



forum for  
**RENEWABLE ENERGY**  
development in Scotland

# HARNESSING SCOTLAND'S MARINE ENERGY POTENTIAL

Marine Energy Group (MEG) Report 2004



SCOTTISH EXECUTIVE



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- MARINE ENERGY GROUP (MEG) REPORT 2004 -**

**EXECUTIVE SUMMARY**

The Marine Energy Group (MEG) was established by the Forum for Renewable Energy Development in Scotland (FREDS) in October 2003. Our task was to assess the potential for developing wave and tidal energy in Scotland, and to produce an action plan for developing that potential.

**A Vision of Success**

The membership of MEG, which is drawn from industry, academia and government, share a common vision:

“To create the world’s leading marine energy industry that will provide a substantial contribution to the economy and environment of Scotland.”

This report sets out our conclusions and recommendations. It proposes an action plan:

- to accelerate the commercial deployment of marine energy devices in Scotland;
- to maximise the contribution from marine energy to Scotland’s energy mix by 2020; and
- to develop a sustainable manufacturing base for marine energy technologies in Scotland.

If, in partnership, government, industry and academia can create the policy, financial and planning framework, **MEG believes that by 2020:**

- **10% of Scotland’s electricity production can come from marine resources;**
- **we could see 1300 Megawatts of marine energy capacity installed in Scottish waters, increasing at a rate of 100MW per year;**
- **Scottish based marine energy companies could be supplying major international export markets;**
- **7000 direct jobs could be created in a diverse marine industry in Scotland, supported by sustainable research development and skills bases.**
- **Scotland should lead the world in the research, development and certification of marine energy devices.**

A new marine energy industry, supplying indigenous and export markets can re-vitalise Scotland’s manufacturing capacity, particularly in remote and rural areas. The prize – an opportunity to create new financial, social and intellectual wealth in Scotland – is huge, but so are the challenges.

**An Action Plan**

The next 5 years will be crucial in determining whether the UK, and Scotland in particular, can create viable domestic and international markets for marine energy devices. **Section C of this report sets out our conclusions and our suggested Action Plan.** Our recommended actions are summarised below in no particular order of priority or sequence. They cover a range of complementary themes and issues that MEG believes must be addressed in parallel if marine energy is to make a significant contribution to the Government’s renewable energy aspirations and targets beyond 2010.

## **CREATING MARKET PULL AND REDUCING FINANCIAL RISK**

- The Scottish Executive and UK Government should acknowledge the case for additional public sector support for marine energy, and give a clear and early commitment to work together to determine the most efficient method and level of financial support that can be provided.
- Both administrations should also ensure that the evidence gathered by MEG and in the various studies mentioned here is fully utilised to inform the forthcoming major review of the GB Renewables Obligations.
- The marine energy sector itself must demonstrate the ability to achieve greater efficiencies and drive down capital and operating costs.

## **DEVELOPING THE ROLE OF THE EUROPEAN MARINE ENERGY CENTRE (EMEC)**

- Subject to the production of a satisfactory business case, EMEC's funding partners should confirm their willingness to support the required extension to accommodate tidal device testing, without delay.
- EMEC should work with Scottish Development International to actively promote overseas marketing of its services, facilities and expertise.

## **ESTABLISHING SCOTLAND AS THE CENTRE FOR MARINE ENERGY CERTIFICATION**

- EMEC must be supported in the work it has already begun to establish Scotland as the internationally recognised centre for marine energy technical, operating and safety standards.
- EMEC, in partnership with the Carbon Trust, SuperGen and the Scottish Executive, should jointly sponsor a programme of work with representatives of the industry, developers, standards agencies, the financial sector and government, to identify the standards required and agree a programme for developing these as quickly as possible.

## **DEVELOPING A SUPPORTIVE PLANNING AND REGULATORY FRAMEWORK**

- The Scottish Executive, with the DTI, must give priority to the delivery of a Strategic Environmental Assessment of Scotland's coastline.
- The Scottish Executive, working with the Crown Estate, should publish clear guidance setting out a clear marine energy consents procedure.
- The Scottish Executive should give consideration to the need for a suitable forum to enable its various Departments and agencies to contribute to appropriate planning guidance for marine energy developers, grid operators and the relevant local planning and environmental agencies.

## **PROVIDING A ROUTE TO MARKET**

- The regulator and grid operator should prioritise action on transmission investment, with particular regard to connecting those remote mainland and island locations that can provide the greatest renewable generation capacity. The cost of this investment must be shared equitably amongst users and beneficiaries, and cannot be borne by host communities and developers alone.

- The Executive and UK Government should consider supporting early commercial development of marine energy by underwriting grid connection for 1<sup>st</sup> and 2<sup>nd</sup> generation projects.
- The Executive should continue to press the regulator to ensure that infrastructure charging mechanisms do not discriminate against emerging industries such as marine energy.

### **DEVELOPING ACADEMIC CAPACITY AND SUPPORTING R&D**

- The Scottish academic sector - funding councils, Universities Scotland and individual institutions - should review and reinforce existing capability in marine energy undergraduate teaching, research and development to meet the future demand for graduate skills and to consolidate the research base.
- Scottish Executive, the enterprise agencies, EMEC and ITI(E) should continue to work with existing and new initiatives such as SuperGen, Marine Energy Challenge and UKERC to maximise the synergies and opportunities that will establish marine energy technology and its manufacturing industry.

### **SUPPORTING SKILLS AND MANUFACTURING CAPABILITY**

- The enterprise agencies should review their economic development strategies and policies to ensure that they can adequately support a vibrant Scottish manufacturing and supply chain for marine energy.
- The enterprise agencies should use the Gap Analysis Report to produce a detailed assessment of the effects of skills gaps on the marine energy sector, and produce a list of specific actions to tackle the issues raised.
- The enterprise agencies, alongside the Scottish Renewables Forum, should support the development of an industry-led Marine Energy Network.
- Scottish Renewables Forum should organise a major international conference to showcase progress and future opportunities for marine energy in Scotland.

We invite government, industry and academia to work with FREDS to help take forward the recommendations set out in this Action Plan.

**Forum for Renewable Energy Development in Scotland  
Marine Energy Group**

**July 2004**

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**INTRODUCTION**

“Through the Forum for Renewable Energy Development in Scotland, the Executive will work with the industry, academia and the new Energy ITI to produce an action plan for the development of a thriving marine energy industry in Scotland.”

*Securing a Renewable Future:  
Scotland's Renewable Energy  
(March 2003)*

**Introduction**

1. At its inaugural meeting in October 2003 the Forum for Renewable Energy Development in Scotland (FREDS) established a Marine Energy sub-Group (MEG). The membership of the Group is shown at Annex A and our terms of reference are at Annex B.

2. This report aims to provide details of the challenges and opportunities that marine energy represents both for Scotland and the UK, together with MEG's conclusions and recommendations in the form of an Action Plan for the strategic development of a potentially major new renewables industry with markets worldwide. It does not attempt to comment on the merits or demerits of particular marine devices and technologies. Similarly, whilst MEG is satisfied that there is a strong case for Government support for our emerging marine energy industry we have not sought to quantify the level of support likely to be required or the best mechanism for delivering this support. We believe those are decisions for Government and we urge the Scottish Executive and the Department for Trade and Industry to use this report and material provided in other recently published work to inform their response.

**Why Marine Energy is Important to Scotland**

3. The Scottish Executive's Partnership Agreement "*Partnership For A Better Scotland*" confirms the Government's commitment to ensuring that by 2020, 40% of Scotland's electricity is generated from renewable sources. In making that commitment, Ministers took account of the contribution which established renewables technologies, such as on-shore wind and hydro, could be expected to make towards the existing 18% target by 2010, and concluded that Scotland was unlikely to achieve a target of 40% based on these technologies alone. Rather, the key to realising Scotland's full renewable energy potential lies in our ability to develop new technologies, particularly (but not exclusively) wave and tidal power.

4. The Executive's commitment to renewable energy is driven by **environmental imperatives**, the **potential for new economic development** and the requirement to achieve a **secure and diverse energy mix**. With the right nurturing and support marine energy can make a very substantial contribution to achieving these objectives.

5. **Environmental Imperatives** - the 1990s was the warmest decade since records began. Without action to reduce greenhouse gas emissions, the earth's temperature is likely to rise faster than at any time in the last 10,000 years or more. The worst effects of climate change can be avoided if greenhouse gases in the atmosphere are stabilised instead of being allowed to increase. MEG recognises that the Executive is strongly committed to increasing renewable energy usage in order to help reduce greenhouse gas emissions and thereby contribute to national and international targets for emissions reductions. We therefore agree that if Scotland is to generate 40% of its electricity from renewable energy sources by 2020 it cannot rely exclusively on wind and hydro; marine technologies will have to make a significant contribution. **MEG believes that by 2020 up to 10% of Scotland's electricity production could be from marine resources – equivalent to around 4000 GWh/year.**

6. **Economic development opportunities** - tidal and wave industries can also make a major contribution to the Executive's top priority of growing the Scottish economy. In the recently published DTI/Carbon Trust Innovations Review wave and tidal energy were identified as technologies with global potential. Scotland is in a very strong position to benefit from the development of an indigenous marine energy industry.

