Dynamic Line Rating Overview

Increasing the capacity of existing power lines

Concurrent cooling enables increased transmission line capacity and renewable energy integration.

The U.S. electrical grid includes about 7,000 operational power plants that send electricity over 642,000 miles of high-voltage transmission lines and 6.3 million miles of distribution lines.

The grid's available capacity has been largely unchanged for decades and needs to increase to accommodate new power plants and renewable energy projects. The difference in time and cost between using existing lines or the construction of new ones can make or break plans for new wind or solar plants.

Wind energy researchers at Idaho National Laboratory believe moving more electricity through existing transmission and distribution lines is both possible and practical. In areas where wind plants are being developed, there is potential to take advantage of wind cooling on transmission and distribution lines concurrent with wind power generation, while identifying additional capacity, line sag and clearance concerns. The key is to pay close attention to the weather.

The more electric current a line carries, the hotter it gets. After a certain point, a line operator cannot add additional current without overheating and damaging the line. However, an increase in wind speed blowing at a right angle to a high-voltage line can cool the line enough to safely increase the amount of current it can carry by 10 to 40 percent.

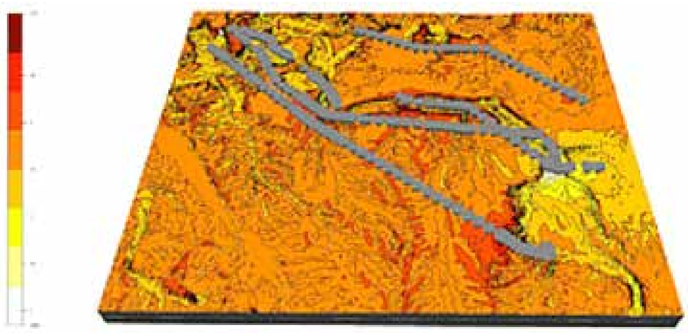
To research these efficiency gains, INL researchers are funded by the Department of Energy's Office of Energy Efficiency and Renewable Energy Wind Energy Technologies Office and collaborate with regional power companies.

CONCURRENT COOLING PROJECT AREA

Power utilities operate transmission lines based on static ratings, which set a conservative limit on the amount of electric current the lines can safely carry without overheating. Static ratings assume there's little or no wind blowing, so in moderately windy places, a line's static rating is often much lower than its real transmission capacity. Those windy places are shared with wind power plants and are called concurrent cooling areas because the wind that generates power also cools transmission lines. Using dynamic line ratings to manage capacity on high-voltage lines in such places helps increase the overall efficiency of power transmission.

The amount of wind cooling a line receives varies with the wind's speed, its direction

Idaho National Laboratory



INL researchers use data from weather stations to create a 3D mean wind speed map. The scale shows wind speeds in meters per second.

relative to the line, local ambient air temperature and how much sun it gets. To better understand this concept, researchers collaborate with several regional and national entities to study various complex terrain areas. One such area is a windy part of southern Idaho that is an interstate utility transmission corridor. The research teams translate detailed weather, line loading and conductor temperature information into dynamic line ratings—real-time estimates of how much current each segment of high-voltage line can safely carry while wind power is generated.

CONCURRENT COOLING MODEL

INL researchers and Idaho Power have installed more than 40 weather stations along transmission lines in windy southern Idaho's interstate utility corridor.

Researchers installed the stations to measure weather conditions along more than 450 line-miles of high-voltage transmission lines. Due to the number of weather stations, researchers use computational fluid dynamics (CFD) to generate wind resource maps of smaller areas, then combine the different simulation areas in the end to see the big picture.

INL researchers and Idaho Power installed more than 40 weather stations along transmission lines in a windy part of southern Idaho's interstate utility corridor.

The research team started with a weather simulation program that meteorologists, wind power developers and researchers typically use to model climate over uneven terrain, then they modified the software to boost the simulation speed with improved resolution and accuracy. Researchers also developed a Java-based software package called General Line Ampacity State Solver (GLASS), which uses weather model results to estimate how much the weather affects a power line's real transmission capacity. This helps determine the relationship between wind energy generation and resulting concurrent cooling of the transmission lines carrying that wind power to homes and businesses.

IMPROVED LINE CAPACITY FORECASTING

The research team continues to validate and refine its CFD-based weather simulation models to run faster and generate increasingly more accurate results for complex terrain. The team also works with multiple utility partners to train system operators in the use of weather station data and software tools to generate transmission capacity operating limits. The ability to reliably make such estimates on a large scale with high spatial resolution brings power utilities one step closer to using a transmission system dynamically coupled with concurrent cooling processes to yield greater all-around benefits.

FOR MORE INFORMATION

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