
Orbital Marine O2 tidal generator

Ocean Conservancy

Protecting the Ocean and Supporting Rural Coastal Communities through RESPONSIBLE MARINE RENEWABLE ENERGY

PART OF THE CLEAN OCEAN ENERGY BRIEF SERIES

The burning of fossil fuels for energy is having widespread and cascading consequences on the ocean. Thus far, the ocean has absorbed more than 90% of the heat and 30% of the carbon dioxide emissions produced from burning oil and gas. This is causing ocean waters to warm and become more acidic, driving sea level rise, and habitat degradation and loss, including coral bleaching.

Coastal communities are also experiencing the effects of climate change—from more destructive storms, to flooding and erosion. Yet, at the same time, many of the most vulnerable of these seaside communities are also highly reliant on the importation of environmentally damaging fossil fuels for electricity and heat generation.

While adapting to the effects of climate change will be critical for communities, the best path forward for a healthy and safe future for people and the environment is to end the use of fossil fuels and shift to clean renewable energy sources.

Ocean Conservancy supports a transition to 100% clean ocean energy by the year 2050. The future should not be dependent on the destructive methods of past ocean energy development. By phasing out offshore oil and gas drilling and replacing it with responsibly-developed clean renewable energy, the ocean and its ecosystems can be protected from many of the future impacts of climate change. Ocean Conservancy is boldly leading efforts toward this complete sea change in ocean energy. Through science-based research, accessible finance, and targeted policy changes, responsible marine renewable energy can be advanced to meet clean energy transition benchmarks while protecting ocean ecosystems, wildlife, and communities.

KEY TAKEAWAYS

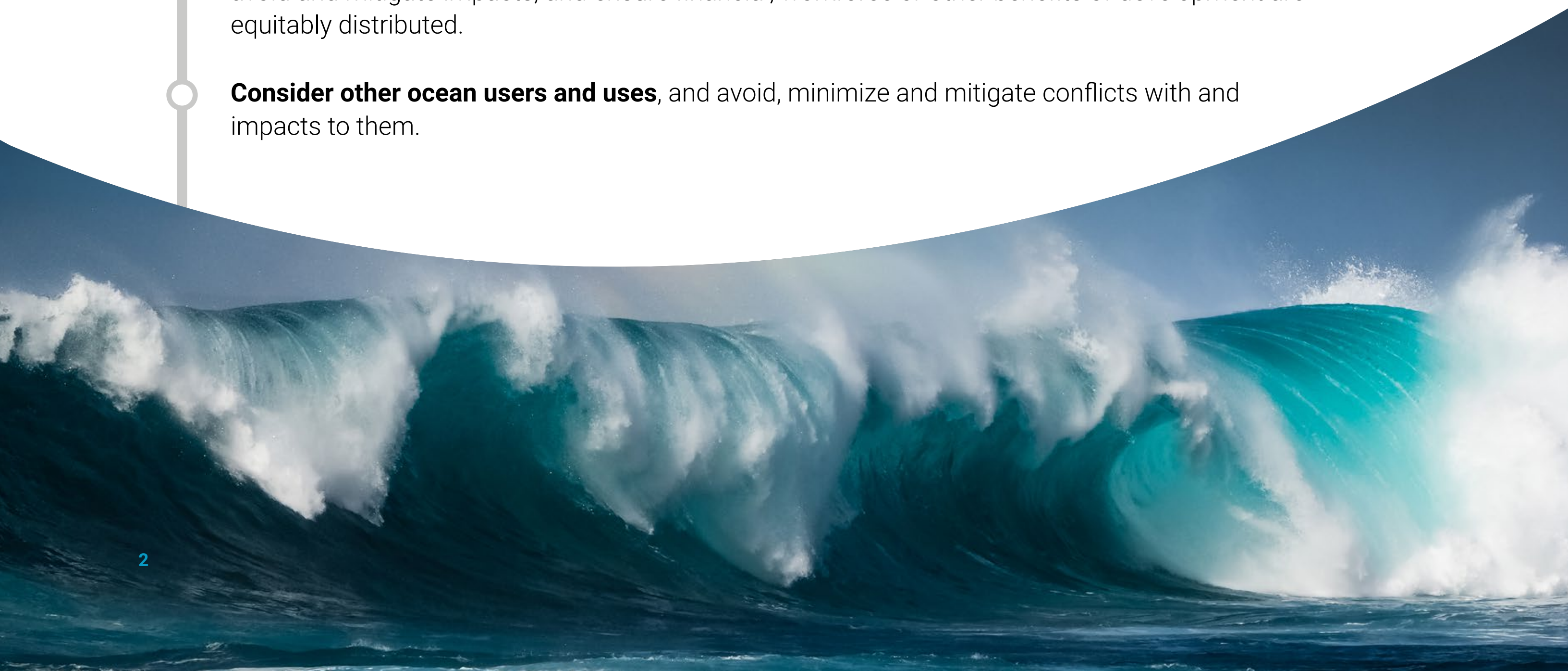
- Climate change is the greatest threat to the health and resilience of the ocean, and to the ecosystems, wildlife, and communities that rely on the ocean.
- Transitioning to a clean energy future will require a broad mix of renewable energy sources. Although offshore wind is the most mature and scalable ocean renewable, its size, cost, and infrastructure requirements could preclude its use in smaller or more remote communities. Other marine renewables will be critical to ensure that everyone has access to clean energy.
- Wave and tidal energy, which are forms of marine renewable energy that harness the kinetic energy of the ocean, are uniquely positioned to provide remote island and small coastal communities access to clean energy.
- Wave and tidal energy technologies hold significant promise and potential. However, funding and permitting challenges create barriers to wide-spread deployment and commercialization in the United States.
- Given the current emerging state of marine renewable energy, now is the advantageous time to invest in community engagement, environmental monitoring, and the development of mitigation technologies to ensure a responsible and just build-out of wave and tidal energy.

