# Commercialization Strategy for Marine Energy

2021


NHA
National Hydropower Association

MARINE ENERGY COUNCIL

# Executive Summary

The abundant potential to develop marine energy is stunning. Harnessing waves, tides, currents, and even thermal gradients, could technically produce ***more than half*** of all the nation's electricity needs.

Demonstration projects and research over the past decade, supported by the U.S. Department of Energy and U.S. Navy, show that innovative marine energy technologies could be the missing link for meeting our nation's clean energy goals and decarbonizing our electricity grid.

What's more, these technologies complement wind and solar technologies. As these variable renewables play an increasing role in the U.S. electricity mix, marine energy resources have the potential to prove particularly valuable to future energy markets.

What's needed now is a commitment—by both the marine energy industry and by the U.S. Federal Government—to **accelerate commercialization of these technologies**.

## Huge Potential for Development

The results of a [new marine energy assessment report] developed by the National Renewable Energy Laboratory (NREL) for the U.S. Department of Energy are astounding.

The total marine energy technical resource in the United States is equivalent to ***57% of the nation's electricity generated in 2019***. Utilizing just 1/10th of these resources would:

- Equate to nearly 6% of electricity generation.
- Produce enough electricity to power 22 million homes.
- Represent more than 3 times U.S. solar generation.
- Equal ¼ of the U.S. coal fleet.

Indeed, the nation's marine energy resources are large, predictable, and geographically diverse.

## Call to Accelerate Commercialization

Marine energy technologies are experiencing rapid innovation. Deployment of these technologies at scale in the United States will benefit the nation by:

- Increasing localized economic development opportunities.
- Creating thousands of high-value jobs.
- Promoting exports in technology manufacturing and related services.

However, without a unified focus on accelerating commercialization, these benefits will be delayed, if recognized at all.

The National Hydropower Association's Marine Energy Council is the U.S. national trade group dedicated to promoting technologies and related services to harness clean, renewable power from marine energy resources. Leading the charge for commercialization, the trade group is calling for domestic marine energy deployment targets of at least 50 MW by 2025, 500 MW by 2030, and 1 GW by 2035.

***U.S. Marine Energy Deployment Targets:***

- **→ 50 MW by 2025**
- **→ 500 MW by 2030**
- **→ 1 GW by 2035**

Meeting these deployment targets will support the Biden/Harris Administration's efforts to "Build Back Better" and increase economic growth, create thousands of high value jobs, support the clean energy transition, and promote exports in manufacturing and related services.

The National Hydropower Association's Marine Energy Council also calls on the U.S. Federal Government to take actions to help meet these deployment targets. Federal policymakers need to:

- Increase financial support for research and development.
- Reduce market barriers.
- Create financial incentives for technology deployment.

Specifically, substantial new investments in the U.S. Department of Energy's Water Power Technologies Office and the U.S. Navy Energy Program will accelerate the pace of technology demonstration, reduce costs, and increase adoption.

## The Time Is Now

Marine energy offers the opportunity to provide lower cost power while dramatically reducing harmful emissions. These resources offer significant near-term promise for widely distributed, previously underserved, or economically distressed waterfront communities. Marine energy can give these localities control over their power supply, increase grid reliability and security, dramatically reduce harmful emissions, and help achieve climate change goals. Marine energy technologies will also facilitate off-grid "Blue Economy" market opportunities.

***Together, industry and government can partner to "walk the final mile," leading the U.S. to successfully transition to a 100% clean energy grid.***

# Marine Energy **Overview**

Marine energy technologies—powered by water-based renewable resources such as currents, tides, and waves—are undergoing rapid innovation and will be critical in helping to reach 100 percent clean energy targets and related climate change goals by 2035. Globally available marine energy resources are vast, reliable, predictable, and environmentally friendly. Commercialization of technologies to safely capture these renewable resources at scale will support localized economic development opportunities and is, to quote President Biden, "a gigantic opportunity to create really good jobs."

Marine energy has significant near-term promise, particularly in coastal, riverine, and island environments that currently rely on high-cost fossil fuels. As a baseload source of electricity, marine energy technologies offer the opportunity to provide lower cost power, dramatically reduce harmful emissions, and create high-value employment for widely distributed, previously underserved, or economically distressed waterfront communities.

In February of 2021, the U.S. Department of Energy (DOE) and National Renewable Energy Laboratory (NREL) released a report entitled *Marine Energy in the United States: An Overview of Opportunities*. The assessment demonstrates that domestic marine energy resources are large and geographically diverse.

The DOE conservatively estimates the marine energy technical resource is 2,300 TWh/year, which is 57% of all U.S. electricity generated in 2019. This is equivalent to powering 220 million homes. If just one-tenth (5.7%) of the technical resource were utilized, marine energy could power the equivalent of over three times U.S. solar generation or one quarter of the U.S. coal fleet in 2019.

The International Energy Agency (IEA) predicts that by 2050 over 300 Gigawatts (GW) of marine energy capacity will be installed globally, which represents $35 billion in investment, creation of 680,000 direct jobs, and annual savings of 500 million tons of $CO_2$ emissions.


*Verdant Power's TriFrame™ mounted tidal turbines for the Roosevelt Island Tidal Energy (RITE) project*

## Marine Energy Value Proposition

DOE supported demonstration projects and research over the past decade show that marine energy technologies will provide clear and competitive benefits to the electric system and facilitate off-grid "Blue Economy" market opportunities. These benefits include marine energy's location near demand loads, relative predictability, generating profiles, and resiliency. Deployment of marine energy technologies at scale will:

- Help defer or avoid the high capital and environmental costs associated with constructing new electricity transmission capacity for remote, coastal locations.
- Greatly reduce integration costs.
- Provide long-term support for high grid penetration of other renewables.

