In Development

Distributed and Fueled

New EPRI Program Explores the Environmental Aspects of Fueled Distributed Generation and Energy Storage

By Brent Barker

It's one of the big energy stories of the 21st century. Once largely powered by central power plants, electric grids in the United States and elsewhere are rapidly becoming powered by more distributed generation. While rooftop solar is significant in driving this transformation, fueled distributed energy resources are also playing a major role. Situated both behind the meter and in front of the meter, these resources include small gas-fired turbines, reciprocating internal combustion engines, and combined heat and power systems.

Based on data from the U.S. Energy Information Administration, EPRI estimated that the total U.S. capacity of small fossil generators (defined as units with a capacity of less than 25 megawatts) totaled 37 gigawatts in 2015. Most of this capacity is gas-fired turbines (including combined heat and power units) and internal combustion engines.

Exploring the environmental impacts of this growth is a primary objective of the new EPRI Program 197, Environmental Aspects of Fueled Distributed Generation and Energy Storage. The program was created through the expansion of several projects in EPRI's Technology Innovation program.

"Program 197 is designed to help us understand the challenges, benefits, and other environmental aspects of fossil distributed energy resources," said EPRI Program Manager Stephanie Shaw. "The research can inform utilities as they plan and site energy resources."

EPRI and the Houston Advanced Research Center (HARC) used a computational fluid dynamics model (developed by HARC) to simulate local air quality effects of distributed fossil units. EPRI studied differences between the HARC model and the fluid dynamics model developed by Cornell University and EPRI. Both models incorporate meteorological data and the effects of terrain and buildings on dispersal of air pollutant plumes. For example, certain buildings can draw a plume toward the ground—an effect known as building downwash.

Results of modeling gas-fired combined heat and power facilities showed minimal local air quality impacts. Increases in concentrations of nitrogen oxides (NO_x) were 1 part per billion (ppb), quite small relative to the U.S. Environmental Protection Agency's 100 ppb standard for nitrogen dioxide (NO_2).

Under meteorological conditions conducive to the biggest air quality impacts, the largest 1-hour increase in fine particulate matter ($PM_{2.5}$) was calculated at only 1 microgram per cubic meter. This is well below the 24-hour federal standard for $PM_{2.5}$, which is 35 micrograms per cubic meter.

Only one scenario resulted in significant local air pollution: 10 megawatts of backup diesel generation at a simulated data center produced 10–50 ppb of NO_2 and 5 micrograms per cubic meter of $PM_{2.5}$.

"With the exception of diesel backup generators, natural-gas-powered distributed resources have relatively low impacts on ground-level concentrations of nitrogen oxides, ozone, and particulate matter in local areas," said EPRI Principal Technical Leader Eladio Knipping.

However, using three-dimensional air quality models to evaluate larger geographical areas, EPRI and the University of California, Irvine, found that air quality impacts can increase significantly when distributed generation is aggregated or clustered regionally. Growth projections used in the modeling ranged from 6 to 24 gigawatts of additional fueled distributed generation capacity by 2030. In all scenarios, the air pollutant concentrations were greatest along the Pacific coast and in the Northeast.

"We found that the most aggressive scenario for penetration of fueled distributed generation could increase ozone concentrations by about 6 ppb," said Knipping. "In a region that already has more than 60 ppb of ozone, a 6 ppb increase could approach the 70 ppb 'non-attainment' threshold under the National Ambient Air Quality Standard. However, these impacts can in large part be mitigated with units that comply with more stringent emissions controls."

The new EPRI program will conduct additional emissions evaluations for new fueled distributed generation, enhance air quality models, and assess environmental impacts based on new distributed generation capacity projections.

Review of Lithium Ion Batteries

Program 197 also focuses on environmental aspects of energy storage technologies, particularly batteries.

GTM Research's *U.S. Energy Storage Monitor Q3 2017* estimates that 364 megawatts of utility-scale energy storage will be deployed in the United States in 2018.

Environmental impacts of batteries can vary by application. For example, the timing and frequency of the charge/discharge cycle can affect greenhouse gas emissions. EPRI is characterizing the impacts of lithium ion batteries in four utility-scale applications:

- Peak shaving and time shifting
- Frequency regulation
- Deferring investment in transmission and distribution infrastructure
- Voltage regulation

Researchers selected 11 storage systems in California with seven different designs using five common lithium ion chemistries. Preliminary results will be available in 2018.

Of particular concern are impacts at the end of a battery's life, when the device may be reused for a different application, dismantled and recycled, or disposed of in a landfill. Researchers are considering truck and ship transport and separation of battery components for recycling.

"Our new program focuses on storage and newer, smaller generation units making rapid inroads in the power system," said Shaw. "Our goal is to guide utilities in a sustainable direction as they deploy these technologies."

Key EPRI Technical Experts

Stephanie Shaw, Eladio Knipping