Quick Facts

NREL analysts have developed a variety of modeling tools for the electrical grid, including ReEDS, which looks at the build-out of generation and transmission systems, and FESTIV, which examines the impacts of variability from wind and solar energy sources.

Building on the groundbreaking Western Wind and Solar Integration Study (WWSIS), NREL analysts created simulations for a more in-depth WWSIS-2. NREL found that the increased cycling of a fossil-fueled plant to accommodate high levels of wind and solar generation increases operating costs by 2%–5%. However, from a system perspective, the fossil fuel costs that are avoided by using solar and wind power are far greater than the increased cycling costs.

WWSIS-2 also found that the negative impact of cycling on overall plant emissions is relatively small, and that the increase in plant emissions from cycling to accommodate variable renewable sources is more than offset by the overall reduction in carbon dioxide and other pollutants.

ReEDS provided the underpinning for the Renewable Electricity Futures Study, and in conjunction with production cost modeling, demonstrated that renewable energy generation from technologies that are commercially available today, combined with a more flexible electric system, is more than adequate to supply 80% of U.S. electricity by 2050.

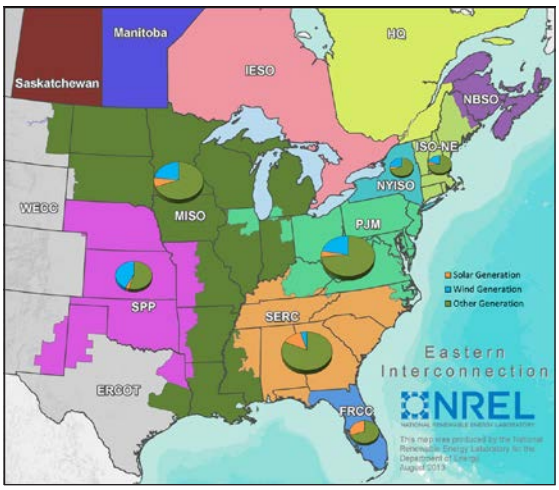
NREL Energy Models Examine the Potential for Wind and Solar Grid Integration

As renewable energy generating sources, such as wind turbines and solar power systems, reach high levels of penetration in parts of the United States, the National Renewable Energy Laboratory (NREL) is helping the utility industry to peer into the future. Using software modeling tools that the lab developed, NREL is examining the future operation of the electrical grid as renewable energy continues to grow.

NREL's Regional Energy Deployment System (ReEDS) model, for example, primarily addresses issues for integrating renewable electric technologies, especially wind and solar resources. At a finer timescale, NREL's Flexible Energy Scheduling Tool for Integration of Variable Generation (FESTIV) simulates the behavior of the electric power system, helping researchers understand the impacts of variability and uncertainty on operating reserves requirements. For many integration studies, NREL also runs a production cost model. All these tools help the utility industry to understand the potential impacts of increased renewable power generation.

NREL has employed these tools to support key regional studies, including the Western Wind and Solar Integration Study, Phase 2 (WWSIS-2), which analyzed the impact of cycling conventional power plants to accommodate more renewable energy generation on the western grid. NREL analysts, using the PLEXOS commercial modeling tool, found that although cycling has an impact on costs and emissions, those impacts are small compared to fuel savings and displaced emissions. Also, the on-going Eastern Renewable Generation Integration Study (ERGIS) is analyzing operations of the eastern grid at an unprecedented resolution to understand how operational changes can be used to more efficiently manage the variability and uncertainty of wind and solar resources.

Using ReEDS, the lab also led the Renewable Electricity Futures Study, which found that renewable electricity generation from technologies that are commercially available today, combined with a more flexible electric system, is more than adequate to supply 80% of total U.S. electricity generation by 2050. NREL also used ReEDS for the SunShot Vision Study, which provides an in-depth assessment of the potential for solar technologies. In addition, NREL studies have quantified the positive impact of other generation, storage, and demand-response technologies.



NREL's ERGIS study is modeling the U.S. portion of the Eastern Interconnection, shown here, at unprecedented resolution. The pie charts on this map show the percentage of wind, solar, and other generation sources for each grid operator under a scenario in which the U.S. portion of the interconnection reaches 30% renewable energy by 2025. The size of the pie charts indicates the amount of power generation for each grid operator.

Illustration by Jenny Melius and Aaron Townsend, NREL

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