Oregon Wave Energy Trust
Utility Market Initiative

Task 3.5.1: Overview of International Standards

www.oregonwave.org

www.peventuresllc.com

The Utility Market Initiative was prepared by *Pacific Energy Ventures* on behalf of the Oregon Wave Energy Trust.

Task 3.5.1 was completed by Ecofys

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For information about this project, please contact Justin Klure at Pacific Energy Ventures:

Phone: (503) 475-2999

Email: jklure@peventuresllc.com

About Oregon Wave Energy Trust

The Oregon Wave Energy Trust – (OWET) - with members from fishing and environmental groups, industry and government - is a nonprofit public-private partnership funded by the Oregon Innovation Council in 2007. Its mission is to serve as a connector for all stakeholders involved in wave energy project development - from research and development to early stage community engagement and final deployment and energy generation - positioning Oregon as the North America leader in this nascent industry and delivering its full economic and environmental potential for the state. OWET's goal is to have ocean wave energy producing 2 megawatts of power - enough to power about 800 homes - by 2010 and 500 megawatts of power by 2025.

Report for:
Oregon Wave Energy Trust – Utility Market Initiative
Overview of International Standards
for Wave and Tidal Energy

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Authored by:
Ir. Peter Scheijgrond, Sr. Developer, Ecofys NL
and Anna Ritzen, Jr. Consultant, Ecofys NL
Reviewed by:
Diane Broad, P.E., Sr. Consultant, Ecofys US

Purpose

The Oregon Wave Energy Trust is supporting a study, the Utility Market Initiative, which has the objective of bringing electric utilities and the wave energy industry together to better understand each others' technical and business issues. Outcomes of the initiative include a set of model procedures, agreements, and technical tools that will help stimulate the wave energy industry in Oregon.

As part of the initiative, Ecofys US has appointed experienced team members from Ecofys in The Netherlands to deliver an overview of the international standards development with respect to wave and tidal energy.

Definitions and Abbreviations:

IEC: International Electrical Commission
DNV: Det Norske Veritas
IEA-OES: International Energy Agency – Ocean Energy Systems
ISO: International Organization for Standardization
EMEC: European Marine Energy Centre
GL: Germanischer Lloyd

Current Status

Currently there are no internationally recognized standards which apply to wave and tidal energy. In order to create international standards for marine energy, guidelines and preliminary protocols are (currently) being drafted by five different parties. They are listed below in order of international recognition and progress.

1. IEC
2. EMEC
3. Carbon Trust and DNV
4. Germanischer Lloyd
5. IEA

Development

1. IEC: TC 114: Marine Energy – Wave and Tidal Energy Converters

IEC has set up a technical committee, TC 114: Marine Energy – Wave and Tidal Energy Converters (2007). Each participating nation will form a Mirror Committee. Ms. Melanie Nadeau has agreed to take the Chair. The standards marked have been submitted as a suggested work program for TC 114.

Goal: To develop international standards for wave and tidal energy technologies that will help establish this promising source of renewable energy as a competitive form of electrical energy production.

Focus: 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.

Planning: TC 114's inaugural meeting was in May 2008. The average development time for IEC publications in 2008 was approximately 36 months

Development process:

1) Identification of the need for new standard
2) Preliminary study and preparation of draft outline
3) Establish a working group (existing or new)
4) Committee meetings and consensus building on the draft
5) Vote on the draft standard
6) Publication of the standard

Country Participants: Canada, China, Denmark, France, Germany, Italy, Japan, Korea, New Zealand, Russia, Spain, Sweden, UK, US

Country Observers: Brazil, Netherlands, Poland, Ukraine

Standards developed by TC 114 will cover:

- Performance measurement of tidal energy converters
- Performance measurement of wave energy converters
- Technical Reports on assessment of wave and tidal energy resource (2 documents)
- Specification and design of grid interface for wave and tidal energy converters
- Manufacture and factory testing of wave and tidal energy converters
- Certification scheme for wave and tidal energy converters

2. EMEC guidelines for standards

EMEC has coordinated the development of a set of guidelines/draft standards, on behalf of the marine renewable energy industry. Each document has been progressed by a working group with individuals representing technology developers, regulators, academia, utilities, and project developers – a true cross-section of the marine energy industry. These guidelines have recently been launched (April 2009). They are available to download free of charge[1].