Presently, offshore wind is the dominant source of ocean-based renewable energy, as it is technologically advanced, commercially viable, and already generating gigawatts of electricity worldwide. Yet, utility-scale offshore wind will not be enough, nor viable, to decarbonize all communities. Other sources of clean ocean energy will need to be developed.

Marine renewable energy technologies, namely wave and tidal energy, show promise as sources of clean energy that can complement existing renewables. The Biden Administration, through its Ocean Climate Action Plan, has stated that it plans "to rapidly and responsibly advance the commercialization of marine energy technologies that convert energy from waves, tides, currents, and other ocean sources."[1] The action plan sets out to bolster marine renewable energy research, education, and workforce development, and to do so through an environmental justice lens. As these technologies advance, it is crucial that their deployment is done with a robust understanding of environmental and social impacts and is coupled with appropriate mitigation measures to reduce risk. If done responsibly, wave and tidal energy can be effective additional sources of clean ocean energy that help to achieve a just energy transition, particularly for remote and rural coastal communities.

OCEAN CONSERVANCY SUPPORTS THE FOLLOWING PRINCIPLES FOR MARINE RENEWABLE ENERGY DEVELOPMENT:

- **Conserve marine biodiversity and ecosystem functions** by avoiding, minimizing, and mitigating environmental impacts; require long-term monitoring and, if needed, adaptive management of impacts (including cumulative) on marine and coastal ecosystems, wildlife, and habitats.
- **Employ best management practices and proven measures or technologies** to reduce impacts to wildlife and habitats, and where needed, support the development of new technologies and practices.
- **Commit to transparency and data sharing**, making data publicly available in understandable formats, including data collected by developers before and during construction and during operations and decommissioning.
- **Include robust engagement** with state and local governments, scientists, conservation groups, affected industries, communities and others from the outset of planning and throughout operation.
- **Respect Tribal sovereignty** and include meaningful engagement with Native American Tribal governments and Indigenous people and organizations, including free, prior and informed consent.
- **Undertake comprehensive efforts with underserved and vulnerable communities** to understand, avoid and mitigate impacts, and ensure financial, workforce or other benefits of development are equitably distributed.
- **Consider other ocean users and uses**, and avoid, minimize and mitigate conflicts with and impacts to them.



Corpower wave energy device

The Opportunity with Wave and Tidal Energy

The repetitive nature of waves and tides makes them particularly valuable renewable energy sources. Waves, driven by winds far out at sea, are consistent within a specific season. They can be forecasted days in advance, allowing for predictable electricity generation from devices closer to shore. Tides are a known entity as well, generated by the gravitational pull of the Moon on the ocean at regular intervals that are also known far in advance,[2] with certain coastlines well-suited for capturing this tidal energy.

Wave and tidal energy converters are used to transform the kinetic energy of the ocean into electricity. Tidal energy devices work in a variety of ways. In some cases, tides push turbines or spiral-shaped foils that are connected to generators; in other cases, tides push kite-like devices that pull a cable affixed to a generator.

Similarly, wave energy can be harnessed in multiple ways: either directly through waves pushing and pulling a buoy-like device or a metal plate affixed to the seafloor, or by using waves to create air vacuums within a hollow device to spin a turbine. Due to these different designs, device locations within the water column can vary tremendously, with some devices completely submerged at different depths, and with others floating at the surface. Some are even installed on coastal structures such as seawalls or ports.[3]

In the U.S., the technical potential for wave and tidal energy is estimated to be 1,620 terawatt hours (TWh)/year, enough energy to support nearly 40% of the country's total electricity use.[4] While this energy potential will likely never be fully built out–given economic, environmental, and cultural considerations–this figure highlights the vast potential of this clean, localized resource that could supply thousands of communities with energy, even if only a portion is ever realized.

Presently, the industry is in its early stages. As of late 2023, only approximately 12.6 megawatts (MW) of tidal energy and 1.96 MW of wave energy are being produced globally.[5, 6] The most advanced commercial tidal devices in the world, despite being the size of large commercial jet liners, only have capacities of 2 MW each. Similarly, advanced commercial wave devices appear significant in size, yet only have 500 kilowatt (kW) capacities each.[7] The majority of wave and tidal projects, which are located in Northern and Western European waters, are demonstration projects, with only one device sending actual energy to the grid.[8] With the enormous potential for wave and tidal energy, there is substantial opportunity for investment and growth abroad and in the U.S.

