Ardavan Amini

Professor Guenther

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Ocean Wave Energy Converters

Abstract

Ocean wave energy converters utilize the renewable power of an ocean to generate electricity. Like with most renewable energies, ocean wave energy is considered a net good for the environment; nevertheless, there are unforeseen issues created by placing wave energy converters in the oceans. The three main culprits of the environmental issues are noise pollution, visual pollution, and the creation of artificial reefs. There are many alternatives for policy creation that will ultimately lead to the decision of combining two different alternatives. This paper will show that the best decision would be to set regulations on noise creation and visual appearance of wave energy converters. Also, funding will be allocated from more efficient forms of renewable energy (e.g. solar and wind) to make wave energy more viable in the energy market and give researchers more freedom to pursue safer, and newer, methods of wave energy creation that will not negatively affect marine life.

The Problem

The question that should be posed to policy makers is as follows: How can the negative externalities of ocean wave energy be lessened without making wave energy useless? The idea of renewable energies has created a sort of illusion where

people and policy makers disregard most of the environmental impacts, but the issues are still a very true reality that should not be tossed aside. By solving, or lessening, this issue, policy makers will be saving marine ecosystems that should remain untouched. If the government does not get involved, researchers will continue their work without much regard for the effects on marine life and visual pollution created by their work. It will, eventually, mess up whale migrations, the beauty of the oceans, and the overall food chain in certain parts of various oceans. Not working on this issue will also lead environmentally conscious researchers to shy away from this form of research because there just is not enough funding for them to care about efficiency *and* the environment.

The Evidence

The use of wave energy converters in the ocean has three main effects: Noise pollution, visual pollution, and the creation of artificial reefs. These problems are not the most harmful manmade effects on the ocean overall; however, not stopping the problem now will lead to a snowball effect where all future, and more efficient, wave energy converters will cause severe problems that will be hard to limit and control.

Noise pollution is a major source of worry for environmentalists. Wave energy converters, for the most part, create a lot of noise in the ocean. Studies done on the effects of noise in the ocean point to adverse effects on sea life including dolphins and various species of fish. According to research done by Smita Singla of MarineInsight.com, “The effect of underwater noise pollution is more painful than anything else for the animals. Most animals are alarmed by the alien sounds. The

deaths can occur due to hemorrhages, changed diving pattern, migration to newer places, and damage to internal organs and an overall panic response to the foreign sounds. There is also a disruption in normal communication between marine animals as a result of underwater noise pollution. This means animals prone to noise pollution are unable to call their mates, look for food or even make a cry for help under such circumstances" (Singla). In these ways, noise pollution ruins an area of marine life and disrupts their natural order. By creating noise in the ocean, the energy converters are effectively disrupting the food chain in that area of the water because fish indigenous to a certain location will move somewhere else and create a whole new ecosystem as well. Singla also mentions that everything from sperm whales to sea bass to brown shrimp can be negatively affected by noise pollution, so it is apparent that noise pollution is not a small issue when dealing with marine life (Singla).

Also, visual pollution is an issue. As wave energy becomes more and more efficient / available, one has to worry about it being to readily used. In terms of sight, a normal six-foot tall person can see out about three miles. If wave energy converters become more feasible in the energy market, many will be placed in peoples' lines of sight. Say goodbye to pristine and untouched ocean views that tourists flock to on the east and west coasts. If the current research continues without any regard to the visual pollution wave energy converters create, the ocean horizons will be lined with buoy-like objects that will make people think twice about, for example, visiting La Jolla Shores or Sunset Cliffs, which are known for spectacular views of the Pacific Ocean. Additionally, wave energy converters would

also be in the way of many different things. The Ocean Energy Council states that the visual pollution created causes a "change of migration route for marine mammals… navigational hazards… and impacts on some forms of recreation, such as scuba diving and jet skiing" (Rick). The effect on recreational activities will no doubt create issues with local tourism and the capital generated from it, which would defeat the financial purpose of going with renewable energy. With respect to migration routes, whales are mostly in trouble because they migrate so much relative to other marine life. A report on the environmental effects of wave power by George Hagerman, of Virginia Tech University, and Roger Bedard, of the Electric Power Research Institute (EPRI), discusses the issues facing some whales: "Some whales have coastal migratory paths, which could be disrupted by wave energy installations. Observations have shown that such installations may constitute barriers that could be difficult to detour around or avoid" (Hagerman and Bedard 11). This is just further proof that shows the negative externalities of creating clean energy by using the ocean as a power source.

