Northwest **Power** and
Conservation Council

February 3, 2026

MEMORANDUM

TO: **Council Members**

FROM: **Annika Roberts, Resource Policy Analyst**

SUBJECT: **Panel on Supply Side Emerging Technologies**

BACKGROUND:

Presenter: Annika Roberts, Resource Policy Analyst, Ben Surrier, Fervo Energy, Justin Klure, PacWave, Tom Bugert, Helion Energy

Summary: Emerging technologies are characterized in the Council's power planning as resources that have long-term potential in the region but aren't yet commercially available. This presentation will include a short summary of the previously discussed approach for including emerging technologies via proxy plant in the Ninth Plan. It will then transition to a panel of yet undiscussed emergent technologies and their relevance to the region. Experts from Fervo Energy (enhanced geothermal), Helion Energy (fusion technology), and PacWave (wave energy) will present their technologies' characteristics and regional relevance to the Council and then will be open to answer any questions these presentations might raise.

Relevance: At past Council meetings, staff laid out the methodology for addressing emerging technologies in the Ninth Power Plan. This approach relies on proxy resources, where a single emerging technology reference plant embodies a collection of characteristics that could be fulfilled by multiple resources. The proxies were differentiated by anticipated future system need, and the type of technology that could address that need. Those agreed to categories are: a clean baseload resource, a clean peaker with mid-duration storage, and a clean long-duration storage resource. February's panel will explore some of the emerging technologies that might fulfill those needs in the future grid. discussion

Workplan: B.2.5 Develop generating resource reference plants and related assumptions for plan analysis

More info: Previous presentations on other emerging technologies:

Small Modular Reactor presentations:
- Grant PUD X-energy: https://www.nwcouncil.org/fs/18093/2022_11_5.pdf
- Terra Power https://www.nwcouncil.org/fs/18184/2023_02_3.pdf
- NuScale Corvallis Tour: https://www.nwcouncil.org/news/2022/10/24/council-members-tour-energy-and-habitat-projects/

Iron Air Battery presentation:
https://www.nwcouncil.org/fs/18693/2024_04_p2.pdf

Hydrogen presentations:
- Douglas PUD renewable hydrogen project[1]:
https://www.nwcouncil.org/fs/18432/2023_08_4.pdf
- Approach to Modeling Hydrogen into the Ninth Power Plan[2]:
https://www.nwcouncil.org/fs/19037/2025_01_5bd.pdf

Demand Side Emerging Technology presentation:
https://www.nwcouncil.org/fs/19521/2025_08_5.pdf

Reference Plant presentation, where emerging technology strategy was initially described: https://www.nwcouncil.org/fs/19129/2025_03_01.pdf

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[1] While this project is intended to produce hydrogen for non-power uses, the material included still provides some useful context for clean hydrogen with on-site electrolysis.

[2] This presentation also focuses in part on non-electric power hydrogen, discussing the Council's high-level approach for estimating industrial and transportation sector hydrogen load in the 9th Plan. The portion pertinent to this discussion is the review of how hydrogen power generation assets will be represented in the Plan.

Panel on Supply Side Emerging Technologies

February 2026

Northwest **Power** and **Conservation** Council

1

Emerging Technology in the 9th Power Plan: a Recap

2

Methodology

- What are emerging technologies?
  - Not yet 'reliable and available' and therefore treated differently from other resources in the plan
  - Different plans have treated ETs differently
- Emerging Technologies in the 9th Plan?
  - Build multiple proxy reference plants that each fill a system need
    - Clean Baseload
    - Clean Peaker/medium duration storage
    - Clean Long Duration Storage
  - Base proxies off a representative technology
    - Most commercial, most data available, strongest current outlook
    - Acknowledge that there are other technologies that could provide these characteristics, esp. in the timeline of ET in the Plan

Why the Proxy Approach?

Reveals what resource characteristics the regional grid might need under the different futures we're testing, and about gaps left by existing technologies

Avoids being overly prescriptive or precise about an unknown future technology—while still acknowledging the likelihood of technological advancement over the next 20 years

Available far enough out that there will be time to revisit any assumptions made by the next Plan when there is more certainty about these technologies

Clean Long Duration Storage

Clean Long Duration Storage | Variable Resource Integration | Operational Flexibility | Seasonal & Daily Demand Shifting

- **Clean Long Duration Storage**: Helps the grid better integrate variable resources, provides operational flexibility, and offers demand shifting on a seasonal scale.
- Representative Technology: Iron air battery
- Alternatives:
  - Electrochemical Energy Storage: Metal anode batteries (lead acid, sodium sulfur etc.) Flow batteries
  - Mechanical Energy Storage: Gravity-based, compressed-air, liquid-air
  - Thermal Energy Storage: Molten salt, latent heat
  - Chemical Energy Storage: Hydrogen

5

Clean Baseload

Clean Baseload | Reliability | Firm Supply

- **Clean Baseload**: Offers reliability and firm supply to the grid.
- Representative Technology: Small modular reactors (nuclear)
- Alternatives:
  - Enhanced Geothermal
  - Wave Energy
  - Fusion

6

Clean Peaker with Storage

Clean Peaker w/load	High Peak Demand	Operational Flexibility	Daily & Hourly Demand Shifting

- **Clean Peaker and Medium Duration Storage:** Mitigates high peak demand, while extending operational flexibility and shorter term, daily/hourly demand shifting.
- Representative Technology: Hydrogen with on site pyrolysis
- Alternatives:
  - Alternative Hydrogen Sources Ammonia & Pyrolysis
  - Flywheels