[1] http://www.emec.org.uk/standards.asp

EMEC Guidelines

1. Assessment of Performance of Wave Energy Conversion Systems*
2. Assessment of Performance of Tidal Energy Conversion Systems*
3. Assessment of Wave Energy Resource*
4. Assessment of Tidal Energy Resource*
5. Guidelines for Health & Safety in the Marine Energy Industry
6. Guidelines for Marine Energy Certification Schemes*
7. Guidelines for Design Basis of Marine Energy Conversion Systems
8. Guidelines for Reliability, Maintainability and Survivability of Marine Energy Conversion Systems
9. Guidelines for Grid Connection of Marine Energy Conversion Systems
10. Tank Testing of Wave Energy Conversion Systems
11. Guidelines for Project Development in the Marine Energy Industry
12. Guidelines for Environmental Appraisal in the Marine Energy Industry
13. Guidelines for Manufacturing, Assembly and Testing of Marine Energy Conversion Systems

*The standards marked have been submitted as a suggested work program for TC 114.

3. Carbon Trust / DNV guidelines for wave energy devices

DNV has prepared (by order of the Carbon trust) a set of guidelines on the application of existing offshore standards to marine energy systems. DNV has investigated what knowledge already exists in other industries and where it may be appropriate and advantageous to use it for wave energy (May 2005).

> *Focus and Goal:* The focus is on wave energy devices with relevant parts for tidal stream energy as well. The goal is, primarily, to provide an aid to technology developers. The guidelines do not represent new technical standards; they are a set of 'signposts' to existing standards, with guidance on why and how these may be useful.

The guidelines recognize that a wave energy device design will do a combination of the following options:

a) Use novel technology;
b) Use existing technology in a novel setting; and/or
c) Use existing technology in a conventional setting.

As might be expected, option c) is generally most amenable to the application of existing standards. Options a) and b) will require some interpretation, and may be best approached by a process of technology assessment called "Qualification of new/unproven technology". DNV defines this as "The process of providing the evidence that the technology will function reliably within specific limits", and involves a mixture of technical analysis and studies, technical risks and reliability assessments, laboratory testing and prototyping. The first part of the guidelines explains Qualification further.

The guidelines then go on to cover major generic, and indeed some quite specialized, component technologies and systems that a wave energy device may use. A complete list of the systems, components and engineering disciplines covered in the guidelines can be seen in the Guidelines' contents list and is also shown below.

The full document is available to download for free[2]: the Carbon Trust (pdf, 1.4MB).

[2] http://www.carbontrust.co.uk/NR/rdonlyres/E3270D26-447C-4ADB-A6C3-B7DB0CEAEBA0/0/WECguideline_tcm4181675.pdf

Carbon Trust / DNV Main Document

- Qualification of new and unproven technology
- Failure mode identification and risk ranking
- Value management and life cycle analysis
- Reliability and cost
- Risk assessment
- Safety philosophy
- Documentation
- Material selection
- Corrosion protection
- Structural design criteria
- Foundation design
- Mooring system analysis
- Stability and watertight integrity
- Electrical and mechanical equipment
- Fire protection
- Instrumentation and control systems
- Umbilical connections
- Cable connection to shore
- Manufacturing
- Installation and retrieval, temporary phases
- Commissioning and handover
- In-service phase – operations and maintenance
- Decommissioning
- Statutory regulations

Appendices

- Fatigue analysis methodology
- Wave modelling and loads
- Technical considerations for air flow turbines
- Technical considerations for gearboxes
- Inspection
- Relevant electrical and mechanical items
- Steel grade conversion

4. Germanischer Lloyd

In 2005 the draft “Guideline for the Certification of Ocean Energy Converters - Part I: Ocean Current Turbines” was issued and has since been further developed.

GL Guideline for the certification of Ocean Energy Converters cover:

- General conditions for approval
- Safety System, Protective and Monitoring Devices
- Requirements for Manufacturers, Quality Management, Materials, Production and Corrosion
- Protection
- Load Assumptions
- Strength Analysis
- Structures, Foundation
- Machinery Components
- Electrical Installations
- Manuals
- Testing
- Periodic Monitoring
- Marine Operation
- Condition Monitoring

5. IEA-OES

The IEA-OES is attempting to address this problem through collaborative research with IEC. In April 2006, the participating countries of the IEA OES agreed an agenda, under Annex 2 of the Implementing Agreement, to develop internationally recognized practices for testing and evaluating ocean energy systems and, in this way, improve the comparability of experimental results and help stakeholders evaluate and select suitable technologies.

The relevant subtask of the work program is subtask 2.3: Guidelines for Open Sea Testing and Evaluation of Ocean Energy Systems.

In view of the other initiatives described in this document which have progressed further, it is expected that the IEA-OES will not continue with this ANNEX.

Subtask 2.3 Guidelines for open sea testing and evaluation of ocean energy systems

- Monitoring and data acquisition Wave and Tidal
- Data preparation and presentation of results Wave and Tidal
- Guidelines on Design, Safety and Installation procedures Wave and Tidal

Guidelines in the design of the Ocean energy system will be compiled based on best practice and experience from the Ocean Energy community. Practical experience that can help future development will be listed. Guidelines developed by DNV and Germanisher Lloyd can form the basis for this task.