



**Stakeholder Workshop on
Environmental Effects of
Marine Energy: North
Carolina**

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Stakeholder Workshop on Environmental Effects of Marine Energy: North Carolina

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North Carolina Coastal Studies Institute, Wanchese, North Carolina
Duke University Marine Laboratory, Beaufort, North Carolina

Facilitators

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Background

Marine energy is defined as the energy harvested from the movement of water in the oceans or large rivers and from ocean gradients. As marine energy project deployments are increasing around the world, there is a need to monitor for potential effects on the marine environment. Based on studies in the U.S. and internationally, responsible development of low carbon sustainable and renewable energy from the ocean can be developed along our coasts without impacting the environment and the uses that support the region.

The Atlantic Marine Energy Center (AMEC) is a university-led consortium created to address the ongoing needs for research, development, and testing on the Atlantic Coast to advance utility-scale marine energy technologies towards commercialization, and to develop smaller-scale off-grid applications. To support AMEC’s effort, researchers from Pacific Northwest National Laboratory (PNNL) and the North Carolina Coastal Studies Institute (CSI) have developed a focused outreach and engagement process around the science of what we know about environmental and social effects of marine energy development, as they pertain to project permitting and development. In 2023 and 2024, the project team conducted in-person stakeholder workshops to specifically deliver the state of knowledge regarding potential environmental and social effects of marine energy in New Hampshire¹, focused on tidal energy, and in North Carolina, focused on wave energy and ocean current energy.

Two workshops were held in North Carolina: at CSI in Wanchese, and at Duke University Marine Laboratory (DUML) in Beaufort. The workshop discussed what is known about effects of wave energy and ocean current energy on the marine environment, marine animals, and the habitats that support them, as well as the human activities that rely on them, with a focus on the Outer Banks area and the Gulf Stream current. The workshop was specifically designed for community members interested in marine energy development. In addition to gaining insight into the state of the science of marine energy environmental and social effects, attendees were able to ask questions and express their interest and

¹ <https://tethys.pnnl.gov/events/stakeholder-workshop-environmental-effects-marine-energy>

concerns about marine energy projects. While no wave or ocean current projects are presently planned for North Carolina and the surrounding area besides device testing at Jennette's Pier Marine Energy Test Center, these waters may be ideally suited for supplying secure locally generated power from wave energy or ocean current energy in future.

The workshop included a presentation with an introduction to marine energy development on the U.S. east coast and some of the challenges it faces; a high-level summary of marine energy environmental and social effects and how they differ from those of offshore wind; and an overview of resources developed to assist with permitting and stakeholder engagement. The presentation also included the description of two fictitious marine energy use cases: wave energy for off-grid applications in shallow waters off northeast North Carolina, and ocean current energy for off-grid applications off the central coast of North Carolina. These use cases were leveraged in the group discussions to trigger questions including the following discussion points:

- what word comes to your mind when mentioning marine energy?
- which of the environmental effects presented is of greatest concern? and
- what was missed, what topics of interest were not mentioned?

Five participants attended the CSI workshop in Wanchese, representing a range of state agencies, university, and Sea Grant staff, while ten participants attended the DUML workshop in Beaufort, representing a range of state agencies, university, Sea Grant, The Nature Conservancy, National Seashore (National Parks Service), and local residents. The responses to an online post-workshop survey are provided as Appendix 2, along with the workshop agenda (Appendix 1) and a list of the questions asked by workshop attendees (Appendix 3).

Discussion

The attendees were encouraged to ask clarifying questions throughout the workshop presentations, as well as participate in the group discussion that centered around targeted questions. This section presents those questions and a summary of the discussion. Offshore wind was often brought up in the discussions, as much as possible the team explained what parts of the material presented applied to offshore wind (as well as marine energy) and where differences lie.

What word comes to mind when mentioning marine energy?

This question was asked of the participants at the beginning of both workshops to understand their initial perception of marine energy. This allowed the team to adjust the appropriate level of information provided to the audience on the potential environmental effects of marine energy and the differences with offshore wind. The question was asked again at the end of each workshop to assess whether the participants' perception had changed. Below (Figure 1) are the four word clouds with the answers to the question, from the CSI workshop on the left and the DUML workshop on the right, beginnings of each workshop on the top and the end of each workshop on the bottom, respectively.

