Workshop on Environmental monitoring for marine energy – instrumentation for devices and arrays

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European Wave and Tidal Energy Conference, Bilbao, Spain

Background

As marine energy demonstration projects progress towards commercial arrays, the lack of information on potential environmental effects continues to slow consenting, delay deployments, and impose expensive monitoring requirements. For many interactions with marine animals and habitats, observing the potential effects of marine energy devices and systems is challenging due to deployment sites characterized by fast-moving and low visibility waters as well as the remoteness of many projects. While there are few instruments and data systems tailored specifically for observing marine energy interactions, many oceanographic instruments are fit for purpose with specialized calibrations, software, and/or integrated onto platforms that can be deployed on or near devices. Data acquisition systems have been developed for measuring and controlling the power production data streams from marine energy devices, but most do not collect environmental monitoring data streams.

There are no standardized instrument or data acquisition systems in use by the many different research groups and monitoring experts across the nations implementing marine energy projects. Developing a suite of instruments and data acquisition systems that are appropriate for monitoring around marine energy devices will provide researchers and device developers tools for, respectively, acquiring data that will inform regulatory processes, and providing data to regulators to help accelerate those processes. This workshop explored the most promising technologies for two of the most common stressors for marine energy devices (collision risk and effects of underwater noise), as well as worked towards recommendations for preferred sets of instruments and data systems that will support permitting decisions and post-installation monitoring programs, in addition to guidance on the proper use of monitoring systems for tidal and wave installations.

The workshop included a presentation from OES-Environmental on examples of environmental monitoring and mitigation around four tidal and wave projects from the U.S. and Europe: Verdant Power RITE tidal deployment in New York, US; CalWave wave energy deployment in southern California, US; SIMEC Atlantis' MeyGen tidal deployment in Scotland, UK; and AW-Energy's WaveRoller wave energy deployment in Portugal. The presentation also included an overview of six instrumented platforms for monitoring collision risk at tidal energy sites and five acoustic instruments for measuring underwater noise.

Following this presentation, two breakout groups were formed around "collision risk monitoring for a tidal project" and "acoustic monitoring for a wave project", using hypothetical scenarios to address the following discussion points:

- how to collect data at the scale of one device (or a small array);
- how to interpret the data from the initial deployments for the next (larger) phase; and
- how to collect the data as the industry grows to the large-scale commercial array phase.

While most of the discussions focused on the three bullet points above, additional talking points included:

- how to avoid the DRIP (data rich, information poor) issue and collect meaningful data;
- what to include in guidance on the proper use of monitoring systems; and
- what to include in guidance on the development and implementation of an effective monitoring and management plan.

About 40 people from 12 countries attended the event, although about half a dozen did not remain for the breakout discussions. The workshop agenda, attendees' list, and responses to an online post-workshop survey are provided as appendices.

Discussion

Throughout the workshop, discussions were centered around several targeted questions. This section presents those questions and a summary of the discussion.

How do we collect data at the scale of one device (or small array)?

- For tidal energy and collision risk:
  - Cameras, passive acoustic monitoring, and active acoustic monitoring (including sonars), either mounted on the turbine itself or moored at a short distance. This assemblage of instruments should be able to cover multiple scenarios of water visibility and light, a wide diversity of animals, and provide some alternative in case of instrument failure.
  - Optical imagery is preferred over acoustic imagery for fish species identification, especially with current speeds above 2 m/s that can be challenging for sonars, but sonars may be more able to detect nearfield behavior and collision events.
  - Using accelerometers and gages embedded in turbine blades to detect collision events is technically challenging and not recommended.
- For wave energy and underwater noise:
  - Should follow the IEC standards and/or specific requirements from regulators (e.g., NOAA NMFS and BOEM require 3D models).
  - Use at least three hydrophones, not too far away from each other, to be able to triangulate the source of noise.
  - Need to measure noise across as many different sea states as possible, for 10-20 min per hour, alongside wave measurements (height, peak period, directionality).
  - Good baseline and background noise measurements will help interpret how sound propagates at the project site.
  - High frequencies remain hard to measure.

