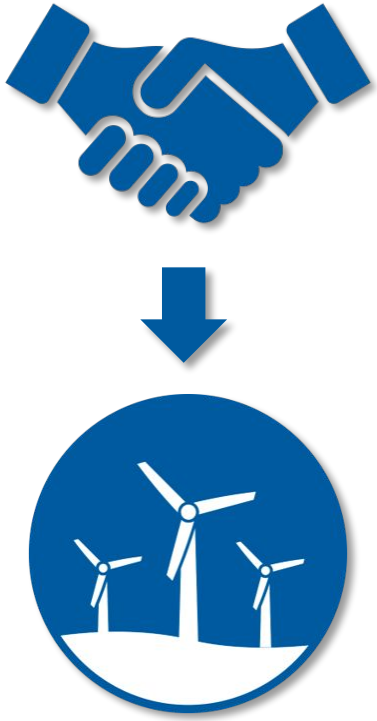
National Offshore Wind Research and Development Consortium

Overview Slides

NOWRDC's Formation

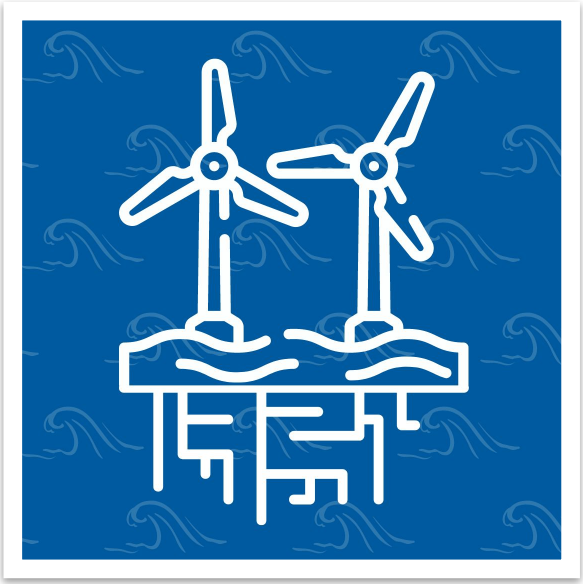
- The National Offshore Wind Research and Development Consortium (NOWRDC) was created in 2018 when the U.S. Department of Energy selected the New York State Energy Research and Development Authority (NYSERDA), to create a new 501©3 non-profit organization to advance offshore wind technology R&D through competitive grants.
- DOE provided initial funding of $20.5 million, which NYSERDA matched to form formed a funding pool of $41 million.
- Since NOWRDC's formation, 7 states, 10 developers, and 10 other public and independent members have joined the Consortium.



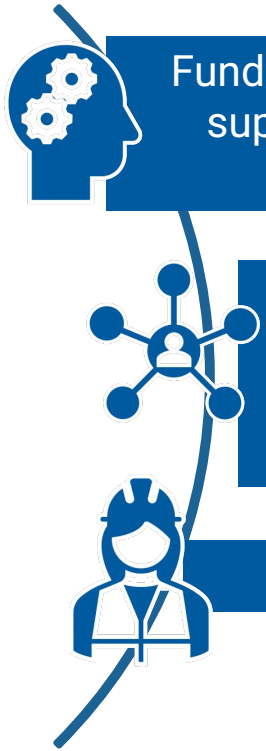
NOWRDC's Mission

NOWRDC is a nationally-focused, not-for-profit organization collaborating with industry to fund prioritized R&D activities to:

- Accelerate the deployment of offshore wind energy in the U.S.
- Address challenges and obstacles facing the offshore wind industry and maximize economic and social benefits.
- Reduce the levelized cost of energy (LCOE) of offshore wind in the U.S.



Our Core Activities



Fund innovation directly responsive to the technical and supply chain barriers faced by offshore wind project developers in the U.S.

Convene strong networks that connect technology innovators, research institutions, project developers, supply chain companies, utilities, and state and federal government agencies

Increase U.S. content and job opportunities

NOWRDC Members and Board

Government & Utilities

Virginia Energy

Massachusetts Clean Energy Center

Maryland Energy Administration

California Energy Commission

New Jersey BPU Board of Public Utilities

Executive Office of the Governor of the State of Maine Energy Office

New York State of Opportunity. NYSERDA

conEdison

Offshore Wind Developers

TotalEnergies

EDF renewables

bp

Ocean Winds

Vineyard Offshore

RWE

Shell

AVANGRID RENEWABLES

Independent Offshore Wind Industry Members

EPRI Electric Power Research Institute

Carbon Trust

DEME Offshore US

Brookhaven National Laboratory

NOWRDC Innovation Funding to Date

2018

Core funding of $41M

$20.5 DOE funds, matched by NYSERDA

2018 - 2024

State funds

Contributed over $9M in additional funding for R&D grants

Present

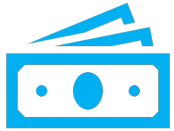
Initial DOE and NYSERDA R&D near full allocation

NOWRDC is increasingly working with state partners on R&D Solicitations

Funding Result:

4 competitive solicitations to date

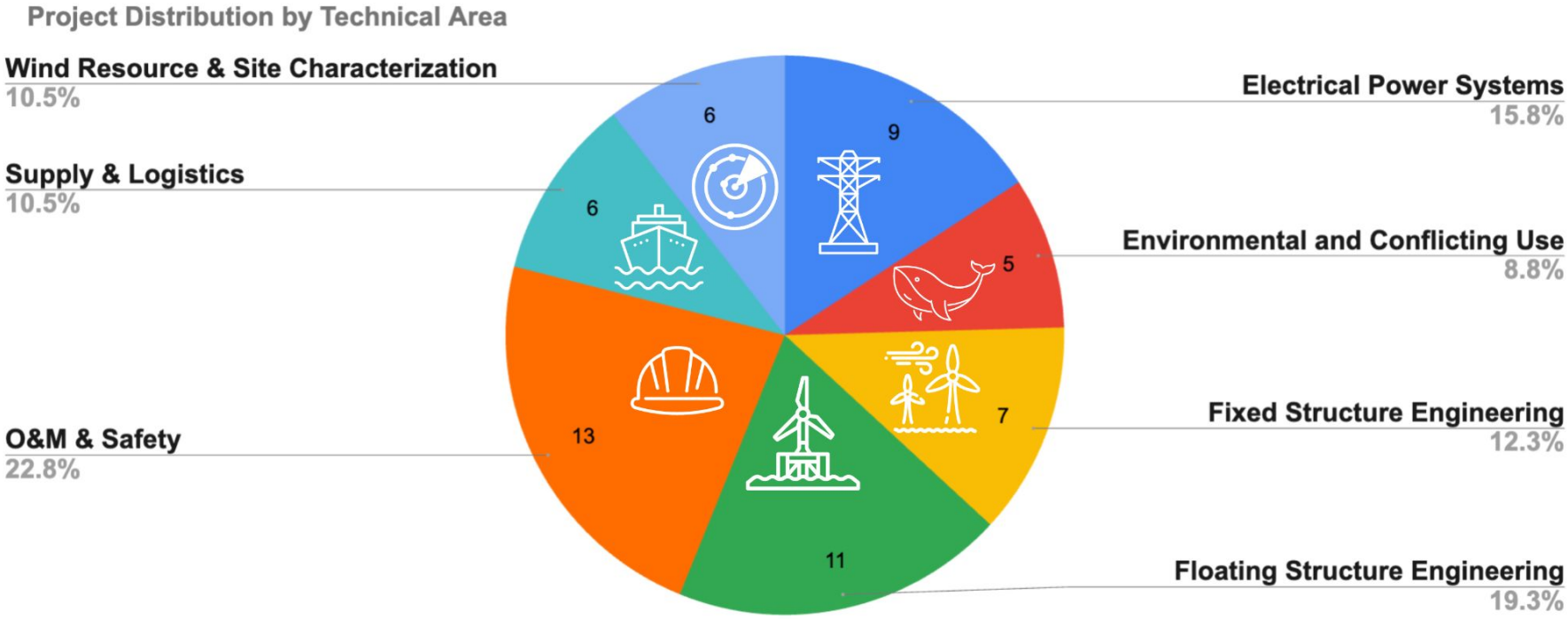
57 project awards



Over $55M in R&D grant funding

Over $6M in programmatic or leveraged funds

R&D Projects Funded to Date



Highlighted Projects

Supply Chain Roadmap for OSW in the U.S.

Project Timeline: Q2 2021 – Q1 2023
Cost Sharing Entity: Maryland
Key Outcomes: The Roadmap supports a unified approach to building a domestic supply chain will be critical for establishing port, vessel, factory, and workforce resources that can be developed in a timely, just, and sustainable way, and identifies the challenges that will have to be overcome to achieve a domestic supply chain.

An OSW Development Strategy to Maximize Electrical System Benefits in Southern Oregon and Northern California

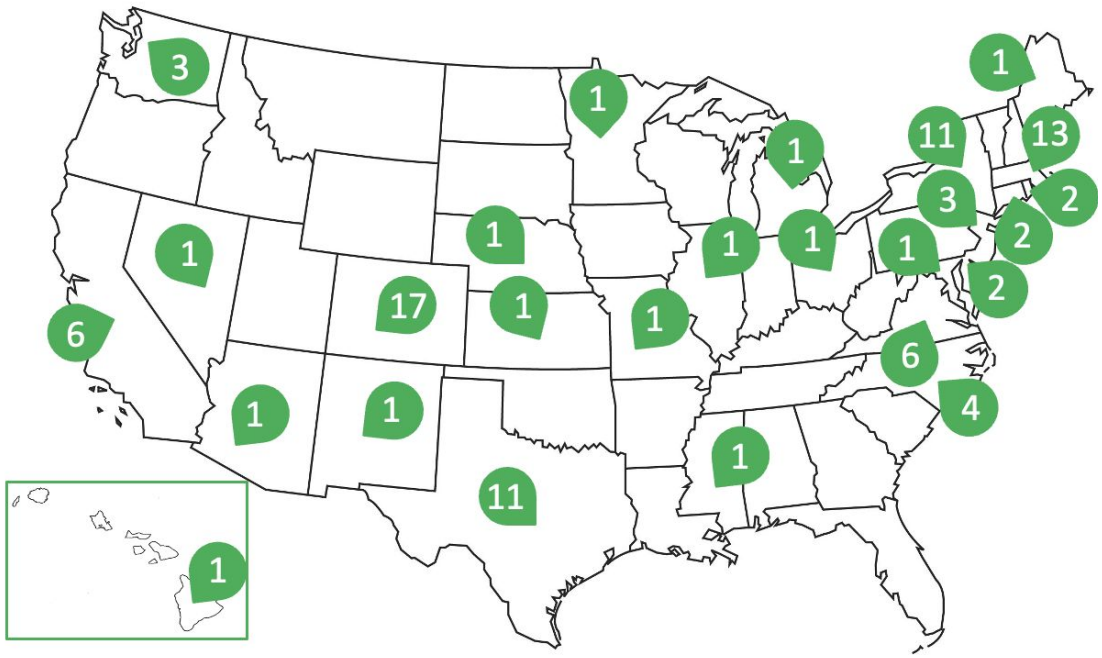
Project Timeline: Q4 2021 – Q3 2023
Cost Sharing Entity: BOEM
Key outcome: This project evaluated and optimized transmission scenarios to deliver offshore wind to west coast load centers. The project demonstrated potential savings of up to $6B annually from a coordinated transmission development approach.

