State-Level Marine Energy Policy Case Study and Overview

Michael Behrmann and Kelly Gjestvang

National Renewable Energy Laboratory

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List of Acronyms

BOEM	Bureau of Ocean Energy Management
CES	Clean Energy Standards
CPUC	California Public Utilities Commission
DG	distributed generation
DOI	U.S. Department of the Interior
DSIRE	Database of State Incentives for Renewables & Efficiency
EPAct 2005	Energy Policy Act of 2005
FERC	Federal Energy Regulatory Commission
IRA	Inflation Reduction Act
ITC	Investment Tax Credit
kWh	kilowatt-hour
MOU	memorandum of understanding
MWh	megawatt-hour
NBT	net billing tariff
NCSL	National Conference of State Legislatures
OCS	Outer Continental Shelf
PNNL	Pacific Northwest National Laboratory
PTC	Production Tax Credit
RECs	Renewable Energy Certificates
R&D	research and development
RPS	Renewable Portfolio Standard
SREC	Solar Renewable Energy Certificate
TWh/yr	terawatt-hours per year
WPTO	Water Power Technologies Office

Executive Summary

The promise of marine energy is, perhaps, as vast as the sea itself. From building coastal resilience to helping states meet their clean energy goals, this burgeoning technology is an exciting addition to our growing renewable energy toolbox.

A particularly compelling aspect of marine energy technology development is the scale of the marine energy resources in the United States and the close proximity to large electrical loads. Forty percent of the U.S. population lives within 50 miles of a coast (U.S. Department of Energy n.d.). Moreover, the total marine energy technical resource in U.S. coastal waters is estimated to be 2,300 terawatt-hours per year, equivalent to 57% of the electricity generated by all 50 states in 2019 (Kilcher, Fogarty, and Lawson 2021).

However, despite its promise, the nascent marine energy industry could be better encouraged by establishing policy frameworks that address current development barriers and impacting its expansion and full deployment potential.

Therefore, to better understand the current U.S. marine energy policy landscape, the research team conducted a study of federal and state policies supporting renewable energy development and deployment.

Federal policy centers around the Energy Policy Act of 2005 (EPAct 2005) and subsequent memoranda of understanding signed by the U.S. Department of the Interior and the Federal Energy Regulatory Commission that better define jurisdictional boundaries for marine energy project approvals, leases, and licensing.

Two federal tax credits—the Production Tax Credit and the Investment Tax Credit—helped accelerate the deployment of solar and wind electricity generation by addressing financial challenges. The proliferation of Renewable Portfolio Standards (RPSs) and Clean Energy Standards—and the resulting renewable energy certificates they established—helped bolster the renewable energy markets state by state, securing project financial viability. A host of net metering laws proliferated, and continue to do so, paving the way for grid-connected renewable energy and its related compensation.

Focusing on California and Maine, the team completed a comparative analysis of their state-level marine energy policy efforts, identified gaps, and assessed how such approaches may or may not impact development of marine energy technologies. Among other findings, the research team drew two conclusions: marine energy policy may work best when tied to RPSs and transmission needs, and the associated policies to address them, are important for marine energy expansion.

The team identified several areas for potential further study:

- An exploration of increased coordination between marine and other renewable resources—such as offshore wind—and marine energy
- The potential benefits of co-location of marine energy projects with other ocean systems
- An economic analysis of the impacts of marine energy development on local economies
- An analysis of interconnection challenges and how microgrids might accommodate the onshoring of marine energy

- An analysis of potential marine energy permitting barriers and consideration of options to streamline the approach.

Over the past 20 to 30 years, federal- and state-level support for renewable energy technologies has helped spur the development of diversified renewable energy portfolio in the power sector , particularly in the context of wind and solar. Just as other forms of renewable energy generation benefitted from tailored funding and legislative support during their initial deployments and early-stage development, so too could marine energy technologies follow a similar trajectory alongside similar support.

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1 Introduction

Marine energy technologies, i.e., those that capture renewable energy from waves, tides, ocean currents, rivers, streams, and ocean thermal gradients, could make significant contributions to the resiliency, increasing demand, and helping meet U.S. energy needs. The U.S. Department of Energy Water Power Technologies Office (WPTO) provides key funding for the research, development, and deployment of marine energy[1] technologies.

Marine energy resources are geographically distributed and well-situated to power coastal communities, as more than 40% of the U.S. population lives within 50 miles of a coast. The predictability of these resources also makes them potential contributors to a stable, reliable clean energy grid (U.S. Department of Energy n.d.).

The total marine energy technical resource in United States coastal waters is estimated to be 2,300 terawatt-hours per year (TWh/yr) (see Figure 1), equivalent to 57% of the electricity generated by all 50 states in 2019. Capturing just one-tenth of that technical resource would equate to 5.7% of our nation's current electricity generation (as of December 2024)—enough energy to power roughly 22 million homes (Kilcher, Fogarty, and Lawson 2021).

