



Information and Analysis of Wave & Tidal market in Scotland

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Invest NI commissioned this research study to gain an understanding of the market potential in the Marine Renewables (Wave & Tidal) Sector in Scotland, which will inform a trade and wider business development strategy to exploit supply chain opportunities for Northern Ireland businesses in 2011-2013.

This report presents the results of a market research, intelligence gathering and contacts identification project into the Wave & tidal Sector in Scotland.

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Introduction

The business opportunities in the marine energy sector centre on five areas:

1. Developing power stations
2. Developing technology for power stations
3. Supplying services to developers of power stations
4. Manufacturing components / equipment for technology companies
5. Supplying services to technology companies

This report provides results of the research and analysis of the marine energy sector in Scotland, aimed at helping NI companies identify business opportunities in this area.

Market size - Energy generation

The “Offshore Valuation Report”¹ found that the UK’s total practical offshore renewable energy resource is 531GW - more than six times current electricity demand.

The quantities of tidal stream and wave energy resource off the Scottish coast were found to be 18GW and 15GW respectively.

Scotland has been described in media reports as the Saudi Arabia of marine energy it has great potential for the development of wave and tidal stream energy (with around 25% of Europe’s tidal stream resource and 10% Europe’s wave resource).

While it will take several decades to realise this level of exploitation of these resources, according to the FREDS MEG report, 1.3GW of total installed wave and tidal stream energy capacity could be operating in Scottish waters by 2020.

During 2010 The Crown Estate awarded leases for 11 projects in the Pentland Firth that have the potential to deliver 1.6MW (see map) – split into the following areas:

- Tidal currents – 1,000MW (5 sites)
- Offshore wave – 400MW (5 sites)
- Nearshore wave – 200MW (1 site)

Based on the breakdown of costs from the analysis undertaken by the Carbon Trust in its “Future Marine Energy” report² the total capital expenditure to deliver these projects is between £2,420 million to £5,580 million. The breakdown using mid range values, with a total expenditure of £4,000 million, is shown in Table 1.

¹ The Offshore valuation, A valuation of the UK’s offshore renewable energy resource. Public Interest Research Centre, 2010.

² Future Marine Energy. Results of the Marine energy challenge: Cost competitiveness and growth of wave and tidal stream energy. Carbon Trust, 2006.

Wave	600MW	£3,000 per kW	Tidal Stream	1,000MW	£2,200 per kW
Item	% of total cost	£ millions	Item	% of total cost	£ millions
WEC (structure, mechanical & electrical)	76%	1,368	Turbine (structure, mechanical & electrical)	78%	1,716
Mooring / foundation	5%	90	Installation	2%	44
Installation	13%	234	Grid connection	13%	286
Grid connection	4%	72	Project management	7%	154
Project management	2%	36			
Pentland Firth Total		£1,800			£2,200

Table 1

Marine energy in Scotland has not developed as quickly as expected in the 2004 MEG Report “**Harnessing Scotland’s Marine Energy Potential**” – due in part to technical difficulties and financial constraints relating to technology development; however, the sector in Scotland as a whole has made some significant steps forward over the last five years.

The provision of strong public revenue support for marine energy projects in Scotland has led to increasing amounts of investment from the private sector and institutional investors. Further development of the facilities at EMEC, to incorporate tidal testing, has strengthened Scotland’s position at the front of the marine energy sector.

In January 2009, the Forum for Renewable Energy Development in Scotland (FREDS) reconvened its industry-led Marine Energy Group (MEG) and developed a “Road Map” to reflect an up-to-date assessment of the status and potential of the marine energy industry in Scotland, alongside recommended actions to ensure its continuing growth.

Evidence from this work and other recent industry reports, such the Renewable UK report “**Channelling the Energy**”³ indicate that while significant progress has been made no technology has reached the stage of being able to secure orders from these utilities for any meaningful share of the £3,000 million on offer for devices to harness these wave and tidal stream resources cost competitively.

This remains the single biggest prize of offer in the marine renewables sector in Scotland, and elsewhere in Europe, and is at the centre of the business opportunities that NI businesses can target.

³ Channelling the Energy. A way forward for the UK wave & Tidal Industry Towards 2020. renewableUK, October 2010.

State of technology development in the Marine energy sector

Current research being undertaken at the University of Exeter, part of the Peninsula Research Institute for Marine Renewable Energy (PRIMaRE), is using a form of analysis known as Technological Innovation System analysis, to identify the various barriers and bottlenecks to the marine energy sector's emergence.

This research has led to the development of technology maturity table that provides a useful means to assess the stage of development of the market and to identify both opportunities and threats present in the sector.

The technology maturity table is shown Table 3.

Of 14 wave energy device developers interviewed as part of this research study the breakdown of technology maturity is as follows:

Step 2	Technology concept and/or application formulated	1 device
Step 3	Analytical and experimental critical function and/or characteristic proof of concept:	1 device
Step 5	Component and/or partial system validation in a relevant environment (Tank Testing):	3 devices
Step 6	System/subsystem model validation in a relevant environment (Scale Test Facilities e.g. NaREC):	6 devices
Step 8	Actual system completed and service qualified through test and demonstration (Full Scale Test Facilities – EMEC):	1 device
Step 9	Actual system proven through successful mission operation (Full Scale Test Facilities – EMEC)	2 devices

A similar technology maturity landscape exists in the tidal energy sector, with no technology having yet passed Step 9 and achieved a pre-commercial deployment of a small array (<10MW or 20 devices) 'commercially' deployed on successful long term grid connected installation.

The single example of a prototype tidal turbine that can claim to have met the step 9 description of having a “Singular system 'commercially' deployed on successful long term grid connected installation” is the MCT project in Strangford Lough, however, the monopole foundation solution for the Seagen unit is limited by water depth and a different technology will be required to harness the majority of the resource in Scotland, which is in deep water sites as outlined in the report “Phase II UK Tidal stream Energy resource assessment”⁴. This report concluded that only 4.4% of the exploitable resource in the UK is located in shallow water sites, with water depth <25m.

The top ten sites identified make up ~80% of the total UK resource and of these sites seven are in Scotland. None of these sites have water depths less than 30m, as shown in Table 2, and it is clear that a technology that can operate in these deepwater sites is key to securing significant share of the exploitable market for tidal energy technology in Scotland.

⁴ “Phase II UK Tidal stream energy resource assessment”, prepared by Black & Veatch for The Carbon Trust, 2005.

Site name	Location	Water depth (m)	% of UK resource
Pentland Skerries	Scotland	59	18%
Stroma P. Firth	Scotland	71	13%
Duncansby Head	Scotland	65	9%
Casquets	Channel islands	115	8%
S. Ronaldsay P. Firth	Scotland	58	7%
Hoy, Pentland Firth	Scotland	76	6%
Race of Alderney	Channel islands	33	6%
S. Ronaldsay/ P.Skerries	Scotland	63	5%
Rathlin Island	N. Ireland	80	4%
Mull of Galloway	Scotland	80	4%

Table 2 Summary details of the main tidal energy sites in the UK

This evidence highlights that a significant business opportunity still exists for the development of a winning technology in wave and tidal that can meet the requirements of the Utilities seeking to spend over £3 billion on devices alone to achieve the 1.6MW in Pentland Firth.

	Step Descriptions:	Step Location:	#
R&D:	Applied & Strategic Research		
	Basic principles observed and reported	Concept for a Wave or Tidal Energy Converter	1
	Technology concept and/or application formulated	Concept for a Wave or Tidal Energy Converter	2
	Analytical and experimental critical function and/or characteristic proof of concept	Utilise Research Providers (Universities etc.)	3
	Component and/or partial system validation in a laboratory environment	Develop Design Utilising Engineering Expertise	4
	Technology Validation		
	Component and/or partial system validation in a relevant environment	Tank Testing	5
	System/subsystem model validation in a relevant environment	Scale Test Facilities e.g. NaREC	6
Demonstration:	System Validation		
	System prototype demonstration in an operational environment	Full Scale Test Facilities - EMEC	7
	Actual system completed and service qualified through test and demonstration	Full Scale Test Facilities - EMEC	8
	Actual system proven through successful mission operation	Full Scale Test Facilities - EMEC	9
Pre-Commercial:	Commercial Validation		
	Singular system 'commercially' deployed on successful long term grid connected installation	Pre-Commercial Deployment - EMEC/Wave Hub	10
	Small arrays (<10MW or 20 devices) 'commercially' deployed on successful long term grid connected installation	Pre-Commercial Deployment - Wave Hub/Pentland Firth	11
Supported Commercial:	Small arrays (<10MW or 20 devices) commercially deployed on revenue support inclusive of all planning/licensing/de-commissioning costs	Commercial Deployment - Wave Hub/Pentland Firth	12
	Medium arrays (10<100MW) commercially deployed on revenue support inclusive of all planning/licensing/de-commissioning costs	Large scale Deployment - Pentland Firth/'Round 1 Sites'	13
	Large arrays (<100MW+) commercially deployed on revenue support inclusive of all planning/licensing/de-commissioning costs	TBD	14

Table 3 Technology maturity table

Key players in Scottish Marine energy market

The companies involved in the development of wave and tidal energy schemes in Scotland, including the winners of leases in the Pentland Firth, are presented in Table 4.