How can the data from the initial deployment be interpreted for the next (larger) phase?

- For tidal energy and collision risk:
  - There remains a lack of empirical data around single devices to train and test models with more devices.
  - Initial optical monitoring should include 24/7 recording and be downscaled to daylight-only after some time with regulators' approval.

  - Gathering lots of data around the first turbine will help identify patterns of behaviors, especially those that would be disrupted with the operation of multiple tidal turbines.
  - Ideally, collision risk will be retired with knowledge collected at the initial deployment scale, once we understand what species are there, when, and how they use the site. The questions should then evolve to what new risks arise as we scale up. At the larger scale, it may not be about the individual risks but larger changes to the environment by removing energy, adding structures, displacing animals, etc.
  - Farfield effects from tidal arrays are currently not monitored (focus is currently on nearfield monitoring for collision risk) and monitoring plans need to be established.
- For wave energy and underwater noise:
  - Regulators and stakeholders need to be convinced that the noise of 30 devices is not 30x the noise of one device.
  - Acoustic propagation models, using baseline data and measurements from the first device, will help assess how the noise from multiple devices will behave.
  - May need to consider a conservative approach, like the offshore wind industry, with worst-case scenarios that don't include destructive interferences.
  - However, if the frequencies recorded around the first device show no overlap with the hearing range of the animals of concern, then models will show that similar results are expected with multiple similar devices, and monitoring may not become necessary.

How will these data be collected as the industry grows to the large-scale commercial array phase?

- For tidal energy and collision risk:
  - It will not be practical to instrument and monitor each and every turbine in an array, nor to maintain all the instruments and process all the data. For instance, the excessively high cost would not be sustainable for a developer and there would be bottlenecks around data storage and processing, as well as expertise to handle and interpret the data. Monitoring intensity will need to be adjusted.
  - A few instrumented platforms could be strategically deployed in and around an array; or have a few highly monitored turbines, with the others left unmonitored.
- For wave energy and underwater noise:
  - Drifting hydrophones could be used to identify hot spots of positive or negative interferences within/around an array and determine the number and locations of fixed hydrophones for long-term monitoring.
  - When using multiple hydrophones, the time synchronization has to be absolutely precise to enable triangulation.
  - A multibeam side-scan sonar could be used to precisely identify the location of each hydrophone once deployed.
  - Researchers need to determine the ideal total number and locations of hydrophones to make recommendations to developers and regulators.

How do we avoid the DRIP (data rich, information poor) issue and collect meaningful data?

- For tidal energy and collision risk:
  - Development of ML/AI for species identification may enable to decrease the efforts to process optical imagery while increasing the reliance on optical cameras.

    - Autonomous data processing algorithms able to discard unnecessary footage and recordings can also help with data storage, in addition to cloud storage.
    - Ensure monitoring plans enable collecting data that will satisfy stakeholders' concerns, not just be scientifically correct.
- For wave energy and underwater noise:
    - Once devices are ready to deploy and fully operational, measure only around one and use back-propagation models from that verified sound source (approach taken by oil & gas and offshore wind industries).
    - Most of the time, regulators just need high-level summaries of device frequencies and sound levels across sea states, not time series.

What do we include in guidance on the proper use of monitoring systems, and guidance on the development and implementation of an effective monitoring and management plan?

- For tidal energy and collision risk:
    - There is a difference between "collision risk" and "collision". Collision risk monitoring is to understand what/how many animals are around and at risk of collision; collision monitoring is to look at the actual event.
    - Guidance needs to be put in place by an approved national or international body for regulators in other countries to adopt, potentially with local adaptations.
- For wave energy and underwater noise:
    - There has to be an incentive for marine energy companies to share information for the greater good – and not just as a black box to give to the government.
    - However, projects usually have to disclose their data if publicly funded, especially in the E.U. and U.S.
    - There needs to be an organization in place to help certify the device frequencies and sound levels that shared publicly.

