Equity Considerations for Renewable Energy Technologies in Alaska Offshore Waters

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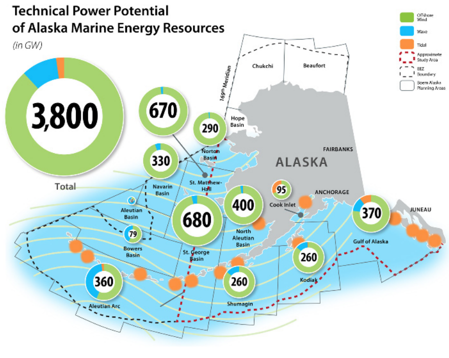


Offshore wind and marine energy resource totals by BOEM planning area. Resource totals are given in gigawatts. Dotted lines show the approximate study area (red) and the exclusive economic zone boundary (black). Data from Doubrawa et al. (2017) and Kilcher et al. (2021). Illustration by NREL

Overview

In this study, we assessed the feasibility of ocean-based renewable energy sources that may be available to help Alaska decarbonize its energy supply, increase coastal resilience, and build energy security and independence. The study focuses on the portions of the Outer Continental Shelf (OCS) off the coast of Alaska and Alaska state waters that are south of the Bering Strait and east of the 169th meridian. The Bureau of Ocean Energy Management's (BOEM's) authority to regulate renewable energy projects extends from the state/federal boundary at 3 nautical miles from shore out to the 200-nautical-mile exclusive economic zone.

Alaska's OCS holds vast renewable energy resource potential. We estimate that 3,800 gigawatts (GW) of potential wind, wave, and tidal energy resource capacity are in Alaska waters, which is more than 3 times the current total generation capacity of the United States in 2022 (1,200 GW) (U.S. Energy Information Administration [EIA] 2023). However, due to many practical constraints, including long distances to demand, poor economic viability, and conflicts with other ocean users and wildlife, only a small fraction of this resource can practically be developed. Roughly 88% of this resource potential (3,350 GW) is from offshore wind energy, with wave energy and tidal energy at 9% (350 GW) and 2% (80 GW), respectively (subject to rounding).

Key Challenge

One key challenge is identifying the location and type of the best renewable resources that can economically support the energy needs for the population centers and industrial energy use sectors moving toward carbon neutrality. Most ocean energy resources are too far from where the electric power is needed, and long-distance transmission costs would be prohibitive. Additionally, it is important for BOEM to ensure equity and accessibility when recommending renewable energy transitions in a collaborative, science-based, and inclusive approach to stakeholder engagement as the energy transition moves forward.

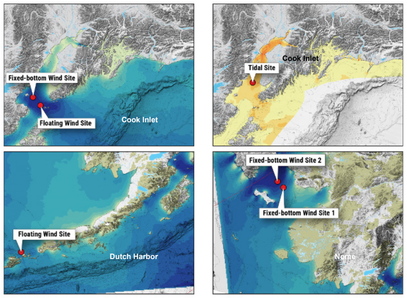
Annual Alaska energy consumption, rates, and primary source by region 2019–2020

Region	Number of Communities	Electricity Consumption (GWh)	Average Residential Effective Rates ($/kWh)	Primary Generation Source
Rural PCE Communities*	194	475	$0.28**	Diesel
Railbelt†	92	4,407	$0.20	Natural gas
Southeast and Other‡	74	~1,000	$0.11–$0.27	Hydropower

GWh = gigawatt-hours; kWh = kilowatt-hours; PCE = Power Cost Equalization Program
*2020 utility statistics data provided by Alaska Energy Authority
**Average rate that residents pay for the first 500 kWh after PCE incentive
†Data are for 2020 and from EIA Form 861
‡Data from former Alaska Energy Data Gateway

Case Studies

The case studies in this study describe the challenges and opportunities of renewable energy projects in select regions of Alaska's OCS. The specific case studies (pictured at right) include two offshore wind sites and one tidal case study in Southcentral Alaska (Lower Cook Inlet), one offshore wind case study in Alaska Peninsula and Eastern Aleutian Islands (Dutch Harbor), and two offshore wind case studies in Western Alaska (Nome). Ocean energy project development scenarios in more remote locations like Dutch Harbor and Nome will require an alternative market (e.g., clean hydrogen) for project viability.