Meet Our Panelists

Ben Surruier—
Fervo Energy
- Enhanced Geothermal

Justin Klure—
PacWave
- Wave Power

Tom Bugert—
Helion Energy
- Nuclear Fusion

FERVO ENERGY

February 10, 2026

Fervo Energy and the Geothermal Decade

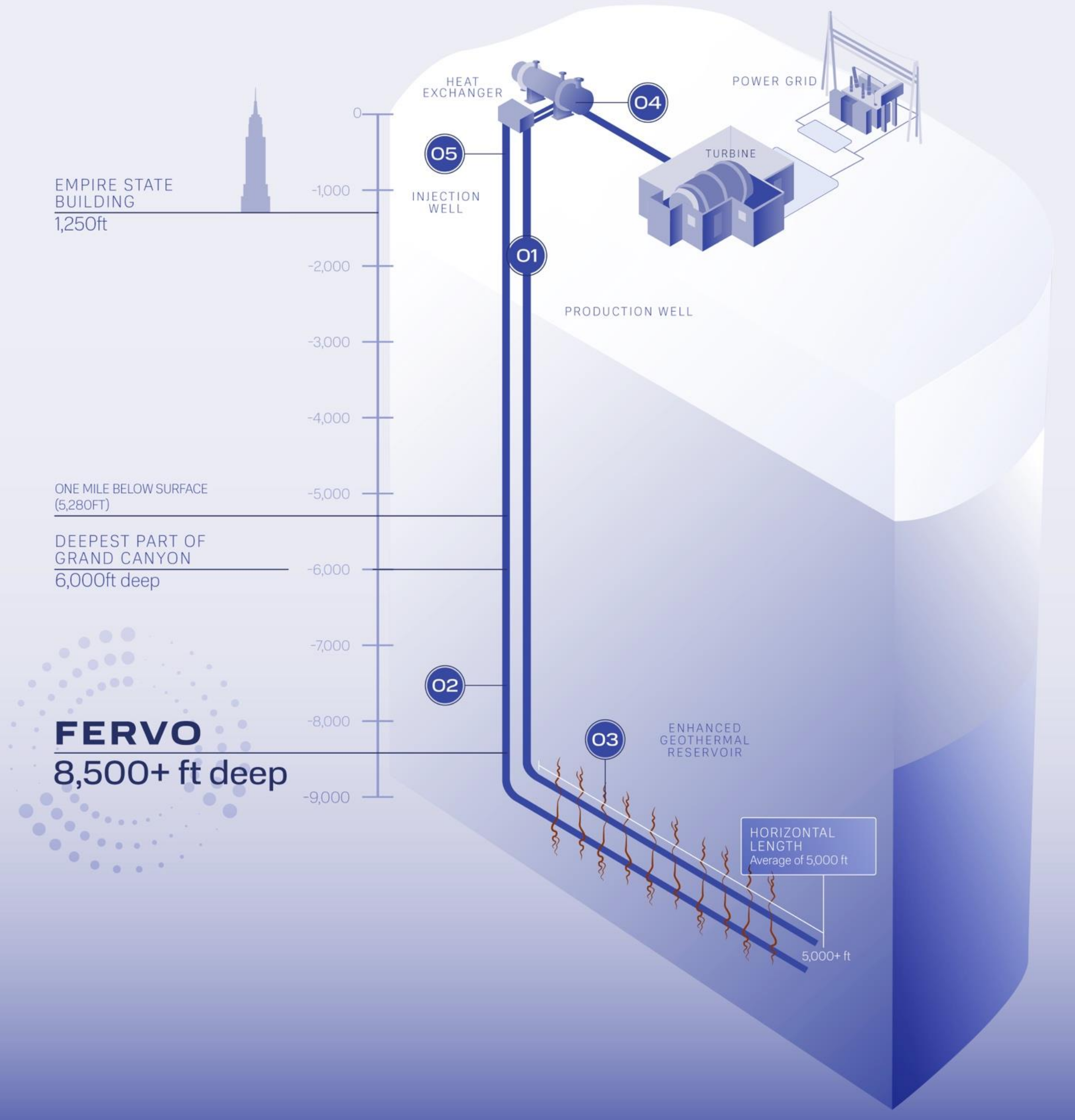
DELIVERING 24/7 CARBON-FREE ENERGY

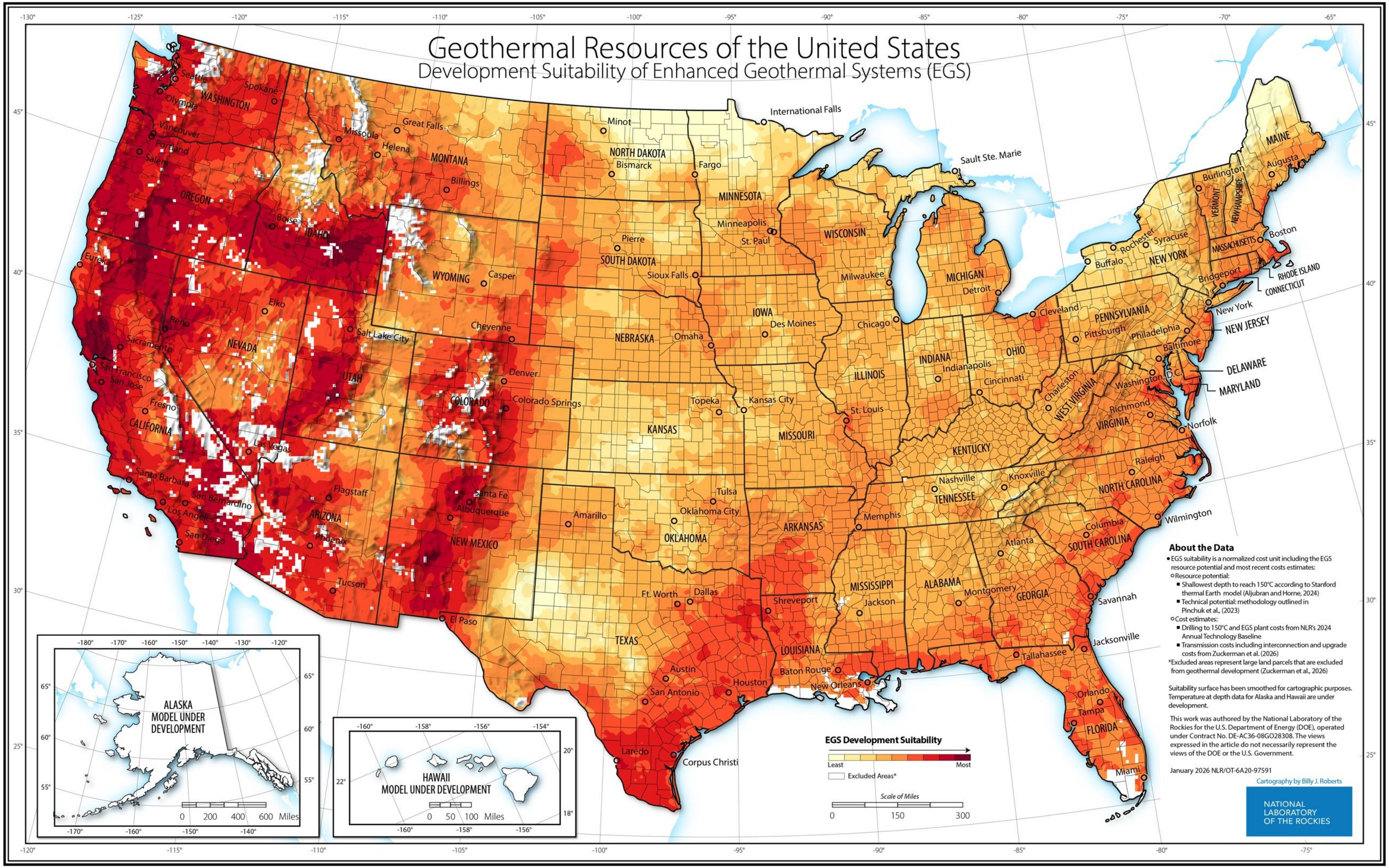
FERVO ENERGY

Next-Generation Enhanced Geothermal Systems (EGS)

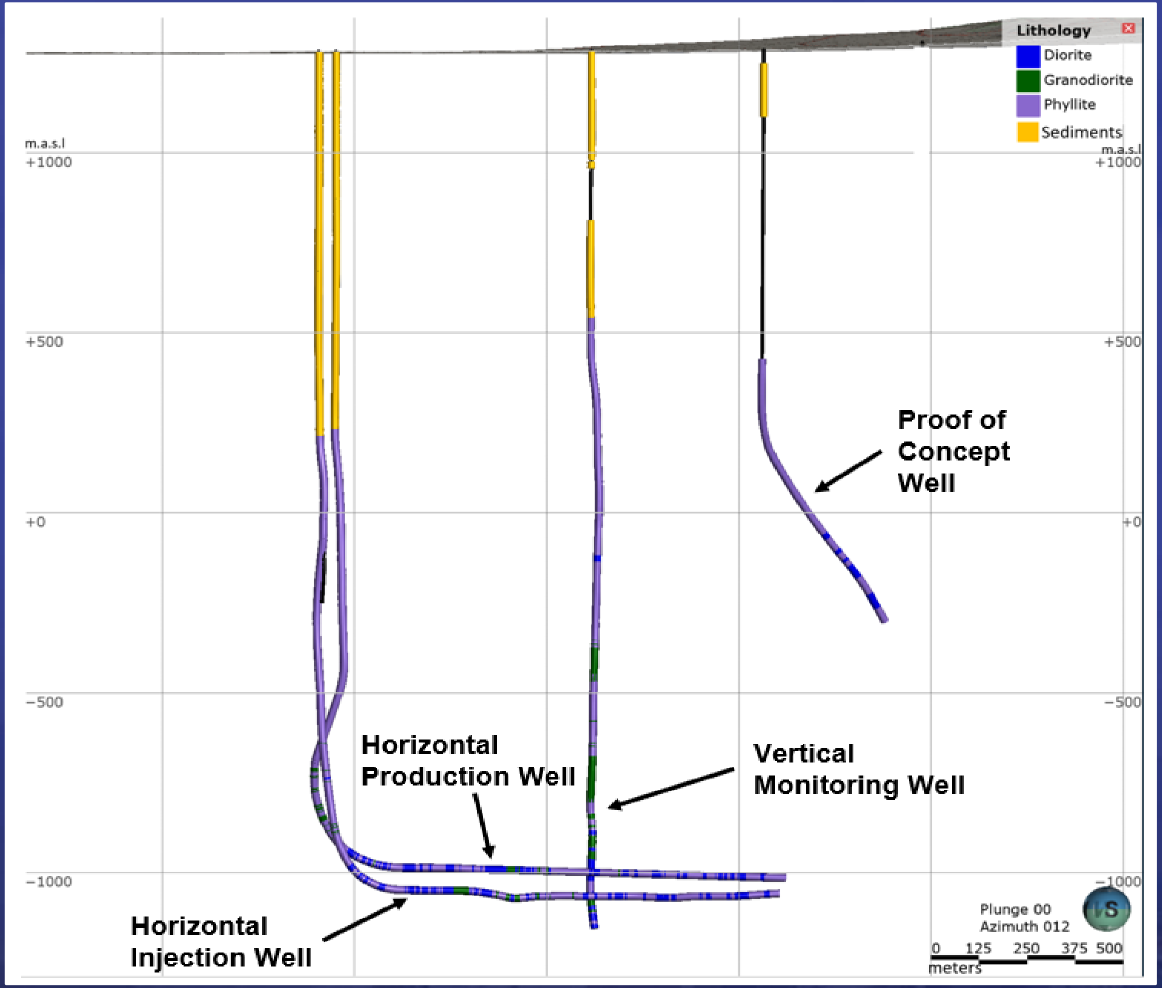
THE PROCESS

01	Wells are drilled vertically before turning and extending horizontally. Fractures are created to enhance the permeability of the geothermal reservoir to form a strong connection between the injection and production wells.
02	Fluid is then pumped down injection wells, flowing through the fractures.
03	As it flows through fractures, surrounding hot rock heats the fluid, which is returned to the surface through production wells.
04	At the surface, hot geothermal fluid is run through a heat exchanger, where its heat is transferred to a working fluid used to spin turbines and generate electricity.
05	100% of the geothermal fluid is pumped back into injection wells, creating a closed-loop cycle where water is not lost to evaporation.

