ACCELERATING MARINE ENERGY COMMERCIALIZATION THROUGH STANDARDS AND CERTIFICATION DEVELOPMENT

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STANDARDS AND CERTIFICATION AS DRIVERS

Previous writings and presentations from these authors, among others, have introduced the critical role of consensus-based standards and certification (including testing) for the commercial success of the marine energy industry [1, 2, 3, 4].

As described, a review of nearly every robust, global market, including personal electronics, household appliances, medical devices, aviation/aerospace, and ultimately the growing marine energy industry, will show a solid foundation of International Standards and Conformity Assessment (certification) activities.

The wind energy industry serves as a highly relevant and enlightening example of the critical role that standards and certification play in the growth and acceptance of its product in the global market. Figure 1, used by the wind energy industry, superimposes key milestones related to standards and certification over the development path of the wind turbine rotor diameter. A similar relationship is seen with installed global capacity of wind, reaching 486.8 GW in 2016 [5].

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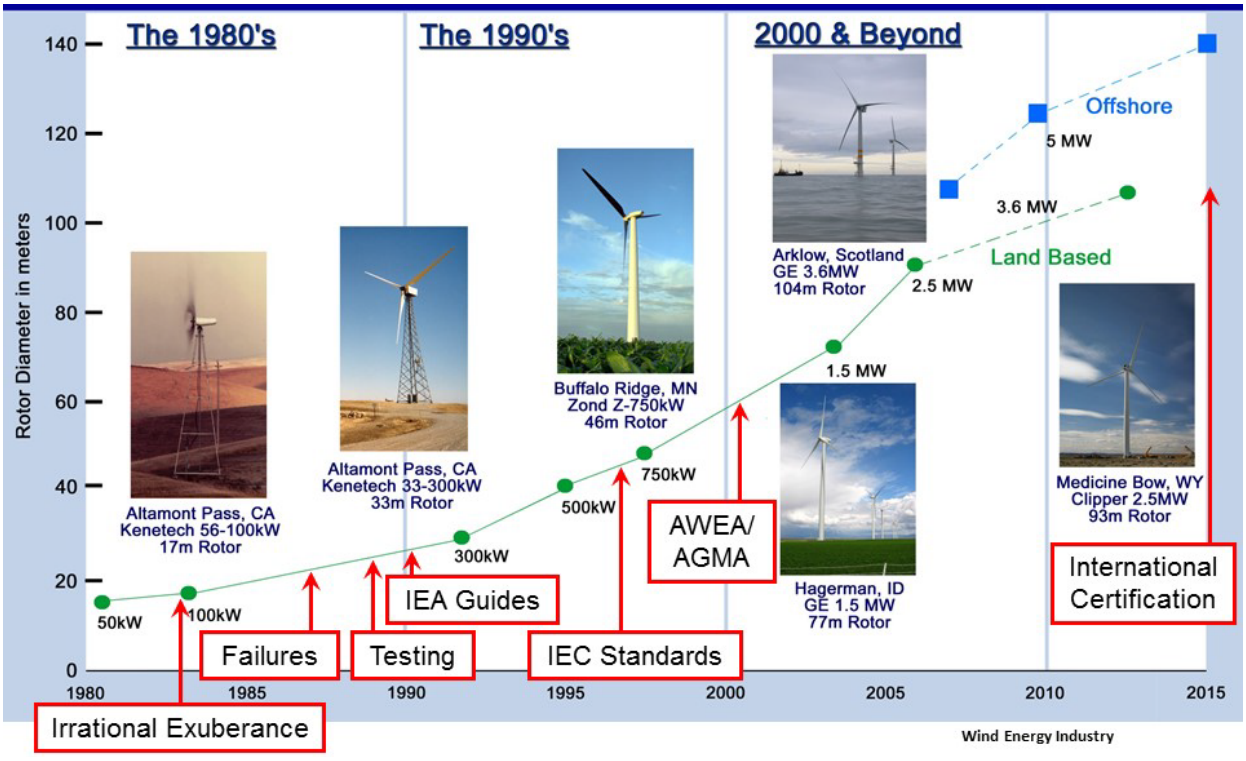

FIGURE 1. WIND ENERGY GROWTH AND THE ROLE OF STANDARDS AND CERTIFICATION

As seen in Figure 1, the first International Energy Agency (IEA) guides for wind energy were introduced in the early 1990s, followed by the first International Electrotechnical Commission (IEC) standards later in the 1990s. The parent Technical Committee (TC), IEC/TC 88 (Wind energy generation systems), was formed in 1988. The joint working group between the American Wind Energy Association (AWEA) and the American Gearbox Manufacturers Association (AGMA) produced a key gearbox standard for wind turbines in the early 2000s. Certification activities continued thereafter at the national level, in parallel with the development of national regulatory requirements, and in 2016 the first international certificate was issued, under the newly formed IEC System for Certification to Standards Relating to Equipment for use in Renewable Energy Applications (IECRE). Clearly, the development and implementation of standards and certification supported the rapid growth and commercialization of the wind energy industry.

