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D.7.5 – Report on the standardization landscape and applicable standards

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Glossary

CEN European Committee for Standardization

CENELEC (CLC) European Committee for Electrothecnical Standardization

EN European Standard

IEC International ElectrotechnicaCommission

ISO International Organization for Standardization; International Standard

MEC Marine Energy Converter

PAS Publicly Available Specification

PTO Power Take-Off (key component of the WECs)

SC Subcommittee

TC Technical Committee

TR Technical Report

TS Technical Specification

UNE Spanish Association for Standardization

WEC Wave Energy Converter

WG Working Group

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Executive summary

D7.5 "Report on the standardization landscape and applicable standards" collects the information on the state of the art in standardization relevant for SEA-TITAN. This analysis of the standardization landscape includes the information on the relevant standards (both, published and under-development) and the relevant standardization technical committees.

The objective of the deliverable is to provide the consortium with the proper knowledge of the standardization landscape at an early stage in order this information can be taken into account in the development of the different working packages as starting material, facilitating the use of existing knowledge and ensuring the compatibility and the interoperability of the results. It is based in the standardization fields of interest identified by SEA-TITAN and the subsequent identification and analysis of related standards and standardization technical committees.

D7.5 is the first deliverable of the Task 7.3 "Standardization activities" and will conform the basis for further steps towards the consideration of the results of SEA-TITAN in future standards contributing to the market acceptance of the developed solutions.

The Spanish Association for Standardization, recently called UNE, and previously called AENOR, as National Standardization Body (NSB), member of CEN-CENELEC and of ISO-IEC, is member of SEA-TITAN to provide support regarding the standardization tasks included in the project (WP7-Dissemination, Commercialization and IP management).

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1. Introduction

1.1 Summary and scope

The purpose of this report D7.5 is to provide information on the standardization landscape and applicable standards relevant for the SEA-TITAN project. It pretends to provide starting information for the work packages to facilitate the use of the existing knowledge and to ensure compatibility and interoperability with already existing solutions by identifying the relevant standards at European and international levels as well as the relevant standardization technical committees in the fields of wave energy converters and other key related topics.

1.2 Project presentation overview

SEA-TITAN deals with the wave energy converters technologies with the main objective of designing, building, testing and validating a simpler, stronger, multi-technology compatible and more cost effective Direct Drive Power Take-Off (PTO) which represents the heart of any wave energy converter, including the power electronic converter (PEC) and control platform and modulation technique. The development aims at achieving high continuous and peak force densities and also high efficiencies with application to multiple wave energy conversion technologies. Additionally, the conceptual design of a superconducting linear PTO will also be addressed.

The project is co-funded by the European Union's Horizon 2020 research and innovation programme, started on 1st of April 2018 and runs for three years. It brings together 11 partners from 7 different European countries including four wave energy technology developers, three R&D entities, an engineering and manufacturer company, a superconductive technology developer, an electro-mechanical contractor and a standardization body.

1.3 Short introduction about standardization

Standards are voluntary technical documents that set out requirements for a specific item, material, component, system or service, or describes in detail a particular method, procedure or best practice. Standards are developed and defined through a process of sharing knowledge and building consensus among technical experts nominated by interested parties and other stakeholders - including businesses, consumers and environmental groups, among others. These experts are organized in Technical Committees (TCs), which are subdivided in Subcommittees (SCs) or Working Groups (WGs). These TCs are included in the structure of the Standardization Organizations (National, European and International, with the respective mirror committees) and work following their internal regulations.

The standardization bodies operate at National (UNE, AFNOR, BSI, DIN, etc.), Regional (CEN, CENELEC, ETSI) or International (ISO, IEC, ITU) level. Sometimes there are different standardization bodies at the same level, but covering different fields. This is the case of ISO (general), IEC (electrical) and ITU (telecommunications) at International level, or CEN, CENELEC and ETSI at European level in the same way. At European level, all the members of CEN and

CENELEC shall adopt EN standards as national standards and have to withdraw any existing national standard which could conflict with them.

The formal definition of a standard is a "document, established by consensus and approved by a recognized body that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context". These include requirements and/or recommendations in relation to products, systems, processes or services. European Standards (ENs) are documents that have been ratified by one of the three European Standardization Organizations (ESOs), CEN, CENELEC or ETSI; recognized as competent in the area of voluntary technical standardization as for the EU Regulation 1025/2012.

There are also different kinds of standardization documents. The most widespread is the standard, which has a different code depending on the organization under it was developed; e.g. EN for European Standards, ISO or IEC for International standards. Other types of documents are Technical Specifications (TS), Technical Reports (TR) and Workshop Agreements (CWA). Further Amendments to the standards are identified by adding A1, A2, etc. at the end of the standard code. A summary of the characteristics of the different standardization documents can be found in the following table 1.

