagement with research institutions through its direct research and development grants and the highly successful innovation vouchers scheme—and marine energy companies have availed of this type of capability development support.

9. There has been a concentrated focus on Inward Investment and through its suite of offices worldwide and in Belfast it regularly facilitates inward investment visits from international renewable energy companies interested in locating in Northern Ireland. These device and technology developers, site developers and component manufacturers are attracted by the volume of renewable energy activity and the levels of expertise and knowledge based in Northern Ireland.

10. Strong marine energy related links have also been established with institutions in the Republic of Ireland including the Sustainable Energy Authority for Ireland (SEAI), the Hydraulic & Marine Research Centre (HMRC) in Cork, the Marine Renewable Industries Association in Ireland (MRIA) and the Marine Institute in Dublin. Invest NI has jointly published two ocean energy reports with SEAI—the 'Review of Engineering & Specialist Support Requirements for the Ocean Energy Sector' and the 'Economic Study for Ocean Energy Development in Ireland.'

11. In May 2010 Invest NI worked with the United States Embassy in Dublin and a range of agencies from Northern Ireland and the Republic of Ireland to host 100 potential US inward investors to Northern Ireland as part of the US and All Island Renewable Marine Energy and SmartGrid Workshop which was designed to showcase Northern Ireland's capabilities in the emerging marine energy sector. The two-day cross border event also outlined plans to further integrate renewable energy sources into the all-island electricity network using the latest developments in SmartGrid technology.

12. The work of Queen's University Belfast (QUB) on wave and tidal technologies is globally renowned and Invest NI is working with the university in the development of an industry-led renewable energy competence centre which will be an active in providing access to research, studies, technologies, sites, equipment and so on. QUB also forms part of a network of UK and international universities that can readily access R&D capability.

13. Invest NI is exploring the potential for a tidal test site in Northern Ireland waters and is proactively working to facilitate and assist potential investors in marine energy to accelerate achievement of their plans. It is working closely with DETI, the Northern Ireland Environment Agency and The Crown Estate to facilitate access for testing and deployment in Northern Ireland waters.

14. It is also currently working with RenewableUK and Regen SW to develop a wave and tidal supply chain model that will assist definition of where the most lucrative business opportunities lie for Northern Ireland companies.

The table below sets out the approximate level of financial support provided to the marine (wave and tidal) energy industry in the last three years.

Project	*Amount of Funding*
Capability Development of the Marine Energy sector—including R&D grants, publication of generic sectoral studies and supply chain development	£750k

Memorandum submitted by JWG Consulting Ltd

I give below my contribution to the evidence from my position as a Consultant in the Wave and Tidal Sector since 1999.

In 1997 I was approached by the DTI to head up a Foresight Group to write a document on "Energies from the Sea—Towards 2020" which was published in 1999, the time when I started in the consultancy business.

I am a chemical engineer by training (Eur Ing, C Eng, C Env) and have spent over 40 years in the energy industries, working in offshore oil and gas for most of the years from 1979 to 1999 both in an Operating Company (Now BG group) and Contracting companies (AMEC and Bechtel).

One of my key tasks has been the development of the European Marine Energy Test Centre (EMEC) on Orkney, firstly as a Technical Advisor/Client Engineer to Highlands and Islands Enterprise and since 2003 as Non-Executive Director of EMEC Ltd. During that time I have also carried out assignments for The Carbon Trust, various Investment Banks and Finance Houses, The REA, a number of major industrial companies and contractors and The Crown Estate.

I am Chairman of the UK National Committee on Ocean Energy Standards (PEL/114) administered by BSI Group.

I wish to emphasise that any opinions expressed below are purely personal and do not necessarily reflect the opinions of any organizations with which I have worked or work currently.