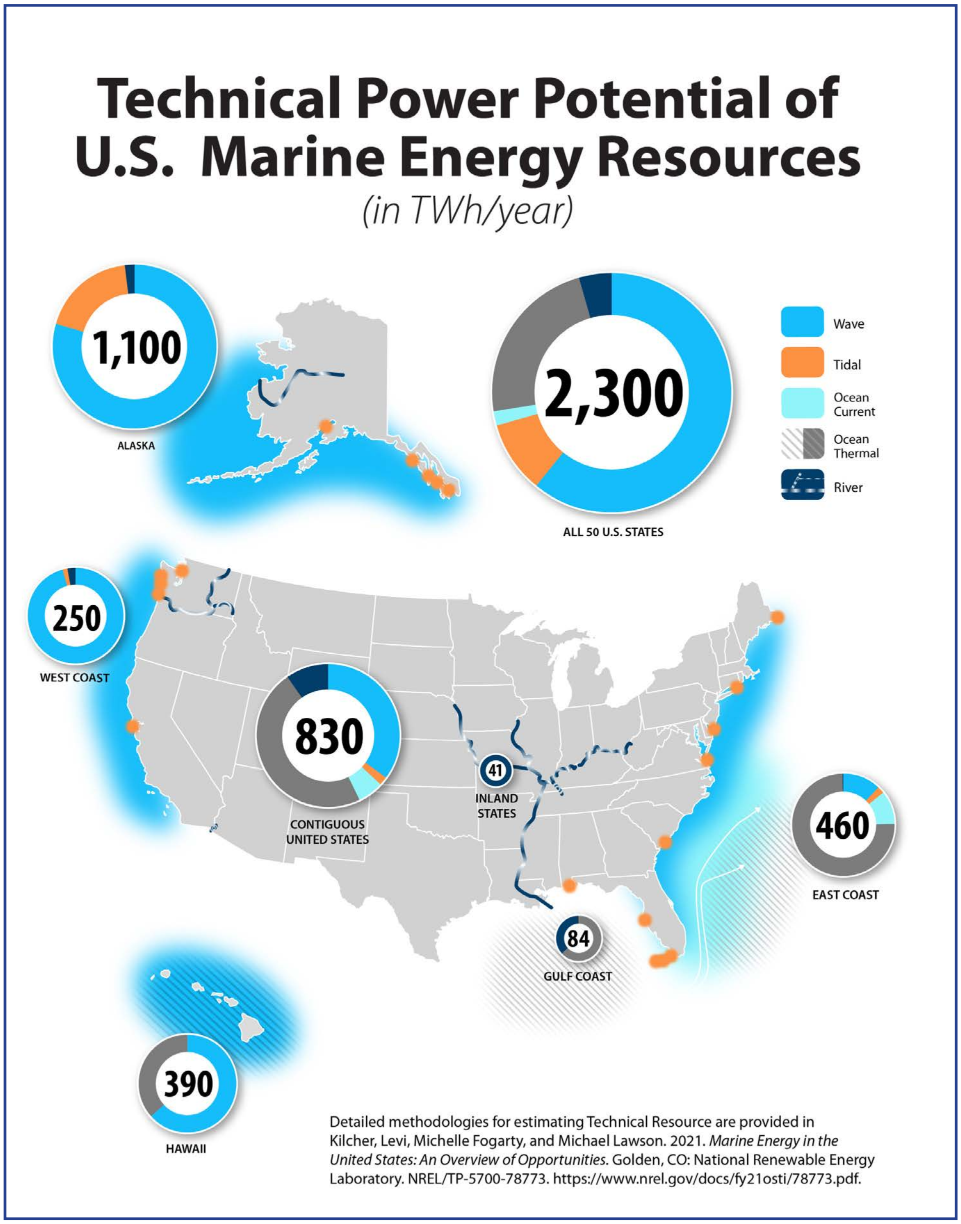
Given the reliability and predictability of marine energy, near-term distributed generation market opportunities include the development of water-based hybrid power systems, "green" hydrogen production, port electrification, clean water systems, electric vehicle and vessel charging stations, underwater data centers, irrigation and aeration pumping systems, and the recharging of energy storage systems.

Marine energy technologies will also help facilitate off-grid "Blue Economy" market opportunities, such as remote underwater vehicle charging, autonomous sensors, and power for the offshore energy, aquaculture, and oceanographic research industries. The U.S. Navy is exploring opportunities for marine energy devices to provide power for maritime security systems, at-sea persistent surveillance, and communications.

Finally, services related to global deployment of marine energy technologies, including resource assessments, along with project feasibility and site selection studies, are critical to building the case for commercial project development and can be a significant source of economic activity and revenue for U.S. companies.

# U.S. Marine Energy Resources

U.S. marine energy resources are significant and geographically diverse. The fifty-state total technical resource of at least 2,300 Terawatt Hours (TWh)/year is equivalent to 57 percent of total electricity generated in 2019. This does not include the significant potential for Ocean Thermal Energy Conversion and salinity gradient differentials. For comparison, total solar generation in 2019 was 103 TWh, 2 percent of all U.S. electricity generation.




*Potential marine energy resources in the United States (National Renewable Energy Laboratory)*

***Wave Energy —*** The U.S. wave energy resource is large (1,400 TWh/year), and the vast majority of this energy is delivered directly to the nation's shorelines where it can be utilized on land. The west coast is a particularly attractive region for wave energy because the resource reaches the shoreline (240 TWh/year), where it can be readily utilized.

***Tidal Energy —*** A smaller resource by comparison (220 TWh/year), tidal energy technologies are—in general—closer to commercialization than wave technologies. It is also a highly predictable form of renewable energy, and many sites are adjacent to markets that could utilize the power available. Tidal energy hot spots are located throughout the Northeast, Pacific Northwest, and Alaskan coasts. Cook Inlet alone could power much of Alaska.

***Ocean Current Energy —*** At a similar level of commercialization as tidal, ocean current energy (49 TWh/year) could provide clean reliable power to millions of homes along the southern Atlantic coast. The Florida Current, part of the Gulf Stream, offers a significant opportunity.

***Riverine Hydrokinetic Energy —*** The nation's free-flowing riverine resource (78.86 TWh/year) is appealing because it could provide a clean and reliable source of power to communities or other infrastructure along the nation's riverbanks and waterways. This is a particularly interesting opportunity for remote Alaskan communities, many of which are located along rivers and typically rely on expensive diesel generators to power their electrical grids.

***Ocean Thermal Energy Conversion/Salinity Gradients —*** The potential for ocean thermal resources is vast and equivalent to 98 percent of all U.S. electricity generation in 2019.

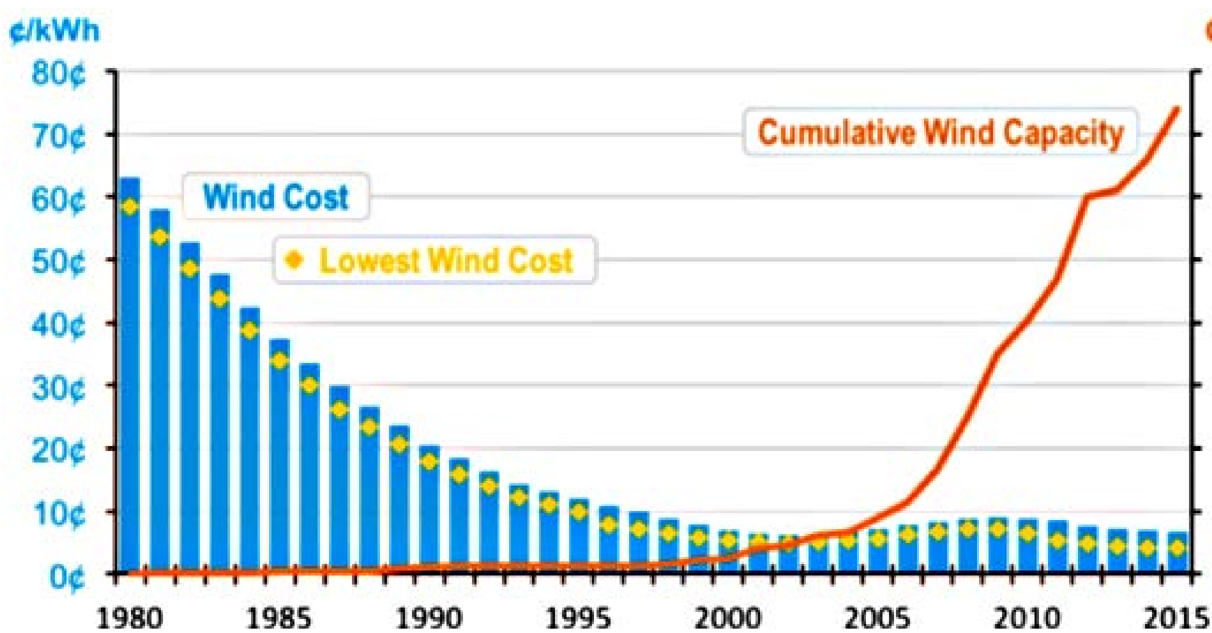
## Continued R&D Required to Advance Marine Energy Technologies