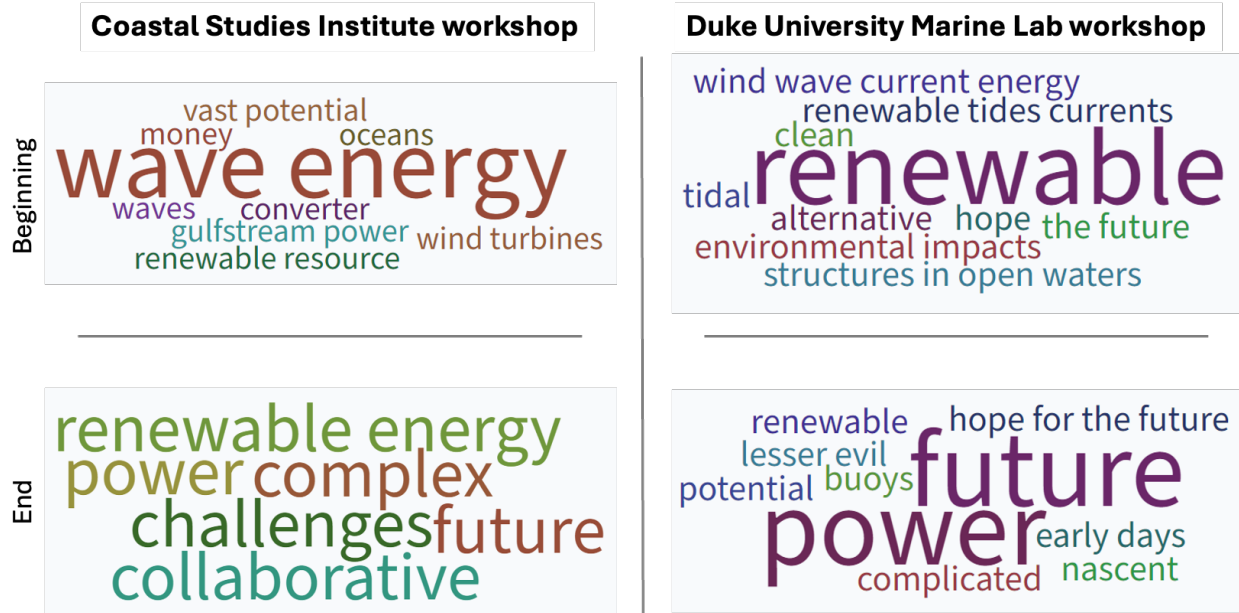


Figure 1. Words that came to the participants’ mind when mentioning marine energy: CSI workshop on the left and DUML workshop on the right, beginning of each workshop at the top and end of each workshop at the bottom, respectively.

Which of the environmental effects presented is of greatest concern?

In this subsection, the main bullets refer to the environmental effects of greatest concern listed by the workshop participants, and the sub-bullets refer to the follow-on discussion between the facilitation team and the participants. Discussions on similar topics from the two workshops were merged under a same bullet.

- Habitat change:
 - In fisheries management, habitat loss is the major concern, having trouble determining what habitat would be lost from what would be gained.
 - The footprint of a wind farm is about 16 km², in 420,000 km² of continental shelf – tiny drop in the bucket compared to the amount of space that is out there; marine energy would have a smaller footprint.
 - Scale of marine energy is miniscule compared to dredging for beach replenishment and bottom trawling.
 - Fish trawling is a big conflict with offshore wind; wind farms will not have “no go” zones in the US.
 - The big difference in Europe is that wind farms are off limits to fishing, they turn into functional MPAs.
 - Closing down waters here by Army Corps of Engineers is a big deal as opposed to in Europe, due to public trust waters.
 - What about considering how the project might affect the shore, not just the water?
- Interest in human and fisheries interactions, what is the biggest concern with this?
 - Access, something is going to be taken away.

