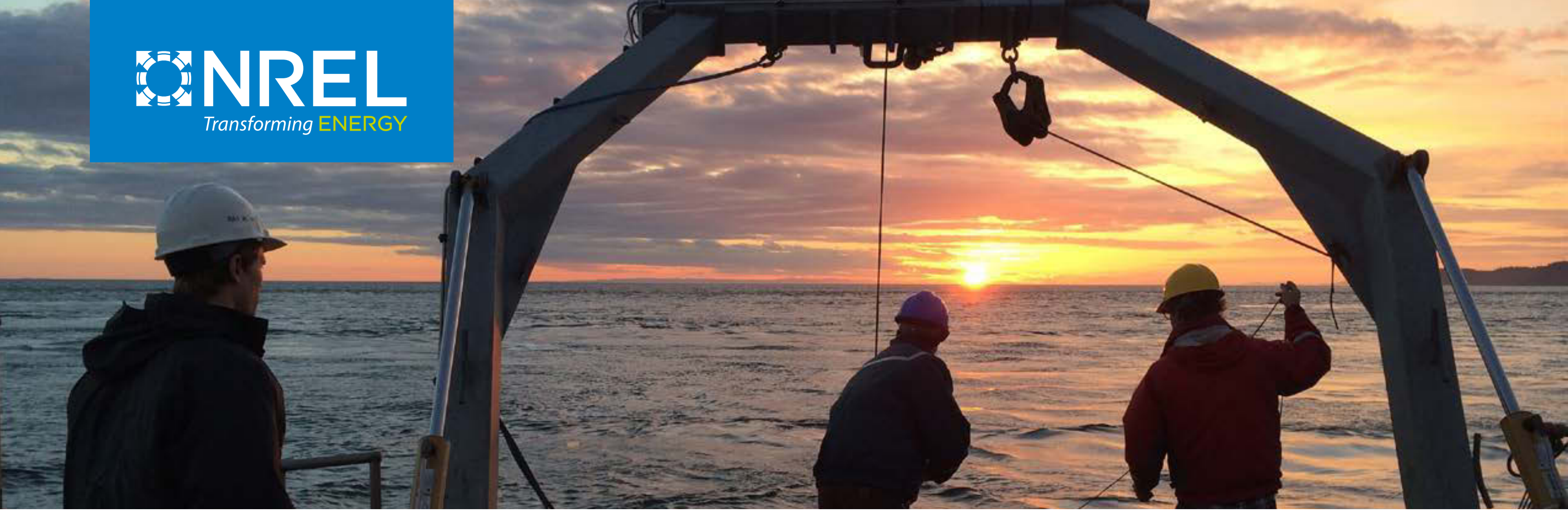


University of Washington researchers deploy a Mid-Water Mooring from the stern of the R/V Jack Robertson as the sun sets over Puget Sound. *Photo by Levi Kilcher, NREL*

Cook Inlet Tidal Energy Resource Characterization Effort

Mooring Deployment Dates: July 1, 2021–August 31, 2021

Measurement Site: 1/4 to 1 nautical mile due west of the East Foreland (60° 43.24′ N, 151° 25.03′ W to 60° 43.24′ N, 151° 26.58 W)

Cook Inlet

Every day, ocean tides pump incredible volumes of water through the world's bays, estuaries, inlets, and passages. Locations where the coastline "pinches" the flow creates fast tidal currents, which can be converted into energy similar to the way wind turbines extract energy from moving air. Tidal power is one of the fastest-growing clean energy technologies and has the potential to provide large amounts of predictable, renewable power, advancing us toward a low-carbon economy.

Located in southcentral Alaska, Cook Inlet contains one of the largest tidal power resources in the world. Midway up the inlet, the water flow accelerates as it squeezes between the eastern and western forelands. Researchers at the National Renewable Energy Laboratory (NREL) are collecting data near the East Foreland that will be released publicly and used by potential project developers to better understand the opportunities and challenges at the site.

Access to affordable, clean power would provide tremendous economic benefits to Alaskans, who face some of the highest energy costs and most extreme climates in the United States. NREL researchers are collaborating with universities and private partners to gain a better understanding of Cook Inlet's underwater environment to pave the way for the creation of efficient and durable tidal energy farms.

Key features and challenges of the site include:

- An estimated capacity of 6–18 gigawatts of theoretical tidal power
- An easy tie-in with Alaska's railbelt electrical grid, which serves most road-connected communities from Homer to Fairbanks
- A highly turbulent underwater environment with large amounts of sediment suspended in the waters throughout the inlet
- Seasonal surface ice as well as subsurface ice that is laden with sand and gravel