Meeting the Unique Needs of Coastal Communities

ISLAND AND REMOTE COMMUNITIES AND ENERGY INDEPENDENCE

Native American Tribes, Indigenous Peoples, Small Island Developing States (SIDS), U.S. territories, and communities located along remote coastal areas have a close relationship with the ocean. The ocean is often central to their cultural heritage and their economies, with the ocean supporting transportation, trade, fishing, recreation, and eco-tourism.

Climate change, as it affects the ocean, is also impacting these remote communities. Degraded natural resources can lead to financial difficulty, which is already occurring in many SIDS. Yet, it is notable that remote and island communities themselves are responsible for producing less than 1% of greenhouse gas emissions that fuel climate change.[9]

However, many remote coastal communities are mired in an unfavorable and costly relationship with fossil fuels. Due to the distance of remote communities from larger population centers and infrastructure, the cost of diesel, natural gas, or other petroleum products can be as much as ten times the average in the U.S., with bulk delivery of petroleum products occurring only a few times each year.[10] In Alaska, this expense amounts to 10% of the income of urban Alaskans and up to 25% for rural Alaskans, regardless of whether or not they live on the coast.[11] SIDS also struggle with high energy costs, with SIDS in the Pacific spending an average of up to 10% of the value of their gross domestic product (GDP) on fossil fuel imports.[12] The cost of fuel for some SIDS can reach 19-28% of their national GDP, as is the case for the Maldives, Guyana, and Palau.[13] In addition, global market shocks and supply disruptions are often felt more sharply across remote and island communities, straining local budgets.

Many of these remote and island communities seek to improve their energy independence, reduce costs, and lower carbon emissions, while keeping their way of life intact.

While solar, onshore wind, offshore wind, and other large-scale renewable technologies are being rapidly deployed around the globe, these technologies may never be viable options or complete solutions for smaller communities. Not all remote communities have the land availability, sun or wind resources, or grid infrastructure to make these technologies viable or cost effective. Additionally, remote communities often only need 500 kW to 5 MW of energy generation capacity— which is in the range of one or two advanced wave or tidal devices[14]—while the capacity of a single offshore wind turbine can be 16 MW[15] or more.[16]

Currently there are no commercial wave or tidal projects operating in U.S. ocean waters. However, the Native Alaskan village of Igiugig has initiated and deployed a river hydrokinetic project—which operates similarly to tidal energy—in its local river.[17]

Other remote and island communities in the U.S. are just now beginning to explore wave and tidal energy, thanks to technological advances, government funding opportunities, and a decline in supply chain costs. For instance, residents of the San Juan Islands in Washington State are investing in developing a pilot tidal energy device in Puget Sound to complement their existing wind and solar energy generation.[18] In February 2024, this project, along with another pilot tidal energy project in Cook Inlet, Alaska, received a combined $6 million in grant funding from the U.S. Department of Energy's Water Power Technologies Office (DOE WPTO).[19]

Marine renewable energy offers remote and island communities an option to realize clean energy independence. With a local energy option, these communities could build resiliency against larger global forces such as international fuel supply disruptions and energy price shocks. Although marine renewables may not replace all diesel use, they can replace a significant portion. A notable example, an island community in Australia has piloted a grid-connected wave energy device that is able to offset one liter of diesel fuel for every three kWh of energy that the device generates.[20] That electricity amount would equate to about one-tenth of the average daily electricity demand of a U.S. household.[21]