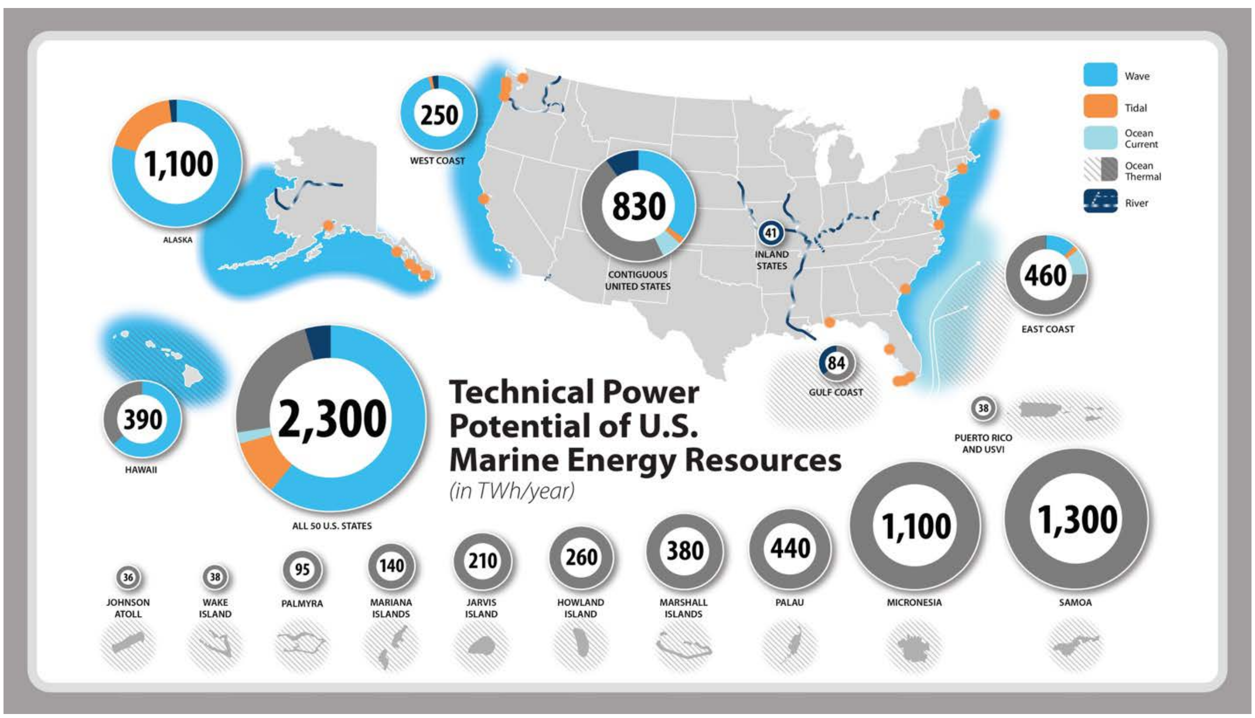

Figure 1. The marine energy technical resource in the United States. The map shows regional amounts as well as a total sum of 2,300 terawatt-hours per year (TWh/yr).

[1] While there is currently no standardized definition for "marine energy," this document will employ the term "marine energy" to describe the industry as a whole. Specific marine energy types, such as tidal energy, may be called out separately as they are referred to in various policy documents. Marine energy technologies can include those converting energy from wave, tidal, current, ocean thermal, and riverine resources through a variety of different engineered systems.

Graphic by John Frenzl, National Renewable Energy Laboratory

Although marine energy has the potential to provide renewable power to the electric grid and isolated communities across the United States, challenges to marine energy project deployment impede wider adoption. Opportunities to address these challenges include, but are not limited to, a greater need for:

- Open-ocean testing sites
- Better-defined siting parameters
- Permitting clarification
- Interconnection to adequate transmission
- Reductions to current high-technology research and development (R&D) and project development costs
- Consistent policy frameworks.

The expansion of federal- and state-level policy efforts has resulted in significant growth in renewable energy across the past two decades. These efforts encouraged renewable energy development by identifying and removing policy barriers and leveling access to distributed energy resources. Successful policies also improved project economic viability through incentive-based programs, broader siting considerations, greater flexibility and access to transmission interconnection for distributed power generators, and the establishment of specific targets to bring more renewable energy into operation.

This paper examines key marine energy policy drivers currently implemented at both the federal and state levels. The authors compare similarities and differences at the state level and identify potential gaps and/or barriers in certain jurisdictions. Examining marine energy policy drivers in Maine and California, two states that passed and enacted legislation targeting greater marine energy development, may help pinpoint the impact such policies have had on wider marine energy technology development and deployment in the United States. Considering these drivers and policy responses may also illuminate pathways to encourage investment, expand domestic renewable energy, enhance opportunities for underserved coastal communities, and lead to the development of more-robust community resilience through the expansion of innovative marine energy technologies.

2 Policy Overview

Over the past several decades, the United States has seen significant renewable energy development. New policies to support greater deployment have flourished, driven by an understanding of the vast potential of renewable energy to meet future energy resource needs. This section discusses federal and state policies related to renewable energy development and deployment.

2.1 Federal Policy Measures

The Energy Policy Act of 2005 (EPAct 2005) is an important piece of renewable energy legislation; however, it created jurisdictional confusion. §388 of the EPAct 2005 amended the Outer Continental Shelf Lands Act, granting the U.S. Department of the Interior (DOI) the authority to regulate the production, transportation, or transmission of renewable energy on the Outer Continental Shelf (OCS). However, the Federal Energy Regulatory Commission (FERC) already held the authority to regulate projects that generate energy from the movement of water in navigable waters of the United States, as well as oversee the siting and licensing of transmission lines of said projects per §23 and §24 of the Federal Power Act (Pacific Northwest National Laboratory [PNNL] 2020; FPA 1935).

To address the discrepancy, FERC and the DOI signed a memorandum of understanding (MOU) outlining the jurisdictions of each agency (DOI and FERC 2009). Per the 2009 MOU and a 2020 guidance document, the DOI is authorized to issue Bureau of Ocean Energy Management (BOEM) renewable energy leases for a marine energy project that is attached to the seabed of the OCS; FERC will issue licenses for such projects (DOI and FERC 2020). For projects in state waters, a marine energy project would need approval or a lease from the state, as well as a license from FERC.

In 2008, FERC issued a white paper titled *Licensing Hydrokinetic Pilot Projects*. It officially defined "hydrokinetic (marine energy) pilot projects" and outlined how marine energy project developers should apply for a license to test their devices in compliance with the Federal Power Act (FERC 2008).[2]

Marine energy devices are subject to FERC jurisdiction, as they generate energy from the movement of water. However, experimental deployments of marine energy devices can petition FERC to apply the "Verdant Exception" for projects that are experimental, short term, and do not send their generated energy to the grid (PNNL 2020). The Verdant Exception was established under *Verdant Power LLC*, 111 FERC ¶ 61,024 (2005), *order on clarification*, 112 FERC ¶ 61,143 (2005), and then reaffirmed under *Maine Maritime Academy*, 130 FERC ¶ 62,234 (2010) (DOI and FERC 2020).

While this white paper helped clarify jurisdictional oversight and control, marine energy deployment is still limited by technology readiness, high project economics for early-stage

[2] FERC defines hydrokinetic pilot projects as "small, short-term, removable, and carefully monitored projects intended to test technologies, sites, or both" (FERC 2008).

systems, and an insufficient supply chain and generation scale (National Research Council 2013).

In comparison, solar and land-based wind technologies grew in both technical capability and scale during the 2000s. Though developers in those industries faced financial challenges related to the deployment of new renewable energy generation resources similar to those faced by marine energy developers today, two federal tax credit programs were created to address the issue, enabling deployment at a larger scale.

The first program, the Production Tax Credit (PTC), originally created in 1992, provides projects and equipment owners a federal tax credit for the first 10 years of a project equivalent to the annual kilowatt-hours (kWh) generated from a qualifying resource multiplied by a specific monetary rate. The rate was dependent upon the type of technology involved and the satisfaction of certain requirements concerning domestic content bonuses and energy community bonuses. Qualifying resources included wind, biomass, geothermal, solar, small irrigation, municipal solid waste, hydropower, or marine energy installations (Stimling 2023).