Maps showing locations of case studies. Illustrations by Billy Roberts, NREL

Estimated levelized cost of energy (LCOE) in 2035 for 1 GW offshore wind case studies and a 100-device, 65-megawatt (MW) array tidal case study. Estimated capital expenditures (CapEx) and operational expenditures (OpEx) are also given for each case study.

CapEx, OpEx, and LCOE	Southcentral Alaska: Lower Cook Inlet Floating Offshore Wind Case Study	Southcentral Alaska: Lower Cook Inlet Fixed-Bottom Offshore Wind Case Study*	Alaska Peninsula/ Eastern Aleutians: Dutch Harbor Floating Offshore Wind Case Study*	Western Alaska: Nome 1 Fixed-Bottom Offshore Wind Case Study*	Western Alaska: Nome 2 Fixed-Bottom Offshore Wind Case Study*	Southcentral Alaska: Lower Cook Inlet 65-MW Tidal Case Study
CapEx ($/kW)	$5,385	$4,292	$4,661	$4,980	$5,397	$5,100
OpEx ($/kW/yr)	$65	$65	$59	$73	$74	$163
LCOE ($/MWh/yr)	$100	$83	$87	$103	$106	$280

MWh = megawatt-hour
*These offshore wind scenarios would likely not exist without the clean hydrogen component; thus, the reader should not make direct comparisons across the LCOE numbers without adding in the cost of clean hydrogen production in these locations.

Ocean Energy Options

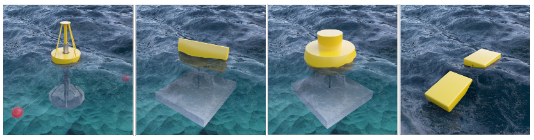
Offshore wind is the most feasible option for renewable energy production in Alaska's OCS in the next 10–20 years.

The technology is commercial, the estimated wind energy potential is substantial, and our LCOE estimates for all offshore wind case studies are lower than the LCOE of the tidal energy case study. The highest-quality resources are the offshore wind and tidal resources closest to the Alaska Railbelt grid (connecting the populated areas from Fairbanks to Anchorage) with the highest energy density (e.g., high average wind speed, high average current speed, or high wave heights). These areas could potentially be developed before 2035–2040.

Resources with limited or no access to the grid may be viable if the electricity generated is used to produce carbon-neutral or "clean" hydrogen.

As the ocean-based resources could enable electricity production greater than the capacity of the Railbelt, clean hydrogen is one longer-term option (e.g. 2050) that can create a parallel path to serve other end uses, which were identified statewide and estimated to range from 4,800 to 83,000 GWh annually. Other possibilities also exist for monetizing the energy produced apart from clean hydrogen.

Offshore wind turbine substructure types. From left: monopile, jacket, inward battered guide, semisubmersible, tension-leg platform, and spar. Illustration by Joshua Bauer, NREL

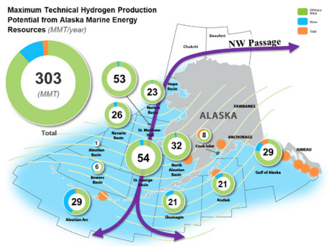


Types of wave energy converters. From left: power buoy, overtopping, point absorber, attenuator. Illustrations by Joshua Bauer, NREL

Energy Justice

Climate change can affect community resilience, infrastructure stability, and energy availability. This can put a strain on communities, their governments, and decision-makers. For many communities, access to resilient, affordable, sustainable, and clean energy resources are priorities, though historically, there have been disparities in the distribution of benefits and burdens of renewable energy systems. Resolving energy vulnerability in communities is key to mitigating the impacts of climate change. In Alaska, renewable energy projects as represented in this study will occur on the ground and in the oceans surrounding communities. It is crucial that BOEM consider ways to bolster just and equitable approaches for energy transitions.

Example tidal energy technology. Illustration by IKM 3D



Maximum hydrogen production potential from Alaska marine energy resources. Values shown are in million metric tons (MMT) per year. Illustration by NREL

- Doubrawa et al. 2017. *Offshore Wind Energy Resource Assessment for Alaska*. NREL/TP-5000-70553.
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