Environmental Effects of Marine Energy: Wave and Ocean Current Energy in North Carolina

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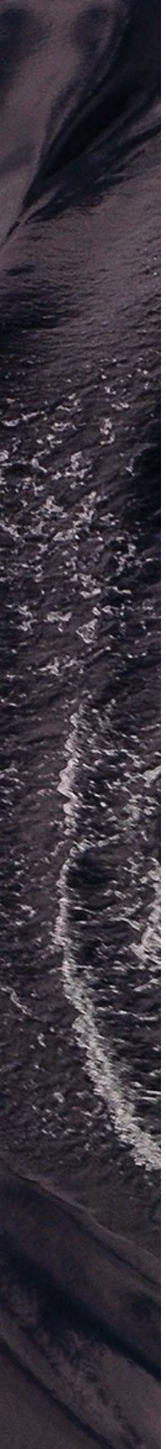


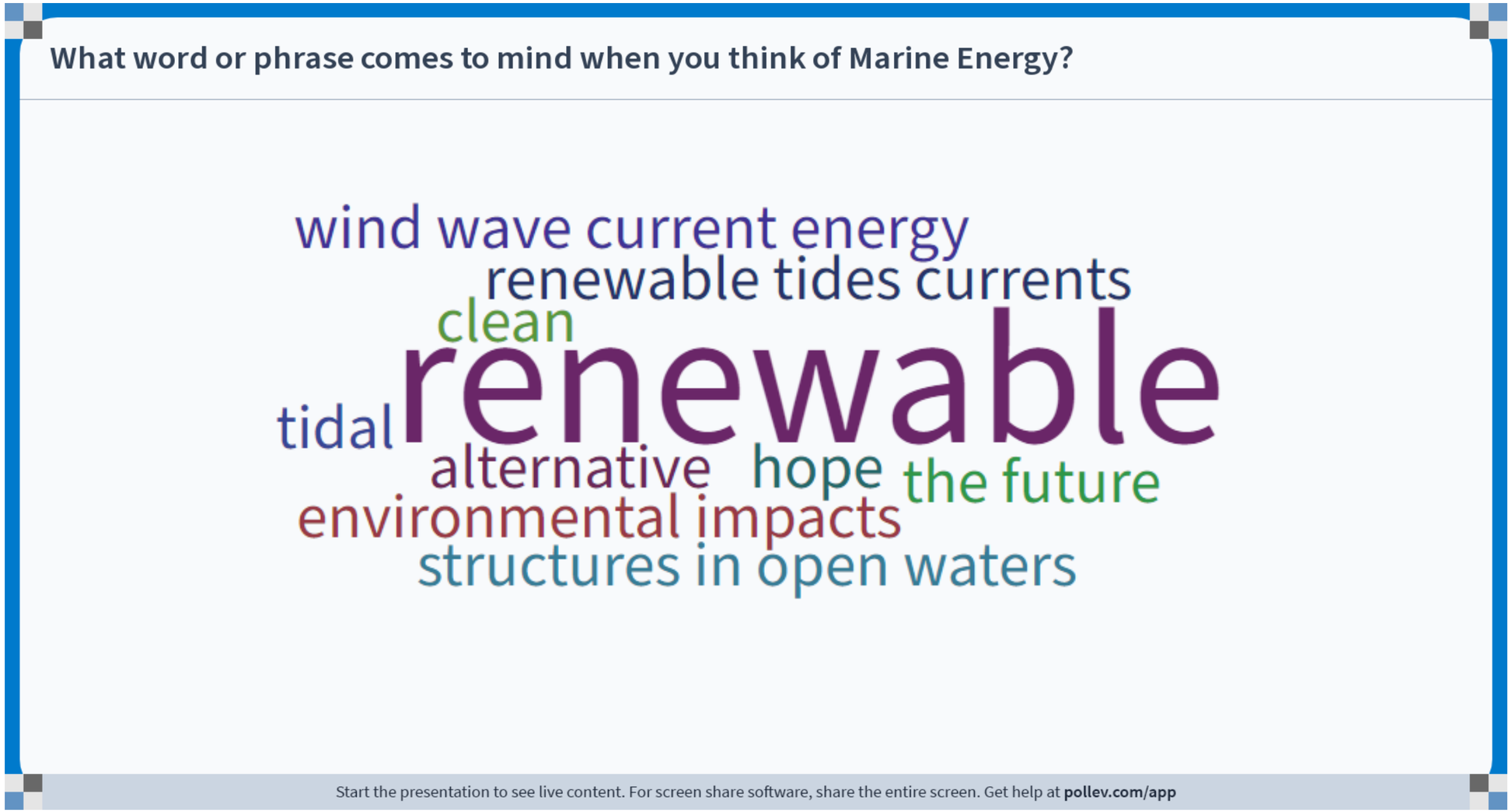
Agenda

Agenda Topic
Arrival
Introductions, objectives of the workshop
Introduction to marine energy
Marine energy environmental and social effects
Marine energy permitting and stakeholder engagement
Break
Wave and ocean current use cases presentation
Group discussions
Wrap up

Introductions

What brought you to this workshop?

What word or phrase comes to mind when you think of Marine Energy?



Objectives of the Workshop

1. Describe environmental and social effects of marine energy and how they differ from those of offshore wind
2. Examine wave energy and ocean current energy projects that might come to North Carolina
3. Collectively learn more about North Carolina coast and marine energy

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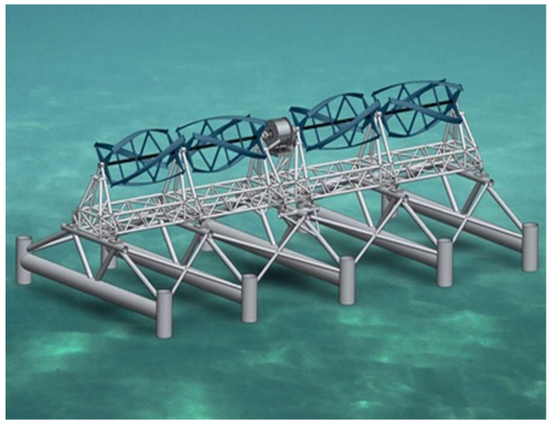
Introduction to marine energy

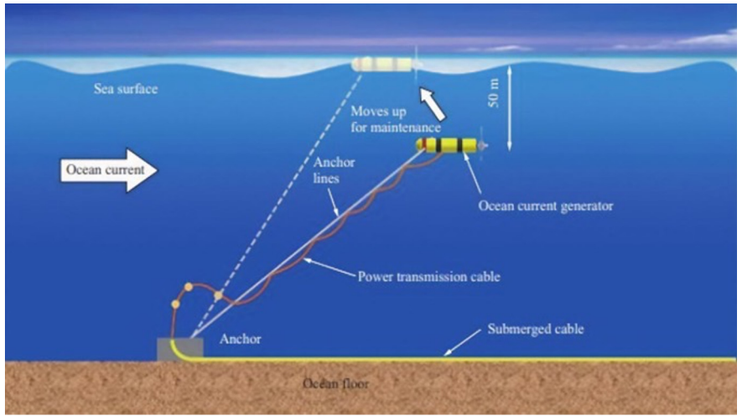
Marine Energy – a new use of the ocean

- Energy harvested from movement of seawater, other features
- Tides, waves, ocean currents, large rivers, thermal & salinity gradients
- Marine energy does not include offshore wind



ORPC

Orbital Marine

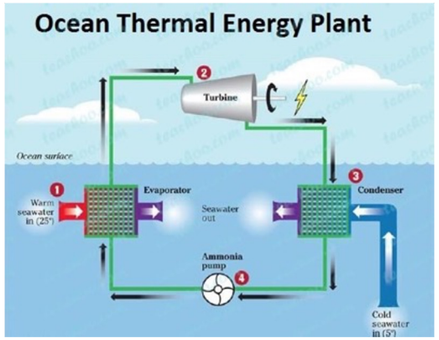


IHI Corp.

Wello

Fred. Olsen

Corpower

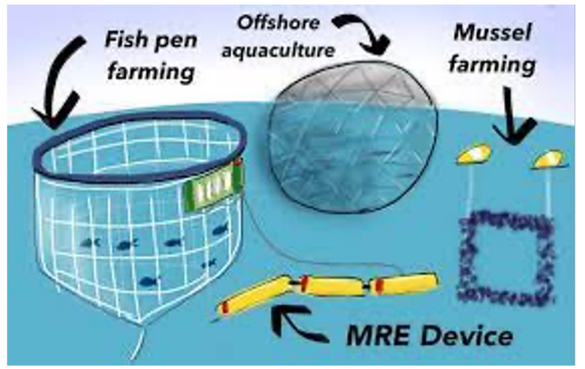


Why Develop Marine Energy?

- Solar and wind can provide 80% of world's renewable energy
  - Marine energy is important piece of 20%
- Additional renewable source for nations' portfolios
- Huge resource in oceans
- Locations/uses where marine energy is unique
  - High latitudes
  - At sea uses (ocean observations, aquaculture, biofuels from macroalgae)
  - With energy storage, microgrids for remote coastal areas, islands

National Public Radio

Geomar



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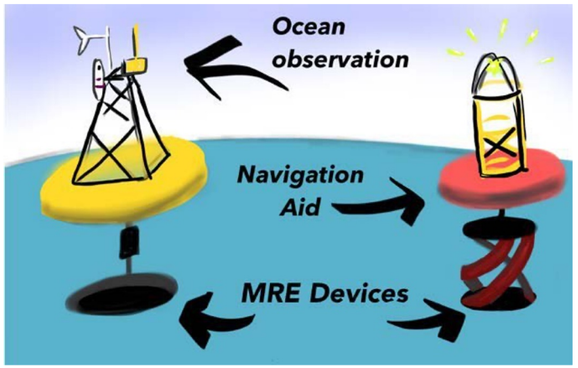

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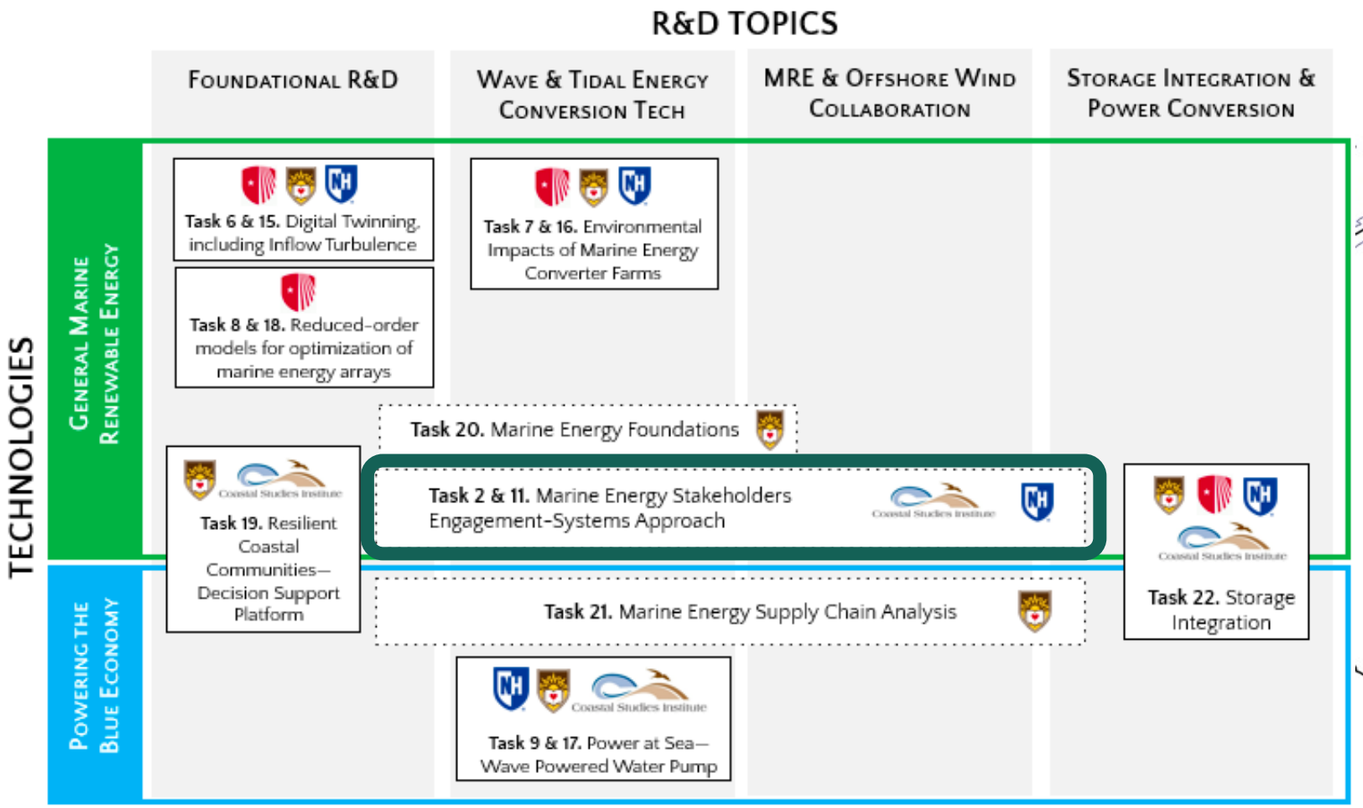
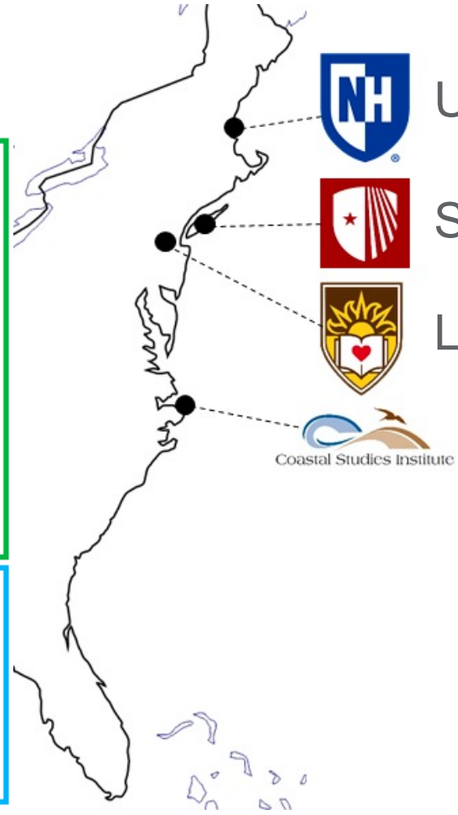
Atlantic Marine Energy Center