Credit: Governor of Alaska's Office, Austin McDaniel

THE IGIUGIG HYDROKINETIC PROJECT

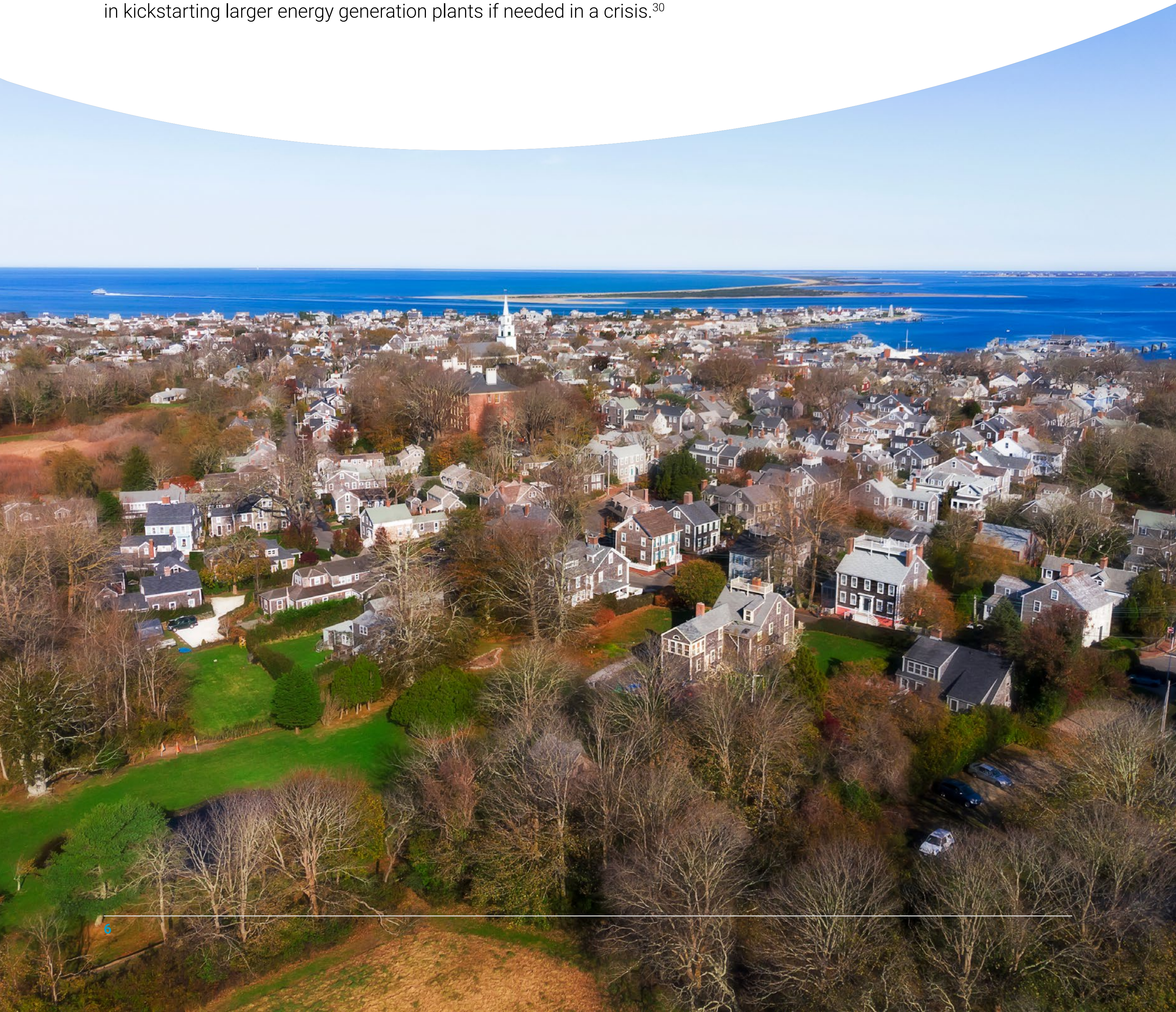
The residents of Igiugig, Alaska, which is a community of 70 people, have long endeavored to remain on their ancestral lands near Lake Iliamna while they adapt to climate and related economic challenges. Igiugig is highly dependent on diesel fuel, and pays approximately $1 per kWh for electricity (about 10 times the national average electricity rate) and $12 per gallon of gasoline (about three times the national average gas price).[22] The Igiugig Village Tribal Council (IVC), through a 100% consensus-driven planning process, committed to addressing these challenges by exploring renewables, including developing a river hydrokinetic energy pilot project in the local Kvichak River. In 2014, the village selected the Ocean Renewable Power Company Inc. (ORPC) as its technology provider to deploy a test iteration of its RivGen® Power System (RivGen®) that year. The project was then licensed by the Federal Energy Regulatory Commission (FERC) in 2019 for deployment and operation of two RivGen® devices with the second one deployed in 2023. Once the project is fully operational and commissioned, IVC expects it will provide approximately 60%-90% of the Village's electricity needs.[23]

IVC sought to harness the consistent power of the Kvichak River, without harming the millions of sockeye salmon and rainbow trout that spawn in the river's headwaters and that have provided sustenance to the people of Igiugig for more than 9,000 years. According to two separate recorded and real-time video footage studies, along with aerial drone imagery and local historical knowledge, it has been documented no fish have been harmed by the first device deployed to date.[24, 25] In addition to careful environmental planning, ORPC has collaborated with community experts on the project's engineering, finances, deployment, and permitting, which has contributed to its success. Additionally, the IVC, not ORPC, holds the 10-year FERC pilot license to operate these devices, which has increased not only local ownership, but also local pride in the renewable energy project.[26]

COASTAL GRID-CONNECTED COMMUNITIES AND ENERGY RESILIENCE

Beyond supporting remote and island communities, marine renewable energy can also support the 40% of the population that lives along the continental U.S. coastline by complementing other renewables. For areas where wind and solar are being developed, marine renewables can provide critical power during anticipated energy generation gaps, rather than relying on fossil fuels to fill those gaps. For example, in studies examining the renewable energy mix of California[27] and the U.S. islands of Moloka'i in Hawai'i and Nantucket in Massachusetts,[28] tidal and wave energy tends to produce the most energy during times when solar and wind produce the least energy. This helps grid operators better schedule clean energy generating capacity and storage to meet daily and seasonal electricity needs. In some cases, tidal energy could provide uninterrupted baseload power in place of fossil fuels, although this will be dependent on specific sites and technologies used.[29] A continuous flow of electricity reduces the need for high battery storage and additional (more intermittent) renewable energy deployment.

Marine renewable energy could also enhance the resiliency of large electricity grid systems. High concentrations of people who live near the ocean often receive power from long-distance transmission lines that are susceptible to damage from storms, earthquakes, or other disasters. Nearby marine renewable devices could provide local back-up electricity to power emergency communications and public health facilities and could assist in kickstarting larger energy generation plants if needed in a crisis.[30]



U.S. Wave and Tidal Energy Development Challenges

As promising as marine renewable energy is, wave and tidal technologies are still very nascent and face many challenges. Many of these challenges, noted below, are not unique to marine renewable energy, which shares characteristics with other ocean and water industries. For this reason, there are various approaches that could be leveraged from established industries to address marine renewable energy's challenges.

