Tidal stream TECHNOLOGY

What's it like to be present at the birth of a new industry that could provide sustainable energy in a rapidly developing world? Rob Stevenson is a man who knows.

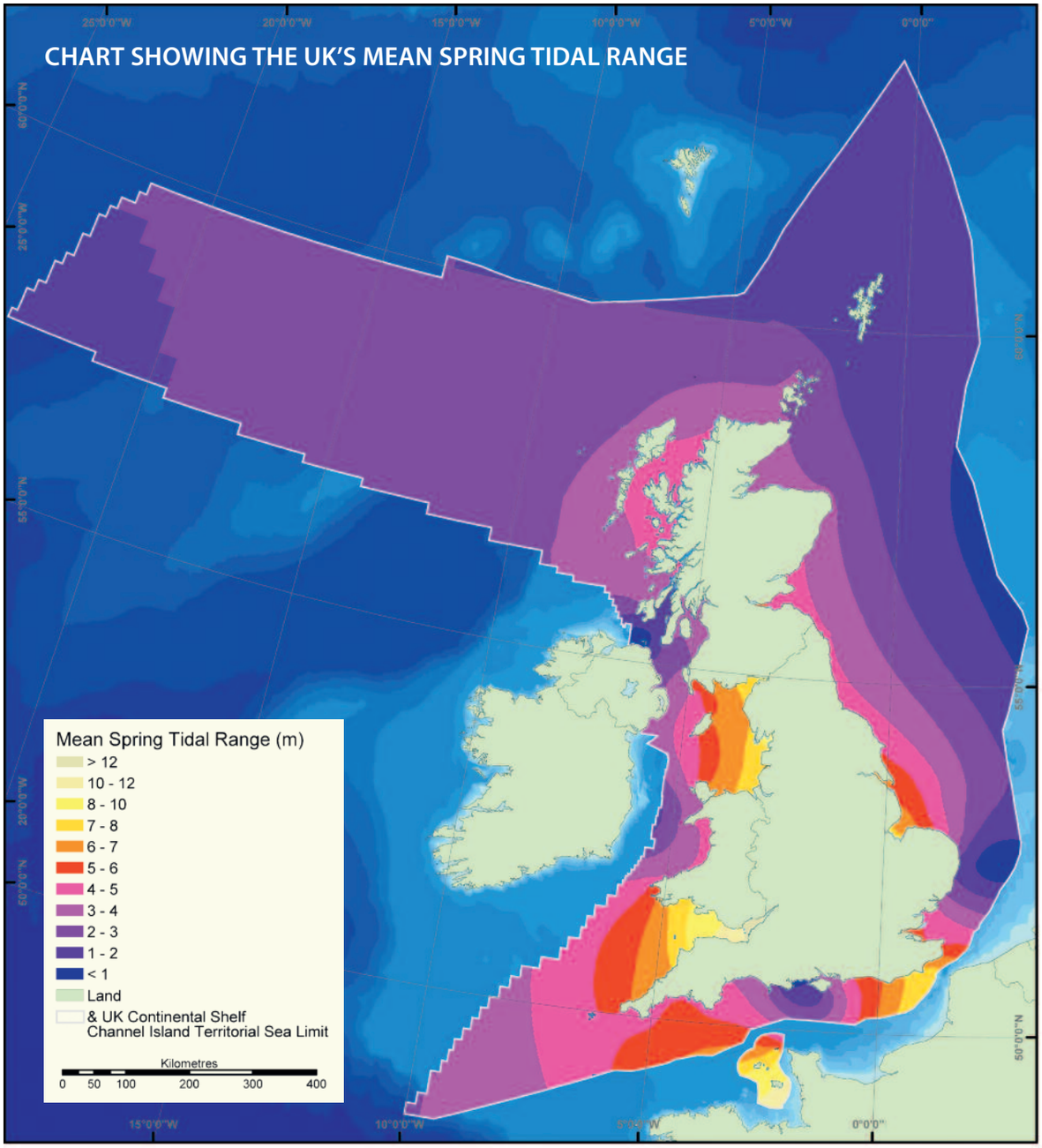
Stevenson is heading the Rolls-Royce work on developing technology to exploit the predictable, sustainable, and clean power of the world's oceans.

