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Comments on Wave and Tidal Energy Study

Additional submitted attachment is included below.

THE OCEAN FOUNDATION

Coastal Coordination Program

August 21, 2024

California Energy Commission, Docket Unit, MS-4
15 P Street, Sacramento, CA 95814-5512

Re: Docket No. 24-IEPR-04
Via email to docket@energy.ca.gov / subject 24-IEPR-04: Wave and Tidal Energy Feasibility Study

Dear Commissioners:

Thank you for this opportunity to provide these comments on the Draft Consultant Report Wave and Tidal Energy: Evaluation of Feasibility Costs, and Benefits, pursuant to California Energy Commission (CeC) Docket #24-IEPR-04.

Please note that NOAA's Designation Documents, Site Regulations, and Management Plans for the Channel Islands, Monterey Bay, Cordell Bank, and Greater Farallones National Marine Sanctuaries preclude seabed disturbance from any source, thus future planning for siting of Wave and Tidal Energy should entirely exempt these areas from consideration. Similarly, avoidance of sites within California's State Network of Marine Protected Areas (CA MPA's) created under the Marine Life Protection Act should also be fully considered in all siting decisions for wave array installations. Each of these CA MPA sites was chosen for its unique characteristics, with a "mirrored-duplicate" intended to provide as-near-as-possible genetic reservoir status in case one individual MPA site were to be hit by an oil spill or other disaster.

California's Senate Bill 605 has directed the CeC and the Ocean Protection Council to complete a study delineating "the feasibility and benefits of using wave energy and tidal energy as forms of clean energy in the state." The study must identify a "robust monitoring strategy" that will "gather sufficient data to evaluate the impacts from wave energy and tidal energy projects to marine and tidal ecosystems and affected species, including, but not limited to, fish, marine mammals, and aquatic plants," to "inform adaptive management" of wave and tidal projects. The CeC, in connection with other state agencies and key parties, shall also identify suitable sea space for wave and tidal projects, and in so doing, must consider "protection of cultural and biological resources with the goal of prioritizing ocean areas that pose the least conflict to those resources."

In addition, CeC has been directed to "identify measures that would avoid, minimize, and mitigate significant adverse environmental and ecosystem impacts and use conflicts," as well as for "monitoring and adaptive management for offshore wave and tidal energy projects." The CeC must submit a report to the Governor and the Legislature by January 2025, summarizing its analysis and recommendations, including those on monitoring, sea space planning, and avoidance, minimization, and mitigation measures.

Background

The possibility of harvesting the mechanical energy of wave motion in water has long enticed the global engineering community. The process of converting the power of the ocean waves into mechanical energy, and then translating that mechanical energy to power rotary generators is called "hydrokinetic" energy. The first known patent to use energy from ocean waves was filed in Paris in 1799.

Wave power differs from tidal power, which instead captures the energy of the differential in water levels caused by the gravitational pull of the sun and the moon. Waves and tides are also distinct from ocean currents which are caused by other forces including breaking waves, wind, the Coriolis effect, an ocean circulation phenomenon known as "cabbeling", and differences in temperature and salinity.

Waves are generated by wind passing over the surface of the sea. As long as the waves propagate more slowly than the wind speed just above the waves, there is an energy transfer from the wind to the waves. Both air pressure differences between the upwind and the lee side of a wave crest, as well as friction on the water surface by the wind, combine to cause water to go into the *shear stress* that causes the growth of the waves.

Wave height is determined by wind speed, the duration of time the wind has been blowing, fetch (the distance over which the wind excites the waves) and by the depth and topography of the seafloor, which can focus or disperse the energy of the waves. A given wind speed has a matching practical limit over which time or distance will not produce larger waves. When this limit has been reached the sea is considered to be "fully developed".

In general, larger waves are more powerful, but wave power is also determined by wave speed, wavelength, and water density. Oscillatory motion is highest at the water surface and diminishes exponentially with depth. However, for standing waves near a reflecting coast, wave energy is also present as pressure oscillations at great depth, producing microseisms in the seafloor. Oceanic microseisms are small oscillations of the ground itself, or tiny earth tremors, in the frequency range of 0.05–0.3 Hz, associated with the occurrence of energetic ocean waves of half the corresponding frequency. These pressure fluctuations at greater depth in the ocean are too small to be harvestable, from the perspective of commercialization of wave power.

