METHODOLOGY FOR TIDAL ENERGY RESOURCE ESTIMATION AND EXPLOITABILITY: QSAIL APPROACH

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A study of the potential for ocean energies in the southern Spanish region of Andalucía is reported, using state-of-the-art methods for characterization of the resources and a comprehensive analysis of the technology status in this emerging field. The study shows that the tidal/marine current potential in the Straits of Gibraltar is a world-class resource, with a theoretical power capacity of up to 7 Gigawatt, GW. Even if only a small fraction of the resource can be extracted, as is likely, it would still rank among the most important sites in the world for tidal/marine current energy. It is considered that this resource, combined with proximity to the grid and to major power consumers, could be large enough to attract companies to customize or develop novel technological solutions for the resource.
A detailed physical and bathymetric description for the entire coast of Andalusia has been created, drawing on scientific competence at the University of Cadiz, Department of Physical Oceanography.

The results obtained were
1. Mapping of the tidal current resource.
2. Technological and non- technological determining factors;
3. Review of energy conversion technologies and maturity.
4. Applicable legislation and regulations.
5. Techno-economic viability methodology and case study.
6. Potential for Andalucía's economic development.

The mean peak current distribution map obtained for the Straits is seen on Fig. 1. The areas of concentrated energy are clearly seen and are caused by a complex interaction of the outflow (westwards) of the colder and denser deep Mediterranean waters and the tidally influenced flow of the warmer Atlantic surface waters, both in turn being controlled by the complex bathymetry.
The energy in marine currents depends on velocity to the third power, P ~ Vc3; thus, accurate and localised measurements of flow are required in order to estimate the energy that can actually be extracted. Most converters under are designed for flows of more than 2 m/s, however, very large water areas in the Straits are flowing at velocities of 1.5 m/s or higher, so there should be many locations to consider for ultimate commercial installations.

EnerOcean has verified with the help of University of Cádiz that the models are accurate and that the values for selected places are in line with these verifications into the Q-Sail project.
Among the other technological determining factors for tidal/marine currents, the range of depths and the slope and nature of the seabed were found important. Various non-technological determining factors need to be taken into account as well, such as protected areas, shipping, fisheries and other uses of maritime space, undersea cables, pipelines etc. For the Straits, detailed sea-use maps have been prepared to show the location of such complementary activities and aid in delineating possible exploitable sites.
For a case study, a site was identified near (but not inside) one of the most concentrated areas, which is outside of all natural parks, fishing zones and maritime traffic routes. The sea bed here is rocky, relatively flat, and the modelled tidal currents show modest velocities but with a favourable directionality.
A model was created for techno-economic analysis of tidal current installations, and used for the site and a hypothetical installation of a novel technology. This case study illustrates the possibility for developing a tidal site in the Straits of a commercial value comparable to other renewable energy sources. In addition, tidal power is predictable years in advance and so has better dispatchability than most other renewable sources such as wind or solar.
Finally and as a method to simplify the application of this methodology to different sites around the World, in this paper a simple method for tidal current modelling in short length convergent elongated channels is presented. The authors have found that for this kind of channels a very suitable approach to tidal current velocity estimation can be obtained through a very simple formulae. This method has been developed to obtain reliable along channel tidal current velocity estimations using as less information as possible. In fact, the only necessary information to apply this method are the harmonic constants of the tidal elevation at any location in the channel and a proper nautical chart. We present a graphical method to inquire when the geometrical characteristics of a given channel allow the application of our approach.
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