University of New Hampshire

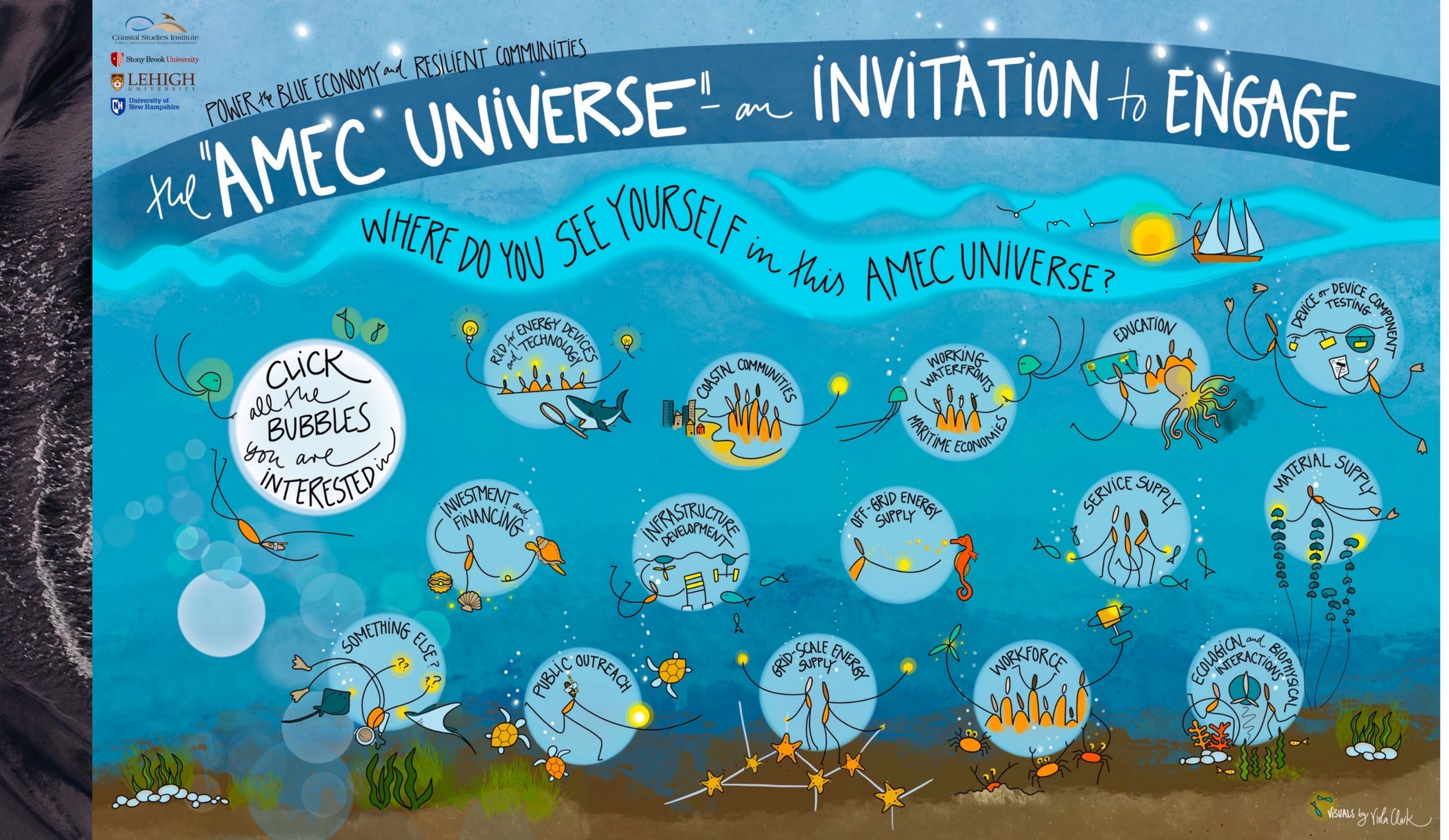
Stony Brook University

Lehigh University

Coastal Studies Institute

Develop a focused outreach and engagement process around the science of what we know about environmental and social effects of marine energy development

Atlantic Marine Energy Center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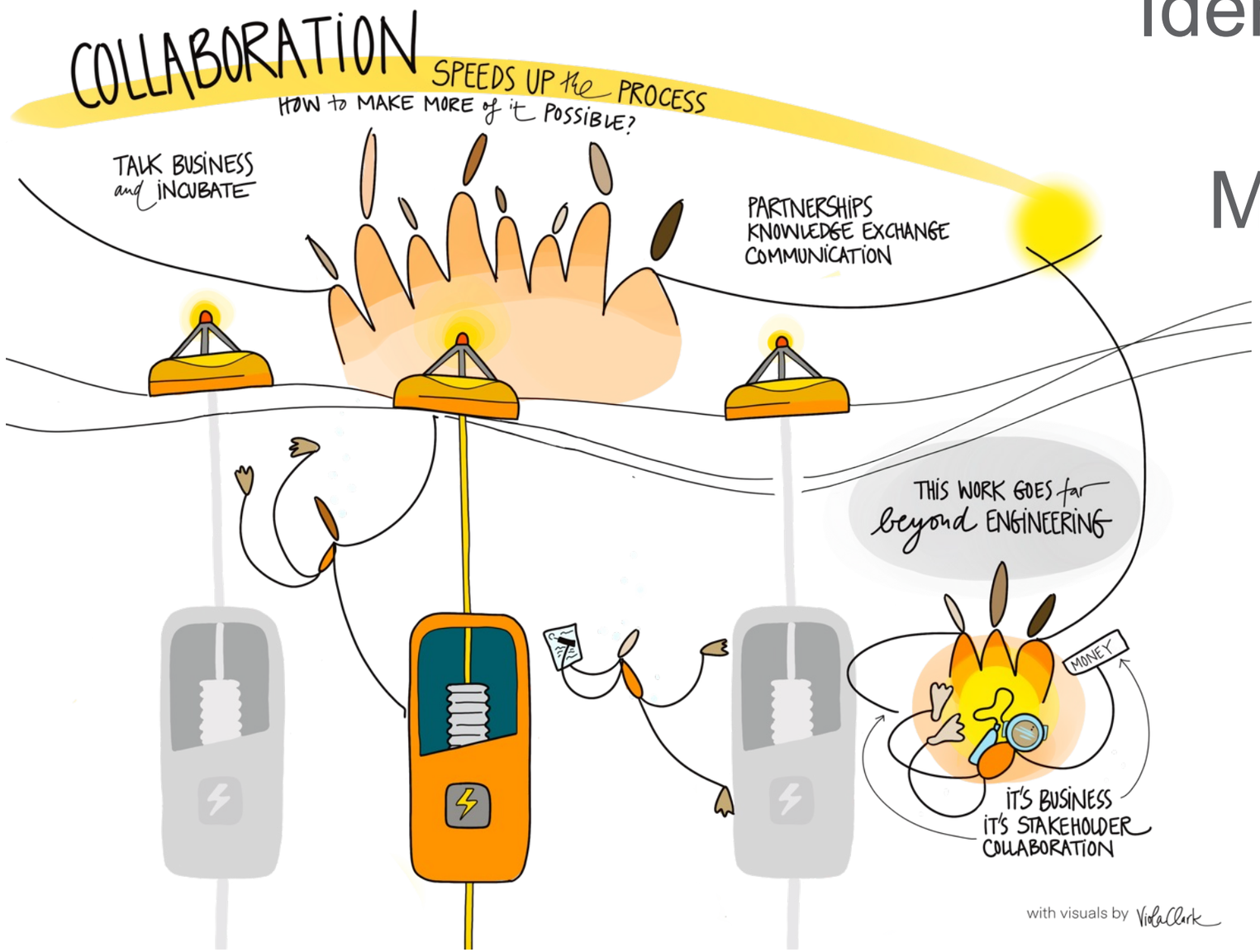
A Multi-Institutional Research Partnership
Stony Brook University
LEHIGH UNIVERSITY
University of New Hampshire
POWER the BLUE ECONOMY and RESILIENT COMMUNITIES
the "AMEC UNIVERSE" – an INVITATION to ENGAGE
WHERE DO YOU SEE YOURSELF in this AMEC UNIVERSE?
CLICK all the BUBBLES you are INTERESTED in
R&D for ENERGY DEVICES and TECHNOLOGY
COASTAL COMMUNITIES
WORKING WATERFRONTS
MARITIME ECONOMIES
EDUCATION
DEVICE or DEVICE COMPONENT TESTING
INVESTMENT and FINANCING
INFRASTRUCTURE DEVELOPMENT
OFF-GRID ENERGY SUPPLY
SERVICE SUPPLY
MATERIAL SUPPLY
SOMETHING ELSE?
PUBLIC OUTREACH
GRID-SCALE ENERGY SUPPLY
WORKFORCE
ECOLOGICAL and BIOPHYSICAL INTERACTIONS
VISUALS by Viola Clark



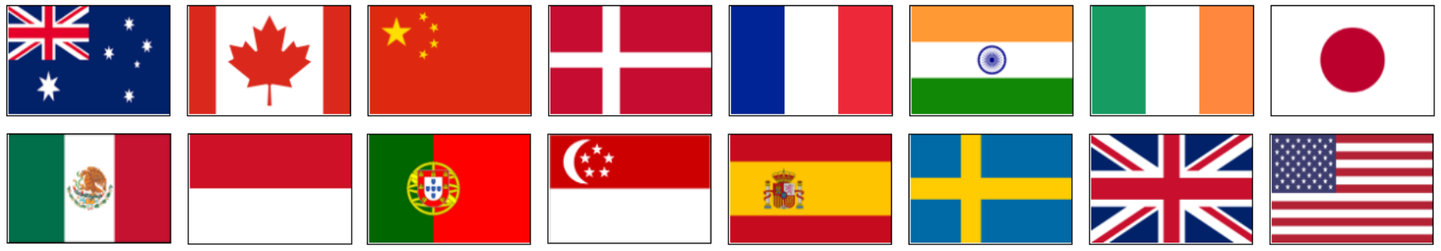
Identify and connect
Engage
Make connections

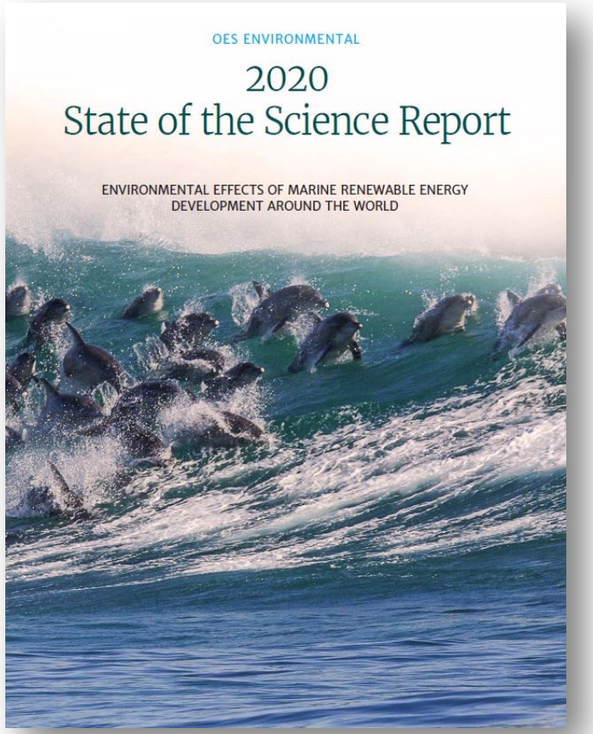
Dive in with us!