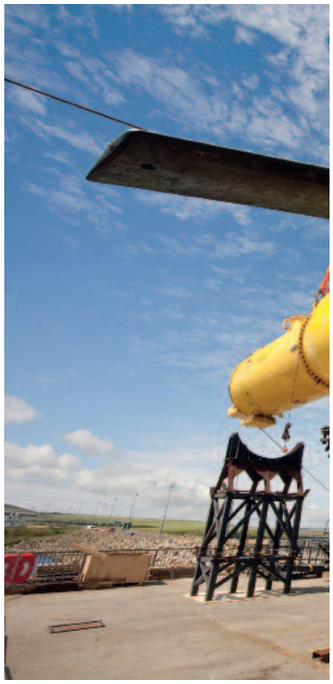
Tidal power comes in two forms: tidal range, which exploits the drop of tides; and tidal stream, which uses the speed of tidal currents. Tapping into the energy inherent in tidal streams allows Rolls-Royce to bring its marine propulsion, turbine and hydrodynamic expertise into an exciting new market with global applications.

According to Stevenson, a tidal turbine is 'like a wind turbine under the sea.' The three bladed rotor sits on a steel tripod attached to the seabed. The nacelle is rotated (yawed) to face the incoming tide. The turbine operates at a depth of 35m and delivers rated power at a nominal tidal flow of 2.7m per second – tidal conditions typically found between islands and larger land masses.

At full power the blades rotate at 17rpm. Power is transmitted through an epicyclic gear box which increases the speed, then through an induction generator and a frequency convertor to generate a uniform output of 50hz which is transmitted to shore via a cable at 6.6kV.

The turbine is buoyant and can be towed to its location.





Above **The 500kW tidal stream demonstrator is prepared.**

Above right **A graphic illustration of how the turbines look on the seabed.**

Below right **Colin Smith, Rolls-Royce Director of Engineering and Technology, Nick Clegg, UK Deputy Prime Minister and David Cameron, UK Prime Minister, discussing a model of the tidal stream turbine.**

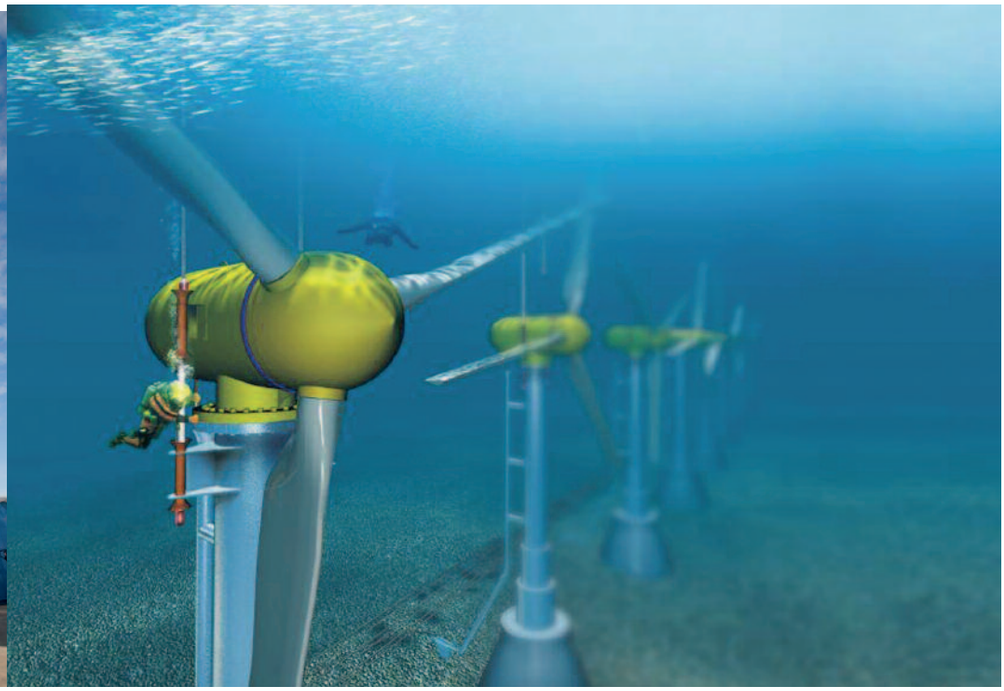
The challenge for the industry over the next ten years is to increase the scale, prove the reliability and reduce the costs of the technology so electricity can be provided at a commercially competitive price.