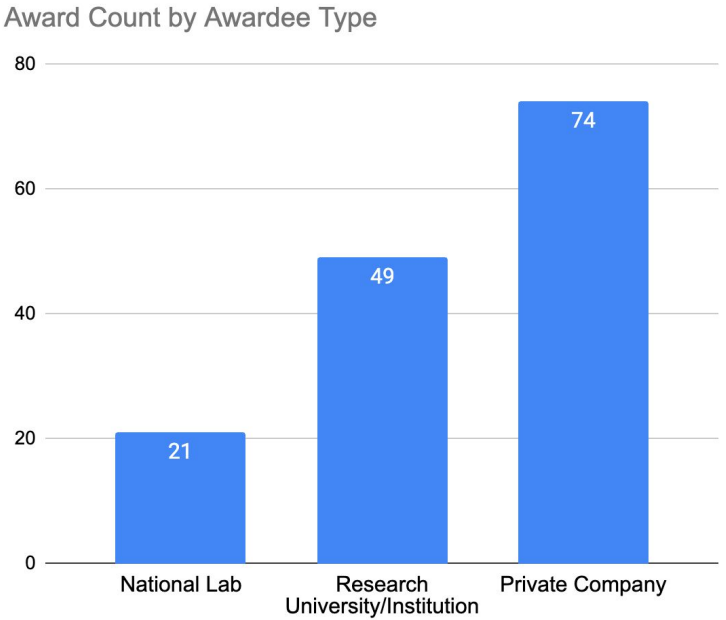
Demonstration of Mooring Components for Floating Offshore Wind

Project Timeline: Q3 2021 – Q3 2024
Cost Sharing entity: Aker Solutions, Principle Power and Technology From Ideas
Key outcome: This project developed, tested, and demonstrated a polymer spring technology to improve mooring modeling capabilities for floating technologies.

Project Map & Awardee Distribution

*Includes prime awardees and subcontractors





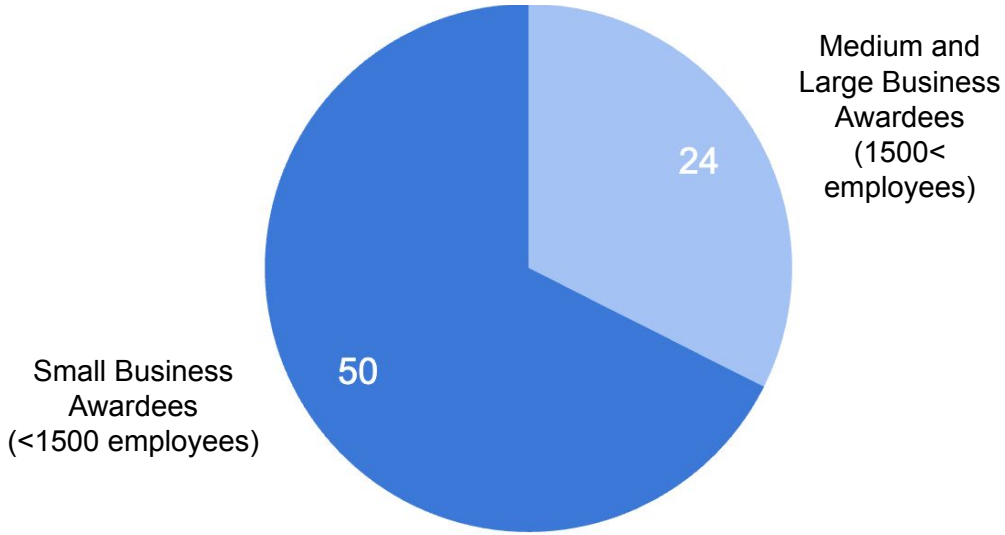
*National Lab awardees include National Renewable Energy Laboratory, Sandia National Laboratory, and Pacific Northwest National Laboratory

Project Map & Awardee Distribution

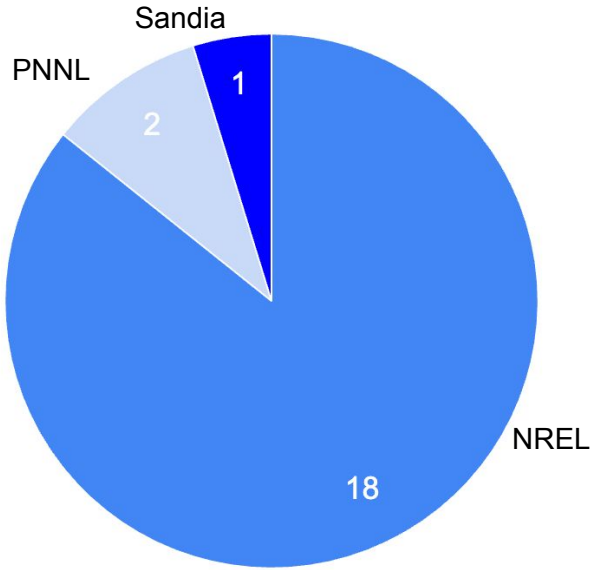
*Includes prime awardees and subcontractors

NOWRDC has successfully engaged small businesses and given them a foothold in the emerging American OSW supply chain.

Private Business Awardees by Business Size



National Lab Awardees by National Lab



Deploying Project Results

NOWRDC has created effective means for sharing project results with the offshore wind industry:

Project Advisory Boards

- Approximately 125 project advisors across NOWRDC's project portfolio, primarily SMEs within OSW developers
- An average of 6 external industry advisors on each project

Project Database

- Accessible repository on NOWRDC's website with key info on all projects for industry to use

Annual National Offshore Wind R&D Symposium

- Multi-day conference showcasing NOWRDC's project portfolio and bringing together researchers to learn from each other
- Over 1,200 registrants for the past two years.
- The fifth annual Symposium was hybrid, in-person in early December 2024 with a virtual livestream option.

