IEC TS 62600-101

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TECHNICAL SPECIFICATION

colour inside

Marine energy – Wave, tidal and other water current converters – Part 101: Wave energy resource assessment and characterization

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MARINE ENERGY – WAVE, TIDAL AND OTHER WATER CURRENT CONVERTERS –

Part 101: Wave energy resource assessment and characterization

FOREWORD

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IEC TS 62600-101 has been prepared by IEC technical committee 114: Marine energy – Wave, tidal and other water current converters. It is a Technical Specification.

This second edition cancels and replaces the first edition published in 2015. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) Incorporation of annual energy production (AEP), formerly detailed in IEC TS 62600-102, as Annex A in this document and in IEC TS 62600-100.
b) Modification to the list of terms and abbreviations

The text of this Technical Specification is based on the following documents:

Draft	Report on voting
114/539/DTS	114/555/RVDTS

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this Technical Specification is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 62600 series, published under the general title *Marine energy – Wave, tidal and other water current converters*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

This document provides a uniform methodology that will ensure consistency, accuracy and reproducibility in the estimation, measurement, and analysis of the wave energy resource at sites that could be suitable for the installation of Wave Energy Converters (WECs), together with defining a standardised methodology with which this resource can be described. This document, when used in conjunction with other Technical Specifications in this series (IEC TS 62600), is intended for several types of users, including but not limited to the following:

- Project developers and investors to accurately and fairly estimate resource availability and mean annual energy production at a potential project site for income or return on investment calculations.
- Device developers striving to accurately estimate and report potential device performance, or recommend a particular device design to a project developer, given specific site conditions.
- Utilities and owners or operators in calculating reliability and predictability of power supply, as well as return on investment.
- Policy-makers, planners, and regulators who are concerned with accurately planning usage of seascape among stakeholders, optimisation of resources, and power supply issues.
- Consultants involved in producing resource data and conducting due diligence studies, who require a standard, compatible, and readable data format.

Application by all parties of the methodologies recommended in this document will ensure that continuing resource assessment of potential development sites is undertaken in a consistent and accurate manner. This document presents techniques that are expected to provide fair and suitably accurate results that can be replicated by others.

The wave energy resource is primarily defined using hydrodynamic models that are successfully validated against measured data. This document deals directly with the theoretical resource and the main focus of the defined methodology is to generate the resource information required to estimate annual energy production. The capture width of a WEC is estimated using the methodology presented in IEC TS 62600-100. Then, using the capture width information, in conjunction with the resource information generated with the methodology described in this document, the methodology in Annex A is used to calculate annual energy production. A framework for estimating the uncertainty of the wave energy resource estimates is also provided in Annex B.

The development of the wave power industry is at an early stage and the significance of particular wave energy resource characteristics is poorly understood. Because of this, the present document is designated as a Technical Specification and will be subject to change as more data is collected and experience with wave energy conversion develops.

An essential element for any published Technical Specification or International Standard is to allow an opportunity to provide feedback on its contents to the appropriate TC 114 Working Group. TC 114 utilizes a standard methodology to allow this. To submit feedback such as proposed changes, corrections and/or improvements to this document, please send an email to the TC 114 Chair using the Contact TC 114 Officers feature on the IEC TC 114 Dashboard, accessible at www.iec.ch/tc114. On the right side of the Dashboard under Further information select the link to contact the TC 114 Officers. On the subsequent page find and select the Send Email link for the Chair to access the email tool.

Complete all the required elements within the email pop-up. For the Subject field please include the document title and edition you are providing feedback for (ex: Feedback for TS 62600-1 ED2). In the Message field, include text which summarizes your feedback and note if further information can be made available (note attachments are not allowed). The Chair may request added information as needed before forwarding the submission to the remaining TC 114 Officers for review and then to the appropriate Working Group for their consideration.

MARINE ENERGY – WAVE, TIDAL AND OTHER WATER CURRENT CONVERTERS –

Part 101: Wave energy resource assessment and characterization

1 Scope

This part of IEC 62600 establishes a system for estimating, analysing and reporting the wave energy resource at sites potentially suitable for the installation of Wave Energy Converters (WECs). This document is to be applied at all stages of site assessment, from initial investigations to detailed project design. This document is to be applied in conjunction with the IEC Technical Specification on WEC performance (IEC TS 62600-100) to estimate the mean annual energy production of a WEC or WEC array as described in the methodology in Annex A. This document is not intended for estimation of extreme wave conditions.

The wave energy resource is primarily defined using hydrodynamic models that are successfully validated against measurements. The framework and methodologies prescribed in this document are intended to ensure that only adequate models are used, and that they are applied in an appropriate manner to ensure confidence and consistency in the reported results. Moreover, the document prescribes methods for analysing metocean data (including the data generated by modelling) in order to properly quantify and characterize the temporal and spatial attributes of the wave energy resource, and for reporting the results of a resource assessment in a comprehensive and consistent manner.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC TS 62600-100:—, *Marine energy – Wave, tidal and other water current converters – Part 100: Electricity producing wave energy converters – Power performance assessment*[1]

IEC/ISO Guide 98-3:2008, *Guide to the expression of uncertainty of measurement*

IHO (International Hydrographic Organisation), 2008, *Standards for Hydrographic Surveys*, Special Publication No. 44, 5th Edition

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

[1] Under preparation. Stage at the time of publication: IEC/DTS 62600-100:2024.