Company	Technical Activities	Supply Chain partners
SSE Renewables	Lease awarded for Costa Head site (pentland firth) - 200MW	Xodus Group has won a three-year contract with SSE Renewables to carry out an Environment Impact Assessment (EIA) for the Costa Head offshore wave site
	Lease awarded for Brough Head site (Pentland firth) - 200MW with Aquamarine Power	
	Lease awarded for Westray South site (pentland firth) - 200MW	
	Lease awarded for Cantick Head site (Pentland firth) - 200MW with Open Hydro	
	subsea cable installations	Briggs Aquatera - Route Selection, Consultation and EIA Studies for a Dounreay–Orkney 132 kV Grid Connection
RWE	Saidir project - 4MW wave - On January 22 2009, the Scottish Government granted consent for the Siadar Wave Energy Project (SWEP) on the Isle of Lewis in the Outer Hebrides	joint project between RWE npower renewables and Voith Hydro Wavegen
		Mott MacDonald assessed coastal environmental impacts as part of the EIA a preferred civil construction contractor has been appointed
	Voith Hydro prototype at EMEC	Baeur renewables
Scottish power renewables	Pelamis P2 prototype at EMEC	Delta Marine - Installation
	Hammerfest Strom at EMEC 2011	

	<p>Sound of Islay Demonstration project:</p> <ul style="list-style-type: none"> - working in partnership with the Islay Energy trust (IET) - EIA complete and ES submitted to Marine Scotland July 2010 - Aim to get consent by early 2011 	
	<p>Lease awarded for Marwick Head site (Pentland firth) - 50MW</p> <p>Phase one of this project will have a capacity of 9MW and a further 41MW will be developed after this initial stage is complete</p>	
	<p>Lease awarded for Ness of Duncansby site (Pentland firth) - 100MW</p> <p>It will be a full-scale development based on learning from the Sound of Islay Demonstration Tidal Array</p>	
Eon	Tow tested Pelamis P2 prototype at Firth of Forth	Delta Marine - Installation
	Planned Pelamis P2 prototype at EMEC in 2011	
	Lease awarded for West Orkney South site (Pentland firth) - 50MW	
	Lease awarded for West Orkney Middle South site (Pentland firth) - 50MW	
Vattenfall	Aegir Wave Power is a joint venture between Vattenfall and Pelamis Wave Power set up with the aim of developing and deploying wave farms off the Scottish coast. This includes the deployment of the Pelamis wave power project off the southwest coast of Shetland	
International Power	Won lease for Inner sound in Pentland Firth as part of the Maygen consortia, along with Morgan Stanley & Atlantis Resources	
	previous plans for 10MW demo project in Pentland Firth	Searoc appointed Chief Engineer to fill the role of owner's engineer
DP Energy	site development work and competing for Saltire prize leasing round	
SLP	active in seeking leases for sites in Scotland for tidal energy schemes	

Table 4 Companies developing sites in Scotland

The technology companies and their activities are summarised in Table 5 and Table 6.

Wave energy technology developers		
Company	Technical Activities	Supply Chain partners
Pelamis Wave power	Orcadian project - Currently testing two P2 machines at EMEC	ContiTech company, Dunlop Oil & Marine - Air Actuators
		Schaeffler – Bearing
		Dassault systemes - Sub modelling & nonlinear analysis
		ABB – Generator
		Sgurr Energy - Technical & Energy assessment and due diligence
		Neptune deeptech – Manufacturing
		Mott MacDonald provided a technical review
		Aquatera - environmental impacts
		Software tools used - Orcaflex & Abaqus
		Searoc
	Lease awarded for Armadale site (Pentland firth) - 50MW (now named Farr point wave farm <ul style="list-style-type: none"> - Phase-1 7.5MW - Grid connection secured for 10MW substation 	
	Joint venture with Vattenfall on Aegir project in Shetland	
	Bernera Wave Farm, western islaes, Scotland. <ul style="list-style-type: none"> - Plans for Up to 26 Pelamis machines (20MW) - Currently in scoping stage 	

Table 5 Wave energy companies active in Scotland

Aquamarine Power	Oyster-1 prototype testing at EMEC since summer 2009.	Isleburn (part of the Global Energy group) manufactured the Oyster device at its Nigg base, requiring up to 60 skilled personnel.
		use of the expertise of 27 local contractors to deploy the Oyster wave energy device as well as EMEC's facilities
		£2 million installation contract awarded to Fugro Seacore in March 2009
	Oyster 2 testing at EMEC planned for summer 2011.	Burntisland Fabrications - Manufacturing (£4m contract) Scottish Enterprise approved a £6m package of assistance to enable BiFab to expand its operations at Fife Energy Park
	Developing Oyster 3	MacArtney is to supply the data collection and transfer systems
		BAE are helping to develop an intelligent diagnostic system & remote ballasting mechanism,
		ABB – invested £8 million in Nov 2010
		Xodus Group - gaining project consent
	Leask Marine – Divers	
Ocean Power Technologies (OPT)	Testing PowerBuoy 150 in EMEC in 2011	Mitsui Engineering & Ship building Co.Ltd are helping in the design of the mooring system
		Isleburn Ltd will work on the steel fabrication
		Converteam are helping in the development of opt's linear generator
		Lockheed Martin provides its expertise in systems integration, lean manufacturing, and test and optimization analysis
		MacArtney has provided infrastructure to the underwater substation Pod
		Aquatera was selected by Ocean Power Technologies (OPT) in early 2007 to complete a device-specific environmental impact assessment (EIA) for OPT's Powerbuoy. This was to support the proposed deployment of the device at the European Marine Energy Centre (EMEC)
AWS Ocean Energy	Deploying of AWS III in the Cromarty Firth	Mott MacDonald provided a technical review

Table 5 (continued) Wave energy companies active in Scotland

Tidal Stream Technology Developers		
Company	Technical Activities	Supply Chain partners
Scotrenewables	Testing SR250 at EMEC on March 2011	Harland & Wolff - manufacturing
		Aquatera - environmental impacts
		Delta Marine – Installation
Pulse Tidal	Demonstration at Kyle Rhea in 2012	Bosch Rexroth – Hydraulic
		Herbosch Kiere – Installation
		DNV – Certification
		IT Power – Engineering
		Niestern Sander- Construction
		Fraunhofer IWES - Control and electrical Systems
	Gurit – Composites	
Atlantis Resources	Currently testing the AK1000 at EMEC	Hallin Marine Subsea International Ltd – Installation
		Soil Marine Dynamics - Fabrication of nacelle
		Isleburn Engineering - gravity base and system assembly
Hammerfest Strom	Testing the HS1000 at EMEC in 2011	BurntIsland Fabrications - Manufacturing (£2m)
		Frazer Nash - Technology assessment
Ocean Flow Energy	Demonstration of Evopod at Sanda Sound in 2011	
TGL – Rolls Royce	Waiting to re-install the 500kW device at EMEC in 2011	
Open Hydro	Currently testing at EMEC	Aquatera - environmental impacts
		RPS and McLaughlin & Harvey - engineering design and procurement, and developing the unique deployment and retrieval processes
Marine Current Turbines	Lease awarded for Brough Ness site (Pentland firth) - 100MW	
	planned Kyle rhea scheme - estimates that the cost of the 5MW scheme, consisting of four SeaGen tidal units, will be £35million	

Table 6 Tidal energy companies active in Scotland

Voith hydro	Testing a 1MW device at EMEC in 2011	Maybe working with Tekmar on a cable protection system for gravity based subsea tidal turbines.
		BAUER Renewables involved in manufacturing and installing the foundation
Swan turbines	developing its 'Cygnet' demonstrator device for installation at EMEC	installation trials with Jumbo Offshore
Torcardo	A Netherlands based business that established a UK subsidiary 'Tocardo Tidal Energy Ltd' in Wick harbour in 2008	Tocardo BV prepared a pre-feasibility study for Pentland Alliance on tidal energy on the Pentland Firth in Feb 2008. Pentland Alliance, composed of companies UKAEA Ltd, CH2MHill & AMEC Nuclear, was established as a bidding consortia for the Dounreay decommissioning project

Table 6 (continued) Tidal energy companies active in Scotland

Other activities

Development of EMEC facilities

EMEC recently commissioned Draka to deliver and extra 5,000 meters of 20kV subsea power cable to the test site in Orkney

Drammen, NO — (February 7, 2011) /PRNewswire/ — Draka Offshore announced today The European Marine Energy Centre (EMEC) has once again selected Draka as their subsea power cable provider with a further purchase of cables and logistical solutions.

In 2010 they also successfully laid 3 new cables; creating two new test berths at the tidal test site off Eday, and another at the Billia Croo wave test site.

Seven kilometres of cable supplied by cable manufacturer Draka from their Norwegian factory at Drammen were laid; creating two new test berths at EMEC's tidal test site off Eday. EMEC also used the opportunity to carry out another project in parallel: to fit bespoke cable terminations to the existing and new cables on site. The terminations, designed and built by oil and gas engineering business, J+S Ltd, allow developers to connect their devices and enable EMEC to vigorously test the cables. The CS Sovereign, a cable laying ship with DP capability operated by Essex-based Global Marine Systems Ltd, was chartered to carry out the work. This challenging project (in up to 6 knots of current) at EMEC's Tidal Test Site

and was carried out by the teams involved under EMEC management, and was completed to time and budget.

Other recent activity at EMEC included:

- Expanded and improved data collection and monitoring contributing to new research agendas,
- progressed 5 of EMEC's industry standards for international adoption as part of the International Electrotechnical Commission
- participated in 25 National and International Conferences (as far afield as the USA, New Zealand, and Taiwan)
- shared expertise in 22 industry working groups and advisory groups, and
- hosted almost 400 visitors including Government Ministers from Chile, industrial and investment corporations from Japan, and TV crews from China, India, and all across Europe.
- Five machines in the water in 2010, meaning EMEC activity in Orkney is truly world leading in the development of Marine Energy.
- The cable laying project EMEC won an award. EMEC, Global Marine, J+S and Draka were jointly awarded "Most Effective Tidal Energy Project Development 2010" at the 4th International Tidal Summit and Awards in London.

Orkney ports

The former wartime naval base at Lyness on the island of Hoy is being transformed into a centre for the maintenance and assembly of wave and tidal devices, with a £3 million redevelopment due to begin in June 2010.

Orkney Islands Council is also developing plans for a substantial extension to the pier at Hatston near Kirkwall, which is well placed to serve developers using the Fall of Warness tidal test site operated by EMEC, the European Marine Energy Centre.