7. Scotland has some of the best wave and tidal-stream resources anywhere in the world – see paragraphs 16-21 for further details – with the potential for a healthy home market for marine technologies. In 2001, the report *Scotland's Renewable Resource* found that up to 21.5 Gigawatt (GW) of wave and tidal energy capacity could be produced in the waters around Scotland.

8. A strong home market is an essential pre-requisite for the development of any industry. With its long involvement in oil and gas exploration, Scotland has many of the necessary skills in manufacturing and design of off-shore equipment vital to the successful development and deployment of marine energy devices.

9. Scotland is already an important player in the energy industry, relative to its scale, and has the opportunity to be at the forefront of the new technologies and their industrial development, which have valuable synergies with our existing capabilities and strengths. We have a strong base of engineering research and development, supported by considerable expertise in several world class universities and research facilities.

10. **Security of supply** - last year the Energy White Paper ("Our Energy Future – Creating A Low Carbon Economy") acknowledged that in 10 years, most of the UK's deep coal mines will be exhausted. By around 2006 we will be a net importer of gas and by around 2010 of oil, and by 2020 we could be dependent on imports to meet three-quarters of our total primary energy needs. As we shift to become a net importer of energy, we may become potentially more vulnerable to price fluctuations and interruptions to supply caused by regulatory failures, political instability or conflict in other parts of the world. One of the best ways of maintaining energy reliability will be through energy diversity. Renewables, and in particular predictable sources such as wave and tidal energy, can provide diversity in our energy mix, vital to security and continuity of supply as fossil fuels continue to deplete. Developing our marine energy resources to the full can help ensure that Scotland continues to play a very significant role in meeting both its own and the UK's future energy needs.

## **A Vision of Success**

11. MEG believes that if Scotland and the UK are to realise the full potential of marine energy technologies, Government and industry need a shared vision of what can be achieved. The membership of MEG, which is drawn from industry, academia and government, share a common vision:

*“To create, the world’s leading marine energy industry that will provide a substantial contribution to the economy and environment of Scotland.”*

*MEG (May 2004)*

12. If, in partnership, Government and industry can create a policy, financial and planning framework that is truly supportive of marine energy technologies, **MEG believes that by 2020:**

- **10% of Scotland’s electricity production can come from marine resources;**
- **we could see 1300 Megawatts of marine energy capacity installed in Scottish waters, increasing at a rate of 100MW per year;**
- **Scottish based marine energy companies could be supplying major international export markets;**
- **7000 direct jobs could be created in a diverse marine industry in Scotland, supported by sustainable research development and skills bases.**
- **Scotland should lead the world in the research, development and certification of marine energy devices.**

13. The prize for Scotland is huge, but so are the challenges. A thriving marine energy industry has the potential to enhance Scotland’s manufacturing capacity, to develop a new indigenous industry, particularly in rural areas, and to provide significant export opportunities.

14. **Section B** of this report assesses the **opportunities** which can help place Scotland at the forefront of marine energy development, and identifies the **challenges** and constraints which will need to be overcome. **Section C** uses MEG’s conclusions to chart an **Action Plan** for the development of a globally successful marine energy industry based in Scotland.

## OPPORTUNITIES AND CHALLENGES

15. This section briefly discusses some of the key opportunities and challenges facing Scotland's nascent marine energy sector.

Opportunities	Challenges
<ul style="list-style-type: none"> <li>• abundant natural resource</li> <li>• strong academic research and technology development capacity</li> <li>• leading edge companies and available skills base</li> <li>• potential to lead in developing world market</li> </ul>	<ul style="list-style-type: none"> <li>• marine energy technologies immature</li> <li>• currently not cost competitive</li> <li>• need to finance early projects</li> <li>• lack of clearly defined planning regime</li> <li>• lack of grid capacity to accommodate early marine energy devices</li> </ul>

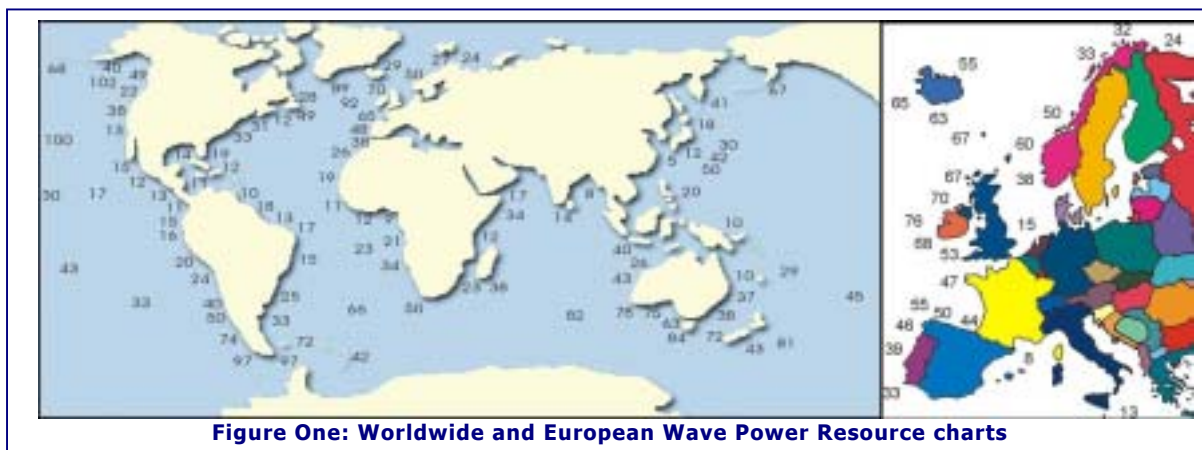
### THE OPPORTUNITIES

#### *Scotland's Marine Energy Resource*

16. The UK, most notably Scotland, possesses a huge wave and tidal energy resource. *Scotland's Renewable Resource*, published in 2001, estimated that up to 21.5GW (79.2 TWh/yr) of wave and tidal energy could be generated from the waters around Scotland. This is greater than the total amount of electricity likely to be generated in Scotland in 2020. Wave energy is intermittent but relatively predictable, tidal current energy is intermittent but largely predictable. Some of the best resources however are located off the north-west coast and northern tip of Scotland, where the electricity supply network is currently least able to accommodate the power that could be delivered to the mainland markets. While the marine resource could readily support 10% of Scotland's 2020 electricity production, the energy must be captured from wave energy fields and tidal current sites that are predictable, reliable and environmentally sustainable. They must also be network accessible, particularly in the early days of the marine energy industry and market.

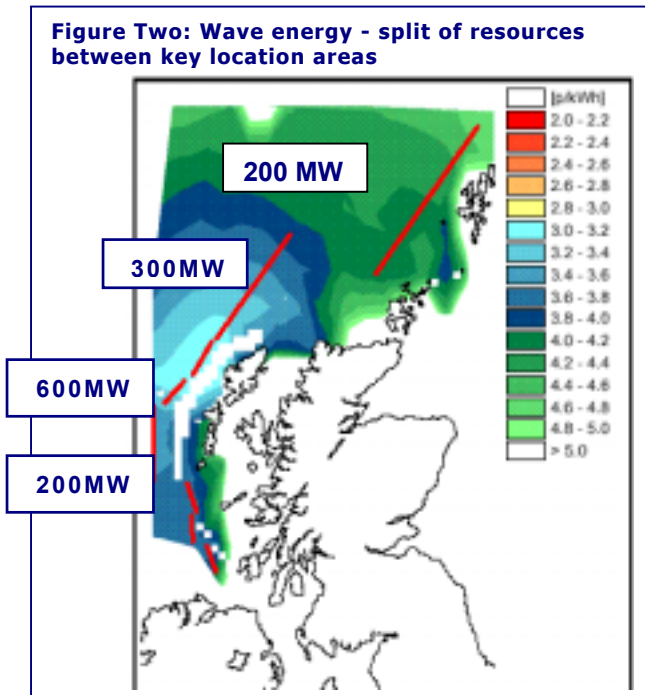
#### *Scotland's Wave Resource*

17. Figure one shows the worldwide, European and UK wave resources available in kW/metre of wave-front. Scotland's sizeable resource compares well with wave regimes elsewhere in the world.



The world-wide potential and opportunity for wave energy technology is also clear.

18. The wave energy that may be exploited off Scotland's west coast is limited by environmental, shipping and bathymetric constraints and the wave climate itself. *Scotland's Renewable Resource* calculates that 14GW (45.7TWh) of wave energy is available at under 7p/kWh. Figure Two shows the expected costs of developing the predicted wave resource in key locations.



