energy technologies institute

An ETI Perspective

The role of tidal energy in a future UK low carbon energy system

ETI10 TEN YEARS OF INNOVATION 2007 — 2017

WHAT IS TIDAL ENERGY

Tidal energy is a form of hydropower that converts the energy obtained from tides into useful forms of power, mainly electricity, offering low risk and zero emissions energy. Tidal stream is a reliable and predictable low carbon energy source, and there is sufficient energy resource in UK waters, if it can be economically exploited, to make a material contribution to a future low carbon UK energy system.

HOW DO YOU CONVERT TIDAL ENERGY?

Tidal energy is produced through the use of tidal energy generators. These large underwater turbines are positioned in areas with high tidal movements and are designed to capture the kinetic motion of the ebbing and surging of ocean tides to produce electricity. The design of tidal turbines are very much like underwater windmills and the rotors are driven by consistent fast moving currents. These submerged rotors harness the power of marine tidal currents to drive generators which in turn produce electricity.

As water is denser than air, tidal turbines can be much smaller than wind turbines which means they can be deployed closer to each other. Any marine energy convertor requires engineering solutions which work in the harshest of environments presenting a unique set of engineering challenges in terms of design, installation and maintenance.

TIDAL ENERGY CONVERTOR SYSTEM DEMONSTRATION PROJECT

Launched in 2012 this ETI project has focused on design, innovation and optimisation of an array-scale coordinated collection of turbines. Over 40 supply chain companies contributed their knowledge to the project. The aim is to demonstrate a clear and verifiable route to delivering a 2020 cost of energy and performance target of £100-200/MWh for marine energy generation as identified in the ETI/UK Energy Research Centre Marine Roadmap, which was created to identify and prioritise the key technology and deployment issues faced by the marine energy sector in the UK.

Led by Atlantis Resources Corporation, with Black & Veatch acting as technical advisors and Lockheed Martin as system engineering integrators, the project has focused on using generic horizontal axis tidal turbines as the building block design for the array. It has specifically considered array designs of 10MW or larger and included a range of different tidal environments.

From the work undertaken, the first phase of the project concluded that the optimal tidal array design is likely to comprise of:

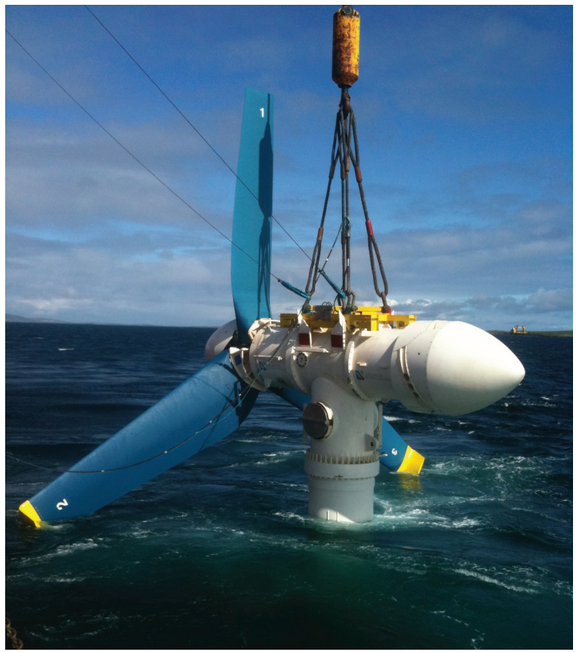
- A foundation structure which helps improve array energy yield
- Two turbine nacelles per foundation to reduce capital costs and marine operations
- Variable pitch blades to provide good driveline control and energy yield
- Three blades per hub to allow the best energy yield, driveline costs, control and safety

When reviewing optimal device design the analysis concluded it should contain:

- A gear-driven medium-speed generator to keep mass, risk and costs down
- Sub-sea power conditioning and conversion (rather than incorporated into each individual nacelle)
- An innovative automated dynamic-positioning intervention system to allow for safe and reliable installation, recovery and maintenance

Key insights from the project work highlighted that device cost reduction will not deliver the targeted cost of energy. For this to happen array-scale system engineering solutions are essential. The industry supply chain also has a major role to play in delivering the potential value of tidal energy. Fortunately much of this required skill set and capability already exists or could be easily developed in the UK. From the design work undertaken in this project, approximately 80% of the features and innovation required to proceed are low risk and are ready for implementation. However uncertainty needs to be considered and assessed when making optimisation choices and establishing likely energy costs.

In the late summer of 2014, the ETI began phase two of the project to design, build and test a multi-turbine foundation structure where two 1.5MW turbines will be installed on a foundation structure at the Atlantis Resources owned MeyGen tidal stream array in Pentland Firth, Scotland. Atlantis are developing an ETI patented innovative and cost effective turbine foundation design as a result of the work undertaken in the first phase of the project. This second phase of the project will run in three stages commencing with the detailed design, fabrication and installation of the structure and its associated technologies with Atlantis responsible for the turbine supply and electrical connection to the local grid.



THE MEYGEN PROJECT

MeyGen is located in the Inner Sound of the Pentland Firth, the body of water that separates the north Scottish mainland from Stroma Island. The Inner Sound has an excellent tidal resource with maximum current speeds of up to five metres per second and has good water depth and access to the grid. It is the world's largest tidal stream project currently under construction and by the early 2020's MeyGen Ltd intends to deploy up to 398MW of offshore tidal stream turbines to supply clean and renewable electricity to the UK grid.

THE OPPORTUNITY FOR TIDAL ENERGY IN THE UK

The value of tidal energy from a national energy system perspective is that it is a reliable and predictable source, but conversion from tide to electricity remains expensive. Work on this project and other marine energy studies undertaken by the ETI indicate that tidal stream has the potential to compete with other low carbon sources in the coming decades. The innovations needed to drive cost down further are known and industry now needs to put them together in an efficient system.

The UK has some of the most powerful tidal waters in the world but the further challenge is that most of these are a long way from the end consumer so it will be important to consider opportunities to match generation sites with local as well as national loads - seeking effective integration with local distribution grid demand as well as through the national transmission grid.

The MeyGen project aims to deliver the first large scale tidal array in the UK. The investor confidence boost that success of this project should provide means that the success of this project is critical to the whole UK tidal power industry.

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