The second federal tax credit, the Investment Tax Credit (ITC), was created with the passage of the EPAct 2005. The ITC provides a project developer with a statutorily set percentage of tax credits based on their investment in qualifying clean energy equipment for a project (Stimling 2023). This incentive, and its occasional accompanying variations—such as the American Recovery and Reinvestment Act of 2009, known as 'Section 1603 Payments for Specified Energy Property in Lieu of Tax Credits (1603)'—have improved the financial viability of solar and wind projects over the last several years (U.S. Treasury Department 2011).

With the advent of the 1603 Program, developers were able to take advantage of the ITC through a direct payment structure instead of tax credits, which aided smaller developers and tax-exempt entities that were otherwise unable to enjoy the benefits afforded by these tax credits. A similar provision, known as Elective Pay or Direct Pay, was created as an option for both the PTC and ITC programs through the passage of the Inflation Reduction Act (IRA). Developers can now also transfer a portion of the tax credits to an unrelated taxpayer as a cash payment if that developer is not able to use Direct Pay (Internal Revenue Service 2024), which was an impossibility prior to the enactment of the IRA.

Table 1. PTC and ITC Structures Following Passage of the Inflation Reduction Act in 2022

Tax Credit	Description of Current Allowances
PTC	"Section 13701 of the Inflation Reduction Act created a new tax credit, the Clean Energy Production Tax Credit to replace the traditional PTC for systems placed in service on or after January 1, 2025. The tax credit is functionally similar to the PTC, but is not technology specific. It applies to all generation facilities that have an anticipated greenhouse gas emissions rate of zero" (Database of State Incentives for Renewables & Efficiency [DSIRE] 2024a). Project size specifics apply, however, and relate to the monetary tax credit awarded and whether new labor standards are applicable. Projects are eligible if they are placed in service by Dec. 31, 2032.
ITC	"Section 13702 of the Inflation Reduction Act created a new tax credit, the Clean Electricity Investment Tax Credit to replace the traditional ITC for systems placed

Tax Credit	Description of Current Allowances
	in service on or after January 1, 2025. The tax credit is functionally similar to the ITC, but is not technology-specific” (DSIRE 2024c). Project size specifics apply, however, and relate to the monetary tax credit awarded and whether new labor standards are applicable. Projects are eligible if they are placed in service by Dec. 31, 2032.

Although the tax credits were intended to help with project development economic challenges, they did not address all barriers to renewable energy development. These barriers include, but are not limited to, challenges with supply chains, trained and available workforce, and the ability to connect to local and regional electrical transmission and distribution infrastructure, commonly known as grid interconnection.

Grid interconnection obstacles grew alongside economic and project-scaling challenges. Interconnection barriers revealed an opportunity for regulatory and policy shifts to increase the breadth of energy resource types and scales allowed on the grid. Once such regulatory and policy changes went into effect, new concepts around rate designs for distributed energy generation emerged. These concepts, which vary from state to state, can determine how much electricity, and at what rate, renewable energy projects could expect for behind-the-meter, overproduced power delivered to the grid. As a result, states began developing new policies and creating what is now known as net metering laws, discussed further in the next section.

2.2 State Policy Measures

Growing public demand, alongside the need to fill gaps in existing policies, has spurred states to expand their support of renewable energy generation in recent years.

Iowa was the first state to pass a Renewable Portfolio Standards (RPSs) law in 1983 (National Conference of State Legislatures [NCSL] 2021), and Colorado became the first state to pass the measure by ballot initiative in 2004 (DSIRE 2023c). As defined by the National Conference of State Legislatures, “Renewable Portfolio Standards (RPS) require that a specified percentage of the electricity utilities sell comes from renewable resources. States have created these standards to diversify their energy resources, promote domestic energy production and encourage economic development” (NCSL 2021).

RPS initiatives continued to proliferate throughout the country, following these early adopters. As of December 2023, 28 states and the District of Columbia had either an RPS law or Clean Energy Standard (CES) on the books, with 28 states having the mandated RPS and 11 states with a mandatory CES, as shown in Figure 2 (DSIRE 2023b). Some states passed a combination of RPS and CES requirements.

Because renewable energy goals and timelines vary from state to state, no two RPS programs are exactly alike. For example, each state can set their own definition as to what qualifies as a “renewable” or “clean” source of energy under their RPS or CES. Figure 2 provides a snapshot of the various states that have adopted an RPS, their particular standards, and the respective timeframes for compliance (DSIRE 2023b).