Waves propagate on the ocean surface, and the wave energy is also transported horizontally with the group velocity. The mean transport rate of the wave energy through a vertical plane of unit width, parallel to a wave crest, is called the wave energy flux (or wave power, not to be confused with the actual power generated by a wave energy harvesting device).

Recommendations

Impacts of Wave and Tidal Energy Should Be Subjected to Objective Analysis Prior to Permitting or Development of Utility-Scale Projects

As wave energy devices and both fixed and floating offshore wind turbine arrays proliferate throughout our coastal waters, we of course will need to pay attention to unintended consequences, cumulative impacts of both together, and learn on-the-fly from each project. Done right, a shift to cleaner energy could potentially offer a hopeful transition away from the worsening climate disaster resulting from burning fossil fuels. But done carelessly, in the wrong places, this industrialization of sensitive ocean upwelling systems amidst prime fisheries and sensitive marine habitats could instead serve to dangerously amplify the damaging climate impacts already facing our nearshore marine environment.

An emerging project called *Tahiti Wave Energy Challenge* is committed to promoting wave energy to accelerate the transition of island and coastal regions to zero-carbon and circular economies. This effort is designed to determine the best wave energy converters in tropical island settings, while raising global awareness of the wave energy sector. As a case study for Pacific Islands, the project is intended to address the technical, social, environmental, regulatory, and financial barriers that limit the adoption of this technology as a key component of island energy mixes so that wave energy can be scaled up throughout French Polynesia utilizing public-private partnerships involving local communities.

California's coastal waters are world renowned for their surfing and recreational value. Wave energy relies on the conversion of ocean wave energy into power; however, little is known about how this harnessing of energy will impact the recreational value of waves. The effects will likely be project specific and will depend on the density and placement of wave energy devices. Wave height reduction is positively correlated with the density of buoy placement and the reduced distance to the shoreline. Wave energy array design should be prioritized to minimize any down-current "wave shadow" effect. Also of concern is the alteration of unique wave characteristics including wave shape and quality, which may result from changes in sedimentation and bathymetry due to wave and tidal energy projects. Furthermore, all impacts, including wave height reduction, may increase as the technology matures and a greater percentage of energy is extracted. Due to the high recreational and tourism value of wave resources to the California lifestyle and economy, potential impacts in this area warrant careful study and monitoring. Surf monitoring studies have been required of related proposals (FERC Douglas County Wave and Tidal Energy Project, Surfer Study). Scientific surf monitoring studies with sufficient baseline data and appropriate adaptive management triggers must be required of wave and tidal energy projects as they have been for other coastal development projects (San Elijo Lagoon Restoration CDP).

The wide variety of technology used in both wave and tidal energy will present significant hurdles to understanding impacts and to the regulatory process for this nascent industry. Additional study should be conducted to identify an industry standard, or prototypes with the least environmental impacts. A more uniform approach to implementation would allow for better monitoring and mitigation of impacts.

A cost-benefit analysis should be included in the second phase of this feasibility study to examine the potential impacts from wave and tidal energy, including environmental impacts, competing uses and economics to determine if the benefits outweigh potential disadvantages. Not considering other ocean uses in this feasibility study severely limits its utility. We are concerned that the high cost of these nascent technologies, three times higher than conventional sources and four times higher than other renewables (feasibility study page 29), could negatively affect ratepayers and other forms of renewable energy that have not yet been maximized and which also pose fewer adverse impacts. Distributed installations as opposed to utility-scale projects of wave and tidal energy seem to be the most likely applications based on this report.

Sea Space Planning

The California Current Ecosystem (CCE) is a unique and highly productive bioregion, supporting high levels of biodiversity. Many species and habitats in the CCE are classified as protected and endangered under federal and state law. These include marine mammals like Humpback, Blue, Fin, and Gray whales, northern elephant seals, and southern sea otters, salmon, sea turtles, and seabirds including short-tailed albatross and marbled murrelets. Protected habitats include federally designated critical habitat for multiple species, as well as Habitat Areas of Particular Concern (HAPC) under the Magnuson-Stevens Act. National Marine Sanctuaries, National Wildlife Refuges, and state Marine Protected Areas (MPAs) require special consideration. The area extending northward of

Cape Mendocino to Heceta Bank, which includes the Humboldt Bay WEA, is a potential multispecies seabird hotspot in Northern California/Southern Oregon. At the same time, the CCE is facing various stressors, including marine heatwaves, changes to nutrient upwelling patterns, and declines in key fisheries.