19. The ability to develop the wave energy fields depends largely on their power levels and location relative to the mainland electricity network. A separate study by the University of Edinburgh for MEG explored the marine-constrained deployment of large, medium and small devices of capacities that may typify emerging equipment. It separated the wave energy fields by incident and device power levels and into broad geographical areas. The overall total power established compares with that reported above after all envisaged offshore constraints are applied. The division of potential power from the wave energy fields favours larger plant in the northern and western approaches, and medium to smaller plant in the mid and southern fields. The typical capacities of plant that may be deployed in each of the areas have been superimposed on figure two. In every case they represent a small percentage of the potential in that area. MEG therefore concludes that wave energy generation could make a full or large-part contribution to providing 1300 MW of marine energy by 2020.

### Scotland's Tidal Resource

20. Figure Three (below) shows the UK tidal current sites with the greatest potential. Scotland has significant resources clustered around the Pentland Firth, Orkney, Shetland and the western coast of mainland Scotland. *Scotland's Renewable Resource* showed that some 7.5 GW (33.5 TWh) of tidal current energy could be available at under 7p/kWh.

**Figure Three: Leading Potential UK Tidal Sites**



21. The Robert Gordon University assessed for MEG the power and potential energy at a number of key Scottish tidal locations, shown in Figure Four. Figures on the left hand side of Figure Four show the potential that might be developed by the full installation of prototype tidal current devices (i.e. devices available and operational after 2005). These capacities increase dramatically if developed by the first and second generation commercial plant to emerge from the new industry. Increasing technological sophistication, alongside ongoing project development and growing operating experience, could realise capacities on the right hand side of Figure Four from full deployment of the best technology available in 2020.

**Figure Four: Tidal Current Potential from Generation Two-Four Devices (2005 -2020)**

	<b>2005 %</b>	<b>Rated MW</b>	<b>Annual Energy (GWh)</b>	<b>2020 %</b>	<b>Rated MW</b>	<b>Annual Energy (GWh)</b>
Pentland Firth	37%	38	101	79%	1837	4827
Orkney	19%	19	50	5%	115	303
Shetland	19%	19	50	7%	153	403
West Highlands	7%	8	20	3%	77	202
South West Scotland	19%	19	50	7%	153	403
	100%	104	272	100%	2336	6138

Source: Bryden 2004

## **SCOTLAND'S RESEARCH AND DEVELOPMENT CAPACITY**

22. Scotland's universities carry out some of the world's leading wave and tidal current research. Much of the renaissance in marine energy development that is underway has been enabled by foundations laid by engineers trained in the Scottish academic research base. Many pioneering companies and organisations are developing full scale prototypes of vanguard wave and tidal current energy converters. Much will be learned in their early deployment to increase predictability, performance, manufacturability, reliability and survivability to enable machines produced by the emerging industry to realise their full commercial potential. This will require there to be a sustained and properly equipped research base within easy reach of the locus of the new industry.

23. Scotland has a uniquely active and compact community of marine energy researchers in the Edinburgh, Heriot Watt, Robert Gordon and Strathclyde Universities. If Scotland is to accelerate its wave and tidal development programme this knowledge base and associated facilities must be reinforced to support the establishment of a Scottish industry. Research work is funded from blue-skies to commercialisation by UK research funding councils, The Carbon Trust, DTI Future Energy Solutions and potentially the Intermediary Technology Institute (Energy). While Scotland is relatively successful nationally in winning support for marine energy, there are still gaps down the technology funding chain and across the skills base. Some of the existing initiatives are summarised below.

### **The SuperGen Marine Energy Consortium**

24. The Engineering and Physical Sciences Research Council (EPSRC) has funded a multi-technology research programme in Sustainable Power Generation and Supply (SuperGen). One of nine competitively-formed consortia, the Marine Energy Consortium was launched in October 2003 and unites Edinburgh, Heriot Watt, Lancaster, Robert Gordon and Strathclyde Universities with twenty industrial partners in a four-year collaboration. The aims of SuperGen are: to increase knowledge and understanding of the extraction of energy from the sea; to reduce uncertainties for future stakeholders in the development and deployment of the technology and to enable progression of new marine energy concepts and devices into their true position in a future energy portfolio. There are many other institutions in the UK active in ocean engineering, naval architecture and offshore technology that have a significant contribution to make to the future of marine energy.

### **The UK Energy Research Centre (UKERC)**

25. Research Councils UK have funded the establishment of a UK Energy Research Centre. One of three technology themes, 'Future Sources of Energy' includes marine energy. The UKERC co-director with responsibility for this theme has been appointed at the Institute for Energy Systems at the University of Edinburgh. A complementary theme, 'Environmental Sustainability of Offshore Energy' also covers marine energy and is led by the Centre for Environmental Change and Sustainability at the University of Edinburgh.

### **The Carbon Trust – Marine Energy Challenge (MEC)**

26. The Marine Energy Challenge programme has been established in response to a Carbon Trust strategic study entitled 'Building Options for UK Renewable Energy' carried out in 2003, which highlighted that the UK has significant wave and tidal stream resource, a strong competitive position and, therefore, the potential to become a global leader in the medium term if these technologies can become cost competitive. Through partnering large engineering design organisations with existing wave and tidal power technology developers, the MEC programme will undertake detailed engineering

design and performance analysis to identify if, and how, tangible reductions in the generation costs are achievable.

### **Maintaining Research Capability**

27. The marine energy research community faces a significant challenge as many of the eminent and senior staff who have been working in the sector since the 1970s near the end of their formal careers. Replacing them from the small UK marine energy research community will be difficult given the specialised nature of their experience and the increased competition from other countries and the newly forming industry.

28. Greater investment in people, both from the UK and abroad, is needed to attract in top class scientists from all of the disciplines, including: oceanologists, engineers, physicists, biologists, materials scientists, manufacturing technologists and economists. Such people will only join the Scottish research base if Scotland and the UK demonstrate that they are serious about investing in marine energy research and the associated career infrastructure. While existing sources fund existing research activity, there needs to be parallel investment in the research facilities and career infrastructure to secure and retain a sustained skills-base in a world-class supportive environment.

### **EMEC's Role in Technology Development**

29. The decision to fund the European Marine Energy Centre (EMEC) in Orkney was visionary, and a clear demonstration of the public sector's commitment to supporting the infrastructure necessary to grow a new industry in this country. The availability of test facilities at EMEC provides a huge opportunity for Scotland and the UK to lead in the development of testing and accreditation standards that will be vital to the progress of marine energy technologies worldwide.

30. EMEC is funded by the Scottish Executive, Highlands & Islands Enterprise, Scottish Enterprise, the DTI, Orkney Island Council and the Carbon Trust. EMEC's infrastructure provides device developers with a purpose built facility for testing their devices in real open sea conditions. It comprises:

- four high voltage 11kV cables, each connecting a test berth to the switching station
- a grid connection for 7MW, with electricity output conditioning
- a SCADA system collecting data from waverider buoys, met station and electricity metering points, as well as from the devices under test
- a location in a wave regime among the best in the world

#### **EMEC's Goals**

- To be the world's first purpose built wave and tidal test centre
- To be a focal point for the R&D into marine energy exploitation
- To become a centre of excellence for marine energy device testing
- To support the development of marine energy
- To lead in the development of marine energy standards and certification

31. EMEC will become increasingly important for developers of marine energy devices. Already, EMEC has secured its first contract to test a device at its facilities, and has made a number of contacts with developers and is negotiating with them. MEG believes that EMEC must play a pivotal role in supporting delivery of a Scottish based marine energy industry, both through providing appropriate testing services and through the development of appropriate standards and certification processes.

32. EMEC currently provides a test facility for wave energy converters. It is now looking to develop a similar facility for tidal device testing. These two facilities combined would enable EMEC to develop as the world leading centre in marine energy.

33. Looking ahead, EMEC sees its role as providing test, validation and certification services to the industry, not only at its test facility but wherever devices are being deployed experimentally or commercially. It plans to develop its skills and knowledge base to enable it to offer consultancy services to device and project developers. This will further enhance its international reputation and ensure that EMEC is recognised as the global centre of excellence.

34. EMEC must begin by establishing a reputation for excellence through its measurement, verification and RD&D role. It must then build on this reputation by offering certification, consultancy and support to the industry. This can be achieved by leading programmes on standards, research both with commercial and academic partnerships, and developing standard testing packages and methodologies. By doing so it will provide an industry lead benefiting the whole of the industry and enhancing Scotland's international reputation.

## **COMPARING SCOTLAND WITH OTHER INTERNATIONAL MARKETS**

35. A key driver in developing Scottish wave and tidal energy capacity is the economic benefits that will flow from device deployment. It is the development of commercial scale wave and tidal farms (as opposed to demonstration projects), and the orders for devices this will create, that will produce significant job benefits. Scotland needs a strong domestic market to provide a firm base for developing an export market.

36. Much has been made of the "Danish model" that was used to develop wind power in the 1970's and '80's, alongside warnings for Scotland not to repeat the mistakes during this period when the UK ceded an early advantage to Denmark. While Denmark's success was based on a number of other factors, the main lesson of its success - that the jobs follow project development - still holds true.