An expansion of harbour facilities is also proposed for Stromness, close to EMEC's wave test site at Billia Croo to the west of Orkney Mainland.

Michael Morrison, business development manager with the council's Marine Services department is the main point of contact.

The first phase of the Lyness redevelopment involves the refurbishment of 265 metres of the harbour's quay, the creation of 4000 square metres of quayside hardstanding, and upgrading power, lighting and water supplies.

Forty per cent of the funding is being provided by the European ERDF fund, with further phases to be planned as the industry develops, both at EMEC and at the commercial sites identified in the Crown Estate's leasing round for Orkney waters and the Pentland Firth.

The proposals for Hatston involve extending the 225-metre pier by a further 150 metres, with the council looking at providing an extra 100 metres of quayside berthing space in Stromness.

Orkney's port information systems are also set for a boost, with an upgrade planned for the VTS (Vessel Traffic Services) software and equipment used at Marine Service's base at Scapa.

The £3 million phase 1 refurbishment at Lyness is expected to be completed by the end of May 2011 and Marine Services Head of Port Development John Orr said, " I am very happy with the progress that works have progressed especially due to very adverse weather conditions at the end of 2010, some time has been lost but the contractor is increasing staffing personnel to play catch up. The sheet piling work is complete, the tubular piles that will support the heavy lift work station is underway with some piles already in place. The concrete cope works are substantially complete for section one of the works (Lyness Wharf area) and the reinforced concrete lay down slab works in this area are underway with 2 panels already complete. Dredging works are slated to commence mid February

Fife Energy Park

Fife Energy Park was established in 2005 for companies working in the energy sectors, with a particular focus on attracting renewable energy firms. It is an assisted area, which allows companies locating there to apply for Regional Selective Assistance (RSA) grants

Amongst the tenants on the 134 acre site are BiFab.

Along with Fife council, Scottish Enterprise has already awarded £1 million from the European Development Fund to help create the site, financing ground works, internal site servicing, the demolition of some existing buildings, signage, and boundary fencing.

In August 2009 £13 million cash provided by Scottish Enterprise, the Scottish government's investment agency, to upgrade the quayside at Energy Park Fife near Buckhaven and undertake further coastal protection work, building on the first phase of refurbishment of the former Kvaerner oil fabrication yard from 2007.

General market information

- Exclusion zone on demo projects imposed by the Crown Estate in the Pentland firth and Orkney waters is hampering companies wishing to get devices deployed.
- Grid is progressing well and a number of big applications have been submitted recently. Reasonable capacity to accommodate ~100MW by 2014 (and unlikely that technology will reach this stage by then) and then with main transmission work coming on stream 2014 / 15 the grid could be ahead of the technology maturity timetable and connection of bigger projects. Main concern is connection of western Isles.
- Plenty of construction opportunities around grid infrastructure in HVDC and sub stations.
- Groups like “Scottish Renewables Forum (SRF)” provide good links to the sector but may be limited to Scottish based businesses.
- Ports – the £70m announced is likely to be spread too thinly and focus on offshore wind centres, like Nigg. Scrabster fell outside this funding call though recent award from Europe funding is going ahead and Phase 1 is due to start.
- Caithness Chamber of Commerce is very active and keen to support work in the wave & tidal sectors.

Sources of Funding for Scottish Marine energy projects

Research has identified sources for over £160 million of funding from public and private sources for marine energy projects in the UK since 2002.

Over £110 million of this has been awarded to Scottish companies for projects being undertaken in Scotland – in particular at EMEC. Approximately £60 million in private sector investment and ~£50 million from government grants.

Specific grant funding identified from Scottish sources was £16.6 million.

By way of reference, ~£3.8 million of UK grant funding went to N. Ireland.

An additional investment of ~£48 million was identified for projects related to marine energy activities in Scotland, for example the Fife Energy Park and ports & harbour upgrades.

DECC recently presented figures for March 09 to March 2010 which show similar trends towards Scotland attracting a significant proportion of public funding available to the sector – and this in turn helps to leverage private sector investment into these Scottish based projects – see Figure 1. Further details are provided in Appendix 1.

GOVERNMENT SUPPORT



Funding body	Public investment committed March 2009 to March 2010 (£m)
Energy Technology Institute	4.6
Technology Strategy Board	12
Carbon Trust Marine Renewable Proving Fund	22
Scottish Government WATES II	10
Total	48.6

Figure 1

UK wide funding:

- Feb 2010 - Carbon Trust MRPF –over £19 million of the of £22 million awarded to projects located in Scotland. Only exception is MCT in N. Ireland.
- Carbon Trust R&D funding since 2002 – £2,242,739 awarded to Scottish based companies (including £1,195,000 to EMEC) out of a total of £3,645,937 throughout the UK.
- TSB awarded £7 million in July 200 with ~£1 million going to Scottish companies and the majority of the rest going to companies working in the Sw of England.
- TSB awarded £2.5 million in January 2011 with 2 out of the three projects based in Scotland.
- The Energy technology Institute have awarded £9,100,000 to two marine energy projects since October 2009. The MacArtney group, based in Aberdeen were awarded £1.1 million and University of Edinburgh are one of the main contributors to the PerAWaT project being lead by Garrad Hassan.
- In July 2009 DECC set aside £60 million for marine energy projects as part of its “Low Carbon Industries Strategy”. Over £27 million of this went to Scotland (£19m of the MRPF and £8m to EMEC). The remainder was split between NaREC (£10 million) and the SW of England (Wavehub £9.5 million and R&D £10 million)
- Other UK funding going to Scotland included the £2 million awarded for upgrade work at Scrabster harbour in October 2010 from DECC’s Nuclear Decommissioning Authority.

Scottish funding:

- July 2010 – WATERS fund, Scottish Executive. £13M to Scottish projects
- Feb 2007 – WATES fund, Scottish Executive - £13.5m for Scottish wave and tidal energy projects
- April 2010 - Burntisland Fabrications Ltd (BiFab) received a grant of £6 million from the Scottish Government and development agency Scottish Enterprise to help finance a new wind turbine components manufacturing facility at Fife Energy Park
- Scottish Enterprise provided a grant of £13 million for the Fife Energy Park in August 2009, which has already attracted £23 million of public sector

investment from Scottish Enterprise, Fife council and the European Union to develop infrastructure on site and support for company growth.

The public finding for Scottish based projects has leveraged significant levels of investment from the private sector into companies and projects based in Scotland.

- Aquamarine have secured private investment of over £34 million since October 2007 and a recent investment of £8 million from ABB values the company at £55 million
- Pelamis has raised over £20 million from a wide consortia of private investors, including the Carbon Trust's Venture Capital in addition to other private sector investment / contracts, such as the purchase of devices by EoN and Scottishpower renewables, that sits alongside grant funding such as the MRPF.
- Scotrenewables raised £6,200,000, an investment from Norway based Fred. Olsen Renewables to build of a full-scale, grid-connected prototype of the device. The device has been built at H&W in Belfast, which Fred. Olsen owns.
- Burntisland Fabrications Ltd (BiFab) received a £11 million investment from the utility company Scottish and Southern energy (SSE) in April 2010, which went alongside a grant of £6 million from the Scottish Government and development agency Scottish Enterprise.

The UK Government and devolved administrations, in particular Scotland, have shown a strong commitment to developing a marine renewables market in the UK. This is evident through the various funding sources that are available.

The recently published factsheet from the Technology Strategy Board⁵ highlights some of the key sources of funding available to developers and, in some instances, to supply chain organisations.

The summary chart is reproduced in Figure 2.

While investment in technology development and R&D will continue to be supported, in particularly from the Carbon Trust, the next major level of investment in the marine energy

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https://ktn.innovateuk.org/c/document_library/get_file?p_l_id=57159&folderId=130246&name=DLFE-1549.pdf

sector will be in small arrays (2-10MW). This is highlighted in the “Marine Energy Technology Roadmap”⁶ report from the Energy Technologies Institute and the UK Energy Research Centre at the University of Edinburgh published in October 2010 – see Figure 3.

The array projects feature strongly in the priority areas identified by the ETI, reproduced for reference in Table 7. Priority areas identified in “Marine Energy Technology Roadmap”, and these areas are expected to attract the majority of public funding in the sector in the next few years – and as a consequence would be expected to leverage corresponding significant levels of investment from the private sector.

These projects could involve significant levels of capital expenditure, and recent estimates in the report “Channelling the Energy” published by RenewableUK in October 2010⁷ indicate that the total capital expenditure on this area needed for the UK to maintain its leading position is ~£320 million (based on six 10MW projects). In addition, there would be annual operating costs of ~£12 million, of which over 80% could be on operation, maintenance and refit activities based on the breakdown provided in the Carbon Trust’s “Marine Energy Challenge” report².

These projects are likely to occur on pre-designated test zones, like the Wavehub in Cornwall, or on sites where leases have been awarded, such as those in Pentland Firth, where the first phase in the build out of the site would effectively be a demonstration array.

⁶ “UKERC Marine (Wave and Tidal Current) Renewable Energy Technology Roadmap. Summary Report” The UK Energy Research Centre, University of Edinburgh & Energy technologies institute (ETI), October 2010.

⁷ “Channelling the Energy. A Way Forward for the UK Wave & Tidal Industry Towards 2020”. RenewableUK, October 2010.