As it considers areas that might be suitable for development of wave and tidal energy, CeC should avoid selecting areas with high conflict with marine life, sensitive habitats, and other ocean users. CeC should also consider how wave and tidal energy development would interact with the development of offshore wind and any potential negative cumulative effects from the combination. Clearly, research that would help the commercial fishing industry assist in siting of wave energy facilities so as to ensure that the wind installations avoid intruding into high catch-per-unit-effort fishing grounds remains a high priority.

Monitoring and Management of Potential Impacts

We urge that CeC use the "mitigation hierarchy" as it develops monitoring and management recommendations to ensure that wave and tidal energy developments first avoid, then minimize and mitigate potential environmental impacts from all stages of development.

Given that many wave and tidal energy technologies rely on seabed anchors and mooring cables, or water passing through turbines or chambers, it is possible that wave and tidal energy technologies will pose similar risks as the floating offshore wind systems that will be used off the California coast, including open loop cooling for direct current substations, or entrainment from desalination systems. Tidal energy technologies are likely to interfere with the diurnal rhythm critical to maintenance of healthy estuarine ecosystems by interfering with tidal influence throughout the estuary. Estuaries are going to be critical habitat for providing a natural "blue carbon" buffer zone to protect human infrastructure from sea level rise, so estuaries should be granted particular deference when CeC considers energy facility siting. Planned shoreline retreat approaches on coastlines and within estuaries should also be accommodated from the beginning of project conception.

Impacts to Benthic Habitat

Because wave and tidal energy systems will utilize seabed anchors, these could have impacts on important benthic habitats. As has been recommended with offshore wind development, renewable energy systems should be sited to avoid biogenic structural habitat, three-dimensional structures created by slow-growing living organisms (including corals and sponges) that support a high biological diversity and density of marine species.

Some of the measures used to manage the effects of offshore wind on benthic habitat could also be used to manage the impacts of wave and tidal energy systems. California offshore wind lessees are required, as a condition of their leases, to avoid intentional contact with hard substrate, rock outcroppings, seamounts, or deep-sea coral/sponge habitat. Lessees must also develop an anchoring plan and maintain a buffer of sufficient distance to fully protect sensitive habitat from anchors and related infrastructure, while accounting for the possible movement of anchors and cables over time. Where impacts to benthic habitat cannot be avoided, developers are required to submit a mitigation plan to responsible agencies, which includes developing plans for mooring systems with a minimally invasive benthic footprint.

Vessel Strikes

Survey, construction, and maintenance vessels transiting to wave and tidal energy sites could pose risks to marine mammals, sea turtles, and other marine life. The risk of serious injury and mortality from vessel collisions increases significantly with vessel speeds of 10 knots or greater. California offshore wind lessees are required to keep vessel speeds to 10 knots or less. The CeC should also recommend that the same vessel speed limit be applied to wave and tidal projects. It has also been recommended that vessels slow to 4 knots or less to adequately protect sea turtles in circumstances where there are visible jellyfish aggregations or floating vegetable mats.

Noise

Wave and tidal energy systems could produce levels of noise that harass or injure marine mammals and other marine life. Vessel noise can trigger changes in the behavior and stress levels of marine animals and can cause auditory masking that further disrupts their use and reception of natural sounds. Research is needed to assess the risk from prolonged and consistent exposure to wave array noise to a broad range of impacted species. Wave array operations can be expected to transmit vibrations to the seabed geology itself and thereby to benthic organisms and to the water column, as well as to transmit sound directly into the water column where it can travel very long distances.

The CeC should recommend that the construction and operations of wave and tidal energy systems avoid harm to marine life. Lease stipulations should require survey and construction vessels to maintain minimum distances from marine mammals, design infrastructure to produce less operational noise, and require project developers to implement plans to reduce operational noise.