37. While Denmark still holds a major stake in the international wind market, other countries with significant wind programmes (such as Spain, Germany and the US) have developed manufacturing capability and used this manufacturing base to serve export markets. However, Denmark, despite its small size, has managed to maintain competitive advantage and survive in a fierce global market; this is largely down to Denmark's early establishment of its own domestic market.

38. Scotland and the UK should be aware, in seeking to develop its wave and tidal capacity, that other countries are similarly active, and have (or are developing) support programmes to assist their emerging industries. If we are to succeed, the support mechanisms available in this country must compare to those provided elsewhere.

## **Portugal: A Market Comparison**

39. Portugal is currently viewed as the benchmark against which other countries are compared in the race to achieve competitive advantage from being early movers in the sector.

40. The key element of Portugal's support is a fixed tariff available for wave technologies. Wave companies are currently being offered €23c/kWh for energy from wave devices. This figure is set for the first 20MW of connected power, although we understand discussions are underway to increase this to the first 50MW. With an assumed capacity of 50% for wave devices and 90% availability, this support equates to around €45m (£30m) per year.

41. A key element of this support is to attract device developers to locate in Portugal, and begin manufacturing there. Not surprisingly therefore, discussions are underway between Portuguese energy companies and a number of UK-based device developers.

42. However, it is too soon to declare Portugal as the front runner to secure the market lead in marine energy devices. Whilst the country has a good academic support network, it is probably not as strong as Scotland's. Moreover, Scotland has potential for tidal power which Portugal does not come close to matching. Scotland has also developed testing support through EMEC that is a vital first step for developers wanting to get devices into the water. Finally, Portugal cannot match the manufacturing and engineering expertise that exists in Scotland, hence its keenness to attract developers by seeking to grow the market first.

## **Other Countries**

43. Other countries (most notably Ireland) have been assessing Portugal's support system and considering similar structures of their own. Out of this wider group, which includes Denmark, France, Ireland, Canada, Australia, USA, Australia and New Zealand, Canada was, until recently, the furthest forward, with developments planned in Vancouver by utility BC Hydro. However, changes in Government have led to support schemes here being shelved. Figure Five summarises current activities in other countries.

**Figure Five: Wave and Tidal support in leading countries**

Country	Activity
Canada	BC Hydro continuing to fund work on wave resource assessment for wave energy projects off Vancouver Island.
Denmark	Have a support scheme for technical development
Ireland	Recently consulted on “options for the development of wave energy in Ireland”. The response to the consultation overwhelmingly voted for option 2 – a market enablement scheme giving a tariff of between €22-28c/kWh. The Irish Government is currently considering its response.
Japan	Historically the biggest funder to date of wave energy projects. Funding is focused at the R&D stage.
New Zealand	Funding from government for a wave power project by the state research company Industrial Research Ltd
Portugal	€23c/kWh for energy from wave devices. This figure is set for the first 20MW of connected power, but discussions are apparently underway to increase this to the first 50MW
Spain	Have set a tariff for wave energy of €6.4c/kWh plus substantial grants available dependent on local content. Tariff is reviewed annually so <i>could</i> be increased in line with Portuguese, particularly in light of the integration of the Iberian market.
South Africa	Through the Eskom/ Sabregen project it has completed a resource assessment. Currently deciding on a technology that can be used
USA	Different states have different renewable support schemes but some include wave as a separate technology. The USA is currently undertaking a 6 state wave energy demo scheme (Oregon, Washington, California, Massachusetts, Hawaii, Maine). Work is currently focused on deciding which technology to use

44. Most of the international support is currently focused on R&D programmes. This is demonstrated by the wide array of wave and tidal devices known to be in development throughout the world. However, some countries are now seeking to put in place wider support measures that will help move technologies on towards commercialisation. We believe that there are currently over 40 companies working internationally to take forward wave and tidal device concepts.

### **Other Regions of Great Britain (GB)**

45. Within GB there is significant activity in the South West and North East of England. In the North East, the New and Renewable Energy Centre (NaREC) has established a strong commercialisation programme, with financial support available for investment in North East firms, and good testing facilities available. Work between Highlands & Islands Enterprise, EMEC and NaREC may bring strategic alliances between the two centres. Test facilities such as those at NaREC could be a future stepping stone for devices on the way to full test in EMEC.

46. In SW England, Renewables SW have proposed the development of a “wave hub” that would provide common infrastructure for early stage commercial devices. Work is at an early stage, and funding has recently been secured for a feasibility study. Clearly, if the UK is to secure an early competitive advantage it will be important to ensure that additional infrastructure investments in different parts of the country are complementary to the public sector investment that has already gone into the testing facilities at EMEC.

## Working with other areas

47. The Scottish marine industry needs to consider how best to work alongside other countries and regions. While deployment of marine energy is certainly a race, developments are still at an early stage, so there remain opportunities for forming strategic alliances, and serious consideration should be given to whether relationships can and should be formalised here. **MEG believes that emerging industrial and academic networks and trade bodies in Scotland should take a lead in pursuing strategic alliances with similar groups elsewhere.**

## THE CHALLENGES

48. There are a number of risks inherent in supporting marine energy technology. This is essentially due to the nature of marine energy as an emerging sector in a renewables market dominated by maturing technologies, particularly wind power. Just as the marine energy technologies are still evolving, so the infrastructure and regulatory framework needed to support this new industry have also still to be developed.

49. MEG believes it is precisely because of these uncertainties that additional financial incentives and structural support are required to help ensure that the domestic market and associated policy, planning and fiscal environment develop in ways that support marine energy technologies. Support is necessary to increase market pull to levels that will encourage learning, streamline development and thus reduce investor risk. **The key challenge for the industry is to demonstrate that costs can be reduced to a level that would see marine energy as competitive with other more established technologies.**

## An unproven technology?

50. While independent experts tend to agree that Scottish companies are amongst the leaders in marine energy technologies, no device is yet fully proven. Funding to date has been research driven, and has helped prove a number of concepts. However, we have yet to see any single technology operating on a commercial scale.

51. The current situation in marine energy is equivalent to that of the wind energy sector in the 1960s and 1970s. Then, there were a number of competing designs and concepts for how best to capture wind energy effectively. Provision of market support, alongside the development of standards and testing, enabled industry to take forward, test and develop the most promising technology concepts. Today, the wind industry has settled on a standard design, and competition and choice within the wind sector comes from commercial decisions made about cost, reliability and size.

52. It is likely that within the next 10 years we will see a plethora of wave and tidal energy devices emerging onto the market, followed by a period of rationalisation and the subsequent improvement and development of a small number of designs. This process is necessary and will help not only to improve devices and their energy capture, but should also help reduce costs. The key here is to provide a support framework that creates market pull and encourages “learning by doing”. But if additional financial support is to be provided for marine energy on an efficient basis, it will be important to ensure that the chosen mechanisms reward success.

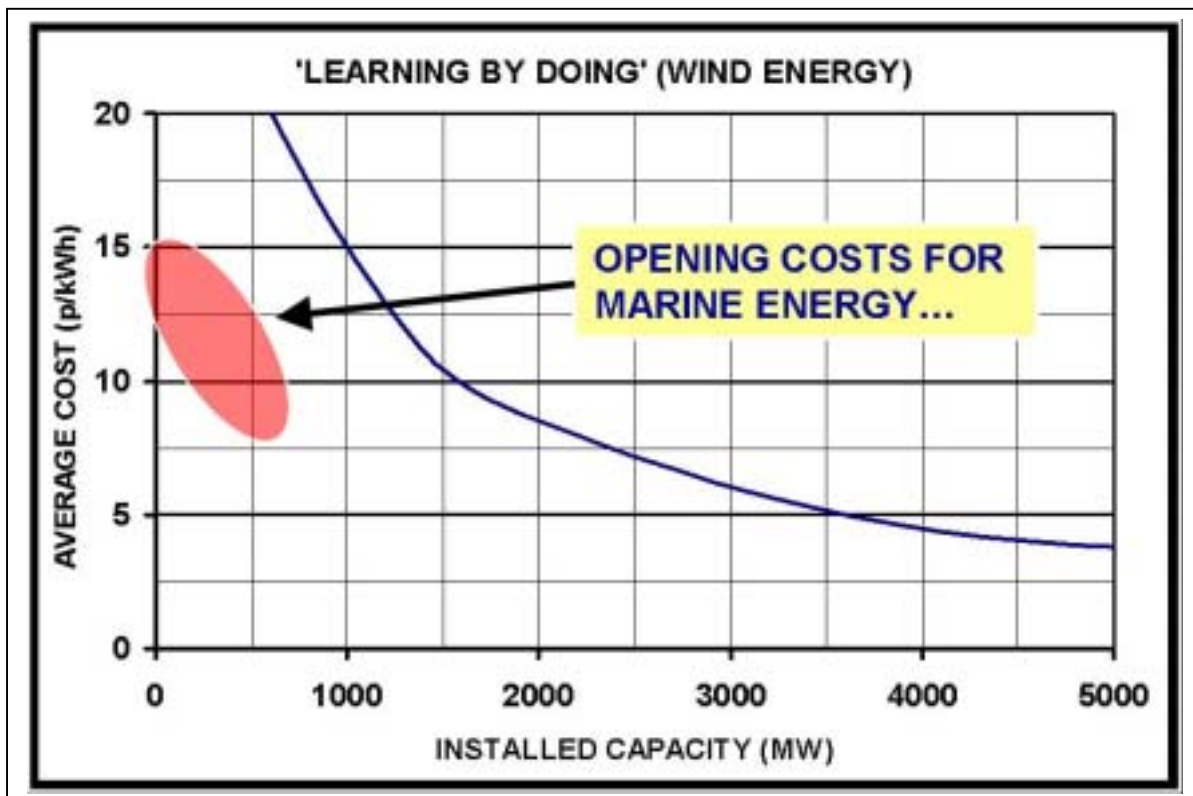
### An uncompetitive technology?