A network of U.S. companies, supported by universities and the National Labs, are working to unlock the global marine energy resource. One of the most significant challenges to the domestic marine energy sector is the need to continually attract private investment to fund innovation and initial demonstrations during the pre-competitive stages of technology development, primarily due to the timelines and technical risks involved.

Unfortunately, the U.S. has fallen behind the leading global competitors in marine energy technology development, which benefit from significantly higher government subsidies dedicated toward research, innovation, and early commercial activities. Without increasing its level of support, the U.S. will become an importer, not exporter, of these technologies and related services and lose many potential high-value jobs.

As with more mature power generation technologies, such as advanced gas turbines or solar converter systems, support from the U.S. Federal Government for critical early-stage innovation and technology deployment efforts are key to igniting commercialization of the marine energy sector. For example, the first large-scale wind farms were installed in the U.S. roughly 35 years ago. However, national wind power deployment did not surge for another 15-20 years, when costs became competitive after extensive federal support. In addition, as shown in the graphic below, the cost of wind power decreased as the pace of project deployments grew. This pattern was repeated with solar development and deployment.

It is important to note, however, that initial commercial wind and solar project deployments took place in the early years before these technologies were price competitive with established sources of electricity generation at the time. A similar trajectory is possible for marine energy with a coordinated set of actions and increased investments by the federal government to accelerate the development and deployment of marine energy technologies and related services.




*Historic wind energy cost/deployment curves in the United States*

# Strategy for Accelerating U.S. Marine Energy Potential

## Deployment Targets

The National Hydropower Association's Marine Energy Council is calling for U.S. marine energy technology deployments of at least:

- ➔ **50 MW by 2025**
- ➔ **500 MW by 2030**
- ➔ **1 GW by 2035**

## Federal Actions Needed to Accelerate Marine Energy Deployment

To meet the deployment targets, federal actions—including funding, leadership, and support—are required in 10 areas:

**1** **System Design, Fabrication, and Demonstration—**Increased funding to support research, design advancement, testing, and validation of marine energy systems, sub-systems, and components. These innovation efforts are critical to increasing demonstration and deployment opportunities and reducing overall Levelized Cost of Energy (LCOE).

**2** **Fostering Distributed Generation Capabilities—**New investments related to identifying and initiating infrastructure upgrades are needed to support high-value, near-term distributed market generation opportunities at scale for marine energy.

**3** **Emerging Opportunities for Off-Grid Power—**Increased funding for the DOE "Powering the Blue Economy" initiative, which will expand the near-term commercial value of power generated by marine energy devices and related services.

**4** **Foundational Research and Engineering Assistance—**Expansion of the research, engineering support, and workforce development activities underway at university-based National Marine Energy Centers, the National Labs, and other qualified non-profit institutions.

**5** **Testing Infrastructure and Validation Support—**Additional funding to expand existing and establish new testing infrastructure (including grid connection and deployment equipment) for marine energy devices along with support for technology validation activities.

**6** **Financial Incentives for Deployment—**Implementation of an aggressive and innovative incentive regime that facilitates rapid development and deployment of marine energy technologies and related services.

**7** **Leveraging International Experience and Standards—**Increased Federal coordination and stakeholder education related to lessons learned on innovation, deployments, and environmental interactions, including development and usage of global technology standards and certifications, which will provide confidence to customers and financial markets.

**8** **Streamlining Permitting and Reducing Regulatory Barriers—**A clear, timely, and predictable regulatory framework is required for siting and permitting marine energy testing and demonstration projects.

**9** **Workforce Development—**Increased funding for programs that build a strong, diverse, and inclusive marine energy workforce.

**10** **Federal Planning, Staffing, and Industry Engagement—**The programs and investments outlined above must be informed by the needs of the domestic marine energy sector to sustain and accelerate a long-term approach to commercialization efforts.

# 1 System Design, Fabrication, and Demonstration

Increased funding to support research, design advancement, testing, and validation of marine energy systems, sub-systems, and components. These innovation efforts are critical to increasing demonstration and deployment opportunities and reducing overall Levelized Cost of Energy (LCOE).

**A significant increase in future funding is required for the DOE Water Power Technologies Office (WPTO) and the U.S.** Navy to support research, design advancement, testing, and validation of marine energy systems, sub-systems, and components. Innovation efforts funded by the WPTO and the Navy are critical to increasing demonstration opportunities and reducing overall costs for marine energy technologies.

There are a wide range of design approaches to marine energy systems. It is likely that unique technology classes will be most effective in various resource areas or different market applications. This underscores the need for increased investments to address these variations with support for system deployments in open waters. A balanced approach is required across the technical readiness spectrum that reflects the higher funding needs of more mature designs. Federal investments will increase energy capture, improve power performance, and enhance the reliability of marine energy devices. These funds also support validation of computational models, a critical step in the design process, along with further development of environmental monitoring technologies.

Marine energy technology development in the U.S. is dominated by small companies with limited sources of external funding. Increased federal investments are critical to supporting the domestic marine energy sector given the global competition in which U.S. companies are at a significant disadvantage. European technology developers, for example, do not have strict cost share requirements to match government funding. U.S. Secretary of Energy Jennifer Granholm should level the playing field by utilizing her authority to waive funding award cost share requirements for pre-commercial marine energy research and development activities.


*C-Power's wave energy system undergoing testing at NREL's Flatirons Campus*

# 2 Fostering Distributed Generation Capabilities

New investments related to identifying and initiating infrastructure upgrades are needed to support high-value, near-term distributed market generation opportunities at scale for marine energy.

**New investments are required to identify and initiate infrastructure upgrades to support high-value, near-term distributed market generation opportunities at scale for marine energy.** For example, funding is required for analysis, planning, and technical assistance related to the decarbonization of coastal ports and expanding access to marine energy technologies for more cost-effective power and economic development opportunities for rural, Tribal, urban, and distressed communities.

Energy delivery systems worldwide are undergoing unprecedented change. There is a rapidly growing market for smaller, decentralized energy capabilities to serve remote rural communities as a complement to large central generation assets and grid infrastructure. For some geographies and applications, it can be far less expensive to install and operate with on-site power generation and micro grids (off or on-grid) than it is to achieve and maintain access to centrally generated power. More and more cities, regions, and industries find themselves operating with both centrally-generated and distributed electricity resources, which sometimes represent a mix of energy technologies as well.