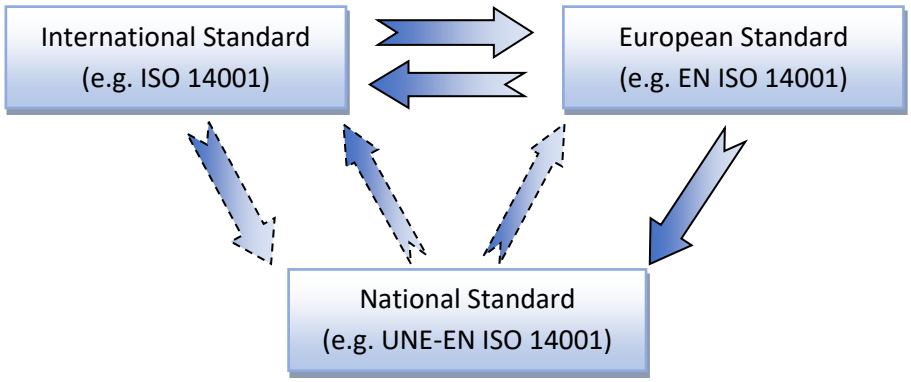
Table 1 – Characteristics of different standardization documents

Type	International code	European code	National code	Main characteristics
Standard	ISO IEC	EN	UNE, NF, BS, DIN, etc. When adopting: UNE-EN, NF-EN, UNE-ISO, NF-ISO, etc.	• Elaboration: 3 years • 2 steps of member approval • European: compulsory national adoption Revision: every 5 years
Technical Specification	ISO/TS IEC/TS	CEN/TS CLC/TS	When adopting: UNE-CEN/TS, NF-CEN/TS, UNE-ISO/TS, NF-ISO/TS, etc.	• Elaboration: 21 months • 1 step of member approval or internal approval in TC • European: optional national adoption Revision: at 3 years (upgrading to EN or deletion)
Technical Report	ISO/TR IEC/TR	CEN/TR CLC/TR	When adopting: UNE-CEN/TR, NF-CEN/TR, UNE-ISO/TR, NF-ISO/TR, etc.	• Elaboration: free timeframe • Internal approval in TC • European: optional national adoption No revision required

Type	International code	European code	National code	Main characteristics
Workshop Agreement	IWA	CWA	Variable	• Elaboration: free timeframe (usually few months) • Internal approval in the Workshop • European: optional national adoption Revision: at 3 years (upgrading to EN or deletion)

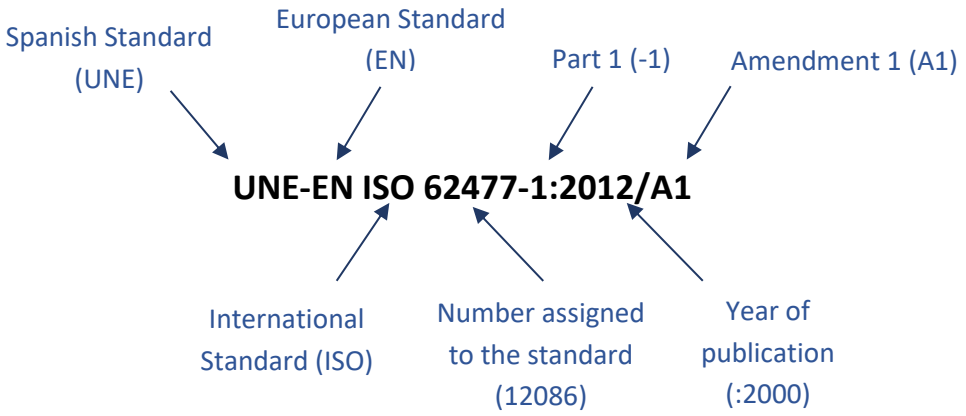
There is also an agreement established between European and International Organizations (e.g. CEN and ISO or CENLEC and IEC) in order to avoid duplication of efforts and promote global relevance of standards, which allows to adopt or develop in parallel each other's standards with the same content and code. National standards could also be proposed as a base for new European or International standards. The following figure 1 shows the tracks of the standards.

Figure 1 – Possible tracks of standards adoption



Therefore, the code of any standard is the combination of the above mentioned issues, and could be explained as shown in figure 2:

Figure 2 – Example of identification of elements in the code of a standard



2. Methodology

The standardization environment relevant for SEA-TITAN project has been identified following the sequence:

1. A list of relevant topics for the standardization analysis was prepared addressing the project with a wide approach in order to capture as much potentially relevant standardization areas as possible, not focussing only in the wave energy converter itself but including also other topics that can have an impact in the overall project.

2. The list of potential topics was delivered to the SEA-TITAN partners for reviewing and validating which resulted in the list of significant standardization areas included in Table 2.

Table 2 – List of standardization areas identified as relevant for SEA-TITAN

Topic	Sub-topic
Marine Energy Converters (3.2)	Terminology of MECs Design requirements for MECs Mooring system for MECs. Assessment Power production performance of WECs. Assessment Wave energy resource at sites. Assessment and characterization Mechanical loads of MECs. Measurement Electrical power quality for MECs. Requirements Early stage development of WECs. Testing procedures Tidal energy converters River energy converters
	Distributed energy resources connection with the grid Interconnecting distributed resources with electric power systems Requirements for the connection of micro-generators in parallel

Systems aspects of electrical energy supply (3.3)	with public low-voltage distribution networks Requirements for generating plants to be connected in parallel with distribution networks Requirements for micro-generating plants to be connected in parallel with public low-voltage distribution networks HVDC Grid Systems and connected Converter Station
Grid Integration of Renewable Energy Generation (3.4)	Terms, definitions and symbols Renewable energy power prediction
Decentralized Electrical Energy Systems (3.5)	Microgrids
Power electronic systems and equipment (3.6)	Semiconductor converter Terminal markings Safety requirements Operation conditions of active infeed converter (AIC) Adjustable speed electrical power drive systems Uninterruptible power systems Low-voltage power supply devices, d.c. output Electronic equipment for use in power installations Bi-directional grid connected power converters
Superconductivity (3.7)	Electronic characteristic measurements Mechanical properties measurement DC critical current measurement AC loss measurements Residual resistance ratio measurement Matrix to superconductor volume ratio measurement Measurements for bulk high temperature Critical temperature measurement Superconducting power devices Superconducting wires
Corrosion of metals and alloys (3.8)	Test methods and prevention Protective paint systems for steel structures

3. The full catalogues of standards of the relevant standardization technical committees in those areas were screened to obtain a filtered list of potentially relevant standards, including already-published and under-development standards.