Atlantic Marine Energy Center

OES-Environmental

- Established by the IEA - Ocean Energy Systems in 2010
- Led by the U.S. DOE Water Power Technologies Office and implemented by Pacific Northwest National Laboratory
- 16 member countries for Phase 4
- Examines environmental effects of marine energy development to advance the industry in a responsible manner
- Publishes syntheses of the current available knowledge on environmental effects (e.g., State of the Science reports)





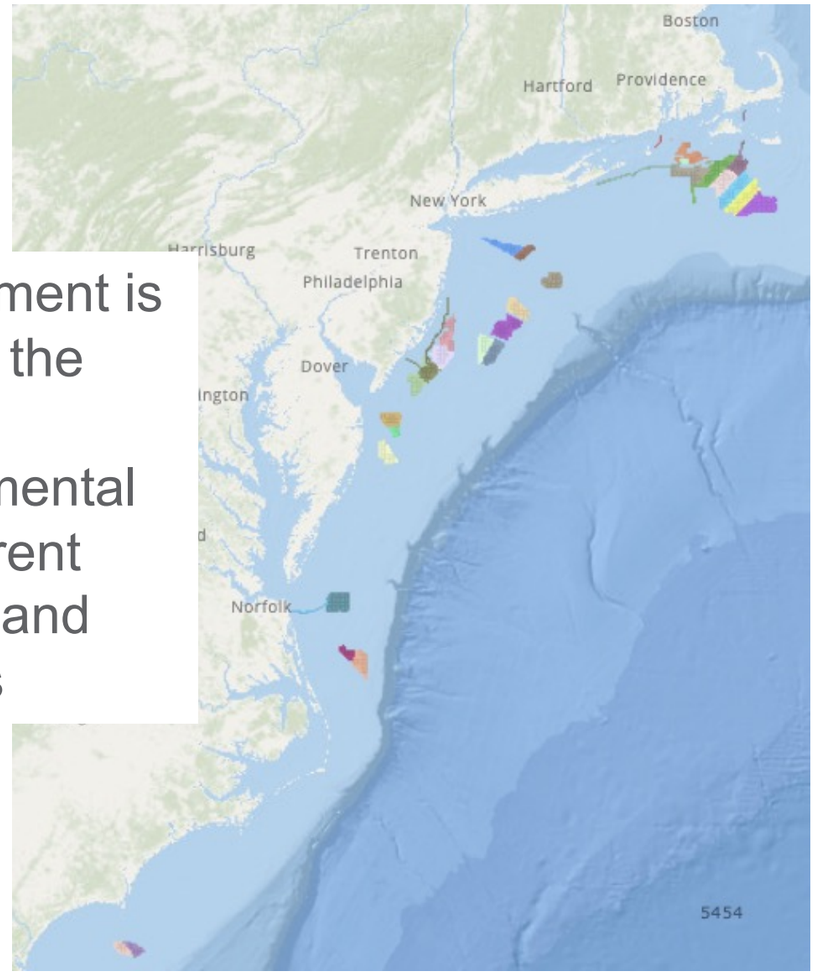
https://tethys.pnnl.gov/publications/state-of-the-science-2020

U.S. East Coast offshore energy context

Existing marine energy (ME) sites

- Offshore wind development is leading renewables on the East Coast
- ME and OSW environmental effects similar but different
  - ➢ Creates confusion and misunderstandings

Offshore wind (OSW) lease areas

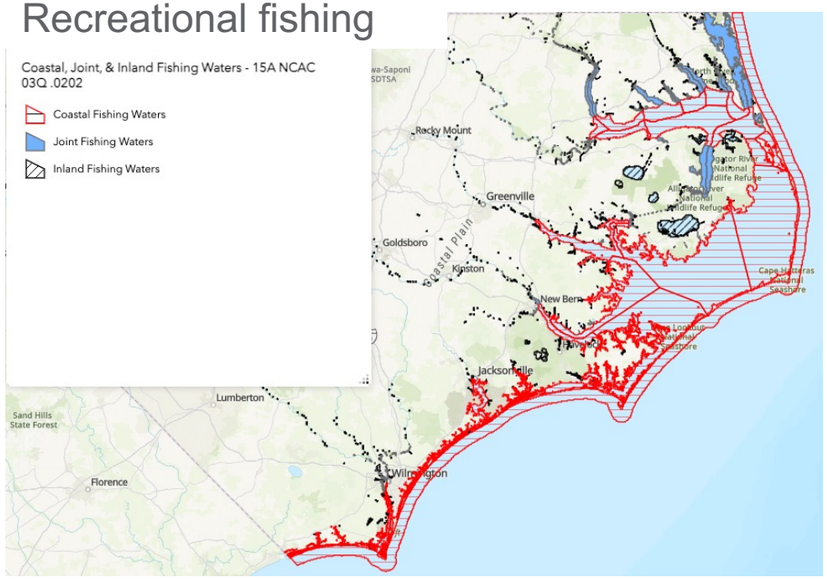


Challenges for marine energy development

The ocean is a busy space

- Lots of human activities at sea
- Often overlapping, sometimes conflicting uses
- Increase in ocean activities with potential for new interactions or conflicts

Recreational fishing



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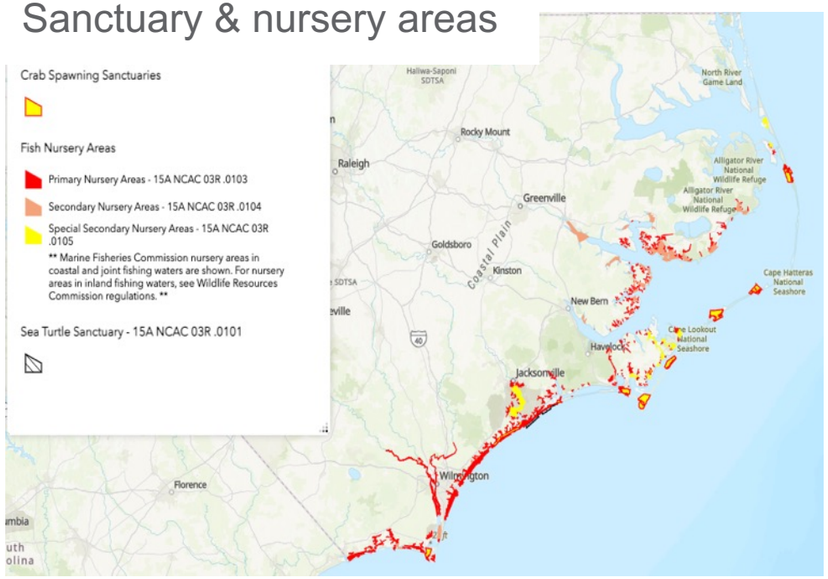
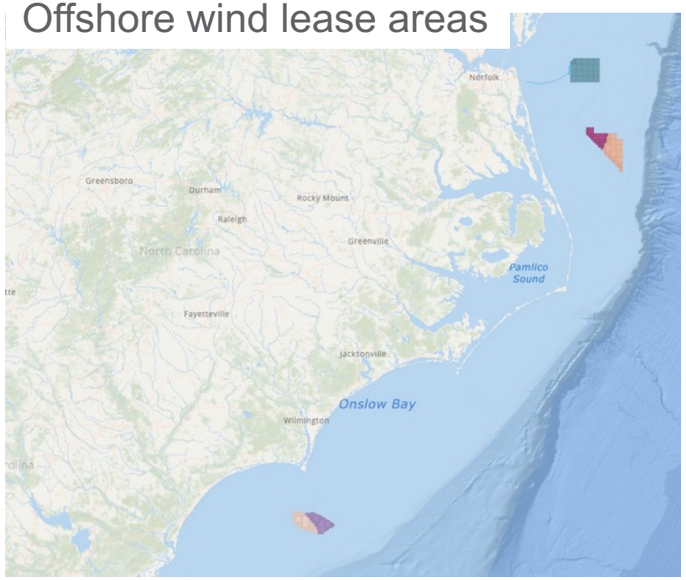
Sanctuary & nursery areas



Offshore wind lease areas



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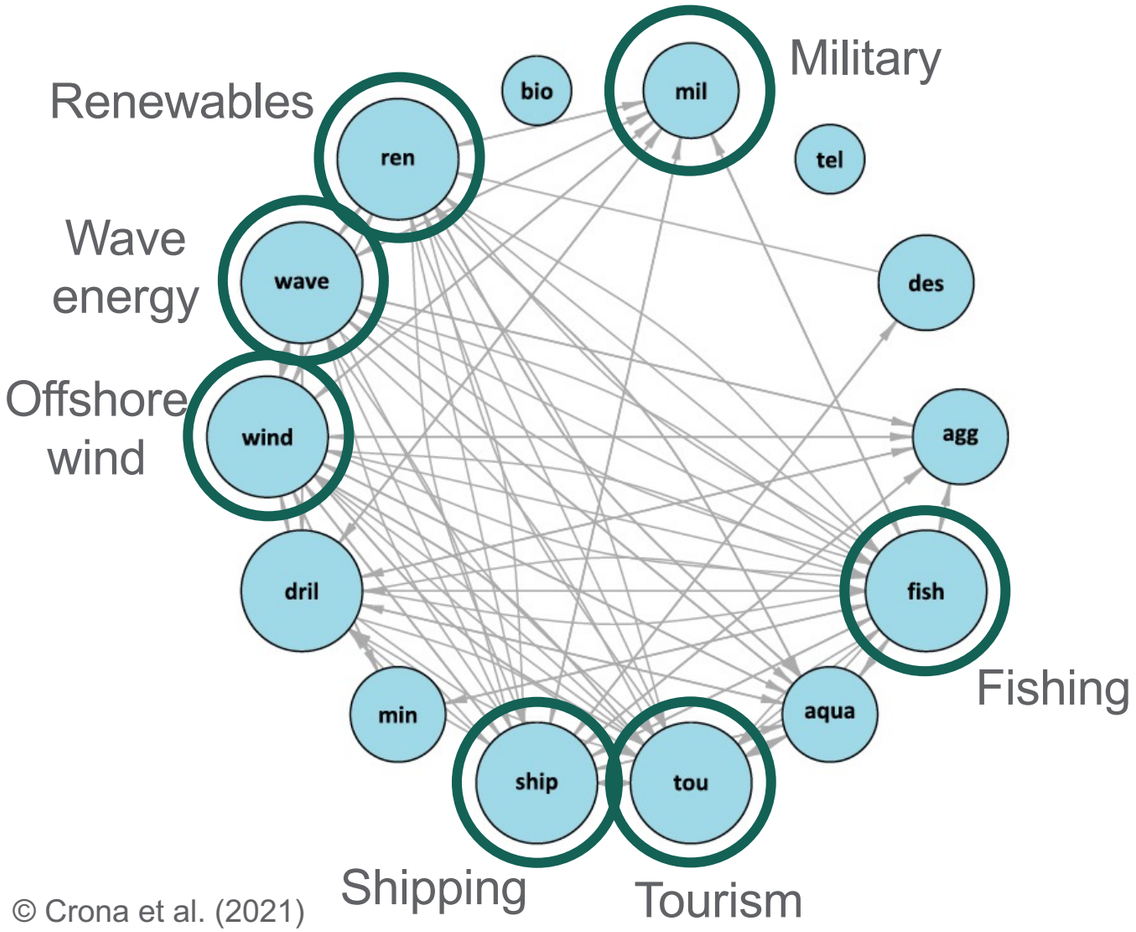
Challenges for marine energy development

The ocean is a busy space



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Engaged communities can

- Separate perceived risks from actual risks
- Distinguish issues specific to marine energy
- Participate in decision-making processes

Important to disseminate relevant and accessible information

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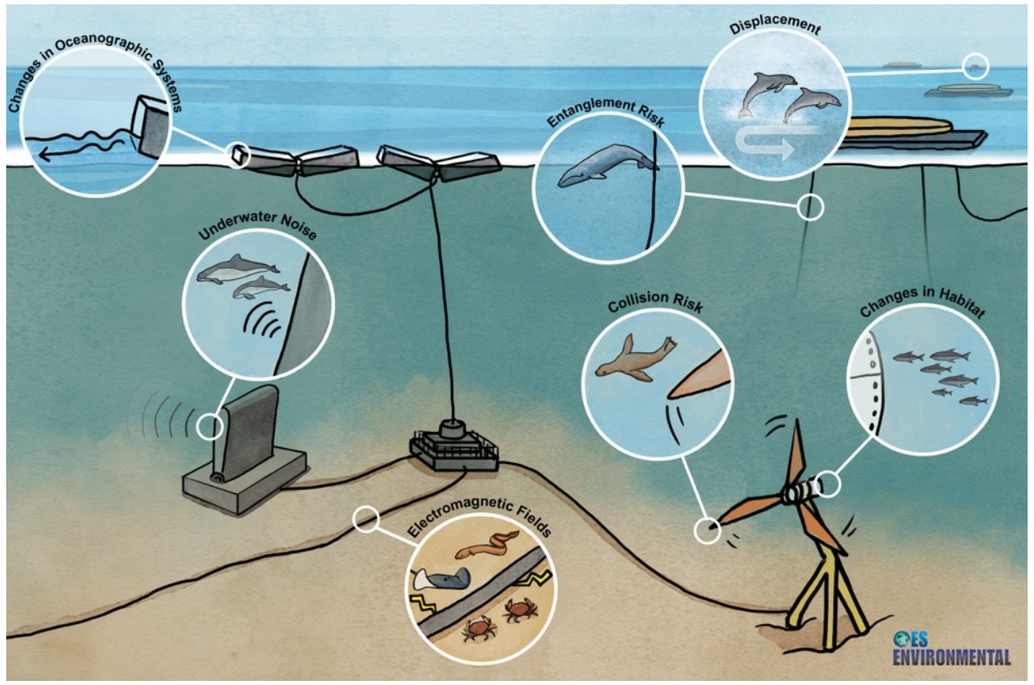
Marine Energy Environmental and Social Effects