The CeC should also consider the cumulative effects of noise from wave arrays in combination with noise from other industrial marine activities and recommend that siting decisions and management measures account for cumulative noise impacts. Research at one of the only existing floating wind farms in the world highlights the importance of considering cumulative noise from floating arrays in environmental impact assessments, especially where projects overlap with each other or with other ocean uses.

Entanglement of Marine Mammals, Sea Turtles, and Other Marine Life

The anchoring and mooring lines used by wave and tidal energy systems could create risks of entangling marine life, and CeC should recommend monitoring of wave and tidal facilities to evaluate and track entanglements, as well the application of various measures to reduce entanglement risks.

Anchoring and cabling systems can create different types of entanglement risks. Primary entanglement involves animals directly ensnared in lines and cables. Secondary entanglement refers to ensnaring wildlife by debris or other materials trapped in mooring lines, mid-water cables, or infrastructure. Tertiary entanglement occurs when debris or fishing gear already entangling an animal gets caught on and becomes anchored to project infrastructure.

A wide range of marine species, including seals, sharks, fish, diving sea birds, and sea turtles could be at risk of secondary entanglement with debris ensnared on floating offshore wind or other renewable energy infrastructure. More information is needed to assess the degree of risk of secondary entanglement, but the severity of its effects in other industrial settings is well established. Entanglement can result in acute and chronic injuries or death and can have secondary impacts including reduced reproductive success and increased energetic costs that may lead to population-level effects. Additionally, as more marine renewable energy projects are constructed, the risk of entanglement will likely increase due to the larger footprint of textured surfaces on which both derelict gear and marine life can be snagged.

Various measures could be used to reduce entanglement risks, including: siting wave and tidal projects to avoid important habitats, requiring the use of large-diameter mooring lines and avoiding chains and fiber ropes, requiring the use of taut or semi-taut mooring lines, continuous monitoring of mooring lines to detect ensnared debris or entangled marine life, and requiring project developers to comply with a proven protocol for responding to entanglements.

Entanglement and Entrainment

Several of the technologies described by CeC – including oscillating water column wave energy converters (WEC), overtopping WECs, oscillating wave surge converters, axial flow turbines, and crossflow turbines – rely on water cycling through chambers, rotors, or turbines to generate power, which could result in serious injury or death of marine life caught in the water flow.

These processes could present risks similar to those posed by open loop cooling or desalination systems, which also cycle water through their systems. The risks include the entrainment and impingement of marine life, particularly smaller order life, such as eggs, larvae, juvenile fish, marine invertebrates, and other zooplankton. Such systems may also pose risks to larger sea life, like juvenile marine mammals and sea turtles.

The CeC and other state agencies should fully assess entrainment and impingement effects before deploying even pilot-scale wave and tidal energy projects. The agency should also require project proponents to develop a monitoring and reporting plan assessing any entrainment and impingement effects. And CeC should evaluate whether any measures could reduce these effects, such as siting outside of sensitive areas, or mechanical features to prevent harm to marine life.

Oceanographic Processes

Upwelling is an essential contributor to the primary productivity that supports the remarkable biodiversity of the California Current Ecosystem. Offshore wind installations have the potential to alter local and regional hydrodynamics, particularly on coastal and offshore upwelling systems. Preliminary modeling indicates reductions in wind speeds from wind turbine installation off California. These changes could have negative effects on fish and invertebrate distribution, settlement, recruitment, and connectivity, including for key prey species.

It is possible that wave and turbine energy systems could affect upwelling processes in similar ways as offshore wind systems, and these effects should be considered as the CeC evaluates the development of wave and tidal energy.

Adaptive Management

Given that wave and tidal energy systems are still in the early stages of development and the lack of information about the effects of such systems on marine ecosystems, it is essential that any projects have adaptive management measures in place. We appreciate the CeC recognizing the need for adaptive management and outlining measures used in pilot-scale wave and tidal projects.

A number of stakeholder groups have provided adaptive management recommendations related to offshore wind, many of which would be relevant to managing the effects of wave and tidal energy projects, including: collecting robust baseline data and developing models to evaluate renewable energy impacts on marine life, requiring project-specific adaptive management plans, ensuring robust monitoring of project operations, requiring project developers to use best available technology and periodically review and update their technologies, curtailing operations if marine life mortality crosses unacceptable thresholds.

