

## **Advances in Next Generation Energy Technologies: Enabling the Transformation of Global Energy Systems**

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The National Renewable Energy Laboratory (NREL), a U.S. Department of Energy (DOE) national laboratory in Golden, Colorado, works with partners around the world on clean energy systems analysis, research, and deployment.

The global view is deliberate. Renewable power generation is increasing around the world. Renewable electricity generated by solar and wind has witnessed significant cost reductions over the past seven years—73% and 23% in cost reductions, respectively.

The challenge: Adding these renewable sources to the electric grid. Distributed, renewable sources add variability to the generation supply and push the limits of existing electricity infrastructure. Renewables on the grid can increase hourly ramp rate and ramp range, the uncertainty of the load, and the need for frequency regulation.

NREL is working to meet the challenges. In 2013 the lab opened the Energy Systems Integration Facility (ESIF) where renewable-electricity-to-grid integration, vehicle-to-grid integration, renewable-fuels-to-grid integration, microgrids, and battery and thermal energy storage are specialties. ESIF boasts the world's most energy efficient high performance computing center (power usage effectiveness of 1.04) where multi-scale power systems are modeled and a visualization center that allows utilities to better understand and layer energy data.

In addition, NREL co-leads the Grid Modernization Laboratory Consortium, a partnership between DOE and the national labs to bring together experts and technologies to collaborate on modernizing the U.S. electric grid. The consortium has a portfolio of more than 80 grid-related projects.

Next up: NREL is identifying research needs for the development of autonomous energy grids – grids that are scalable, reconfigurable, and self-organizing; are extremely secure and resilient; and can self-optimize in real time to ensure economic and reliable performance while integrating energy in all forms.