APPLICABILITY AND EXTENSION OF IEC TECHNICAL SPECIFICATIONS USING OPEN SEA DATA

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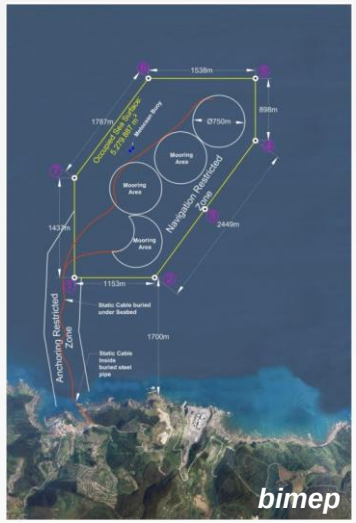
Project background

Challenge:

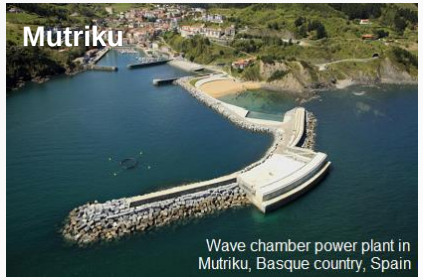
Wave energy **costs remain high** versus conventional forms of energy.

Very **limited open-sea experience** to fully understand and address the challenges (device performance, survivability and reliability).



Objectives:

- **Gather & publish 2 years of open-sea operating data** using a floating, Point Absorber OWC at BiMEP test site and Mutriku OWC plant.
- **Validate four innovations**, opening the way to reduce cost by 50%
  - Bi-radial air turbines
  - Shared mooring lines
  - Elastomeric moorings
  - Advanced control systems



OPERA faces key challenges of wave energy

A problem to solve

No established/applied sector standards

Why we need standards

- Reducing risk (technological and business)
- Increasing investor confidence

Current situation

- IEC TC 114 established 1st editions of a range of Technical Specifications (TS) to guide activities associated with ocean energy.
- Under development & subject to change as more experience available

OPERA faces key challenges of wave energy

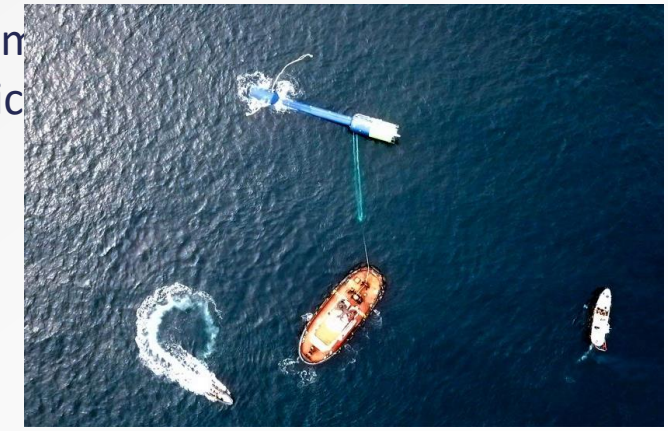
OPERA aims to accelerate establishment of standards for wave energy with first documented and real-case application of IEC/TC114

How?

1. Provide **the first documented real-case application** of existing IEC Technical Specifications (TS)

2. **Evaluation of uncertainty** in measuring and reporting performance.

3. **Extend the data sets** using validated at-sea measurem
power performance and power quality profiles, and predic
and scales.



Why we need standards | What is needed? | OPERA | TS-100 TS-102 | Preliminary results

WP5 Applicability and extension of IEC Technical Specifications using open sea data

- Assessing TS 62600 - :
  - **10 : Assessment of Mooring system for Marine energy converters**

  University of Exeter
  - **30 : Electrical power quality requirements for wave, tidal and other water current energy converters**

  University College Cork
  - **100 : Electricity producing wave energy converters - power performance assessment**

  University of Edinburgh/ Tecnalia
  - **101 : Wave energy resource assessment and characterization**

  Tecnalia
  - **102 : Wave energy converter performance assessment at a second location using measured assessment data.**

  University of Edinburgh

WP5 Applicability and extension of IEC Technical Specifications using open sea data

TS-10 Assessment of Mooring system for Marine Energy Converters

- Defines rules & assessment procedures for the design, installation and maintenance of mooring & anchoring systems for floating MRE devices.