   The study was performed in a first stage over more than 800 standards leading to a first draft sent by UNE to the partners with 164 standards which ultimately resulted in the 79 standards included in this deliverable.

4. SEA-TITAN partners were asked to identify form this list the standards more closely related to their tasks and objectives in the project. Additional information about specific standards was provided. The result of this analysis is the content of chapter 3.

Two additional topics were originally selected, electrical energy storage systems and power installations, but were discarded after a deeper analysis.

The standardization study covers both, the European (CENELEC and CEN) and international (IEC and ISO) standardization systems including amendments and corrigendum. The study is structured in standardization areas for which relevant published and under development standards and the pertinent standardization technical committees (TCs) are identified.

3. Relevant standardization landscape for SEA-TITAN

3.1 General considerations

For each topic the published and under-development standards are showed first and the responsible standardization technical committees secondly. The published and under-development standards showed come from a screening process of the whole list of standards of the responsible standardization committees. The scope of the standardization committees is included, as well as comments on their activity where applicable. The term "standard" covers standards, technical specifications, technical reports and workshop agreements despite they are different types of standardization documents as explained in Chapter 2.

In some of the topics is it possible to find subjects covered by international standards (from IEC and ISO), by European standards (coming from CENELEC and CEN) or both. Referring to this last case, if a subject is covered by a European and an international standard, those standards can be identical or not, depending on whether there is any specific European requirement on the subject. When a European and an international standard exist for a subject, the standard can be listed below in two different ways:

A "*" in the reference of the standard means that there are two standards for the subject, a European standard and an international standard. Only the European standard is showed to avoid duplication.

A Standard containing "EN IEC" or "EN ISO" in its reference means that there is one standard applicable to both, European and international environments.

The status of the standards is provided for each reference allowing to acknowledge if the standard is:

Published:	the standards is published with no running work on it
Under modification:	the standard is published but related work (an amendment or a new version) is under development
Under development:	the standard is being developed, there is not an available finished document yet

For electrotechnical standards it is common that the current version of a standard coexists for some time with a former version to facilitate the transition to stakeholders. The information below refers to the latest versions of the standards.

3.2 Standardization on Marine energy converters

3.2.1 Relevant standards

Reference	Title	Status
IEC/TS 62600-1:2011	Part 1: Terminology	Published
IEC/TS 62600-2:2016	Part 2: Design requirements for marine energy systems	Under modification
IEC/TS 62600-3	Part 3: Measurement of mechanical loads	Under modification
IEC/TS 62600-10:2015	Part 10: Assessment of mooring system for marine energy converters (MECs)	Published
IEC/TS 62600-30	Part 30: Electrical power quality requirements for wave, tidal and other water current energy converters	Under development
IEC/TS 62600-100:2012 IEC TS 62600-100:2012/COR1:2017	Part 100: Electricity producing wave energy converters - Power performance assessment	Published
IEC/TS 62600-102:2016	Part 102: Wave energy converter power performance assessment at a second location using measured assessment data	Published
IEC/TS 62600-101:2015	Part 101: Wave energy resource assessment and characterization	Published
IEC/TS 62600-103	Part 103: Guidelines for the early stage development of wave energy converters: Best practices and recommended procedures for the testing of pre-prototype scale devices	Under development
IEC/TS 62600-200:2013	Part 200: Electricity producing tidal energy converters - Power performance assessment	Published
IEC/TS 62600-201:2015	Part 201: Tidal energy resource assessment and characterization	Published
IEC/TS 62600-202	Part 202: Scale testing of tidal stream energy systems	Under development
IEC/TS 62600-300	Part 300: Electricity producing river energy converters - Power performance assessment	Under development
IEC/TS 62600-301	Part 301: River energy resource assessment	Under development

NOTE The titles of all the above standards are preceded by "Marine energy - Wave, tidal and other water current converters" which is omitted in favour of clarity. As an example, the

complete title of the first standard referred is IEC/TS 62600-1:2011 "Marine energy - Wave, tidal and other water current converters - Part 1: Terminology".

3.2.2 Standardization technical committees

- **IEC/TC 114 Marine energy - Wave, tidal and other water current converters**

  Scope "To prepare international standards for marine energy conversion systems. The primary focus will be on conversion of wave, tidal and other water current energy into electrical energy, although other conversion methods, systems and products are included. Tidal barrage and dam installations, as covered by TC 4, are excluded. The standards produced by TC 114 will address:
  - system definitions;
  - management plan for technology and project development;
  - performance measurements of wave, tidal and water current energy converters;
  - resource assessment requirements;
  - design and safety including reliability and survivability;
  - deployment, operation, maintenance and retrieval;
  - commissioning and decommissioning;
  - electrical interface, including array integration and / or grid integration;
  - testing: laboratory, manufacturing and factory acceptance;
  - measurement methodologies of physical parameters of the device"

- **CLC/SR 114 Marine energy - Wave and tidal energy converters**

  CLC/SR 114 is not a formal standardization committee, all the activity in the field is developed in IEC/TC 114. The sense of CLC/SR is just allocating future adoption of IEC standards as European standards. There are not existing or under-development standards currently in this TC.