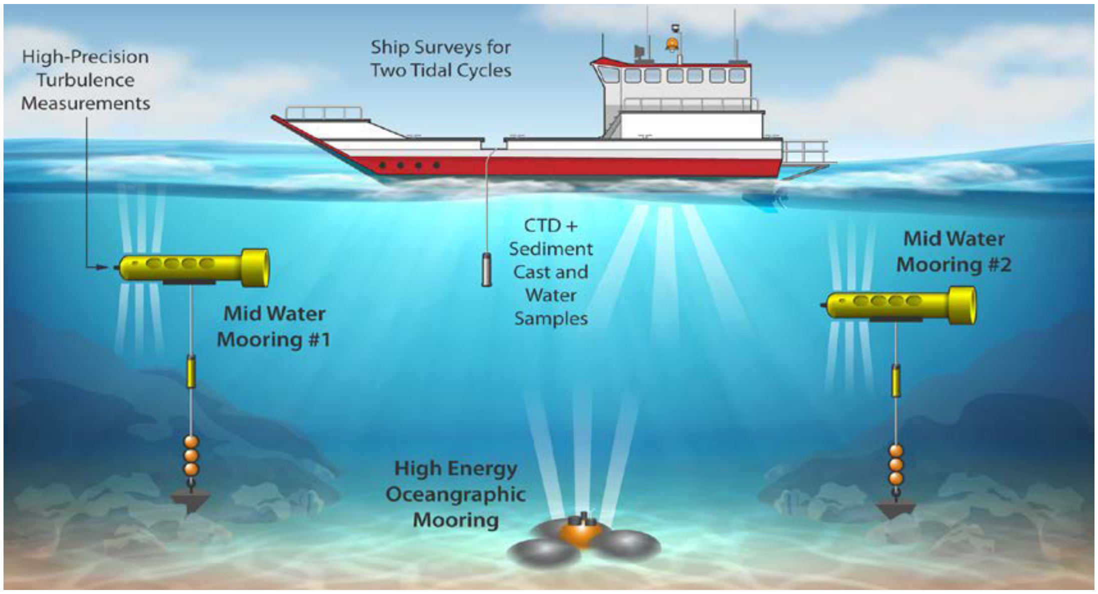
Summer 2021 East Foreland Measurements

This summer, NREL will be preparing detailed resource measurements at the East Foreland, near Nikiski. The measurements are designed to improve understanding of the resource and engineering challenges that future projects are expected to encounter, including:

- **Water velocity**—This determines the amount of energy that can be generated at the site—stronger currents have greater power potential. Water velocity is measured by acoustic Doppler current profilers (ADCPs), which send sonic pings through the water along "acoustic beams." The instrument listens for the echo of its ping, reflected off particles in the water. The change in the tone of the ping—caused by the Doppler effect—is a result of the speed of the water in the direction the beam is pointing. The readings from multiple beams can be triangulated and converted into a three-dimensional water velocity measurement (with direction and magnitude).
- **Turbulence**—Most people are familiar with turbulence as a disconcerting aspect of air travel. In scientific circles, turbulence refers to the chaotic fluctuations of wind or water velocity. In the same way that airplanes are designed to withstand turbulence, wind and water (tidal) turbines

must also be designed to withstand these fluctuations. Therefore, real-world measurements of turbulence at potential tidal energy sites are critical for engineering robust tidal energy turbines. Turbulence is measured by the same ADCPs that measure water velocity.

- **Salinity and temperature**—Salinity and temperature are measured by thermistors and conductivity sensors and are essential to understanding the density of water, which also influences the amount of power that can be generated.
- **Suspended sediment**—NREL will be measuring sediments using instruments that quantify particle sizes and concentrations based on optical backscatter from lasers and other small light sources. The team will also be taking water samples to characterize the sediments. A detailed understanding of these particles informs the design of many tidal device components—such as seals and bearings.



MWMs and the HEOM will be in the water throughout July and August 2021.The ship-surveys will be conducted in late August and will measure the cross-channel spatial variability of current speeds, sediment concentrations, salinity, and temperature. All hardware, including anchors, are designed to be recovered from the site. *Illustration by Al Hicks, NREL*

Two types of moorings will be used to measure hydrokinetic energy at the East Foreland: a midwater mooring (MWM) with a recoverable anchor and a high-energy oceanographic mooring (HEOM).

Midwater Mooring

The MWM comprises a 12-foot-long, 20-inch-diameter, streamlined buoy. This buoy will float in the middle of the water column (25 meters above the seafloor and 18 meters below the surface) and will be anchored in place using a 3,200-pound anchor.

The buoy holds downward- and upward-looking ADCPs that measure water velocity throughout the water column. The buoy also has an acoustic velocimeter at its nose that assesses turbulence with high precision. By placing the instruments in this buoyant system at a midwater depth, the system mitigates the risk of this design being buried by sediment or damaged by boulders or other debris at the bottom of the channel. The motion of the buoy will be removed from the velocity measurements by combining measurements of the buoy's motion from the down-looking ADCP with signals from inertial motion sensors onboard the platform.

High-Energy Oceanographic Mooring

HEOM is a seafloor-based mooring that houses upward-facing instrumentation. All the instruments are housed in a "pop-up" buoy that detaches from the body of the HEOM by means of an acoustic release. HEOM's instrument package comprises an ADCP with external battery housings, an acoustic velocimeter, and a satellite beacon. The secondary recovery system for the HEOM comprises acoustically activated inflation chambers that fill with air from high-pressure air tanks onboard. Once inflated, the entire HEOM will float to the surface and be retrieved by the research team.

Research Partners

The MWM system was designed and tested in the Puget Sound in close collaboration with the University of Washington's Applied Physics Lab. Similar work was performed near Eastport, Maine, with the Ocean Renewable Power Company, which also supported the planning and permitting phase of this work. TerraSond Limited is the primary marine operations contractor, and Integral Consulting is conducting sediment measurements.

This work is supported by the U.S. Department of Energy's Water Power Technologies Office under the marine energy resource characterization effort—a multilab collaboration that includes NREL, the Pacific Northwest National Laboratory, and Sandia National Laboratories.

For more information on NREL's resource characterization work, visit: nrel.gov/water/resource-characterization.html

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