TS-30 Electrical Power Quality Requirements for Wave, Tidal and other Water Current Energy Converters

- Presents methods & requirements for collecting & analysing data to assess power quality.
- Includes resource classification, sensor placement, testing procedures, and identifies related IEC standards for electrical power generation.

WP5 Applicability and extension of IEC Technical Specifications using open sea data

TS-100 Electricity producing wave energy converters - power performance assessment

- Presents methods & requirements when assessing WEC electrical power production performance & calculating Mean Annual Energy Production.
- Includes how to measure & discretise resource & power production measurements (H_{m0} and T_E)
- Recognises that additional parameters might be required to account for variation in power readings.

TS-101 Wave energy resource assessment and characterization

- Establishes system for estimating, analysing and reporting the wave energy resource at sites potentially suitable for the installation of WECs.
- Used in conjunction with TS-100 to calculate the annual energy production.

WP5 Applicability and extension of IEC Technical Specifications using open sea data

TS-102 Wave energy converter performance assessment at a second location using measured assessment data

- Presents methods & requirements when estimating performance at a second location based on observations at an existing location.
- Describes how to account for mismatches in site characteristics: fitting, physical or validated numerical models.
- Sets out how changes in WEC characteristics should be accounted for.

How are we applying these TS & what are our experiences & conclusions so far?....

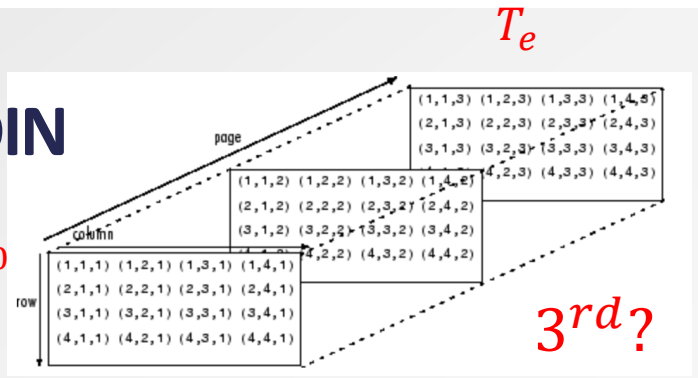
Power Performance TS-100/102 - UEDIN

OPERA open sea data: 1 hourly power measurements with associated resource at BiMEP & wave by wave power assessments

Objectives:

- Implementation of TS-100 with detailed analysis of areas of uncertainty in power performance parameters and dealing with missing or spurious measurements
- Extension of known 2D power matrix development to 3D scenario
  - To develop a methodology
  - Validate a 3D matrix using real sea data & assess if improvement
- Apply TS-102 assessing WEC performance at second location to examine issues of predicting power performance using scaled prototype

Power Performance TS-100/102 - UEDIN



Experience & conclusions so far…

- Uncertainties in power measurements
  - Important to investigate why power output values differ for similar sea states (H_S, T_P)
  - Detailed & validated recording of conditions during measurements
- 2D->3D: which third dimension (spectral bandwidth or mean direction)?
- Scaling issues when considering second location:
  - The device designed is not optimised for the second location =>
    - ✓Device changes from site to site need to be well described
    - ✓Need to identify which components can't be easily scaled and will affect behaviour.