NOWRDC’s Project with Crowley Instrumental in South Fork Wind Farm

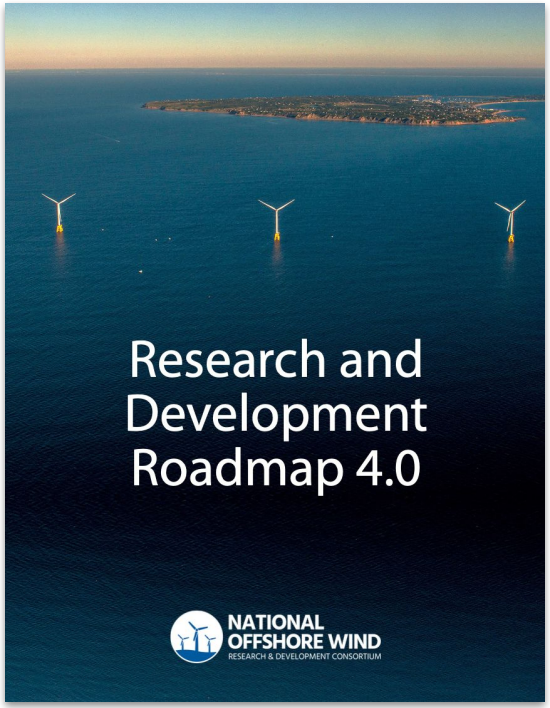
The NOWRDC Project: NOWRDC’s project with Crowley, "Technical Validation of Existing U.S. Flagged Barges as a 'Feeder' Solution for the U.S. Offshore Wind Industry," focused on the feasibility of using minimally modified U.S.-flagged barges, accompanied by tugs, to efficiently deliver WTGs to WTIVs offshore.

The Findings: A Cargo Feeder System (CFS) comprising a lead tug, a deck cargo barge loaded with WTG components, and a support tug can effectively deliver to WTIVs, enhancing the installation process. This approach not only streamlines operations but significantly reduces downtime and costs, leveraging existing vessels to keep WTIVs continually erecting wind generators.

The Deployment: Thanks to this innovative "feeder" solution, Crowley successfully transported WTGs for the 132 MW South Fork Wind Farm, utilizing U.S.-flagged vessels and operated by the skilled members of the Seafarers International Union.

Research and Development Roadmap 4.0

- NOWRDC's R&D Roadmap serves as our overarching technical guidance document
- Specifically focused on technology advancement in 3 pillars:
  - Pillar 1: Offshore Wind Farm Technology Advancement
  - Pillar 2: Offshore Wind Power Resource and Physical Site Characterization
  - Pillar 3: Installation, Operations and Maintenance, and Supply Chain
- The Roadmap is updated approximately every 2 years
- Version 4.0 was released in April 2023, and Version 5.0 is under development and set to be published Q4 2025



New Project Approaches - Novel Approaches to Delivering on Mission

SMART-POWER Workforce and Supply Chain Analysis

NOWRDC is leading a regional offshore wind workforce assessment and supply chain roadmap with SMART-POWER states Virginia, Maryland, Delaware, and North Carolina.

Offshore Wind Innovation Hub

The Offshore Wind Innovation Hub accelerates startup commercialization and fosters community collaboration in New York, with NOWRDC supporting since inception through solicitation review, administrative support, and industry connections.

New Project Approaches - Novel Approaches to Delivering on Mission

Inter-array Wake Impacts Joint Industry Project (JIP)

NOWRDC is working with NREL on a state and industry funded JIP better characterizing inter-array wake impacts on the US East Coast.

Joint Solicitation with Innovate UK

In 2023, NOWRDC ran a joint competitive solicitation with Innovate UK and US state funding - partnering UK and US research teams to solve global OSW industry challenges.

NOWRDC'S Broad Impact

To date, NOWRDC has funded **55 research projects**, with **39 now completed**. Upon project completion, we collect both **quantitative reports** and **testimonial feedback**.

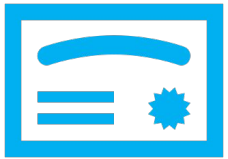
With enough projects now closed out, we have been able to conduct a comprehensive review of how our funding influences individual projects and the broader offshore wind industry.

Following is a summary of our impact assessments, presented in three key areas:

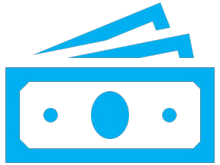
1. **High-Level Summary Statistics:** Overview of portfolio distribution, TRL & CRL advancements, matched funding, and more.
2. **LCOE Impact:** A detailed analysis of LCOE impacts, with a link to the full report available in our resources tab.
3. **Project PI Testimonials:** Insights from project leaders on how NOWRDC funding has supported their work and contributed to project success.

NOWRDC Funding and Competitive Solicitations

4 competitive solicitations to date



57 project awards



Over $55M in R&D grant funding

Over $6M in programmatic or leveraged funds

Goals of the funding:

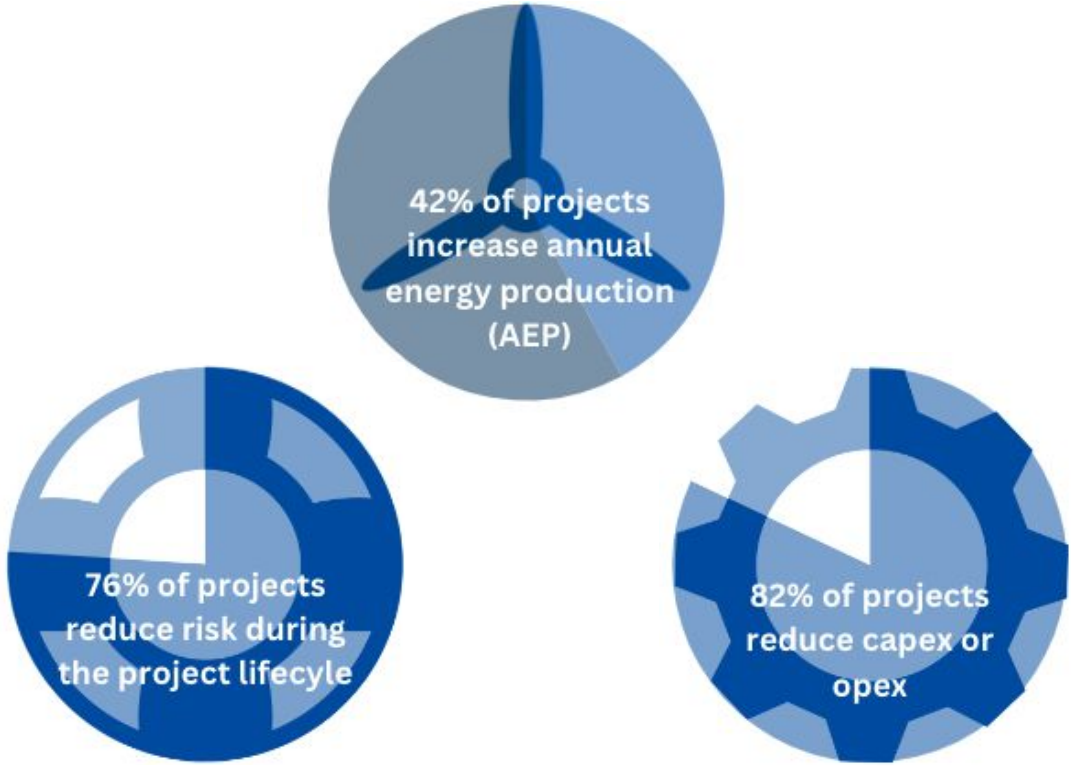
- Accelerate the deployment of offshore wind energy in the U.S.
- Address challenges and obstacles facing the offshore wind industry and maximize economic and social benefits.
- Reduce the levelized cost of energy (LCOE) of offshore wind in the U.S.

High Level Impact Stats

NOWRDC-funded projects have, on average, advanced by:

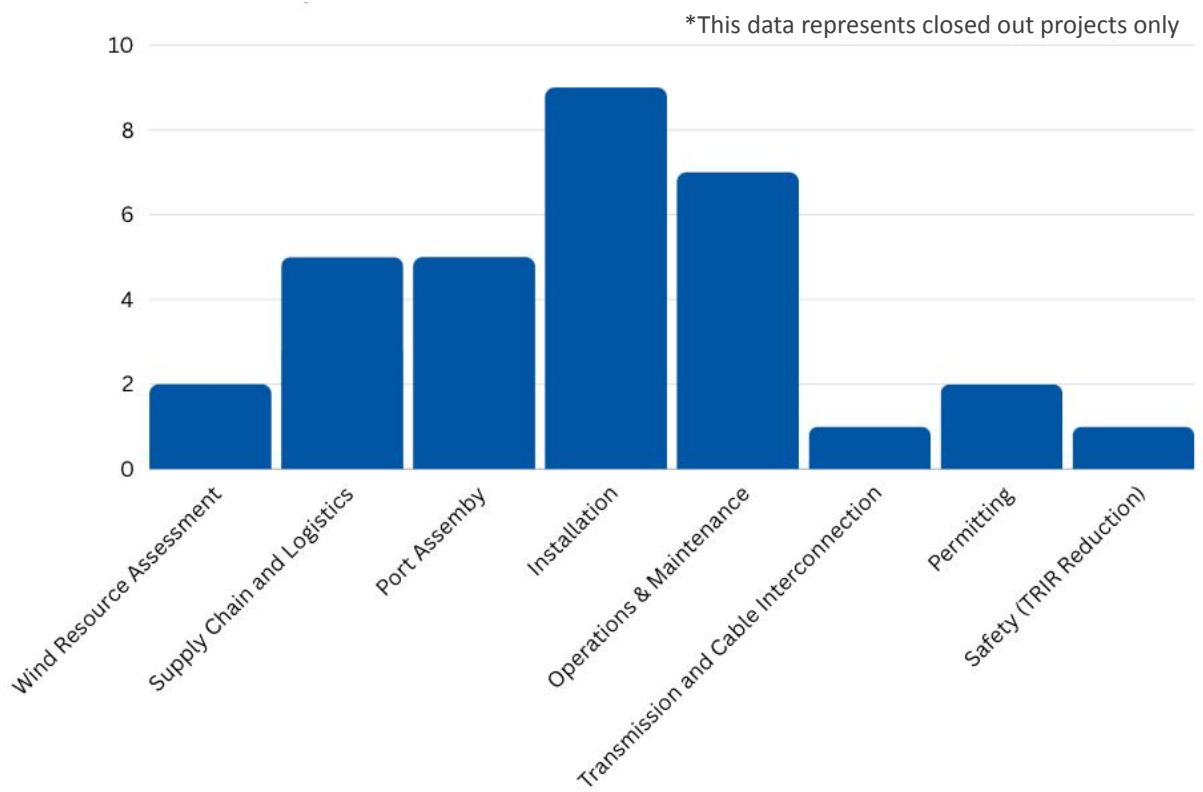
3 levels on the Technology Readiness Level (TRL) scale

1.5 levels on the Commercial Readiness Level (CRL) scale



NOWRDC Project #s Across OSW Project Development Stages

NOWRDC's research and development funding has significantly impacted each stage of offshore wind project development, with the **greatest advancements seen in Installation and Operations & Maintenance.** By driving innovation and reducing costs, NOWRDC is accelerating the industry from concept to commercial deployment.

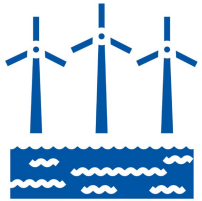


LCOE Impact

NOWRDC has assessed the impact its closed out project awards have had on the levelized cost of energy (LCOE) and annual energy production (AEP) metrics of offshore wind in the US.