The Ocean Renewable Power Company (ORPC), based in Portland, Maine, has an ongoing project in Igiugig, Alaska demonstrating the benefits of distributed marine energy power generation. The project utilizes local river currents, in conjunction with a smart microgrid and other renewables, as a comprehensive baseload-renewable distributed energy generation solution. After years of preparation, in 2019 ORPC installed its 40-kW RivGen® Power System in the Kvichak River at Igiugig.

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*RivGen® by ORPC during deployment in the Kvichak River near Igiugig, Alaska*

The device operated throughout 2020 and demonstrated its ability to survive the harsh Alaskan winters. Planning is underway for installation of a second RivGen® device in conjunction with a smart microgrid and energy storage. Once installed, the system will reduce diesel usage by 90 percent, provide a clean energy baseload power solution to the Igiugig community, and create new local economic development opportunities. The project is supported by the DOE WPTO, the DOE Office of Indian Energy Policy and Programs, and private investment.

Igiugig is representative of remote communities that pay five to ten times more for electricity than the typical American. Decentralized distributed electricity generation provides a range of benefits, such as resiliency, efficiency, and improved access to power in communities lacking grid access. These systems can serve both remote areas and high-density populations. When distributed energy resources, which include energy storage, are integrated, and combined as hybrid power systems, there can be even greater efficiencies. Development of these types of projects not only add renewable energy capacity but also provide opportunities for economic development through lower energy costs and related high-value jobs.

Increased investments are required to accelerate planning and demonstration of these capabilities. Two near-term potential market opportunities for marine energy technologies and services include port electrification and green hydrogen production. Work underway at the European Marine Energy Centre (EMEC) is demonstrating the potential of these distributed market opportunities. Located in the Orkney Islands off the top of mainland Scotland, with an abundant wave and tidal resource, EMEC is the world's leading marine energy testing and innovation facility and operates a 7 MW wave site and a 4 MW tidal site.

Due to the constrained nature of the Orkney grid, which has more renewables feeding it than demand allows, EMEC installed hydrogen generation facilities based at its tidal test site's substation and generates green hydrogen using community-owned wind power and tidal energy (a world first). This hydrogen is being utilized to solve energy problems locally – in road and marine transport, and even a six-seater hydrogen fuel-cell powered plane. EMEC also has R&D projects utilizing hydrogen in industrial processes such as whiskey distilling, and other applications such as heating and cooling. In 2019, EMEC launched ReFLEX, a £28.5M project which essentially turns Orkney into a virtual energy system, linking energy demand assets to variable renewable supply. The economic impact of all these activities for Orkney and Scotland has been huge, with significant development for ports/harbors and the local supply chain. EMEC is an incredible regional development story, which can be replicated throughout the U.S. and the world.


*Green Hydrogen fueled hyflyer demo in Orkney, Scotland utilizing marine energy technologies*

# 3 Emerging Opportunities for Off-Grid Power

Increased funding for the DOE "Powering the Blue Economy" initiative, which will expand the near-term commercial value of power generated by marine energy devices and related services.

**Increased investments are required for the DOE "Powering the Blue Economy" initiative, which will expand the near-term commercial value of power generated by marine energy devices.** DOE research shows that marine energy is likely in the near term to be the most cost-effective and reliable power source in several distributed markets, such as desalination, oil and gas production, underwater data centers, and other emerging needs. However, these technologies must be tailored to specific applications and demonstrated to facilitate adoption.

Integration of marine energy technologies into "Blue Economy" markets will offer practical real in-water experience and the insight to recognize the potential impact of transformative technologies. Successfully serving these markets will drive down learning curves, increase system performance, and lead to significant reductions in LCOE. Growth in these markets will also provide industry with near-term revenue, unlock additional private investment in the sector, and advance technology toward future utility-scale grid-connected deployments.

The University of Hawaii and University of Washington demonstrated these capabilities with a project featuring the Fred. Olsen "BOLT Lifesaver" with the Wave-powered Adaptable Monitoring Package (WAMP). The project was funded by DOE, the National Science Foundation, and the U.S. Navy and located at the Wave Energy Test Site (WETS) off Marine Corps Base Hawaii (MCBH). The project demonstrated an alternative means of powering oceanographic instrumentation without using utility-supplied electrical grid power or single-use batteries.

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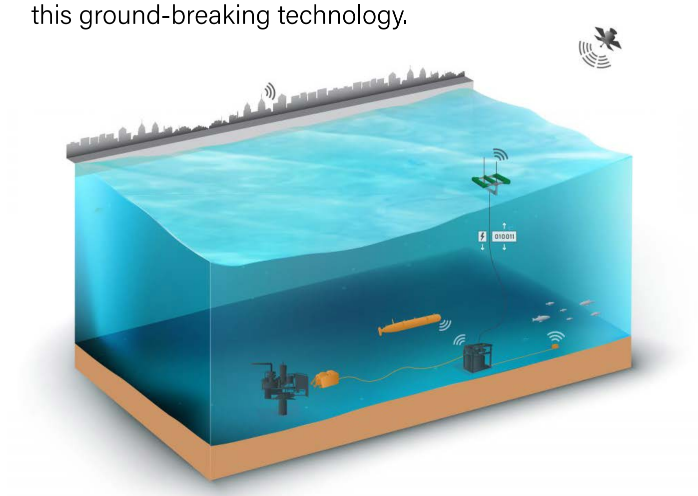
*University of Hawaii/University of Washington sensor package testing at WETS, Hawaii*

Receiving its power from the Lifesaver, at the equivalent of ten car batteries a day, the WAMP provided a persistent, integrated environmental underwater sensing system and demonstrated a wireless underwater power transfer. Capabilities included a real-time detection and classification of data streams on board with a high bandwidth data link to shore for instrument control and data transfer. This was the world's first demonstration of the potentially transformative capability for marine energy technologies to enable persistent oceanographic observation and under water vehicle re-charge without a cable to shore.

A demonstration of more advanced capabilities will occur at WETS in 2021. C-Power, an Oregon-based technology company, has initiated construction of its SeaRAY autonomous offshore power system (AOPS) for its upcoming sea trials. An AOPS is a class of system that provides kilowatt (kW) scale power and real-time data and communications links for remote, unmanned vehicles, sensors, and operating equipment. These capabilities enable safer, cleaner, cheaper, and more robust operations at sea. The SeaRAY AOPS is the first renewable-energy system capable of simultaneously supporting multiple marine payloads. The WETS demonstration will showcase this ground-breaking technology.



*CPower's upcoming Autonomous Offshore Power System (AOPS) demonstration at WETS, Hawaii*


*Ocean Power Technologies' PB3 PowerBuoy before deployment in the North Sea for Premier Oil*

# 4 Foundational Research and Engineering Assistance

Expansion of the research, engineering support, and workforce development activities underway at university-based National Marine Energy Centers, the National Labs, and other qualified non-profit institutions.