- What are the solutions?
 - Mapping exercises with fishermen to collaborate in siting.
 - Collaborative decision making needs to be done location by location, not transferable because people need to feel like they have a say.
- Do you wait for collaborative decision making until there is a proposal?
 - Some people would feel betrayed if you wait until the developer shows up, you would want to involve the stakeholders early on.
 - There needs to be a balance between getting the right people involved and being mindful of people's time if you are going to get them involved early.
 - Maybe talk about the siting considerations for fisheries early on, that way when something is proposed, they are already aware, and then they can be informed of the finer details.
- It is important to consider where fisheries might want to go 10, 20, and 30 years from now, in addition to areas currently fished.
- For fisheries or stakeholders in general, the wording can be important. Saying a device is new and permanent can have negative connotations and can create hesitancy. If you phrase it that marine energy devices can be removed if they need to and they need to have decommissioning plans, then you are most likely to have support
 - Adaptive management based on monitoring data and marine spatial planning is important.
- Who pays the price and who benefits from renewable energy?
 - Offshore wind paid a high price because of concerns around the North Atlantic right whale.
- Aquaculture and marine energy in North Carolina
 - Mainly oysters and other bivalves, in estuaries, or indoor, not much potential or interest in sea pens.
 - Mostly an economic and siting feasibility issue.
- Research community is using the fishing community for research employment, which could potentially offset some of the conflict if they build trust and fishers see the process for themselves.
- Approach of environmental effects along the Atlantic Coast
 - The Atlantic Coast is really like four separate ecosystems that are constantly changing and moving, so stressor-receptor interactions will be different based on where exactly you decide to place a device.
 - Some animals use the Gulf Stream as transit so that is an additional risk.
- Mooring lines
 - Not concerned about tensioned lines to the seabed but concerned about the draped tethers from the surface buoys in PBE applications.
 - Worries about biofouling or debris (e.g., sargassum) accumulating on the lines, causing animals like sea turtles to feed on the lines and face increased entanglement risk.
 - Cleaning of mooring lines would be helpful, but it will likely not be often enough.
- Cumulative impacts
 - Large arrays of marine energy devices could change the scale of other environmental impacts, like climate change.

- What about various lubricants inside the device?
 - Vast majority of devices are water lubricated, so there shouldn't be any toxic spills.
 - Toxic spills may become a concern for floating wind.
- What are the hypothetical speeds of turbines?
 - Pretty slow, about 15 to 25 rpm.
- Are there other differences that we can identify between wind and marine energy?
 - No pile driving installation.
 - Scale is much smaller.
 - No risk for birds and bats collision, expect diving seabirds with tidal turbines.

What was missed, what topics of interest were not mentioned?

In this subsection, the main bullets refer to the omitted topics of interest listed by the workshop participants, and the sub-bullets refer to the follow-on discussion between the facilitation team and the participants. Discussions on similar topics from the two workshops were merged under a same bullet.

- Economic feasibility and benefits
 - 95% of failed projects around the world are due to money issues.
 - Partnering with things that already exist could help reduce co-use conflicts and economic loss.
 - Marine energy devices can use smaller ports, smaller vessels, and smaller supply chains.
 - Towns in Scotland have been transformed by the marine energy industry, but also causes some strain on economic systems by too many people so the town would need to be able to sustain it.
 - Who pays and who benefits
 - Does AMEC have social scientists that are looking at this?
- Energy production
 - How much energy, what size, and where is it going? What is the benefit vs. risk?
 - Marine energy will not go head-to-head with wind or solar or land-based energy.
 - More about energy justice for small communities and island communities, powering a coastal community with frequent outages would be worth the risk.
- Climate change considerations
 - Marine energy devices can be moved to new places in case things shift due to climate change, but more modeling needs to be done.
 - OES-Environmental is going to be doing more work around climate change.
 - Using marine energy to power mCDR technologies.
 - Some mCDR companies are doing uncontrolled experiments around the world, which could cause impacts, so need to be aware of that.
 - Vesta group in North Carolina is starting a trial of beach enrichment with olivine.
- Shipping as a stakeholder group
 - Barge and tow
 - Offshore boating – yachts
 - Shipping industry uses the Gulf Stream to save fuel
- Visual clutter

- Learning from wind, getting ahead of this for an array will be important.
- Nearshore aquaculture has not done very well with visibility concerns, so it could be a concern when surface arrays develop.
- Some surface tidal devices look enough like boats that people haven't complained.
- Wind farm in Brunswick County was pushed out farther due to very slight visual impacts.
- What type of device is most likely for this region?
 - Smaller scale blue economy.
 - Wave and ocean current.
 - Using an existing structure would be the best idea.
- What is the future of this technology in the South-East U.S.?
 - Some potential in the Gulf Stream but likely a way off due to significant technical challenges.
 - Some tidal potential in the Florida Keys.
 - Most suitable areas seem to be Cape Hatteras and Florida straits.
- Is Gulf Stream energy harnessing viable?
 - Because of the vastness of the resource, it needs to be considered.
 - Start with small scale, like powering AUVs.
 - Wave energy may be more viable.
 - Climate change may influence the resource.
 - There are many organisms that spend time in Gulf Stream.
- Is there a marine debris potential?
 - We have seen it over the last 10 – 15 years, but we are seeing less of it as the industry develops.
 - Bay of Fundy turbine lost its blades within a short amount of time due to misunderstanding of current strength and engineering needs.
 - Something important to consider when talking to stakeholders, particularly for boaters.
- How do we get this information to the people where it needs to go? Like governments or regulators?
 - By doing more workshops like this.
 - With the State of the Science reports and related outreach material.
- How messy is this likely to be with permitting with federal and state governments getting involved?
 - We can't reinvent the wheel each time and need to leverage experience from past deployments, successful or not.
- How does the present push for marine energy compare to previous interest?
 - In 2008, WPTO received its first funding for marine energy and hydropower, but it was originally an idea in the 1960s.