NOWRDC modeled innovation deployment across three hypothetical baseline wind farms:

Nearshore fixed bottom



Farshore fixed bottom

West Coast floating site

Across each case, deploying NOWRDC-funded innovations led to:

Significant **LCOE reductions** ranging from **3-9.5%,**

and increases in **AEP** ranging from **1.5-3.5%.**

LCOE Impact

NOWRDC has prioritized projects that have the potential to significantly reduce the Levelized Cost of Energy (LCOE), a critical metric that determines the economic viability of offshore wind energy.

These selected projects represent cutting-edge innovations and strategies across multiple areas, including technology development, operational efficiency, and cost reductions in both capital expenditures (CapEx) and operational expenditures (OpEx).

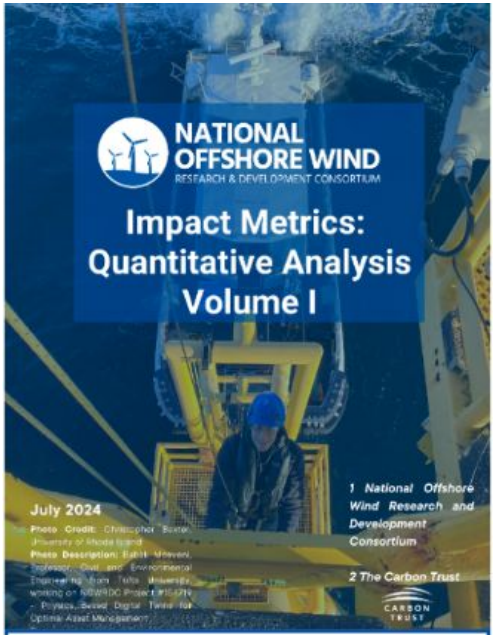
Each project highlighted in the following slides was rigorously modeled to assess its potential impact on LCOE, ensuring that these advancements will help make offshore wind energy more competitive and scalable.

Metrics Analysis Conclusions

Through this metrics assessment exercise we have been able to provide a high level takeaway about the impact of the innovations supported by NOWRDC funding. These results go to show that the **US innovation landscape is strong and varied,** and with the right support can achieve a real impact on the US offshore wind industry. NOWRDC provides a **targeted and impactful source of funding** across many technical areas and to entities across the nation, whose research work is the key to being able to arrive at these results. While this captures just a small portion of our portfolio, the analysis demonstrates strong potential impact on the industry.

This was the first iteration of this analysis, and updates and revision are anticipated for the future. We anticipate being able to add even more impactful innovations into this broader analysis as the consortium's closed out project portfolio grows. Updates may include new baseline areas, such as the Gulf of Maine, where more geographically specific technologies may provide an increased impact.

If you are interested in helping us with this work in the future please reach out to Julian Fraize, at julian.fraize@nationaloffshorewind.org.



NOWRDC's Qualitative Impact - Testimonials

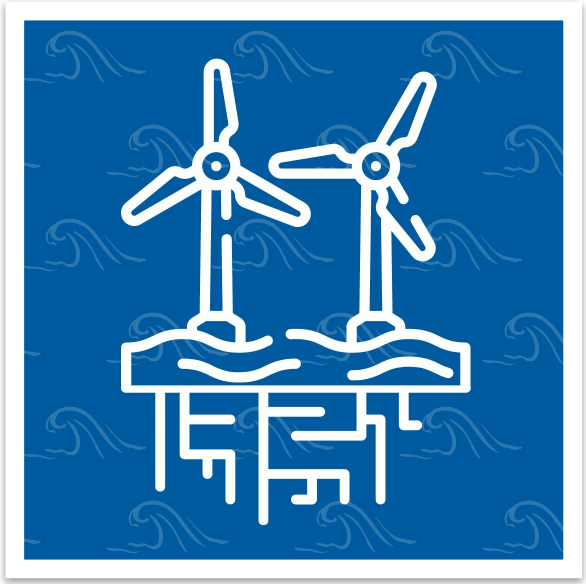
Project leaders across the offshore wind industry have highlighted the invaluable support and collaboration facilitated by NOWRDC, emphasizing how the partnership has accelerated innovation and fostered groundbreaking solutions. Beyond measurable outcomes, these testimonials showcase the qualitative benefits of working with NOWRDC, such as enhanced industry connections, access to specialized expertise, and the ability to take on ambitious projects that may not have been feasible otherwise.

"Working with NOWRDC was incredibly useful as it presented us **unique opportunities** to learn about other developments in OSW technologies and s**hare lessons learned with others in the field.** As a NOWRDC awardee we also learned how to present a united front from a technology perspective when talking to the industry. Finally, a major benefit of working with NOWRDC was **access to a project advisory board of very interested experts."**

- Mary Coyne; Anduril. Project 129: Fully Autonomous Subsea Asset Inspection by a Shore-Launched AUV.

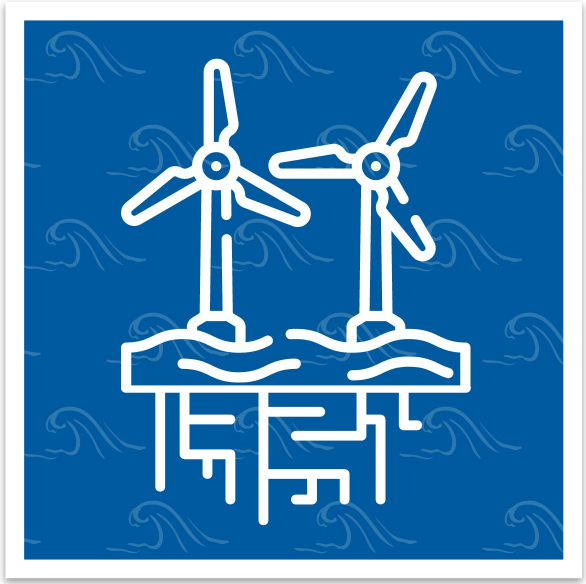
Industry Member Benefits

- Ability to identify industry needs to steer NOWRDC's R&D funds and resulting project awards
- Participation in NOWRDC network comprised of federal, state, and industry partners that provide value beyond technical R&D
    - Main points of interaction include Board of Directors (quarterly), R&D Committee (monthly), and project advisory boards (opt-in per project, quarterly)
- Real time access to technical innovation and direct connection with technology developers (full awardee list linked here)