Marine energy environmental effects

Stressors: marine energy devices and systems that may cause harm

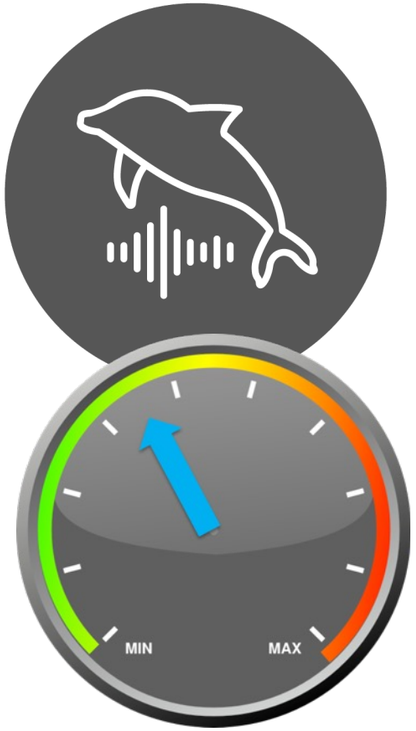
Receptors: marine animals, habitats, ecosystem processes



Priority stressor-receptor interactions

- Collision risk
- Underwater noise
- Electromagnetic fields
- Habitat changes
- Mooring line encounters
- Changes in oceanographic systems
- Displacement / barrier effects

Underwater noise



CONCERN:

- Potential disruption of marine animal navigation, communication
- Could cause physical harm and/or behavioral changes
- Marine mammals and certain fish species

KNOWLEDGE:

- Marine energy devices may add to anthropogenic sounds and disturb animals
- Have international specification for measuring marine energy device noise
- So far noise from turbines and wave energy converters fall below U.S. underwater noise thresholds
- Noise propagation models not validated in high energy environments

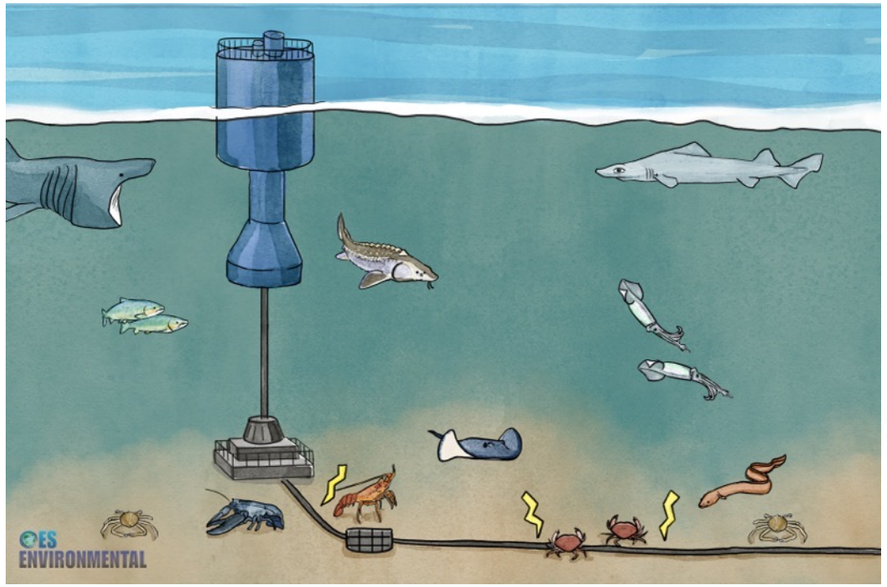
Electromagnetic fields (EMF)

CONCERN

- EMF from cables may affect organisms that use natural electric or magnetic fields for orientation, navigation, and/or hunting

KNOWLEDGE:

- Marine energy-related EMFs come from power cables, devices' moving parts, substations/transformers
- Power cables can be buried in sediment, separating animals from EMF
- Lab and field studies have shown little evidence of behavioral effect on aquatic species, no expected harm



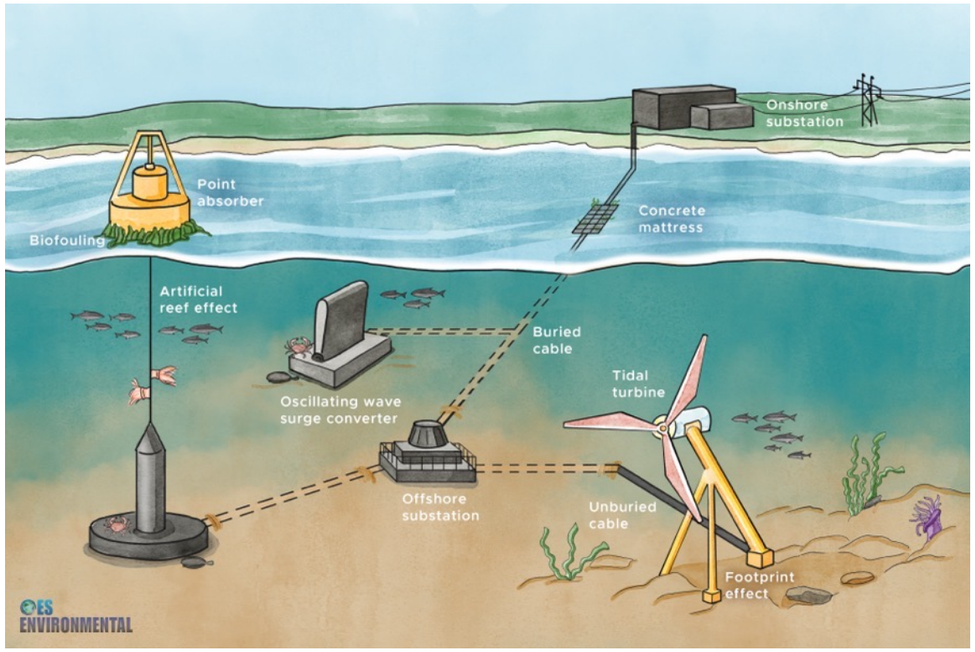
Habitat changes

CONCERN:

- Changes in benthic and pelagic habitats, artificial reef effect, colonization or patterns of species succession due to presence of marine energy devices and parts

KNOWLEDGE:

- Can learn from other offshore industries
- Footprint of devices and anchors are small on seafloor
- Mooring lines and floats in water column
- Devices attract fish and invertebrates, but no mechanism of harm
- Careful siting of devices can minimize risk



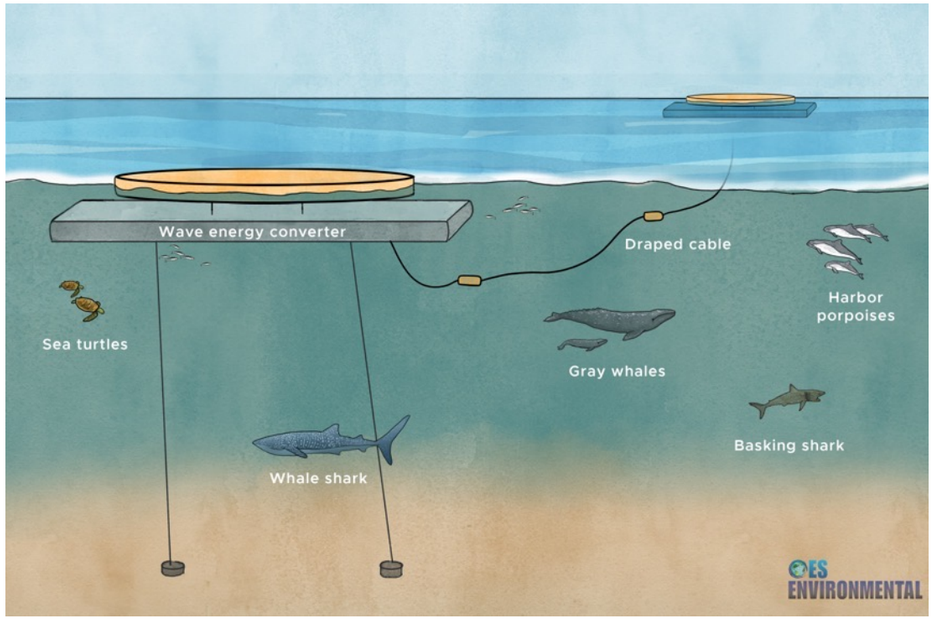
Mooring line encounters

CONCERN:

- Entanglement or entrapment of animals (marine mammals, sea turtles) with mooring lines/cables
- Potential to entangle fishing gear, further entanglement of animals

KNOWLEDGE:

- Concerns arise due to entanglement in lost fishing gear
- No free end of lines, insufficient slack to allow looping
- Scales do not match, entanglement highly unlikely



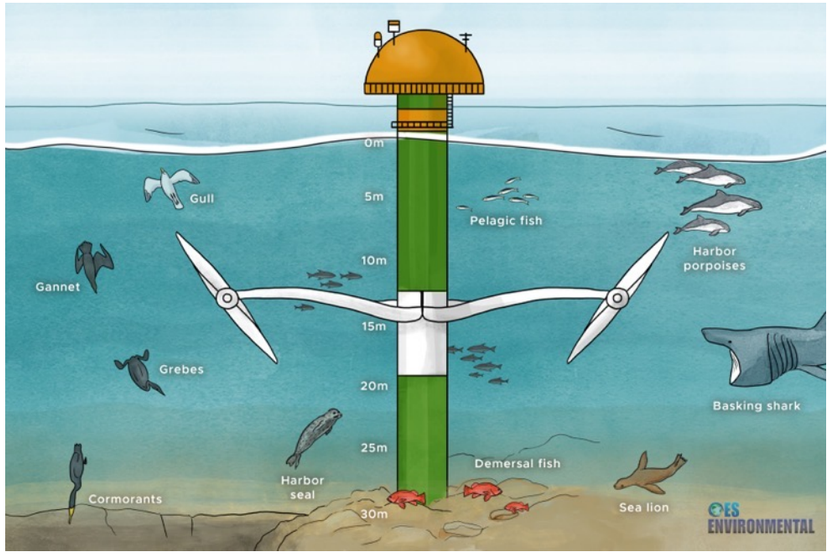
Collision risk

CONCERN:

- Risk of tidal turbines' rotating blades causing injury and/or death to marine mammals, fish, sea turtles, and diving seabirds

KNOWLEDGE:

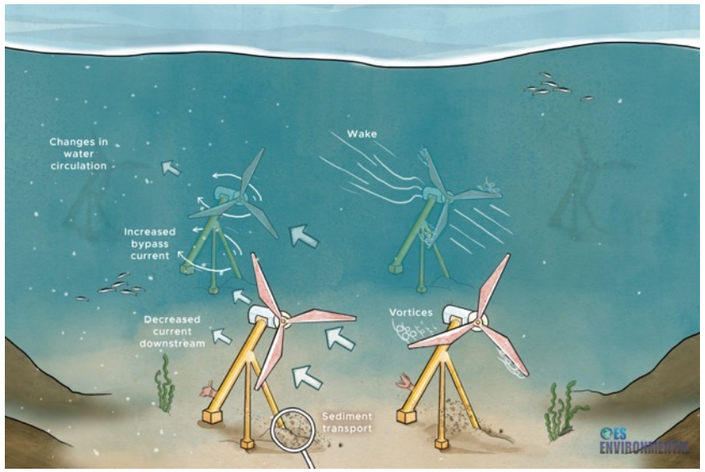
- No observations of marine mammal or seabird colliding with a device
- Observations of fish interactions have shown no harm
- Technologies to observe collision not well developed, difficult to operate in high-energy environments
- Collision risk examines individual animals, but need to put in context of risk to populations

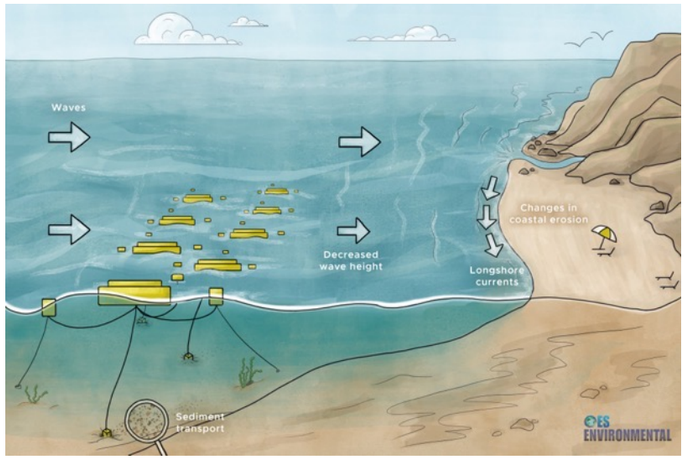


Changes in oceanographic systems

CONCERN:

- Changes in circulation, wave height, sediment transport
- Secondary changes in water quality, ecosystem processes

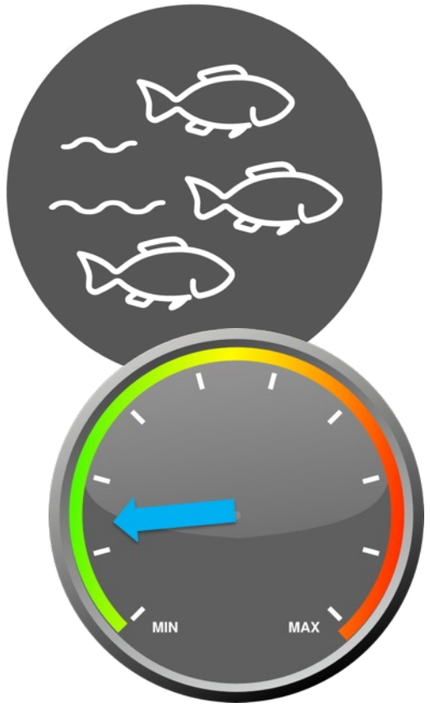




KNOWLEDGE:

- Changes from single devices or small arrays appear immeasurably small
- Numerical models suggest changes may be measurable only with very large arrays

Displacement

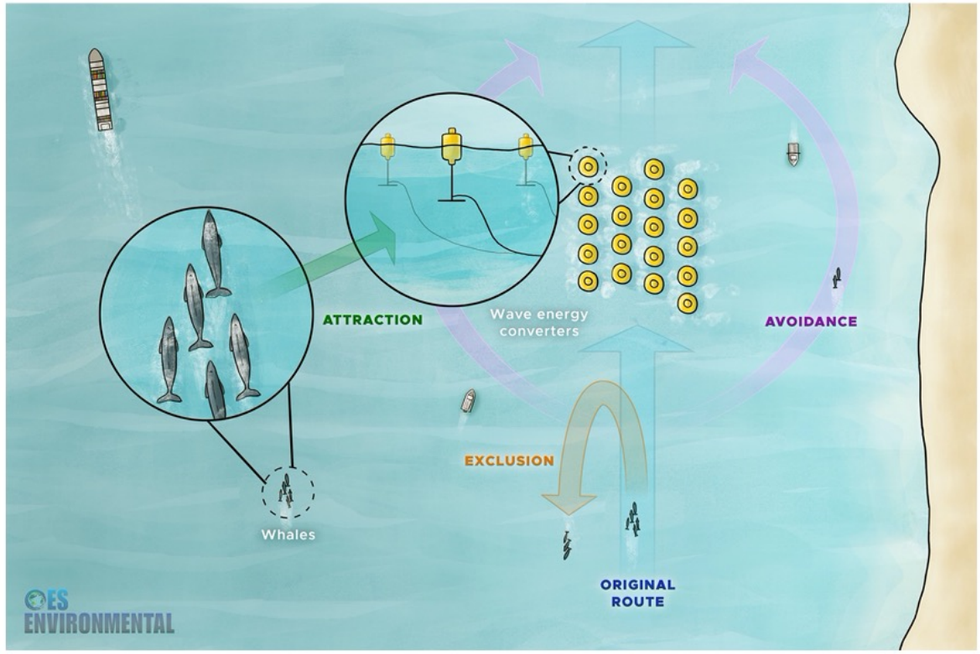


CONCERN:

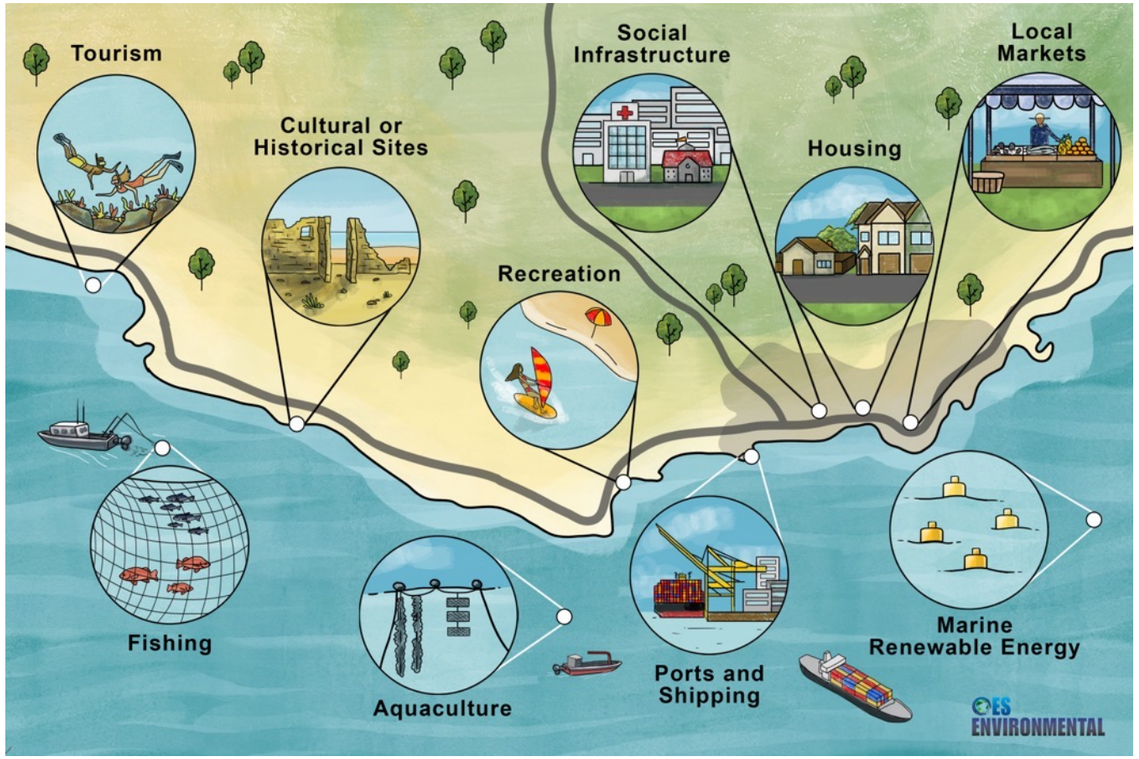
- Arrays of devices may displace marine animals from migration routes or essential (feeding, rearing, mating, etc.) habitats
- Potential for a range of consequences, from effects on individuals to populations

KNOWLEDGE:

- Outcome of 1 of 3 mechanisms (i.e., attraction, avoidance, and exclusion) triggered by a receptor's response to one or more stressors
- No field studies that address displacement of marine animals around marine energy arrays
- Identification of species potentially at risk of displacement is important during project planning



Socio-economic effects



- Any potential social and economic impacts of MRE development
- Often overlooked during planning, permitting, and developing processes
- Literature from other industries (fisheries, OSW, etc.) available to inform and anticipate socio-economic effects of MRE
- Need for MRE-specific information and social and economic data collection
- Lack of information on methodology

Check out MRE socio-economic data collection toolkit: https://tethys.pnnl.gov/marine-energy-social-economic-data-collection-toolkit

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Marine Energy Permitting and Stakeholder Engagement

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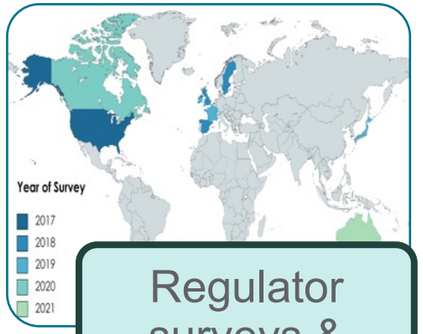
Scientific support for permitting

Relevant Agencies: NC Dept of Environmental Quality, BOEM, NOAA, USFWS

Scientific information

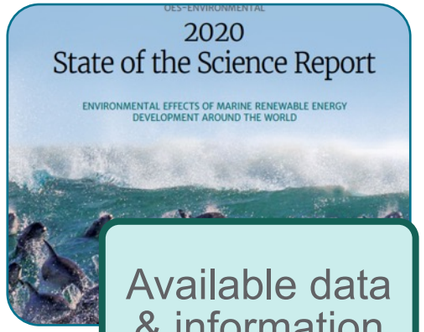
Useful formats, approaches and tools for application

Scientific support for permitting



Regulator surveys & webinars

Regulators' needs

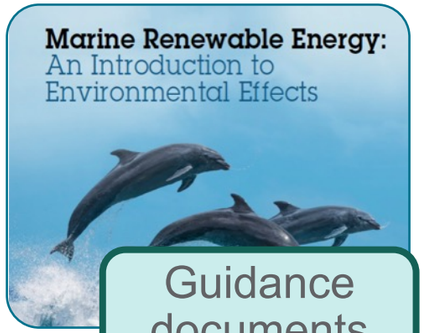


Available data & information

Regulators' input & feedback

Risk retirement

- Evidence bases
- Data transferability



Guidance documents

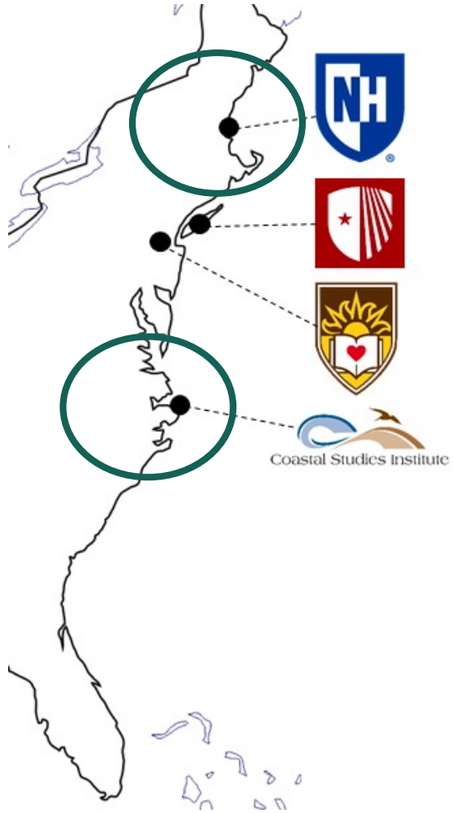
MRE Brochure

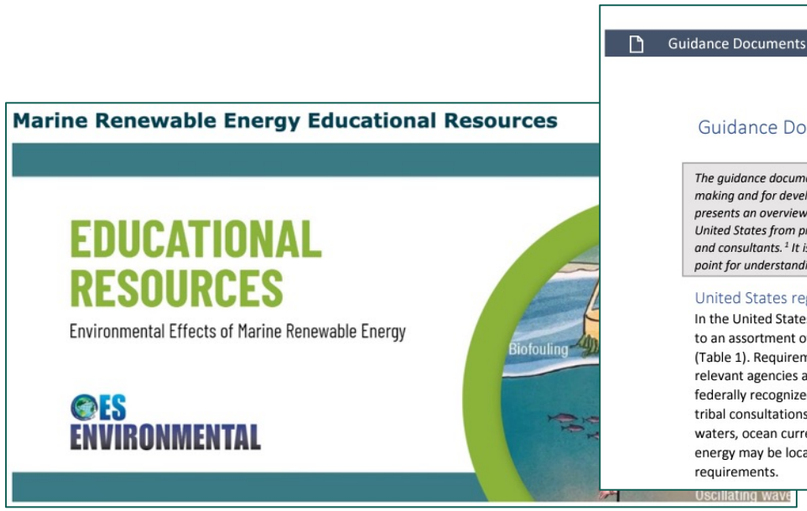
Marine energy community feedback

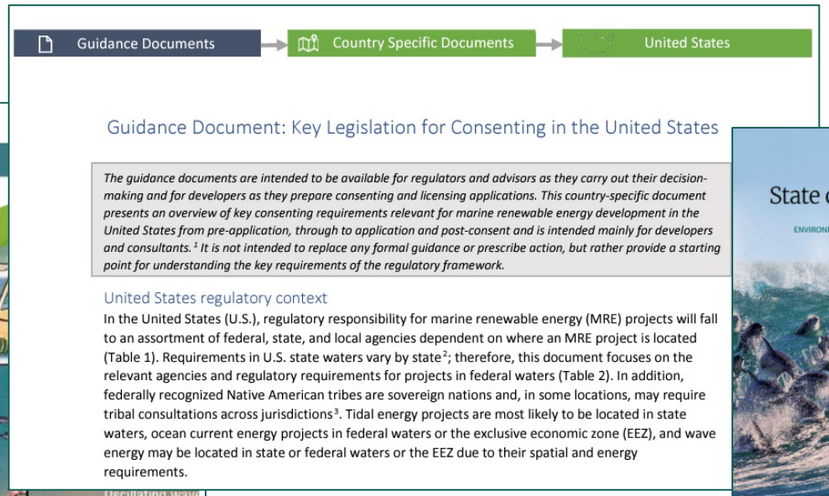
Support for AMEC

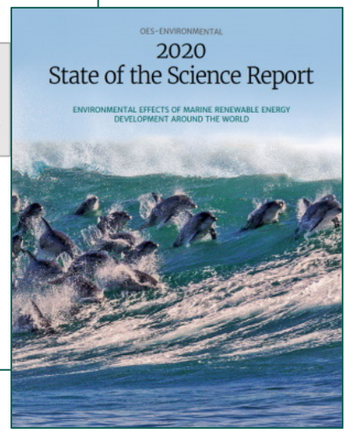
For the AMEC region:

- Develop use cases in New England and North Carolina
- Hold in-person workshops to foster discussion amongst stakeholders
- Address similarities and differences between marine energy and offshore wind environmental effects
- Highlight extensive resources available on marine energy environmental effects and permitting









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Break

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Use Cases

Leveraging hypothetical marine energy use cases

Objectives

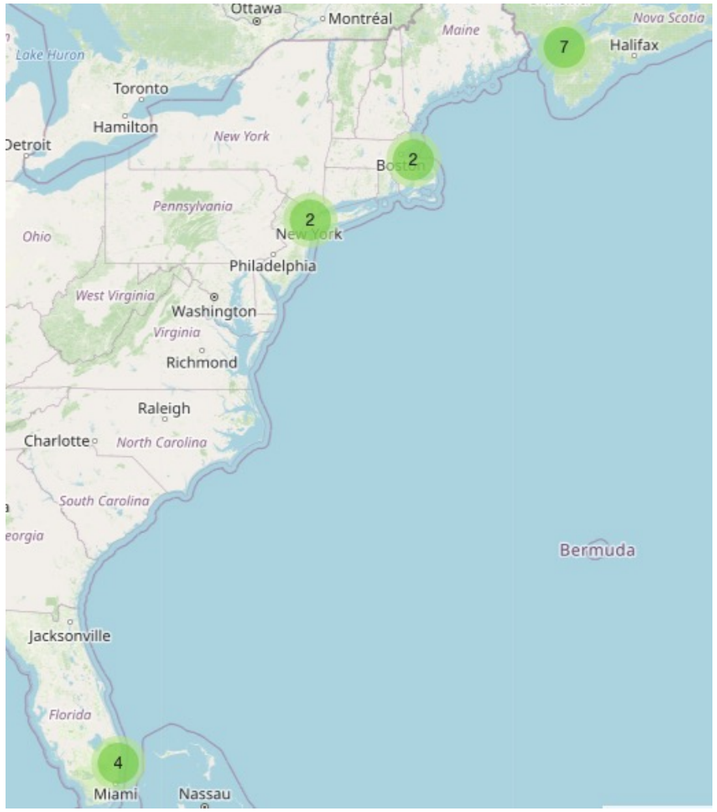
- Understand the marine energy landscape on the U.S. Atlantic coast
- Share targeted information with the stakeholders

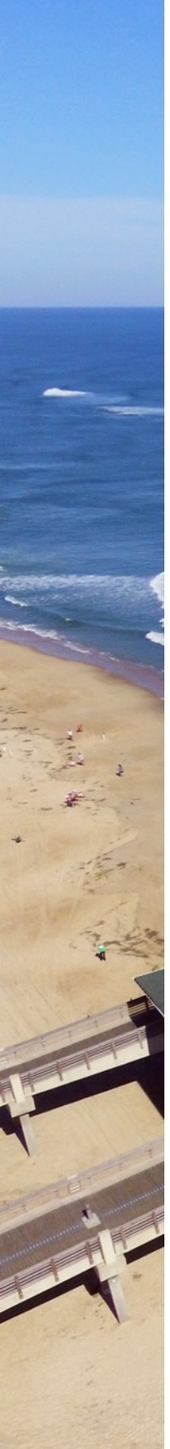
Process

- Reviewed past, present, and planned projects
- Identified stakeholders involved in planning and permitting processes
- Identified environmental issues
- Identified user/stakeholder concerns

Results

- Tidal energy hypothetical use case in New England
- Wave energy & ocean current hypothetical use cases in North Carolina





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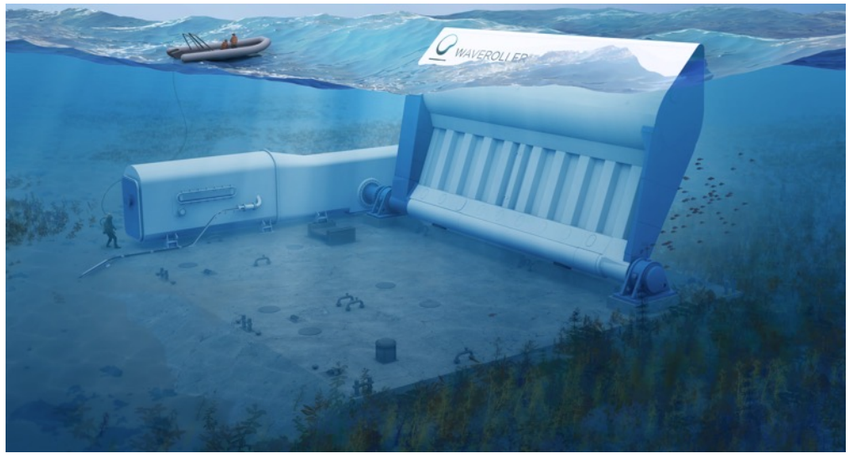
Wave Energy Use Case

Different kinds of wave energy converters

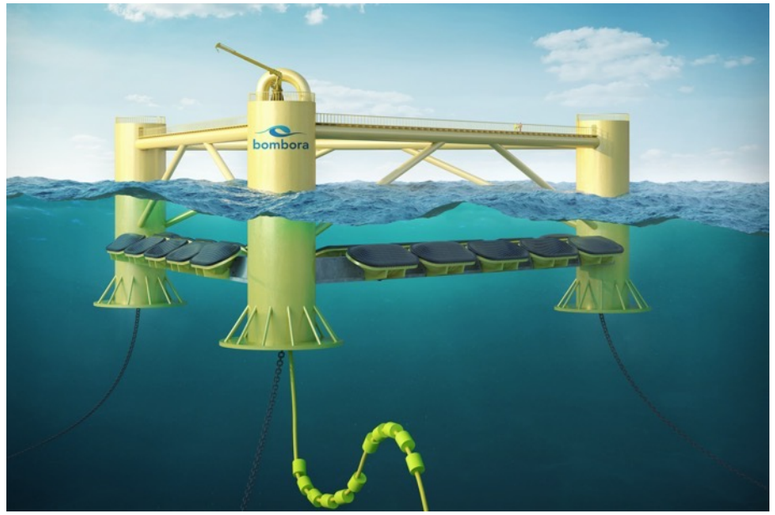


Oscillating wave surge converter

Point absorber

Oscillating water column

Surface attenuator



Pressure differential

Wave energy use case description

- Point absorber
- Small scale
- Shallow water off Jennette's Pier
- Surface buoy
- Fixed platform on seabed
- Grid connection or point-of-source applications
- Application: power oceanographic observation buoy

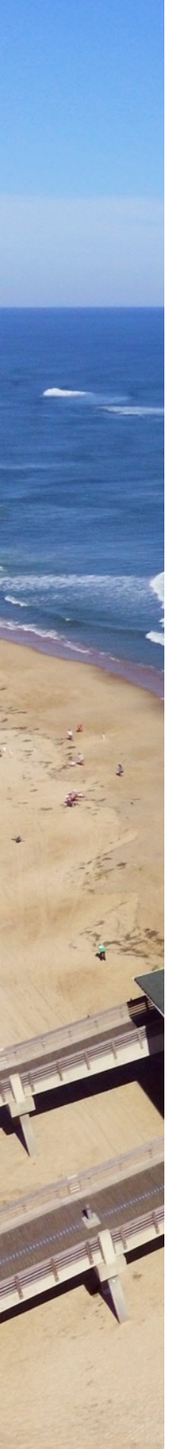
Example of a point absorber WEC: Ocean Power Technologies

Receptors of potential concern

- Green sea turtle (T)
- Kemp's ridley sea turtle (E)
- Leatherback sea turtle (E)
- Loggerhead sea turtle (T),
- Hawksbill sea turtle (E)
- North Atlantic right whale (E)
- Bottlenose dolphin (protected)
- Atlantic sturgeon (E)
- Shortnose sturgeon (E)

Kemp's Ridley turtle: NOAA Fisheries

Bottlenose dolphin: The Marine Mammal Center



Potential environmental effects of the WEC

Underwater Noise Effects

Habitat Changes

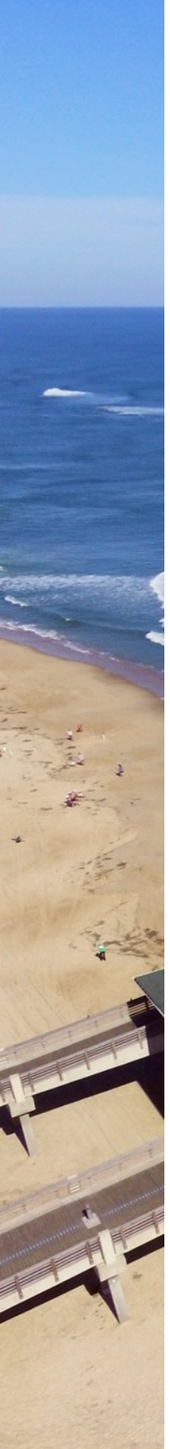
Electromagnetic Fields Effects

Entanglement Risk

Stakeholder involvement

- Stakeholder groups:
  - Commercial/recreational fishers
  - Boat operators
  - Shipping (e.g., tow and barge)
  - Recreational users – diving, surfing, tourism, etc.
  - Environmental organizations
  - North Carolina aquarium
  - Coastal Studies Institute
  - US Coast Guards
  - US Army Corps of Engineers
  - Etc.

- Transparency and communication is important in stakeholder involvement
  - Wave energy research conducted at Jeanette's pier is featured in outreach and education displays for the public and visitors



Useful references

Jennette's Pier Wave Energy Test Center

https://www.coastalstudiesinstitute.org/jptestcenter/

North Carolina Species of Concern

https://www.fisheries.noaa.gov/southeast/consultations/threatened-and-endangered-species-list-north-carolina