53. MEG's analysis of the expected opening operating costs of a number of wave and tidal developers shows that such technologies cannot compete against existing mature power generation technologies – be they conventional or renewable. However, this is to be expected, given that all technologies start life as expensive options, and only seriously begin reducing their costs as market share and opportunity present themselves.

54. MEG believes that the expected operating costs of marine energy devices can achieve a level that would justify some initial financial support. The key areas which we considered were the gap between the current forecast costs for wave and tidal devices and those of currently competitive generation technologies, and the scope for reducing that gap as rapidly as possible.

55. Figure Six (below) shows the operating costs of wind, and the expected opening costs for marine energy. The wind industry has shown itself capable of driving down costs as market share increases, and it is to be expected that marine will be able to follow this path. The fact that marine is starting from a comparatively low cost (as an early technology) should give investors, be they public or private, some reassurance.

**Figure Six: Learning By Doing. A comparison between wind energy and the opening costs of marine energy**



## **Testing, Certification and Standardisation**

56. Even with a viable financial support mechanism in place, industry and government will need to continue working together to develop appropriate testing, certification and standardisation facilities and work programmes.

57. We have already commented on the vital role that EMEC has to play in leading to the development of certification and standardisation. A key lesson from the development of wind energy was that independent verification of performance data is critical, both in proving a concept and in satisfying the needs of private investors. Work is now underway to ensure that certification and standardisation work takes place in tandem with device testing and deployment. This is being led by the Carbon Trust through its Marine Energy Challenge.

58. EMEC is working with the Carbon Trust and SuperGen to ensure that their respective initiatives on standards are appropriately coordinated. Supported by funding from HIE and One North East, EMEC has produced a standard for the marine renewables industry entitled "Performance Assessment – For Wave Energy Conversion Systems in Open Sea Facilities". This is the first detailed standard in this area. EMEC has also been working with device and project developers, academic institutions and other interested parties to promote the role and need for recognised industry standards.

59. Progressing this work will require the identification of those standards that are required by the industry, and their subsequent development. The Marine Energy Challenge initiative has employed DNV to begin identifying the codes and standards required for the design and building of devices. SuperGen also has a work package addressing design guidance for MECs (Marine Energy Converters). Together, these initiatives will lay the ground work for the identification of the required codes and standards. It is essential that this work also takes account of initiatives being developed elsewhere in Europe. EMEC is ideally suited to lead this work, but it will require support – intellectual, technical and financial – from industry, academia and Government.

## **Grid access and availability**

60. A problem facing all renewables generators in Scotland is the constrained nature of the transmission and distribution network. Substantial development of marine energy will only occur if developers have access to an electricity market at a national, rather than local level. This means having the ability to export electricity to the population centres in Scotland around the central belt, as well as to markets further south in England.

61. However, the need for new investment in the grid, combined with substantial interest in developing onshore wind energy projects throughout Scotland, means that the transmission owners now have offers for connections above a level they can provide without major grid upgrades. The GB Transmission Issues Working Group has reported on this topic, and has proposed grid upgrades across Scotland in three stages (which emerged from the Renewable Energy Transmission Study, or RETS). There are substantial time pressures and risks to the successful delivery of some of these proposals.

62. There is a serious risk that without timely provision of new grid infrastructure, and the targeted provision of a part of this capacity for marine energy developments, marine energy in Scotland may not progress beyond the demonstration phase. There is therefore the potential for technologies to be proven in Scotland, but then be forced to migrate to other areas outside Scotland to develop fully. With this comes the risk that manufacturing opportunities and the jobs they could provide will not be realised in Scotland but will migrate elsewhere with the successful technologies.

63. Alongside the problem of developing a GB transmission infrastructure that can accommodate marine energy, device developers are also facing problems in how to gain access to the distribution grid in Scotland. Demand for grid access is particularly strong in Orkney, Shetland and the Western Isles, but these local networks are currently operating at full capacity. This problem is particularly acute on Orkney, where EMEC is seeking to increase its connection capacity to allow future tidal test facilities to connect. Despite the active cooperation of the distribution network operator, there are substantial challenges to making this happen.

64. April 2005 will see the introduction of the British Electricity Trading and Transmission Arrangements (BETTA). While BETTA will allow Scottish generators access to a GB electricity market, at present no decisions have been made about how to release investment to include island communities in the GB transmission network. Furthermore, no work has been done to ensure charges for generators on island communities will not be prohibitive. MEG calls on Ofgem, National Grid Company, transmission owners and all other relevant parties to work constructively to enable, and not frustrate, future large-scale generation on island communities.

65. MEG is seriously concerned that a lack of national and local grid capacity remains one of the key barriers and risks to developing a successful marine energy industry in the UK. Whilst we recognise that through the work of the GB Transmission Issues Working Group progress is being made in agreeing the investment necessary to upgrade the national grid, we believe that early innovative solutions need to be found if marine energy devices are to gain access to the relatively modest grid capacity essential for their demonstration and development.

### **An uncharted planning environment?**

66. The regime governing marine energy development in Scotland is extremely complex. A number of consents are required in order to construct and operate electricity generating plant in Scotland's waters. The procedures and timescales required to obtain these various consents are a potential constraint on the future development of the sector, and it is vital that they are co-ordinated and streamlined as far as possible.

67. In order to achieve this, it will be essential to understand as far as possible the nature of the interaction between marine energy devices and the environment in which they will operate. This means that as much information as possible about any impacts on (for example) navigation, marine life, sea birds, tidal flow patterns and coastal erosion should be collated and made available to aid and guide developers, consultees and consenting authorities.

68. A Strategic Environmental Assessment (SEA) of Scotland's offshore environment for wave and tidal technologies will play a hugely important role in allowing the industry to progress with commercial developments in waters around Scotland. MEG believes that a Scottish SEA should begin as soon as possible, in order to allow such development to take place in the period before 2010.

**- AN ACTION PLAN -**

69. The challenge to grow a world-leading marine energy industry in Scotland cannot rest solely with any single sector or organisation. Technology developers have to demonstrate that they can make the transition from testing tank to full-scale deployment in a challenging marine environment. Developers and investors need to show vision and the confidence to back commercial scale marine energy projects. And Government has the responsibility to create a policy, planning and fiscal framework that will encourage investors and developers to make that commitment.

70. The next 5 years will be crucial in determining whether the UK, and Scotland in particular, can build on our technology advantage and create a viable domestic and international market for marine energy devices. The conclusions and suggested actions that follow are not listed in order of priority or sequence. Rather, they describe a range of complementary themes and issues that MEG believes can and must be addressed in parallel if marine energy is to make a significant contribution to the Government's renewable energy aspirations and targets beyond 2010.

**CREATING MARKET PULL AND REDUCING FINANCIAL RISK**

71. Scotland has a clear lead in the development of marine energy technologies, but these are still at an early stage. Recent injections of Government research funding have been crucial to the development of many promising designs and prototypes. However, the DTI/Carbon Trust Renewable Innovation Review and more recent studies carried out for the British Wind Energy Association and the Renewable Power Association have identified a major funding gap between demonstration/testing and pre-commercial/commercial deployment.

72. An economic appraisal carried out for MEG (see Annex C) confirms the existence of a funding gap and identifies a strong case for additional Government support to help bridge it. Without such support, private investment in marine technology would be inefficiently low and it is unlikely therefore that a marine energy industry would develop in the UK. As well as the economic development opportunities that could be lost, a failure to support a marine energy industry could significantly undermine the Government's renewable energy targets beyond 2010.

73. The current market support levels available through the Great Britain Renewable Obligations (GBROs) and Climate Change Levy are valuable, but will be insufficient in themselves to close the funding gap and attract investors. Additional support might be delivered in a variety of ways – via a new capital support scheme; through some form of revenue support, where developers are rewarded for actual output (by way of a new tariff for marine output, or through additional ROCs for marine output subsequent to suitable amendments to the GBROs); or a combination of these. Although early stage capital support for construction and grid infrastructure will be important, MEG believes that operating aid is the best way to accelerate commercialisation. MEG is pleased to note that the Scottish Executive has already commissioned an independent study by IPA Consulting to assess the levels of support required to deliver installed marine energy capacity on the scale suggested in this report, how that support might best be delivered, and the possible implications for other participants in the renewables market.