Next Steps

- Synthesize common themes across the three workshops.
- Identify avenues for future engagement activities.

Appendix 1: Workshop Agenda

Start Time	Agenda Topic
1:00 pm	Arrivals
1:20 pm	Introductions, objectives of the workshop
1:30 pm	Introduction to marine energy
1:45 pm	Marine energy environmental and social effects
2:15 pm	Marine energy permitting and stakeholder engagement
2:45 pm	Break
3:15 pm	Wave and ocean current use cases presentation
3:35 pm	Group discussions
4:45 pm	Wrap up

Appendix 2: Online Survey

Three 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: 1/7
 - Very good: 4/7
 - Good: 2/7
2. What did you like about the workshop?
 - The ability to have discussions and ask direct questions.
 - Plenty of information.
 - Learning about marine energy.
 - Overall interaction.
 - Very interactive experience.
 - Open format, accessibility to experts.
 - Informative and knowledgeable presenters.
3. What did you dislike about the workshop?
 - Not enough test sites in the Southeast.
 - The diversity of stakeholders was low.
 - Nothing.
4. What other topics would you like to see addressed in future workshops?
 - More economic information, like energy generation or jobs creation.
 - Add a section on Blue Economy applications.
5. Do you have any additional feedback for the team?
 - Keep up the Tethys work. Websites and databases are excellent.
 - Thanks!!
 - None come to mind.

Appendix 3: Questions from attendees

CSI Workshop 3/25

- How often do the OES-Environmental State of the Science reports come out?
 - End of each phase, every 4 years
- Was there much discussion about EMF for PacWave?
 - PacWave had to do baseline and post installation EMF monitoring
- Has anyone looked at the animals that live in the sediment and their sensitivity to EMF?
 - Some have looked at invertebrates in the sediment but mostly related to temperature changes due to cables rather than EMF
- Have there been any studies in Cook Inlet?
 - There has been research but no devices yet
- How deep are the ocean current devices in Japan and Korea?
 - Not sure but they are not off the continental shelf
- Can we learn about changes in oceanographic systems from large aquaculture systems?
 - They are not really analogous
- Is there anywhere in the world where marine energy devices are at a commercial scale?
 - First ones are in the UK, but they are scaling up in steps, starting at 4 and could go up to 86 – MeyGen and Nova Innovation with 7 smaller turbines in the water
 - Also going to commercial scale with tidal kites on Faroe Islands
- Which of the companies are using the drone shape on the surface?
 - Orbital, Mangallenes, and others
- Might consider DOD in relevant agencies for permitting
 - We do have to consider DOD for permitting but it is a challenge
- Does offshore wind have something similar to stakeholder engagement process as marine energy?
 - [SEER](#) is starting to put out information on offshore wind
 - East Coast also has many groups that has a lot of this info available
- Manatee would be a receptor for Jennette’s pier, giant manta ray not likely
- Right whale would be a receptor in the Gulf Stream, but the sturgeon is likely too far away
 - Should have more shark species – hammerhead, dusky sharks, black nose shark, etc.
 - Many species on the IUCN list are not included in regulatory processes because they are not classified as endangered or threatened, but they should be considered
- Department of Defense, shipping, fisheries should be added to stakeholders for Gulf stream

DUML Workshop 3/27

- Are floating tidal turbines moored? Yes.
- Surprised not to see secondary entanglement not on this list, and is attraction included in displacement? Yes.
- You still have to anchor these systems, so how are they anchored? Not pile driving?
 - Gravity based, pin pile, embedment anchors, etc. but no pile driving.
- There are no utility scale marine energy devices in the U.S., so how do we know that operational noise will fall below U.S. underwater noise thresholds?

