BUSINESS:

NREL researchers find wind and solar power provide net benefits to Western grid

Daniel Cusick, E&E reporter

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Fossil fuel power plants that have long provided steady baseload power to much of the West will not be significantly affected by the integration of more solar and wind energy on the grid, a new analysis from the National Renewable Energy Laboratory has found.

The findings, presented in phase two of NREL's "Western Wind and Solar Integration Study," should help dispel the notion that the addition of intermittent energy resources like wind and solar will significantly drive up pollution and operating costs at coal-fired power plants due to what is known as "cycling."

Cycling refers to powering up and down of mostly coal- or gas-fired boilers to accommodate the ebb and flow of electrons moving from wind farms and solar arrays onto regional power grids. Experts have noted that without careful cycling of baseload power plants, unanticipated surges in wind and solar power could overload the grid. By the same token, a rapid drop-off in intermittent energy resources without backup generation could lead to brownouts and other problems.

Experts have also noted that the frequent cycling of power plants could drive up the cost to run such plants and increase the amount of pollution they emit, because fossil fuels burn much less efficiently during cold starts.

But NREL researchers Debra Lew and Greg Brinkman found that the benefits of incorporating wind and solar into Western utility grids far outweigh the drawbacks, especially when accounting for the cost savings associated with reduced demand on fossil fuels. Pollution levels, meanwhile, dramatically dropped when utilities increased their reliance on renewables, while the negative effects of cycling on pollution rates were relatively small.

The findings are based on data from roughly 40 "balancing areas" within the Western Interconnection, the grid system that serves the West Coast. Researchers evaluated changes across the system at five-minute intervals using scenarios that involved utilities using as much as 33 percent wind and solar power.

$7B a year in avoided fuel costs

Carbon dioxide emissions fell by between 29 and 34 percent under a high renewable fuels scenario, and emissions of CO2 were largely unchanged whether or not utilities cycled their fossil units. Similar deep pollution cuts were also modeled for sulfur dioxide and nitrogen oxides, although cycling did have some mild impacts on SO2 and NOx emission rates.

And while increased cycling to accommodate wind and solar generation raised the average power plant's operating costs between 2 and 5 percent, the study found that "avoided fuel costs are far greater than the increased cycling costs for fossil-fuel plants," said Lew, the NREL project manager for the study.

The researchers found that incorporating high levels of wind and solar power would reduce fossil fuel costs by about $7 billion per year across the West, while incurring cycling costs of $35 million to $157 million per year. "For the average fossil plant, this results in an increase in operations and maintenance costs of $0.47 to $1.28 per megawatt-hour (MWh) of generation," the study found.

Phase two of the "Western Wind and Solar Integration Study" follows an initial report done in May 2010, which examined the viability, benefits and challenges of integrating high levels of wind and solar power into the Western electricity grid. The phase one study found it was technically feasible to increase renewables generation if certain operational changes could be made at power plants, but it also raised key questions about how cycling affects utilities' costs and emissions profiles.

The next questions, according to Lew, became, "How big are these secondary impacts, and do they significantly negate the positive impacts that wind and solar bring to the table?"

The answers, while slightly varying across a fossil plant's primary pollutants, were clear when costs and benefits were considered on the whole.

"Our high wind and solar scenarios, in which one-fourth of the energy in the entire Western grid would come from these sources, reduced the carbon footprint of the Western grid by about one-third," Lew said. "Cycling induces some inefficiencies, but the carbon emission reduction is impacted by much less than 1 percent."

Wind outcompetes gas and coal

To calculate wear-and-tear costs and emissions impacts on fossil plants, NREL designed five scenarios whereby utilities maintained a fuel mix of up to 33 percent wind and solar energy on the Western Interconnection power system for the year 2020.

The study assumed an average natural gas price of $4.60 per million British thermal units and allowed for significant cooperation between utilities and grid authorities and optimal usage of transmission capacity across the Western Interconnection. NREL then modeled operations of the entire Western Interconnection for that year in five-minute intervals to understand potential impacts within every hour.

"From a system perspective, high proportions of wind and solar result in lower emissions and fuel costs for utility operators," Lew said. "The potential cycling impacts offset a small percentage of these reductions."

Lastly, the NREL researchers found that increases in wind and solar generation were more likely to offset natural-gas-fired generating units than coal plants. "Wind tends to reduce generation from combustion gas turbines, while solar tends to increase starts and ramps of gas turbines to meet peaks that occur at sunset," the researchers found.

However, during periods of peak wind energy production, researchers found that wind "displaced nearly all the gas output and significantly cut into the coal output," according to the report. Alternately, under a high solar energy scenario, the sun's intensity "was high enough at midday to lead to significant curtailment of wind/PV and ramping of coal up and down on a daily basis."

The researchers also observed seasonal variability in the way wind and solar power were integrated into the grid. During summer, when electricity demand tends to rise with the greater use of air conditioning, "capacity was required more than flexibility," the report said. Alternately, "In the spring, balancing the load with high instantaneous wind/solar penetrations required a lot of flexibility."

Click here to view the NREL study.

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