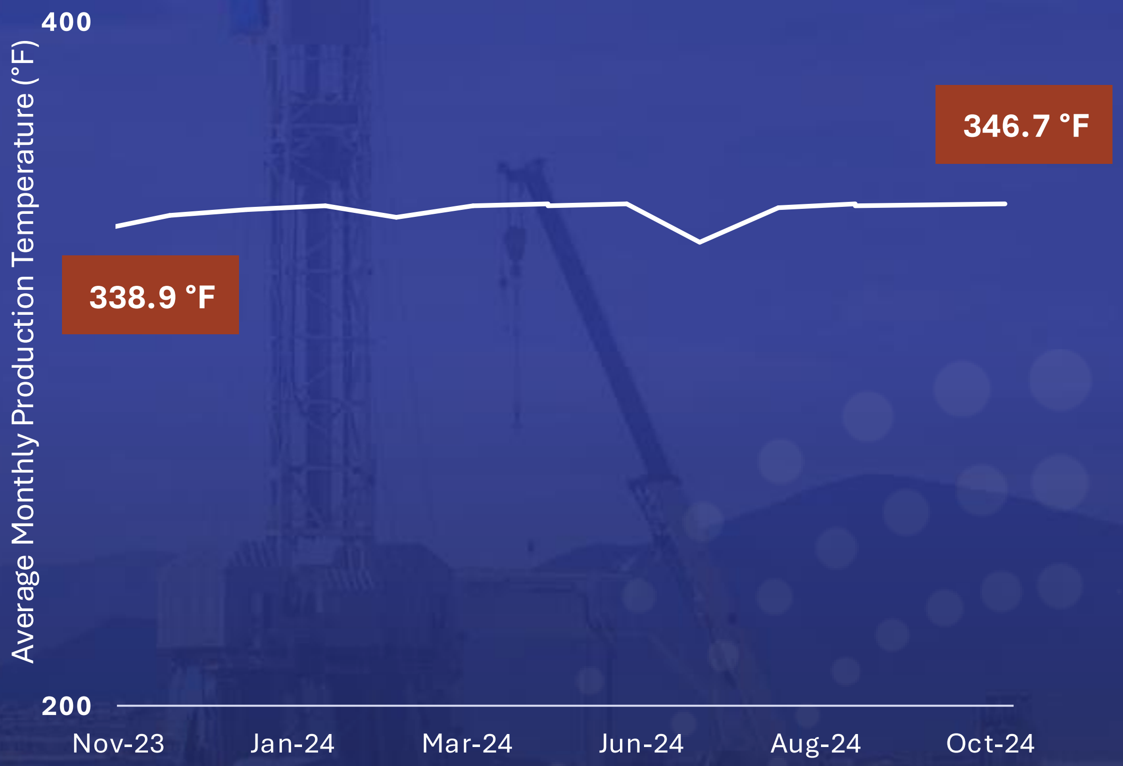



Geothermal Resources of the United States
Development Suitability of Enhanced Geothermal Systems (EGS)
WASHINGTON
OREGON
CALIFORNIA
NEVADA
IDAHO
MONTANA
WYOMING
UTAH
COLORADO
ARIZONA
NEW MEXICO
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
KANSAS
OKLAHOMA
TEXAS
MINNESOTA
IOWA
MISSOURI
ARKANSAS
LOUISIANA
WISCONSIN
ILLINOIS
MICHIGAN
INDIANA
OHIO
KENTUCKY
TENNESSEE
MISSISSIPPI
ALABAMA
GEORGIA
FLORIDA
SOUTH CAROLINA
NORTH CAROLINA
VIRGINIA
WEST VIRGINIA
MARYLAND
DELAWARE
NEW JERSEY
PENNSYLVANIA
NEW YORK
CONNECTICUT
RHODE ISLAND
MASSACHUSETTS
VERMONT
NEW HAMPSHIRE
MAINE
Seattle
Olympia
Spokane
Vancouver
Portland
Salem
Eureka
Boise
Missoula
Great Falls
Helena
Billings
Casper
Cheyenne
Elko
Reno
Sacramento
San Francisco
San Jose
Fresno
Las Vegas
Salt Lake City
Denver
Colorado Springs
Santa Barbara
San Bernardino
Los Angeles
San Diego
Flagstaff
Phoenix
Tucson
Santa Fe
Albuquerque
El Paso
Minot
Bismarck
Fargo
Pierre
Sioux Falls
Omaha
Topeka
Kansas City
Amarillo
Oklahoma City
Tulsa
Ft. Worth
Dallas
Austin
San Antonio
Houston
Laredo
Corpus Christi
Shreveport
Baton Rouge
New Orleans
International Falls
Minneapolis
St. Paul
Des Moines
Milwaukee
Chicago
St. Louis
Memphis
Jackson
Sault Ste. Marie
Detroit
Indianapolis
Cincinnati
Cleveland
Nashville
Knoxville
Atlanta
Montgomery
Tallahassee
Jacksonville
Orlando
Tampa
Miami
Savannah
Columbia
Wilmington
Raleigh
Norfolk
Richmond
Charleston
Washington, D.C.
Baltimore
Philadelphia
Pittsburgh
New York
Bridgeport
Buffalo
Rochester
Syracuse
Boston
Burlington
Augusta
ALASKA
MODEL UNDER
DEVELOPMENT
0 200 400 600 Miles
HAWAII
MODEL UNDER DEVELOPMENT
0 50 100 Miles
EGS Development Suitability
Least
Most
Excluded Areas*
Scale of Miles
0 150 300
About the Data
• EGS suitability is a normalized cost unit including the EGS resource potential and most recent costs estimates:
○ Resource potential:
▪ Shallowest depth to reach 150°C according to Stanford thermal Earth model (Aljubran and Horne, 2024)
▪ Technical potential: methodology outlined in Pinchuk et al., (2023)
○ Cost estimates:
▪ Drilling to 150°C and EGS plant costs from NLR's 2024 Annual Technology Baseline
▪ Transmission costs including interconnection and upgrade costs from Zuckerman et al. (2026)
*Excluded areas represent large land parcels that are excluded from geothermal development (Zuckerman et al., 2026)
Suitability surface has been smoothed for cartographic purposes. Temperature at depth data for Alaska and Hawaii are under development.
This work was authored by the National Laboratory of the Rockies for the U.S. Department of Energy (DOE), operated under Contract No. DE-AC36-08GO28308. The views expressed in the article do not necessarily represent the views of the DOE or the U.S. Government.
January 2026 NLR/OT-6A20-97591
Cartography by Billy J. Roberts
NATIONAL LABORATORY OF THE ROCKIES

Project Red, Fervo's 3 MW commercial pilot with Google, is the **most productive EGS project** in history



Project Red shows **over one year** of operating track record with **zero thermal decline**



Project Cape Station: Building EGS at utility scale, today.

500 MW Project

Located in Beaver County, Utah

Fully contracted, with Phase I (100 MW) scheduled to begin production in 2026

Phase II (400 MW) to begin production in 2028

20+ Wells Drilled

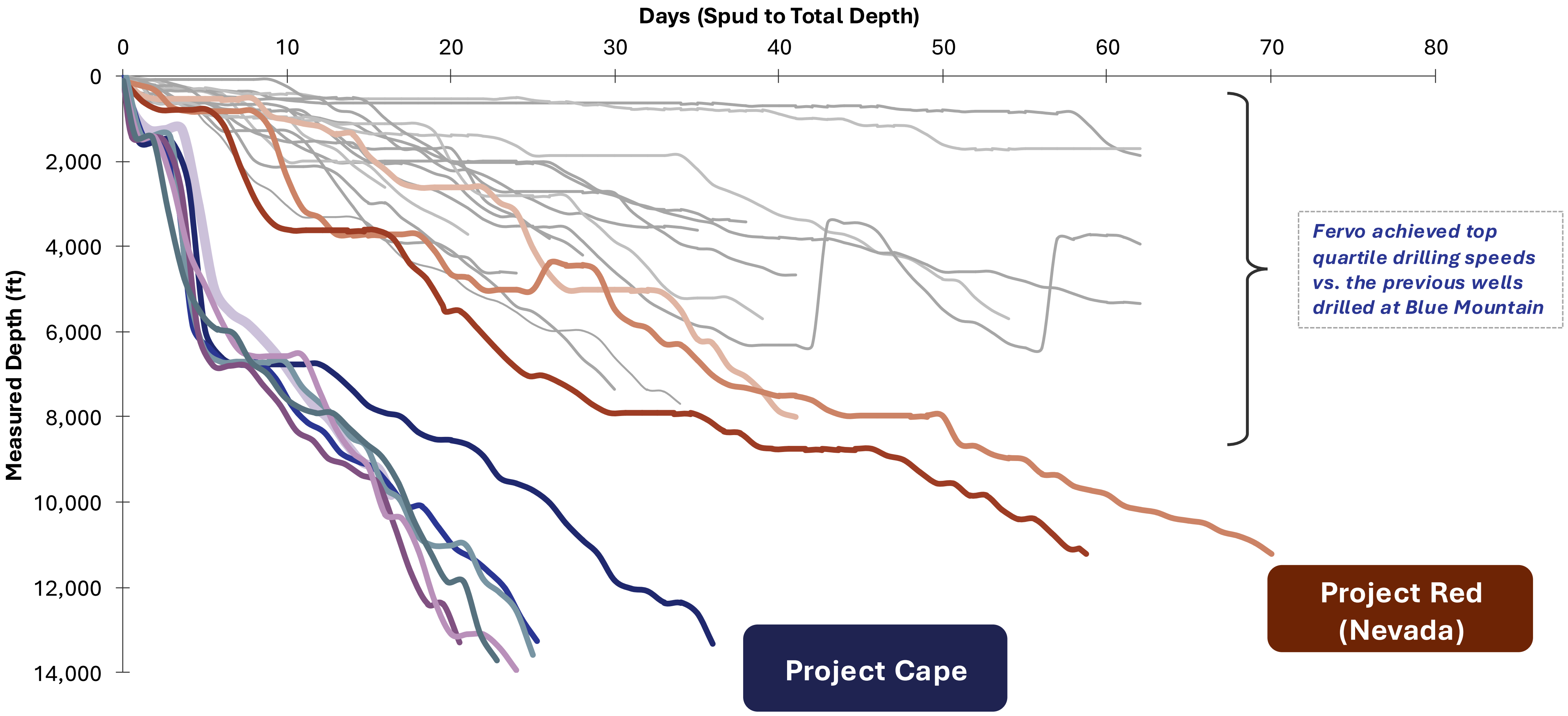
Over 20 wells of the Phase I well field drilled

3 Power Plants in Construction

Three Turboden Organic Rankine Cycle geothermal power plants and associate power equipment currently under construction on site

Early Drilling Results Demonstrate Best-In-Class Performance Vs. Conventional Geothermal