PRIORITY A ACTIVITIES
Installation methods
1st Generation device and array sea trials
Recovery methods
Reliability modelling tools
Resource analysis tools
2nd Generation device development
Foundations and mooring systems
Array design and modelling tools
Energy conversion system (e.g. PTO)
Design optimisation tools
Array interaction analysis
Low-cost O&M techniques
Performance data collection
New device and component development (step change)
Offshore umbilical / wet HV connectors
Device modelling tools
Performance guidelines & technical specifications

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Table 7 Priority areas identified in “Marine Energy Technology Roadmap”

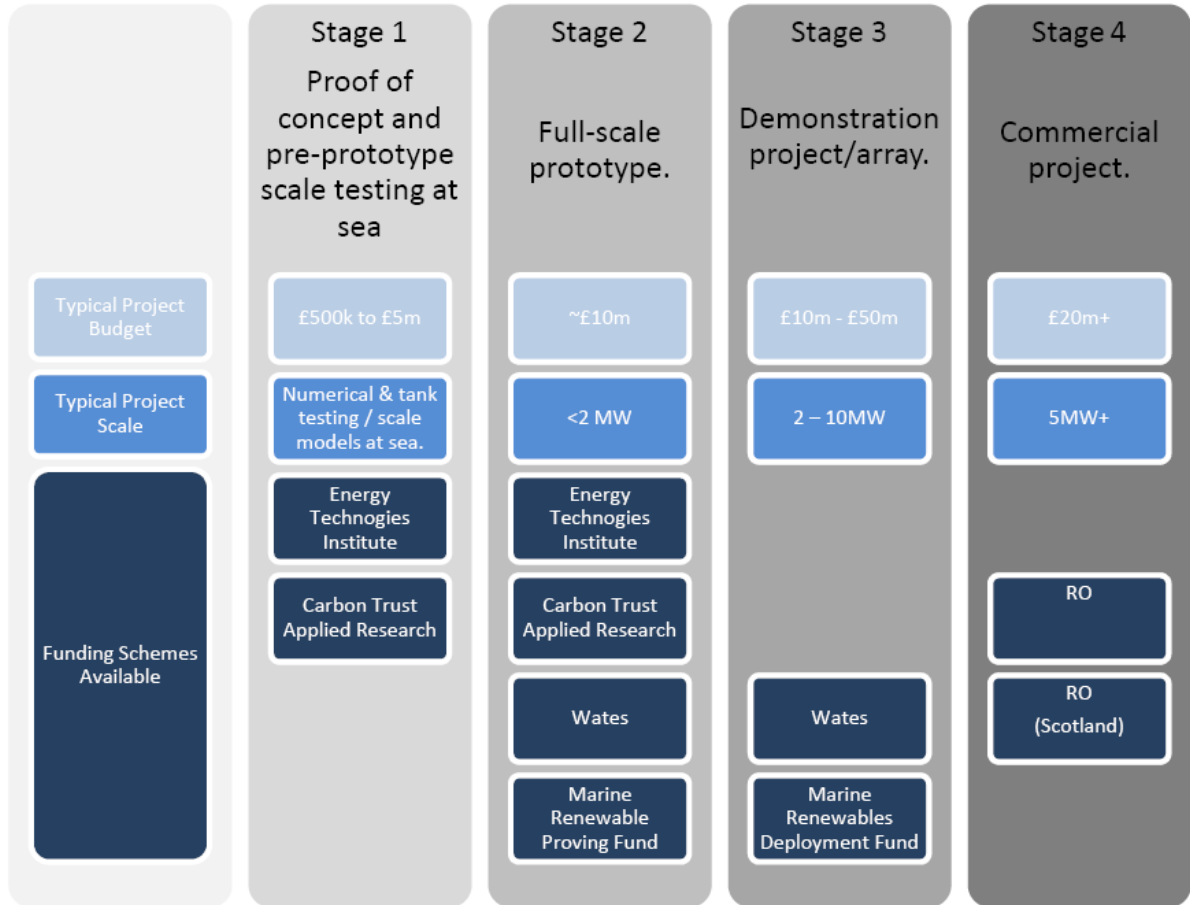
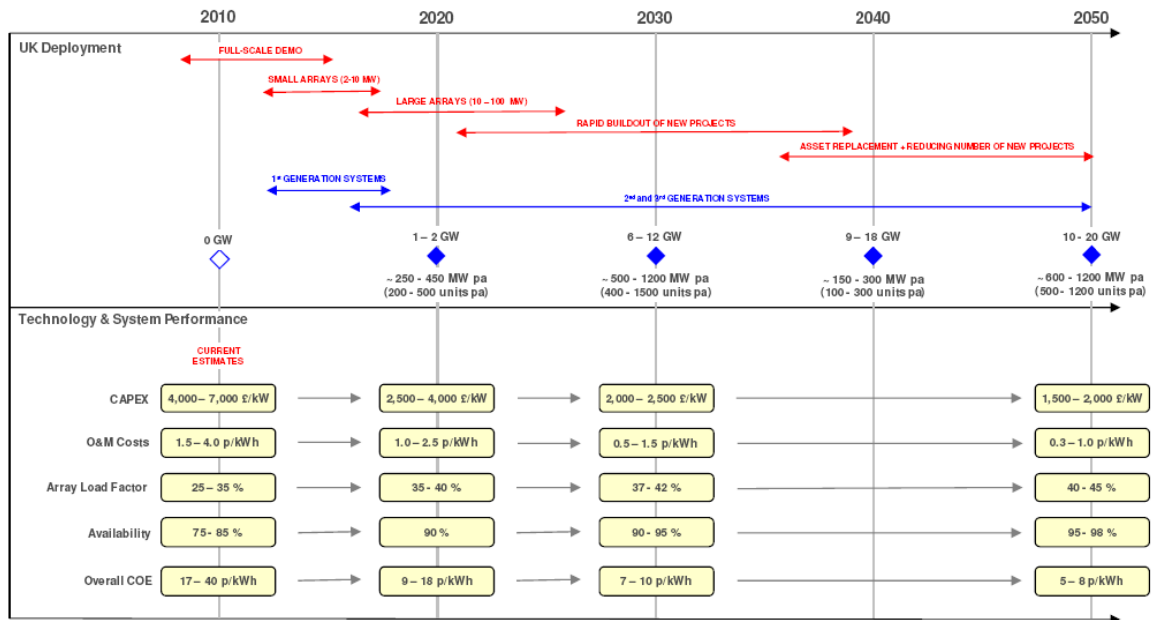


Figure 2 Chart from TSB factsheet on funding form marine energy projects



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Figure 3 Chart from the “Marine energy technology Roadmap”

Timescales for project development

In order to gain insight in when the main elements of capital expenditure (construction & deployment) are likely to take place, the timescales for project development on these sites needs to be considered.

The European Marine Energy Centre (EMEC) has produced guidelines for project development in the Marine energy industry⁸.

Six stages are considered as follows:-

- Stage 1 – Site Screening
- Stage 2 – Project feasibility
- Stage 3 – Project design and development
- Stage 4 – Project fabrication and installation
- Stage 5 – Operation and maintenance
- Stage 6 – Decommissioning

Many developers may choose to undertake most of the elements of Stage-1 and stage 2 without having secured a lease from The Crown Estate for access to the seabed to undertake the project. This investment is usually made as a step to securing a lease or winning a competition for leases, for example the Pentland Firth competition for leases.

The expertise required for these stages include:

- Resource assessments
- Technology assessments
- Environmental studies
- Electrical connections and access to transmission grid systems
- Logistics
- Health & Safety
- Scheme design
- Financial modelling

Developers may budget between £100,000 to £500,000 for these stages, depending on the risks associated with not gaining a lease or security for seabed on which to progress the project.

Many of the developers have in-house expertise in most of these areas and at this stage the opportunity for external sub-contractors may be limited to specialist areas, such as detailed resource modelling & scheme design, with total contracts awarded likely to be in the £50,000 to £200,000 range.

Once a lease for the seabed has been secured, for example the companies awarded leases in the Pentland Firth, the level of investment increases and the focus is on the design and development of the project (Stage-3).

One of the main elements of work at this stage is the Environmental Impact Assessment required to achieve consent to progress with the construction and installation of the project.

⁸ <http://www.emec.org.uk/standards.asp>

This will usually entail extensive survey work and consultations with stakeholders and could take 2-3 years to complete. For example, Scottishpower Renewables announced in September 2008⁹ that they were evaluating a site in Islay for a tidal energy demonstration project. Following completion of the Environmental Impact assessment (EIA) and submission of the detailed Environmental Statement (ES) in July 2010¹⁰, they hope to gain consent from Marine Scotland for the project to go ahead in early 2011.

The project design will be developed in parallel with the EIA and all elements of the scheme will require engineering studies to be undertaken – these will include:-

- Detailed resource studies – numerical modelling & site measurements
- Productivity analysis & technology performance assessments
- Optimisation of array layout and scheme design
- Foundation design
- Cable route and electrical transmission system
- Grid connection studies
- Installation methods
- Operation & maintenance plans
- Decommissioning plans

In addition the procurement strategy and health & safety consideration would be addressed at this stage.

Once consent has been granted the project can progress to detailed design, fabrication and installation (Stage-4), though progress at this stage will be determined by the financial viability of the scheme – for example the RWE Siadar Wave Energy Project (SWEP) on the Isle of Lewis in the Outer Hebrides was awarded consent in January 2009, though securing sufficient funding for this 4MW wave energy demonstration project is critical to ensuring the project's future success¹¹.

The timeline and projected spend on project development activities are shown in Figure 4.