Connectivity of Wave Arrays to the Grid

Wave energy arrays with anticipated connectivity to shoreline infrastructure and transmission grids must also avoid potential adverse effects on sensitive terrestrial features and coastal public parklands, typical of those impacts associated with the 2023 application submitted to FERC for a proposed saltwater pumped-storage facility that would have virtually eclipsed the public trust values inherent in Fort Ross State Historic Park (FERC Project No. 15287-000). The applicant for this facility would have utilized seawater intakes and effluent discharge points illegally located within the Greater Farallones National Marine Sanctuary while using discharge infrastructure buildout on the California Coastal Rocks National Monument. The application for the Fort Ross Pumped Storage facility was ultimately rejected by the Federal Energy Regulatory Commission (FERC) but other equally controversial and environmentally-damaging locations are now being considered for other OSW transmission and infrastructure projects on the California coastline and elsewhere.

County governments along the California coast have spent decades designing and gaining federal certification of their Local Coastal Plans (LCP's) under the auspices of the Coastal Zone Management Act (CZMA) for management priorities that, in many cases, will affect any siting of wave arrays and HVDC substation installations and transmission infrastructure. OSW-associated substation planning must consider interconnectivity with coastal power grids and terrestrial substations to determine a path of "least-harm" routing that does not create irreconcilable space-use, engineering feasibility, or visual blight conflicts with sensitive coastal natural resources.

Further, arriving at wave energy array designs should not just assume an ever-expanding demand design load for the grid itself, but must instead take into account a cost-benefit analysis for improved grid efficiencies, as well as positive inducements for consumer-adopted energy efficiency and conservation measures.

Prospective substation locations identified thus far can be identified at https://caoffshorewind.databasin.org/maps/new/#datasets=0ecfadf7fbb94a588644bd42b779e435

Types of Impacts

Wave energy array impacts may include the following:

- Impingement:
  Large fish and other aquatic life are trapped and smashed against screens at the opening of the intake structure as water is drawn into the cooling system.

- Entrainment:
  Early-life-stage fish, eggs, and larvae can be exposed to pressure and mechanical stress.

Other Topline Issues

Light: Lighting on a wave array device or accompanying substation at night will likely have greater impacts than lighting contemplated on the wave arrays. This issue must be addressed. Intensity, coloration, and color temperature of lighting is likely to have profound implications for the level of impact of the facility on surrounding ecosystem health. Particular species of seabirds are attracted to lights associated with offshore structures, often with fatal results.

Ship Strikes: Ship strikes of marine mammals and other sea life by service vessels visiting all facets of wave array installations should be avoided as much as possible. This may involve speed reductions, on-board observers, and yet-to-be-developed technologies that detect animals in the water column in real time.

Power Infrastructure: Null-loads, transformers, and transmission line disconnects and line terminators are known to have the potential to "leak" stray electrical currents into the surrounding salt water of the ocean, in addition to accompanying EMF fields that surround electrical components during normal operations. Various marine species are extremely sensitive to stray electrical fields, thus publicly-funded research in this arena is necessary to mitigate or eliminate such impacts.

Anchors: While the configuration of anchoring systems for wave array devices is still in the design phase, minimizing their cumulative footprint on the seabed, and simplifying the cable web in the water column, should be done now, not later. A detailed plan for eventual decommissioning of all elements of the wave array infrastructure, including full removal of substations and all associated anchoring cables and seafloor linkages at end-of-use abandonment, needs to accompany the implementation plan from the very beginning.

See also https://baykeeper.org/column/protecting-marine-life-at-california-power-plants/

Transmission of energy from renewable energy installations to shore-based energy consumers may evolve to include specialized technologies that require more than electrical transmission cables. Prospective technologies involving energy transmission to shore by pipeline transport of hydrogen or ammonia are on the drawing boards globally. Pipeline transport would bring with it concerns about chemical spills, hazardous air pollution, and fire and explosion risks. As a contingent transportation technology is considered, it is hoped that the CeC will have facilitated publicly-funded peer-reviewed research to appropriately weigh such technologies against traditional electrical cables.

Thank you for this opportunity to comment on Docket #24-IEPR-04.

Sincerely,

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