In comparison, early guides for marine energy were published by the European Marine Energy Centre (EMEC) in 2009 and EquiMar in 2011. IEC/TC 114 (Marine energy – wave, tidal and other water current converters) was formed in 2007. The first IEC/TC 114 Technical Specification (TS) was published in 2011 and significant work continued and is ongoing. International certification activity began in 2011 and the Marine Energy Operational Management Committee (ME-OMC) of the IECRE was formed in 2014.

As with the advancement of the wind industry, the continued commitment and engagement from the entire range of marine energy stakeholders to the development and implementation of International Standards, and the associated Conformity Assessment rules and procedures, is critical to the continued growth and commercialization of the industry at large.

A summary of the progress, activity and strategy for IEC/TC 114 and the ME-OMC are provided here, along with a discussion of the role of standards and certification in accelerating the advancement of the marine energy industry.

FIRST IEC/TC 114 TECHNICAL SPECIFICATIONS

Following the publication of the Terminology TS (62600-1, Ed. 1) in 2011, the next two TSs published were for the power performance assessment of electricity producing wave energy converters (WECs) and tidal energy converters (TECs), in 2012 and 2013 respectively. The WEC power performance assessment TS (62600-100, Ed. 1) outlines the test and measurement requirements to produce a normalized power matrix and, using resource assessment data, the annual energy production of a WEC at the specific test site. Similarly, the TEC power performance assessment TS (62600-200, Ed. 1) outlines the test and measurement requirements to produce a power curve, including a detailed framework for reporting results, and provides guidance for the calculation of annual energy production.

The two power performance assessment TSs are key to the marine energy industry as they enable a common comparison between various technologies at a given wave or tidal energy site. This common comparison enables project developers, investors, insurers, and perhaps regulators, to evaluate technology (devices) in an objective way, greatly reducing risk and uncertainty. Performance testing to standards is also a key component of the certification process; third-party verification of compliance to the power performance assessment standard is a mandatory component of Type Certification in the wind industry, for example.

In 2015, the wave energy (62600-101, Ed. 1) and tidal energy (62600-201, Ed. 1) resource assessment and characterization TSs were published. Estimates of key wave resource data, such as mean annual wave power, and tidal resource data, such as the annual velocity distribution, support improved estimates of annual energy production and reduce uncertainty. Key terms introduced throughout include the Theoretical, Technical and Practical Resource [6].

The "Design requirements for marine energy systems" TS (62600-2, Ed. 1) was published in 2016 and represented a key milestone in the progress of IEC/TC 114. Covering both wave and tidal energy converters, this fundamental document began the process of codifying the best practices necessary to design, operate, and maintain a marine energy converter. Used in conjunction with the moorings TS (62600-10, Ed. 1), these documents establish minimum loads analysis requirements, include safety factors for device designers, and serve as the basis for Certification Bodies to participate in the ME-OMC.

SIGNIFICANT IEC ACTIVITY ONGOING TODAY

At present, IEC/TC 114 has fifteen participating member (P-Member) countries[2] and eleven observer member (O-Member) countries on eight Project Teams (PTs), six Ad-hoc Groups

[2] Canada, China, Denmark, France, Germany, Iran, Ireland, Israel, Japan, Republic of Korea, Netherlands, Spain, Sweden, United Kingdom and United States

(AHGs), and two Maintenance Teams (MTs) engaged in writing new TSs, assessing incoming information on TS application, and preparing the published TSs for a 2nd Edition. To date, IEC/TC 114 has published eight TSs and five more are pending publication in 2018, as shown in Table 1.

Maintenance Team 1 (MT-1) is currently active updating the Terminology TS (62600-1, Ed. 1) to include new and updated terms from published TSs and to remove terms no longer appropriate (those commonly defined elsewhere, for example). MT-1 is also preparing marine energy terms to be uploaded to, and aligned with, those in the Electropedia, the IEC online electrical and electronic terminology database.

Maintenance Team 2 (MT-2) was established in 2016 immediately following the publication of the Design TS (62600-2, Ed. 1). The scope of MT-2 is to improve the document usability, ensure that safety levels are consistent with industry expectations, and to work to increase the applicability for third-party verification. MT-2 plans to issue a 2nd Edition TS by the end of 2018.

The existing AHGs are currently considering the next steps for the published TSs; a number of the groups are preparing to transition to MT and active document revision. It is anticipated that a 2nd Editions will be published before 2020 for many (if not all) of the existing TS documents. AHGs are also currently working to receive information from marine energy industry stakeholders on the application of each TS.

Sales statistics suggest that the TS documents are beginning to be used within the industry, however, feedback to the AHGs has been limited, likely due to the small number of full-scale, grid-connected marine energy deployments globally. Additional AHGs will be established to receive comments on new TSs as they are published.

The IECRE is currently comprised of 16 Member Bodies and operates three Sectors: Marine Energy (ME), Solar Photovoltaic (PV), Wind Energy (WE). Member Bodies, by definition, are "fully representative of the national conformity assessment community in RE equipment and should include wide representation from industry, regulatory authorities and standards bodies as well as conformity assessment interests [7]."

