INTEGRATED MONITORING FOR MARINE ENERGY

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INTRODUCTION

The European Marine Energy Centre (EMEC) is the world's leading real-sea test and demonstration facility for wave and tidal energy converters.

In 2012, under the UK Energy Technologies Institute funded ReDAPT project, EMEC designed, built and operated a bespoke Integrated Measurement Platform for resource assessment and characterisation in high velocity tidal flows.

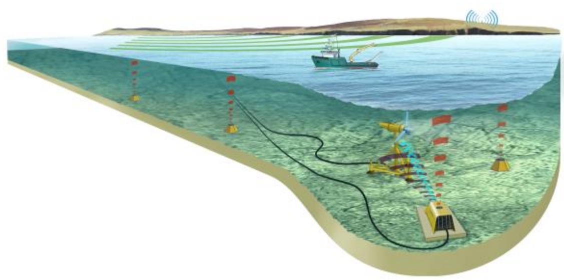

FIGURE 1. ILLUSTRATION OF MONITORING SYSTEM.

The system was deployed at EMEC's Fall of Warness tidal test site in Orkney in 2012 where it remained in situ for six months prior to being retrieved.

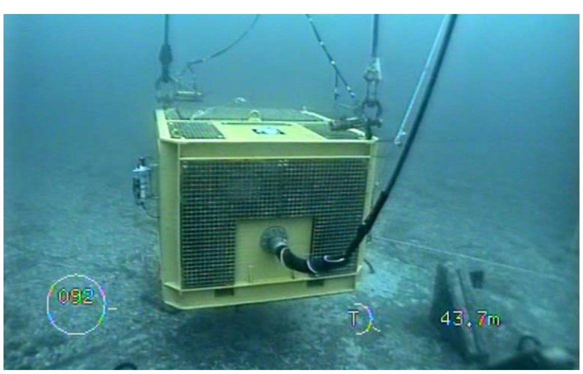

FIGURE 2. UNDERWATER IMAGE FROM THE INITIAL SEABED POD DEPLOYMENT IN AUTUMN 2012.

In 2014, funding was awarded from the Scottish Government's Marine Renewables Commercialisation Fund, which is managed by the Carbon Trust, to review the lessons learnt from the initial prototype build and deployment, and build this into the next generation prototype.

In June 2015, following months of development and planning, EMEC's upgraded Integrated Monitoring Pod was successfully deployed at EMEC's tidal energy test site.

FIGURE 3. EMEC'S INTERGRATED MONITORING POD.

Data collection in high velocity tidal flows

EMEC's Integrated Monitoring Pod has been designed to operate in high velocity tidal flows. It integrates a variety of sensors to undertake comprehensive concurrent environmental measurements, to supply real time data and provide improved characterisation of high energy marine environments.

The first of its kind pre-commercial prototype is connected to the shore via a subsea cable to facilitate 24/7 real-time data collection, and can deliver live data feeds back to EMEC for use by the marine energy developers using the site.

FULL SYSTEM SPECIFICATIONS AND DATA REQUIREMENT

This complete system combines onshore and offshore components. The onshore components include marine radar, met station, and a vessel tracking system.

The offshore components include active sonar (50-250 kHz), Acoustic Doppler Current (and wave) Profiler (600 kHz ADCP with ping sampling rate at 2 Hz.), passive sonar (2 hydrophones), a conductivity, temperature, density, turbidity (CTD/Tu) sensor and CCTV.

The passive acoustic hydrophones provide a means to measure ambient and operational noise at the test site, including comparative analysis with short-term, spatial data from drifting ADCP deployments. The data collected was in 30 minute .wav files at a 300 KS/s sample rate 16 bit resolution. Due to location and network restrictions, 2 TBs of raw data backed up to a disk drive and transported back to EMEC offices for analysis using MATLAB.

Principle recorded data for the ADCP's in time series are:

- H_{max}: Maximum wave height
- H_{m0}: Significant wave height
- T_P: Peak wave period
- D_P: Direction of waves at the peak period
- T_{MEAN}: Mean wave period
- D_{MEAN}: Mean wave direction
- U_{BIN}: Flow speed at each vertical bin
- Θ_{BIN}: Flow direction at each vertical bin
- η: Water depth

The CTD/Tu installed provided estimates for speed of sound for calibration of the active and passive acoustic and ADCP data streams. The turbidity sensor provided an estimate of suspended sediment load (fines) in the sea, by measuring scattered light from a sample volume near the sensor.

Two CCTV cameras relayed images back to EMEC's offices, with quality of images as seen in below figure 4.

FIGURE 4 CCTV IMAGES

Making the real-time data feeds available to developers will assist in device design, enable more accurate assessment of device performance, and support operations and maintenance planning.

FIGURE 5. DATA FEEDS FROM EMEC'S INTERGRATED MONITORING POD.

LESSONS LEARNT

Lessons learnt from the design, development and deployment of the Pod are being discussed and planned into future operational deployments of equipment at EMEC. These are summarised below.

Procurement:

The supply of specialised subsea components can be problematic and requires early stage research and planning for long lead times.

Construction:

It is vital to account for the harsh tidal environment that the pod will operate in during construction and the following measures have proven to be key considerations:

- Potential cable movement and exposure to debris can be minimised by 'over-engineering' cables and connectors when routing them.

- Pressure testing enclosures during construction helps to ensure that each module is correctly assembled prior to deployment.

- A strong paint finish, beyond manufacturer recommendations helps to minimise corrosion.

Deployment & recovery:

During all offshore operations, sensitivity to the changeable conditions in a hostile tidal environment is paramount. Thorough and continuous planning is required to ensure safety at all times. Key points noted during this project include:

- Use of four-point mooring system reduces reliance on expensive dynamic positioning vessels and can be undertaken by local marine operators with extensive experience operating in hostile conditions.

- Subsea drop cameras provide improved visibility and more accurate control to the skipper when positioning the vessel as compared to ROV.

Commissioning:

Given the modular nature of the pod, it is necessary to break the commissioning down into clear, granular steps to test each element of the system and various stages. This helps to identify and resolve any issues at an early stage before diagnosis becomes complicated by the wider 'system'

Data collection and analysis:

In general, data collection went well and has benefitted from testing in order to resolve some initial issues and further develop requirements. In particular, flow shielding is beneficial for improved passive acoustic data collection and commercial use of the pod may require on-board processing capability.

Inspection:

Investigation conducted by EMEC staff has revealed corrosion of components designed for use at greater depths for longer periods of time, namely subsea connectors. Further studies into the suitability of small power and signal connectors for use in marine renewable energy projects could benefit the sector and help accelerate its development. Additionally, the degradation of the main cable has highlighted the need to consider additional protection in the dynamic environments used for marine energy deployments.

NEXT STEPS

The Integrated Monitoring Pod was recovered on 19 October 2015 following months of transmitting real-time data feeds.

EMEC is fitting current sensors to the Pod as part of enhancements before redeployment in Quarter 2, 2016.

The pod is set up as a plug-and-play prototype with the ability to install additional sensors as required, with future development focused on supporting data collection at commercial marine energy array projects.

EMEC is keen to collaborate with industry – particularly developers of sensors and those planning marine energy arrays - to drive the development of the Pod further and ensure that it fits the needs of all end users.

ACKNOWLEDGEMENTS

EMEC would like to thank the Scottish Government and the Carbon Trust for supporting the development of the Integrated Monitoring Pod.