My responses to the Committee's questions are given below:

Executive Summary

- UK has a huge wave and tidal resource which should be utilised for energy supply security.
- Policies need to be focused, long term and consistent. Also funding offers must take realistic situations into account when being evaluated. Encourage adaptively monitored and managed deployment to ensure environmental matters are not ignored.
- Other countries are using FITs to encourage marine energy, some are pursuing it aggressively.
- New and emerging technologies cannot be immediately viable—they will follow a Learning Curve in cost reduction and need support from consumer and tax payer in a balanced manner.
- Encourage adaptively monitored and managed deployment to ensure environmental matters are not ignored.
- Fabrication yards and technical services are available in the UK to be encouraged into the marine renewable sector.
- A Severn Estuary "tidal fence" should be re-considered.
- PFIT would cause less hesitation by the investment community than CFD.
- There is a skills shortage in this sector as in many technically based industries.

Detailed Question Responses

1. *What are the potential benefits that marine renewables could bring to the UK and should Government be supporting the development of these particular technologies?*

1.1 The UK has a huge indigenous marine energy resource amounting to more than 40% of all that in Europe—as a Nation we must be making use of that in maintaining our energy supply security, alongside other energy sources.

1.2 Diversity improvement by developing wave and tidal alongside wind, waves last 12–24 hours after the wind stops at any location, tidal rates are variable but always predictable. "By developing a portfolio of wind, wave and tidal stream resources in the UK—variability is reduced, capacity credit is increased and balancing costs are reduced" (Sinden, G "Diversified Renewable Energy Strategy", 2005)

2. *How effective have existing Government policies and initiatives on marine renewables been in supporting the development and deployment of these technologies?*

2.1 Government Policy has been helpful in promoting independent testing and certification of devices. The instigation of EMEC as a project was a result of a similar enquiry to this one in 2000 by the House of Commons Science & Technology Committee.

2.2 In recent times, grants have been distributed by too many agencies with slightly differing or overlapping policies which has led probably too much spent on administering grants. This is now being tackled more realistically with TSB, Carbon Trust and ETI. However, there is evidence that ETI suffers from conflicting requirements within its private industry participants which often shows as a lack of clarity and direction in what they are trying to achieve. One or two of their calls have suffered abrupt changes of rules and directions which have left applicants frustrated after putting in a lot of work to respond and suddenly finding they are excluded.

2.3 Why did no-one qualify to claim an MRDF grant? Many parts of Government seemed to be surprised by the inability of technology developers to achieve this. The idea was admirable that companies should not make more money than necessary to pay their way on the project. However, some part of the balance of finance for most of the potential applicants had to come from VC type sources where returns of around 30% are the norm (the investments being viewed as high risk). The way in which the grants were calculated, and the surrounding rules, did not recognise this aspect and consequently no company could raise the money in a manner that actually resulted in just "paying their way" without excess profit. There's a need to fully grasp commercial realities in inventing these grant schemes.

2.4 There has been a historical disconnect between Westminster Government who have not shown a similar level of commitment to wave and tidal energy as that of the Scottish Government. I have seen occasions when opportunities have been lost by a failure of the two Governments to agree on funding and to have an agreed and consistent participation. There is a case for better co-ordination. I note the problem seems lesser in the case of the Welsh Administration.

3. *What lessons can be learnt from experiences within the UK and from other countries to date in supporting the development and deployment of marine renewables?*

3.1 Korea places a levy on their major utilities and uses it to fund significant tidal projects requiring large investments. These are tidal barrages at Sihwa (operational) 254 MW; Garolim (due 2012) 480MW and Incheon (due 2015) 1 GW. Tidal stream is being progressed at Uldolmuk which is in pilot plant stage.

3.2 Portugal offers an FIT for Marine renewables. A FIT that offers a premium over base electricity price is an easier concept for investors to evaluate.

3.3 It is vital the UK does not make the mistakes with wave and tidal technologies that were made with wind and nuclear, to allow technologies to be developed in UK then commercialised or sold to overseas companies. UK then has to buy them back to make use of them—and is much lower down the value chain.