First, the industry is challenged by its relatively small size. Only 10 to 20 wave and tidal energy technology developers are active in the U.S. These are mostly start-up companies that are working on the commercialization of their devices, not broader business, development, and permitting issues.[31] Additionally, only about 120 firms and research institutions are tangentially involved with marine energy.[32] With so few domestic firms, and with few international firms entering the U.S. market, only about 10 device deployments have occurred in the U.S. in the past 20 years,[33] and these have all been temporary or reduced-scale devices designed for research, demonstration, and pilot purposes.

Another challenge is the wide variety of devices, given the various types of marine resource characteristics around the U.S.'s coastlines such as wave size, flow, and water depth that must be considered to capture the power of the ocean. Currently, there are six different types of device designs to capture tidal energy[34] and eight types of designs to capture wave energy.[35] This wide range can complicate deployment methods as each design will likely have a different set of requirements. This can make it difficult to assess environmental impacts, build investor confidence, and create economies of scale. As technology convergence slowly continues, this challenge may subside.

The U.S. federal government is increasingly providing support to overcome development and deployment challenges for marine renewable energy. DOE WPTO has received increased appropriations dollars for marine renewable energy research and development,[36] although federal regulatory agencies will also need funds for dedicated capacity and training to support this growth. The inclusion of marine renewable energy as one of the eight priority actions in the Ocean Climate Action Plan also underscores the Biden Administration's intent to further the commercialization of these technologies.[37]

While these are important launching steps to technological maturity, additional nuanced challenges, detailed below, will need to be addressed to enable these technologies to be brought to remote and coastal communities.

LACK OF ADVANCED COMMERCIAL PROJECT FUNDING

Despite the federal government's recognition of the importance of investing in emerging technologies, marine renewable energy start-ups in the U.S. have not been able to move technologies beyond pre-commercial stages. DOE WPTO funding is often directed towards early project stages, rather than toward long-term testing of devices that can show performance levels and power generation capabilities in real ocean conditions. While the foundational research is important to inform deployment, limited long-term public funding is hampering entrepreneurs from reducing their financial risk.[38] Without long-term financial stability to bring projects from the seed stage to more advanced development stages, private investors have hesitated to invest, leaving young wave and tidal energy firms in a tenuous "valley of death" scenario, where they fail before communities that are eager for renewable energy can even deploy the technology.

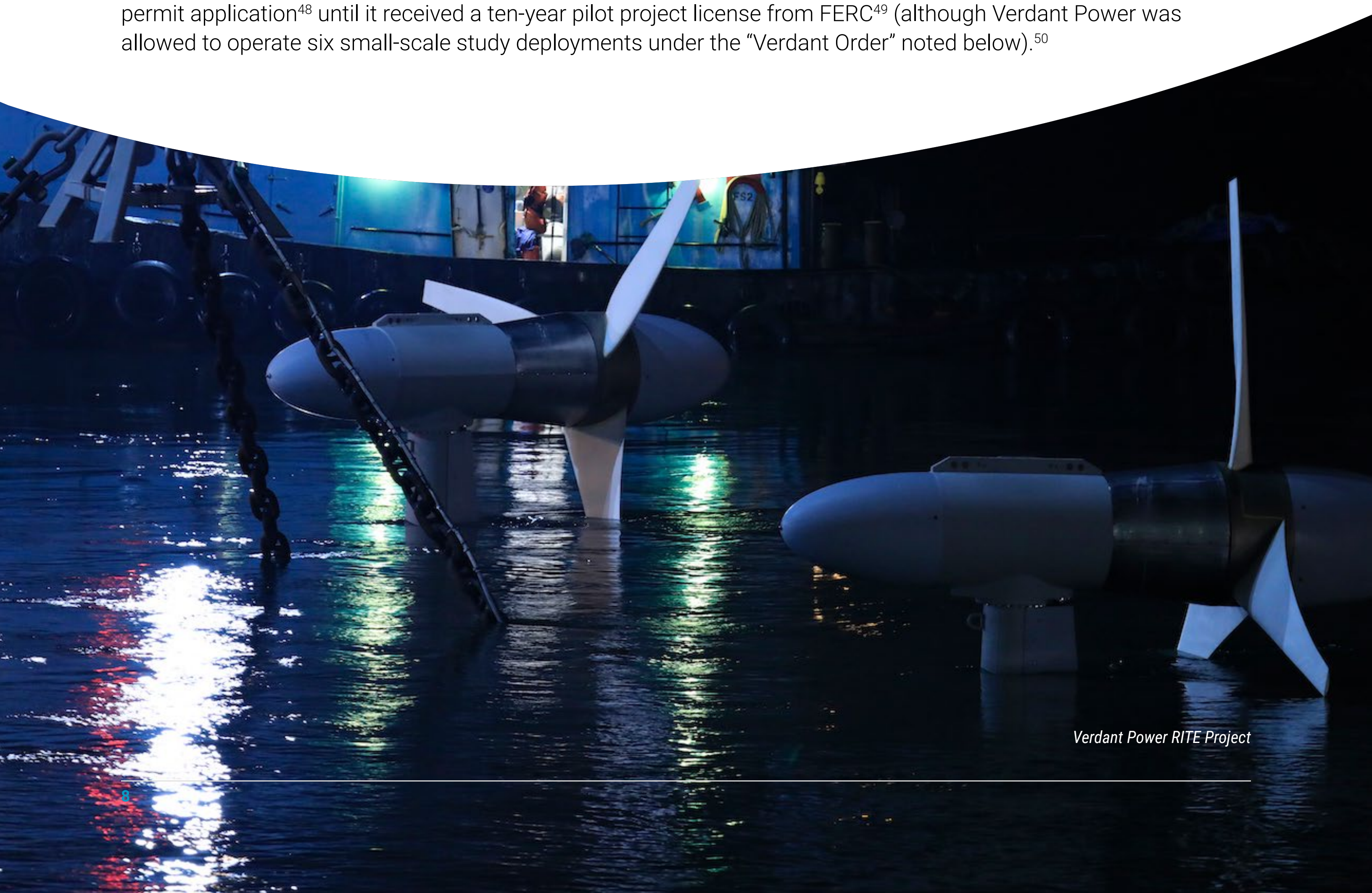
Other technologies such as virtual reality, medical devices, and some forms of clean energy have made it through this valley of death[39] through a number of strategies. These strategies include obtaining public and private funding from a wide variety of sources; commercializing early to meet specific needs; engaging and collaborating with stakeholders early; and benefitting from government policies in the form of tax breaks, innovation funds, and infrastructure support. For example, if the DOE Office of Clean Energy Demonstrations (OCED)[40, 41] expanded its portfolio to explicitly include wave or tidal energy devices, this could open the door to millions of dollars in funding that could be used in tandem with DOE WPTO funding to move technologies from early stages to long-term development.