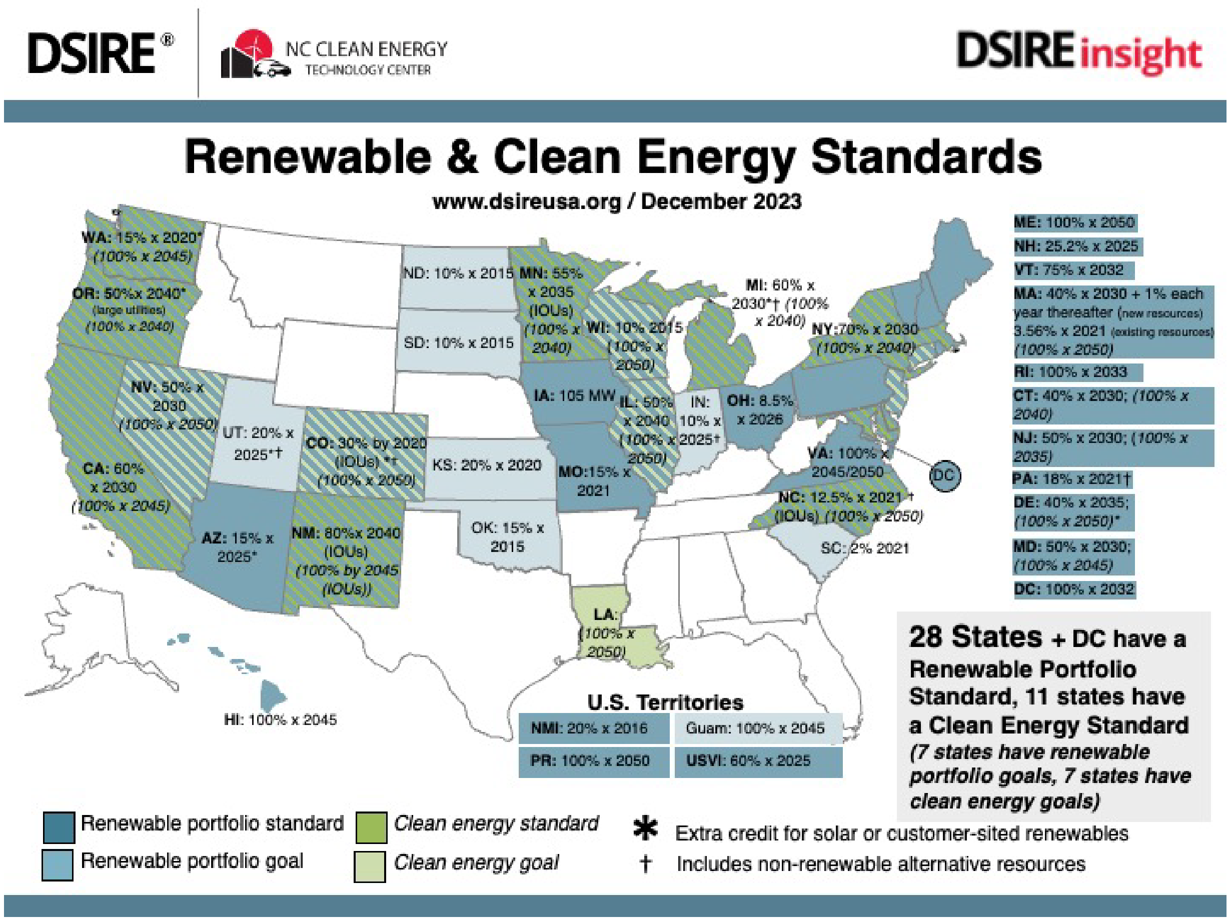

Figure 2. State-level renewable and clean energy standards in the United States.

Illustration from DSIRE (2023b)

Along with delineating specific renewable and clean energy standards and goals, RPSs established a market mechanism to financially support renewable projects through the creation of renewable energy certificates (RECs). As defined by the U.S. Environmental Protection Agency, an REC is "a market-based instrument that represents the property rights to the environmental, social, and other non-power attributes of renewable electricity generation. RECs are issued when one megawatt-hour (MWh) of electricity is generated and delivered to the electricity grid from a renewable energy resource" (U.S. Environmental Protection Agency 2024). Annually, should a utility face a shortfall in required REC purchases, they can instead make payments under an alternative option known commonly as an Alternative Compliance Payment. These payments are typically placed into a fund that can be used for grants or other structures to further the deployment of renewable energy projects.

Moreover, states may elect to establish a carve-out for particular technology classes under their respective RPS, creating a separate REC classification. This separate REC classification can then be allotted a higher REC price value for electricity generated from that specific technology. For example, the state of Massachusetts created a carve-out program for electricity generated from solar energy projects. Solar RECs (or SRECs) could then be sold, per statute, for a higher price than RECs created for other types of energy-generation sources (Massachusetts Clean Energy

Center n.d.). This positively impacted project economics and helped spur significant growth in the solar photovoltaics market in the state.

An important consideration of early technology deployment, as is currently the case with marine energy devices, is the need for grid connection—and to be compensated for electricity delivered there. Although some marine energy projects may be scaled to only behind-the-meter or off-grid projects, others will need access and interconnection to the larger electric grid. As marine energy scales in project electrical generation size, especially as project sizes increase overtime, electric grid interconnection is expected. Access to local distribution electrical networks is available in some jurisdictions that allow for greater economic compensation for electricity delivered to the electric grid for project scales typically below several megawatts of generation capacity. This is known as net metering, defined by the National Renewable Energy Laboratory as "an arrangement for metering and billing customers with distributed generation (DG). Metering & billing arrangements are key components of compensation mechanisms which reward DG system owners for the electricity they self-consume and/or export to the grid. A DG system owner's full compensation also depends on retail rate design (i.e., how much a customer pays for electricity from the grid) and sell rate design (i.e., how much a customer receives for electricity exported to the grid)" (Aznar 2017).

A net metering policy typically needs to be in place before a project is commissioned. Such policies confirm compensation for the excess generated electricity that will be delivered to the grid and can factor into project economics. Figure 3 shows where net metering laws have been passed throughout the United States (DSIRE 2023a).

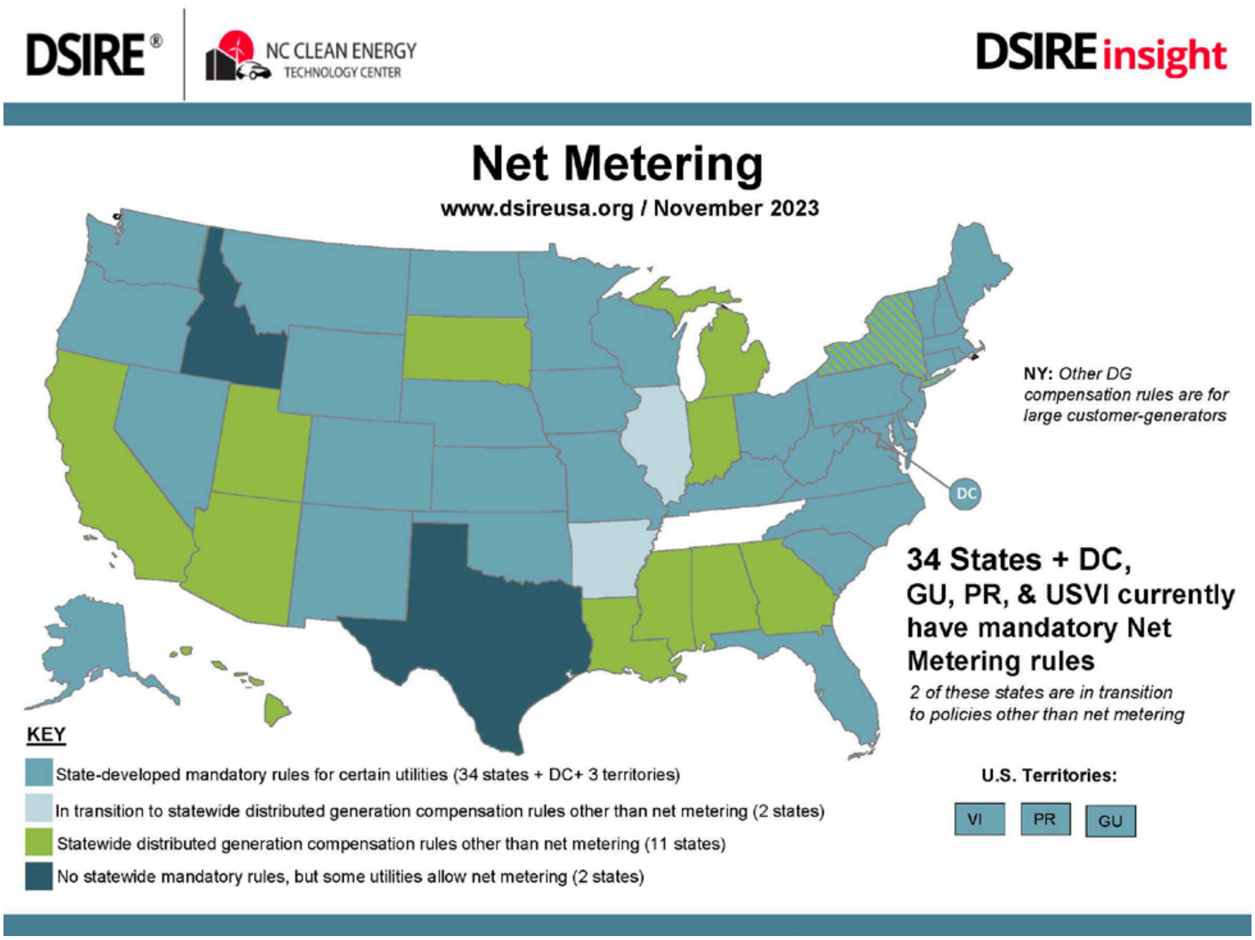

Figure 3. State-level net metering policies in the United States

Illustration from DSIRE (2023a)