3.3 Standardization on Systems aspects of electrical energy supply

3.3.1 Relevant standards

Code	Title	Status
IEC/TS 62786:2017	Distributed energy resources connection with the grid	Under modification
IEC/IEEE PAS 63547:2011	Interconnecting distributed resources with electric power systems	Published
IEC/TR 62511:2014	Guidelines for the design of interconnected power systems	Published
IEC/TS 63060	General aspects and methods for the maintenance of installations and equipment of electrical energy supply networks	Under development
EN 50438:2013	Requirements for micro-generating plants to be connected in parallel with public low-	Published

	voltage distribution networks	
CLC/TS 50549-1:2015	Requirements for generating plants to be connected in parallel with distribution networks - Part 1: Connection to a LV distribution network above 16 A	Under modification with new title: Part 1-1: Connection to a LV distribution network - Generating plants up to and including Type A
CLC/TS 50549-2:2015	Requirements for generating plants to be connected in parallel with distribution networks - Part 2: Connection to a MV distribution network	Under modification

3.3.2 Standardization technical committees

- **CLC/TC 8X System aspects of electrical energy supply**

  Scope "To prepare the necessary standards framework and coordinate the development, in cooperation with other TC/SCs, of CENELEC standards needed to facilitate the functioning of electricity supply systems in open markets."

- **IEC/TC 8 Systems aspects of electrical energy supply**

  Scope "To prepare and coordinate, in co-operation with other TC/SCs, the development of international standards and other deliverables with emphasis on overall system aspects of electricity supply systems and acceptable balance between cost and quality for the users of electrical energy. Electricity supply system encompasses transmission and distribution networks, generators and loads with their network interfaces.

  This scope includes, but is not limited to, standardization in the field of:
  - Terminology for the electricity supply sector,
  - Characteristics of electricity supplied by public networks,
  - Network management from a system perspective,
  - Connection of network users (generators and loads) and grid integration,
  - Design and management of de-centralized electricity supply systems e.g. microgrids, systems for rural electrification.

  While relying on efficient and secure data communication and exchange, TC 8's scope does not include standards for communication with appliances and equipment connected to the electric grid or for communication infrastructure serving the electric grid.

  TC 8 is responsible for the maintenance of basic publications (horizontal standards) on standard voltages, currents and frequencies ensuring the consistency of the IEC publications in these fields.

TC 8 cooperates also with several organizations active in the field of electricity supply such as CIGRE, CIRED, IEEE, AFSEC, IEA."

3.4 Standardization on Grid integration of renewable energy generation

3.4.1 Relevant standards

Code	Title	Status
IEC 62934	Grid integration of renewable energy generation - Terms, definitions and symbols	Under development
IEC/TR 63043	Renewable energy power prediction	Under development

3.4.2 Standardization technical committees

- **IEC/TC 8_SC 8A Grid Integration of Renewable Energy Generation**

  Scope: "To prepare and coordinate, in co-operation with other TC/SCs, the development of international standards and other deliverables for grid integration of variable power generation from renewables such as PV and wind energy with emphasis on overall system aspects of electricity supply systems (grids) as defined in TC 8 scope, but not covering issues usually covered by regulation such as renewable policies. SC 8A focuses on the impact of a high percentage of renewables connected to the grid, considering that their variability and predictability impact the functioning of the whole electricity grid. It covers grid integration standards for renewable energy, aggregating contributions of all grid users and prescribing interaction modes between the grid and power plants. This includes requirements for interconnection and related grid compliance tests, as well as standards or best practice documents for planning, modelling, forecasting, assessment, control and protection, scheduling and dispatching of renewables with a grid level perspective.

  Note 1: SC 8A deals with the grid level requirements enabling secure, non-discriminatory and cost effective operation of electricity supply systems with a significant share of renewable generation and cooperates with TC 82, TC 88, TC 95, TC 114, TC 115, TC 117, TC 120 and other product committees to ensure technical feasibility and verification of the implementation of the grid level requirements.

  Note 2: SC 8A coordinates with TC 8 which covers standards related to Distributed Energy Resources (e.g. interconnection with the grid, design and operation of micro grids)."

This international standardization committee is quite new, there is not an equivalent committee at European level.

