



## COMPANY PROFILE

Oceanflow™ is dedicated to developing and exploiting Evopod™, a family of low motion floating semi-submerged platforms with mooring and power export systems. Founded in 2006, Oceanflow is principally a design and product development organisation with Evopod as its core product, designed and built round proven technologies and components used in the marine, offshore oil & gas and wind turbine industries.

## TECHNOLOGY

Oceanflow has taken a total systems approach to the challenge of exploiting tidal stream energy. Its Evopod solution provides not just an efficient turbine-generation technology but a cost effective way to deploy and maintain a farm of turbines in the harsh working environment of tidal streams. Evopod uses a relatively simple but effective system that allows the free floating turbine to maintain optimum heading with the tidal stream at all times. It is tethered to the seabed by conventional marine mooring systems as used by floating offshore structures. The semi-submerged floating solution also places the turbine in cleaner more energetic flow and offers improved access for maintenance compared to bottom mounted devices.

Oceanflow and Evopod are UK registered trade marks

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## FLOATING TIDAL ENERGY DEVICE HIGHLIGHTS

- Extensive testing in open sea conditions including more than one year of continuous deployment off the west coast of Scotland demonstrating survivability in harsh winter conditions.
- Simple accessible tidal stream turbine technology operating in the cleaner faster flow in the top 1/3<sup>rd</sup> of the water column.
- Large diameter unducted turbine allows the efficient exploitation of a wide range of flow conditions.
- Oceanflow's family of low motion platform and mooring solutions facilitate deployment of turbines from OEMs that do not have their own deployment solution.
- Mooring system does not need a level seabed as required for bottom mounted installations.
- Lower installation costs than bottom mounted devices.
- Low operational and through life costs through easier access for maintenance.
- Strong IP/Patent protection with granted patents in place.
- Scaling potential of Evopod lends it to far wider market opportunity from community asset to large scale deployment.

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## MARKET OPPORTUNITY

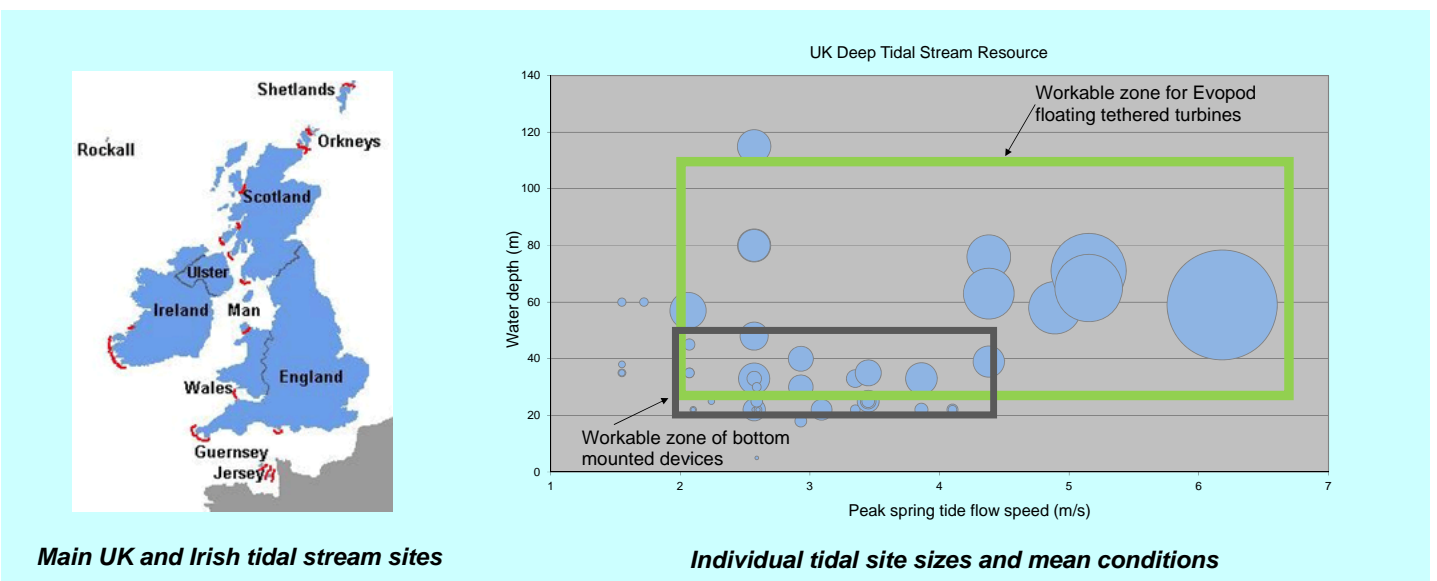
The potential for generating electricity from tidal streams has been assessed in some detail by a number of independent studies. These have determined the UK's extractable tidal stream energy resource as ranging between 15TWh/y to 30TWh/y and equates to between 6GW to 12GW of installed capacity. The annual revenue potential of this capacity amounts to between £2bn to £4bn based on an assumed strike price of around £135/MWh. First projects into market in the UK and other countries receive more substantial support in order to boost the development of technologies with the UK offering a strike price of £305/MWh.