74. We believe it is essential that the Scottish Executive and the UK Government should consider jointly how best to provide the necessary and appropriate financial support for marine energy. Whilst

we recognise that any new support mechanism could not be introduced immediately, **a clear and early commitment from Government that it will make available additional financial support, sufficient to deliver real progress, would be invaluable in reducing risk and creating confidence amongst developers, potential manufacturers and investors alike. At the same time, there is a clear responsibility on the industry to continue to demonstrate that it can use its experience and learning to reduce significantly the cost of marine energy devices to a level that would, over time, be competitive with other renewable technologies.**

### **Actions**

- **The Scottish Executive and UK Government should acknowledge the case for additional public sector support for marine energy, and give a clear and early commitment to work together to determine the most efficient method and level of financial assistance that can be provided.**
- **Both administrations should also ensure that the evidence gathered by MEG and in the various studies mentioned here is fully utilised to inform the forthcoming major review of the GB Renewables Obligations.**
- **The marine energy sector itself must demonstrate the ability to achieve greater efficiencies and drive down capital and operating costs.**

### **DEVELOPING THE ROLE OF EMEC**

75. **Good testing facilities are essential if device developers are to make the transition from the laboratory to the sea.** The creation of EMEC has provided a major boost to the marine sector; continued commitment from its funding partners and the industry is needed to consolidate EMEC as the pre-eminent global testing facility. An important element in attracting developers will be ease of planning – MEG welcomes the recent change to the procedure for acquiring consent for developments at the test site which reflects and supports the unique intentions underpinning the facilities. The relevant procedures should remain under review

76. The establishment of tidal test facilities at its site in Orkney represents the next important stage in establishing EMEC as a comprehensive marine energy test centre - this will be invaluable to tidal device developers, among whom there is clear evidence of demand. Moreover, it makes sense to build on the investment already made in EMEC rather than see the development of a tidal test facility elsewhere. EMEC also needs to market its services to technology developers overseas. This will be essential in establishing the Centre's importance internationally and encouraging project development, technology capture and inward investment.

### **Actions**

- **Subject to the production of a satisfactory business case, EMEC's funding partners should confirm their willingness to support the required extension to accommodate tidal device testing, without delay.**
- **EMEC should work with Scottish Development International and other trade partners to actively promote overseas marketing of its services, facilities and expertise.**

## ESTABLISHING SCOTLAND AS THE CENTRE FOR MARINE ENERGY CERTIFICATION

77. The development of independently verifiable standards for the performance and testing of marine energy devices will assist technology developers in proving concepts and provide much needed assurance for potential investors.

78. MEG firmly believes that if Scotland is to become a world leader in marine energy, **we must seize the initiative to build on the investment at EMEC and establish this country as the primary centre for development of international standards.** There are strong parallels to be drawn with the strategy adopted so successfully by the Danes at the Risø wind laboratory. Robust standards, established in partnership with the appropriate national/international bodies, will be a key part of opening up the opportunity for marine energy by building confidence and helping encourage private equity funding.

79. If we can get this right, there will also be opportunities in associated parts of the marine sector such as due diligence provision. Much of this early standardisation work can take place alongside device testing at EMEC, which can play a pivotal role in providing authoritative benchmarks for industry participants and investors. But collaborative partnerships must be established across Europe and with key bodies such as the British Standards Institute, the International Energy Agency, the Carbon Trust and others. An important first step is to establish what standards the industry and the financial sector need.

### Actions

- **EMEC must be supported in the work it has already begun to establish Scotland as the internationally recognised centre for marine energy technical, operating and safety standards.**
- **EMEC, in partnership with the Carbon Trust, SuperGen, the Scottish Executive and the DTI, should jointly sponsor a programme of work with representatives of the industry, developers, standards agencies and the financial sector, to identify the standards required and agree how these will be developed as quickly as possible.**

## DEVELOPING A SUPPORTIVE PLANNING AND REGULATORY FRAMEWORK

80. Under legislation shortly to be introduced in Scotland and elsewhere in the UK, the full-scale commercial development of marine renewable energy will need to be preceded by a Strategic Environmental Assessment (SEA) of Scotland's coastline and territorial waters. MEG consider it essential that the Scottish Executive and the DTI commission this work as a matter of urgency.

81. A comprehensive SEA of Scotland's marine environment would provide the Scottish Executive and its agencies with valuable information to inform the development of appropriate planning guidance for marine energy developers. The Executive should give consideration to establishing a suitable forum to enable its various Departments and agencies to contribute to such guidance.

82. Ownership and operation of the consents regime for offshore renewable energy developments also needs to be established with absolute clarity. MEG recognises the progress made by the Executive in putting in place a single point of contact for the various consents required for offshore developments within territorial waters. We also welcome the fact that, subject to assent for the UK Energy Bill, the Executive will have responsibility for extending these arrangements into the Scottish

part of the Renewables Energy Zone. MEG is, however, concerned that the proposals within the Energy Bill in respect of decommissioning consents will mean a return to multiple consenting authorities within Scottish waters.

### Actions

- **The Scottish Executive, with the DTI must, as a matter of urgency, commission an SEA of Scotland's coastline.**
- **The Scottish Executive, working with the Crown Estate, should agree and publish clear guidance on the marine energy consents procedure.**
- **The Scottish Executive should give consideration to the need for a suitable forum to enable its various Departments and agencies to contribute to appropriate planning guidance for marine energy developers, grid operators and the relevant local planning and environmental agencies.**

### **PROVIDING A ROUTE TO MARKET**

83. In order to make the move to large scale commercial developments, the industry needs access to sufficient and affordable grid capacity. However, at the present time, there is high demand for new connections that is leading to a lack of capacity for renewables developments across much of Scotland. Work is in progress from the Scottish System Owners (SSOs), Scottish Hydro Electric Transmission Limited and ScottishPower Transmission Limited, to bring forward proposals for upgrading parts of the Scottish grid network. Two of the upgrades proposed which could have particular relevance for marine energy are from Beaully to Denny and Beaully to Ullapool.

84. Before approving the necessary investment in infrastructure, the regulator and SSOs will take into account the levels of financial and planning commitment from both developers and Government. In authorising upgrades, the regulator must take account of investment risk, and achieving best value for supply customers. Government policy, and the current commitment across Scotland and Great Britain, will also be an important consideration. Once this authorisation is in place, it is important that the relevant planning processes are observed and negotiated as speedily and efficiently as thoroughness allows.

85. **Alongside this, developers need to be assured that transmission charges from the GB System Operator and the Regulator will not be so prohibitively high that they inhibit renewable energy development in remote parts of the country, both on-shore and offshore.**

### Actions

- **The regulator and grid operator should prioritise action on transmission investment, with particular regard to connecting those remote mainland and island locations that can provide the greatest renewable generation capacity. The cost of this investment must be shared equitably amongst users and beneficiaries, and cannot be borne by host communities and developers alone.**
- **The Executive and UK Government should consider supporting early commercial development of marine energy by underwriting grid connection for 1<sup>st</sup> and 2<sup>nd</sup> generation projects.**

- **The Executive should continue to press the regulator to ensure that infrastructure charging mechanisms do not discriminate against emerging industries such as marine energy.**

## **DEVELOPING ACADEMIC CAPACITY AND SUPPORTING R&D**

86. Scotland has a long history of excellence in research and development of marine energy. The Universities of Edinburgh, Heriot Watt, Robert Gordon and Strathclyde are internationally recognised centres of expertise.

87. The continued development of marine research and academic expertise is vital if Scotland is to maintain its pre-eminence in this field and support its emerging marine energy industry. The sector needs Scotland's research base to play a significant role in securing the future of first generation marine energy devices; developing second generation marine technology and evolving components, performance monitoring and maintenance techniques. If the Scottish academic sector is to rise to this challenge the Scottish Higher Educational Funding Council and individual institutions need to review their commitment to and investment in the teaching and research needs of the emerging marine energy industry. The SuperGen programme can contribute by coordinating and expanding research programmes to include further institutions and companies.

88. The recently established Intermediary Technology Institute - Energy (ITI(E)) has a key role to play in forging stronger links between Scotland's research community and industry. While industry has already taken on and developed a few first generation solutions for marine energy capture, MEG considers that the ITI(E) can make a significant contribution to the development of a thriving marine energy sector in Scotland through fast-tracking development of new device concepts, monitoring and measurement equipment, as well as 2<sup>nd</sup> and 3<sup>rd</sup> generation device technology. MEG recommends that ITI(E) embraces such opportunities as part of its technology foresighting work.

