REFERENCE	Carbon Trust
Title:	Future Marine Energy
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URL:	http://www.carbontrust.co.uk/Publications/publicationdetail.htm?productid=CTC601 Additional materials developed in the Marine Energy Challenge are available at: http://www.carbontrust.co.uk/technology/technologyaccelerator/marine_energy.htm Details of the Carbon Trust's follow-on programme, the Marine Energy Accelerator, are given at: http://www.carbontrust.co.uk/technology/technologyaccelerator/mea
Date accessed:	January 2007
Web Format:	pdf
IEA topics covered	Ocean Energy
Geographical focus:	UK focus
Brief Abstract:	Between 15-20% of current UK electricity demand could eventually be met by wave and tidal stream energy (with 3% possible by 2020). Energy from initial wave energy farms is estimated to cost between 12- 44p/kWh, with central estimates for offshore wave farms of 22-25p/kWh. Initial tidal stream farms are estimated to cost between 9-18p/kWh, with central estimates of 12-15p/kWh. In present market conditions, marine energy is likely to be more expensive than other renewables and conventional generation until at least hundreds of megawatts capacity are installed. Fast learning or a step change cost reduction is needed to make offshore wave energy converters cost competitive for reasonable amounts of investment. Tidal stream energy could become competitive with current base costs of electricity within the economic installed capacity estimated for the UK, 2.8 GW.

OUTPUTS	
Short Report?	NO
Major report?	YES
Visualisations?	YES
Information held on dedicated software?	Growth projections are held on computer models.
- which package?	

ARCHITECTURE	
Timescales used:	Up to 2020 for most forecasts / projections.
Trends and drivers?	YES
- list	• indigenous nature and lack of fuel price volatility of marine renewables. • potential for the UK to play a leading role in developing marine generation technologies.
Enablers?	YES
- list	4 innovation-based routes to cost reduction are identified: concept design developments; detailed design optimisations; economies of scale; and learning in production, construction, installation, operation and maintenance Within these, different priorities are listed: • accelerate the progress of technology development, through ongoing RD&D into concept and detailed engineering design • encourage early development of wave and tidal stream farms to accelerate learning effects. • for offshore wave energy, set an environment for fast learning and maximise the likelihood of step change cost reductions • develop track records of survivability and reliability • encourage convergence on optimal technologies as soon as possible. 5 wider enablers (or 'growth factors') are also identified: • strategic and security of supply considerations (sustained high fossil fuel prices and import dependency) • the availability of finance for technology and project development (including public support) • the readiness of technologies to be commercially exploited, and the approach to managing risks in the development process • the availability of grid connections, network capacity, the electrical engineering design of devices and variability/intermittency of power generation • environmental and regulatory factors, including local environmental impact, consents and permits processes and regulatory change
Performance measures/targets?	NO
- list areas	
Mapping of RD&D activities?	NO
Critical assessment of	NO

capabilities?	

PROCESS	
Methods used:	
- Desk study?	YES
- Consultation	YES
- Interviews?	Unknown
- Facilitated workshop(s)	YES
- Working groups/task force	YES
- Integrated Process	YES
Stakeholders engaged:	
– **University based researchers**	YES
– **Other public sector researchers**	YES
– **Business – technology**	YES
– **Business – other**	YES
– **Government - energy**	YES
– **Government – SET**	Unknown
– **Government - other**	Unknown
– **NGOs**	Unknown
No of people engaged:	25 organisations formally engaged in the Marine Energy Challenge. Other unnamed organisations were also consulted.
Budget (if known):	£3m public funding over 18 months for the Marine Energy Challenge.
Commitment to re-visit?	No, although a follow-on funding initiative has been made by the Carbon Trust, the *Marine Energy Accelerator*.

ACTIONS IDENTIFIED	
List of actions?	Not in detail. Priority research areas for marine energy are listed in a document prepared by Black and Veatch for the Carbon Trust's Marine Energy Accelerator programme, available at http://www.carbontrust.co.uk/technology/technologyaccelerator/mea
Actions listed according to timescale?	No, but sets of 'assumptions' for each of the 5 cost factors identified above are developed for 2005-10 and 2010-20. These provide the basis for estimates of deployment of between 1.0 to 2.5 GW of each of wave energy and tidal stream energy by 2020, with a total capital cost of £1,000 to 2,500 m for each.
Actions prioritised?	YES (in Black and Veatch document).
Sequencing/dependencies identified?	NO
Responsibility for actions identified?	YES. Actions specified for different stakeholder groups (see below).
Types of actions identified:	
- Basic research?	YES (in Black and Veatch document).
- list areas	Academic researchers and funding bodies: • place greater emphasis on cost reduction topics, particularly to overcome cost barriers that are

<table>
<tr><td></td><td>common to many device concepts.
Initial R&D stage priorities:
• concept and detailed engineering design, tank model testing, sub-assembly and component testing
Specific research priorities identified in Black and Veatch document
Black and Veatch assessed research priorities according to three criteria: cost contribution and commonality; cost reduction potential; lack of industry cross-over.
• Tidal Devices:
High priority: gearbox (and alternatives)
Medium priority: rotors; structural materials; sub-sea cabling; device-mounted electrical plant; offshore substation; mooring
• Wave devices:
High priority: structural materials (floats and device body)
Medium priority: electric generator, mooring tethers, anchors and WEC connection; AC/DC/AC power converter; offshore to onshore cable; offshore substation
Note: the Carbon Trust subsequently invited organisations to tender for R&D on top three priority areas for each of wave and tidal devices under its Marine Energy Accelerator Programme. See above weblink for details.</td></tr>
<tr><td>- Applied research?</td><td>Yes. See above for details from B&V report. General priority areas from CT main report listed below.</td></tr>
<tr><td>- list areas</td><td>Technology developers:
• maintain strong focus on cost reduction.
• accelerate engineering testing and prototype demonstration to develop track records of survivability, reliability and generation performance characteristics.
Large scale prototype stage priorities:
• manufacturing, fabrication, installation and testing/monitoring of sea-going prototype.</td></tr>
<tr><td>- Development & demonstration</td><td>YES</td></tr>
<tr><td>- list areas?</td><td>• develop proven methodologies to conduct resource assessments and energy yield predictions
• develop standards for certification of device structural integrity, reliability and moorings or foundations
• develop evidence of long-term availability, linked to robust maintenance philosophies.
Initial small farms stage priorities:
• consents and permits, resource assessment, bathymetric and geotechnical surveys, site</td></tr>
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	civil/electrical engineering design, transformers, subsea cables and switchgear, device installation and monitoring. Larger farms stage priorities: • as initial farms, but at larger scale
- Other types of action?	YES, general themes listed by stakeholder group.
- list other types	Public sector funders: • give increased support over time for RD&D and cross-cutting technology issues to help deliver cost reductions; • support project development from now into the medium term, contingent on technologies proving technically viable in the first instance, and later, evidence of reducing costs • develop a clear long-term policy framework to give greater investment certainty. • accelerate the development of promising technologies that are already advanced. • continue investigating promising concepts that are less advanced, especially those offering step change cost reductions. • stop developing unpromising technologies. Some concepts being pursued are unlikely ever to be cost-competitive. Ofgem and electricity network operators: • Actively consider the future capacity of wave and tidal stream energy when planning grid modifications and upgrades. Government, industry and environmental stakeholders: • Take a pragmatic, prioritised approach to overcoming environmental uncertainties • Take a proportionate approach to local environmental impacts of small developments, recognising the global environmental benefits from future, larger projects.