Beyond state-level RPS statutes and net metering, there are additional policies that have spurred greater adoption and development of renewable energy. Prescriptive—and typically competitive—grant opportunities for specific projects developed within a state jurisdiction have been used to reduce the upfront—and traditionally high—financial burden of early technology deployment and project development. These monetary grants, or other financial incentives such as tax credits, have historically filled difficult funding gaps associated with early-stage renewable energy technologies. States can leverage these incentives to address financial barriers for marine energy, coupled with targeted incentives to support particular stages of technology maturation.

Figure 4. State-level policy measures impacting renewable energy project development

Graphic by Michael Behrmann, National Renewable Energy Laboratory

Finally, siting/permitting requirements and interconnection are critical to the development of any renewable energy resource, especially for early-stage technologies. For example, the deployment of large-scale, offshore wind energy would require a mix of state- and federal-level approvals for the siting, permitting, construction, and operation of that equipment. In contrast, while federal involvement through FERC would occur at this stage of development for marine energy projects in general, the smaller, closer-to-shore (state waters) siting used in most pilot and early-stage projects would necessitate state-level regulatory oversight and approval as well.

Although state-level legislation and policies specific to marine energy may currently be few and far between, there is a potential for expansion. Moreover, many renewable-energy-related policies already on the books offer an important foundation for new technologies, such as marine energy. Marine energy and efforts to support the industry through policy and regulatory efforts should first start with utilizing already established renewable energy policies rather than expending the efforts and resources necessary to gain a new policy foothold.

3 Marine Energy Policy Case Studies

As a newer technology with relatively few installations throughout the United States, marine energy is still in its infancy. Although there is undoubtedly fertile ground, or ocean, for its expansion, specific industry challenges—many of which are at the state level—must first be addressed to spur meaningful growth in marine energy development.

Despite ambitious renewable energy goals, there has largely been a lack of development of consistent policy measures across coastal states focused specifically on enabling the deployment of marine energy devices. An investigation of existing state-level marine energy policies uncovered only two enacted pieces of legislation—those within the states of Maine and California.

Though other coastal states have begun to investigate the potential of marine energy, these inquiries are ongoing and have produced little in the way of legislative action to date. For example, in September 2022, New Jersey introduced Bill A4483[3] to evaluate the potential of marine energy and to establish wave and tidal generation goals, but the bill has not yet been enacted. Additionally, though Oregon has been supportive of marine energy and the development of PacWave (a wave energy test site currently being built in Oregon state waters), it currently has no legislatively enacted marine energy policies on the books.

This lack leaves few opportunities to develop a robust comparative review of such policies and their effectiveness on expanding the marine energy industry throughout the United States. Nevertheless, these examples can inform future marine energy policy development and wider renewable energy policies in progress.

The following section analyzes the legislative actions taken by Maine and California in support of marine energy. The case studies compare and contrast the approaches taken by the states to encourage the development of marine energy technologies and support the wider marine energy industry.

3.1 Case Study: California

The state of California has been at the forefront of supporting energy efficiency and renewable energy generation since the California energy crisis of 2000–2001 (U.S. Energy Information Administration n.d.).

In 2003, the California Public Utilities Commission (CPUC) passed their first *Energy Action Plan*, which called for renewable energy generation goals, upgrades to transmission and distribution infrastructure, the promotion of distributed generation, and more. The 2003 *Energy Action Plan* was revised in 2005 and again in 2008 (California Public Utilities Commission [CPUC] n.d.-b).

California first signed an RPS in 2002 with the passing of Senate Bill (SB) 1078. The original RPS requirement was 20% renewable energy by 2017 (CPUC n.d.-c). In 2015, the RPS was

[3] Bill A4483 Aca (1R), 220th Legislature (2022). https://www.njleg.state.nj.us/bill-search/2022/A4483.

updated with SB-350, requiring 50% renewable energy by 2030. Several additional substantive updates occurred over the last several years (CPUC n.d.-a). Most notably are recent revisions, including SB-100 passed in 2018, whereby the target renewable clean energy requirements increase to 44% by 2024, 52% by 2027, 60% by 2030, and 100% by 2045 (CPUC n.d.-a). Table 2 is a summary of the estimated annual RPS-certified renewable energy according to the California Energy Commission (California Energy Commission 2023).

Table 2. Estimated Annual RPS-Certified Renewable Energy

Year	Percent of Retail Sales (%)	Solar (gigawatt-hours)	Wind (gigawatt-hours)
2011	16.6	1,234	14,575
2015	25.4	17,629	24,107
2017	32.6	28,822	25,616
2022	39.4	43,906	30,633

In addition, California is also at the forefront of grid reliability. The state has successfully maintained grid reliability alongside high renewables integration—especially in the context of variable generation from wind and solar. Marine energy is also a variable generation technology, which has unique impacts on electrical grids. These impacts must be taken into account for projects to be successful.

Grid reliability has been a key policy focus following the California energy crisis of 2000–2001. In 2009, CPUC conducted an analysis of high levels of distributed generation and the associated grid impacts. Their major finding was that a significant infrastructure build-out would have to accompany an RPS goal of 33% renewable generation (Gillette and Marks 2009). A 2024 National Renewable Energy Laboratory report supported this assertion. In *Maintaining Grid Reliability – Lessons from Renewable Integration Studies*, two of the findings were that (1) demand could be met through a portfolio approach of various resources and (2) expanding the transmission networks are central to increasing grid reliability (Denholm, Chernyakhovskiy, and Streitmatter 2024).

