ATLANTIS

PROJECT DESCRIPTIONS

Sandia National Laboratories – Albuquerque, NM

ARCUS Vertical-Access Wind Turbine – $2,505,098

Sandia National Laboratories will design a vertical-axis wind turbine (VAWT) system, ARCUS, with the goal of eliminating mass and associated cost not directly involved in capturing energy from the wind. A VAWT is ideal for floating offshore sites. Its advantages over horizontal-axis wind turbines (HAWTs) include improved aerodynamic efficiency and a platform-level placement of the turbine's drivetrain that greatly reduces system costs. The ARCUS design replaces the turbine's tower with lighter, tensioned guy wires. The result is a lower tower top mass than traditional VAWTs. This greatly minimizes platform and system costs. Instead of designing the platform to eliminate the motion of the turbine, the project team will design the oscillating turbine-platform system to operate safely within an allowable response. The ARCUS turbine will ensure the technical leadership of U.S. commercial and research institutions.

General Electric Company, GE Research – Niskayuna, NY

Design and Develop Optimized Controls for a Lightweight 12 MW Wind Turbine on an Actuated Tension Leg Platform – $2,800,000

GE Research will design and develop optimized controls for a 12 MW (megawatt) floating offshore wind turbine (FOWT). The team will use advanced control algorithms that operate the turbine and are designed concurrently with the integrated structure of the FOWT. The proposed turbine designs and co-designed controls have the potential to reduce the mass by more than 35% compared with installed FOWT designs.

Principal Power Inc. – Emeryville, CA

DIGIFLOAT: Development, Experimental Validation and Operation of a DIGItal Twin Model for Full-scale FLOATing Wind Turbines – $3,600,000

Principle Power Inc. (PPI) plans to lead a consortium of public and private institutions to develop, validate, and operate the world's first digital twin software tailored to floating offshore wind applications. This digital twin model will be a real-time, high-fidelity numerical representation of the WindFloat Atlantic (WFA) Project, one of the world's only existing floating offshore wind farms. A fleet of interconnected ocean buoys that will be deployed at the WFA site as part of this project can estimate and predict the local environmental conditions. Insights from the model can give designers, operators, and other stakeholders greater understanding of the asset's performance and operation, leading to less downtime, lower operational costs and better predictive capabilities. Assessing floating offshore wind turbine performance in a real, dynamic, offshore environment enables co-simulation tools to create superior, next-generation designs by closing the design feedback loop of a real-world project.

The University of Texas at Dallas – Richardson, TX

A Low-Cost Floating Offshore Vertical Axis Wind System – $3,000,000

The University of Texas at Dallas (UT-Dallas) team plans to develop a floating turbine design featuring a vertical axis wind turbine (VAWT). The design will exploit inherent VAWT characteristics favorable to deep-water environments and use a control co-design approach to overcome common challenges. VAWTs offer advantages over traditional offshore wind designs because they have a lower vertical center of gravity and center of pressure; require a smaller, less expensive floating platform; and have the potential to reduce operations and maintenance costs due to platform-level access to the drivetrain. The UT-Dallas team will design a system based on a hierarchical control co-design (H-CCD) framework tailored to the floating VAWT system design. Their design framework includes aero-elastic tailoring of the rotor to reduce parked and operating loads, coordination of active on-blade flow control with rotor speed control to reduce torque variability, a lightweight and stable platform design, and a modular drivetrain.

The University of Massachusetts – Amherst, MA

A Co-Simulation Platform for Off-Shore Wind Turbine Simulations– $1,175,252

The University of Massachusetts Amherst will develop software for the coupled simulation and control co-design of floating offshore wind turbines. The physics of the fully coupled solid, liquid, and gas motion will be solved using a fully coupled particle-mesh algorithm called APIC (Affine Particle in Cell). The free, extensible, and widely supported animation software, Blender, will serve as the user interface for this new co-simulation physics engine. The free Sandia software, Dakota, will then interface with the proposed co-simulation results through Blender to perform design optimization using a control co-design approach. The team's software will be open source, intuitive, extensible, fully supported, and have fully coupled dynamic modules written to be efficient on massively parallel supercomputers.

National Renewable Energy Laboratory – Golden, CO

USFLOWT: Ultraflexible Smart FLoating Offshore Wind Turbine – $1,500,000

The National Renewable Energy Laboratory (NREL) will design an innovative system to unlock the floating offshore wind market by lowering the cost of energy below the current value of fixed-bottom offshore wind plants (7.5 ¢/kWh). The team's design, USFLOWT, is comprised of an advanced wind turbine with ultra-flexible and light blades, advanced aerodynamic control surfaces, and a revolutionary substructure: the SpiderFLOAT (SF). The SF is bioinspired, ultra-compliant, modular, and scalable. The project has three main goals: 1) complete the preliminary control co-design of a 10-MW unit, or USFLOWT-10; 2) complete the 50% Front End Engineering Design of a demonstrator to be constructed and tested in Phase II of the ATLANTIS program; and 3) advance the commercialization of the USFLOWT technology.

