House Science Committee, Subcommittee on Energy
Advancing the Next Generation of Solar and Wind Energy Technologies
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Chairman Lamb, Ranking Member Weber, Members of the Subcommittee, good morning. It is my privilege to be here this morning on behalf of the 114,000 men and women in the U.S. wind industry to discuss the tremendous contributions our industry is making and the important R&D work that is keeping the U.S. competitive. As the President and CEO of the American Wind Energy Association, I am proud to represent our 1,000 member companies with a common interest in encouraging the expansion of wind energy resources in the United States, including wind turbine manufacturers, component suppliers, project developers, project owners and operators, financiers, researchers, utilities, marketers, customers, and their advocates. Today wind energy is lowering the cost of electricity for consumers, enhancing rural economies and actively reducing U.S. emissions. Wind energy is an American success story, providing jobs, investment, manufacturing and related economic and environmental benefits across the country. A few highlights:

- Today a record 114,000 Americans spread across all 50 states have jobs supporting the wind industry.
- Over 500 American factories in 42 states build many of the 8,000 parts found in a modern wind turbine.
- The industry is proud to hire America's veterans at a rate 72 percent higher than the national average.
- At least 69 percent of U.S. congressional districts have either an operating wind farm or wind-related factory, or both.
- The U.S. now has 96,443 MW of installed wind capacity, with wind supplying 6.5 percent of the country's electricity.
- At the state level, six states generate at least 20 percent of their electricity from wind turbines on an average day.
- In 2018, the U.S. wind industry invested $12 billion in new projects and provided over $1 billion in payments to state and local governments and landowners.
- The 3,123 new turbines built across 20 states in 2018 are reaching previously unseen levels of productivity. Wind farms built over the last five years have seen average annual capacity factors of 40 percent, with some individual projects in more recent years achieving over 50 percent.
- At the end of 2018, the U.S. had a potential offshore wind pipeline of over 25,700 MW spanning 10 states in the Northeast, Mid-Atlantic and Great Lakes regions.

Now, let me talk about how the Department of Energy's Wind Energy Technologies Office plays an important role in this success story. Spurred in part by the DOE's Wind Energy Technology Office, U.S. wind deployment has more than tripled over the last decade. Today wind is the largest source of renewable generating capacity in the country. The R&D, innovation and collaboration undertaken by the Wind Energy Technology Office has

advanced wind turbine technology and overcome market barriers that would otherwise constrain wind energy deployment. Investments have increased output, improved reliability, and reduced costs. However, continued progress in all these areas will be critical for the U.S. to attain global leadership in wind energy and maximize benefits for the U.S. economy and electricity consumers.

Consistent with other DOE technology programs for nuclear energy, fossil energy and others, DOE has a central role to play in R&D even for a commercial technology like wind energy. For example, DOE's datasets, modeling and supercomputing capabilities are unique and important for a variety of R&D initiatives. DOE's investments and capabilities have enabled higher-risk, higher-reward research projects and analysis that companies could not do on their own, facilitated industry collaboration to resolve tough technical challenges, and provided third-party research results that are often more credible to federal, state and local regulators, thus potentially streamlining permitting barriers.

Over the last several years, the DOE Wind Energy Technology Office has provided support to projects with ties to every U.S. state, helping grow the economic benefits of wind energy across the country. I would like to highlight a handful of the programs undertaken by the Wind Energy Technology Office that continue to play a crucial role in keeping the U.S. on the cutting edge of innovation and clean energy deployment.

Wildlife and Radar issues

The wind industry invests millions of dollars a year and collaborates with federal and state officials and conservation organizations to study the interactions between wind energy and wildlife and to reduce impacts. Continued DOE investments in this area may lead to minimization measures, including detection, deterrent and operational adjustments and/or mitigation solutions that facilitate improved permitting by federal agencies like U.S. Fish and Wildlife Service. DOE can be particularly valuable in helping validate technologies developed by the private sector. Third party validation along these lines can be helpful in convincing federal and state regulators to accept the results and support usage of the solution.

The wind industry also supports continued investment by DOE and partner agencies to test hardware and software solutions to mitigate potential impacts from wind turbines on radars.