Furthermore, California allows multiple types of customer-based renewable energy generation to interconnect with the grid, and CPUC specifically lists ocean current energy as an allowable generation source under this umbrella (CPUC n.d.-a). These smaller-scale, customer-based renewable energy generation sources are also able to take part in net energy metering; however, any new interconnections after April 15, 2023, are subject to the new net billing tariff (NBT) pursuant to Decision D.22-12-056 (CPUC n.d.-a;). The major difference between the new NBT and net energy metering is "that under the NBT, compensation for excess generation exported to the electric grid is applied to a customer's bill at a rate reflecting the value of this generation to the grid" (CPUC n.d.-a).

California is also a champion of wave and tidal energy development. In 2008, the California Energy Commission and California Ocean Protection Council conducted an analysis and published a report called *Developing Wave Energy in Coastal California: Potential Socio-Economic and Environmental Effects* (Nelson et al., 2008). Following this report, in 2010, the state signed an MOU with FERC to formally coordinate a review of marine energy projects in California (FERC and California 2010). This coordinated review includes energy, environmental, and economic aspects of marine energy projects, a first step in expanding deployment of these technologies.

In October 2023, California signed into law SB-605 – Wave and Tidal Energy. SB-605 was passed as an emergency action, highlighting the importance the state has placed on this technology and its potential beneficial impacts. California's SB-605 states the following:

> "This bill would require the Energy Commission, as part of a specified 2024 energy policy review, in consultation with other appropriate state agencies to evaluate the feasibility, costs, and benefits of using wave energy and tidal energy, as specified. The bill would require the commission, in coordination and consultation with the California Coastal Commission, the Department of Fish and Wildlife, the Ocean Protection Council, and the State Lands Commission, to work with other state and local agencies and stakeholders to identify suitable sea space for offshore wave energy and tidal energy projects in state and federal waters. The bill would require the Energy Commission to submit a written report to the Governor and the Legislature on or before January 1, 2025, that includes a summary of findings from the evaluation and considerations that may inform legislative and executive actions, as specified" (California State Senate 2023).

Linked to California's current climate and clean energy goals, SB-605 also calls for the evaluation of transmission needs and permitting requirements associated with potential wave and tidal energy projects (California State Senate 2023).

A key component of California's SB-605 is the evaluation of the current transmission system and potential infrastructure needs associated with wave and tidal energy. Transmission infrastructure is critical to the successful development of any large-scale energy generation project. Transmission studies and upgrades should be carefully considered, however, because they can be complex, costly, and time-consuming (California Energy Commission n.d.).

The bill also requires the identification of actions that can be taken to potentially benefit the workforce, the economy, and the wave and tidal energy industry as a whole. Given the state's experience with renewables, officials appear to be aware of the potential benefits that wave and tidal energy might offer the workforce and economy, and for this reason, it is likely that future policy actions will take these potential gains into account.

It is important to note, though, that SB-605 is not a call for the immediate deployment of marine energy devices. Instead, it mandates the evaluation of wave and tidal energy, with findings summarized in a written report, to guide future proposed legislation or directives from the governor. In July 2024, California released a draft version of a *Wave and Tidal Energy Evaluation of Feasibility, Costs, and Benefits Senate Bill 605 Report* for public comment. The final version must be submitted to the governor and legislature by Jan. 1, 2025.

SB-605 features multiple embedded measures that other states could consider implementing as well. First, California is taking an incremental and measured approach to determining the most promising opportunities and deployment locations for wave and tidal energy. They are working to gather facts and considerations prior to developing more prescriptive policies and goals. Second, California is evaluating the potential transmission needs of wave energy, which may be critical to future policies and actions. Third, California appears focused on the potential beneficial impact wave and tidal energy could have on the economy and workforce within coastal communities and, potentially, on the state as a whole.

SB-605 is the first step in a multistep approach to developing additional, more-prescriptive policies and goals around marine energy.

3.2 Case Study: Maine

As another coastal state, Maine has also taken various policy actions related to ocean-based energy, including marine energy, throughout the years.

Similar to California, Maine has an RPS in place. Maine's RPS was enacted into law in 1999 and was most recently amended in 2019 to increase the renewables target to 80% by 2030 and 100% by 2050 (DSIRE 2024b). Under the original RPS legislation, eligible renewable technologies included tidal energy and hydroelectric resources but did not include other forms of marine energy (Maine State Senate 2019). This fact remains true today, as the law has not yet been expanded to include wave energy, ocean current energy, or other forms of marine energy resources (Maine State Senate 2019).

In November 2008, Maine's governor created the Task Force on Ocean Energy, charged with the explicit task of recommending "[a] strategy for moving forward as expeditiously as practical with the development of the ocean energy resources of the Gulf of Maine" (Maine Department of Environmental Protection 2018).

In June 2009, Maine's governor signed "Public Law 270, An Act To Facilitate Testing and Demonstration of Renewable Ocean Energy Technology" (Maine State Senate 2009). Public Law 270 states the following:

> "Whereas, the Gulf of Maine contains vast, untapped renewable ocean energy resources, including a globally significant offshore wind energy resource estimated at over 100 gigawatts, and tidal and wave power resources with significant potential to contribute to the State's renewable energy mix and create related business opportunities; and
>
> "Whereas, promising technologies exist and others are being developed to harness these renewable ocean energy resources for transportation and home heating needs; and
>
> "Whereas, these significant renewable ocean energy resources will help address the economic and environmental challenges we face as a result of over-reliance on oil and natural gas to meet energy needs; and
>
> "Whereas, Governor John E. Baldacci created the Ocean Energy Task Force to develop strategies to promote the State's renewable ocean energy resources, including research and testing of new technologies to harness those resources; and

> "Whereas, the Ocean Energy Task Force has identified the need to streamline and coordinate state permitting and submerged lands leasing requirements for renewable ocean energy demonstration projects so that the State can become an international proving ground for testing promising new technologies in state waters in specific locations along the coast in an environmentally responsible manner" (Maine State Senate 2009)

The Ocean Energy Task Force submitted a final report in December 2009 (Maine Department of Environmental Protection 2018). In response to the final report, Maine signed "Public Law 615, An Act To Implement the Recommendations of the Governor's Ocean Energy Task Force on April 7, 2010" (Maine State Senate 2010). This law sought to encourage tidal and wave energy development, along with enacting the following measures:

- "Requiring that the Public Utilities Commission take into account the state's renewable energy generation goals in determining the public need for proposed transmission lines;
- Directing the Public Utilities Commission to solicit proposals for long-term contracts to supply installed capacity and associated renewable energy and renewable energy credits from one or more tidal energy demonstration projects;
- Directing the Governor's Office of Energy Independence and Security to make recommendations to the Legislature regarding terms and conditions for long-term contracts to supply installed capacity and associated renewable energy and renewable energy credits from renewable ocean energy projects; and
- Directing the Maine Port Authority to assess existing port facilities and make recommendations to the Legislature regarding acquisition of real estate needed to facilitate renewable ocean energy development opportunities.
- Directing the Bureau of Revenue Services to report to the Legislature regarding whether and under what circumstances ocean energy-generating equipment in transit within the State on April 1 [2010] is exempt from personal property tax.
- Establishing a Renewable Ocean Energy Trust fund to protect and enhance the integrity of public trust-related resources and related human uses of the State's submerged lands" (Maine Department of Environmental Protection 2018).

