

## NWTC Helps Guide U.S. Offshore R&D

The National Wind Technology Center (NWTC) at the National Renewable Energy Laboratory (NREL) is helping guide our nation's research-and-development effort in offshore renewable energy, which includes:

- Design, modeling, and analysis tools
- Device and component testing
- Resource characterization
- Economic modeling and analysis
- Grid integration.

As the U.S. increases its efforts to tap the domestic energy sources needed to diversify its energy portfolio and secure its energy supply, more attention is being focused on the rich renewable resources located offshore. Offshore renewable energy sources include offshore wind, waves, tidal currents, ocean and river currents, and ocean thermal gradients.

### Design, Modeling, and Analysis Tools

NWTC researchers assist industry partners with power system design review and analysis, provide technical assistance to solve specific technical problems, and conduct parallel research to provide a foundation for the increasingly complex engineering design and analyses needed in highly advanced system configurations.

A full suite of free, open-source, and professional-grade computer-aided engineering, design, and integrated system software tools is available to



An offshore wind energy plant off the coast of Denmark. Photo by Vestas Wind Systems, NREL 27985

support the offshore wind and water industries and research communities with state-of-the-art design and analysis capabilities. These tools include models of the effects of turbulent inflow, unsteady aerodynamic forces, structural dynamics, drivetrain response, control systems, and hydrodynamic loading. Downloads are available on the NWTC Information Portal at <https://nwtc.nrel.gov/software>.

### Device and Component Testing

Our staff of offshore-trained test engineers and technicians can conduct a wide range of field measurements to verify system performance and dynamic responses. Researchers at the NWTC developed a modular offshore instrumentation package that can be customized as needed for specific applications. The NWTC also operates and maintains the nation's premier

laboratory facilities where researchers work with industry partners to conduct structural testing of wind and water power systems and components, which include turbine blades/rotors and power take-off and control systems.

NREL is fully accredited by the American Association of Laboratory Accreditors (A2LA) to conduct wind turbine certification tests and, for the past two decades, NWTC researchers have helped international partners develop and write certification standards.

### Resource Characterization

For more than 15 years, NWTC meteorologists, engineers, and geographic information system experts have produced wind resource characterization maps and reports used by policymakers, private industry, and other government organizations to inform and accelerate the development of wind energy in the U.S.



An example of a water power system that captures the energy of ocean waves, driving a generator to produce electricity. *Photo by Ocean Power Technologies, NREL 22857*

To provide data on design conditions, researchers at the NWTC are assessing the potential contribution of techniques such as remote sensing and modeling. This includes comparing the data provided by remote sensing devices and models to data collected by traditional methods to establish their accuracy and increase acceptability to certification and banking institutions. Building on lessons learned from European offshore wind facilities, teams from the NWTC create and refine mesoscale modeling and computational fluid dynamics tools to predict array effects on wind turbines and wind resources in operating facilities.

## Economic Modeling and Analysis

NWTC researchers conduct market and economic analyses of offshore wind projects to quantify the impact of various technical innovations on the leveled cost of wind energy. The lab's Wind Turbine Design Cost and Scaling

Model estimates component-level costs based on wind turbine size, annual energy production, and operation costs. The model represents the initial capital investment of offshore wind projects, considering project size, water depth, distance from shore, and turbine technology. Our researchers also develop discounted cash-flow models to quantify the impact of financing rates, investment or production incentives, and ownership structures on cost of energy.

In addition, the NWTC has compiled a database of installed and proposed project costs based on its extensive research on projects in Europe, the U.S., and emerging offshore markets. These data show cost trends that are useful to offshore wind energy stakeholder groups, including the U.S. Department of Energy, manufacturers, developers, and financial institutions.

## Grid Integration

Understanding the regional grid impacts of offshore wind—both to the existing onshore grid and to the offshore grid as it evolves—is essential for smooth grid integration. The NWTC's foreknowledge of grid integration issues, as well as transmission system planning and expansion issues, will lead to more effective interconnection and integration of offshore wind energy. Offshore grid interconnection should include an assessment of proposed radial versus backbone wind plant connections and the assessment of offshore renewable energy resource zones or lease areas that integrate the planning and construction of offshore wind with the installation of needed transmission. As wind plants grow in size and move farther from shore, the NWTC will lead efforts to analyze the behavior and modeling of offshore electrical transmission systems with respect to grid-system reliability, grid losses, and grid-architecture options.

In addition, the NWTC operates the controllable grid interface (CGI), the first test facility in the U.S. to have fault simulation capabilities which allows manufacturers and system operators to conduct certification tests in a controlled laboratory environment. The CGI is fully integrated with two dynamometers and has the capacity to extend that integration to renewable energy devices in the field and to a matrix of electronic and mechanical storage devices on the same site.

## Partner With Us

The NWTC makes its resources, equipment, and facilities available to those interested in pursuing offshore development. From partnerships to licensing technology to using NWTC facilities, there are a wide range of options for collaborations.

Past partnerships include:

- Manufacturers of offshore energy technology and equipment
- Universities and other research institutions
- Government agencies
- Other national laboratories.

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