⁹ http://www.scottishpower.com/PressReleases_1764.htm

¹⁰ http://www.scottishpowerrenewables.com/pages/sound_of_islay.asp

¹¹ <http://www.rwe.com/web/cms/en/309656/rwe-npower-renewables/sites/projects-in-development/marine/siadar/the-proposal/>

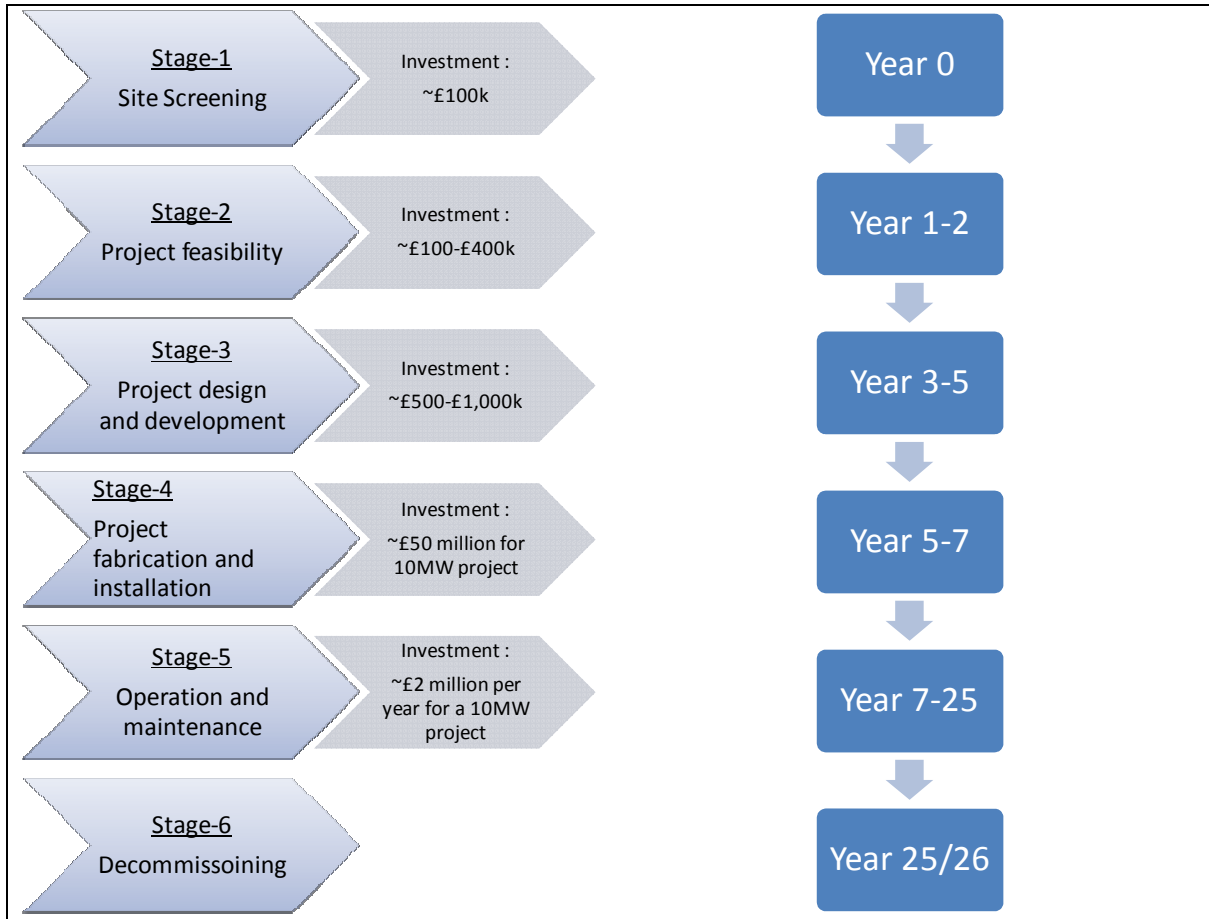


Figure 4

Timescales for technology development

The technology development timescales, types of activities and typical budgets are shown in Figure 5.

A more detailed analysis of these activities is available in the “development and evaluation protocol”

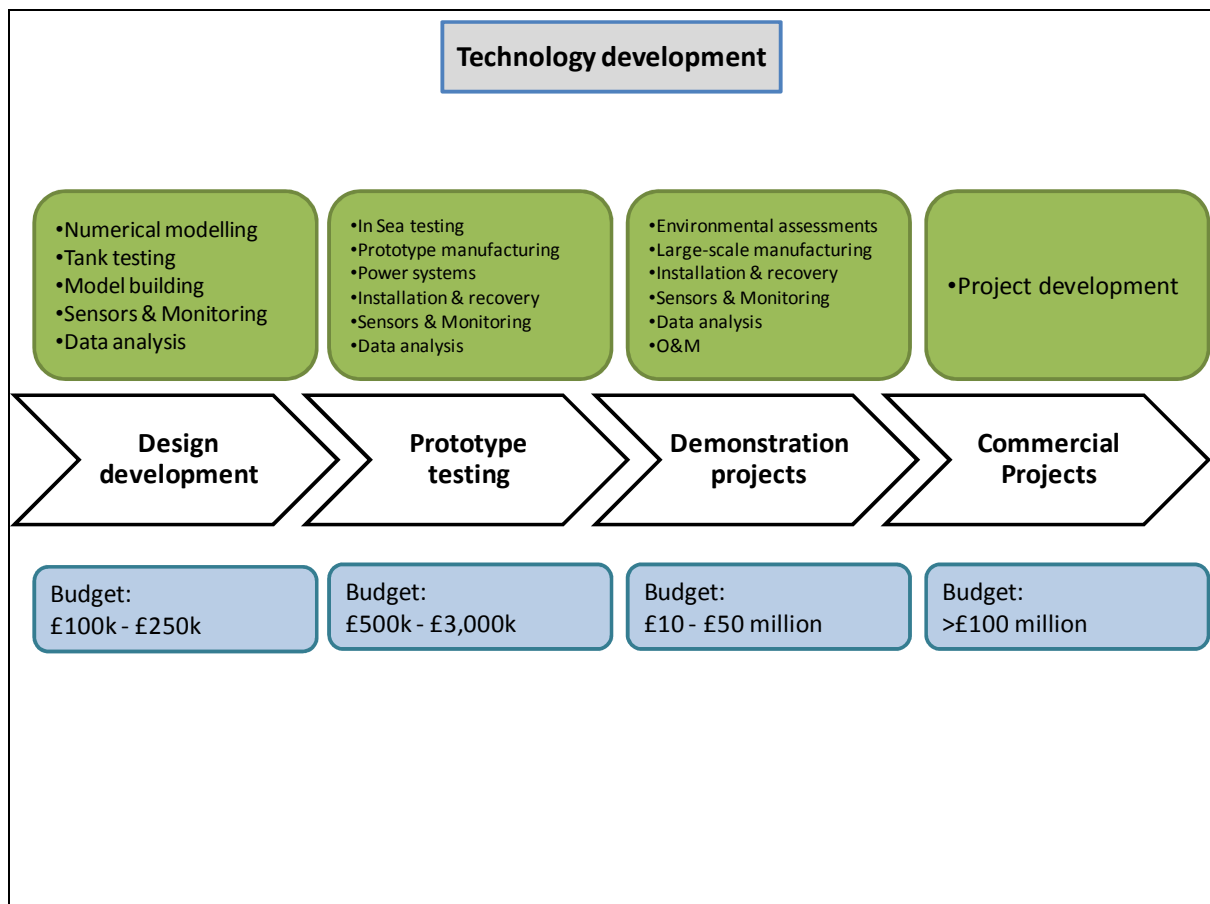


Figure 5

Further market analysis of technology development

Scaled device testing:

- less than 10 companies per year using test tanks & or non-grid connected / intermediate scale test facilities in UK & Ireland, where expenditure on hiring test tanks or external sub-contractors is typically in the £30k - £50k range.
- a large range of available sites, either formally established or areas used by companies near their locations for short term testing.
- Several business throughout the UK & Ireland, both from academic groups and existing consultancy companies, provide support for the testing and analysis.
- Opportunities for new entrants who can develop better analysis techniques to enable these companies to complete this phase of work quicker and more cost effectively than they had hoped for – though these companies tend to have limited budgets for external sub-contractors, which means more creative partnerships arrangements are likely to be required.
- These projects tend to seek funding after this phase of work is completed and support with obtaining investment from the private sector and grant support for next stage of the technologies development would be of value to these companies.

Prototype testing:

- last year alone 4-5 wave prototypes & 4-5 tidal prototypes in the water
- total spend on manufacturing, deployment, monitoring estimated to be £30 - £40 million.
- similar level of expenditure expected for next year, where 7 prototypes are due to be deployed and ongoing monitoring of operational projects.
- Most of the tidal turbine deployments are at EMEC and Scottish companies have benefited through manufacturing and supplying services to the projects attracted to the test site.

Demonstration projects: expenditure expected to be greater than £250 million over next 5 years and interest from private sector to invest alongside government support to deliver these projects.

- At least 10 technology companies and their development partners have plans to invest in these pre-commercial projects over the next 2-4 years. Four have interests in the FORCE area in Canada, four are working on projects in Scotland (including three of the FORCE candidates).
- Some development activities but none deployed or operational and any final commitments are likely to be subject to securing funding, for example from NER300 or other EU / government support.
- No deployment will occur unless business case is viable ie ROCs & grants cover costs.
- UK and EU funding expected to be targeted at getting these projects deployed.

Role of Scottish renewables and other government players

Scottish Renewables

Scottish Renewables is the Forum for Scotland's Renewable Energy Industry and was established in 1996 to provide united voice for the renewable energy industry in Scotland.

Scottish Renewables is a forum of key players with interests including biomass, hydro, micro, marine and wind technologies. It is largely funded through subscriptions from Members who receive benefits commensurate with membership of a Trade Association.