89. The new UK Energy Research Centre is an important milestone in encouraging joint working and coordination of energy research within the UK academic sector. Plans articulated to develop a Centre for Marine Energy, closely linked to the overall Centre strategy, are to be welcomed. There is a need to ensure that this initiative links appropriately with the ITI(E) and other funding sources. A Scotland based Marine Energy Centre could significantly inform ITI(E)'s decisions on investments in the emerging marine energy sector. MEG strongly supports this development - such initiatives can help coordinate and maximise the benefits of activity between the academic research base, commercialisation bodies and the emerging marine energy industry.

### **Actions**

- **The Scottish academic sector – funding councils, Universities Scotland and individual institutions - should review and reinforce existing capability in marine energy undergraduate teaching, research and development to meet the future demand for graduate skills and to consolidate the research base.**
- **Scottish Executive, the enterprise agencies, EMEC and ITI(E) should continue to work with existing and new initiatives such as SuperGen, Marine Energy Challenge and UKERC to maximise the synergies and opportunities that will establish marine energy technology and its manufacturing industry.**

## SUPPORTING SKILLS AND MANUFACTURING CAPABILITY

90. Scotland possesses the skills necessary to support a successful marine energy sector. MEG believes that sufficient manufacturing and technical capability exists in Scottish-based companies. Moreover, the Scottish oil and gas sector has 30 years expertise of building, deploying, operating and maintaining offshore structures in a hostile marine environment. The scope for diversification is significant, enabling a Scottish marine energy manufacturing sector to grow and flourish. However, the sector will need nurturing and support in the early years.

91. The recent report *Renewables Supply Chain Gap Analysis*, prepared for the DTI and the Scottish Executive, highlighted significant growth opportunities. The report's findings and recommendations should be built upon, and programmes developed that can effectively support the emerging marine energy sector. Scottish Enterprise and Highlands & Islands Enterprise will play a vital role in developing expertise and capacity in their areas, and must ensure that their support programmes are robust and relevant.

92. MEG believes that industry must also take a lead. Bodies such as the Scottish Renewables Forum (SRF) should ensure that they are providing the correct support services – helping to coordinate learning and information sharing, and acting as a source of expert advice and information. The enterprise agencies can also play a role, although this initiative should be viewed as industry led.

93. The SRF, working alongside Scottish Enterprise and Highlands & Islands Enterprise, as well as in partnership with fellow members of the Scottish Energy Industries Group should lead on the development of an industry network for this emerging sector. This could be tremendously productive, balancing the need for coordination with the growing importance of industry representation. It is vital that the emerging marine energy sector builds strong links with the established oil and gas sector

94. MEG believes that the potential for this network to develop into a separate marine energy trade association in co-ordinating and providing valuable support to the sector should be thoroughly scoped. There could also be merit in Scotland hosting a major international conference as a platform to showcase our marine energy industry and the opportunities that exist in this country.

### Actions

- **The enterprise agencies should review their economic development strategies and policies to ensure that they can adequately support a vibrant Scottish manufacturing and supply chain for marine energy.**
- **The enterprise agencies should use the Gap Analysis Report to produce a detailed assessment of the effects of skills gaps on the marine energy sector, and produce a list of specific actions to tackle the issues raised.**
- **The enterprise agencies, alongside the Scottish Renewables Forum, should support the development of an industry-led Marine Energy Network.**
- **Scottish Renewables Forum should organise a major international conference to showcase progress and future opportunities for marine energy in Scotland.**

## NEXT STEPS

95. MEG was established as a short-life working group tasked with reporting to FREDS in accordance with the terms of reference set out at Annex B. This report fulfils that commitment and we are grateful to the membership of the Forum for their agreement to publish our conclusions and recommendations. We recognise that the **Action Plan** we have proposed (at Section C) sets a number of challenges for Government, the enterprise agencies, academic bodies and the marine energy industry itself. We believe that it is for FREDS to decide how it wishes to co-ordinate the implementation of our suggested **Action Plan**. We would, however, draw particular attention to our recommendations for **Creating Market Pull and Reducing Financial Risk** and urge that the Scottish Executive and the UK Government act quickly to confirm their willingness to provide the necessary additional financial support for marine energy technologies. The price of delay could be an opportunity lost forever.

FREDS – MARINE ENERGY SUB-GROUP (MEG)

MEMBERSHIP

**Richard Yemm** – Managing Director, Ocean Power Delivery

**Robin Naysmith** – Head of Energy & Telecommunications Division, Scottish Executive

**Alan Broadbent** – Network Services Manager, Scottish & Southern Energy

**Professor Ian Bryden** – Robert Gordon University

**David Gibb** – Wavegen

**Fred Hearle** – Weir Engineering

**Niall McCollam** – Intermediary Technology Institute (Energy)

**Andrew Mill** – Director, European Marine Energy Centre

**Brian Nixon** – Director of Energy, Scottish Enterprise

**Neal Rafferty** – Energy Policy Adviser, Scottish Executive

**Robin Wallace** – Institute of Energy Systems, Edinburgh University

**Tom Whyte** – Economic Adviser, Scottish Executive

**Ian Marchant (Sponsor)** – Chief Executive, Scottish & Southern Energy

**Maf Smith (Secretary)** – Chief Operating Officer, Scottish Renewables Forum

**FREDS – MARINE ENERGY SUB-GROUP (MEG)  
TERMS OF REFERENCE**

The Scottish Executive believes that marine energy can make a significant contribution to achieving Scotland's aspiration to generate 40% of its electricity from renewable sources by 2020. Moreover, Scotland's abundant natural resources, combined with our indigenous offshore industry, marine engineering capabilities and strong academic research capacity, suggest that Scotland could develop a manufacturing base for marine energy technologies. The Forum for Renewable Energy Development in Scotland has decided to establish a Marine Energy sub-group to bring forward an action plan for developing Scotland's marine energy potential.

The Marine Energy sub-group will consider and bring forward proposals for:

- a. accelerating the commercial deployment of marine energy devices and maximising the contribution that marine energy can make towards Scotland's energy mix by 2020; and
- b. developing a manufacturing base for marine energy technologies in Scotland.

In particular, the sub-group will:

- provide a realistic assessment of the potential marine energy resource in the waters around Scotland and its suitability to support different marine energy technologies;
- identify any planning issues that would need to be addressed to support the large-scale deployment of marine energy devices;
- suggest measures to overcome the barriers to moving from research to demonstration and accelerating the commercial deployment of marine energy devices;
- advise on the opportunities to establish an international role for the Marine Energy Test Centre in Orkney;
- assess the scale of the financial challenge to be overcome if marine energy is to become commercially viable, and suggest affordable measures which could help achieve this;
- identify the key challenges and opportunities for establishing a manufacturing base in Scotland for marine energy technologies;
- examine progress in other countries and suggest how Scotland might secure a competitive advantage in the deployment and manufacture of marine energy devices; and
- suggest suitable milestones and targets to promote the development of Scotland's marine energy potential.

The sub-group will be accountable to the Forum and will report during 2004

**FREDS Secretariat  
October 2003**

## MARINE ENERGY - THE CASE FOR GOVERNMENT SUPPORT

1. Marine energy technology is still at an early stage of development and, as with any new technology, there will always be some irresolvable uncertainty over future costs and the effect of future innovations. It is likely that the cost of different technologies will converge on those projected from the actual costs experienced by the devices currently at the most advanced stages of development. The current high capital costs will only come down with further prototyping and commercial manufacture. Although the technology has the potential to become cost-competitive with other renewable energy options such as offshore wind in future, if it does not receive support in the interim period it is very unlikely that it will be able to reduce its costs to competitive levels.

2. In order to establish whether there is a case for Government funding the wave and tidal industry has, for the purpose of this economic appraisal, been treated as if it were a single firm applying for Regional Selective Assistance (RSA). The question posed therefore is: does the case presented by the industry for Government support, as articulated by MEG, pass the various tests as per the RSA selection process?

3. Marine energy technology is still exploring a wide range of possible technologies and because these technologies are at a very early stage of development costs are somewhat uncertain. Consequently a number of scenarios of the likely capital and operating costs need to be considered. These are tested by sensitivity analysis here but will be explored in greater detail in a complementary study commissioned by the Scottish Executive.<sup>1</sup>

4. The following assumptions have been used in this appraisal:

- An appraisal period of 15 years has been chosen with the project starting in 2005 and running to 2020. The sensitivity of the results to project life has been tested.
- The industry in Scotland is assumed to be 100 per cent UK owned.
- The 'without project' scenario is that the project would not go ahead at all or, if it did, it would go ahead elsewhere, for example in Portugal.
- As with all new technologies there will be a technology learning curve and the costs of building wave and tidal machines will fall as the number of machines and installed capacity increases. (see paragraphs 53-55 in the main report).
- The capital expenditure costs (CAPEX) are the number of machines built times the cost of a machine plus an additional 30% to cover other capital expenditure costs other than those associated with building the actual marine devices.
- For machines built in 2005 and 2006 operating costs are assumed to be 6% of total CAPEX for the first 5 years and 4% for years 6 to 15.  
For machines built in 2007 and 2008 operating costs are assumed to be 5% of total CAPEX for the first 5 years and 4% for years 6 to 15.  
For machines built after 2008 operating costs are assumed to be 4% of total CAPEX throughout the 15 year life of the machine.
- The capacity factor is 35% for all machines and the availability factor is 95% for machines built before 2008 and 97% for those built after 2008.