The other major issue with wave energy converters, the creation of artificial reefs, also needs to be discussed. The creation of artificial reefs changes the entire ecosystem of the area affected; however, there are conflicting reports on the externalities of reef creation. On the one hand, it sustains more species for longer periods of time, but, on the other hand, it is an unnatural process that is artificial; therefore, it is still affecting the environment in a way it is not meant to be. An Energy.gov report by Glenn Cada highlights this issue that was brought up in a Department of Energy (DOE) workshop: "… Mooring systems could affect bottom

habitat during operation. Device may create structural habitat in open waters" (Cada 177). These issues were not thoroughly investigated (due to lack of funding), but it is still an issue worth addressing. The report mentioned earlier by Hagerman and Bedard also mentions the creation of artificial reefs: "Wave power may provide artificial hauling-out space for seals and sea lions or nesting space for seabirds, enabling larger populations to exist than otherwise might exist under natural conditions. Likewise, submerged surfaces of wave energy devices and associated seafloor structures such as anchors and power cables will provide substrates for colonization by algae and invertebrates, creating "artificial reef"…" (Hagerman and Bedard 4). Although they argue that it could help sustain life, they disregard the effect on the prey of those mammals. The fish and barnacles eaten are adversely affected by the "new home" of these seals, sea lions, and so on. It is not as if these forms of marine life can just sustain themselves without anything else. By placing more energy converters in the ocean, it could effectively wipe out certain species of fish and marine life that would otherwise be left unharmed.

The Alternatives

1) Limiting / Regulating Research Options

Regulating how much noise wave energy converters can create will effectively lessen the impact of the noise pollution issue. Also regulating how visible wave energy converters are could get rid of the visual pollution issue. By passing laws regulating noise and visual pollutions, most of the issues will be solved.

2) Allocating Funding from Solar / Wind Energies

For the most part, it is public knowledge that the "big guys" in renewable

energy are solar and wind companies. They have the highest consumer efficiencies and receive the most funding from government agencies such as the DOE; however, allocating some of that funding to wave energy would be beneficial because it could become a more viable option. Some of the money can be allocated from the SunShot Initiative created by the DOE since about $110 million was made available for solar research. This seems like a high amount just for solar seeing as how most of the efficient research going on is in the private sector.

3) Changing the Locations of Wave Energy Converters

By moving wave energy converters, they would not be in direct sight in the location they were before, but they would just be put somewhere else. For example, wave energy converters could be placed further off into the ocean so it would not be in anyone's direct line of sight.

4) Status Quo

This alternative would mean that researchers continue their research without worrying about noise / visual pollution. Basically, it would mean that none of the issues would be solved.

The Evaluative Criteria

The most important aspects to consider are the effect on marine life and overall research in wave energy. The evaluative criteria that would best fit the desired outcome would be what would save the most marine life. Since it is apparent that these criteria would hurt research, it is important to consider what would help further research into wave energy converters. Basically, the policy that saves the most marine life without hindering wave energy opportunities is ideal.

The Outcomes of Policy Alternatives

1) Limiting / Regulating Research Options

This alternative would save the most marine life in a direct way. The regulating of how much noise and visual pollution can be generated by wave energy converters would very much lessen the adverse affects on marine life and the supposed effects on tourism (by not blocking ocean views, not being in the way of people in the water, etc…). The regulation on visual pollution would be overkill when it comes to converters being in the way of navigation, though, according to Coast Guard Laws mentioned in a blog entry for the Ocean Energy Council: "Title 33 Navigation and Navigable Waters. The district commanders of the U.S. Coast Guard have the authority to determine whether an obstruction in the navigable waters of the United States is a hazard to navigation and, if so, what markings (lights, fog signals, etc.) must be placed on or near the obstruction for the protection of navigation" (Beyen and Wilson). This seems to be one of the only laws directly affecting the visual pollution created that affects ships, but alternative 1 encompasses all aspects of the visual pollution created.

Alternative 1 would, however, have a negative effect on research. By regulating noise levels and visual appearances of energy converters, the researchers are backed into a corner where they can be much less creative. Similarly, since there is no addition to their funding, they are further backed into said corner. This would seriously hinder the future feasibility of wave energy in the renewable energy market. By only negatively affecting researchers and the smaller wave energy industry, it would have little pushback in terms of political feasibility.

Environmentalists will think of this outcome in two ways: Helpful in preserving marine life, and killing a form of renewable energy that could eventually compete in the energy market.