Current board includes members that have an interest in wave and tidal energy, for example:

- Jeremy Sainsbury | Natural Power Consultants
(Chairman & Grid Group co-Chair)
- Alasdair MacNiven | RWE Npower Renewables
(Vice Chairman & Hydro Group Chair)
- Gareth Davies | Aquatera
(Marine Group co-Chair)
- Richard Yemm | Pelamis Wave Power
(Marine Group co-Chair)
- Keith MacLean | Scottish & Southern Energy
Grid Group co-Chair
- Allan MacAskill | SeaEnergy Renewables Ltd
(Offshore Wind Group Chair)
- Maria McCaffery | Renewable UK
- Paul Mitchell | University of Aberdeen
- David Cameron | EDF Energy
- Ray Hunter | RES UK Ltd
- Andrew Jamieson | ScottishPower Renewables

Further details on Scottish Renewables and their role in the wave and tidal sector:

- They have over 300 members covering all renewable energy technologies and supply chains
- Specific focus area (one of fourteen) on marine – wave & tidal.
- Scottish Renewables aim is to represent and promote the interests of its membership by engaging proactively with Government, industry groups, stakeholders and the public to promote a permissive environment that the growth and deployment of the Scottish marine industry
- Annual conference – 22/23 March 2011

- Dedicated Marine Energy conference – in Inverness in Nov 2010 – where Scottish Renewables Marine Policy Paper was launched, which sets out the industry's recommendations to Scottish Ministers ahead of the Holyrood election in 2011.
- Members include international companies actively pursuing market opportunities in Scotland. A list of members linked to marine energy sector is provided in Appendix 2 - 74 members linked to marine energy sector have been identified.
- The breakdown of members linked to the marine energy sector are as follows:

Type of Organisation	Number
Academic	7
Consultant	16
Developer	17
Government	4
Manufacturer	1
Media	4
Non-Government Organisation	6
Operations & Maintenance	2
Technology developer	12
Trade body	5

- Scottish companies & organisations account 50% of the marine energy members (37 out of 74) and a further 17 are International companies with an office in Scotland
- Full Membership Fees are:
 - Large (250+ employees, PLCs) - £5,500
 - Medium (11-249 employees) - £1,995
 - Small (up to 10 employees) - £760
 - Sole Trader (registered as such with HMRC) - £435

Highlands and Islands Enterprise

Highlands and Islands Enterprise (HIE) is the Scottish Government's economic and community development agency for the region in Northern Scotland which covers more than half of Scotland and is home to around 450,000 people.

- HIE's role is to develop sustainable economic growth across the region.
- Funding & support:
 - Regional Selective Assistance (RSA) is the main investment grant scheme for businesses in designated areas of Scotland (the 'assisted' areas).
 - SMART:SCOTLAND provides financial assistance to SMEs to help support projects, which represent a significant technological advance for the UK sector or industry concerned
 - University of the Highlands & Islands (UHI) - The UHI HI-Links project aims to help businesses in the Highlands and Islands develop and prosper through

greater access to the knowledge, expertise and technology available in Scotland's universities, colleges and research institutes.

- International links - HIE can offer Highlands and Islands businesses many opportunities to engage with the Massachusetts Institute of Technology's Media Lab
- Greenspace Research – University of the Highlands & Islands (UHI)
 - renewable energy and built environment research at UHI Millennium Institute's Lews Castle College in the Scottish Highlands and Islands
 - Their Energy Visualization and Simulation Lab provides computational research support for energy visualisation, simulation and remote collaboration
 - commercial arm - Greenspace Live - is responsible for taking commercialisable research and development projects to the marketplace.

Scottish Development International

- SDI role is to attract companies and inward investment to Scotland
- They are very active around events like All Energy

Marine Scotland

Marine Scotland is the directorate of Scottish Government (SG) responsible for the integrated management of Scotland's seas.

Established on 1 April 2009, Marine Scotland brings together the functions and resources of the previous SG Marine Directorate, Fisheries Research Services (Marine Scotland Science) and Scottish Fisheries Protection Agency (Marine Scotland Compliance). Marine Scotland has around 700 staff, a network of offices and laboratories around Scotland, and substantial support assets, including research and protection vessels, and surveillance aircraft.

Jim McKei from Marine Scotland presented at the recent MRIA's Ocean Energy Industry Forum on the 3rd February 2011 in Dublin. Presentations are available at www.mria.ie

They are the organisation to contact if considering deploying marine energy devices at sea in Scotland.

Trade bodies and Collaborative groups

Aberdeen Renewable Energy Group (AREG)

<http://www.aberdeenrenewables.com/>

- launched almost 10 years ago
- perfectly placed to position the North East of Scotland on the global green, sustainable energies map... to make Aberdeen and Aberdeenshire as famous for renewables as they are for offshore petroleum
 - innovative private - public partnership that:
 - acts as a catalyst to the transfer of upstream oil & gas expertise to offshore renewables
 - also undertakes flagship projects, not least the European Offshore Wind Deployment Centre and Energy Futures Centre
- over 150 members active in a wide range of renewable energy sectors around the globe – professional services, technical services, grid, wind, wave & tidal, bio, solar & PV, hydrogen & fuel cells, geothermal, hydro energy
 - wave and tidal members are mostly drawing from key players in the oil & gas sector based in Aberdeen.
 - membership open to Aberdeen based companies and committed to promoting the Aberdeenshire area.
- working towards delivery of an ambitious and exciting portfolio of renewable energy projects, designed to position Aberdeen City and Shire as a centre of excellence in renewable energy.
 - Through a joint venture with Vattenfall, the 5th largest energy provider in Europe, AREG is looking into the feasibility of developing an Offshore Windfarm, off the North East coast of Scotland.
 - Developing a state-of-the-art Energy Futures Centre in Aberdeen's beach area to house some of the city's key players in renewable energy development.
 - Establishing a new Renewables Research Centre and a Professorship in Energy Futures, supported by the University of Aberdeen, The Robert Gordon University and Aberdeen City Council.
 - Assisting in the development of the All Energy Exhibition and Conference in Aberdeen – the largest renewables show in the UK

North Scotland industries Group (NSIG)

<http://www.nsig.co.uk/>

- mission is to improve and enhance the business prospects of members and the wider Highland community through collaborating internally, as well as externally with appropriate agencies. Promote and market the available skills, services, and facilities to the energy markets in the UK as well as overseas, and address Issues of Concern that may be deemed to be detrimental to the economic growth of business in the North of Scotland.
- Membership benefits include:
 - Quarterly networking events with major speakers from the target markets
 - Access through the website to “members only” information on opportunities and contacts
 - Being profiled through the Business North newsletter, the website and at national and international exhibitions
 - Access for relevant companies to the focus and action groups for the Oil & Gas, Renewable Energy, Caithness & Orkney, and Moray & Inverness
 - Political lobbying, both with MPs and MSPs, as well as attendance at committees in Holyrood
- Members include professional services, technical services, banks, port authorities, government bodies, oil & gas businesses
- Key players from Wave & tidal sector include Aquamarinepower, Voith Hydro Wavegen, Aquatera & Xodus Group

Orkney Renewable Energy Forum (OREF)

<http://www.oref.co.uk/#>

- formally established towards the end of 2000, and became a Company limited by guarantee in 2005.
- principal aims are to promote and develop sustainable local energy resources and promote local skills and expertise.
- Members of the Forum include representatives of the local authority, renewable energy generators, energy experts, civil engineers, Island Development Trusts, environmental consultants, educational and research establishments, electrical engineering and construction companies, amongst others.
- Membership costs from £100 for companies with 1-2 employees to £750 for companies with over 21 employees.

Energy Technology Partnership (ETP) in Scotland

<http://www.etp-scotland.ac.uk/Home.aspx>

- ETP is an alliance of strong, independent Scottish Universities, engaged in world class energy Research, Development and Demonstration (RD&D)
- The ETP has been instrumental in the development of a number of such facilities in Scotland. Examples include:
 - The European Marine Energy Centre Ltd.
 - PURE hydrogen from wind demonstration project
 - Beatrice offshore windfarm demonstrator
 - The National Hyperbaric Centre
 - Energy Technology Centre
 - Fife Energy Park
 - The Hydrogen Office
- The ETP Directorate provides senior energy research leadership from each of the three Scottish regional engineering pools
 - Professor Jim McDonald (Chair) - University of Strathclyde
 - Professor Patrick Corbett - Heriot Watt University
 - Professor Robin Wallace - University of Edinburgh
 - Professor Paul Mitchell - University of Aberdeen
 - Professor John Irvine - University of St. Andrews
- The ETP comprises those universities which are part of the three existing Scottish regional pooling arrangements (i.e. Northern, Glasgow and Edinburgh Engineering Research Partnerships) along with the University of St Andrews and Edinburgh Napier University
 - Northern research partnership: University of Aberdeen, The Robert Gordon University, University of Dundee
 - Glasgow research partnership: University of Strathclyde, Glasgow Caledonian University, University of Glasgow, University of the West of Scotland
 - Edinburgh research partnership: University of Edinburgh, Heriot Watt University
- Other programme partners:
 - University of the Highlands and Islands - Energy Research Group
 - Scottish European Green Energy Centre

- The Advisory Group provides strategic advice and support to the ETP in relation to industry and policy matters of relevance to the Scottish RD&D community. Members include key players from industry and the Scottish wave and tidal sector:
 - Ian Marchant (Co-Chair), Scottish and Southern Energy
 - Alan Bryce, Scottish Power
 - Dr. Mike Farley, Doosan-Babcock
 - Martin McAdam, Aquamarine Power
 - Mike Straughen, Wood Group

Islay Energy Trust

<http://www.islayenergytrust.org.uk/>

- a community owned organisation that aims to develop renewable energy projects for the benefit of the community whilst reducing Islay's carbon footprint
- IET is managed by a board of trustees. The Trustees are elected by IET members. Anyone over the age of 17 who lives or has property on Islay can become a voting member of IET.
- ARC Consortium - the Islay Energy Trust, the Kintyre Energy Trust and the Tiree Community Development Trust have formed the Argyll Renewables Communities ("ARC") Consortium to identify ways in which their communities can become active participants in the development and operation of offshore wind and marine energy projects, rather than merely bystanders, so as to ensure the best possible outcomes for their communities, as well as for all stakeholders.
- The Sound of Islay Tidal Energy project
 - the Scottish Government has given consent to ScottishPower Renewables to proceed with the project. The project is the world's first tidal energy array to be given consent and if testing is successful in Orkney this summer 10 x 1MW devices will be installed just south of Port Askaig in the summer of 2013.
 - It is estimated that the project has spent almost £160,000 on services on Islay so far and this is likely to reach £500,000 by the time that installation is completed.