4. *Is publicly provided innovation funding necessary for the development of marine technologies and if so, why?*

4.1 New and emerging technologies cannot be instantly commercial and need support for a period to proceed down "Learning Curve" and reduce costs. A reasonable Learning Curve for marine renewable is 90% which would reduce installed costs per MW to that of offshore wind after some 1.25GW of tidal is installed ie around 2020. This assumes a Learning Curve for Wind of 92% as the wind technology is more mature and the learning rate slows. At this time we should be seeing Capex of around £2.1m/MW and offshore wind will have just over 18GW installed. Tidal cost/kWh will have fallen from c. £0.3 (10MW array) to around £0.14/kWh.

It follows that some means of supporting this, ideally as a Premium FIT which can reduce as costs fall, is still required. This can be socially funded rather than by the taxpayer. However for a few years some measure of public capital grant would assist.

4.2 Public investment has been leveraging private investment at a rate of £5 private for every £1 of public funding over the last two years. It is to be hoped that this will continue at an enhanced rate in future.

4.3 Funding that goes directly into projects is preferable to funding which carries the overhead of some "technology organisation" that does not directly benefit deployment of devices.

5. *What non-financial barriers are there to the development of marine renewables?*

5.1 There has been slow progress in the acceptance by the environmental lobby of the need to proceed with deployment and adaptive monitoring and management of environmental risk in the case of marine renewable. A certain amount of baseline environmental monitoring has been done and there is less excuse for biologists to plead an absence of data to delay progress and permitting decisions.

5.2 Planning limitations continue in practice to stifle progress with deployments, although there is much more goodwill evident to streamline processes in future. There is some anecdotal evidence that Scotland, being a smaller and simpler administration, has made more progress in "joined-up" thinking than the rest of the UK.

6. *To what extent is the supply chain for marine renewables based in the UK*

6.1 Many companies in UK, including a number that support Oil & Gas industry can also support marine renewable. Some overseas suppliers have begun to open up UK premises and offer employment opportunities. Further encouragement to overseas companies to open up in the UK in support of a growing industry is to be welcomed. UK companies can offer consultancy, engineering, some fabrication and assembly and manufacturing of high value components

6.2 UK could be an assembly base for marine renewable devices even though many components need to be sourced most cost effectively overseas. The UK fabrication yards that have been mothballed, some of which are re-opening for the offshore wind sector can also support marine renewables.

7 *How does Government policy affect the development of these industries?*

7.1 Above all things there needs to be consistent and long term policy lead from Government to give confidence to the investment community and major industrial companies to invest in the marine renewable industry. One concern arising from the proposed EMR changes is that the move away from the ROC system will cause delay to investment while the financial community work out the implications. This is exacerbated by the preference being expressed for contract-for-difference (CFD). See 8.1 below.

7.2 Government policy needs to create and encourage a steady stream of orders to UK companies, especially where new yards or facilities have been re-opened. Labour needs a continuity of employment and businesses need reassurance that their operation will not be suddenly ground to a halt by a policy change. Several fabrication and assembly yards could be operating to support the marine renewable industry if continuity could be guaranteed. A wider view of what is "value for money should be taken to include the avoidance of the social costs of putting people out of work.

7.3 Not giving an option for a bid for a tidal stream solution for the R Severn Estuary was a missed opportunity. A tidal stream "fence" could have involved over 800 machines with a gate closure on the deepwater channel and produced a peak output of 800MW for a cost that could have been privately funded at around £2.2–2.4 billion. It would also have left options for other fences to be installed at later dates. Although the power produced is very much lower than the conventional barrage would have delivered, the cost and environmental impact would have been much lower. It would also have kick-started a tidal stream industry involving several technologies and been an excellent project to stimulate growth. It could be run in parallel with the Pentland Firth and Orkney Waters developments. The opportunity is still not lost. More than one consortium is in a position to proceed if Government gave a green light.

8. *What approach should Government take to supporting marine renewables in the future?*

8.1 As stated in 7.1 above, policy needs consistency and to be as simple as possible. A Premium FIT on a reducing basis over a defined period, could still avoid excessive profits for investors at the consumers expense. CFD requires a series of judgements on pitching of the strike price that leaves a lot of room for error and confusion. The PFIT could still be reviewed at intervals to ensure that acceptable but not excessive rates of return are being made. CFD Also makes investment decisions more difficult than a straight premium above cost.