Next Steps

- Update critical evidence needs in the global context.
- Develop a description of commonalities and differences among consented projects worldwide for the 2024 State of the Science report.
- Enhance collaboration and exchange between monitoring and research teams.

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Appendix 1: Workshop Agenda

Start Time	Agenda Topic
16:00	Introductions, purpose of the workshop
16:10	Monitoring plans, collision risk instruments & platforms, acoustic instruments, scenarios
16:35	Breakout discussions
17:15	Report out
17:25	Next steps
17:30	Adjourn

Appendix 1: Workshop Attendees

Name	Affiliation	Country
Angela Williamson	Blue Economy CRC	Australia
Irene Penesis	Blue Economy CRC	Australia
Hugh Wolgamot	University of Western Australia	Australia
Bruce Cameron	Envigour	Canada
Maricarmen Guerra	Universidad de Concepcion	Chile
Martin Moreau	HydroQuest / Ifremer	France
Abbascadeh Sholcoaheh	Otto Von Guericke University	Germany
Stefan Hoerner	Otto Von Guericke University	Germany
Ralf Starzmann	Schottel	Germany
Maximilian Hengstmann	University of Stuttgart	Germany
Tony Lewis	Ocean Energy & MAREI	Ireland
Benedicte Hoofd	Blue Oasis	Portugal
Erica Guy	Hydrotwin	Portugal
Rodrigo Sanz	Magallanes Renovables	Spain
Sam Fredriksson	SMHI, University of Gothenburg	Sweden
Goran Brostrom	University of Gothenburg	Sweden
Jan Sundberg	Uppsala University	Sweden
Hsu Wen Yang	Industrial Technology Research Institute	Taiwan
Shian-Yie Tzang	National Taiwan Ocean University	Taiwan
David Gold	CGG	UK
Naomi Wood	European Marine Energy Centre	UK
Paul Evans	Intertek	UK
Gabriel Scarlett	Mocean Energy	UK
Cameron Johnstone	Strathclyde Univ	UK
Benjamin Williamson	University of the Highlands and Islands	UK
Lorraine Minatoishi	Architecture & Engineering serving the Pacific Region	U.S.
Grace Chang	Integral Consulting	U.S.
Kaus Rashukumar	Integral Consulting	U.S.
Tim Mundon	Oscilla Power	U.S.

Pedro Lomonaco	Oregon State University	U.S.
Jezella Peraza	University of Washington	U.S.
Jackie Culotta	U.S. DOE / NOAA	U.S.

Appendix 2: Online Survey

Eight workshop participants responded to the online survey that was offered at the end of the workshop. The questions and answers are presented below.

1. How would you rate the workshop?
    - Excellent: 6/8
    - Very good: 2/8
2. What did you like about the workshop?
    - The two case studies - good to get into the specifics and consider when the perceived risks are important in wave and tidal projects. Andrea and Ian are a very good team. I like how they communicate what they are finding and what's next. Great job.
    - Background info + group activity: great combination.
    - Knowledge of panel, subject matter experts and participants. Really good interaction, everyone felt at ease to put their ideas across.
    - Great interaction at scientific level.
    - People's enthusiasm and interest.
    - Interacting with broad range of experts.
    - Accessible.
3. What did you dislike about the workshop?
    - I disliked nothing.
    - Pity that we had to choose between the two topics, both equally interesting.
    - Not enough time for discussion.
    - Not enough time. Maybe more info on TS 30 could have helped.
    - Nothing really.
4. What other topics would you like to see addressed in future workshops?
    - Cumulative environmental assessments. When is the cumulative effect from a wave and/or tidal farm an impact or a benefit to the environment? What can we learn about this from offshore wind farms?
    - Social aspects.
    - Bringing industry, regulators, and academia together.
    - Similar interpretations of TS 30.
    - Similar but expanded.
    - Wider range of stressors.
5. Do you have any additional feedback for the team?
    - Thank you!
    - Great work!
    - Very positive with good preparation.
    - Good work!!