Each Sector is managed by an Operational Management Committee (OMC). At present, the ME-OMC has representation from six Member Bodies [3]. Each OMC is tasked with operating certification schemes appropriate for their industry and have the authority to form working groups to advance this task. The third meeting of the ME-OMC was held in Madrid, Spain in 2017. The fourth meeting will be held in March 2018 in Seattle, WA, USA. The ME Sector has three active WGs to support the development of marine energy specific certification deliverables, including Test Reports; Conformity Statements; and Prototype and Type Certificates; among others.

NEXT STEPS FOR IEC TC 114 AND THE ME-OMC

Beginning in 2018, IEC/TC 114 expects to publish a number of new TSs, as shown in Table 1. In addition to those mentioned, three active PTs are currently writing new TSs (Acoustic Characterization, Tidal Scale Testing, and Measurement of Mechanical Loads) and they will be published in 2019-2020. As described above, it is likely that a number of the published Ed. 1 TSs will be updated to Ed. 2 in the next two to three years. These updates will incorporate the feedback received since publication and resolve outstanding technical issues. AHG 8 was established under IEC/TC 114 to coordinate and facilitate the harmonization and alignment of all TSs published, including terminology, technical content and formatting agreement, among others.

Proposals for new TSs for development will be considered by IEC/TC 114 based on the guidance provided in the Strategic Business Plan [4] and the progress of activities on active PTs and MTs. A careful balance is necessary between pushing the pace of standards writing while considering the National Committee resources and the availability of the individual experts.

The ME-OMC is targeting the issuance of Renewable Energy Test Reports (RETR) to 62600-200 and 62600-100 in 2019. To achieve that goal, the ME Sector Rules of Procedure were approved in 2017, as were Operational Documents (ODs) for the issuance of Test Reports and Conformity Statements, the fundamental underpinnings of Certificates. Based on these approvals, the rules for the Peer Assessment of RE Certification Bodies (RECBs) and RE Test Laboratories (RETLs) are under development in advance of the issuance of scheme deliverables. An initial three-year transition period for test laboratory self-assessment based on ISO 17025 accreditation is under consideration to encourage initial RETL participation. At present, EMEC and NREL are the only known test laboratories accredited to ISO 17025 for full-scale wave and tidal testing with a scope in 62600-100 and 62600-200, among others TSs [8, 9].

In general, progress on the ME-OMC has been steady and methodical for a number of reasons:

[3] France, Japan, Netherlands, Spain, United Kingdom and United States

[4] The IEC/TC 114 Strategic Business Plan is available at www.iec.ch/tc114/

parallel development of IECRE System level rules, limited resources for members travel and engagement, relative inexperience with Conformity Assessment, ongoing TS development under IEC/TC 114, and a clear interest to track and learn from both the wind and solar industries as they develop certification products. Specifically, many of the IEC/TC 114 TSs are based on standards developed by the wind industry (IEC/TC 88) and the marine certification products may look similar to those developed by the WE Sector.

TABLE 1. PUBLISHED AND PENDING IEC/TC 114 TECHNICAL SPECIFICATIONS

Published:
IEC TS 62600-1:2011, Terminology
IEC TS 62600-2: 2016, Design requirements for marine energy systems
IEC TS 62600-10:2015, Assessment of mooring system for marine energy converters
IEC TS 62600-100:2012, Electricity producing WECs - Power performance assessment
IEC TS 62600-101 :2015, Wave energy resource assessment and characterization
IEC TS 62600-102: 2016, WEC power performance assessment at a second location using measured assessment data
IEC TS 62600-200:2013, Electricity producing TECs - Power performance assessment
IEC TS 62600-201:2015, Tidal energy resource assessment and characterization
Pending Publication (2018):
PT 62600-20 (OTEC)
PT 62600-30 (Power Quality)
PT 62600-103 (WEC Scale Testing)
PT 62600-300 (River Power Performance)
PT 62600-301 (River Resource Assessment)

CONCLUSIONS

The development of consensus-based standards, and their support of a global certification system, is critical to the success of the marine energy industry, reducing risk and increasing stakeholder confidence. In particular, the adoption of best practices outlined in International Standards (and Technical Specifications) enables the direct comparison of technologies for analysis by investors, insurers, and all other interested commercial parties.

It is critical that the terminology, processes and methodologies outlined in the published IEC/TC 114 documents are adopted and embraced by the marine energy industry. Feedback based on in situ application is critical to improve future editions and to ensure the reliable design and safe operation of marine energy converters.

Major challenges for IEC/TC 114 and the ME-OMC include constraints on funding and resources across the industry, leading to limited travel and member participation, both of which erode the ability to reach a true international consensus. Challenges outside of the industry, including political/economic volatility, are offset by encouraging developments in the global effort to offset climate change and success stories of marine energy deployments globally.

The success of the IEC/TC 114 and the ME-OMC efforts, as with the marine energy industry at large, depends on the long-term commitment of resources from all industry participants. As new standards are developed and existing standards refined, and as the certification products are accepted globally, the reliability, performance and safety of marine energy converters should increase significantly. The cost to enter global markets should also be reduced, ensuring a real return on the substantial investment required to develop and maintain these devices and projects, including the associated standards and certification products.

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