Blue Mountain/Cape: Days on Well



Learning by doing unlocks project economics

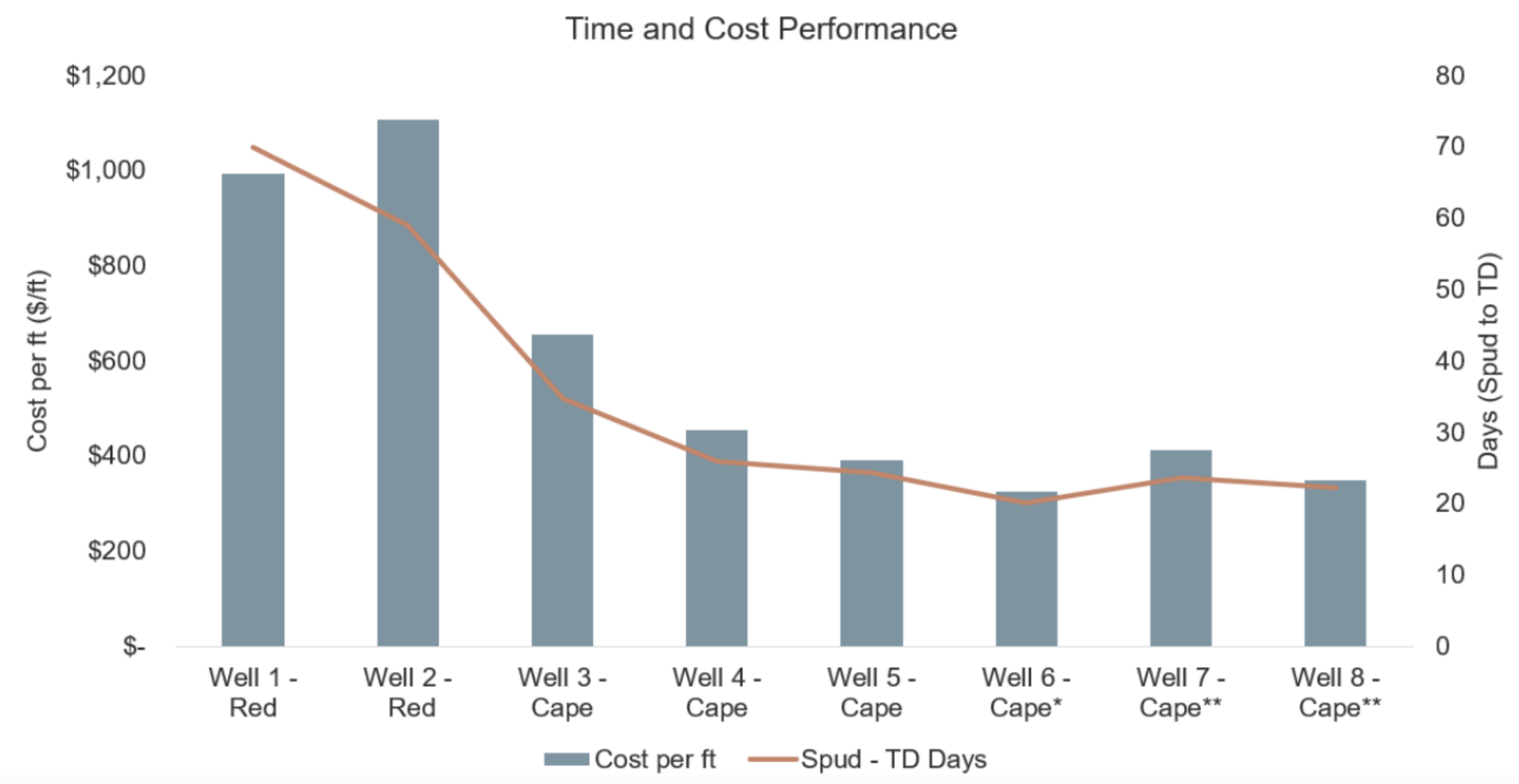
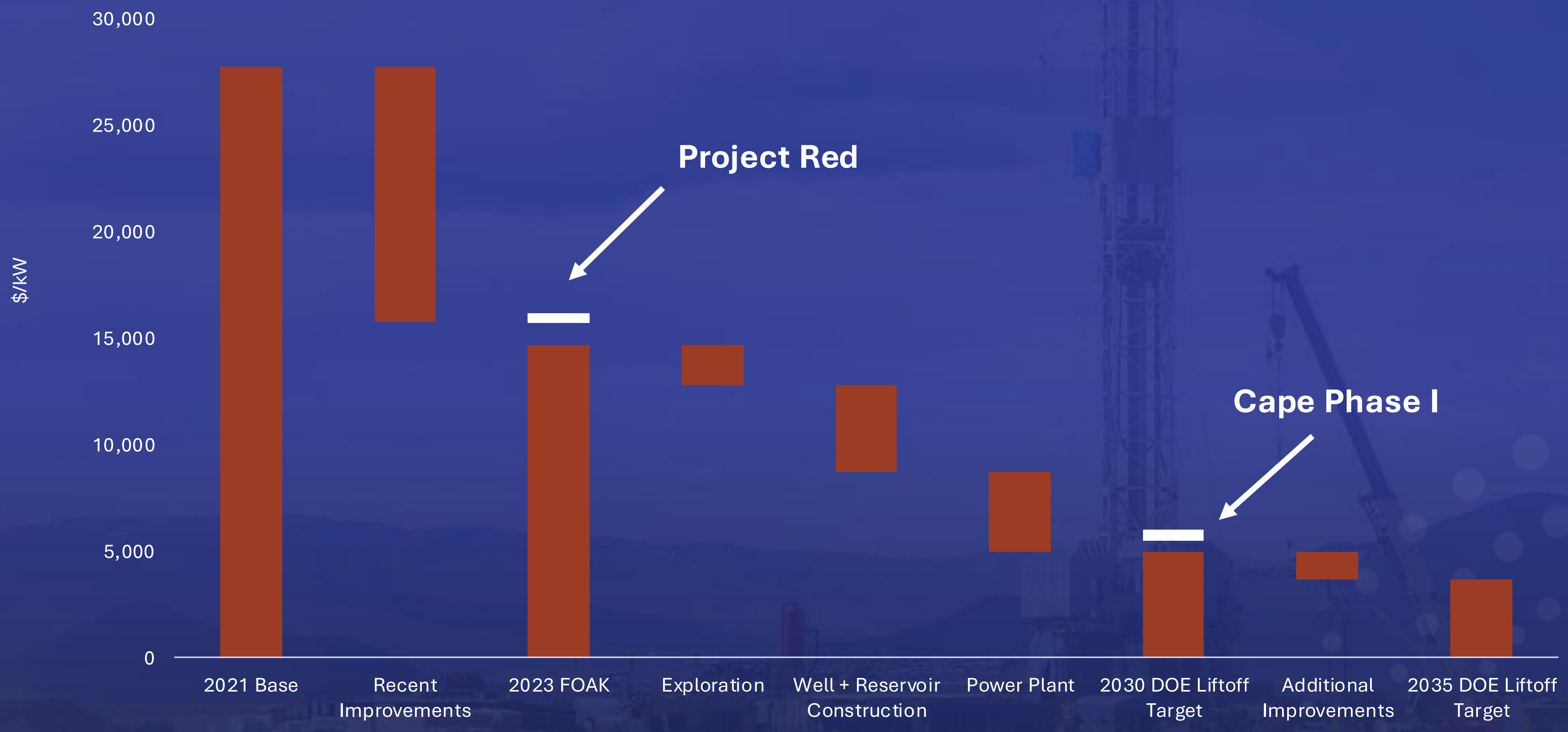


Figure 4: Fervo horizontal well cost per ft and spud to TD trends

*Well 6 – Cape represents a well with a barefoot completion design, with no production liner capital/installation costs incurred
**Well 7 – Cape represents a well with 1500 ft of additional granite drilled, and casing design optimization to increase power per producer by 0.5MW

- Drilling costs can account for up to 50% of project capex
- Drilling time accounts for over 75% of total well cost
- 60% reduction in drilling time over just eight wells
- Virtuous cycle of Deployment, learning and cost reduction to scale

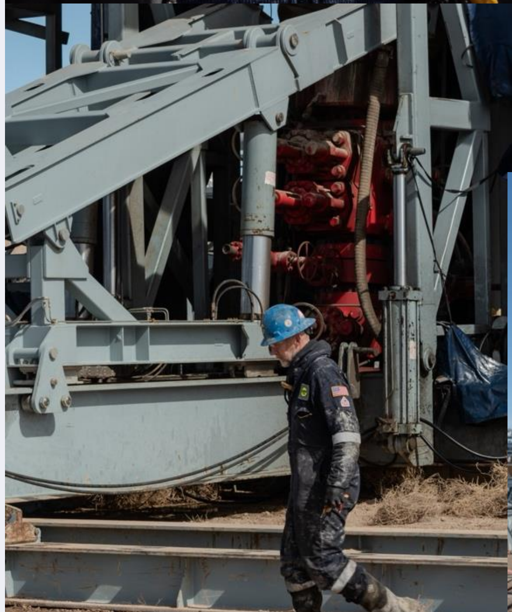
Fervo continues to set the pace for lowering EGS costs, **more than a decade** ahead of NREL's "Advanced Technology" case



Source: Department of Energy Next-Generation Geothermal Power Liftoff Report (2024)

Cape Station ORC 1, December 2025






Thank you.