The UK is well placed to lead in the development of tidal stream energy with an estimated 15% of the world commercially attractive resource. Other countries that have a significant resource are France, Norway, USA, Canada, the Pacific coast of Russia, Mexico, Chile, Argentina, western India, China, Japan, South Korea and Indonesia.

Evopod's ability to operate efficiently and effectively in deep water provides distinct advantages in the UK market. Most of this extractable energy is found in relatively deep water sites where the peak flow is faster than 3.5m/s. In addition the stronger, steadier flow is in the upper half of the water column away from seabed topography disturbances, a region that can only be accessed by tethered devices. The most energetic sites and their scale are illustrated by the larger circles in the diagram below (from Black & Veatch). While the fixed seabed installations provide a solution for the smaller energy sites (bottom left quadrant in the chart below), Evopod can operate in the wider quadrant thanks to the ability to exploit deeper water sites with its floating tethered technology.

The fast flowing deep water locations in areas such as the Pentland Firth are typically exposed to harsh wave conditions requiring high survivability in extreme waves and are precisely the locations for which Evopod has been developed and demonstrated. Many such sites are likely to be beyond the economic reach of most if not all competitor tidal devices under development, which are predominantly fixed bottom mounted structures. This is due to the challenges of installing fixed structures in deep waters where the limited environmental windows for carrying out marine operations pose significant technical and financial risks to the industry. Oceanflow offers an integrated solution to the exploitation of tidal stream sites with its tethered Evopod devices that overcome many of the key technical risk areas associated with bottom mounted devices.

Evopod has wider applications than just exploiting tidal stream energy. Tidal streams are a form of hydrokinetic energy and other sources of hydrokinetic energy that Evopod can exploit are ocean currents and rivers using Evopod's efficient horizontal axis turbine solution. The accessibility of a buoyant, tethered Evopod makes it eminently suitable for exploiting these alternative renewable energy resources. In the case of ocean currents, Evopod's ability to operate effectively in deep water makes it particularly attractive.



Main UK and Irish tidal stream sites

Individual tidal site sizes and mean conditions

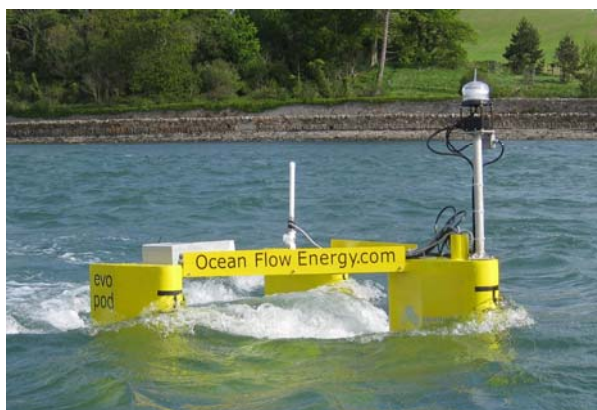
## TECHNOLOGY

Evopod is a device for generating “clean” electricity from free flowing tidal streams and ocean currents. Evopod has been specifically developed to address the need for a tidal current device that can operate in exposed sites where severe waves also make up the environment.