**Funding is required for expansion of the research, engineering support, and workforce development activities underway at the university-based National Marine Energy Centers, along with the National Labs and other qualified non-profit institutions.**

Marine energy technologies offer substantial promise but present unique engineering and operational challenges. For example, marine energy involves construction and long-term operations in a corrosive environment. The technical obstacles, however, also offer opportunities for foundational research supported by cross-institutional, multi-disciplinary teams working in collaboration with a focus on capabilities that can apply to wide ranges of marine energy devices. These could include establishing critical research aligned with commercial site development and preparing tools essential for project approval.

Congress authorized establishment of National Marine Energy Centers to unify R&D, testing, and educational programs. There are now four centers, including the Pacific Marine Energy Center (Oregon State University, University of Washington, and the University of Alaska Fairbanks), the Southeast National Marine Renewable Energy Center at Florida Atlantic University, the Hawaii National Marine Renewable Energy Center at the University of Hawaii, and the newly established Atlantic Marine Energy Center based at the University of New Hampshire. Faculty, staff, and students engage with key stakeholders to investigate technical, environmental, and social dimensions of marine energy to accelerate commercialization.

*University of Alaska Fairbanks researchers at the Tanana River marine energy test site*

Federal investments in marine energy research, development, and testing activities at the National Marine Energy Centers, along with the National Labs and other research institutions, has yielded substantial advances in understanding of the potential for marine energy along with technology innovation. In addition, universities play a unique role in supporting research in a manner that also develops a pipeline of well-trained students with capacity to supply the needed workforce for National Labs and the private sector.

Federal Actions to Accelerate Marine Energy Deployment

# 5 Testing Infrastructure and Validation Support

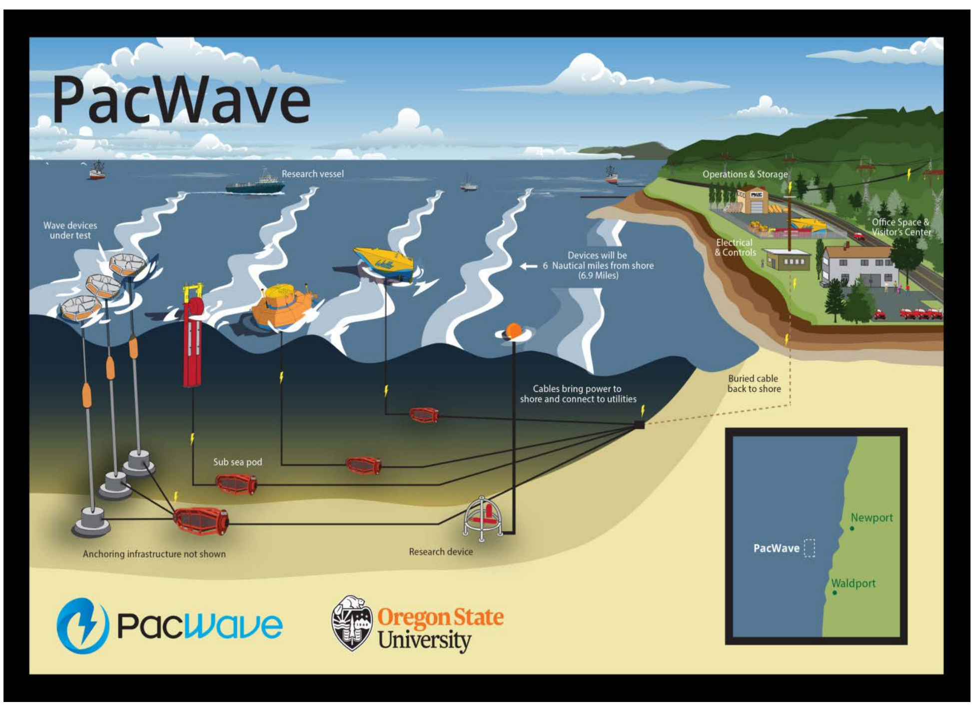
Additional funding to expand existing and establish new testing infrastructure (including grid connection and deployment equipment) for marine energy devices along with support for technology validation activities.

**Increased funding is required to expand existing and establish new testing infrastructure (including grid connection and deployment equipment) for marine energy devices along with support for technology validation activities.**

A key barrier to marine energy development is the difficulty of testing and demonstrating new designs. Land-based technologies can field-test quickly, cheaply, and in many locations including on private land. Marine energy technologies must field test each device in carefully selected, highly regulated public waters where access is difficult and grid connections do not exist. Likewise, wave and tidal tanks and flumes appropriate to test smaller-scale marine energy devices are relatively limited, expensive, and often require long wait times to access.

Funding is needed for testing infrastructure across the range of Technology Readiness Levels (TRL), from modeling and analysis tools, bench- and tank-scale facilities, and scaled prototype open-water testing. Funds are also required for facility accreditation activities and programs such as the Testing Expertise & Access for Marine Energy Research (TEAMER) to ensure testing accuracy and consistency. DOE should coordinate with the U.S. Navy and other agencies on funding opportunities related to technology testing activities. In addition, development of environmental monitoring technologies along with research to expedite permitting and in-water demonstrations are also critical to accelerate device deployments.

*The PacWave grid-connected test facility in Newport, Oregon*




One example is PacWave, the DOE funded offshore test facility for wave energy devices being developed by Oregon State University. PacWave will have non-grid and grid connected test berths capable of supporting up to 20 MW of power production. After years of effort, PacWave received its 25-year hydroelectric production license from the Federal Energy Regulatory Commission on March 1, 2021, and will soon enter construction. Opening is targeted for 2022 or 2023.

Federal Actions to Accelerate Marine Energy Deployment

# 6 Financial Incentives for Deployment

Implementation of an aggressive and innovative incentive regime that facilitates rapid development and deployment of marine energy technologies and related services.

**Implementation of an aggressive and innovative incentive regime is required to facilitate rapid development and deployment of marine energy technologies and related services through tax and other policies.** In addition to the technology R&D efforts discussed above, federal incentives that support manufacturing volume discounts and lower deployment costs through experience installing a number of devices is just as critical to reducing the overall cost of marine energy technologies and increasing their adoption.

At a time when the country is seeking ways to increase the deployment of carbon-free technologies and create high value employment opportunities, federal policy should invest in emerging renewables, like marine energy, that contribute to these goals. We must take this opportunity to build back a better electrical system than what has been developed over the past century. Marine energy technologies can support a new approach that puts people and communities first by providing lower cost power and increased economic opportunities all while helping fight climate change.

Long-term incentives are needed to accommodate the risky nature of pre-competitive marine energy technologies, which are capital intensive and have long regulatory and development lead times. Policies that provide support for marine energy will attract substantial private investments and foster job growth and economic benefits throughout the country. The continued availability and long-term certainty of these incentives are also critical for the developing marine energy sector.