Ben Serrurier

Director of Government Affairs & Policy

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FERVO ENERGY

PacWave South

Testing Wave Energy for the Future

Justin Klure, Managing Director
Pacific Energy Ventures

Northwest Power and Conservation Council

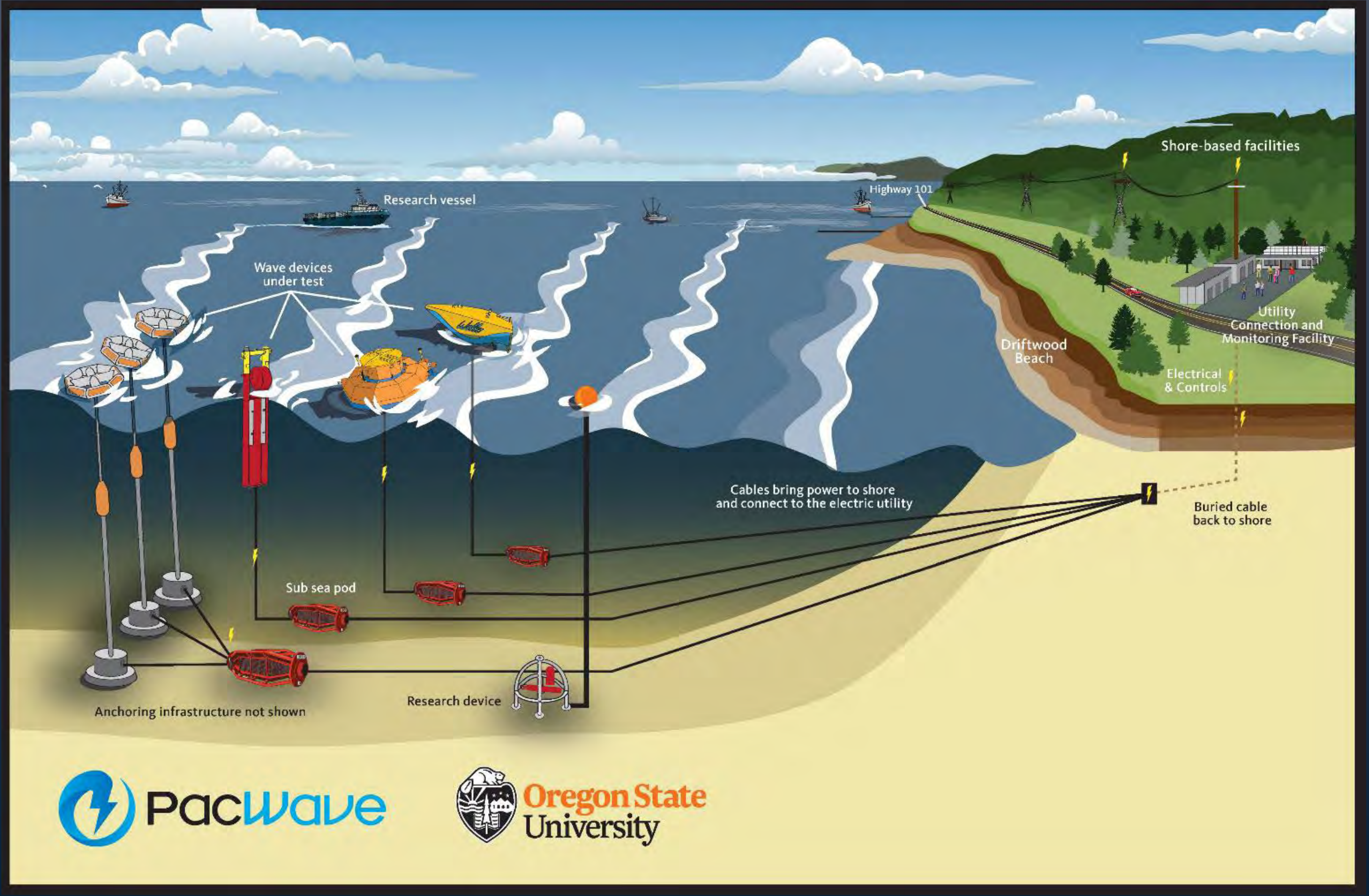
Portland, Oregon
February 10, 2026

What is PacWave?

WET-NZ deployed at PacWave
Photo: Sean Moran

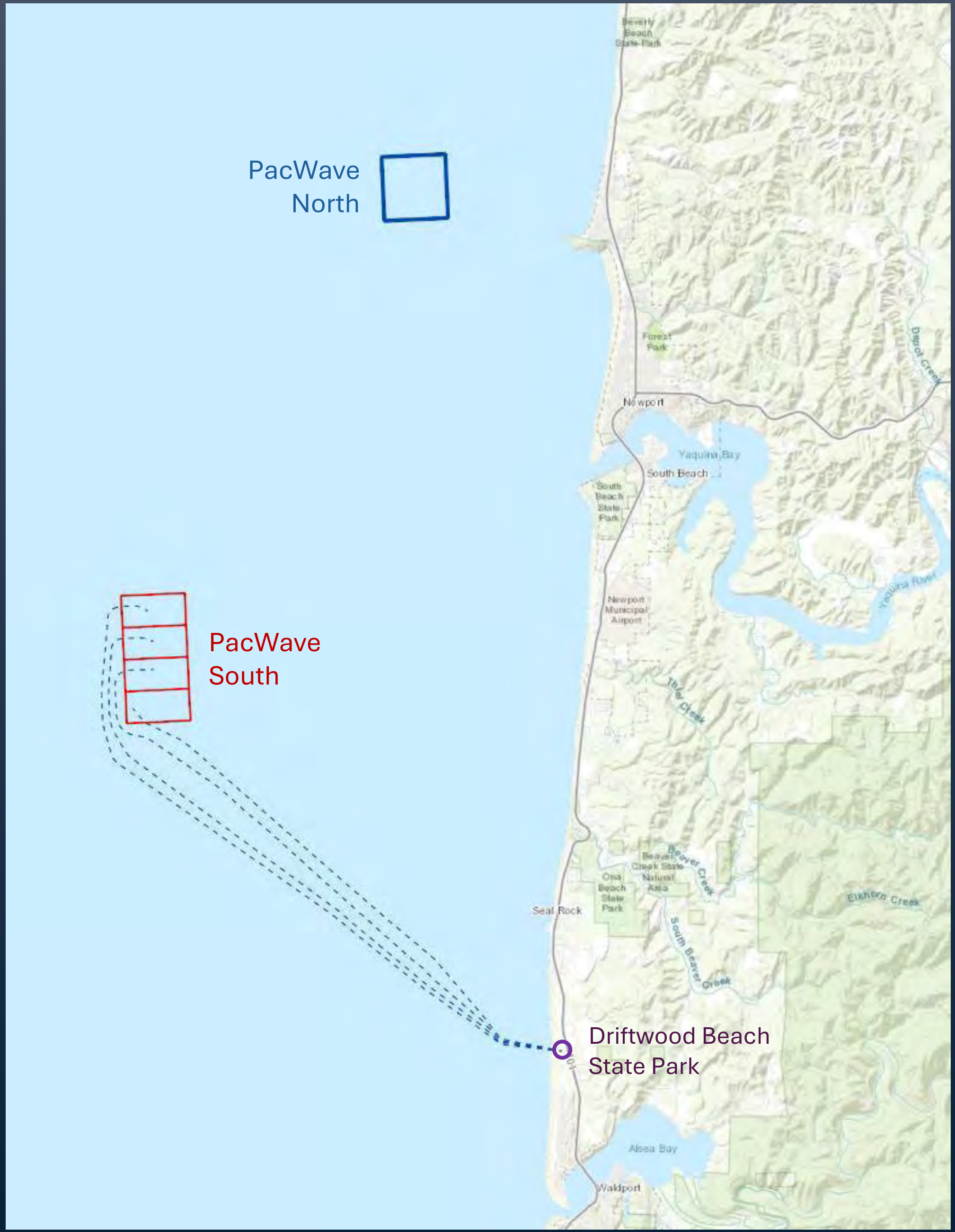
- The only grid-connected, pre-permitted, open ocean wave energy test facility in the U.S.
- Located 7 miles off the coast of Newport, OR
- Developed and operated by Oregon State University
- Primarily funded by the U.S. Department of Energy
- Offers support for testing, R&D, demonstration, and full-scale deployments of wave energy systems and other innovative technologies
- Primary mission: support the national and international marine energy industries on their path to commercialization
- Secondary mission: enable and support research focused on the advancement of marine energy

PacWave Concept



PacWave

PacWave Test Sites

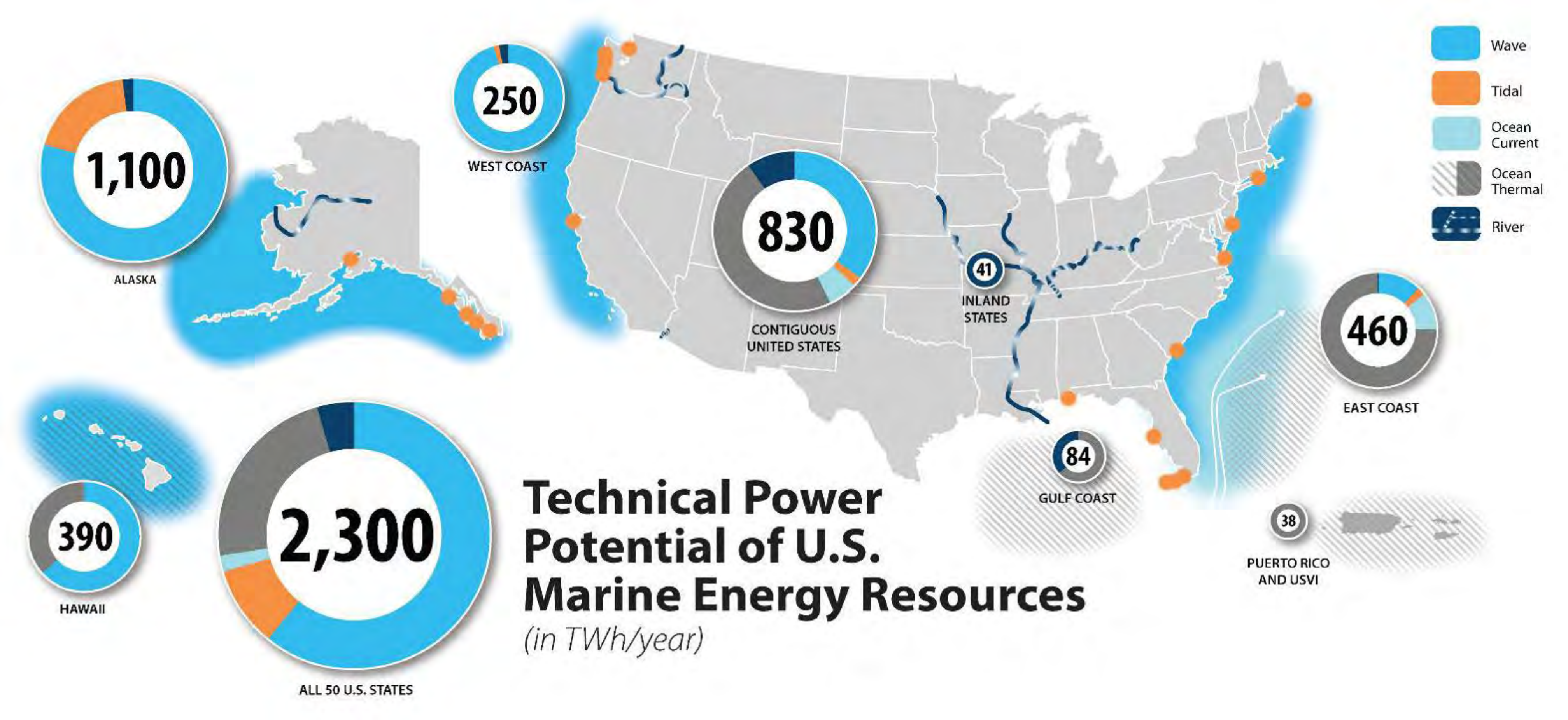


PacWave

Wave Energy Has Significant Potential

- In theory, wave energy off the U.S. could meet over 60% of the country’s utility-scale electricity needs
- Wave energy is considered a highly concentrated energy source:
  - 5 to10 times greater than wind
  - 10 to 30 times greater than solar
- Wave energy can complement wind and solar energy, as wave energy is more consistent than wind and solar, which are intermittent
- Wave energy is more predictable, and therefore reliable than wind or solar

Why Wave Energy?



