**FUTURE MARINE COST OF ENERGY**
DECC and Scottish Government | 2009-2010
Black & Veatch worked in partnership with Ernst & Young to develop a future cost analysis of the marine energy sector (including wave, tidal stream and tidal range technologies). The results were incorporated in the Marine Energy Action Plan 2010.

**WAVE DEVICE COST OF ENERGY OPTIMISATION**
Confidential wave developer | 2008
Black & Veatch carried out a cost of energy optimisation using value engineering exercises to identify ways in which performance could be improved and optimised, and therefore CoE reduced.

**MARINE ENERGY CHALLENGE (MEC)**
The Carbon Trust | 2004-2005
The Marine Energy Challenge (MEC) was created by the Carbon Trust to position the UK at the forefront of wave and tidal energy. The aim of the MEC was to technically and commercially develop the growing marine energy industry in order to exploit the UK’s tidal and wave energy resources. Black & Veatch’s strong multi-disciplinary team was therefore well placed to assist in this effort and was paired up with three separate wave developers to analyse and advance their wave device designs. Black & Veatch assisted the Carbon Trust in the due diligence, design development, and cost-of-energy optimisation of the Aquabuoy, P.S. Frog, and Wave Dragon wave devices to increase their performance and decrease their cost through innovation, value engineering, and key parameter optimisation. Black & Veatch carried out an independent analysis of the main tidal current energy conversion technologies and their costs and suitability for different sites. Black & Veatch used the results to predict how the costs of electricity generation from tidal stream might reduce in the long-term.

**POLICY DEVELOPMENT**
INTEGRATED RESOURCE PLANNING
Hawaiian Electric Company (HECO) | 2012
Black & Veatch provided cost and performance assessments of potential energy projects in Hawaii including wave energy and OTEC.

**TECHNICAL SUPPORT**
The Crown Estate | 2011–ongoing
Black & Veatch is providing technical support to the Crown Estate in wave and tidal energy, as they develop their appreciation of the technology landscape, identify strategic areas for future leasing and progress their strategy to support growth of the emerging industry.

**SCOTTISH MARINE MARKET REVIEW**
ITI | 2009-2010
(1) Energy commissioned Black & Veatch, in conjunction with IPA Energy & Water Economics, to assess the marine energy market needs and opportunities for the Scottish economy, providing recommendations on priority market interventions to catalyse development in this sector.

**SEVEN TIDAL POWER FEASIBILITY STUDY, UK Department of Energy and Climate Change | 2008-2010**
A cross-departmental Government study of the feasibility of tidal power generation in the Severn Estuary was being undertaken to inform a decision on whether the Government could support a tidal power project in the Severn Estuary and if so, on what terms. Black & Veatch, as part of the Parsons Brinckerhoff led consortium appointed by Government, provided vital engineering and environmental support to the feasibility study through a Strategic Environmental Assessment and Options Appraisal, together with associated stakeholder engagement and specialist environmental research and fieldwork.

**LOW CARBON TECHNOLOGY COMMERCIALISATION REVIEW**
The Carbon Trust | 2008
Black & Veatch reviewed wave energy technology as part of a wider engineering assessment of low carbon technologies. It included a review of the industry and current state of the art of wave technology, a funding and barrier analysis, and estimation of the potential future commercialisation of the wave energy industry in the UK and globally.

**RENEWABLE ENERGY**
The Black & Veatch global renewable energy group has current experience in all major renewable energy technologies and is actively engaged in projects from early concept definition and research to turnkey project execution. This experience extends across all sources of sustainable energy including:
- Tidal
- Wind
- Hydro
- Biomass
- Solar

**WAVE AND TIDAL SKILLS**
- Resource Assessment-Project Development
- Technology Development
- Due Diligence
- Cost-of-energy Analysis
- Policy Development

Black & Veatch has been involved in wave and tidal technologies since 1975.

Using our innovation, value engineering, and bespoke key parameter optimisation programmes, we work with technology developers to prioritise areas for design development in order to increase performance and decrease costs.

**MARINE ENERGY SERVICES**

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**RESOURCE ASSESSMENT AND PROJECT DEVELOPMENT**

**TIDAL RESOURCE MODELLING**
Energy Technologies Institute (ETI) | 2011–ongoing
Black & Veatch in collaboration with HR Wallingford and the University of Edinburgh are developing a Continental Shelf Model (CSM) of the UK to assess the UK’s tidal energy potential, to inform the design of energy harnessing schemes and to evaluate their impact on European coasts.

**UK TIDAL CURRENT RESOURCE ASSESSMENTS**
Confidential project developers | 2009–2010
Black & Veatch has completed tidal current resource assessments of the Pentland Firth, and other UK tidal sites using a detailed hydrodynamic model.

**SEVERN TIDAL POWER RESOURCE MODELLING**
UK Department of Climate Change (DECC) | 2008-2010
Black & Veatch prepared the Strategic Environmental Assessment for a UK Government study of the feasibility of tidal power generation in the Severn Estuary. The work included parameterisation and optimisation of the potential schemes and major multidimensional hydrodynamic modelling to predict the effects.