Transmission and grid integration

On a larger scale, DOE modeling and analysis has been important in demonstrating how the increasing diversification of generating resources (natural gas, wind, solar, storage etc.) can be reliably integrated into the grid. Continued DOE efforts via the widely-respected experts at the national labs to assess the impact of generation shifts, including even larger percentage of wind penetrations, and recommend approaches to maintaining reliability is valuable for grid operators, utilities, generators, regulators, and consumers.

By way of example, the national labs can help the North American Electric Reliability Corporation (NERC) research how to maintain system inertia with increasing penetration of

inverter-based resources. The multi-lab, multi-technology office "Beyond LCOE" initiative will help consider how to value services the grid needs to remain reliable. And, DOE should invest in regional cost-benefit analysis on various advanced transmission technologies that can help get more capacity and flexibility out of the existing grid and on opportunities to reduce barriers ("seams") between regional grid operators.

At the regional level, DOE work to improve the coupling of visualization displays with forecasting tools help grid operators better manage their power system operations, including improved outage management and reduced curtailment, so they can utilize wind power at a lower cost.

As part of a wind farm, storage in tandem with energy management software can be used to improve the dispatchability of wind. It would be particularly helpful if DOE were to cost-share the demonstration of long duration storage systems paired with wind, with the goal of validating various energy storage system hybrid designs. The validation would include, but not be limited to, the compilation and reporting of data on changes to ramp control; frequency regulation; and load shaping (over periods of up to one hour). Examples of storage technologies that could be paired with wind projects include flow batteries, steady-state batteries, liquid air energy storage, compressed air energy storage and pumped hydro.

A2e initiative [Atmosphere to Electrons]
This DOE initiative (which involves public-private partnerships) seeks to research, analyze, and validate the aerodynamic effects of complex atmospheric conditions, variable terrain, and machine wakes. DOE datasets and supercomputing power are central to this effort. It is a large challenge that will be a critical element of enabling the industry address imperfect predictions and better optimize turbine design, farm layout, and operation. These improvements will help reduce the cost of energy for both land-based and offshore wind, benefitting consumers.

Advanced technology and components
Breakthroughs and advancements are needed to continue driving down the cost of wind power and other generating technologies. Funding by the DOE enables industry to pursue higher risk/higher reward technology programs that might not otherwise move forward. This area includes investments to analyze and improve component technologies such as towers, blades, drive trains, control systems, as well as material developments.

One area that is of interest to industry is service life extension. The expected lifespan of wind farms has been extended from 20 years to 30 or more years. DOE has played an important role in collaborating with industry to better understand key component failures and strategies to address. Better understandings mechanical component failures can improve the ability to deploy preventative maintenance to avoid problems, prolonging asset life and lowering costs.

Advanced manufacturing technologies
Investments in this area are needed to bring the benefits of manufacturing advances to the wind industry where many suppliers to the major manufacturers do not have the ability to

invest in such advancements. Much of this activity falls under DOE's Advanced Manufacturing Office. Such support can benefit the 500 manufacturing facilities across the U.S. that serve the U.S. wind industry.

Technologies and issues unique to offshore wind

DOE's efforts on research specific to wind turbines in a marine environment should continue focusing on driving down the cost of offshore wind, installation challenges, mitigation of environmental impacts to facilitate federal permitting, grid interconnection and integration, and supply chain needs, all of which are important to growing the nascent offshore wind industry in the U.S.

I am confident that clear authorization and robust funding from Congress will allow the Wind Energy Technologies Office to continue to accelerate innovations and outcomes. We fully support the Office's stated goal of achieving "breakthroughs in reducing the levelized cost of energy (LCOE) for land-based wind by 50 percent from today's LCOE, to $.023/kWh without subsidies by 2030 and achieving a 50 percent reduction in offshore wind and distributed wind by 2030 from a 2015 benchmark." A cleaner, more diversified, low-cost electricity mix is good for all Americans. Thank you for the opportunity to advocate on behalf of our American wind energy workers for R&D that will keep the U.S. on the cutting edge of wind energy technology.