Marine Energy in the United States: An Overview of Opportunities
National Renewable Energy Laboratory (2021). NREL/TP-5700-78773.
https://www.nrel.gov/docs/fy21osti/78773.pdf.

Wave Energy Challenges

Testing Infrastructure

- Limited testing infrastructure for technology development

Technology Development

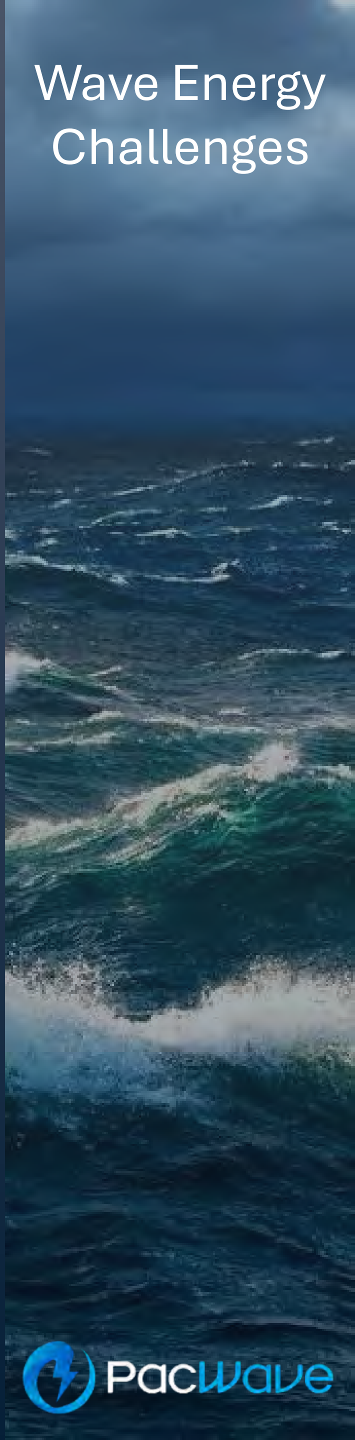
- Lack of technology convergence
- Costs and timeframes associated with emerging marine technologies
- Low cost of competing renewable electricity generation

Regulatory and Environmental

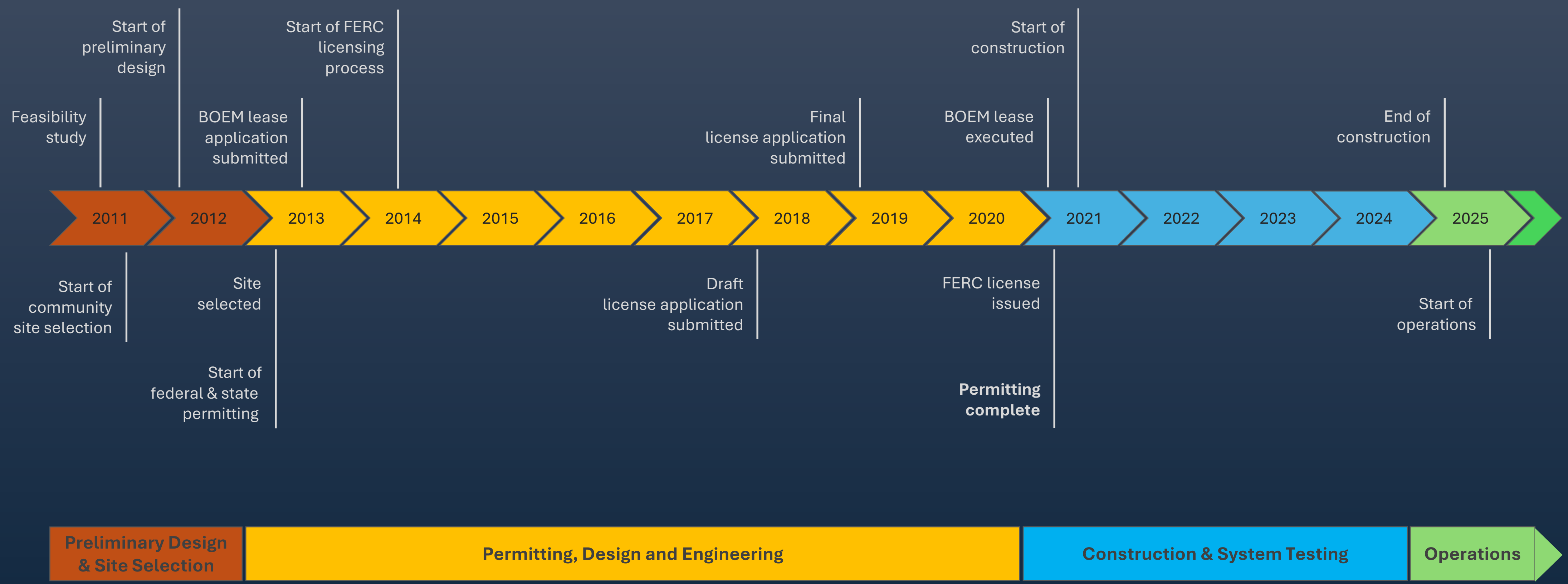
- Perceived environmental uncertainty
- Multiple federal and state agency jurisdictions and regulations