In August 2009, following the creation of the Task Force and the signing of Public Law 270, Maine signed an MOU with FERC to coordinate the review of marine energy projects in the state (FERC and Maine 2009). While Maine was early in their efforts to deploy marine energy in a more coordinated manner, similar to California, the intent of Public Law 270 and the FERC MOU is focused on the research and early deployment of marine energy rather than on economic and workforce development efforts, as was the case in the California legislation.

At the time of the 2009 MOU, marine energy technology was in the R&D stage, which is largely the case today. Public Law 270 identifies wave energy converters as a developmental technology in relation to offshore wind energy projects, specifically as "part of an offshore wind energy demonstration project and is designed and sited to test production of electricity from wave energy in conjunction with and in a manner that complements electricity produced by an offshore wind energy turbine" (Maine State Senate 2009). This connection to offshore wind generation remains today and is the only Maine state policy that specifically addresses wave energy.

Public Law 270 also recognizes ocean-based energy, including wave energy, as a means of potentially addressing environmental and energy challenges. The law is grounded in support of the deployment of these technologies, with an eye toward commercialization. This support includes the permitting process outlined in Public Law 270, as well as attempts to further streamline it.

Regarding Maine's net metering law, tidal energy is included as an eligible technology for program participation, as long as the device's generating capacity is less than 5 megawatts of alternating current. The ability of tidal energy to participate in net metering allows for the offtake of overgeneration of a project and may provide an easier path to project viability and economic success for future grid-connected projects.

Maine established multiple best practices that other states might consider implementing: (1) the streamlining and coordinating of state review and approval processes with FERC; (2) state support for the R&D of marine energy technology toward commercialization and scaling; and (3) the inclusion of marine energy, specifically tidal, as an allowable renewable energy generation source under Maine's RPS and net metering law.

3.3 Similarities and Differences Between Maine's and California's Marine Energy Policies

Although state energy policies vary in scope, approach, and desired outcomes, common themes and best practices can be identified. In reviewing the Maine and California case studies, we can identify similarities and differences, along with gaps warranting greater investigation, as follows. Table 3 summarizes these observations.

Identified themes and similarities are as follows:

- **Researching and developing marine energy technologies, along with successful deployment of demonstration projects, is an important first step toward larger-scale marine energy deployment**. Both states demonstrate their intent to support more marine energy projects as a general approach to meeting energy demands and achieving clean energy mandates and goals.
- **Effective marine energy policy may work best when tied to renewable portfolio standards at its policy core.** When comparing the effective deployment and scale of other forms of renewable energy supported by an RPS in a state jurisdiction, it appears that greater incorporation of marine energy into those programs could result in high adoption rates for that technology class. Both Maine and California currently have RPS statutes with goals to reach 100% renewable or clean energy by 2045 and 2050, respectively. In Maine's RPS, however, there would need to be an expansion of qualifying marine energy technologies under the law, as the law currently omits explicit inclusion of several types of marine energy technologies. Additionally, it is important to note that potential higher adoption rates could depend on other factors, such as technology- and/or project-related impacts on the levelized cost of energy, which are topics not explicitly explored in this paper.

- **Transmission needs—and subsequent policy measures to address them—may help bolster new renewable energy deployment** and could be considered when setting new state-level climate or renewable energy goals.

Identified differences are as follows:

- **Greater focus on economic and workforce development efforts** appears within California's law but is less pronounced in Maine's law. This difference could be related to when the respective laws were enacted and the changes that have since occurred in the renewable energy industry with respect to workforce goals.
- **Greater focus on supporting deployments that test marine energy devices** appears explicitly within Maine's law. California's law focuses on an initial broad analysis of marine energy. As noted in the similarities section, this is a relatively minor difference**.**

Potential gaps are as follows:

- **Address the need for defined and stable pathways to deliver and sell the electricity produced by power generators to identified offtakers**. Other forms of renewable generation developed state-level procurement processes to create a pathway for offtakers. This may be a necessary component of scaling marine energy, when technologically appropriate. Potential programs such as the California Renewable Market Adjusting Tariff program may be a resource, along with Maine's LD 1895 in 2023—An Act Regarding the Procurement of Energy from Offshore Wind Resources (California Public Utilities Commission 2024; Maine State Senate 2023).
- Because California is in the early stages of determining their marine energy deployment path, it is also in an earlier stage of outreach and engagement with interested or potentially affected parties than Maine. However, this nascent stage could offer an opportunity to **tailor engagement and outreach efforts toward disadvantaged communities and Tribal Nations, better incorporating their perspectives into the planning process**. This early engagement may provide improved communication and information gathering, particularly with regard to historical and cultural context, which could help developers avoid costly delays in project siting and permitting.
- **Transmission is not easily addressed at a national scale given the varying regulatory and oversight structures employed throughout the country.** California's electric grid is managed by the California Independent System Operator, Maine is part of the Independent System Operator of New England, and their state policies and regulations vary greatly. Recent FERC orders may help address this challenge, however, by focusing on long-term planning for larger regional transmission infrastructure build-out (FERC 2024).
- **With the exception of Maine's inclusion of wave energy as part of an offshore wind project, the concept of system co-location or co-use of leased or identified areas has been minimal** (Maine State Senate 2009). Though co-location/co-use is occurring, especially in aquaculture developments, it appears that maximizing the use of such marine spaces is currently hindered by the lack of policy and regulatory direction to encourage this type of coordination and use. Co-locating marine energy with other types of energy generation or other economic activity could potentially expand project deployment for marine energy technologies—however, more R&D is necessary.

Table 3. Similarities and Differences Between Maine's and California's Policies Related to Marine Energy

State	RPS Marine Energy Inclusion	Net Metering	Transmission	Deployment	Workforce	Economic Benefits	Permitting and Leasing
Maine	Tidal	Tidal	Alignment with FERC for general permitting terms (tidal projects)	Explicitly identified in existing law for testing of technologies	Not explicitly identified in existing law	Not explicitly identified in existing law	FERC MOU to streamline this process
California	Tidal, Wave, Ocean Thermal	Ocean thermal	Explicitly identified as area of needed study	Explicitly identified and included in investigation	Explicitly identified and included in investigation	Explicitly identified and included in investigation	FERC MOU created a partnership between parties

An important consideration not reviewed in this paper relates to the current and ongoing impact the offshore wind industry may have on California, Maine, and other state jurisdictions. Although there may be opportunities to coordinate the deployment of marine energy technologies with offshore wind (as stipulated by Maine's Public Law 270), the research team determined that to be beyond the focus of this analysis.