State Member Benefits

- Participation in Board of Directors, R&D Committee, and State Action Network
  - Network connections that provide value beyond technical R&D
- Ability to steer NOWRDC's R&D agenda and resulting project awards
- Opportunities to leverage funding and form collaborative innovation programs with other states and countries



Thank you

NOWRDC's full project database is available here:
https://nationaloffshorewind.org/project-database/

NATIONAL OFFSHORE WIND
RESEARCH & DEVELOPMENT CONSORTIUM

Appendix I: NOWRDC Projects by Technical Challenge Area

NOWRDC Projects: Transmission and Grid Stability

Contractor	Project Title
NREL	Development of Advanced Methods for Evaluating Grid Stability Impacts
PNNL	An Offshore Wind Energy Development Strategy to Maximize Electrical System Benefits in Southern Oregon and Northern California
GE Research	DC Collection and Transmission for Offshore Wind Farms
Tufts University	Transmission Expansion Planning Models for Offshore Wind Energy
Offshore Wind Consultants	Shared Landfall and Onshore Cable Infrastructure for Cable Colocation Feasibility Study
ThayerMahan	Transmission and Export Cable Fault Detection and Prevention Using Synthetic Aperture Sonar
University of Michigan	Robust Stabilization of Subsea Power Cables using Nonlinear Energy Sinks
Clarkson University	Atlantic seaboard offshore stability risk evaluation & service
Rutgers University	AIRU-WRF: AI-powered Physics-based Tool for OSW Forecasting and Grid Integration
EPRI	Offshore Wind Black-Start Feasibility Framework for System Restoration Planning
NREL	Development of Advanced Methods for Evaluating Grid Stability Impacts

NOWRDC Projects: Ocean Area Coexistence

Contractor	Project Title
CODAR Ocean Sensors LTD	Oceanographic HF Radar Data Preservation in Wind Turbine Interference Mitigation
Advisian	Technology Development Priorities for Scientifically Robust and Operationally Compatible Wildlife Monitoring and Adaptive Management
Cornell University	Right Wind: Resolving Protected Species Space-Use Conflicts in Wind Energy Areas
Saildrone	Renewable Powered, Uncrewed Mobile Assets to Monitor Protected Marine Mammals
NREL	Co-Design Solutions for U.S. Floating Offshore Wind and Fishing Compatibility

NOWRDC Projects: Fixed Structure Engineering

Contractor	Project Title
ESTEYCO SL	Self-Installing Concrete Gravity-Base Substructure Sizing for 15MW Turbine
Texas A&M	Vibratory-Installed Bucket Foundation for Fixed Foundation Offshore Wind Towers
Keystone Tower Systems	Tapered Spiral Welding for US Offshore Wind Turbine Towers
DEME Offshore US LLC	Tri-Suction Pile Caisson Foundation Concept
RCAM Technologies	A Low-Cost Modular Concrete Support Structure and Heavy Lift Vessel Alternative
Stony Brook University	Computational Control Co-design Approach for Offshore Wind Farm Optimization
NREL	Wind Farm Control and Layout Optimization for U.S. Offshore Wind Farms

NOWRDC Projects: Floating Structure Engineering

Contractor	Project Title
PCCI, Inc.	Quarter Scale Testing of the Intelligent Mooring System for FOWT Platforms
ESTEYCO	Evolved Spar Concrete Subconstructure for Floating Offshore Wind US-Based Design
Deep Reach Technology	Application of Novel Offshore Oil & Gas Platforms to Large Wind Turbines
Virginia Tech	Dual-Functional Tuned Inerter Damper for Enhanced Semi-Sub Offshore Wind Turbine
NREL	Standardized Scalable Mooring Solutions Optimized for the U.S. Supply Chain
NREL	Shared Mooring Systems for Deep-Water Floating Wind Farms
Principle Power, Inc.	Innovative Deepwater Mooring Systems for Floating Wind Farms (DeepFarm)
Principle Power, Inc.	Demonstration of Shallow-Water Mooring Components for FOWTs (ShallowFloat)
UMass Amherst	Techno-Economic Mooring Configuration and Design for Floating Offshore Wind
Triton Systems, Inc	Innovative Anchoring System for Floating Offshore Wind
University of Maine	Design and Certification of Taut-synthetic Moorings for Floating Wind Turbines

NOWRDC Projects: O&M and Safety

Contractor	Project Title
EPRI	Verifying OSW Turbine Blade Integrity During Manufacture
GE Renewable Energy	Self-Positioning Single Blade Installation Tool
GE Research	Autonomous Vessel-Based Multi-Sensing System for Inspection and Monitoring
UMass Lowell	A Novel Structural Health Monitoring System for Offshore Wind Turbine
Anduril Industries Inc.	Fully Autonomous Subsea Asset Inspection by a Shore-Launched AUV
Tagup Inc.	Survival Modeling for Offshore Wind Prognostics
GE Research	Enabling Condition Based Maintenance for Offshore Wind
GE Research	Radar Based Wake Optimization of Offshore Wind Farms
Tufts University	Physics Based Digital Twins for Optimal Asset Management
UMass Lowell	Offshore Wind Turbine Blade Monitoring Using Computer Vision and AI
Tufts University	Novel Fluid Film Bearing for Wind Turbines Main Bearing Application