RenewableUK

- RenewableUK is the trade and professional body for the UK wind and marine renewables industries. Formed in 1978, and with 660 corporate members, RenewableUK is the leading renewable energy trade association in the UK.
- Dedicated Wave & tidal manager – Oliver Wragg
- Annual conference held every autumn includes wave & tidal sessions and dedicated Wave & tidal conference held every spring.
- Annual membership fees - Large Company £10,620; Medium Company £5,304; Small Company £1,656
- now has a full time Northern Ireland Officer, for which we will be looking to NI representatives and we have also recently established a number of "virtual" wave and tidal groups on finance, technology and standards, consents and licensing, H&S and supply chain. So there would be plenty of opportunities to engage with the association.
- Key players in Scotland are active in RenewableUK groups.

European Ocean Energy Association

- The European Ocean Energy Association (EU-OEA) is the voice of the ocean energy sector at the European level. It is a non-profit association with a growing international membership of more than 70 of the world's leading companies involved in wave, tidal, Ocean Thermal Energy Conversion (OTEC), and salinity gradient energy technologies
- Current president is Sian George from Scottish company Aquamarinepower
- Annual membership fees - Large Company €10,000; Medium Company €5,000; Small Company €2,000
- Annual conference – in Brussels in June2011

Sector events

All Energy

The All Energy exhibition and conference, held during May each year in Aberdeen since 2001, has become one of the most widely attended renewable energy events in the UK. The event has always attracted exhibitors and attendees from the wave and tidal energy sectors from both the UK and other international locations. For example, at last year's event Pure Marine met with companies from India, Brazil, South Korea and the US.

Renewable UK conferences

The Renewable UK annual conference was hosted by Glasgow in November 2010 and had a dedicated wave and tidal exhibition in addition to a dedicated programme of speakers on wave and tidal energy.

There was a strong Scottish theme to the wave and tidal event with a dedicated session titled "Pentland Firth Focus". The RenewableUK also runs an annual wave & tidal energy conference that has regularly contained speakers and exhibitors with direct links to the Scottish market.

Other Scottish and International events relevant to the investigation of the wave and tidal sector in Scotland include:-

- **Scottish Renewables Annual conference**
 - the landmark policy and networking event in Scotland's renewable energy calendar held each March
 - mostly focused on offshore wind though supply chain businesses, utilities involved in wave & tidal, along with some key players in wave & tidal sector attend.
- **Scottish Low Carbon Investment Conference** (<http://www.slciconference.com/>)
 - This conference is part of the SLCI project, a Government-backed initiative identifying and debating the opportunities and challenges around major offshore developments and infrastructure projects, as well as showcasing innovative technological solutions to attract investment. It supports Scotland's aspiration to harness its natural resources, create wealth, skills and security of energy and ultimately to play its part in delivering climate change targets
 - Exhibitors at the 2010 conference included Pelamis wave power, Aquamarinepower, Oceanflow energy and Pulse tidal.
 - 2011 conference is in Edinburgh in September

- **European Wave and Tidal Energy conference (EWTEC)**
 - European Wave and Tidal Energy Conference is held every two years and is focused on wave and tidal energy research, ranging from technical through to cross-cutting policy, finance and environmental subjects.
 - EWTEC 2011 is to be held from 5-9 September 2011 at the University Southampton, UK.
 - Attracts key players from Scotland along with people from the wider European wave & tidal sector
- **International Conference on Ocean Energy (ICOE)**
 - Held every two years and the 2012 conference will be in Dublin.
 - The 2010 conference in Bilbao, Spain included a strong representation from key players in the Scottish market
- **Global Marine Renewable Energy Conference – in the US**
 - Annual conference held in the US.
 - Scottish Development International are one of the sponsors

Appendix 1

Carbon Trust - Applied R&D	£3,654,937	Notes
Scotland based projects:	£2,243,729	
Aquamarine Power Ltd - 2008	£250,000	Oyster Array Optimisation and Detailed Engineering Design
Artemis IP Ltd - 2007	£255,602	Scotland
Scotrenewables - 2006	£149,976	Scotland
AWS Ocean Energy - 2006	£125,000	Scotland
Waveplane - 2003	£268,151	Scotland
EMEC - 2002	£1,195,000	Scotland
Other UK locations:	£1,411,208	
Emblet Energy - 2006	£165,000	Bristol
C-Wave - 2006	£161,195	Southampton
Hydro Venturi Limited - 2002	£99,918	England
IT Power - 2003	£81,993	Hampshire
Joules Energy Efficiency Services Ltd - 2005	£128,300	N. Ireland
Ocean WaveMaster Ltd. - 2002	£161,550	Manchester
Offshore Wave Energy Ltd - 2003	£160,000	Portsmouth
Orecon UK Ltd - 2003	£134,534	Southampton
Pure Marine Gen - 2008	£153,137	N. Ireland
Trident Energy	£73,686	Essex
University of Manchester - 2005	£52,125	Manchester
University of Manchester - 2003	£39,770	Manchester
Carbon Trust - MRPF. Awarded February 2010		
Atlantis Resources	£3,800,000	for the development of its 1MW AK-1000 turbine
Voith Hydro testing at EMEC	£1,700,000	
Aquamarine	£5,100,000	to support the manufacture of its second generation wave energy device, Oyster 2
MCT	£2,700,000	secured funding to support the enhancement of SeaGen
Pelamis	£4,800,000	
Hammerfest Strom	£3,900,000	construction and testing of a 1 MW tidal power device at the European Marine Energy Centre (EMEC) in Orkney. The tidal turbine, known as HS1000, is expected to be fully operational in Orkney by 2011.
TSB		

Jan 2011 - £2.5m awarded to three major projects	£2,500,000	
Bauer Renewables Ltd		to design, manufacture and test novel seabed drilling technology for the installation of underwater device foundations aiming to reduce the cost of installation and deployment of tidal energy devices
		Seabed Drilling Equipment for Voith Hy Tide 1-MW Tidal Turbine at EME
		Partners: Bauer Renewables Ltd (lead), Voith Hydro Ocean Current Technologies, University of Exeter, Mojo Maritime Ltd
Pelamis Wave Power Ltd		Orcadian Pelamis P2 Wave Farm Demonstration
		Partners: Pelamis Wave Power Ltd (lead), E.ON Climate & Renewables UK, ScottishPower Renewables (UK) Ltd
Marine Current Turbines Ltd		SeaGen: Additional Environmental Characterisation and Array Impact Extrapolation
		Partners: Marine Current Turbines Ltd (lead), Queens University Belfast, University of Exeter, University of Southampton
July 2010 - 9 projects receive £7m funding	£7,000,000	
(Scottish projects)	£800,000	
AWS Ocean Energy	£350,000	Assessment of novel WEC with rubber air-water interface; performance validation, optimisation and demonstration of associated cost benefits
		University of Strathclyde
Green-Tide Turbines Ltd		Improved materials for energy generation through advanced tidal device technology design (ACRONYM 'TidalDesign')
		TWI Industrial Electro Tech NewPro Foundries Netcomposites TWI Academic
Small Hydro Company Ltd		Validating the Generic Application of an Innovative Second Generation Horizontal Axis Cross Flow Tidal Turbine
		Oxford University
Marine Current Turbines Ltd	£250,000	Fully Submerged Evolution of SeaGen for Exposed Open Deep Water Locations
		Mojo Maritime Ltd University of Edinburgh Queens University Belfast
Tidal Generation Limited		DEEP-Gen V
		Romax Technology
Fred Olsen Limited		BOLT-2-WAVEHUB

		Supacat Limited Scotrenewables Ltd University of Exeter
Offshore Wave Energy Ltd	£2,500,000	to develop with IT Power a marine demonstration device for ocean deployment at the Wave Hub
		IT Power A&P Mojo Gifford NaREC Plymouth University (PRIMaRE) NPL DNV
Aquamarine Power Limited	£450,000	Maintenance Strategy and Remote Ballasting for Oyster wave energy converter
		BAE Systems Surface Ships Limited
Aviation Enterprises Ltd		Tidal Turbine Blades - Maximising Reliability and Performance and Reducing Cost (BMAX)
		Advanced Composites Group Ltd MERL Ltd Wessex Resins & Adhesives Ltd Bristol University
WATERS - July 2010		
Aquamarine	£3,000,000	The funding will support the further development of the 2.4MW Oyster demonstration project in Scotland
WATES - Feb 2007		
EMEC	£500,000	to develop a testing berth at the European Marine Energy Centre
EMEC	£2,500,000	additional funds ring-fenced for upgrading the site at the EMEC to help accommodate these devices
Scotrenewables	£1,796,000	for the the SRTT is a floating tidal stream energy converter - the final claim will take place in march 2011
Pelamis 4 device project - CRE Energy Ltd	£4,141,000	to use four of Ocean Power Delivery's Pelamis devices arranged as a single wave energy array
AWS Ocean Energy	£2,128,000	design, construction, installation, testing and demonstration of a 500kW Archimedes Wave Swing ("AWS") wave energy converter at the European Wave Energy Centre
Open hydro	£1,214,000	250kW Open-Centre Turbine to be installed on the sea bed at EMEC's tidal site
Ocean Power Technology	£598,000	for the Powerbuoy
Aquamarine Power	£275,000	for the Oyster device
CleanTechCom	£273,000	two 1m diameter siphon pipes which pass through the No 1 Churchill Barrier on land at the Northern tip of Lamb Holm island on Orkney