MAKESHIFT AND COMPLICATED PERMITTING

As with other emerging energy industries, the system of laws and regulations governing marine renewable energy deployment is evolving with the technology. The permitting for research, demonstration, and pilot wave and tidal energy projects in the U.S. largely relies on the same federal rules and regulations that govern large hydroelectric dams. However, the applicability of these rules and regulations does not easily translate to wave and tidal projects. Only about 20 projects[42] have applied for federal permits, and fewer have obtained them.[43]

Coordination among federal and state agencies during the permitting process, though important and necessary, has also complicated, and in some cases extended, the timelines for projects, with state agencies having limited resources to navigate the regulation of a new ocean activity.[44] For instance, there are not yet agreed-upon methods for environmental monitoring and data collection across different wave and tidal energy projects.[45] This has led to disagreements among regulators and developers over the amount and type of monitoring required.[46]

The average length of permitting is six years from start to completion for marine renewable energy applications for pilot and research deployment due to these combined permitting issues.[47] One early example, Verdant Power's Roosevelt Island Tidal Energy (RITE) project, deployed outside New York City, needed nine years from its preliminary permit application[48] until it received a ten-year pilot project license from FERC[49] (although Verdant Power was allowed to operate six small-scale study deployments under the "Verdant Order" noted below).[50]



Verdant Power RITE Project

There are examples where more efficient permitting pathways for scaled-down projects have been made available. Under the "Verdant Order," FERC now exempts for up to 18 months small (under 5 MW capacity) tidal and wave energy devices from needing a hydrokinetic pilot project license for installation if the device is used for research purposes and if the power generated is not sold. These projects still require a preliminary FERC permit and must be compliance with other state and federal law requirements, such as an Army Corps of Engineers permit.[51] The RITE Project used the "Verdant Order" pathway to conduct its initial studies that helped prepare its 10-year pilot project license application.[52]

Similarly, in 2013, the Ocean Renewable Power Company (ORPC) used the FERC pilot license process to deploy its Cobscook Bay Tidal Energy Project. As part of the pilot license, FERC regulators and ORPC applied a process called adaptive management to develop new environmental monitoring methodologies, and to modify the project's license requirements within existing regulatory requirements, such as by reducing the frequency of monitoring surveys, as confidence grew regarding the low potential for impacts. This flexible decision-making process has been effective as a tool for wave and tidal device deployments thanks to the robust monitoring of natural resources operations, and the adjustment of policies or operations for iterative natural resource management.[53, 54]

Although the "Verdant Order" provides an improved permitting pathway for pilot projects such as the ORPC project, this order only covers limited deployment for research and testing to support a pilot project license. More substantial permitting improvements are needed to allow for the efficient build-out of commercial-scale marine renewable energy projects. Explicit permitting policies aside, the lack of data sharing and public-private research partnerships has siloed agency staff, which has reduced regulatory efficiencies and expertise for project development efforts.[55] Permitting agencies should require non-proprietary data to be shared, and state and federal task forces may also help with development and joint research projects to facilitate information.[56]

While these challenges are complex, they are solvable with smart policy, coordination, and planning.