3.5 Standardization on Decentralized electrical energy systems

3.5.1 Relevant standards

Code	Title	Status
IEC/TS 62898-1:2017	Microgrids - Part 1: Guidelines for microgrid projects planning and specification	Published
IEC/TS 62898-2	Microgrids - Guidelines for Microgrid Operation (and Control)	Under development
IEC/TS 62898-3-1	Microgrids - Technical Requirements - Protection	Under development
IEC/TS 62898-3-2	Microgrids – Technical requirements - Energy Management Systems	Under development
IEC/TS 62898-3-3	Microgrids – Technical requirements – Self-regulation of dispatchable loads	Under development
IEC 63189-1	Virtual Power Plants- Part 1: Architecture and Functional Requirements	Under development
IEC/TS 63189-2	Virtual Power Plants- Part 2: Use Cases	Under development

3.5.2 Standardization technical committees

- **IEC/TC 8/SC 8B Decentralized Electrical Energy Systems**

  Scope "Standards enabling the development of secure, reliable and cost-effective systems with decentralized management for electrical energy supply, alternative/complement/precursor to traditional large interconnected and highly centralized systems. The most popular concept is currently the "microgrid" defined as a group of interconnected loads and distributed energy resources with defined electrical boundaries that acts as a single controllable entity and is able to operate in both grid-connected and island mode. Decentralized energy systems have applications for developing countries (focussing on access to electricity) as well as for developed countries (focussing on high reliability, black-out recovery and/or services). Interactions within Decentralized (Multi) Energy Systems should also be considered.

  Standardization activities in this proposed SC will proceed with cooperation with concerned TC/SCs and SyCs, including but not limited to IEC SyC Smart Energy, TC 22, TC57, TC64, TC82, TC88, TC 95, TC120."

There is not an equivalent committee at European level.

3.6 Standardization on Power electronic converters

3.6.1 Relevant standards

Code	Title	Status
EN 60146-1-1:2010*	Semiconductor converters - General requirements and line commutated converters -	Published

	Part 1-1: Specification of basic requirements	
EN 60146-1-3:1993*	Semiconductor convertors - General requirements and line commutated convertors - Part 1-3: Transformers and reactors	Published
EN 60146-2:2000*	Semiconductor converters - Part 2: Self-commutated semiconductor converters including direct d.c. converters	Published
IEC/TR 60146-6:1992	Semiconductor convertors - Part 6: Application guide for the protection of semiconductor convertors against overcurrent by fuses	Published
EN 61148:2012*	Terminal markings for valve device stacks and assemblies and for power conversion equipment	Published
EN 62477-1:2012* EN 62477-1:2012/A11:2014 EN 62477-1:2012/A1:2017	Safety requirements for power electronic converter systems and equipment - Part 1: General	Published
IEC/TS 62578:2015	Power electronics systems and equipment - Operation conditions and characteristics of active infeed converter (AIC) applications including design recommendations for their emission values below 150 kHz	Published
EN 62040-1:2008* EN 62040-1:2008/A1:2013 EN 62040-1:2008/corrigendum Feb. 2009	Uninterruptible power systems (UPS) - Part 1: General and safety requirements for UPS	Under modification
EN 62040-3:2011*	Uninterruptible power systems (UPS) - Part 3: Method of specifying the performance and test requirements	Under modification
EN 61204:1995* EN 61204:1995/A1:2001	Low-voltage power supply devices, d.c. output - Performance characteristics	Published
EN 50178:1997	Electronic equipment for use in power installations	Published
EN 62909-1:2018*	Bi-directional grid connected power converters - Part 1: General requirements	Published
IEC 62909-2	Bi-directional grid connected power converters - Part 2: Interface of GCPC and distributed energy resources and additional requirements to Part 1	Under development, also as EN

Identified standards for the specific topic of "Adjustable speed electrical power drive systems" are listed separately:

Code	Title	Status
EN 61800-2:2015*	Adjustable speed electrical power drive systems - Part 2: General requirements - Rating specifications for low voltage adjustable speed a.c. power drive systems	Under modification at European level
EN 61800-5-1:2007* EN 61800-5-1:2007/A1:2017*	Adjustable speed electrical power drive systems - Part 5-1: Safety requirements - Electrical, thermal and energy	Published
EN 61800-5-2:2017*	Adjustable speed electrical power drive systems - Part 5-2: Safety requirements - Functional	Published
prEN IEC 61800-5-3	Adjustable speed electrical power drive systems - Part 5-3: Safety requirements for encoders - Functional, Electrical and Environmental	Under development at EN
EN 61800-7-201:2016*	Adjustable speed electrical power drive systems - Part 7-201: Generic interface and use of profiles for power drive systems - Profile type 1 specification	Published
EN 61800-7-202:2016*	Adjustable speed electrical power drive systems - Part 7-202: Generic interface and use of profiles for power drive systems - Profile type 2 specification	Published
EN 61800-7-203:2016*	Adjustable speed electrical power drive systems - Part 7-203: Generic interface and use of profiles for power drive systems - Profile type 3 specification	Published
EN 61800-7-204:2016*	Adjustable speed electrical power drive systems - Part 7-204: Generic interface and use of profiles for power drive systems - Profile type 4 specification	Published
IEC/TS 61800-8:2010	Adjustable speed electrical power drive systems - Part 8: Specification of voltage on the power interface	Published

3.6.2 Standardization technical committees

- **CLC/TC 22X Power electronics**

  Scope: "To prepare standards dealing with power electronics. The standards will deal with equipment, their component parts (especially electronic devices) and their extension to the system aspect. Standards for power converters interfacing general power systems to dedicated systems, for example railways, shall be dealt with jointly by TC 22X and relevant product committees. The following are excluded: - converters

for rolling stock; - converters and charging equipment for electrical vehicles; - emitters for telecommunication; - dimmers for lighting."

- **IEC/TC 22 Power electronic systems and equipment**

  Scope "To prepare international standards regarding systems, equipment and their components for electronic power conversion and electronic power switching, including the means for their control, protection, monitoring and measurement.

  Note 1.- Components which are comprised within the scope include electronic devices.