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<sup>1</sup> ***“Financing the Development of a Marine Energy Industry in Scotland”*** a report commissioned by the Scottish Executive from IPA Energy Consulting (not yet complete)

- The revenues from ROCs are 5 pence per kWh throughout the 15 years of the project. The revenues from exports are assumed to be similar to the Portuguese feed-in tariff of 23 eurocents per kWh or 15½ pence/kWh (converted at current rate of 1.5€ to 1£). The revenues from any new UK revenue support mechanism are assumed to be 6 p/kWh for 6 years for domestic machines built before 2008 and 3 p/kWh for 6 years for machines built in 2009 and 2010. No UK revenue support is given for machines built after 2010.
- Capital grants are given to offset the costs of building domestic devices at the rate of 30% of CAPEX for machines built before 2008 and at 15% of CAPEX for machines built in 2009 and 2010. No capital grants are given for machines built after 2010.
- Production in the domestic market grows by a steady 100 MW of installed per year after 2010 while export markets grow by 25% per year after 2010.
- By 2020 domestic installed capacity is 1300MW which is equivalent to some 10% of forecast Scottish electricity generation.
- Turnover in the domestic market peaks at around £223 m in 2017 and then falls for a couple of years as the transitional feed-in tariff disappears before rising again after 2020. However revenues from the domestic market are dwarfed by export turnover which increases steadily to reach over £2000 m by 2020.
- 10 jobs are assumed to be created for every MW of installed domestic capacity and 7 jobs created for every MW of export capacity installed (based on <sup>2</sup>).
- Project capital expenditure builds up as the number of marine devices builds up and reaches a peak of over £1.3 billion by the end of the 15 year period in 2020, equivalent to the building of over 6400 marine devices. Operating capital rises in line with CAPEX to reach almost £300 m by 2020.

5. The principal tests in an RSA appraisal centre around:

- Additionality: What would happen in the absence of Government funding? There is the need to demonstrate that Government funding is necessary to enable the project to go ahead as planned. This may be to reduce the risks associated with the project, or to influence the choice of a mobile project's location.
- National and regional benefit: All projects should contribute positive benefits to both the regional and national economy. This is measured by the efficiency test.
- Jobs: The project must create or safeguard jobs. The jobs should last for at least 5 years and the project should not simply displace similar jobs elsewhere in the UK.

6. Additionality: Without Government funding there are two possibilities. Firstly there is a strong likelihood that the fledgling marine energy industry in the UK will go abroad, most probably to Portugal where a tariff of 23 eurocents per kWh (approximately 15.5 pence at the current exchange rate of 1.5 € = £1) is available. The other possibility is that the UK industry will simply not develop in any form either here or abroad.

7. Under the present ROC arrangements only onshore wind projects are entering the market, as they are currently the most cost competitive renewable generation source. Some parties have argued that the ROS is essentially providing excess profits to onshore wind farms, and that it is not providing an incentive to other renewables generation sources. Certainly on the basis of the current financial support for the marine energy industry, i.e. no tariffs and no capital grants, only ROC support at 5 p /kWh the industry would never make a profit. Running the status quo scenario produces the following

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<sup>2</sup> ***“Financing the Development of a Marine Energy Industry in Scotland” a report commissioned by the Scottish Executive from IPA Energy Consulting (not yet complete)***

benefits to the UK economy when discounted at the normal RSA rate of 10%. On this basis the additionally test is passed and without support the benefits the industry could bring to the UK economy would be lost. This concurs with views published by a number of Government agencies, trade associations and marine energy developers, concluding that marine energy requires additional targeted support in order to bridge the 'funding gap'.

**Base Case Scenario (Status Quo – No Additional Funding)**

Appraisal Results, £000	Appraisal Life						
	5	6	7	8	9	10	15
<b>BENEFIT TO UK ECONOMY</b>	<b>-14</b>	<b>-19</b>	<b>-25</b>	<b>-34</b>	<b>-87</b>	<b>-92</b>	<b>-63</b>

8. National and regional benefit is measured by the efficiency test. The efficiency test attempts to measure the effect of the project on UK national income. For UK-owned companies, the benefit to the UK economy is equal to the benefit to the firm, discounted by the return to the average project in the UK. UK grant is treated as a transfer with no effect on UK national income. It has been assumed that all the firms involved in the marine energy industry in Scotland are 100% UK owned so in order to pass the test all that has to be demonstrated is that there will be benefit to the UK economy.

9. On the basis of the assumptions outlined in paragraph 4 the efficiency test is passed. The overall net benefit of the project going ahead to the UK economy is £1.5 billion after 15 years but even if we shorten the project life we still get a pass with the project showing positive after 6 years.

**Domestic Export Market Scenario (See Paragraph 4 For Assumptions Used)**

Appraisal Results, £000	Appraisal Life						
	5	6	7	8	9	10	15
<b>BENEFIT TO UK ECONOMY</b>	<b>-14</b>	<b>50</b>	<b>99</b>	<b>159</b>	<b>211</b>	<b>353</b>	<b>1,478</b>

10. A strong home market is the base from which the industry can attack export markets. The capture of export markets is, however, the key to continued expansion as the domestic market is assumed to increase at a steady rate after 2010. Exports on the other hand are assumed to grow by 25% year on year after 2010. If we assume that there is no export break through then the economic case for support is very much weakened. Without any exports the benefits to the UK economy fall substantially.

**Domestic Market Only (Export Markets Are Not Developed)**

Appraisal Results, £000	Appraisal Life						
	5	6	7	8	9	10	15
<b>BENEFIT TO UK ECONOMY</b>	<b>-2</b>	<b>15</b>	<b>26</b>	<b>32</b>	<b>25</b>	<b>4</b>	<b>28</b>

11. In line with emerging technologies throughout history it is highly unlikely that the capital and operating costs of marine energy devices will not fall as installed capacity increases. The *Renewables*

*Supply Chain Gap Analysis Study*<sup>3</sup> envisaged that the current costs for wave and tidal energy of 10-15 pence per kWk would fall to about 4-to 8 pence by 2020.

12. Jobs - MEG forecasts that by 2020 some 7000 jobs could be created by the marine energy industry in Scotland. On the basis of a total grant of £156 million, made up of £125 m in revenue support and £31 m in capital grants, this works out at around £20,750 per job. (The value of the grant after tax and discounted by the normal 10% rate is some £71 m). It is thought that the level of displacement would be very low since there are no competing firms at present, most of the output will be for export and there is idle labour resources from the fabrication industry associated with North Sea oil and gas.

13. One potential source of displacement could arise if the revenue support were to result in a large increase in electricity prices (similar to what has happened recently with water charges) for Scottish firms in general relative to firms south of the border. This might have two distinct effects; costs rise for existing Scottish firms making them less competitive and non-Scottish firms may be deterred from relocating here, both of which could potentially result in a loss of jobs to the Scottish economy. This however is not thought to be likely. Even if the full amount were passed on to electricity consumers this is a very small sum compared with the total cost of electricity consumed by Scottish firms in 2000. Indeed it represents only about 3½ % and this share will fall as energy prices are expected to increase in the coming years as a result of the introduction of carbon trading from next year and the expected increase in gas prices.

## CONCLUSIONS

- There is a strong case for Government support to the industry on market failure grounds. Without such support private investment in marine energy technology would be inefficiently low.
- The promotion of the marine energy industry in Scotland will not only help towards delivering the Executive's 40% renewable energy target by 2020 but will also contribute to the Executive's number one priority of growing the economy. A thriving marine energy sector has the potential to enhance Scotland's manufacturing capacity, to develop a new indigenous industry, particularly in rural areas, and to provide significant export opportunities. In the context of the Executive's 'green jobs' strategy it will also contribute towards another of the Executive's cross cutting priorities that of sustainable economic development.
- A "funding gap" currently exists between demonstration and commercial scale development in the marine energy sector. Under the current arrangements of limited R&D grants and the Renewables Obligations, the marine energy industry is simply too expensive to compete. The additionality test is therefore passed since under the present funding arrangements the marine energy industry is unlikely to develop in the UK.
- The development of marine energy industry in Scotland with Government support will bring benefits to both the UK and Scottish economies and so the efficiency test is passed. However based on the available evidence and on the assumptions used in the above appraisal it will be necessary to develop some kind of export market if these benefits are to be maximised.
- The prospect of over 7000 direct jobs in the industry by 2020, many of them in remote rural areas, is attainable. These will be additional jobs as the likely level of displacement will be extremely low.

**July 2004**

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<sup>3</sup> *Renewables Supply Chain Gap Analysis Study* by Mott MacDonald and the Bourton Group for DTI and Scottish Executive (January 2004).

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