Wave-by-wave assessment of Power Production TS-100/101 – Tecnalia

OPERA open sea data: BiMEP and Mutriku

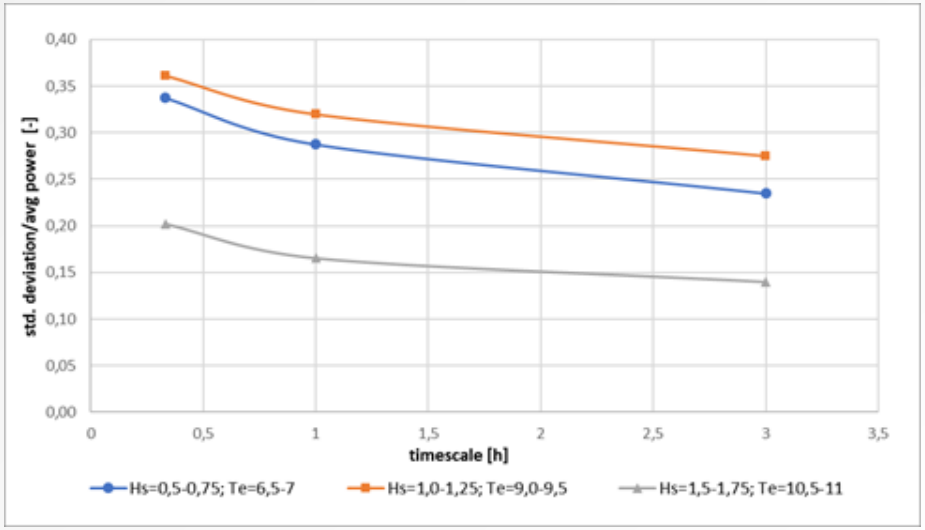
Objectives:

- To produce a finer temporal resolution scatter plot t**o identify sources of scatter** in hourly or 3-hourly time series, and **reduce uncertainty**
- To examine power performance for both individual waves and groups of waves

Wave-by-wave assessment of Power Production TS-100/101 – Tecnalia

Experience & conclusions so far…

- Power performance assessed using: 3 hours, 1 hour, 20 min timescales.
- So far, dispersion in power performance estimation generally decreases going from 30 min to 1h & to 3h sampling durations. More data needed to assess if this is more than simply the effect of sample size.
- Now examining finer timescales to help assess:
  - the effect of phenomena such as wave groupings on power assessment;
  - the influence of wave resource sample duration on power assessments, including the common oceanographic practice of hourly 17 minutes samples.



Three sea-states showing lower variability as recording time is increased

Power Quality TS-30 - UCC

OPERA open sea data: 20 kHz three phase voltage and current measurements at Mutriku

Objectives:

- Implement TS-30
  - with power quality monitoring system at Mutriku, recording data for all sea-states required
- Extend data-sets
  - by verifying UCC dry-lab model and using for further analysis as we can control the sea-states and apply different grid conditions
  - to undertake power quality measurements for three control laws, up to 16 sea states

Mutriku control cabinet

Photo source: Oceantec D1.1Process Instrumentation Definition

Power Quality TS30 - UCC

Experience & conclusions so far…

- Certain tests outlined in TS-30 difficult to implement e.g.
  - Requirement for phase-to-neutral voltage measurements: typical Variable Frequency Drives (VFD) do not include neutral line
  - Temporary voltage drop response tests: require additional equipment and controls = extra cost and expertise average developers may not have

- TS30 document has 3 resource classifications
  - 6 months of data collection required to get representative data sets
  - Massive data storage and analysis requirements (1.2+ GB of data generated during the recommended sample time)

Moorings TS10 - UEXE

OPERA open sea data: WP2 Mooring loads assessment and reduction, shared mooring validation

Objectives:

- Undertake a mooring design study based on the TS10 criteria
- Step by step comparison of TS10 and DNV GL E301
  - Identification of significant differences
  - Identification of gaps related to MRE devices, e.g. tidal range for the changes of water depth etc.
- Analyse impact of moorings on power performance (*Linked to TS100*)

Moorings TS10 - UEXE

Experience & conclusions so far…

- Difficult to isolate the impact of moorings on power performance:
  - In this case, device motions are influence by the PTO and the influence of chamber pressure.
  - However, there a significant number of factors that may be impacting results & none can be isolated when examining real sea data.
  - Currently determining if any impact can be isolated using the numerical model.
  - Will provide feedback on the difficulties experienced and consider the significance of different technologies when assessing the impact of moorings.

Public reports - timeline

D5.1 Wave energy measurement methodologies for IEC/TS

D5.2 Recommendations to TC114 from real-case applications of wave energy technical specifications (due **May 2019**)

D5.3 Uncertainty in wave energy converter power performance assessment (due **May 2019**)

D5.4 Extending wave energy converter power quality dataset (due **May 2019**)

D5.5 Fault ride-through demonstrator (due **May 2019**)

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Further information

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