  Note 2.- The scope does not include telecommunications apparatus other than power supplies to such apparatus.

  Group Safety Function: Power electronic converter systems and equipment for solar, wind, tidal, wave, fuel cell or similar energy sources"

- **IEC/TC 22/SC 22E Stabilized power supplies**

  Scope: "To prepare international standards for low voltage bi-directional grid connected power converters (GCPC), d.c. to a.c. power converters and stabilized d.c. switched-mode power supplies.

  This includes: specifications and performance and specific vocabulary, EMC, safety and system aspects (e.g. interaction with smart low-voltage electrical installations).

  The scope relates to power electronic converters handling various different types of power sources and/or loads. Power electronic converters for special applications (e.g. power drives, uninterruptible power systems, photovoltaic systems) are covered by the relevant TC/SCs."

- **IEC/TC 22/SC 22F Power electronics for electrical transmission and distribution systems**

  Scope: "Standardization of electronic power conversion and/or semiconductor switching equipment and systems including the means for their control, protection, monitoring, cooling and other auxiliary systems and their application to electrical transmission and distribution systems.

  NOTE Typical examples are power electronic equipment for flexible a.c. power transmission (controlled series capacitors, unified power flow controllers, etc), converters and associated equipment for high-voltage direct current (HVDC) systems irrespective of d.c. voltage level, reactive power compensation means (static VAR compensators, STATCOM, etc), power electronic equipment for smart grids, connection to electrical transmission and distribution systems of renewable and distributed power generation (wind farms, solar stations, etc) including the standardization of system-related features of d.c. systems with d.c. voltages 100 kV and lower, as well as other applications where power electronics is used, e.g., phase shifters and active filters"

- **IEC/TC 22/SC 22G - Adjustable speed electric drive systems incorporating semiconductor power converters**

  Scope: "To prepare international standards for electronic power conversion equipment in adjustable speed electric drive systems, including the means for their control, protection, monitoring and measurement.

  Excluded are traction applications and electric vehicles. "

- **IEC/TC 22/SC 22H - Uninterruptible power systems (UPS)**

  Scope: "To prepare international standards for uninterruptible power systems (UPS) including system aspects as well as equipment and component requirements specific for UPS"

3.7 Standardization on Superconductors

3.7.1 Relevant standards

Code	Title	Status
EN 61788-8:2010*	Superconductivity - Part 8: AC loss measurements - Total AC loss measurement of round superconducting wires exposed to a transverse alternating magnetic field at liquid helium temperature by a pickup coil method	Published
EN 61788-10:2006*	Superconductivity - Part 10: Critical temperature measurement - Critical temperature of composite superconductors by a resistance method	Published
EN 61788-12:2013*	Superconductivity - Part 12: Matrix to superconductor volume ratio measurement - Copper to non-copper volume ratio of Nb3Sn composite superconducting wires	Published
EN 61788-13:2012*	Superconductivity - Part 13: AC loss measurements - Magnetometer methods for hysteresis loss in superconducting multifilamentary composites	Published
EN 61788-14:2010*	Superconductivity - Part 14: Superconducting power devices - General requirements for characteristic tests of current leads designed for powering superconducting devices	Published
prEN 61788-20*	Superconductivity - Part 20: Superconducting wires - Categories of Practical Superconducting Wires - General Characteristics and Guidance	Under development
EN 61788-21:2015*	Superconductivity - Part 21: Superconducting wires - Test methods for practical	Published

	superconducting wires - General characteristics and guidance	

3.7.2 Standardization technical committees

- **IEC/TC 90 Superconductivity**

  Scope: "To prepare international standards (IS) related to superconducting materials and devices"

- **CLC/SR 90 Superconductivity**

  CLC/SR 90 is not a formal standardization committee, although there are standards under this standardization committee all the activity in the field is developed in IEC/TC 90. The sense of CLC/SR is just allocating the adoption of IEC standards as European standards.

3.8 Standardization on Corrosion of metals and alloys

3.8.1 Relevant standards

Code	Title	Status
EN 13173:2001	Cathodic protection for steel offshore floating structures	Published
EN 12495:2000	Cathodic protection for fixed steel offshore structures	Published
EN 16222:2012	Cathodic protection of ship hulls	Published
EN ISO 18086:2017	Corrosion of metals and alloys - Determination of AC corrosion - Protection criteria (ISO 18086:2015)	Published
EN 12499:2003 EN 12499:2003/AC:2006	Internal cathodic protection of metallic structures	Published
EN 13509:2003	Cathodic protection measurement techniques	Published
EN ISO 11782-1:2008	Corrosion of metals and alloys - Corrosion fatigue testing - Part 1: Cycles to failure testing (ISO 11782-1:1998)	Published
EN ISO 14713-1:2017	Zinc coatings - Guidelines and recommendations for the protection against corrosion of iron and steel in structures - Part 1: General principles of design and corrosion resistance (ISO 14713-1:2017)	Published
EN ISO 14713-2:2009	Zinc coatings - Guidelines and recommendations for the protection against corrosion of iron and steel in structures - Part 2: Hot dip galvanizing (ISO 14713-2:2009)	Under modification