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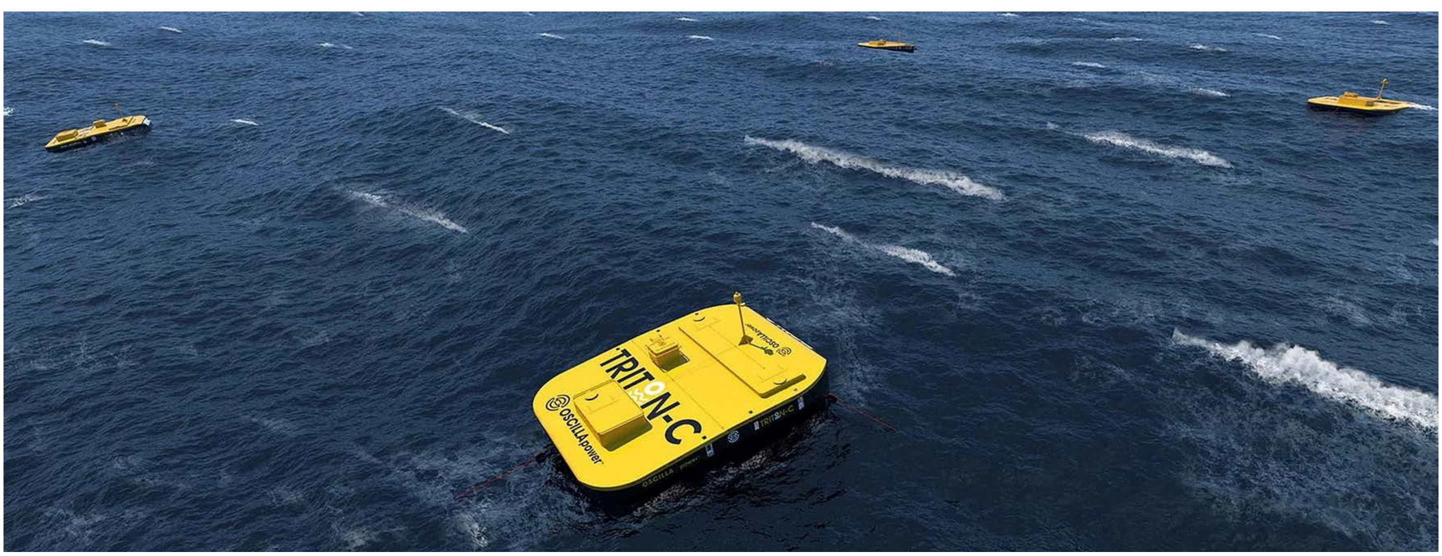
*Rendering of an array of Oscilla Power's Triton-C wave energy converters*

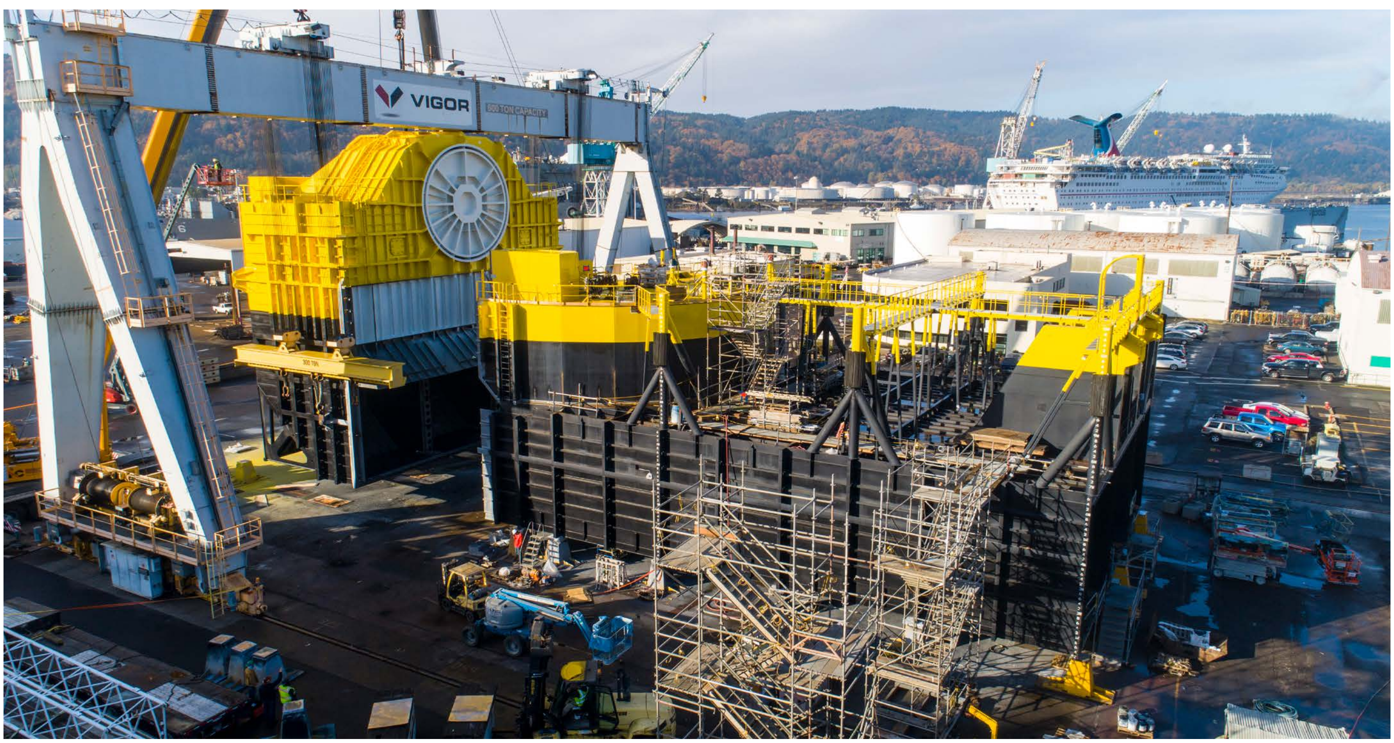


One potential program for consideration would be the creation of a fund within the $25 billion Title XVII Innovative Energy Loan Guarantee Program to allow its utilization to support deployment of initial marine energy technology projects. While marine energy meets program eligibility requirements, the minimum $1 million upfront costs for due diligence is unreasonable as it effectively makes the program unavailable to projects below the $40 million to $50 million range. Congress should consider setting aside funding within Title XVII to support newly emerging technology deployment at scale. These funds will help companies decrease LCOE through manufacturing gains, accelerate deployments, and increase technology adoption while meeting the nation's renewable energy and job creation goals.

Tax incentives have historically been one of the most effective federal tools to accelerate development and deployment of clean energy technologies. Unfortunately, the current tax regime structure has provided very limited support for the marine energy sector to date. Marine energy is an eligible resource under the Section 45 Renewable Electricity Production Tax Credit (PTC) but, unfortunately, at only half the credit rate.

