Feature—Getting a Head Start on Future Environmental Issues

By Chris Warren

The Story in Brief

It's tempting to assume that the widespread deployment of solar and wind will reduce or mitigate the future power system's environmental impacts. The reality is that new environmental challenges are emerging, and relatively little is known about them. EPRI has launched a multifaceted three-year initiative to anticipate and understand these challenges and inform solutions ahead of major impacts.

For millennia, sages and intellects have pondered the future and how to shape it in a positive way. Abraham Lincoln made such exercises seem realistic when he said, "The best thing about the future is that it comes one day at a time."

Lincoln's words point to the need to think and act each day in ways that shape better outcomes. As the power system incorporates more distributed energy resources (DER), including solar and wind, it can be tempting to assume that the transition will reduce environmental challenges.

While sustainability drives many changes across the power system, any potential transformation brings unanswered environmental questions and potential challenges. For example, what are the environmental challenges of solar panel degradation after a few decades of operation? What is the proper end-of-life use, if any, for the panels? Is it best to dispose them in a landfill? Can valuable materials such as gallium be recovered and reused?

Identifying Questions, Seeking Answers

Consider just a few of many emerging questions: What are the environmental impacts of lithium mining for battery manufacturing? How are emissions affected when coal and natural gas power plants are cycled more to balance intermittent solar and wind generation? What are the impacts of emissions from DER that use fossil fuels?

This article, the first in a series on environmental issues in the power system of the future, examines EPRI research on air quality effects of fossil DER connected to the grid as alternate and backup power sources. Fossil DER—which make up almost 60% of all DER today—include combined heat and power plants, diesel generators, small single-cycle turbines, microturbines, and fuel cells.

"Some people think that what you don't know can't hurt you, but that is often what hurts you in the end," said Stephanie Shaw, an EPRI senior technical leader who leads the fossil DER air quality research. "If you don't understand the landscape, then you will be unprepared if a challenge emerges later."

To examine future environmental issues comprehensively, EPRI proposes seven factors to consider before any new generation or other infrastructure is added to the grid:

- Changing customer values and attitudes (such as those of the "Prosumers" who produce electricity at their businesses and residences)
- Power plant design
- Permitting
- Construction
- Operations and maintenance
- New and emerging technologies
- End-of-life questions

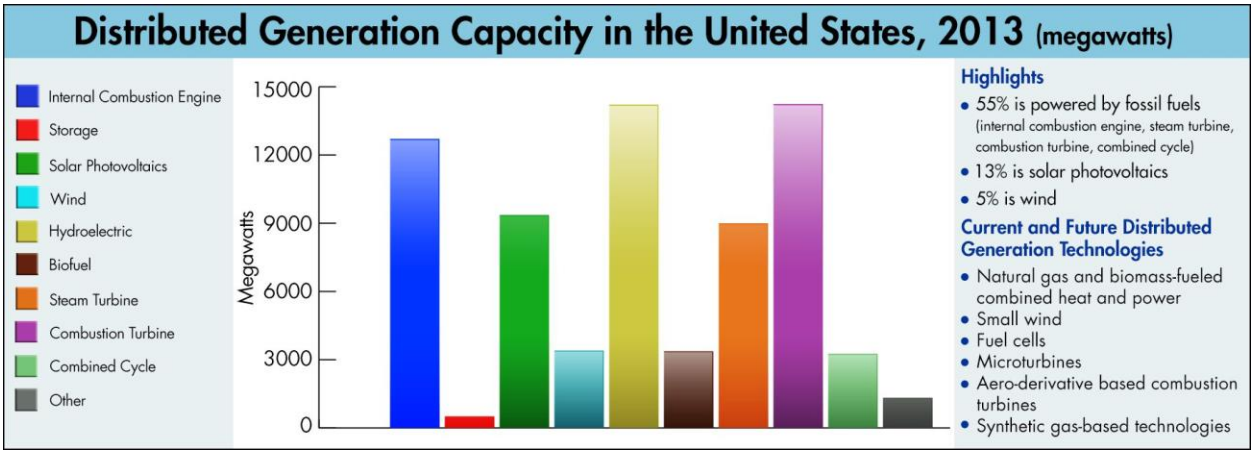
Seven Factors for a Big-Picture Perspective on the Environment

To comprehensively address environmental issues that arise in the future power system, EPRI has identified seven factors to analyze before any generation, distribution, or transmission infrastructure is deployed:

Customer attitudes
Design
Permitting
Construction
Operations and maintenance
New and emerging technologies
End-of-life

A thorough examination of these seven factors can identify multilayered environmental issues that emerge in an increasingly complex power system with two-way power flows. "All we did at the bulk generation level in the past was say that the load is 100 gigawatt-hours, and DER are producing 10 gigawatt-hours, and we would ignore the environmental impact of that 10 gigawatt-hours," said EPRI Chief Sustainability Officer and Environment Vice President Anda Ray. "Now we have to pay attention to the characteristics of this two-way flow because it can mean building more distribution infrastructure, which can also have an environmental impact."

