Deep Green technology could potentially double the tidal power market’s potential, reduce the cost of energy by up to 60% and decrease the weight per installed MW by at least 20 times compared to other tidal energy converters.

The PowerKite project

The EU H2020 PowerKite project has a budget of €5.1 million and brings together nine partners from three countries. Over 30 months, this state-of-the-art project will make advances in several fields: PTO modelling, electrical design, mechanical design, data acquisition, analysis and optimisation. Alongside the funding from the EU, SSPA is also receiving support from Region Västra Götaland (VGR) for parts of its work to develop the turbine.

The overall objectives of the PowerKite project are:

• to gather experience in open sea conditions;
• to enhance the structural and power performance of the PTO for a next generation tidal energy converter;
• to ensure high survivability, reliability and performance as well as a low environmental impact and competitive cost of energy in the (future) commercial phases.

Developing the next generation of renewable electricity technologies

The Deep Green subsea tidal kite consists of a kite (wing) which carries a turbine and a nacelle. By means of a rudder and servo and control systems, the kite is steered in its predefined trajectory. The struts are connected to the tether, i.e. the mooring line that attaches the kite to a mooring point fastened to a foundation on the seabed.

The core innovation of the PowerKite project resides in the electro-mechanical design of the PTO, which allows the array to be deployed in sites with low velocity currents. The project will develop components for the turbine, generator, seabed power electronics, array transformer and subsea export cable. Open sea trials will play a crucial role in the project as the deployment of the first full-scale Deep Green prototype will allow extensive offshore data to be collected for the PTO system.

A site has already been selected and development and preparation for the installation are underway in Holyhead Deep, located 7 km off the shore of Anglesey, Wales. Holyhead Deep is 80–90 metres deep and has tidal current veloci-
SSPA and ocean energy
SSPA has been involved in various projects related to ocean energy. SSPA’s three major test facilities are also utilised in the model testing of various marine energy converters that use waves and current water. SSPA is working in several areas relating to ocean energy such as risk analyses before establishment, biofouling and countermeasures, reliable measurement methodology, wave measurement, hydrodynamic calculations and simulations. CFD is used by SSPA to study hydrodynamic effects as a stand-alone tool or in combination with testing. SSPA also has extensive experience in the numerical modelling of hydrodynamic noise from ship propellers, which could be put to use for the current power turbine, as well as experience in measurements at sea of underwater radiated noise. A rigorous testing campaign of Minesto’s Deep Green subsea kite was conducted in model scale at multiple stages in SSPA’s towing tank and cavitation tunnel. The technique has since been refined and adjusted before the prototype testing in open sea started.

Turbine sub-system
The main part of SSPA’s project work are within the following areas:
- Modelling and Simulations
- Offshore Measurements and Data Collection
- Sub-system Development and Laboratory Tests

SSPA’s contribution aims to design an improved turbine for the second and third generation full-scale power plants by using both advanced CFD models and physical model tests in the cavitation tunnel. SSPA will also take part in “open-sea” tests of the quarter-scale power plant in Strangford Lough, Northern Ireland. The project also plans to collect feedback from the first full-scale Deep Green power plant that will be installed during the next few years.

Deep Green’s turbine works in complex operating conditions that are very different from most known operating environments. The variability of pressure, speed, inflow angle and torque load that are part of the operating envelope for the Deep Green turbine pose a considerable design challenge.

In designing an optimal turbine for Deep Green, many factors need to be taken into account. Lifetime cost, robustness against collisions with floating debris, resistance against corrosion, ease of maintenance, emitted noise, captured power and matching the generator to the frequency converter are among the more prominent considerations.

The two main design alternatives are a ducted turbine and an open turbine. Both of these turbines have been tested in the SSPA cavitation tunnel. By way of previous designs and testing iterations, the concept has arrived at a preliminary design that does not cavitate and provides acceptable performance.

The turbine will be mathematically modelled and simulated so as to take into account the variability of pressure, speed, inflow angle, torque load and the effect of these factors on its rotational speed. The design work requires several steps: development/adaption of design tools, parametric optimisation and CFD analysis of design. The last two steps are part of an iterative process where the feedback from model tests will be used to improve the design further.

Read more at: powerkite-project.eu

Minesto
Minesto was spun out from Saab Group in 2007 and has successfully carried out the technological development of Deep Green technology ever since. This technology is designed to produce electricity from low-velocity tidal and ocean currents. Minesto AB has about 40 employees in Gothenburg, Sweden; Holyhead, Wales; and Portaferry, Northern Ireland. Minesto has been awarded a lease agreement from the Crown Estate for an installation site of a 10 MW array in Holyhead Deep off the coast of Anglesey. In May 2015, Minesto secured, via the Welsh European Funding Office, a €13 million investment from the European Regional Development Fund for the commercial rollout of Deep Green.

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