TidGen tidal energy pilot device

UNDERSTANDING AND MONITORING UNKNOWN ENVIRONMENTAL IMPACTS

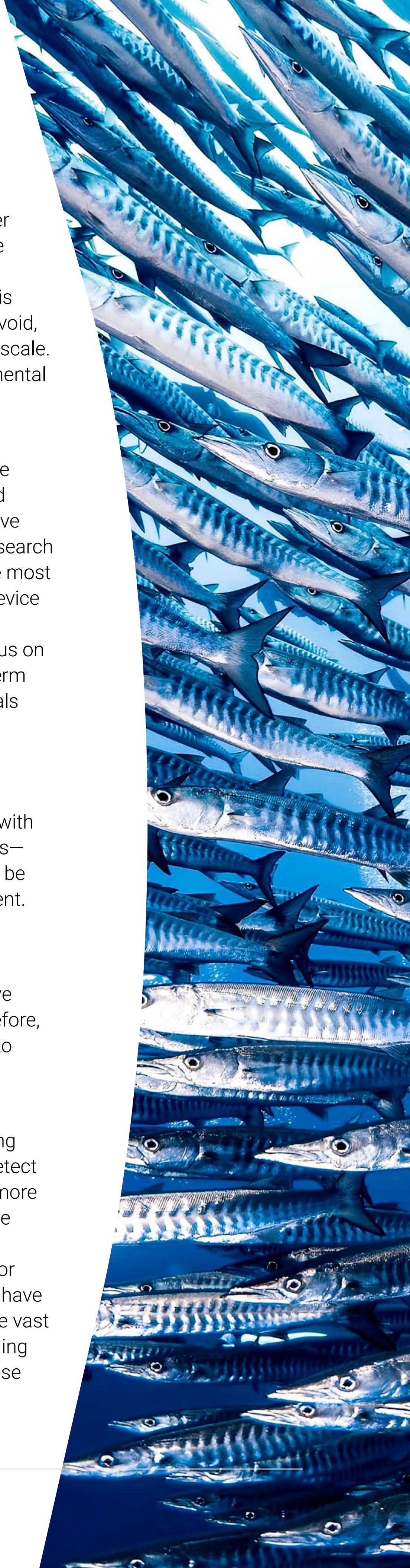
All devices and structures deployed in the ocean will have some level of effect on the environment. The introduction of wave and tidal devices could potentially alter habitats or oceanographic conditions, create underwater noise pollution, produce electromagnetic fields, or cause other impacts. The displacement of marine life, animal collisions, or entanglement could also occur from these new devices.[57] It is crucial to monitor to identify potential impacts and determine best practices to avoid, minimize, and mitigate significant ones before deployments increase in size and scale. Because few devices have been deployed in the ocean thus far, data on environmental impacts are limited.

The U.S. is a global leader in the study of environmental effects from wave and tidal devices. It leads in the number of environmental studies conducted on marine renewable energy, responsible for about 18% of total studies, followed by Scotland (17%) and the UK (13 %).[58] This work to study the environmental impacts from wave and tidal devices is supported by U.S. government investments in foundational research and development.[59] Of the environmental studies conducted on these devices, the most common include literature reviews of natural ecosystems to infer impacts from device deployments and modeling exercises. Lab experiments and field observations are increasing; however, many information gaps remain because lab experiments focus on scaled-down, single device deployments and field tests are relatively rare. Short-term monitoring in-water for pilot device impacts on fish, seabirds, and marine mammals have used various technologies including imaging sonars, echosounders, video cameras, passive and active acoustics, transect and visual surveys.[60, 61]

From the few demonstration device deployments in the ocean, minimal impacts, such as underwater noise and animal collisions, have been detected.[62] However, with so many types of devices—including larger devices deployed for longer timespans—and different ecosystem settings for potential deployment, additional studies will be needed to better understand and, if necessary, mitigate impacts to the environment.

To address these environmental information gaps, baseline studies should be conducted now to provide a strong foundation for regulators and developers to adaptively manage operations to better avoid, minimize, and mitigate any negative impacts for current or future projects.[63] As development ramps up, monitoring before, during, and after the deployment of devices will allow developers and regulators to detect impacts, and identify potential mitigation measures quickly.

Building monitoring technologies that can be deployed in tandem with marine renewable energy devices is a critical step for monitoring and adaptively managing impacts and is currently underway. Monitoring technologies need to be able to detect ecosystem or wildlife interactions, something that remains a challenge even for more mature ocean energy technologies. This is because these technologies need to be able to withstand highly energetic environments, without experiencing corrosion and biofouling, while providing data over long timeframes. Multiple instruments for simultaneously monitoring different effects will likely be needed, and some firms have begun exploring machine learning and artificial intelligence as tools to analyze the vast amounts of data captured.[64] As deployments increase, additional dedicated funding will be needed to refine and standardize monitoring technologies for studying these projects and the potential interactions with their host environments.



Notably, the U.S. will boost its wave device testing capabilities with the forthcoming PacWave South test site off the coast of Oregon. The site is expected to be operational in early 2025, providing a platform for testing devices and monitoring environmental impacts.[65] This test site will be a pre-permitted, grid-connected site that can accommodate up to 20 wave energy converters, producing up to 20 MW. Devices that meet certain criteria in terms of type, capacity, and other requirements will be able to test at this site, directly in the ocean, much quicker than if each technology developer had to apply for the requisite permits for each device. Oregon State University, the project lead, will conduct environmental monitoring of the devices at the site. The environmental data and information gleaned from trials of various wave energy converter devices at PacWave South, and a similar existing Navy Wave Energy Test Site in Hawai'i, need to be appropriately shared with scientists, decision makers, local communities, and other ocean users. Doing so will inform adaptive management approaches, improve project permitting, and increase public trust, investor confidence, and the growth and commercialization of wave and tidal technologies.