EN ISO 14713-3:2017	Zinc coatings - Guidelines and recommendations for the protection against corrosion of iron and steel in structures - Part 3: Sherardizing (ISO 14713-3:2017)	Published
ISO 11845:1995	Corrosion of metals and alloys -- General principles for corrosion testing	Under modification
ISO 13174:2012	Cathodic protection of harbour installations	Published
ISO/WD 23226	Corrosion of metals and alloys -- Guidelines for corrosion testing of metals and alloys exposed in deep sea water	Under development
ISO 12944-1:2017	Paints and varnishes -- Corrosion protection of steel structures by protective paint systems -- Part 1: General introduction	Published
ISO 12944-4:2017	Paints and varnishes -- Corrosion protection of steel structures by protective paint systems -- Part 4: Types of surface and surface preparation	Published
ISO 12944-5:2018	Paints and varnishes -- Corrosion protection of steel structures by protective paint systems -- Part 5: Protective paint systems	Published

3.8.2 Standardization technical committees

- **CEN/TC 219 Cathodic protection**

  Scope: "Standardization in the field of external and internal cathodic protection of buried or immersed structures of metallic materials (e.g. pipes for the transport of gas, water and fuels; off-shore constructions; ships; fuel storage tanks; telecommunications and electric cables etc). reinforced concrete buildings, structures, foundations, pipelines ect). The influence of coatings and/or stray currents (AC and DC) on the performance of cathodic protection systems. The anodic protection of internal surfaces of structural components. Standardization of a framework for a system and related procedures for the definition and verification of the competence level of operators in the field of cathodic protection."

- **CEN/TC 262 Metallic and other inorganic coatings, including for corrosion protection** and corrosion testing of metals and alloys

  Scope: "standardization in the field of metallic and other inorganic coatings, for corrosion protection of metals and for decorative and engineering purposes"

- **ISO/TC 156 Corrosion of metals and alloys**

  Scope: "Standardization in the field of corrosion of metals and alloys including corrosion test methods, corrosion prevention methods and corrosion control engineering life cycle. General coordination of activities in these fields within ISO."

- **ISO/TC 35/SC 14 Protective paint systems for steel structures**

Scope: The scope of the Subcommittee is not specified. The scope of the ISO/TC 35 states "Standardization in the field of paints, varnishes and related products, including raw materials."

3.9 Standardization on Data Management

3.9.1 Relevant standards

Code	Title	Status
EN ISO/IEC 27000:2017	Information technology - Security techniques - Information security management systems - Overview and vocabulary (ISO/IEC 27000:2016)	Published
EN ISO/IEC 27001:2017	Information technology - Security techniques - Information security management systems - Requirements (ISO/IEC 27001:2013 including Cor 1:2014 and Cor 2:2015)	Published
EN ISO/IEC 27002:2017	Information technology - Security techniques - Code of practice for information security controls (ISO/IEC 27002:2013 including Cor 1:2014 and Cor 2:2015)	Published
EN ISO/IEC 27037:2016	Information technology - Security techniques - Guidelines for identification, collection, acquisition and preservation of digital evidence (ISO/IEC 27037:2012)	Published
EN ISO/IEC 27038:2016	Information technology - Security techniques - Specification for digital redaction (ISO/IEC 27038:2014)	Published
EN ISO/IEC 27041:2016	Information technology - Security techniques - Guidance on assuring suitability and adequacy of incident investigative method (ISO/IEC 27041:2015)	Published
EN ISO/IEC 27042:2016	Information technology - Security techniques - Guidelines for the analysis and interpretation of digital evidence (ISO/IEC 27042:2015)	Published
EN ISO/IEC 27043:2016	Information technology - Security techniques - Incident investigation principles and processes (ISO/IEC 27043:2015)	Published

The list contains only the standards adopted at European level, more standards related to security techniques exist at international level.

3.9.2 Standardization technical committees

- **CEN/CLC/JTC 13 Cybersecurity and Data Protection**

Scope: "Development of standards for cybersecurity and data protection covering all aspects of the evolving information society including but not limited to: - Management systems, frameworks, methodologies - Data protection and privacy - Services and products evaluation standards suitable for security assessment for large companies and small and medium enterprises (SMEs) - Competence requirements for cybersecurity and data protection - Security requirements, services, techniques and guidelines for ICT systems, services, networks and devices, including smart objects and distributed computing devices Included in the scope is the identification and possible adoption of documents already published or under development by ISO/IEC JTC 1and other SDOs and international bodies such as ISO, IEC, ITU-T, and industrial fora. Where not being developed by other SDO's, the development of cybersecurity and data protection CEN/CENELEC publications for safeguarding information such as organizational frameworks, management systems, techniques, guidelines, and products and services, including those in support of the EU Digital Single Market."

- **ISO/IEC JTC 1/SC 27 IT Security techniques**

  Scope "The development of standards for the protection of information and ICT. This includes generic methods, techniques and guidelines to address both security and privacy aspects, such as:

  - Security requirements capture methodology;
  - Management of information and ICT security; in particular information security management systems, security processes, and security controls and services;
  - Cryptographic and other security mechanisms, including but not limited to mechanisms for protecting the accountability, availability, integrity and confidentiality of information;
  - Security management support documentation including terminology, guidelines as well as procedures for the registration of security components;
  - Security aspects of identity management, biometrics and privacy;
  - Conformance assessment, accreditation and auditing requirements in the area of information security management systems;
  - Security evaluation criteria and methodology.

  SC 27 engages in active liaison and collaboration with appropriate bodies to ensure the proper development and application of SC 27 standards and technical reports in relevant areas.

