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1. Introduction

Description: Report with recommendations for procedures adaptation to 62600-200 Power performance assessment.

This report describes the methodology used by EMEC to derive recommendations on the suitability and usability of the 62600-200 TS for power performance assessment of inshore tidal stream turbines using the Tocardo T2Si turbine installation at Oosterschelde as a case study.

2. References

- /1/ IEC TS 62600-200, Part 200: Electricity producing tidal energy converters - Power performance assessment
- /2/ IEC TS 62600-201, Part 201: Tidal energy resource assessment and characterization
- /3/ 2016R0076 - OTP Yield Performance Check - Tocardo
- /4/ 2012M0045 - Method of calculation of annual energy yield - Tocardo

3. Methodology - 62600-200 Power performance assessment

Tocardo provided EMEC with internal documentation on the performance assessment carried out by Tocardo on their T2Si installation at Oosterschelde (Ref. /3/ and Ref. /4/). EMEC have reviewed this documentation alongside EMEC's own internal performance assessment validation documentation against the 62600-200 TS to identify gaps and variations in the processes, and recommendations based upon these evaluations.

3.1. Review scope

3.1.1. T2Si performance assessment

The performance assessment carried out by Tocardo was an internal document (Ref. /3/) and did not make reference to the IEC 62600-200 TS, therefore there are many areas of the document not compliant with the recommended methodology. For the purposes of the recommendations in this document, the variations are described and the reasons given by Tocardo for these variations are explored to determine if the IEC methodology would have been feasible in this context.

4. Technical requirements

4.1. Comparison

The Tocardo performance assessment process used for the Tocardo Oosterschelde deployment is compared to the TS 62600-200 below and will be used to outline the recommendations regarding the TS 62600-200 later in this document.

62600-200	Tocado performance assessment	Comments
1.Scope/2.Normative references/3.Terms and definitions/4.Symbols, units and abbreviations		
5.Site and test conditions	<p>Bathymetry surveys and analysis of obstacles not reported, the main disrupting feature being the dam structure in which the turbines are deployed.</p> <p>Flow conditions measured before deployment, mainly to validate numerical modelling of the flow. Directionality of flow not reported. Equipment used and calibration of equipment not reported. Separate surveying for resource assessment and model validation was not carried out.</p> <p>The nature of the deployment does not meet the requirements for test site constraints, in both performance enhancing features, and operational constraints.</p>	<p>Requirement for free-stream conditions, or representative site unfeasible for a deployment of this type.</p> <p>A methodology for flow characterisation is proposed within the supporting documents, further investigation into the suitability of these methods is required.</p>
6.Tidal energy converter (TEC) description	Details of turbine under test are not presented. A modelled power curve showing rated power is included.	
7.Test equipment	<p>Details of equipment used and calibration for electrical power measurement are not presented.</p> <p>Tidal flow data was not directly measured during performance assessment, flow speeds were derived from a numerical model using measured head heights either side of the barrier, equipment used for these measurements and calibrations not presented, details of flow speed modelling presented in separate document.</p>	Feasibility of using numerical model requires further investigation.
8.Measurement procedures	<p>Testing period chosen falls short of 15 days minimum.</p> <p>Calibration of equipment is not presented.</p>	The report suggests that in this situation it is necessary to further split the flood ebb tides into increasing/decreasing.

62600-200	Tocado performance assessment	Comments
	<p>Data is filtered when current speed is out with normal operating limits (above stall speed).</p> <p>Data measurement quality thresholds not presented.</p> <p>Data split on flood-increasing, flood decreasing, ebb increasing, ebb decreasing rather than solely flood and ebb tides.</p> <p>Incident resource not directly measured, single value for current flow used, not integrated across turbine area.</p> <p>Turbulence and wave effects not mentioned.</p>	<p>Difficulty encountered with the feasibility of ADCP measurements being used for performance assessment during turbine deployment, spatial variability of flow very high due to nature of flow around structure, requires further investigation into proximity of measurement required for accurate results.</p>
9.Derived results	<p>Measurements of salinity and temperature not carried out.</p> <p>Data was filtered in post-processing.</p> <p>Method of bins not fully applied due to lack of ADCP measurement.</p> <p>Uncertainty calculations were not mentioned.</p> <p>Power presented as a single value rather than value with standard deviation.</p> <p>Velocity vertical shear profiles not calculated.</p> <p>Power curve presented against head difference measurement rather than velocity.</p> <p>TEC overall efficiency not calculated.</p>	<p>Most variations could be avoided with existing techniques, excepting the ADCP deployment issue covered earlier.</p>
10.Reporting format	<p>Detailed description of turbine not presented.</p> <p>TEC site report not presented.</p> <p>Grid report not presented.</p> <p>Test equipment report not presented.</p> <p>Power curves presented against head difference not velocity and no uncertainty bars calculated or plotted.</p>	

TABLE 1 - CONTENT COMPARISON BETWEEN 62600-200 AND TOCARDO PERFORMANCE ASSESSMENT

5. Main observations and recommendations

5.1. Technical requirements

Considering the comments in Table 1 - Content comparison between TS 62600-200 and the Tocado performance assessment document (*Ref. /3/*), the main comments and recommendations are presented below.

- An expectation of free stream velocity measurements is not feasible for this type of deployment.
- The main variations derive from difficulty in making flow speed measurements while turbines are deployed in the structure, the spatial variability of current flow is very high, so a suitable point for simultaneous resource measurement close enough to the turbine is hard to define.
- This report suggests that resource/power performance studies at this type of site can be achieved using modelled velocities derived from the known head differences at the dam, provided that a correlation with velocity measurements is performed.
- It is crucial that the correlation velocities are obtained from the planned turbine location, as there are very localised funnelling effects through the dam.
- The report suggests that separate correlations are required for increasing and decreasing head differences, as well as flood and ebb tides for this kind of deployment.
- Individual modelled velocity correlations must be carried out for each individual turbine in the case of an array deployment, due to the high spatial variability.
- It is recommended that higher spatial resolution velocity measurements than currently recommended are to be carried out as part of the site/resource assessment phase of the performance assessment.
- When a period of operation was chosen when no interruptions due to regulations were experienced, there is a close agreement between simulated and actual power generated.