As a PTC qualifying resource, marine energy project developers can elect to take the Section 48 Investment Tax Credit (ITC) at the full 30 percent rate. The challenge, however, is that the marine energy sector is in the pre-competitive phase with few projects currently in operation. Therefore, marine energy developers have not yet been able to utilize the PTC or ITC credits. Proponents with projects in the development pipeline still view tax incentives as a critical policy tool to ensure these new technologies are economic and financially viable in the future. However, as currently structured, these programs are not enough at this time to provide the support required by the domestic marine energy sector.

When available to marine energy, policies that allow PTC/ITC-eligible taxpayers to monetize the value of the tax credits will also be needed. Examples include the Department of Treasury's Section 1603 grants in lieu of tax credit program or elective payment provisions. The one-time payment under the Section 1603 program would provide a more efficient direct investment into the marine energy sector. New proposals would allow investor-owned utilities, independent power producers, as well as public power entities to receive the benefit of the credits upfront in the form of a refund of an overpayment of tax, expanding the pool of investors for eligible projects.




*The OceanEnergy buoy under construction in 2019 at Vigor Shipyard - Portland, Oregon*

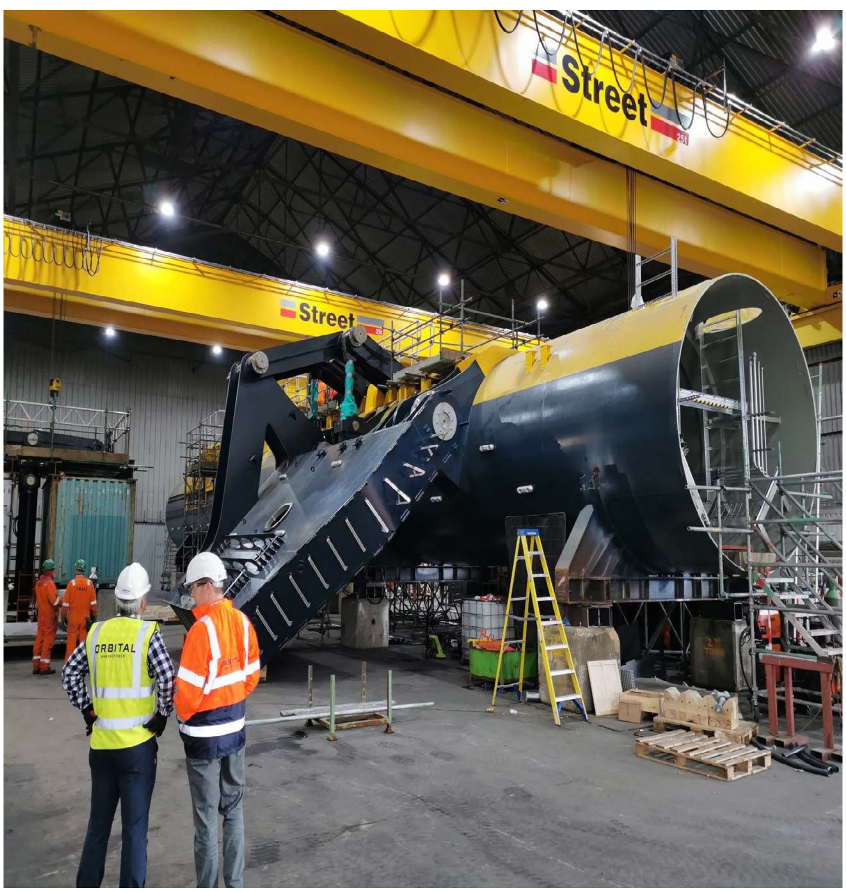
# 7 Leveraging International Experience and Standards

Increased Federal coordination and stakeholder education related to lessons learned on innovation, deployments, and environmental interactions, including development and usage of global technology standards and certifications which will provide confidence to customers and financial markets.

**Increased federal agency coordination and stakeholder education is required related to global lessons learned on marine energy technology innovation, deployments, and environmental interactions.** DOE should expand commercial pathways for marine energy technologies and related services by developing and implementing agreements with non-U.S. entities to fund activities of mutual interest. Existing international cooperative vehicles, including MOUs, should be strengthened to allow support to be exchanged and leveraged to accelerate marine energy innovation and deployment. These efforts should also encourage the participation of non-U.S. research centers and their end-users in U.S. funding opportunities and vice versa.

DOE must also continue supporting development and use of international standards, certificates, and conformity-assessment procedures for marine energy, which will provide confidence to customers and financial markets. One example of U.S. leadership is the Verdant Power Roosevelt Island Tidal Energy (RITE) Project in New York City installed in October 2020. Verdant deployed its TriFrame™ Mounted Gen5 Tidal Turbines to demonstrate the distributed resource potential of marine energy by delivering power directly into Manhattan buildings through ConEdison's local grid, avoiding transmission assets.

*Orbital Marine's O2 tidal energy device under construction in Scotland before deployment to EMEC*




Assessment of the power performance of the Verdant turbines is being conducted by EMEC, the first marine energy lab designated with Renewable Energy Testing Lab (RETL) status by the International Electrotechnical Commission (IEC). The Verdant turbines are the initial technology assessed by EMEC as a RETL and supports Verdant's effort to receive the first internationally recognized Renewable Energy Test Report (RETR) through the IEC system. The turbines performed at 100 percent availability, generating 100 MWh in only 85 days of continuous operation, a record for marine energy production in the U.S. The RETR will verify Verdant's compliance with formulated international standards and underscore buyer, financial, and insurance confidence in Verdant Power systems on a global basis, thereby improving export opportunities.

# 8 Streamlining Permitting and Reducing Regulatory Barriers

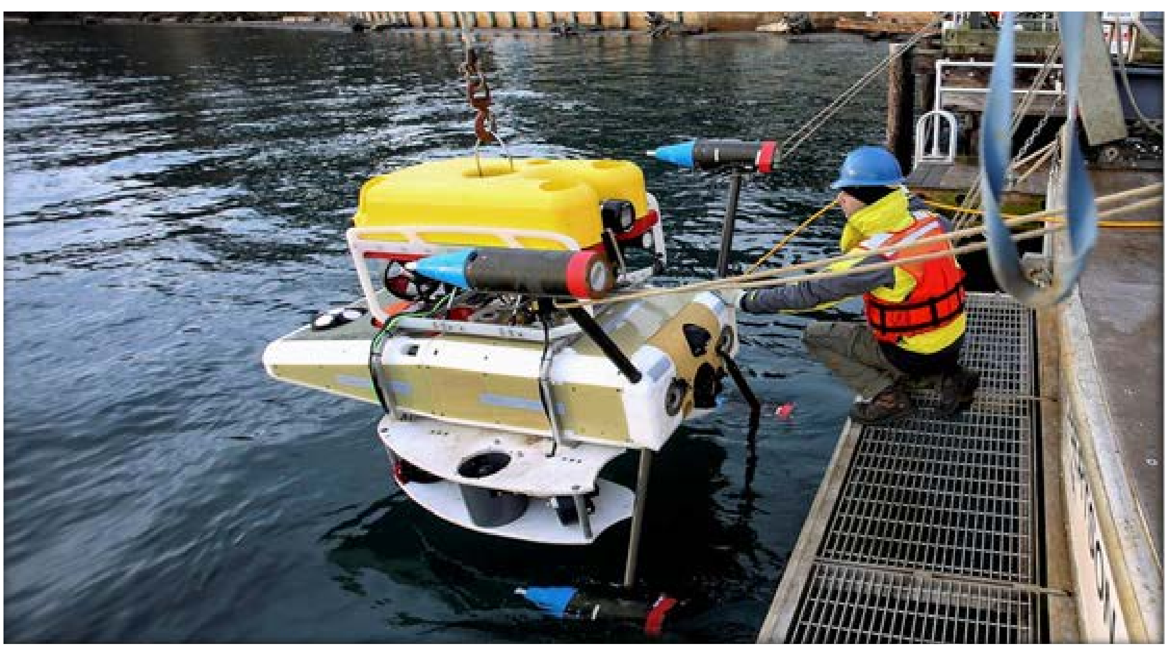
A clear, timely, and predictable regulatory framework is required for siting and permitting marine energy testing and demonstration projects.