4. Conclusions

As a result of the study of the standardization landscape through the methodology explained above, the following conclusions can be drawn:

1. There is a number of standards and standardization technical committees directly related with the main objectives of SEA-TITAN:

- Different aspects of the **wave energy converters**, such as the design requirements, the power performance assessment or the measurement of mechanical loads, are already covered by standards (*see 3.2.1*) developed in the relevant standardization technical committee, IEC/TC 114 (CLC/SR114). These standards shall be taken into account in the design and development of the innovative WEC.

- The **power electronic converters** are also widely covered by standards dealing with safety and design requirements, performance and characterization (*see 3.6.1*), including specific standards for adjustable speed electrical power drive systems. CLC/TC 22X and IEC/TC 22 are the standardization technical committees to be considered in this field. These standards shall be part of the starting material in the development of the power electronic converter of the WEC.

- The characterization, performance and test methods of **superconductors** are also addressed by standards (*see 3.7.1*) coming from the standardization technical committee IEC/TC 90 (CLC/SR 90). The mentioned standards will be helpful when developing the conceptual design of the superconductive PTO.

2. Additionally to the above standardization areas, standards in the next topics where also identified as relevant for the development of SEA TITAN such as:

- The aspects of the **connection of the marine energy convert to the distribution networks** including microgrids as potential market for WECs (*see 3.3.1*, *3.4.1* and *3.5.1*), covered by the standardization technical committees CLC/TC 8X and IEC/TC 8 and their Subcommittees.

- The different methods for the **protection of metals against corrosion** and the corrosion tests (*see 3.8.1*) addressed by different standardization technical committees such as CEN/TC 219 and ISO/TC 156

- General aspects of **data management** (*see 3.9.1*), which are standardized under CEN/CLC/JT 13 and ISO/IEC/JTC1/SC 27.

When undertaking the different tasks in the project the above mentioned standards are to be considered to take into account existing market accepted criteria and to ensure compatibility with current technologies in the different fields.

Next steps in Task 7.3 "Standardization activities" are aiming to contribute to the dissemination of the results of SEA-TITAN and to transfer those results to future standards. This will be done through the standardization committees relevant for SEA-TITAN which are compiled in the next table:

Table 3 – Relevant standardization committees for SEA-TITAN

Topic	Standardization technical committee
Wave energy converters	IEC/TC 114 Marine energy. Wave, tidal and other water current converters

	(CLC/SR 114)
Power electronic converters	CLC/TC 22X Power electronics IEC/TC 22 Power electronic systems and equipment IEC/TC 22/SC 22E Stabilized power supplies IEC/TC 22/SC 22F Power electronics for electrical transmission and distribution systems IEC/TC 22/SC 22G Adjustable speed electric drive systems incorporating semiconductor power converters IEC/TC 22/SC 22H Uninterruptible power systems (UPS)
Superconductivity	IEC/TC 90 Superconductivity (CLC/SR 90)
Connection of the marine energy converter with the distribution networks	CLC/TC 8X System aspects of electrical energy supply IEC/TC 8 Systems aspects of electrical energy supply IEC/TC 8/SC 8A Grid Integration of Renewable Energy Generation IEC/TC 8/SC 8B Decentralized Electrical Energy Systems
Protection of metals against corrosion	CEN/TC 219 Cathodic protection CEN/TC 262 Metallic and other inorganic coatings, including for corrosion protection and corrosion testing of metals and alloys ISO/TC 156 Corrosion of metals and alloys ISO/TC 35/SC 14 Protective paint systems for steel structures
Data management	CEN/CLC/JTC 13 Cybersecurity and Data Protection ISO/IEC JTC 1/SC 27 IT Security techniques

To achieve these objectives, further assessments will be performed by the partners to determine the type of interaction to be established with the identified standardization technical committees. The ways of interaction of the project with the standardization committees could include:

- The participation of one or more SEA-TITAN partners in the standardization technical committees. Standardization is an open activity and all interested parties may participate in a CEN/CENELEC, ISO/IEC technical committee through the designation of

National Standardization Bodies/National Mirror Committee. Some of the partners are already participating in some of the identified standardization committees;

- The participation through the formal liaison of the SEA-TITAN project with European standardization committees to participate directly as liaison organization which intends to make technical contributions to their works. This option would be further analysed since in several of the identified topics there is not a formal standardization activity at European level;

- The dissemination of the SEA-TITAN project progress by delivering reports to the relevant standardization technical committees or by attending relevant technical committees meetings;

- Feeding the standardization committees with standardization proposals coming from identified gaps and needs.

Additionally, the activity of the standardization committees required will be periodically reported by UNE.

Following the present deliverable, above options will be analyzed with the partners to determine the most suitable way to contribute to future standards with the results and approach of the project. In addition, it will be decided which standardization committees will be addressed and how for disseminating the results. These will be the first steps towards D7.6 "Report on the contribution to standardization" to be delivered in M36 which will contain the steps and progress of the interaction with the standardization system.

5. References

For the elaboration of this report, the following sources have been consulted:

- IEC Website (www.iec.ch)
- CENELEC Website (www.cenelec.eu)
- CEN/CENELEC Projex Online database (projex.cen.eu) (restricted to authorized users)
- CEN Website (www.cen.eu)
- ISO Website (www.iso.org)
- ISO Project Portal (isotc.iso.org) (restricted to authorized users)