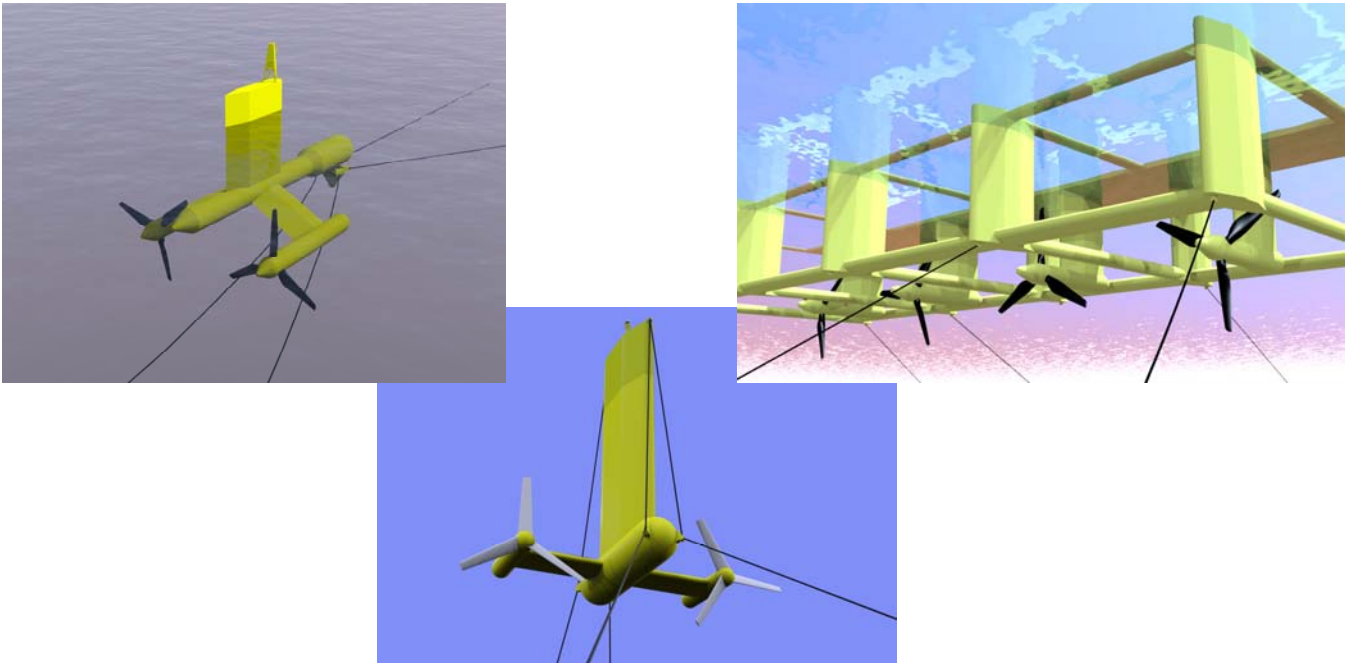
The novel features that allow Evopod to operate successfully in this environment are:

- Patented low motion hull form for tidal stream and ocean current energy recovery [Patents awarded in UK (GB 2422878), USA (7,541,688) and South Africa (2007/3743)].
- High survivability of device in extreme waves
- Simple but effective mooring system that allows the device to maintain an optimum heading into the tidal stream, patent awarded in the UK (GB2450962B)
- System for reducing blade hydrodynamic loads in extreme flow (UK patent application GB1222892.0)
- System for deploying a semi-submerged turbine (UK patent application GB1519817.9)

In the summer of 2014 the Company deployed a community energy scale mono-turbine unit rated at 35kW in Sanda Sound (E35-01). E35-01 was deployed continuously for 13 months and successfully demonstrated the survivability of the moorings and power electronics under winter storm conditions at this very exposed site. The unit is being prepared for redeployment as a grid connected device in 2016. Prior to this the Company had demonstrated a 1/10<sup>th</sup> scale grid connected unit in the sea at Portaferry, Northern Ireland and tested a twin-turbine unit at model scale in Newcastle University’s flume tank.



There is more than one embodiment of Evopod platform and mooring technology. All of the solutions embody Oceanflow's semi-submerged tethered low motion platform technology as protected by UK and USA patents. The twin turbine and multi-turbine units have the potential benefit of even lower unit cost of generated electricity with individual turbines rated at up to 1.2MW. Images of these solutions are shown below.



The turret moored solutions are used with Oceanflow's in-house fixed pitch turbine design while the spread moored solution employ third party OEM's variable pitch turbines.