Tethys: Wave Energy

https://tethys.pnnl.gov/technology/wave

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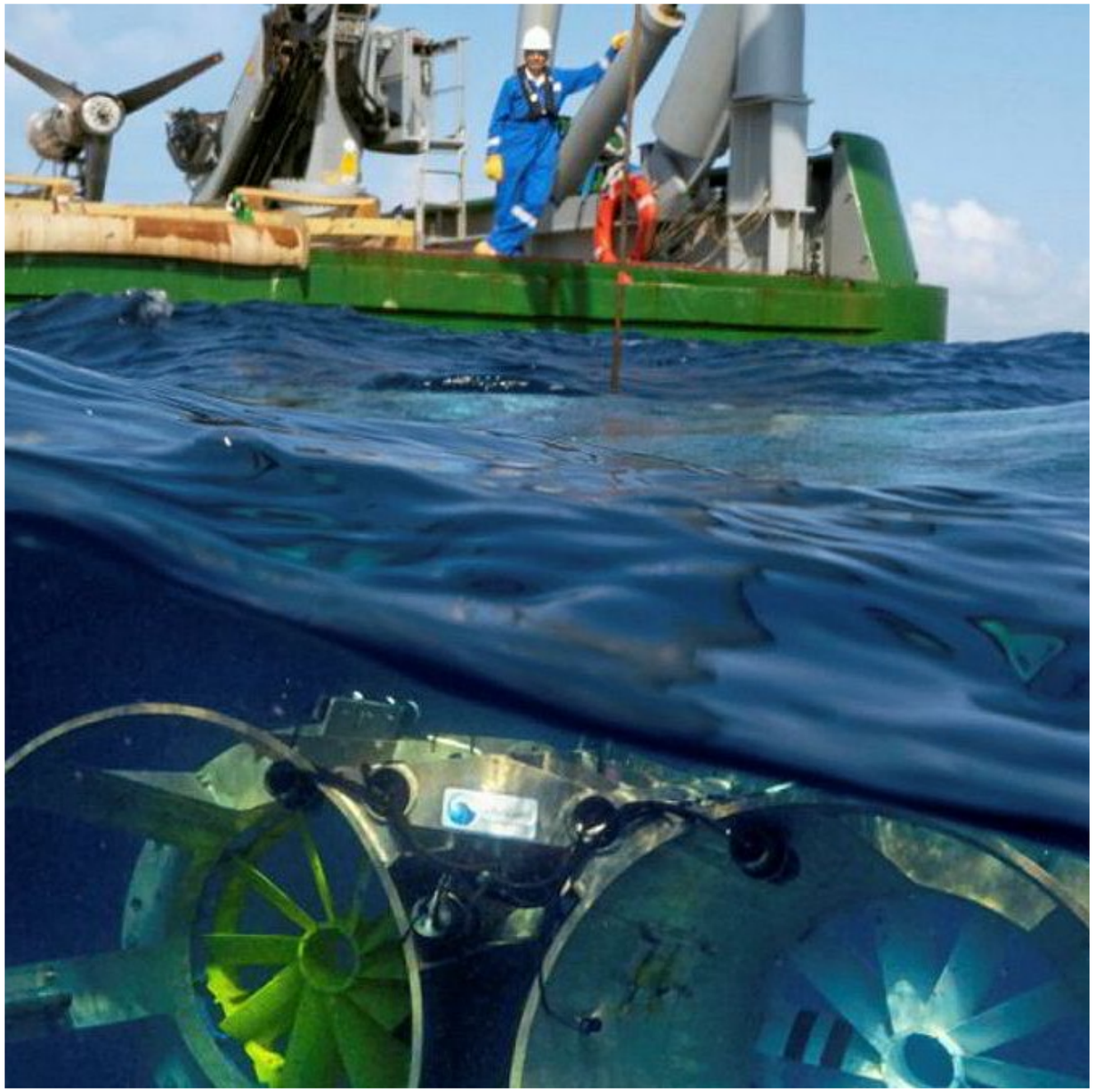
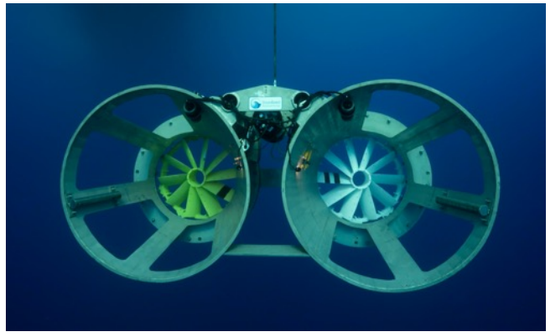
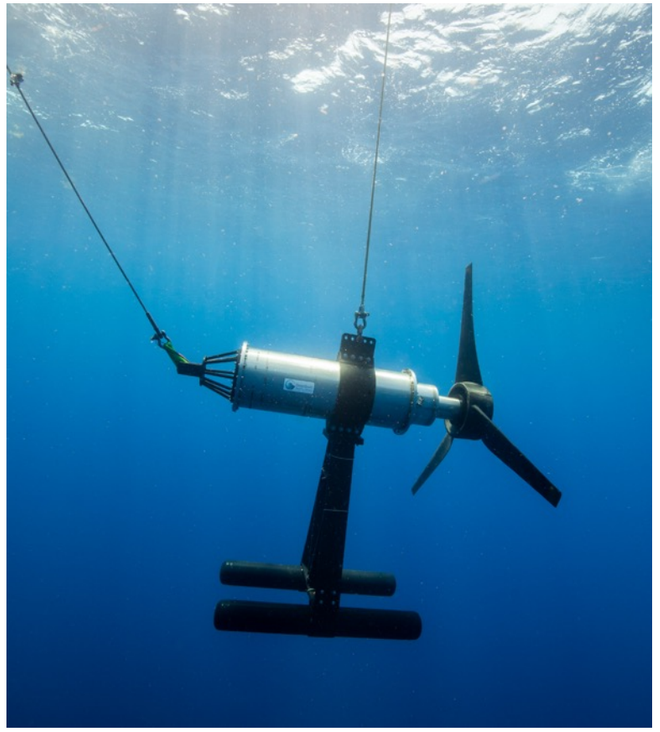
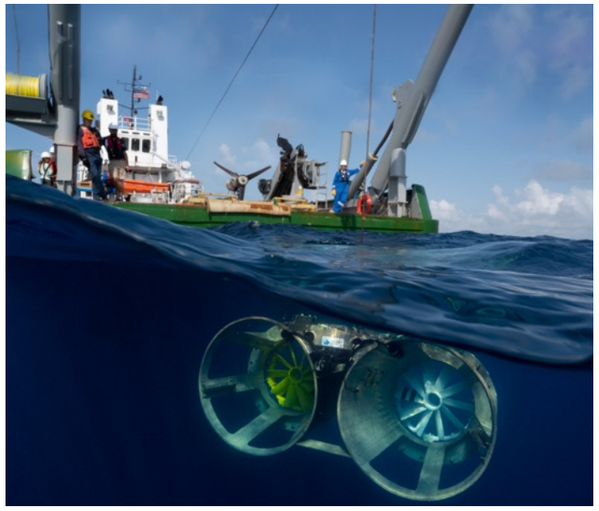
Ocean Current Energy Use Case

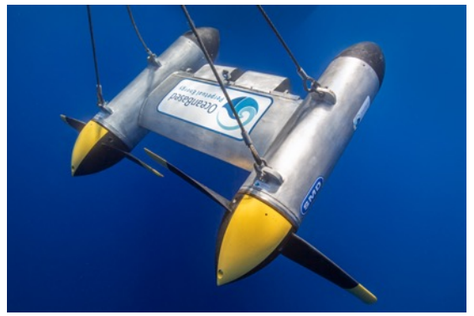


Different kinds of ocean current energy turbines





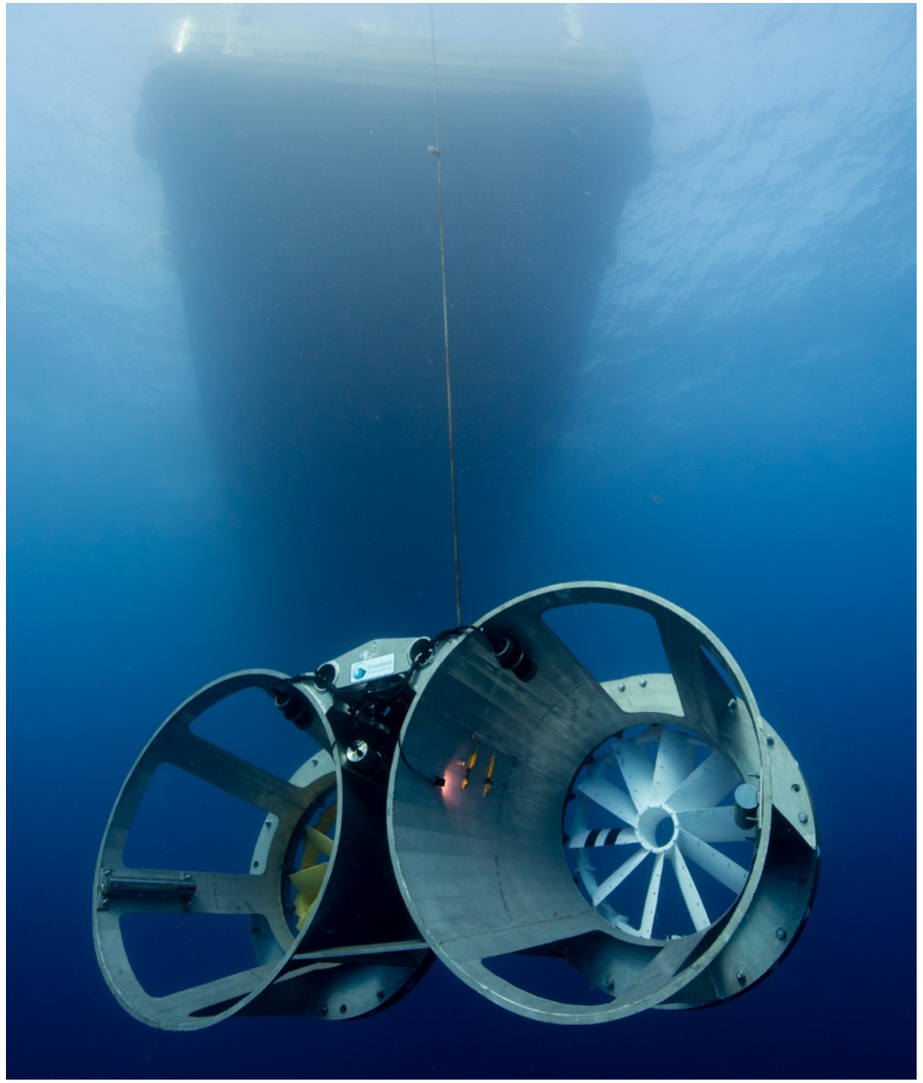




OceanBased Perpetual Energy

Ocean current energy use case description

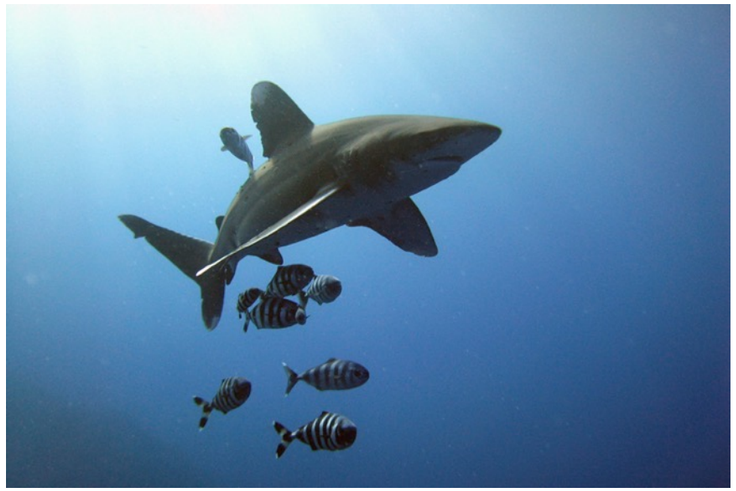
- Submerged turbines
- Suspended from a floating platform (moored to seafloor)
- Single device (with two turbines)
- Offshore, in the Gulf Stream
- Power exported back to surface platform
- Application: power offshore aquaculture facility



Example of a submerged ocean turbine design from OceanBased Perpetual Energy

Receptors of potential concern

- Green sea turtle (T)
- Kemp's Ridley sea turtle (E)
- Leatherback sea turtle (E)
- Loggerhead sea turtle (T)
- Hawksbill sea turtle (E)
- North Atlantic right whale (E)
- Fin whale (E)
- Sei whale (E)
- Blue whale (E)
- Bottlenose dolphin (protected)
- Oceanic whitetip shark (T)
- Giant manta ray (T)



Oceanic whitetip shark: NOAA Fisheries

Green Turtle: NOAA Pacific Islands Fisheries Science Center

Potential environmental effects of the turbines

Collision Risk

Electromagnetic Fields Effects

Underwater Noise Effects

Habitat Changes

Entanglement Risk

Stakeholder involvement

- Stakeholder groups
  - Commercial/recreational fishers
  - Boat operators
  - Shipping (e.g., Transatlantic, tow and barge)
  - Recreational users – tourism (e.g., whale watching)
  - Environmental organizations
  - North Carolina aquarium
  - Coastal Studies Institute
  - US Coast Guards
  - US Army Corps of Engineers
  - Etc.

Photo by Elenathewise / Thinkstock

Useful references

OceanBased Perpetual Energy:

https://oceanbased.energy/wp-content/uploads/2020/08/OceanBased-InfoGraphic-After.pdf

North Carolina Species of Concern:

https://www.fisheries.noaa.gov/southeast/consultations/threatened-and-endangered-species-list-north-carolina

Tethys: Ocean Current

https://tethys.pnnl.gov/technology/ocean-current

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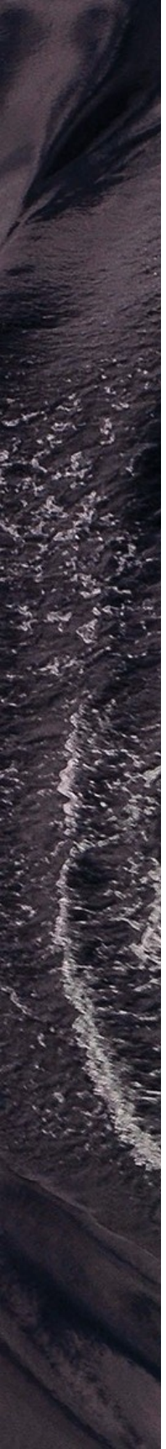
Discussion

Which of the effects we presented is of greatest concern to you?



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Which of the effects we presented is of greatest concern to you?

Collision risk
Collision risk to marine mammals
Cumulative effects
Cumulative / scale impacts
Displacement
Displacement as we scale up marine energy
Entanglement
Habitat change
Interference in getting the power to shore and substation placement
Mooring line encounters
Navigation impacts
Transmission lines to land
Underwater changes

What have we missed? Do you have topics of interest we have not mentioned?