8.2 Investors look for long term certainty—EMR is inevitably going to cause an investment hiatus, anything that can be done to simplify and cause less confusion to the investment community is to be welcomed in that context.

9. *Are there any other issues relating to the future of marine renewables in the UK that you think the Committee should be aware of?*

9.1 The shortage of skills is an issue for marine renewable as it is with offshore wind and oil and gas—as with almost every other technical enterprise in UK. There is a crying need to revitalise, develop and improve the UK engineering workforce. This must start at all levels: schools, universities, apprenticeships and other vocational training and re-training (just as has been done in the medical profession with transition courses for suitably qualified personnel). Somehow we must enthuse our school age children in the technically based disciplines and work opportunities. At present, a very high percentage of new engineering graduates and other technically skilled people are coming from overseas. It is necessary to motivate the UK student body and workforce back towards these disciplines and adjust the education system to prepare them for it.

9.2 Some degree of transfer of skilled people from the hydrocarbon based industries should take place if the UK is really serious about decarbonising the electricity supply system. Hydrocarbons will be with us for the foreseeable future but the intensity of employment in those industries could be reduced.

September 2011

Memorandum submitted by Jeremy Baster

1. Introduction

There is considerable concern in Orkney, amongst those renewable businesses and the Council, who together have been following the Project TransmiT process, that the general direction of travel of the review does not look like being helpful to the islands. The Council works closely with the Councils in Shetland and the Western isles, and knows that these concerns are shared in those islands.

Project TransmiT's two main focuses, transmission charges and connection arrangements, are both of great interest to Orkney. Both will have a bearing on whether, and when, transmission reinforcement between Orkney and the mainland will take place—an essential pre-condition for the development of a world-class marine energy industry in the islands. The Council has been closely engaged with the work being undertaken in relation to both issues, trying to ensure that the outcome of both reviews will resolve problems which are blocking transmission reinforcement in the islands.

2. Transmission Charges

In respect of transmission charges, Orkney (together with the other Scottish islands) is outside the zonal charging system which applies on mainland UK. Transmission charges for Orkney would therefore consist of the zonal charge for the adjacent mainland area, plus a charge reflecting the cost of providing a link across the Pentland Firth, as this link is regarded as local or enabling works. Whilst no firm figures are available, it has been estimated that the combined charge would be around £65/kW, approximately three times the adjacent zonal charge for the North of Scotland, which is itself the highest zonal charge in the UK. This represents a significant disincentive to investment in renewable inthe islands, including marine energy. The hope has been that a new charging methodology emerging from Project TransmiT would remedy this problem—but there is now concern that Project TransmiT is moving in the wrong direction.

3. Connection Arrangements

In respect of connection arrangements, the present requirement for developers to underwrite the cost of investment in new transmission is seen as a substantial barrier to entry. Indeed this view was fairly uniform across respondents to Ofgem's initial consultation, but it is a particular problem for Orkney because of the size range of projects, and the fact that only the largest and financially strongest projects can undertake the required underwriting; medium and small projects more typical of Orkney find it more difficult to provide their share of underwriting, and to take on the exposure to risks in other projects, which is inherent is sharing underwriting with others. In addition the extent of the "local works" which require underwriting (the requirement to underwrite "wider works" having been temporarily lifted by Ofgem) is much greater in Orkney than is typical in the UK—the ratio of local:wider works exceeds 20:1 for Orkney, as compared with something of the order of 3:1 as a UK average. This reflects the application in the North of Scotland of the definition of the local:wider works boundary, which results in all works between Orkney and the nearest MITS point at Blackhillock in Moray being defined as local.