The rapid deployment and retrieval system created by Rolls-Royce will be key to this. It allows the turbine to be installed or uninstalled in 20 minutes, maximising the time it spends producing electricity and minimising the costs of deployment and maintenance for the operator. This can be achieved because the turbine is semi buoyant. It can be towed to and from the point of operation.

Once on site it uses a patented winch and clamp design, avoiding the need for divers, to winch the nacelle down to its tripod and lock it in place. For maintenance the process is reversed. Simple and efficient it avoids the need for specialist ships – high capacity lift vessels – to deploy it.

The unique way the system yaws is another source of competitive advantage. Tides do not always turn through 180 degrees. As the tide turns – four times a day – the turbine turns with it. As a consequence it can position itself to face directly into the tide at the optimal angle and extract the maximum energy possible at the same time as withstanding the strain that tidal forces (up to 200 tonnes) exert on the equipment.

Rolls-Royce is currently testing an early 500kW demonstrator of a tidal stream turbine at the European Marine Energy Centre in Orkney, Scotland. During recent trials offshore Orkney, the turbine generated 53MWh of electrical power and achieved Renewable Obligation Accreditation from Ofgem – the UK's gas and electricity regulator. It is the first tidal stream device to receive such a certificate.



For the UK, tidal power could be a viable low-carbon energy source. As an island nation and with a wealth of the small archipelagos, the UK is well placed to both develop and exploit tidal power. This opportunity is enhanced by UK and EU commitments to increase the proportion of energy generated from renewable sources over the next decades.

Working with low speed turbines, with high torque and at sea, are all areas in which Rolls-Royce has extensive expertise through its substantial marine business. A key part of the turbine's power driver is core Rolls-Royce technology drawing on the company's marine propulsion and motion control heritage.

Rolls-Royce first became involved in the technology following an investment in 2008 in Tidal Generation Limited, a company started a year earlier by a group of visionary entrepreneurs. It became a wholly owned subsidiary of Rolls-Royce in 2009 as the potential of TGL's technology and the synergy with existing Rolls-Royce expertise became obvious. Rolls-Royce aims to be one of the leading players in a market with the worldwide potential to be generating in excess of 40GW of electricity post-2020. It believes it has the design and technology to achieve such a position.

But the market is still in its infancy. Achieving the 40GW goal not only involves successful technological development but also the right long term tariff structure for electricity. Stevenson believes that, at a similar stage of maturity, tidal stream has the capacity to be cost competitive with offshore wind. Long term tariffs encourage manufacturers to invest in development and so reduce production costs.

With such investment the UK has the potential to be a leader in designing and developing this technology. Investment will also contribute to UK government plans to reduce carbon emissions by 2020. The entry into the marketplace of large companies like Rolls-Royce and others is essential to give confidence to government and prospective operators of tidal arrays that the technology has commercial potential.

The next step is the development and deployment of the next generation of demonstrator, a 1MW turbine, supported by the Energy Technologies Institute (ETI) ReDAPT project, in early 2012. By the middle of the decade the company plans, alongside other competitors, to provide a 10MW array – comprising ten 1MW machines. At this point the company believes it will be getting close to having a commercial offer – tried and tested equipment that it can guarantee. Such an array needs to be supported by government both through enhanced tariffs and capital investment. This will address the inevitable issues that developers of the first devices are bound to encounter.

According to Stevenson, 'This industry is very new – it's not a commercial business as yet. How it develops will ultimately depend on the actions we take and the actions of others, particularly the UK government. We are confident we've developed a device that works. We will use our core engineering skills to reduce costs and continuously improve performance to be one of the key players in the market.'

KEY FACTS BOX

Weight: 135 tonnes Net buoyancy: 6.6 tonnes Rotor diameter: 18m
Turbine length: 21m Turbine width: 2.6m to 3.5m Turbine height: 4.5m
Installed water depth: 35m to 80m Water speed at rated power: 2.7m/s
Cut-in velocity: 1m/s Maximum operating water speed: 3.4m/s
Power exported via subsea cable to grid at 6.6kV

Author: Simon Kirby is part of the Rolls-Royce communications team in Derby. He has previously worked in communications roles across the public sector.