**TIDAL CURRENT RESOURCE ASSESSMENT**
Carbon Trust | 2008–2010
Black & Veatch completed an update of the assessment of the extractable tidal current resource from an initial study in 2005. The results are based on work undertaken in collaboration with the University of Edinburgh.

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**RESOURCE ASSESSMENT**

**MARINE GUIDELINES—TIDAL RESOURCE ASSESSMENT**
BSI/IEC | 2009–ongoing
Black & Veatch has provided the UK expert to represent the British Standard Institute (BSI) in the development of international standards for ‘tidal resource assessment’ by the International Electro technical Commission (IEC). The project team leader for these standards is also a Black & Veatch professional.

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**PROJECT DEVELOPMENT**

**MARINE GUIDELINES—TIDAL RESOURCE ASSESSMENT**
European Marine Energy Centre (EMEC) | 2008-2010
Black & Veatch was the main author for the ‘Tidal Resource Assessment’ EMEC standard, published by the British Standard Institute.

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**Due Diligence**

**PROJECT DEVELOPMENT OF TIDAL CURRENT SITE, USA**
Confidential Client | 2008
Black & Veatch provided project development assistance to a major project developer in the USA. The work has included resource assessment, technology review, structural assessments, array layout and energy extraction, FMEA assessment and economic feasibility.
Black & Veatch undertook a review of available technical and geophysical data for a proposed project development site and used this information to select and provide a cost estimate for a suitable anchoring system for a wave device.

WAVE ENERGY DEVICE DEVELOPMENT
C-Wave | 2008
Black & Veatch undertook an optimisation of the design of the walls and space frame of C-Wave.

DUE DILIGENCE
MARINE RENEWABLES PROVING FUND (MRPF) Carbon Trust | 2009–2011
The Marine Renewables Proving Fund was managed by the Carbon Trust (CT). Black & Veatch undertook due diligence for the MRPF which included an assessment of the current engineering and predicted performance of SeaGen. Black & Veatch has carried out independent economic modelling of the costs of SeaGen, used the most up-to-date scaling and learning techniques to predict future costs and assessed optimal farms and commercial prospects.

VENDOR’S DUE DILIGENCE
Marine Current Turbines (MCT) | 2006, 2009, and 2011 (updates)
Black & Veatch reviewed the vendor’s due diligence for MCT which included a detailed assessment of the current engineering and predicted performance of SeaGen. Black & Veatch has carried out independent economic modelling of the costs of SeaGen, used the most up-to-date scaling and learning techniques to predict future costs and assessed optimal farms and commercial prospects.

ANACONDA IDA AND TECHNOLOGY DEVELOPMENT
The Carbon Trust–Cheekmate Sea Energy | 2007–2010
As part of the Marine Energy Accelerator, Black & Veatch undertook a detailed assessment of the Anaconda wave device. Black & Veatch also separately assisted Cheekmate Sea Energy in the development of the Anaconda wave device by producing a technology road map (which involved careful planning to conduct 1/25th scale tests in a tank, witnessing of the testing and analysis of the results) and supervision of a manufacturability study which reviewed and costed the different options to manufacture the rubber tubes.

REVIEW OF TIDAL AND WAVE TECHNOLOGIES
Confidential Power Utility Company | 2009
Black & Veatch presented a high level review of the leading wave and tidal technologies to a leading European integrated utility. The work involved tidal and wave techno-economic review and assessment against carefully chosen criteria including future cost of electricity, engineering/management team, financial strength and commercial prospects.

OCEAN THERMAL ENERGY CONVERSION (OTEC) TECHNOLOGY
Confidential technology developer | 2009–ongoing
In the role of Independent Engineer, Black & Veatch undertook an independent assessment of two proposed OTEC facilities and the governing design, engineering and testing studies completed by the technology developer. Based on the findings of the assessments, an opinion was formed on the developer’s capability to design and construct the plants and whether or not the technology could provide an attractive and viable form of electrical power. Services provided by the Black & Veatch team included the following:
- Engineering review of key structural and civil engineering aspects of the OTEC facilities with particular focus on the design concept and associated mooring system.
- Independent review of economic assessments/forecasts and project timelines for the manufacture, installation and commissioning of both facilities.

COST OF ENERGY
TIDAL CURRENT PLATFORM COST OF ENERGY REVIEW
Tidal Stream Ltd | 2011–2012
Black & Veatch reviewed and commented on a Cost of Energy model for a semi-submersible platform.

WAVE ENERGY CONVERTOR—COST OF ENERGY REVIEW
Pelamis Wave Power (PWP) | 2011
Black & Veatch reviewed and commented upon PWP’s latest Cost of Energy model and forecast.

WAVE ENERGY—COST OF ENERGY STUDY
The Carbon Trust | 2009–2010
Black & Veatch reviewed the cost of wave energy for the Carbon Trust. Based on the review of technical and commercial documents made available by three leading wave energy developers, the cost and performance of the devices were assessed.