**A clear, timely, and predictable regulatory framework is required for siting and permitting marine energy testing and pilot demonstration projects.** Unfortunately, the existing process for marine energy projects in state and federal waters is lengthy and costly. It involves numerous consultations with stakeholders and the approval of local, state, and federal agencies. A review of marine energy pilot projects approved to date by the Federal Energy Regulatory Commission (FERC), which has licensing jurisdiction over the sector, shows that the average time to obtain construction permits is seven and a half years. This timeframe is prohibitive to scaling up the deployment of mature marine energy devices.

Transforming the regulatory regime to create needed efficiencies to reduce the amount of time to permit marine energy research, testing, and validation projects will require close coordination between industry and the DOE, the Navy, FERC, the Bureau of Ocean Energy Management, the National Oceanic and Atmospheric Administration, other relevant federal and state agencies, and interested stakeholders. To ensure cost-effective demonstration and deployment activities, the following actions are required:

- DOE-led interagency/interjurisdictional efforts to reduce the complexity and costs of securing permits for marine energy testing and initial deployment activities.
- Retirement of potential environmental risks.
- Initiatives that promote domestic coordination and communication, international partnerships, and knowledge transfer to avoid unnecessary and duplicative efforts from project to project.
- Support state/regional collaborative efforts to share data related to marine energy.

*The University of Washington adaptable monitoring package for marine energy projects*



# 9 Workforce Development

Increased funding for programs that build a strong, diverse, and inclusive marine energy workforce.

**Increased funding is needed for programs that build a strong, diverse, and inclusive marine energy workforce.** Given that marine energy is a newly emerging renewable power sector, there is a need to raise its visibility and foster a better understanding of its exciting potential as a career choice for students within universities, trade schools, and at the primary education level. In addition, targeted efforts are required to recruit diverse individuals, including people of color and women, to ensure they have the opportunity and are provided the tools to make up a significant portion of tomorrow's marine energy workforce. Finally, veterans and skilled workers from other economically challenged industries are potential future employees for the marine energy sector but may require special training or other accommodations.

One example of these efforts is the DOE WPTO-funded Science, Technology, Engineering, and Math (STEM) workforce development project led by the National Renewable Energy Laboratory (NREL) and the Hydropower Foundation. The overall objective is to lay the groundwork for developing a more robust and vibrant marine energy workforce while creating STEM-based educational materials and a better understanding of industry needs.

One of the many goals of the project is to empower educators to include marine energy technologies in their academic programs and curriculum across multiple STEM disciplines. For example, the NREL/Hydropower Foundation team engaged with academic organizations, students, and industry to develop the Portal and Repository for Information on Marine Renewable Energy (PRIMRE). The portal provides educators and students with high-quality, interactive materials and information on career opportunities along with educational and training programs for K-8, high school, college, and graduate school students. The project also supports an ongoing dialogue that brings together students, university professors, and industry to discuss critical topics and challenges within education and workforce development and how to bridge the gap between academia and industry.

Funding is also required for programs that prioritize workforce diversity and can target under-served institutions, such as Historically Black Colleges and Universities (HBCUs), to reach these populations. Funding should support outreach to targeted students within the academic community, provide training about the opportunities within the marine energy sector, and support hiring programs that introduce and help match students with potential employers.

Other workforce development efforts deserve additional support. This includes the WPTO- funded Marine Energy Collegiate Competition. Now in its second year, the competition offers multidisciplinary teams of undergraduate and graduate students the opportunity to gain hands-on experience and industry connections while working on innovations that can play a vital role in advancing the sector. Through the competition, students are challenged to explore opportunities for marine energy technologies in existing maritime industries via real-world concept development. Students will research and develop business cases, pitch their plans to a panel of judges and hypothetical investors, and perform actual prototype testing.

Another example is the Oak Ridge Institute for Science and Education (ORISE) Marine Energy Graduate Student Research program. This competitive fellowship program offers participants the opportunity to enhance their education and training in marine energy, increase their marketability, and gain access to top scientists and state-of-the-art equipment through internships and experiences at DOE offices, National Labs, and industry partners.

*NC A&T student team won "The Rising Star Award" - 2020 DOE Marine Energy Collegiate Competition*

# 10 Federal Planning, Staffing, and Industry Engagement

The programs and investments outlined above must be informed by the needs of the domestic marine energy sector to sustain and accelerate a long-term approach to commercialization efforts.

**The programs and investments outlined above must be informed by the needs of the marine energy sector to sustain and accelerate a long-term approach to commercialization efforts.** NHA's Marine Energy Council appreciates its working relationship with the DOE WPTO and the U.S. Navy and proposes joint development of an achievable multi-year technology research, demonstration, and deployment roadmap which should include:

- A reasonable "vision" for marine energy in the U.S. with costs and benefits.
- Sufficient annual budget requests for the WPTO to reach the vision, including right-sizing the DOE staff to match higher program funding levels.
- Regular industry surveys of priorities and gaps in R&D that DOE/Navy should support.
- Testing facility development.
- Supply chain recruitment.
- New measures of success beyond LCOE such as the number of devices tested or MWs installed similar to calls by Ocean Energy Europe (2.9 GW deployed globally by 2030).
- Fund pilot program using the Broad Agency Announcement model in addition to specific Funding Opportunity Announcements currently utilized by DOE.
- Refined resource assessments.

*Public event before deployment of the ORPC RivGen® device in the Kvichak River near Igiugig, Alaska*

## Contacts


Malcolm Woolf, NHA President and CEO (mwoolf@hydro.org)

Paul Gay, NHA Marine Energy Council Co-Chair (paul@strategicmi.com)

Luciana Ciocci, NHA staff (luciana@hydro.org)



NHA

National Hydropower Association

601 New Jersey Avenue, NW
Suite 660 ▪ Washington, D.C. 20001
202.682.1700 ▪ www.hydro.org

/NATLHYDROASSOC
@NATLHYDROASSOC