4. Progress of Project Transmit in Respect of Transmission Charges

The Working Group of technical experts established by Ofgem, and drawn from stakeholders (key supply companies) has been examining alternative transmission methodologies, ranging from the "postage stamp" solution of a socialised uniform transmission charge, irrespective of location, to an improved version of the existing cost-reflective, locational, methodology (known as ICRP, hence the "improved ICRP" option). The Council has been following the deliberations of the Working Group closely, via a group of Scottish stakeholders organised by Scottish Renewables Forum.

Ofgem has now begun the process of modelling the options—essentially limiting this work to the two main options, although some sensitivity testing will be undertaken. The initial results of the modelling show that the postage stamp solution, which would be extended to the islands, results—as is to be expected—in a very much lower charge for Orkney than the current estimates.

Clearly this would resolve the islands problem, if this option were to be selected. However it would seem that the "improved ICRP" option is more favoured, since it retains and validates some of the underlying principles of the existing methodology, especially a locational dimension. Initial modelling of these options suggest that the gradient of zonal charges (highest in the North of Scotland, lowest, in fact negative, in the south of the UK) will become shallower, with a lower starting point in the North of Scotland. This will have the positive effect of reducing the total island charge, but because it will leave the local element of the islands charge unchanged, it will increase the disparity between the islands charge and that of the adjacent mainland zone, making the islands comparatively less attractive as a location for projects.

The hope in the islands has been that a new charging methodology would encompass the islands as an integral part of the UK, effectively with an islands zonal charge with a modest premium over the adjacent mainland zones—this being the position of the Scottish Government as well. However, it appears that "Improved ICRP" effectively leaves out the islands and makes their relative position worse.

5. Progress of Project Transmit in Respect of Connection Arrangements

Following the responses to the initial consultation, National Grid brought forward a proposal—CMP192—which would reduce both the liability for new transmission investment that is placed on new generators, but even more so the underwriting requirement, which would now reflect the risk of new investment being left "stranded" by cancellation of projects (a situation which has never arisen in the electricity network). Again, the Council has been following closely the Working Group established to examine this proposal.

Once again the issue of local and wider works, and their different treatment, raises difficulties for the islands. Under the National Grid proposal , liability for wider works would be shared 50/50 between generators and Demand (in other words, final consumers), but for local works no such sharing is proposed, on the grounds that such works benefit only generators, and not Demand. But in the islands there is an argument that demand (which is likely to grow in the years to come) will benefit by greater security of supply, and that a consequent accelerated switch to electricity by consumers will increase carbon savings.

An alternative proposal, arguing that 50/50 sharing should also be applied to local works, has been made within the Working Group, and forms part of a current consultation by National Grid. This alternative is being strongly supported by the Council and by others in the North of Scotland (including the mainland areas which also require extensive local works), but will only be accepted if Ofgem can be convinced that end consumers will benefit, to compensate for taking on a share of risk.

6. Review of DECC's s.185 Transmission Charge Capping Powers

The power to introduce a scheme of capping of transmission charges in an area where these are unduly onerous was given to the Energy Minister by the Energy Act 2004. The Minister agreed earlier this year to review the use of this power in relation to the Scottish Islands. The review has been welcomed by the Islands, although introduction of a scheme (which can last for only 10 years, half the lifetime of a renewable investment) is regarded very much as second best, compared with a solution of the islands charging issue through inclusion in a new charging methodology. Indeed there are indications that the existence of the s.185 power may be taken in some quarters as a reason for neglecting the islands in the development of a new charging methodology.

Be that as it may, the islands are cooperating with DECC in the provision of data to assist in its comparative analysis of projects in the islands and the mainland. Nevertheless the primary focus remains on Project TransmiT as the preferable route for resolving the islands transmission charge issue, as well as for easing the user commitment burden. The view in Orkney is that the islands are an integral part of the UK, and that they should be treated as such in new charging methodology, not penalised and discriminated against by being left in limbo, reliant on DECC exercising its (temporary) capping power. That the islands are the best place for the UK to successfully develop a world lead in wave and tidal energy, constitutes another powerful reason for resolving transmission charging and user commitment barriers in the islands.

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