Potential Environmental Effects of Marine Renewable Energy in Tropical and Subtropical Ecosystems

RELEVANCE TO MARINE RENEWABLE ENERGY

Marine renewable energy (MRE) projects and associated studies on environmental effects mainly exist in temperate regions. As MRE develops in tropical and subtropical regions, there is a need to assess its potential environmental effects. In those regions, all types of MRE resources are available: wave energy, tidal energy, ocean current energy, ocean thermal energy conversion (OTEC), and salinity gradient energy.

OTEC uses temperature gradients between warm surface waters and cold deep waters to produce energy, a unique feature of tropical and subtropical regions. Salinity gradient energy uses the differences in salinity between freshwater and seawater; the greatest potentials are found along warmer coastlines. Although MRE resources exist, prior and existing MRE projects are relatively sparse and most target wave energy resources. Because of the unique marine ecosystems (e.g., coral reefs, mangroves) of tropical and subtropical regions that support multiple ecosystem services (e.g., tourism, fisheries), MRE development may present additional risks compared to temperate regions.

STATUS OF KNOWLEDGE

Potential environmental interactions associated with MRE in tropical and subtropical regions are similar to those in temperate regions: collision risk, underwater noise, electromagnetic fields, changes in benthic and pelagic habitats, changes in oceanographic systems, entanglement, and displacement. The importance of these interactions in tropical and subtropical regions may differ with the unique receptors (marine animals, habitats, ecosystem processes). Tropical and subtropical regions host a diverse range of habitats such as coral reefs, mangroves, and seagrass beds that provide feeding, breeding, spawning, and nursing grounds for a wide variety of marine animals, including commercially important and endangered species. Effects on biodiversity and ecosystem function are commonly identified as the most important concerns for MRE development in these regions. Instead of focusing on a limited number of key species as is commonly done in temperate ecosystems, an ecosystem approach is needed to consider all species and their relationships (e.g., predator–prey, competition) when studying the environmental effects of MRE in tropical and subtropical ecosystems. Beyond addressing environmental effects, understanding community needs and gaining public support are crucial to the success of an MRE project. Examples of socioeconomic concerns for MRE development in tropical and subtropical regions include impacts on the fishing and tourism industries.

REMAINING UNCERTAINTIES

In tropical and subtropical regions, the MRE industry has experienced slow development. Limited guidance for developers, marine spatial planning, environmental regulations, industry roadmaps, and a general lack of standardization for environmental impact assessments of MRE projects have all contributed to this deficiency. Additionally, the lack of long-term baseline data prevents a comprehensive understanding of the natural variations of ecosystems, which is needed to evaluate the potential effects of MRE projects. A better understanding of concerns and potential social effects within specific regions and communities is also needed. Strong community involvement from the inception of an MRE project will help fill in knowledge gaps that project developers may have about local social concerns. Community acceptance of projects could be bolstered by investing in education efforts directed at stakeholders that focus on MRE and potential environmental and socioeconomic effects.

RECOMMENDATIONS

Improved understanding of tropical and subtropical environments and their natural variation can be carried out by combining monitoring and modeling studies around MRE devices. A list of research questions around MRE should be established and prioritized on a regional or national basis. Promoting collaboration among stakeholders, as well as knowledge transfer between projects, will enable valuable research around early-stage MRE projects. Ultimately, assessing the cumulative effects of MRE with other anthropogenic activities at sea should be done using a system-level effects approach.

OES-Environmental 2024 State of the Science report and executive summary available at:
https://tethys.pnnl.gov/publications/state-of-the-science-2024

Go to *https://tethys.pnnl.gov* for a collection of papers, reports, presentations, and other media about environmental effects of MRE.

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