Funding

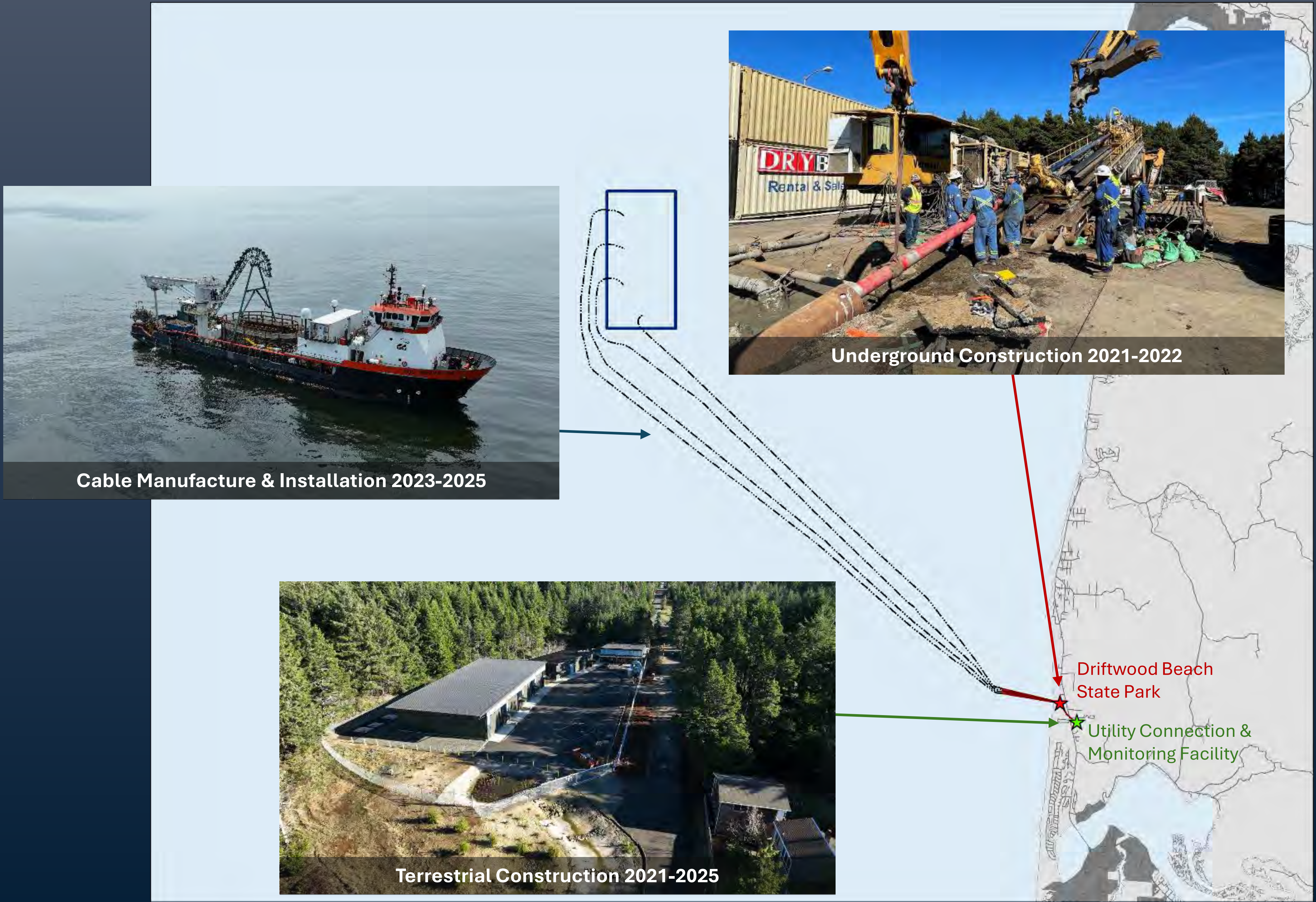
- Limited public and private investment



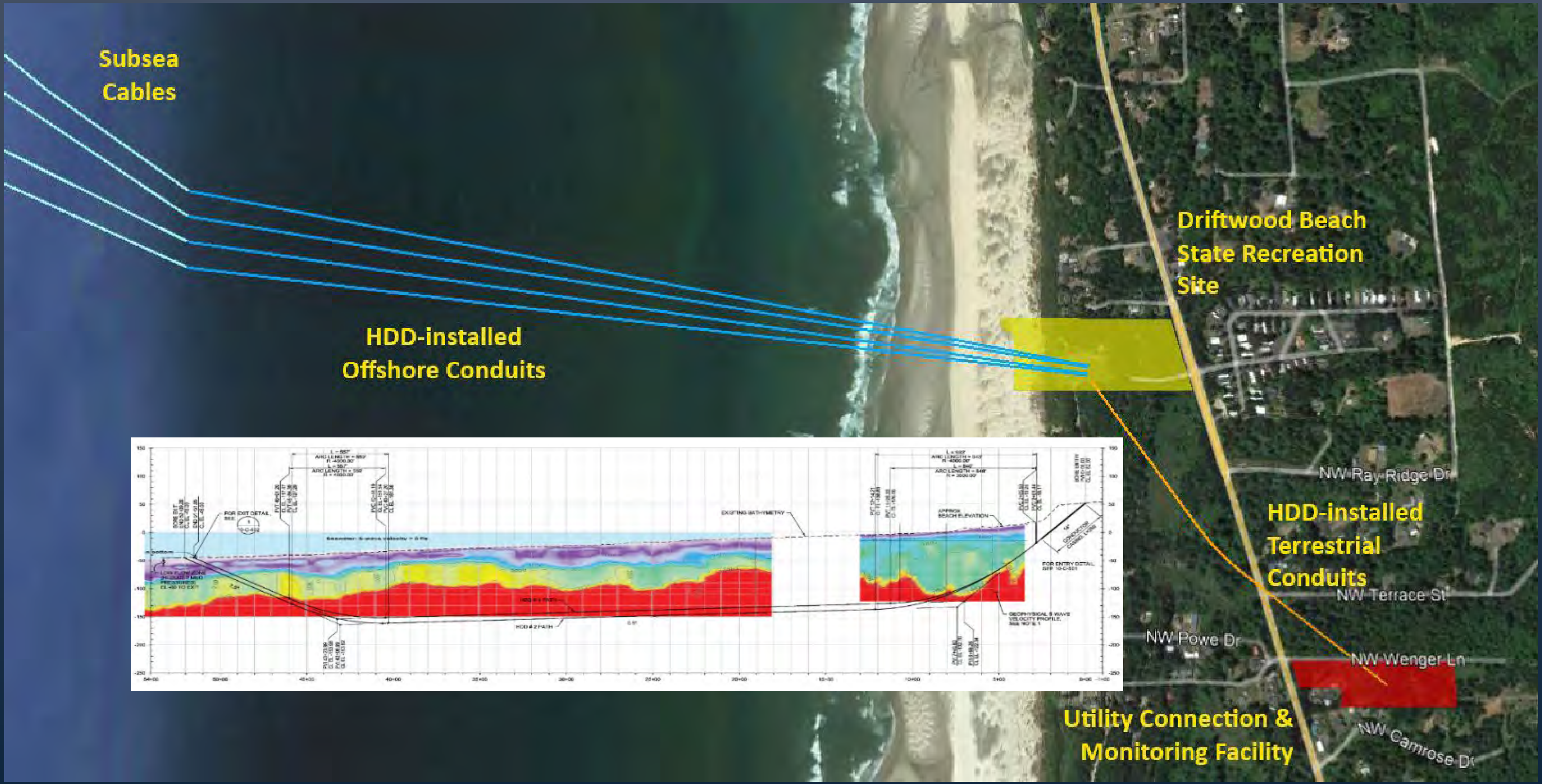
PacWave South Timeline



Construction Phases



Underground Construction



PacWave

Underground Construction

PacWave

Underground Construction

PacWave

Underground Construction

Underground Construction

Underground construction work took almost a year.

A total of 6.2 miles of cable conduit were installed below ground.

Cable Landing Site (Driftwood Beach State Park) – May 2022

PacWave

Underground Construction

PacWave

Terrestrial Construction

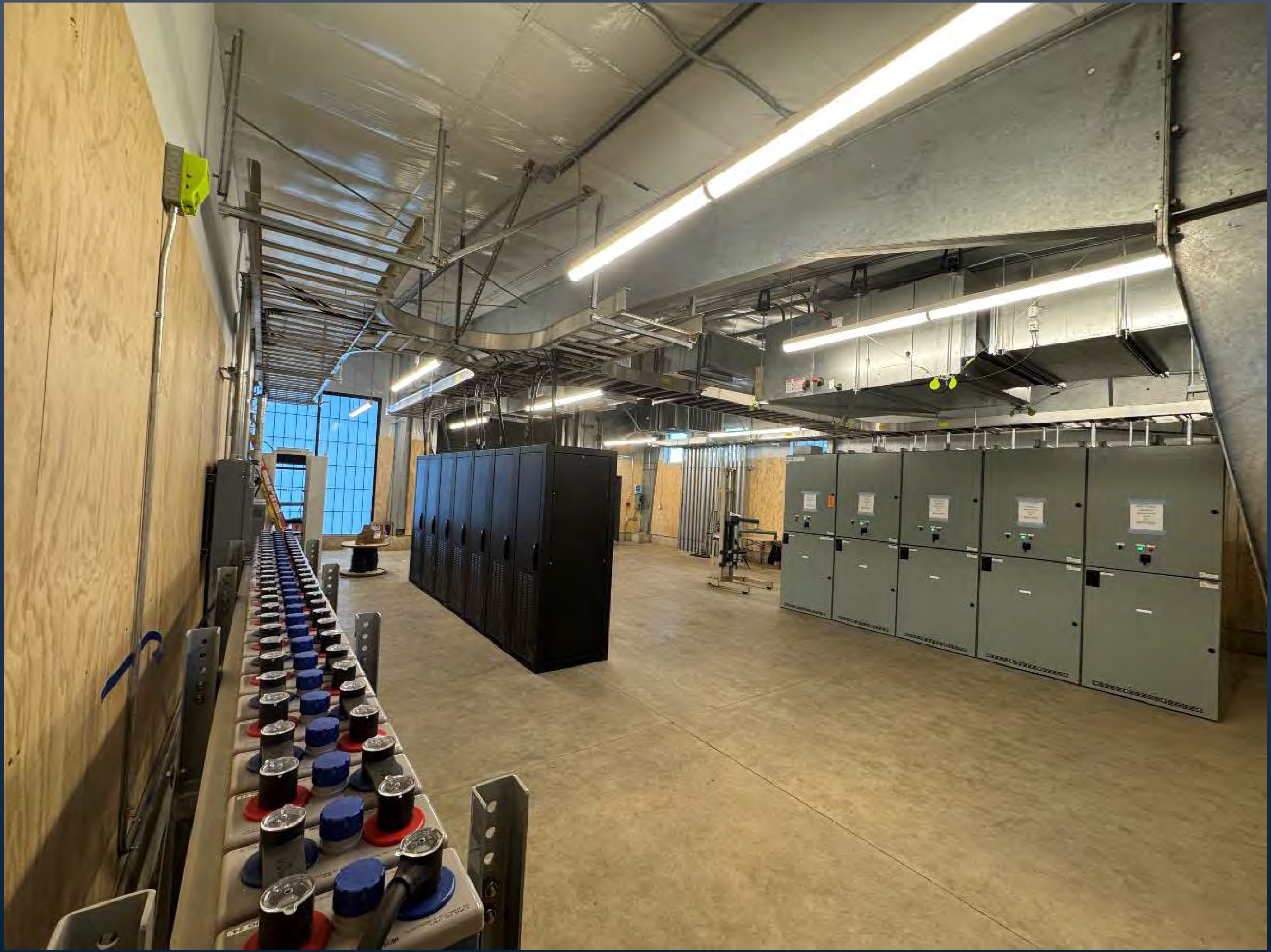
PacWave UCMF – February 2025

PacWave

Terrestrial Construction

PacWave

Terrestrial Construction



Terrestrial Construction

PacWave

- Four subsea & four terrestrial 36 kV AC cables
- Manufactured by Nexans in Norway & Switzerland
- Connectors manufactured by MacArtney in Denmark
- Subsea cables terminated with half a subsea connector
- Shipped from Norway to U.S.