4 Symbols and abbreviated terms

For the purposes of this document, the following symbols and units apply.

The results of the resource assessment shall be presented in accordance with the SI system of units. Results can also be presented in terms of an alternative system of units if desired.

Symbol	Definition	Units
$c_{g,i}$	group velocity of the i^{th} discrete frequency	[m/s]
C_W	capture width	[m]
$C_{W,i}$	discrete capture width	[m]
d	directionality coefficient	
f_i	i^{th} discrete frequency	[Hz]
f_p	peak frequency	[Hz]
g	acceleration due to gravity	[m/s^2]
h	water depth	[m]
H_{m0}	spectrally estimated significant wave height	[m]
J	omni-directional wave power	[W/m]
J_θ	wave power resolved along the direction θ	[W/m]
$J_{\theta_{Jmax}}$	maximum directionally resolved wave power	[W/m]
k_i	wave number associated with the i^{th} discrete frequency	[m^{-1}]
m_n	spectral moment of n^{th} order	[m^{2}s^{-n}]
n	number of sea states	-
$MV(p)$	monthly variability statistic of parameter, p	
s	directional spreading parameter	
S_i	variance density over the i^{th} discrete frequency	[m^2/Hz]
S_{ij}	variance density over the i^{th} discrete frequency and j^{th} discrete direction	[m^2/Hz/rad]
T_{02}	spectrally estimated average zero-crossing wave period.	[s]
T_e	spectrally defined energy period (also written as T_{-10})	[s]
T_p	peak wave period	[s]
T_z	average zero-crossing wave period	[s]
δ	factor insuring that only positive components are summed	
Δf_i	frequency width of the variance density of the i^{th} discrete frequency	[Hz]

Symbol	Definition	Units
$\Delta\theta_j$	angular width of the variance density of the j^{th} discrete direction	[rad]
$\grave{o}_0$	spectral width	
ρ	reference sea water density	[kg/m^3]
θ	direction of wave propagation	[deg]
$\theta_{J\max}$	direction of maximum directionally resolved wave power	[deg]
φ	geographical latitude	[rad]

5 Classes of resource assessment

5.1 General

This document is intended to be applied across a range of resource assessment study types, from reconnaissance studies spanning a large region to detailed design studies focused on a specific site. The procedure to be followed when undertaking an assessment of the wave energy resource depends on the stage of the study and the study objectives.

Three distinct classes of resource assessments are indicated in Table 1. A Reconnaissance (Class 1) resource assessment is most suitable for application over large areas of seascape and would typically be the first resource assessment conducted in an area. A Feasibility (Class 2) resource assessment is most suitable for refinement of a Reconnaissance resource assessment prior to undertaking a design resource assessment. A design (Class 3) resource assessment is most suitable for application over small areas of seascape and is typically the final and most detailed assessment conducted for a particular project.

The user shall declare the class of resource assessment being undertaken and shall follow the appropriate procedures prescribed herein.

Table 1 – Classes of resource assessment

Class	Description	Uncertainty of wave energy resource parameter estimation	Typical long-shore extent
Class 1	Reconnaissance	High	Greater than 300 km
Class 2	Feasibility	Medium	20 km to 500 km
Class 3	Design	Low	Less than 25 km

NOTE Information on typical extent is provided for guidance only. The class of resource assessment depends on the degree of certainty required, not on the extent or size of the study area.

The results and outputs from previous resource assessment studies can be considered for use as boundary conditions in more detailed studies. As the project progresses through a number of development stages, the wave energy propagation model and its application should be refined such that the uncertainty of the resource estimation decreases. The following factors can reduce uncertainty:

- use of more capable models that include more accurate representation of the physical processes, as outlined in Table 5 in 7.2;
- finer discretization in frequency, direction, space and time;

- use of more realistic boundary conditions and system forcing (winds, currents, etc.);
- availability of additional measurements for model validation; and
- modelling longer durations.

5.2 Resource assessment and characterization flow chart

The flowchart in Figure 1 depicts the general methodology outlined in this document. Different procedures are to be followed depending on the class of the resource assessment. For Class 1 studies, the resource assessment can be based either on:

a) analysis of existing archived sea state parameters, provided they were generated using a methodology consistent with the requirements for Class 1 studies set forth herein, or
b) analysis of directional spectra generated through the application of a numerical wave propagation model in a manner consistent with the requirements for Class 1 studies set forth herein, or
c) application of Measure-Correlate-Predict (MCP) methods as specified in Clause 8.

For Class 2 and Class 3 studies, the assessment shall be based on either:

d) analysis of directional wave spectra generated through the application of a numerical wave propagation model in a manner consistent with the requirements for Class 2 or Class 3 studies set forth herein, or
e) application of MCP methods as specified in Clause 8.

Regardless of assessment class, the numerical model used to generate the directional wave spectra spanning space and time shall be appropriate for the task, configured in an appropriate manner, and successfully validated against measured oceanographic data. The boundary conditions and source terms (i.e. wind, wave or tidal fields) used to force the numerical model shall also be suitable and verified.