With Maine and California both focusing on floating offshore wind research and deployment, there exists a potential opportunity to investigate coordinated policies related to research, supply chain, and workforce needs moving forward. However, the gigawatt scale being pursued for offshore wind as compared to the current kilowatt scale of marine energy technologies creates a significant disparity between the resources and the types of policies used for their deployment.

As illustrated above, there are similarities and differences between the states of Maine and California and their policy approaches to marine energy development. Growing interest in renewable energy among other U.S. coastal states may result in greater policy disparities, as each attempt to meet their respective renewable energy goals as well as satisfy their constituents' needs. If efforts to coordinate these burgeoning state policies are not taken at an early stage, significant differences from state to state may result, which could further slow the deployment of marine energy technologies and projects.

4 Conclusion

State and federal policies to support renewable energy development have taken a wide variety of approaches over the last 20 to 30 years. This paper examined the marine energy policies of Maine and California, comparing them and the approaches taken, and, where possible, determining outcomes for and impacts on the marine energy industry.

These policies paved the way for newer marine energy technologies currently under development and/or early deployment stages. The marine energy industry can learn from—and potentially pursue—policies similar to those enacted by Maine and California and potentially mirror the progress they achieved in deploying marine energy resources. Additional policy development around marine energy resources at the state level could enable the conversion of this abundant resource to add additional domestically generated energy to the U.S. mix.

Just as other forms of renewable energy generation, such as wind and solar, benefitted from tailored funding and legislative support during their initial deployments and early-stage development, marine energy technologies currently in R&D may also benefit from similar support considerations to realize greater project deployment.

4.1 Key Takeaways

State Level:

State Renewable Energy Policy Development:

- **The RPS can be an important policy driver at the state level in expanding marine energy deployment.** A first step would be to include all types of marine energy as allowable generators in a state's RPS. Renewable technologies, such as wind and solar, have benefited from RPSs. Effective approaches to bolster renewable energy technologies through state RPSs have included the use of specific technology carve-outs, such as the solar carve-out employed in Massachusetts.
- **Economic benefits brought about by renewable energy projects is becoming more of a factor when states consider policy actions.** This is evidenced by California's SB-605 statutory language in Section 1. Future policies may further incorporate community economic benefits into statute; the marine energy industry may need to account for such a policy shift when exploring state policies and regulations for project development. This may add an additional challenge for marine energy developers and may impact achieving acceptable levelized-cost-of-energy levels, especially when competing with more-established renewable energy technologies.
- **States could coordinate when developing marine energy and other ocean energy system policies to address wider regional needs and impacts.** Rather than relying upon state-by-state efforts to deploy marine energy, greater coordination among states could positively impact the wider regional economy and energy supply. For these reasons, coordination may be important to consider early in the policy development process for marine energy.

State-Level Monetary-Focused Technology Deployment:

- **States interested in supporting marine energy could consider developing state-based incentives.** These incentives could comprise a financial incentive—or a suite of state-based incentives—to support the continued development of marine energy generation resources and help defray costs associated with the novel and often site-specific nature of marine energy systems. These incentive packages could also consider how best to leverage federal funding opportunities and allow for the stacking of incentives to meet evolving project and technology financial needs.
- **Further research on transmission infrastructure is necessary to ensure the effective siting and grid interconnection of marine energy.** Although smaller marine energy projects will occur before need arises for larger-scale grid interconnection, the topic should be prioritized to give ample time for research, development, and regulatory and legislative consideration.

5 Research Opportunities

This analysis uncovered the need for greater investigation into numerous areas of policy development and utilization in support of an expanded and more effective deployment of marine energy.

Below are several research topics worthy of deeper investigation. The recommendations below may be drawn through analysis of material found within this paper, of the references used therein, or from approaches utilized in the renewable energy industry more broadly.

Recommendations for additional research are as follows:

- Increase exploration of opportunities available to marine energy deployment through **increased coordination with other renewable resources**, such as offshore wind. Further analysis can illuminate greater project site utilization for open-water marine energy testing deployment, supply chain development across technologies, and workforce training across technologies, among other potential areas of interest.
- Research the commercialization and economic effect of appropriately sited **co-location** projects with other ocean energy systems. This relates to both the potential benefit toward greater marine energy deployment—to the host project—and the technology power output and project economics given the opportunity to better utilize the project area for more beneficial uses.
- Research options for policy development and coordination regarding **complementary uses** in areas where marine energy can be sited. To date, the policy development focus has largely been to support specific R&D system deployment without the inclusion of other resiliency efforts and Blue Economy opportunities and needs such as aquaculture, coastal microgrids, or other applications.
- Analyze and identify **opportunities for leveraging cross-benefits** regarding existing and new project funding sources—at both the state and federal levels—to help reduce project costs and facilitate economic conditions of marine energy technologies.
- Consider the potential impact of **aligning federal funding opportunities with specific state marine energy policy measures** and how this could incentivize states to pass those policy measures and potentially increase coastal resiliency, while deploying more marine energy projects.
- Complete an economic analysis on the **impacts of marine energy development on local economies**. Analyze and potentially validate how enacting specific policy adjustments and carve-outs applied to renewable energy policies can impact local economies. Given those results, apply the anticipated generation opportunity for marine energy technologies to understand the economic impact and opportunity of this technology. This analysis could include a deeper concentration on community benefits stemming from marine energy projects.
- Continue to consider challenges regarding **interconnection** to the grid and the potential benefits of microgrids to accommodate the onshoring of marine energy.
- Identify the potential opportunities of and barriers to developing **microgrid integration**, as many initial marine energy projects will require smaller-scale power integration before reaching utility-scale deployments. Moreover, identify what challenges may arise through current regulatory and utility frameworks to provide for this integration.

- Expand the policy analysis to understand potential **permitting barriers** and options to facilitate a more streamlined approach.
- Consider investigating **permitting and siting parameters for siting marine energy and its relationship to engagement with communities** hosting the development. This investigation could include an analysis of the benefits of greater communication and engagement with state and local officials, project developers, and the communities where those projects are likely to be sited and their role in potentially streamlining this often challenging and lengthy process.
- Investigate the potential impact of how **incentivizing R&D** in RPS-approved jurisdictions impacts marine energy and how that might relate to other economic R&D measures at both the state and federal level.
- Investigate areas where marine energy may be missing from federal policies and analyze the impact of including **marine energy in federal policies**.
- As more states develop and enact **statutes related to marine energy**, continue the analysis conducted in this paper.

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