## INVESTMENT BACKGROUND

- 2006: Oceanflow starts the development of Evopod with grants from Regional Development Agency and management funds.
- 2008: Aquamarine Power Limited invests £100k and takes a seat on the Board.
- 2010: Three Norwegian family offices invest £200k with an additional £450k in 2011.  
Oceanflow awarded a £560k WATERS grant from Scottish Enterprise to support the site development and grid connection of a 35kW Evopod device (E35) to be installed in Sanda Sound, South Kintyre in 2013.  
Sale of two 1kW Evopod units to Edinburgh University for a Government funded research programme.
- 2011: Oceanflow signs an Agreement for Lease with The Crown Estate for the site in Sanda Sound.
- 2012: Marine Scotland award a licence to deploy E35 in Sanda Sound and a contract for the build of the first E35 is signed with a Scottish fabricator.
- 2012: The Lease with The Crown Estate is signed and the moorings for E35 are installed in Sanda Sound.
- 2013: E35 unit fabricated and outfitted in Scotland.
- 2014: New investment of £350k secured to fund the installation and operation of E35.
- 2014: E35 installed in Sanda Sound in the summer of 2014.
- 2015: E35 completes 13 months deployment in Sanda Sound including over the winter months and demonstrating the survival characteristics of the platform, turret mooring system and turbine generator with its power electronics.

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## BUSINESS PLAN AND CREDENTIALS

Oceanflow's Board has paid particular attention to the economics of the company with very low operating costs in comparison to project costs and therefore a low cash burn rate enabling the company to deliver projects to very tight budgets.

Oceanflow's involvement on all the different aspects of tidal energy site development contributes to demonstrate the advanced development stage of Evopod technology:

- Leasing negotiations with The Crown Estate leading to an award of a lease for the Sanda Sound site.
- Environmental monitoring and assessment leading to the award of a licence from Marine Scotland.
- Data capture and analysis for the 1/10<sup>th</sup> scale device tested since 2009.
- Commercial sale of two 1/10<sup>th</sup> scale turbines for an academic research programme.
- Supervision of construction of the 12 tonne 35kW devices.
- Development of health and safety procedures for construction and approved load-out, transportation and marine deployment procedures subject to independent audit by marine warranty surveyors.
- Development of platform solutions for supporting third party's turbines.

The Oceanflow Board recognises that the knowledge and expertise within the company provides a unique marketing opportunity. Oceanflow uses this knowledge to provide design consultancy services to other areas of the marine renewables industry specialising in the design of platform and mooring systems and the dynamic modelling of farm deployments. This has led to the company identifying a potentially low cost solution for floating offshore wind and the filing of a patent for its innovative multi-float spar assembly process (UK Patent Application GB 1511857.3).

Oceanflow's board and management team has extensive experience in offshore structure, marine design, hydrodynamics and electrical power systems, all in harsh offshore environments. This experience has been key to the development of the company. **Graeme Mackie** (founder and CEO of Oceanflow) has 35 years experience of leading marine projects in the defence, oil & gas and renewables energy industries. **David Hewitt** (Chairman of the board) is a professional Naval Architect with 30 years experience in executive management positions in the marine, defence, commercial shipping and offshore oil & gas markets. The other member of the board is **Frederik W. Mowinckel** (serial entrepreneur in various industrial and renewable energy sectors). The board is supported by **Alan Cramond** (Financial & Business Consultant) who is also a director of Oceanflow's Scottish project development company Oceanflow Development Ltd and **Matthias Haag** who as CEO of Gemini offshore wind brings the experience of delivering major renewable energy projects and prior to that was COO of wave energy company Aquamarine Power. Scottish Enterprise, as an investor in Oceanflow, also supports the board through the involvement of its financial advisor **Frances Gillespie**.

## OPPORTUNITY

Oceanflow has a unique, proven technology that has application to the widest range of tidal stream, ocean current and run-of-river resources with its patent protected platform and mooring systems design and in-house developed turbine and control system solution. The Company has assessed different options for the future development of Evopod units at different scales. This ranges from the current small device for community energy projects to arrays of larger devices for bulk power generation, the production design for which has still to be completed. The ability of Evopod to incorporate third party original equipment manufacturer (OEM) turbines opens up the opportunity to integrate Evopod into the tidal or ocean current energy strategy of a major technology player.

In short, this provides an exciting acquisition opportunity to prospective purchasers of the company to pursue the development and commercialisation of Evopod technology and the ability to exploit the vast tidal energy resources both in the UK and overseas.