2) Allocating Funding from Solar / Wind Energies

Alternative 2 would not directly assist in preserving marine life, but it does help researchers continue work on wave energy with more opportunity. The biggest issue with this alternative by itself is that there are *no* checks or balances for researchers' works. The funding might be spent on forms of wave energy that could have *even worse* effects on marine life through increased noise and visual pollution. This alternative would also receive the most pushback because it is taking away money from very large corporations that have a lot of pull in environmental policy. It is a sort of David vs. Goliath story because the wave energy industry is miniscule compared to the solar industry; nevertheless, the framework exists in Europe where all forms of renewable energy are given a fair amount of funding out of a general fund for renewables, so it has some measure of practicality.

3) Changing the Locations of Wave Energy Converters

Even though this alternative is an easy fix, it only solves the issue of noise and visual pollution in a local area. Somewhere else will struggle with the adverse effects of wave energy converters; it is basically just moving the problem somewhere else. In terms of political feasibility, there would be a moderate amount of pushback by the governments of the new locations where the energy converters would be placed.

One can argue that wave energy converters could be moved to locations far

away from anything such as marine life, ship trails, and areas where people can visibly see the converters; however, there will always be one or more of these objects in any given part of the ocean. Even if there is a small area that will be unaffected, it cannot be large enough to house multiple wave energy converters.

4) Status Quo

The status quo means that researchers will not have enough funding to make wave energy viable and marine life will suffer just as much. The status quo solves none of the issues. The status quo would be the most politically feasible because policy makers do not need to do anything at all.

	Regulate Noise/Visual Pollution	Allocate Funding	Moving Energy Converters	Status Quo
Environmental Issues Addressed	3	0	~2 locally, but really 0	0
Political Feasibility	High	Low	Medium	High
Research Growth Effect	Low	High	Low	Medium

Fig. 1: Outcome-Criteria Matrix

This outcome-criteria matrix lays out the argument made in this section. It shows that the regulations address the most issues, but it fails to assist in research; meanwhile, allocating funding helps with research but not the big issues dealing with marine life and other visual pollution issues. Alternatives 3 and 4 do not seem to really produce worthwhile outcomes, though. Even though they have moderate and high feasibilities in terms of politics, they do not solve the issues and are probably pointless alternatives. The desired outcome would be that marine life is preserved and wave energy has the chance to reach a point where it can be viable in the energy market.

The Tradeoffs

Alternative 4 is worse compared to any other option because it is static: nothing is moving, nothing is happening, and nothing is better.

Alternative 3 is worse compared to alternatives 1 and 2 because it solves no issue unless the issue was at a much smaller, and local, scale.

By deciding on alternative 1 instead of 2, one is effectively making marine life the priority and disregarding the need for clean and renewable energy. Also, picking alternative 1 will be a much cheaper option because it only regulates a small percentage of energy researchers; whereas, option 2 calls for a redistribution of money so there is a more fair "playing field" so to speak.

With respect to research, alternative 2 takes the cake because it puts funding in the hands of the researchers that will actually help in making wave energy more of a reality, but, again, it lacks the necessary push to the researchers to focus on lessening the noise and visual pollution effects.

The Decision

After considering all of the alternatives, all of the outcomes, and all of the tradeoffs, it is apparent that no one-policy alternative can solve the entire problem. The ultimate decision is to combine alternatives 1 and 2. Alternative 1 regulates noise and visual pollution, so researchers would be backed into a corner, but the addition of alternative 2 would give them funding that would given researchers freedom to work on newer and safer ways of creating wave energy converters.

Also, the increase in funding would mean that researchers would have more of an ability to research the ecological effects of their future work. This would be

very beneficial in making wave energy a “no-lose” form of energy. While many could argue that this decision is unfair to the solar industry because the funding would come out of a chunk from the SunShot project, it is important to realize that making another form of renewable energy more accessible would increase the credibility and social acceptance of renewable energies overall. It should be looked at as more of an investment in trying to make renewable energies the primary energy source in the United States slowly but surely. The solar industry would never have reached the efficiency and cost-effectiveness it has today without adequate amounts of government funding, so it should be only natural to help wave energy break through that threshold into commercial feasibility.

For this problem, there does not need to be some flashy or over-the-top alternative because the research will not catch up overnight to compensate for changes in policy and regulations. By instituting regulations while giving extra funding to wave energy researchers, this policy is ensuring that the environment, in all aspects, is being made cleaner and safer.

Why This Matters

What would be the point of saving marine life if a form of energy that could help replace fossil fuels was set aside? What would be the point of making more efficient forms of cleaner energy if marine life are displaced from their natural habitats or even die? This is why this policy and issue are important. It avoids the hypocrisy of saving the environment in one way, but ruining it in another. It makes sure that there is not this snowball effect where someone opens his or her eyes in 20 years and sees that the wave energy that is saving the ozone is, at the same time,

killing multiple species indigenous to the ocean.

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