Graphic: Nexans

Cable Manufacture & Installation

PacWave

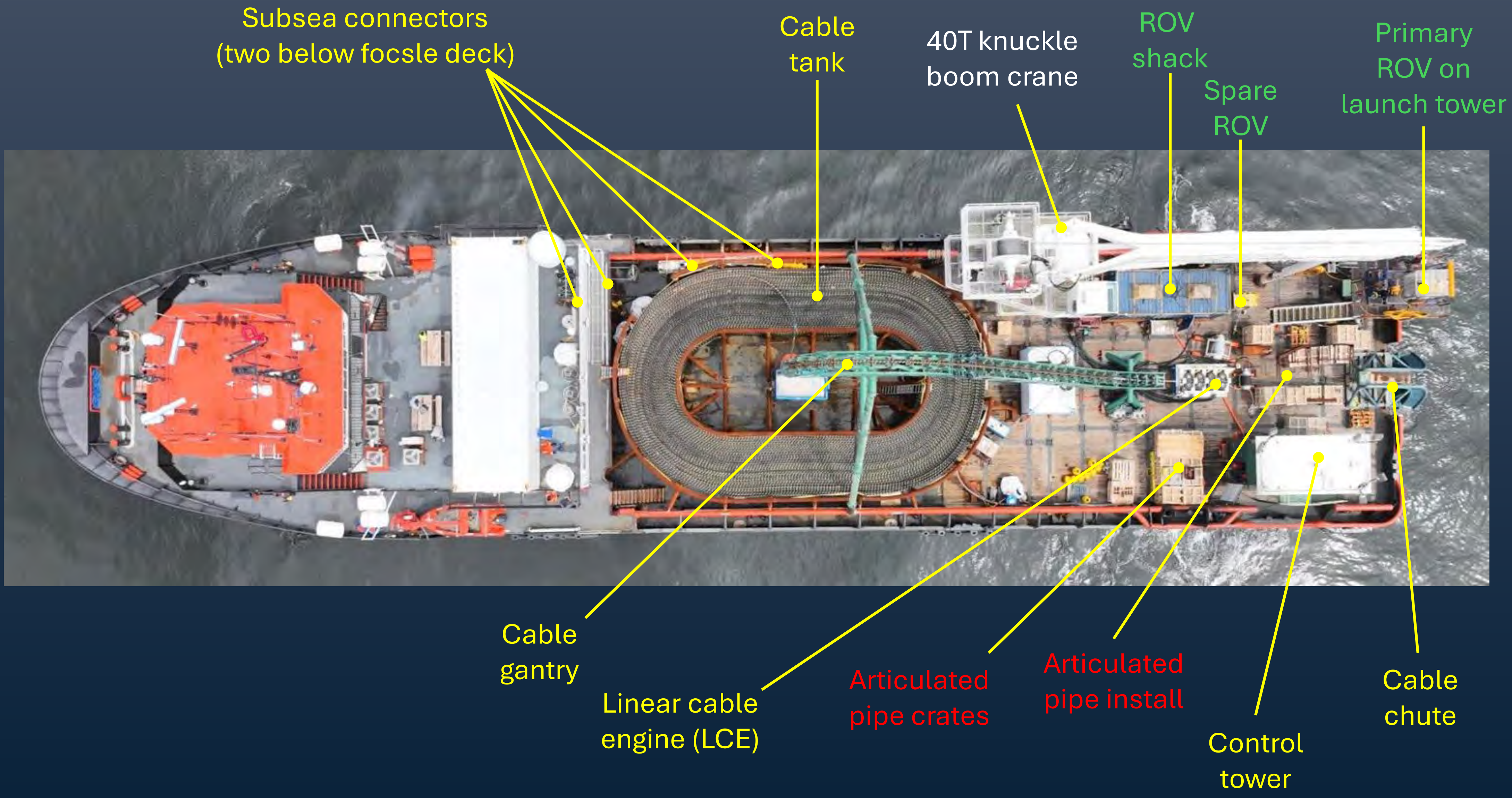
Cable Manufacture & Installation

PacWave

Cable Manufacture & Installation

PacWave

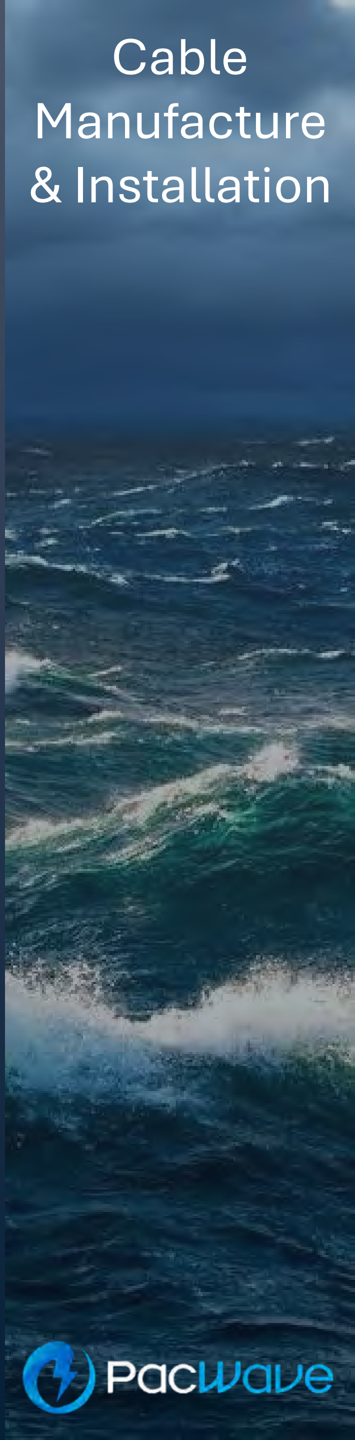
Cable Manufacture & Installation



Cable Manufacture & Installation

PacWave

Cable Manufacture & Installation



PacWave

PacWave Updates

March 19 — Final completion of shoreside construction

April 14 — Final completion of cable installation

March & April — **U.S. Department of Energy** (DOE) **"Go/No-Go" review** of Pacwave

July 17 — **U.S. Secretary of Energy** approval of recommendation for PacWave to move into its operational phase

PacWave

PacWave Updates

August & September	**Cooperative Research & Development Agreements** (CRADA) with the **NREL** and **PNNL** (PNNL)
September 10	**Power Purchase Agreement** with **Bonneville Power Administration**
September 25	**Interconnection Agreement** with the **Central Lincoln People's Utility District**
September 26	**DOE award modification authorizing PacWave to move into its operational phase**

Transitioning to the Operational Phase

Current activities include:

- Seafloor (benthic) habitat and organism monitoring
- Acoustic monitoring
- Wave & current resource characterization
- Planning for WEC deployments at PacWave

Initial Test Clients

▪ CalWave Power Technologies	California	xWave
▪ C.Power	Virginia	SeaRAY
▪ Portland State University & Aquaharmonics	Oregon	

All funded through a 2022 Department of Energy funding opportunity

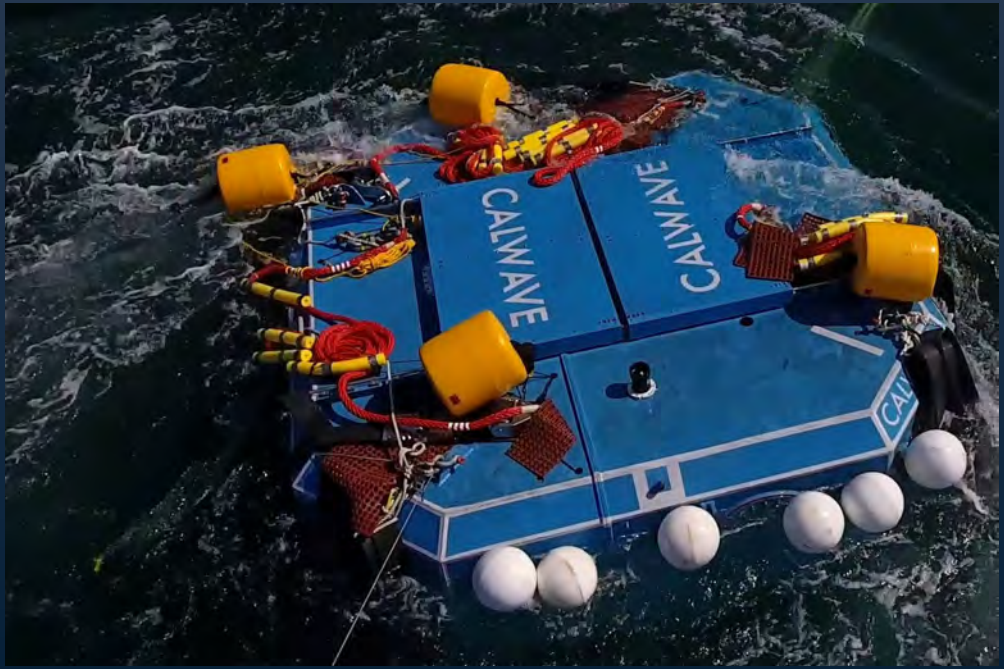
First deployments currently scheduled for summer 2026

Photo: CalWave

Photo: C.Power

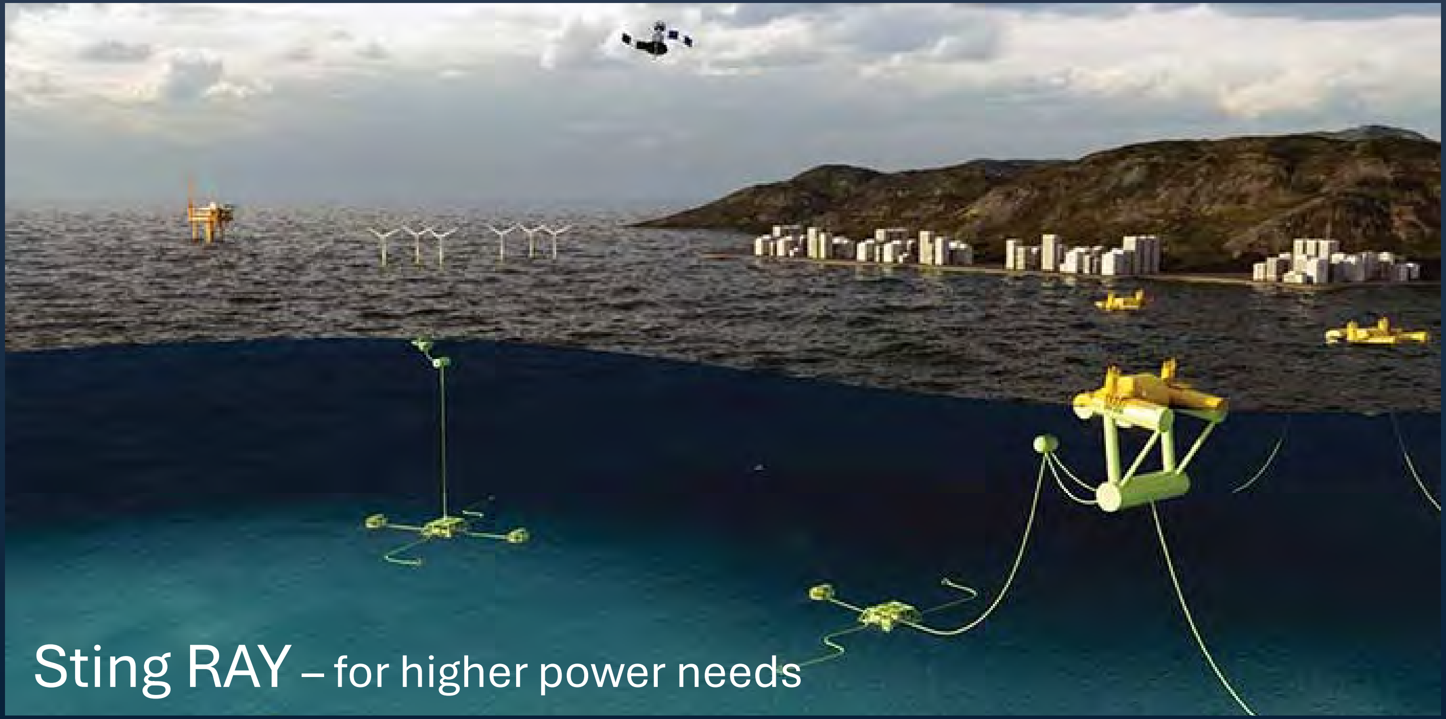
PacWave

CalWave



C.Power

SeaRAY – for lower power needs



Sting RAY – for higher power needs


PacWaveEnergy.org
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