National Renewable Energy Laboratory – Golden, CO

Wind Energy with Integrated Servo-control (WEIS): A Toolset to Enable Controls Co-Design of Floating Offshore Wind Energy Systems – $2,708,864

The National Renewable Energy Laboratory (NREL) will develop a Wind Energy with Integrated Servo-control (WEIS) model, a tool set that will enable control co-design (CCD) optimization of both conventional and innovative, cost-effective floating offshore wind turbines (FOWTs). NREL's WEIS model will be entirely open-source and publicly accessible, bringing together many components and disciplines into a concurrent design environment. The tool will optimize the FOWT physical design together with the controller. It will be flexible and modular so that users can incorporate their own models, inputs, and load cases. The team's design will capture all of the critical nonlinear dynamics, system interactions, and life-cycle cost elements for a large range of FOWT archetypes and control actuators and sensors.

National Renewable Energy Laboratory – Golden, CO

The FOCAL Experimental Program – $1,529,923

The National Renewable Energy Laboratory (NREL) in collaboration with the University of Maine (UMaine) will develop and execute the Floating Offshore-wind and Controls Advanced Laboratory (FOCAL) experimental program. The project's goal is to generate the first public floating offshore wind turbine (FOWT) scale-model dataset to include advanced turbine controls, floating hull load mitigation technology, and hull flexibility. Current FOWT numerical tools require new capabilities to adequately capture advanced designs based upon control co-design methods. The FOCAL experimental program will generate critical datasets to validate these capabilities from four 1:60-scale, 15-MW (megawatt) FOWT model-scale experimental campaigns in the UMaine Harold Alfond W2 Wind-Wave Ocean Engineering Laboratory. The experiments will generate data for FOWT loads, motion, and performance, while operating with advanced turbine and platform controls in realistic wind and waves.

Otherlab – San Francisco, CA

AIKIDO - Advanced Inertial and Kinetic energy recovery through Intelligent (co)-Design Optimization – $2,614,145

Traditional wind turbines have grown larger to reach the higher wind speeds found at greater heights and enable the blades to intercept a larger area of wind. The stiffness required to hold up the blades and nacelle has caused turbines to become extremely heavy and consequently expensive. Otherlab will develop a new architecture for wind systems based on compliant materials, energy-generating structural surfaces, and advanced control systems that overcome the need for stiff, expensive materials by actively controlling how the system interacts with the environment.

WS Atkins – Houston, TX

Scale Model Experiments for Co-Designed FOWTs Supporting a High-Capacity (15MW) Turbine – $1,560,660

WS Atkins will focus on generating experimental data that can be used to validate computer programs and new technologies developed for floating offshore wind turbine (FOWT) applications. The team will use a 15-MW (megawatt) wind turbine in experiments to assess the behavior of conventional and unconventional FOWT structures. The WS Atkins team will make their data accessible to ATLANTIS project members and the public to facilitate benchmarking of new designs, accurate calibration of computer tools, and a FOWT database for future research.

Rutgers University, The State University of New Jersey – Piscataway, NJ

Computationally Efficient Atmospheric-Data-Driven Control Co-Design Optimization Framework with Mixed-Fidelity Fluid and Structure Analysis – $1,356,872

Rutgers University will develop a computationally efficient, atmospheric-data-driven, control co-design optimization software framework for floating offshore wind turbine design. They will focus on developing a modular computational framework for the modeling, optimization, and control of primary structures coupled to the surrounding air, water, and actuator dynamics. Their framework will integrate traditional aeroelastic models with higher fidelity simulation tools. This project will yield a modular and open-source framework that will be available to the other Phase 1 teams to support the broad mission of the ATLANTIS Program.

The University of Central Florida – Orlando, FL

Model-Based Systems Engineering and Control Co-Design of Floating Offshore Wind Turbines – $487,777

The University of Central Florida will develop a comprehensive causality-free modeling and simulation platform that facilitates control co-design, assists in incorporating multi-physics models, adapts to design changes, and allows rapid simulations to validate models and evaluate controllers. The team will study unique control concepts such as active tether actuation, gyroscopic balancing, hydraulic actuation, and individual pitch control. The research will reduce the time, cost and risks associated with experimentation, and open opportunities for better exploring the design space for higher efficiencies and optimality of floating offshore wind turbines. With a strong foundation of underlying physics, this approach will accelerate design iterations, leading to faster translation of product to market.

The University of Maine – Orono, ME

Ultra-light Concrete Floating Offshore Wind Turbine with NASA-developed Response Mitigation Technology – $1,398,202

The University of Maine (UMaine) team will design an ultra-lightweight, corrosion-resistant, concrete floating offshore wind turbine (FOWT) equipped with NASA motion mitigation technology originally developed to reduce vibrations in rockets. UMaine has adapted this technology to counteract FOWT motions, leading to lighter platforms, increased turbine performance, and a lower levelized cost of energy (LCOE). Their proposal will take a radical next step in the field of offshore wind while building upon UMaine's 12 years of experience in successfully designing and deploying the first grid-connected floating offshore wind turbine in the U.S. The proposed technology is a departure from current floating concepts and achieves a significant LCOE reduction, even when using standard wind turbine architectures. The program will leverage the design, numerical modeling, and scale model testing capabilities of the UMaine Harold Alfond W2 Wind-Wave Ocean Engineering Laboratory to significantly advance this concept.