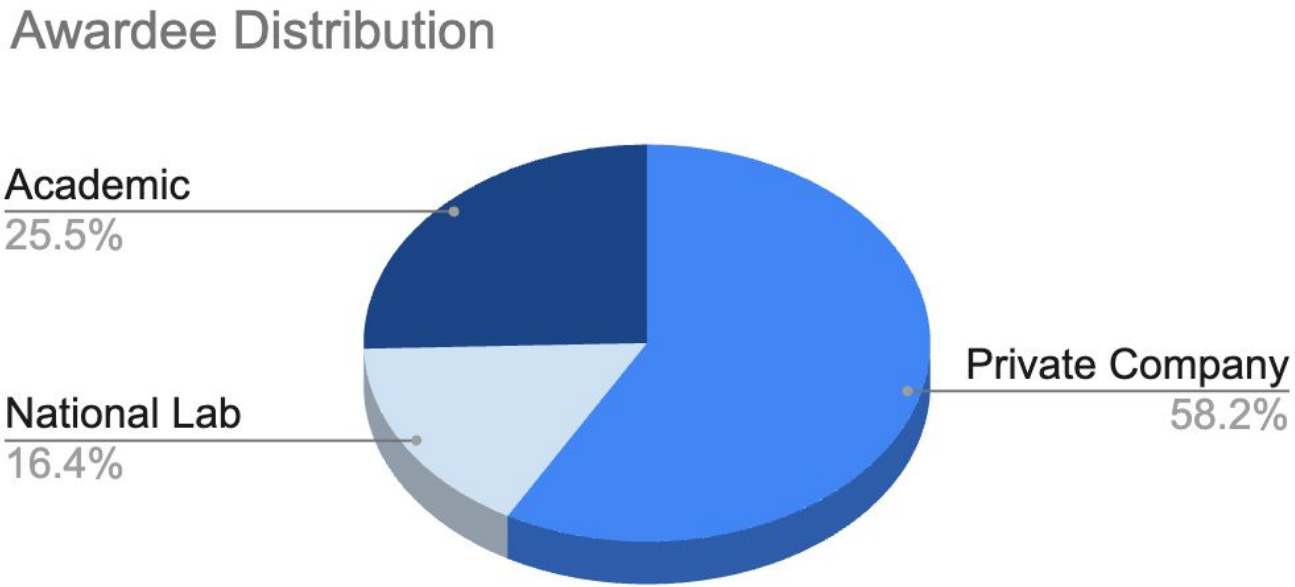
NOWRDC Projects: Supply and Logistics

Contractor	Project Title
NREL and BNOW	30GW by 2030: Supply Chain Roadmap for Offshore Wind in the US
Crowley	Technical Validation of Existing U.S. Flagged Barges as a “Feeder” Solution for the U.S. Offshore Wind Industry
Exmar Offshore Company	Feasibility of a Jones Act Compliant WTIV Conversion
MARIN USA	Comparative Operability of Floating Feeder Solutions
GE Renewable Energy	Weld Assembly of Large Castings
NREL	SMART-POWER Workforce and Supply Chain Analysis

NOWRDC Projects: Wind Resource and Site Characterization

Contractor	Project Title
NREL	A Validated National Offshore Wind Resource Dataset with Uncertainty Quantification
GE Research	Impact of Low Level Jets on Atlantic Coast Offshore Wind Farm Performance
Cornell University	Reducing LCoE from Offshore Wind by Multiscale Wake Modeling
WHOI	Development of a Metocean Reference Site near the MA & RI Wind Energy Areas
Northeastern University	Long-Term Availability and Bankability of Offshore Wind Through Hurricane Risk Assessment and Mitigation
NREL	Assessment of Cluster Wakes Impacts to Optimize U.S. Atlantic Offshore Wind Energy Area Development

R&D Projects Funded to Date



Appendix II: NOWRDC Board Members and Staff

NOWRDC Board Members

Elizabeth Andrews –
Director, Offshore Development

James Battensby – Technology & Innovation Lead

Sam Aronson –
Director emeritus

Jan Matthiesen – Director, Offshore Wind and Maritime Decarbonisation; **NOWRDC R&D Committee Chair**

Stuart Nachmias – President and CEO of Con Edison Transmission; **NOWRDC Board Treasurer**

Jan Klaasen –
Business Unit Director

NOWRDC Board Members

Antoine Cognard – Vice President, Offshore Projects Delivery

Ron Schoff – Director, Renewable Energy & Fleet Enabling Technologies; **NOWRDC Board Vice Chair**

Rebecca Ullman – Head of External Affairs; **NOWRDC Board Secretary**

Jenny Briot – Senior Director, Business Development

Ruth Perry – Head of Regulatory Affairs, Offshore Power Americas

Joanne Langsdorf – Offshore Wind Business Developer

NOWRDC Board Members

Carrie Hitt – Senior Director, Grid and Transmission Policy

Robert Catell – Chairman, Advanced Energy Research and Technology Center

Vince Maiden – Director, State Energy Office

Adrienne Downey – Director of Offshore Wind at Power Advisory LLC; **NOWRDC Board Chair**

John Bruckner – Former President, National Grid, New York; **NOWRDC Executive Committee member**

NOWRDC Board Members

Eric Coffman –
Director of Energy Programs

Lisa Engler –
Deputy Managing Director,
Offshore Wind

Kevin Uy – Manager, Energy Supply Branch, Energy Research and Development Division

Robert Brabston –
Executive Director

Doreen Harris –
President and CEO

Celina Cunningham – Deputy Director, Governor's Energy Office

NOWRDC Core Staff

Lyndie Hice-Dunton, PhD
Executive Director

Julia Dombroski, PhD
Offshore Wind Innovation Hub Associate

Kori Groenveld
Senior Program Manager

Christine Sloan
Deputy Executive Director

Melanie Schultz
Program Manager

Julian Fraize
Program Manager