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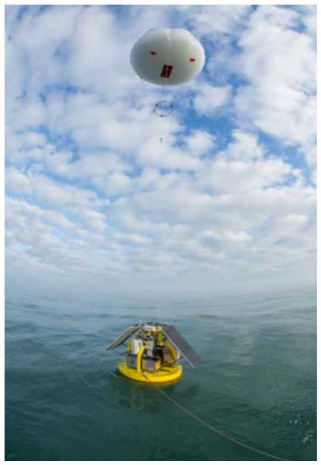
Development of a Balloon-Borne Barge-Mounted Wind Measurement Platform



Sandia National Laboratories (SNL) is developing a low-cost, environmentally safe, and weather-proof sensor system that can be deployed offshore for extended periods of time for wind resource monitoring. The system has clear economic benefits over meteorological (met) tower approaches and is easily relocated to multiple locations across a project site. The end development goal is a buoy or barge-based, balloon-borne atmospheric measurement platform that operates autonomously in all but the most severe weather conditions, provides data of comparable accuracy to a met tower, and provides more accurate wind data at higher altitudes than floating lidar at half the cost.

The system consists of an anchored barge or buoy that serves as a platform for solar power, data collection, and aviation lighting, and a tether line between a balloon and barge that is strung with sensor modules that include sonic anemometers and fiber-optic based distributed temperature sensing (DTS). A prototype system was deployed 8 km off the coast of South Padre Island, TX in early 2014.

Guyed met towers have been used for several decades to assess boundary layer wind speeds at potential wind development sites on land. However, high equipment and installation costs are associated with this approach in the offshore environment. If a balloon and barge-based system were used for site assessment, rather than an offshore met tower, installation and annual operating costs associated with site assessment could be reduced from $10,000,000 to $1,000,000, or by 90%. Similarly, if a balloon-based system was used rather than an offshore lidar system, installation and annual operating costs could be reduced from $2,000,000 to $1,000,000, or by 50%.

Wind resource characterization requires wind speeds at and above the hub height of a proposed wind turbine, which can exceed 120 m. The system in development by SNL measures wind speed, wind direction, pressure, relative humidity, and GPS-derived latitude, longitude, and altitude in situ at user-specified levels with wireless data transmission to a base station on the barge. DTS temperature measurements are collected every 0.25 m between the balloon and the surface, and fiber can also be deployed underwater from the barge to collect DTS profiles of ocean temperature. The balloon-borne platform is compliant with FAA and USCG regulations and will function autonomously in day and night conditions. Data and images from the system will be transmitted to shore-based receiving stations.

Under funding from NYSERDA, SNL seeks to develop and deploy a ruggedized, next-generation system in a BOEM offshore lease area within the Atlantic Ocean for extended periods of time. The wind speed, wind direction, and temperature data will be correlated with data from onshore met towers and other available offshore in situ measurements, and the system will be optimized with respect to data accuracy and autonomy. The in situ balloon-based data will also be compared against existing AWS and NREL offshore datasets. The system will undergo terrestrial testing at existing SNL operating sites within the U.S. The integration of an Acoustic Doppler Current Profiler into the system, to collect data regarding current loading on offshore turbine support structures, will be investigated.

The end system will be capable of functioning autonomously for extended periods of time to meet customer requirements, will provide in situ measurements of wind speed, wind direction, meteorological parameters, and turbulence of comparable quality to an offshore met tower at reduced cost, provide second-scale temporal data that are not provided by existing offshore wind model datasets, and may be used to improve marine boundary layer modeling parameterization schemes and inform offshore turbine design standards.

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