LACK OF COMMUNITY AWARENESS AND ENGAGEMENT

Because wave and tidal energy technologies have not yet reached commercial-scale deployment and grid connectivity, most remote and island communities are largely unaware that wave and tidal energy could potentially satisfy their local energy needs.

When projects are deployed in the future, communities could have varying concerns about wave and tidal energy devices. Concerns over impacts to wildlife, and alignment to cultural heritage, as well as ocean use conflicts (e.g., fishing, ecotourism, boating, shipping, and aquaculture) are just some of the issues that will need to be considered. Without adequately understanding and addressing these issues, a project developer may be stalled or unable to deploy their project due to community opposition.

Engaging local Tribes, coastal communities, and ocean users early and often can help avoid any potential delay or opposition. Not only will engagement help establish community support, but it could help spur interest among other remote and island communities in their own projects. Much of this interaction should be led by the government and by project developers. For instance, the DOE Energy Transitions Initiative Partnership Program (ETIPP)[66, 67] was established in 2020 for this purpose. While it is a good start, it is currently limited to servicing only about ten communities each year.[68]

One example, where community engagement has fostered support is with ORPC and the Igiugig Village [see blue box above]. The project was led by Igiugig Village residents who selected the developer rather than the developer arriving with an agenda. ORPC has worked closely with local engineers, boat captains, contractors, and other Village members throughout the project lifespan.[69] Further, the RivGen® hydrokinetic energy device, which shares the same waters as the culturally and nutritionally significant sockeye salmon population, has had with no documented negative environmental effects. With an established working relationship, Igiugig Village commissioned ORPC to deploy a second device in 2023 to further reduce Village diesel fuel usage.

Last, government representatives should be conduits to foster community engagement. Community members may contact federal employees such as National Oceanic and Atmospheric Administration (NOAA) Sea Grant officers or the FERC Office of Public Participation staff to inquire about wave and tidal energy. Where possible, it would be beneficial to have staff who are able to understand the particular concerns held by those local residents.

A strong framework for engagement can help facilitate whether the project is a good fit for a community.[70] Broader existing processes, such as regional ocean planning, can also provide ways to inform communities of the risks and benefits of wave and tidal energy. Smart planning may also help increase public support of the new technologies, reduce conflicts, and ease approval issues.[71]

Recommendations to Advance Wave and Tidal Energy Development

With the ocean changing rapidly due to the effects of climate change, leaders must act today to support the responsible development of marine renewable energy. Ocean Conservancy recommends the following policy actions:

INVEST IN DEVICE DEVELOPMENT AND DEPLOYMENT

Federal and state government agencies, such as the DOE WPTO and OCED, should provide predictable funding and financial incentives each fiscal year throughout the development, testing, and deployment phases of individual wave energy devices and tidal array projects.

INVEST IN OR INCENTIVIZE THE COLLECTION OF ENVIRONMENTAL DATA

Federal and state agencies should require and support baseline survey work, environmental monitoring, analysis, and information sharing before, during, and after the installation, operation, and decommissioning of marine renewable energy projects.

IMPROVE PERMITTING

Federal and state regulatory agencies should be appropriately funded and trained to permit marine renewables and they should collaborate with legislators to improve permitting efficiency. This includes specific, consistent, and clear guidance for obtaining approvals and permits. When faced with novel technology applications and the permitting of research and demonstration devices, regulatory agencies should encourage adaptive management approaches for activities that would inform pilot project license applications, mapping, or research purposes. Increased interagency coordination through a federal task force, working group, or even a regional ocean partnership could also support a coordinated permitting process.

ENCOURAGE DATA AND KNOWLEDGE SHARING

Federal and state agencies need to identify effective measures to share data and knowledge within the permitting process to build public understanding, expedite scientific discovery, assist the development of environmental mitigation measures, and accelerate technology development.

ELEVATE MARINE RENEWABLE ENERGY AS PART OF THE JUST CLEAN ENERGY TRANSITION

Trusted federal representatives should engage Tribal Nations, state governments, coastal communities, and ocean user groups early and often about the potential benefits and risks of marine renewable energy. Further, communities where marine renewable energy is built will need training and physical infrastructure investments to take advantage of these clean ocean energy resources while mitigating any disproportionate costs of the new activities.

Conclusion

Climate change is a global crisis and is having an outsized impact on island and coastal communities. For many of these communities to benefit from a just transition from legacy fossil fuels to renewable energy, they will need multiple clean energy solutions to provide them with viable options. Increased investment now in the responsible development of wave and tidal energy devices—coupled with enhanced environmental monitoring, mitigation measures, and information sharing that can inform local decision-making—will help ensure these communities are not left behind in the just energy transition.

To learn more about other clean ocean energy solutions, visit **CLEANOCEANENERGY.ORG**

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