In Development

# EPRI Explores Air Quality Impacts of Fossil Distributed Generation

***By Garrett Hering***

At the dawn of the Electric Age in the late 1800s, small, local fossil-powered generators provided power to businesses and homes. In the early 1900s, large plants replaced these distributed generation (DG) resources, and most of the plants (and their emissions) were moved away from population centers.

In the 21st century, distributed generation—fossil and renewable—is making a comeback. Until now, the air quality impacts of these modern fossil DG facilities have not been examined rigorously.

In 2016, EPRI began releasing the results of a three-year research project to shed light on fossil DG deployment and its air quality impacts. Researchers developed atmospheric models to simulate how fossil DG air pollutants affect local and regional air quality. They also used EPRI's U.S. Regional Economy, Greenhouse Gas, and Energy (US-REGEN) model to explore how DG penetration scenarios based on other economic models would affect the overall generation portfolio.

"There is a concern that rising levels of fossil distributed generation will deteriorate air quality. Our research explores local and regional air pollution from these facilities to inform stakeholders and to assist in the development of air quality management plans," said EPRI Principal Technical Leader Eladio Knipping.

## Fossil DG Inventory

Principal Technical Leader Stephanie Shaw and Knipping discovered a lack of information on fossil DG capacity in the United States. They consolidated data from national, state, and local databases to create the first comprehensive inventory of U.S. fossil DG, defined as behind-the-meter generators with a capacity of less than 25 megawatts.

The total U.S. capacity in 2014 was about 14,500 megawatts. Three categories account for all but about 200 megawatts:

- Internal combustion engines (primarily diesel-fueled backup generators): 6,300 megawatts
- Combustion and steam turbines (mostly natural gas–fueled combined heat and power units): 7,500 megawatts
- Combined-cycle plants: 500 megawatts

Combined heat and power systems, usually powered by cleaner burning natural gas, produce relatively low emissions. Diesel-powered backup generators produce higher emissions but are used primarily during emergencies and planned outages.

## Modeling Air Quality

In a separate 2016 study, EPRI and the Houston Advanced Research Center developed a model to simulate local air quality effects of fossil DG units in Houston, Texas. The team focused on early afternoon of a typical summer day.

"The goal was to assess the immediate near-source impacts of different types of distributed generators in an urban environment," said Shaw, who leads the fossil DG air quality research.

Researchers examined three hypothetical generators commonly used, each with two operational scenarios: a 25-megawatt natural gas turbine operating in simple-cycle or combined heat and power mode; a 25-megawatt natural gas turbine in a cold startup with moderate or high formaldehyde emissions; and a datacenter with 10 megawatts of either diesel- or natural gas–fueled backup power. Simulations of formaldehyde, ozone, particulate matter, and nitrogen dioxide emissions assumed a single generation unit operating for two hours.

Only one of the six scenarios generated significant air pollution: the diesel backup generator for the datacenter boosted ambient nitrogen-dioxide emissions by 10–50 billion parts per million by volume (ppbv) within 2 kilometers downwind of the source. Just one scenario modeled for natural gas turbines increased emissions by more than 1 ppbv for any gases other than ozone. This indicates that many fossil DG units can be quite clean on their own.

However, substantial increases in air pollution can result when individual units are aggregated regionally. In regional modeling of the continental United States, researchers developed fossil DG deployment scenarios for 2050 ranging from 14 to 40 gigawatts, with the Pacific Coast and Northwest showing the most economic potential. EPRI then modeled the potential air quality impacts of these scenarios.

Preliminary results, to be published in a peer-reviewed manuscript in late 2016, indicate measureable impacts in the vicinity and downwind of the sources—for example, an increase by several ppbv of ozone. “Such impacts can affect efforts to attain air quality standards,” said Knipping.

“We found that within a few kilometers of natural gas units, single-source impacts are usually very small,” Knipping said. “But there can be significant regional increases in emissions and concentrations of ozone and particulate matter when there is broad market adoption. The size of those increases depends on the type of technology, application, and location.”

### Key EPRI Technical Experts

Eladio Knipping, Stephanie Shaw