"Electric power companies used to emphasize the principle that everything has to be least cost," said Ray. "The emphasis has shifted as more consumers and investors have environmental sustainability as a value."



Though much of the newly installed distributed generation is solar, fossil-powered distributed generation still accounts for the vast majority of the total. The data is for units less than or equal to 25 megawatts.
Source: U.S. Energy Information Administration

A grid that relies more on distributed resources demands an environmental paradigm shift for society and utilities alike. “The environment used to be considered a hurdle for the industry,” said Ray. “I want to build this new plant; just tell me what I have to do environmentally to ‘check the box’ and move forward. But now the environment is integral to the utility’s overall value proposition, which means that end-of-life and many other issues and costs need to be considered in the design phase of everything that touches the power system.”

EPRI’s multiyear initiative extends across its research sectors and includes a broad range of stakeholders in North America and globally, including power companies, customers, regulators, policymakers, and others. The intent is to pave the way to a cleaner, more robust power system and avoid unintended environmental consequences.

From Tall Stacks to Urban Canyons

Discussion of the changing power system often centers on the addition of renewable DER, especially solar and wind. But a large proportion of distributed generation is also coming from fossil-powered DER, primarily natural gas combined heat and power plants (see chart). Driving this is the desire by energy-intensive industries such as manufacturing and food processing for the most cost-effective energy. For emergency power, hospitals, businesses, residential customers, and others rely on diesel generators.

The spread of these relatively small fossil DER units, which EPRI has defined in its research as 25 megawatts or smaller, raises important air quality questions. The traditional power system has been dominated by large, central coal and natural gas-fired plants, usually located far from population centers, which can offer air quality benefits. “With central station coal or natural gas, you benefit from their tall stacks that release emissions at an elevation of 200 meters,” said Shaw. “Those emissions are going to dilute, react, and change before they reach the ground. Often, the environment can do its work to transform those emissions into something much less harmful, though that’s not always the case.” With continuous emissions monitoring and emissions control devices at these facilities, many impacts are well understood, and air quality has improved in recent years.

Fossil DER often operate at street level near or in cities and towns. Because such emissions can be released into urban canyons created by tall buildings and narrow streets, they are not always subject to the natural dilution that occurs high in the sky. Local and regional air quality impacts of such units are largely unknown, and EPRI launched the first comprehensive examination in 2014.

Shaw lists just a few of the unknowns. “Are fossil DER emissions sufficiently low that the environmental impacts are negligible? Are there emissions controls on these units, and are they needed? Do we have modeling tools to calculate impacts from individual sites? Do we have tools to calculate cumulative regional impacts?”

Generally, fossil DER units must be permitted before going into service. For emergency generators, permits restrict hours of operation and fuel types to minimize air pollution. Growing interest in using fossil DER for demand response—which may entail ramping up and down rapidly to help utilities meet peak demand—has led state and local regulators to reconsider permitting standards. This will require a better understanding of emissions.

In 2014, Shaw and EPRI Principal Technical Leader Eladio Knipping began the three-year initiative by determining what is known about emissions from fossil-fueled DER. These include particulate matter, carbon monoxide, nitrogen oxides, sulfur dioxide, and carbon dioxide. “These devices are not regularly measured,” said Shaw. “So we scoured available emissions information from our utility members and other sources.” This legwork revealed important details about the types and levels of emissions.

Also in 2014, EPRI developed air quality models to characterize emissions within a half-mile of facilities, as well as regional models to predict impacts in areas the size of southern California or the northeastern United States.

Researchers are modeling various scenarios to determine current impacts, as well as impacts in 2035 based on projected deployment of fossil DER.

The Work Ahead

Building on this groundwork, Shaw, Knipping, and their team in 2015 will continue to evaluate model scenarios and begin emissions measurements in the field. The first field site is a 15-megawatt combined heat and power natural gas facility. Although this unit is small relative to a traditional power plant, monitoring it will yield valuable information because emissions tests were conducted when it was commissioned five years ago, and it has been operating regularly since then. “A big question is how these devices age,” said Shaw, adding that she plans to measure emissions at a fossil DER facility participating in a demand response program.

This work seeks to identify future research priorities and provide information to guide practical solutions. Scientifically sound insights on air quality impacts of increased fossil DER can inform regulators as they modify and implement emissions rules. The research can guide utilities as they consider where to install fossil DER units and how much capacity to add in specific locations to comply with air quality regulations. The results can also help inform other EPRI researchers and organizations developing new emissions control equipment for fossil DER.

The work that Shaw and her colleagues are doing today is aimed at guiding choices that lead to an improved future. “If the data show that increased fossil DER is a net positive for the environment, then that helps everyone involved make a better choice,” she said. “And if there are concerns about future air quality impacts, the research can help us provide recommendations to minimize them.”

Key EPRI Technical Experts

Stephanie Shaw, Eladio Knipping