- International standards require baseline surveys at the site to understand the ambient noise first before adding a device, and modeling studies enable predicting noise levels from additional devices
- Does the wave flap have a lot of noise?
 - Interestingly the most noise have been coming from the mooring chains rattling around
- Have cumulative effects been studied? Not yet.
- Important to poke holes in marine energy before it gets developed too far in order to identify the risks early on before it gets taken over by people who don't care about the risks
 - We are trying to learn from wind and oil and gas and get out ahead of it
- Are crabs killed by EMF?
 - Sometimes they are attracted or repelled, but not killed
- What is the goal of scaling up in Scotland?
 - MeyGen in Pentland Firth has 4 turbines and is permitted for 86, other projects underwater as well
- Will the size of devices be increased when scaled up?
 - 1- 2 MW is probably as big as they will get
 - About 12 – 18 meters diameter for turbines
- How are large arrays of big turbines different from dams and animal passage?
 - Turbines move very slowly
 - There isn't just one exit to get away from the turbine but the whole space around
- When BOEM looked at Kitty Hawk South, they did an assessment early on, and then decided against it. But then went back to it and regulators didn't make them redo the assessment even though it had been years
 - Developer will still be required by BOEM to conduct baseline surveys before any construction begins
- What happens to floating things like algae and jellyfish that can't move out of the way of a turbine?
 - Because of hydrodynamics and diversion in front of turbines, some of the small immobile organisms go around
- In 200 to 300 years, could arrays scale up to hundreds to thousands of turbines?
 - Likely the environmental effects will keep the industry from scaling up that much.
- Are there studies on wind farms that show changes in oceanographic conditions?
 - Yes, it's called the wake effect; mostly modeling studies.
- Is there information on where these devices are sited?
 - Nothing currently planned for North Carolina at this point
- Environmental effects on benthic organisms such as vibrations of cables?
 - Haven't seen many negative impacts on benthic habitat, at least where organisms cannot recover
 - Some developers try to design their anchors and cable protections to create more desirable habitat with nooks and crannies
- Mitigation measures for biofouling, especially for moving parts?
 - Most dynamic parts don't biofoul because of the motion
 - Devices could be a stepping-stone effect for invasive species, but this have never been shown (despite targeted studies) but it should be monitored

- Would there be scour protection for any of these devices?
 - Could get scour in rivers or shallower depths and that would require mitigation
 - Very few devices are on piles like offshore wind and only minimal scour will occur around anchors
- Is transmission cable AC or DC?
 - AC, and there will be underwater substations and transformers to combine into one export cable, which will have stronger EMF than cables from every single device
 - Working up towards DC for longer cables to move energy more efficiently (HVDC)
- Environmental impact is not just from the device itself, it needs to be considered for the whole system, including the cables and mooring lines
 - Agreed, and the research community is looking into it
- How far can you drill under the sediment to avoid the intertidal zone?
 - On the scale of miles, mostly limited by cost
- Every energy, including renewable energy will have a cost and it is important to consider those
- For the wave use case would the cable from the WEC to the buoy be in the sediment or water column?
 - It would be draped in the water column so there would be some EMF in the water column and it would not be able to be buried to mitigate that risk, but the EMF dies off quickly to background levels
- U.S. Coast Guard should be on the use case list of stakeholders
- What is the scale of an ocean current turbine?
 - About 10 meters wide but could be up to 30 meters
- What is the resilience of an ocean current turbine to a tropical storm in the Gulf Stream?
 - Subsurface devices can help avoid that weather if deep enough
 - Some devices have built-in tech to pull them down in the water column in the case of storms
 - Would most likely plan deployment and regular maintenance to avoid hurricane season
- Hypothetically, you would probably get marine energy in the water quicker than you would get offshore aquaculture in North Carolina
- What about powering the Pioneer Array?
 - Series of buoys and gliders that sample and monitor area, ocean observation system
 - It's in the works, Sandia and other national laboratories are looking at ways to power the buoys with wave energy
- Have you reached out to the owner of Frying Pan Shoals tower to potentially power with marine energy?
 - No, but this old observation station platform could be an interesting use case
- What definition do you have for habitat changes? Is there an impact on megafauna at big project sites?
 - Any modification to the benthic and pelagic habitats between baseline and operation that stand out from natural variability; megafauna are part of the ecosystem so any impact to their habitat is considered
- Is it really realistic that marine energy can make up the whole 20% of remaining energy?
 - No, it will be a case-by-case scenario, and as part of an "all of the above" mix for renewable energy sources

- How many jobs do these types of projects generate, permanent vs. temporary?
 - Manufacturing, installation, maintenance, supply chain, all create jobs
 - Port cities will benefit
 - Fishers in the North Sea are working for tidal energy companies to avoid losing their jobs