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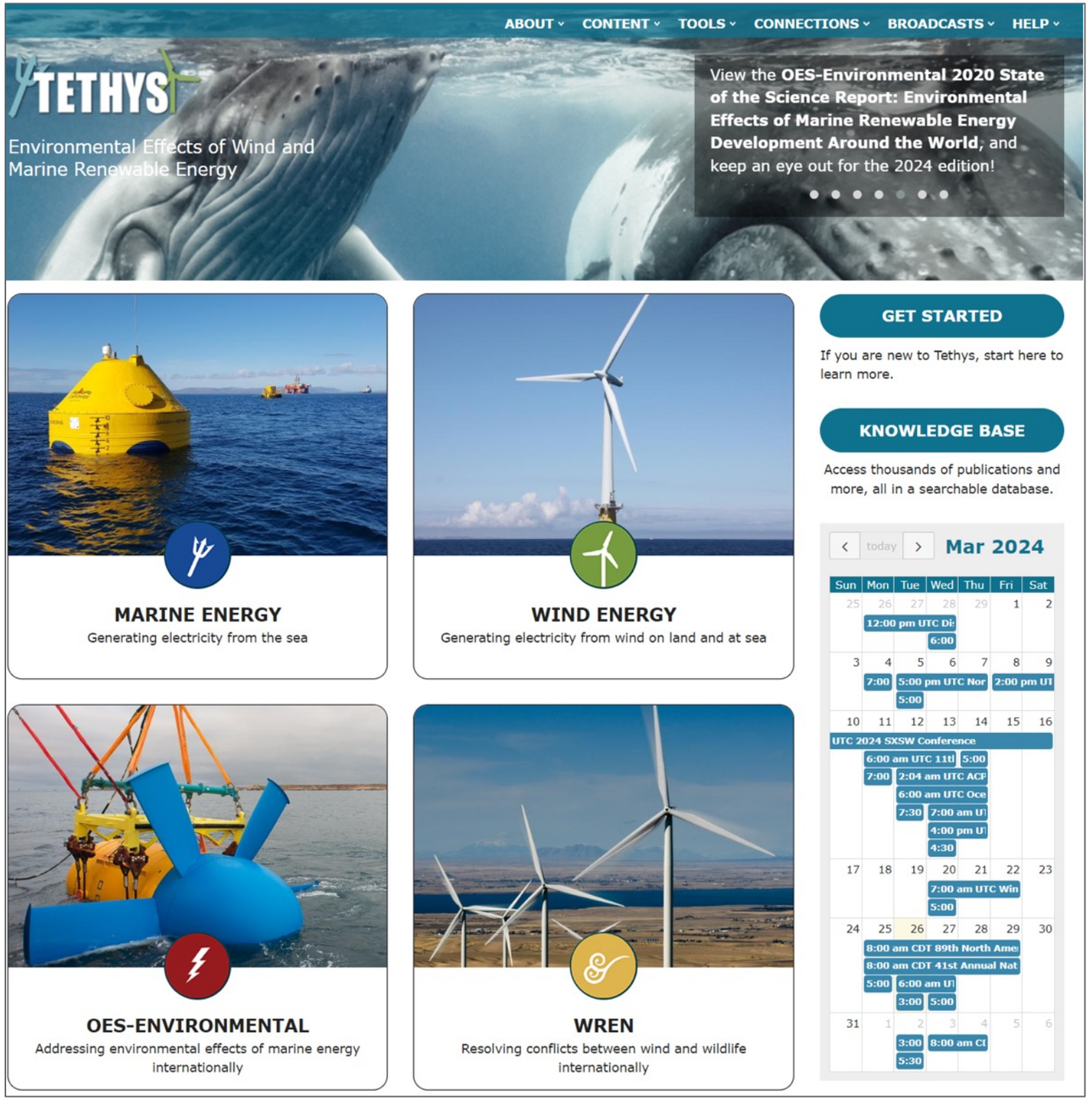
Wrap Up

Tethys website

https://tethys.pnnl.gov/

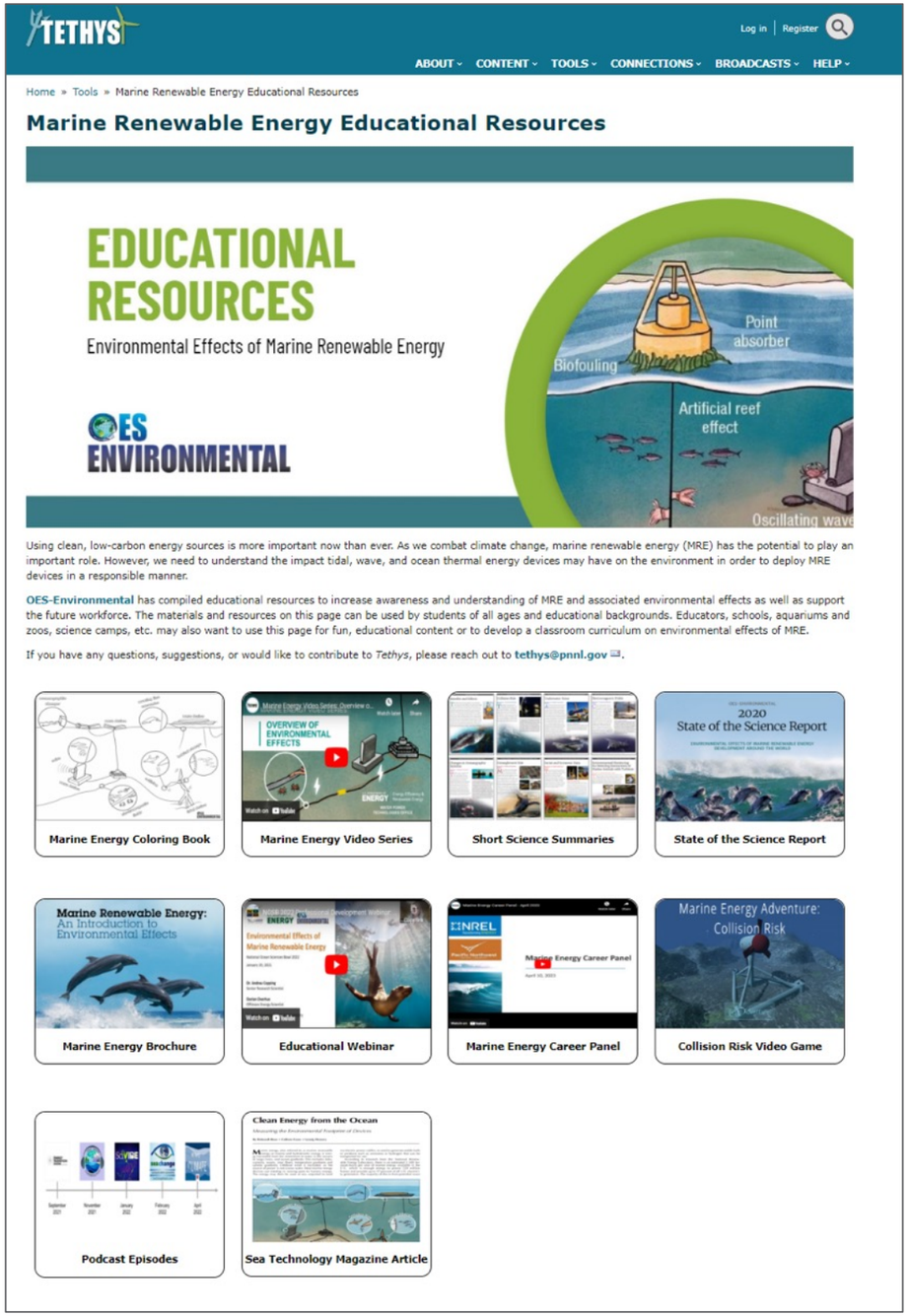
- Online Knowledge Base, marine and wind energy
- Hosts almost 4,300 marine energy and 6,700 wind energy documents
- Additional content, tools, and resources
  - Webinars,
  - OES-Environmental Metadata,
  - Risk retirement resources,
  - MRE Educational Resources,
  - *Tethys* Blasts, etc.



MRE educational resources

- Provide resources for students of all ages to increase understanding of environmental effects of MRE
  - Updated in 2023

- New resources added:
  - Marine energy videos
    - ✓ Overview of Environmental Effects
    - ✓ Underwater Noise
    - ✓ Electromagnetic Fields
    - ✓ Changes in Habitat
  - Marine Energy Adventure: Collision Risk Game available
    - ✓ Play as fish to navigate collision risk!



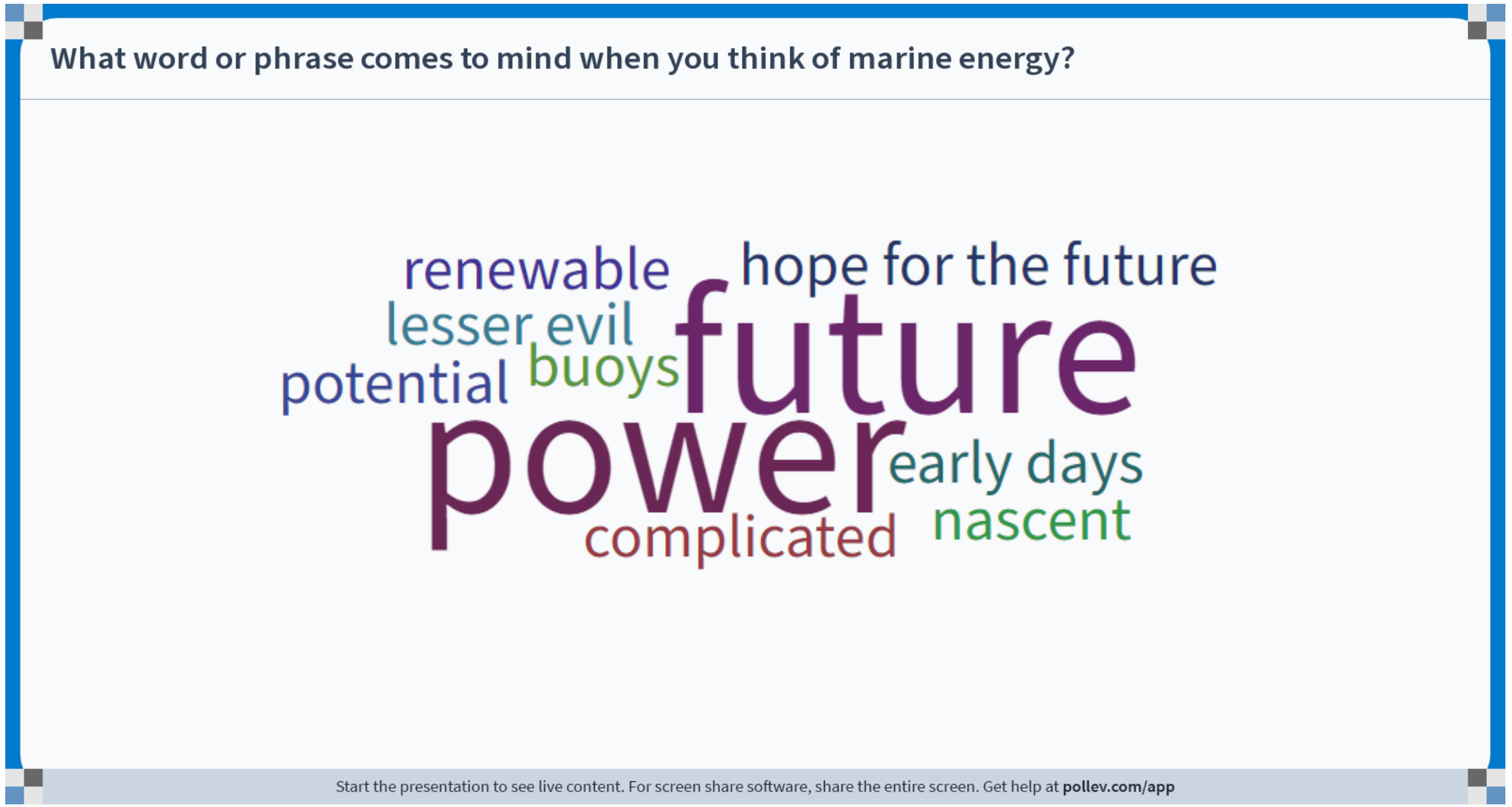
https://tethys.pnnl.gov/marine-renewable-energy-educational-resources

Outreach tool:
Choose your own collision risk adventure

https://tethys.pnnl.gov/marine-energy-adventure-game

- Currently for fish
- Spring/summer 2024: new version with harbor porpoise and floating tidal turbine

What word comes to mind when you think of marine energy?

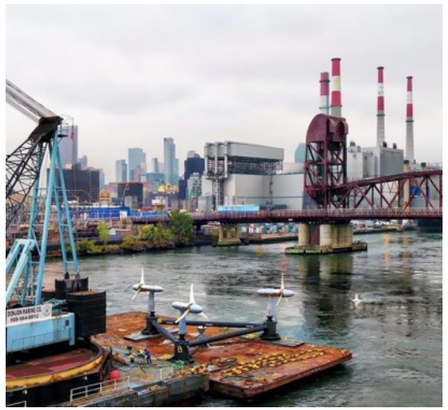


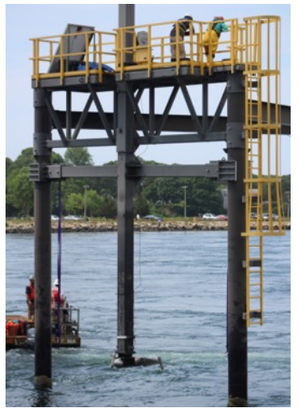
Next steps and conclusions

Synthetize the two North Carolina workshops in a report

Engaging with a wide spectrum of stakeholders on the U.S. Atlantic coast to:

- **increase awareness** of marine energy and its environmental and social effects
- **hear concerns** from stakeholders about marine energy
- **improve local knowledge** of marine energy
- **create local support** for the developing industry





Thank you

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Workshop webpage

Survey