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Estimation of the tidal energy potential in the Scheldt estuary using a three-dimensional unstructured hydrodynamic model

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The objective of this work is to assess the tidal stream energy potential in the Scheldt estuary, through the application of technical specifications from the International Electrotechnical Commission (IEC). The IEC TS 62600-201:2015 establishes a system for analysing and reporting, through estimation or direct measurement, the theoretical tidal current energy resource in oceanic areas including estuaries.

Velocity distribution at the potential deployment site is examined using a high-resolution three-dimensional model of the ocean currents based on the TELEMAC system. The mesh size ranges from 400 m at the mouth of the estuary to 50 m near the potential pilot sites. The unstructured mesh size allows a realistic representation of the detailed bathymetric features, the narrow straits and channels where the most intense currents are. The model is forced at the lateral boundaries with sea surface elevation predicted by the global tidal model Finite Element Solution 2012 (FES 2012) and the river flow from the Scheldt River. The model is calibrated using public data obtained from water level measurements at the ports of Vlissingen, Breskens and Cadzand.

The velocity magnitude and direction calculated over one month at the pilot site are extrapolated over a year by means of a harmonic analysis. At the depth of the tidal current turbine (-2.5m below the sea level), the annual mean of the velocity magnitude is 0.7 m/s with a maximum of 1.6 m/s for the selected pilot site. Velocity magnitudes are in the range of 0.5 to 1 m/s for 54.9% of the time, and above 1 m/s for 17.7% of the time. There are two prevailing directions for the water flow: 47% of current velocity is eastward (direction 70°-90°N) and 46% is westward (direction 250°-260°N). The expected annual energy production is calculated using the modelled velocity distribution and the technical characteristics of the vertical axis water turbine developed by Water2Energy.

The results of this analysis shows that the site has limited potential in terms of energy production. However, the site could still be relevant as a pilot demonstration site for shorter durations. The analysis based on IEC technical specifications will be useful for the identification and comparison of more energetic sites in the future. Also, this results provides feedback to the IEC on the usability of the technical specification for improvements.

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