Wavegen	£149,000	development and testing of an advanced Wells turbine system which is expected to be utilized on a wave energy project on the Western Isles, at Siadar
Tidal Generation	£77,000	extraction of a core sample of seabed from the berth area Tidal Generation's machine will occupy
Highlands & Islands Enterprise		
Aquamarine Power		
Scrabster Harbour - Nov 2010	£5,000,000	to help develop the harbour as a key component of Scotland's renewable energy infrastructure
Orkney - Nov 2010	£2,950,000	to create six new industrial units at Hatston Industrial Estate in Kirkwall. This would meet the needs of tidal energy developers using the European Marine Energy Centre test site at Eday.
South Uist, community landowner Sealladh na Beinne Moire - Nov 2010	£5,000,000	towards a £9.9m project to create new marine leisure and fisheries facilities, and provide access to land for community and commercial development.
Shell Springboard		
Ocean Flow Energy - 2009 winner	£20,000	Regional Winner 2009
Pulse Tidal - 2010 winner		Regional Winner & UK Finalist 2010
Pulse Generation Limited - 2007 winner		Regional Winner - Commended 2007
Scotrenewables - 2006 winner		Regional Winner & UK Winner 2006
Scottish Government.		
Burntisland Fabrications Ltd (BiFab) - April 2010	£6,000,000	funding from the Scottish Government and development agency Scottish Enterprise to help finance a new wind turbine components manufacturing facility at Fife Energy Park. £2 million of Regional Selective Assistance (RSA) - the main investment grant scheme for businesses in designated areas of Scotland - plus a £4 million commercial loan from Scotland's main economic development agency, Scottish Enterprise The funding will go towards financing a new 12,000 square metre manufacturing facility at Fife Energy Park, in Methill, which is expected to secure up to 400 jobs
Fife Energy Park - August 2009	£13,000,000	funding to help an industrial park in Fife become a world leader in advanced manufacturing for the renewables sector.

		cash will be provided by Scottish Enterprise, the Scottish government's investment agency, and will be used to upgrade the quayside at Energy Park Fife near Buckhaven and undertake further coastal protection work, building on the first phase of refurbishment of the former Kvaerner oil fabrication yard from 2007.
		Amongst the tenants on the 134 acre site are BiFab
	£2,450,000	additional £2.45 million that Fife Council recently approved
	£1,000,000	Along with Fife council, Scottish Enterprise has already awarded £1 million from the European Development Fund to help create the site, financing ground works, internal site servicing, the demolition of some existing buildings, signage, and boundary fencing
Physical Sciences Research Council (EPSRC)		
Aquamarine Power & QUB		a five year research partnership the Wave Power Research Group at Queen's University Belfast
		Professor Trevor Whittaker, Head of the Wave Power Research Centre and a world-renowned expert on wave power and coastal engineering, will continue to supervise PhD students sponsored by Aquamarine and the UK's Engineering and Physical Sciences Research Council.
DECC		
Low Carbon Transition Plan July 2009	£59,500,000	
Wavehub, Cornwall	£9,500,000	
NaREC	£10,000,000	
South West Regional Support for deployment and R&D	£10,000,000	
EMEC	£8,000,000	
MRPF (Carbon Trust)	£22,000,000	
Nuclear Decommissioning Authority		
Scrabster harbour - Nuclear Decommissioning Authority Oct 2010	£2,000,000	a £2 million NDA contribution to Scrabster Harbour Trust's plans for a new pier that will ultimately bring jobs to Caithness
Energy Technologies Institute – ETI		

Performance Assessment of Wave and Tidal Array Systems (PerAWaT) - Oct 2009	£8,000,000	a project led by Garrad Hassan, and including EDF Energy, EON, the University of Edinburgh, the University of Oxford, Queen's University Belfast and the University of Manchester will develop a series of models to predict the performance of wave and tidal stream generator arrays.
Macartney - Dec 2009	£1,100,000	18 month project, costing £1.1m and led by MacArtney, will develop an 11kV wet-mate connector, which will be tested and demonstrated under workshop and real-sea conditions
Investment from the private sector		
Aquamarine Power	£34,800,000	Aquamarine Power has received significant funding and support from Scottish Enterprise, Highlands and Islands Enterprise, the Technology Strategy Board, the Royal Academy of Engineering, the Engineering and Physical Sciences Research Council (EPSRC) and the Scottish Government.
£11million funding round announced Dec 2010:		
ABB ventures £8m for 14% stake valuing them at £55m	£8,000,000	
SSE £2.7m to maintain 45% stake	£2,700,000	
Irish investment bank NCB put in £300,000	£300,000	
£6m announced in June 2010	£6,000,000	investors include Scottish and Southern Energy, Scottish Enterprise, our Norwegian investors and Sigma Capital Group
£10m announced Sept 2009	£10,000,000	proceeds of the fundraising will be used to fund the testing programme and for general working capital purposes
£1.5m - Oct 2007	£1,500,000	Sigma capital - Edinburgh-based specialist asset manager. Investment from its second sustainable energy fund, the Sigma Sustainable Energy Fund II (SSEF II)
£6.3M - Oct 2007	£6,300,000	SSE investment for 50% stake - valuing company at over £12.5m
BiFAB		
investment from SSE for 15% stake - april 2010	£11,000,000	
Scotrenewables - £6.2 million of private venture capital on 2008/09	£6,200,000	from Fred. Olsen renewables to building of a full-scale, grid-connected prototype of the device.

Pelamis		
june 2004 - VCs and Carbon trust	£7,500,000	
June 2006 - consortria of investors	£13,000,000	The consortium was led by SAM Private Equity and includes Hydro Technology Ventures, The Carbon Trust, 3i, GE, Atmos, New Energies Invest, Partnerships UK, Impax Environmental Markets plc, Merrill Lynch Investment Managers, Sigma Technology Group, Sustainable Performance Group, Tudor Group, Vantania Holdings Limited and Commons Capital.

Appendix 2

Members of Scottish Renewables linked to the Marine energy sector:

Organisation	Location / Scottish presence	Type of Organisation
Heriot Watt University	SCOTLAND	Academic
University of Aberdeen	SCOTLAND	Academic
University of Dundee	SCOTLAND	Academic
University of Edinburgh	SCOTLAND	Academic
University of Glasgow	SCOTLAND	Academic
University of Highlands & islands	SCOTLAND	Academic
University of Strathclyde	SCOTLAND	Academic
Aquatera	SCOTLAND	Consultant
Atkins Power	Glasgow office	Consultant
Frazer-Nash Consultancy	Glasgow office	Consultant
GL Garrad Hassan	Glasgow office	Consultant
Mott MacDonald	Glasgow office	Consultant
Narec	Northumberland	Consultant
Natural Power	SCOTLAND	Consultant
Partrac Ltd	Glasgow office	Consultant
PMSS	Hants office	Consultant
Royal Haskoning Environment	Glasgow office	Consultant
RPS Group	Glasgow office	Consultant
SeaRoc UK Ltd	East Sussex	Consultant
Senergy Econnect	Tyne & Wear	Consultant
SMRU Ltd	SCOTLAND	Consultant
Wood Group Renewable Energy Services	SCOTLAND	Consultant
Xodus Group	SCOTLAND	Consultant
Centrica	Edinburgh office	Developer
Dong Energy Power UK Ltd	London office	Developer
E.ON Climate & Renewables	Coventry office	Developer
EDF Energy	London office	Developer
EDP Renewables	Edinburgh office	Developer
Fluor Limited	Farnborough office	Developer
Fred. Olsen Renewables	London office	Developer
International Power Marine Developments Ltd	London office	Developer
Mainstream Renewable Power	Glasgow office	Developer
RWE npower renewables	Stanley office	Developer
ScottishPower Renewables	SCOTLAND	Developer
SeaEnergy Renewables Limited	SCOTLAND	Developer
SSE Renewables	SCOTLAND	Developer
Statkraft	Norway - london office	Developer

Vattenfall	Sweden - Edinburgh office	Developer
Lagan Construction	dunfirmline office	Developer / Construction
RES Group	Glasgow office	Developer / consultant
Highlands & Islands Enterprise	SCOTLAND	Government
Orkney Islands Council	SCOTLAND	Government
Sustainable Development Commission	SCOTLAND	Government
The Highland Council	SCOTLAND	Government
Subocean Group Ltd (Technip ?)	SCOTLAND	Installer
ABB Ltd	Warrington office	Manufacturer
Global Energy Group	SCOTLAND	Manufacturer
Siemens Wind Power	denmark office	Manufacturer
Weir Power & Industrial	SCOTLAND	Manufacturer / Technology developer
Media Generation Events Ltd (All Energy)	SCOTLAND	Media
Aberden Renewable Energy Group (AREG)	SCOTLAND	Non-Government Organisation
Enterprise Ireland	Glasgow office	Non-Government Organisation
EMEC	SCOTLAND	Non-Government Organisation
Islay Energy Trust	SCOTLAND	Non-Government Organisation
RSPB Scotland	SCOTLAND	Non-Government Organisation
The Carbon Trust	east Kilbride office	Non-Government Organisation
Marine5	SCOTLAND	Operations & Maintenance
Osiris Marine Services	West Yorkshire	Operations & Maintenance
Aquamarine Power	SCOTLAND	Technology developer
Atlantis Resources Corporation	London / singapore	Technology developer
AWS Ocean Energy	Inverness	Technology developer
Ecomerit Technologies	California, USA	Technology developer
Green Ocean Energy	SCOTLAND	Technology developer
Langlee Wave Power AS	Norway	Technology developer
Lunar Energy	East Yorkshire	Technology developer
Nautricity	SCOTLAND	Technology developer
Openhydro	Rep. Ireland	Technology developer
Pelamis Wave Power	SCOTLAND	Technology developer
Tocado Tidal Energy	Netherlands / Thurso office	Technology developer
Voith Hydro Wavegen Limited	SCOTLAND	Technology developer
Highland Renewable Energy Group	SCOTLAND	Trade body
North Scotland Industries Group	SCOTLAND	Trade body
Orkney Renewable Energy Forum (OREF)	SCOTLAND	Trade body
renewableUK	London	Trade body
Subsea UK	SCOTLAND	Trade body