New study suggests ways to mitigate fuel shortages

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In New England, constraints in the supply of natural gas have led to nearly a quarter of all unscheduled power plant outages. In a new study, researchers used data from power plant failures in the 2010s to develop a supply curve of the costs required for generators to mitigate fuel shortages in the region. The study found that storing both oil and gas on-site could reduce dependence by power plants on gas grids in geographic

areas with few pipelines.

The study was conducted by researchers at Carnegie Mellon University (CMU), The Pennsylvania State University, and the North American Electric Reliability Corporation. It is published in *The Electricity Journal*.

"Gas supply issues have affected the ability to generate electricity during times of high demand," says Jay Apt, Professor at CMU's Tepper School of Business and Department of Engineering and Public Policy, who co-authored the study. "For example, it's estimated that the extended cold weather event in January 2014 cost New England electricity ratepayers roughly $1.8 billion."

New England has no native gas production, so fuel assurance for natural gas power plants is an area of concern; half of all installed power plant capacity in the region is fueled primarily by gas and nearly half of all electricity comes from natural gas power plants. When heating demand spikes on key gas supply pipelines to the region, those pipelines cannot always meet all the region's heating demand and demand for power-plant fuel at the same time.

The effect of gas supply constraints on Northeastern power generators can be seen by comparing the average fraction of total unscheduled generator outages due to gas fuel unavailability to those during days of high demand for heating. In recent periods of high electricity and gas demand, unscheduled gas shortages accounted for 5 to 25 percent of all unscheduled generator outages during every hour of those periods.

Dual fuel capability—that is, the ability to burn either oil or gas—is one way to mitigate gas supply shortages, and about a third of ISO New England's natural gas power plant capacity has dual fuel capability (ISO New England is an independent, not-for-profit corporation that manages the high-voltage power system over six New England states). But

building dual fuel storage tanks for the remainder has been considered prohibitively expensive.

In 2019, one of the study's coauthors—Seth Blumsack, Professor of Energy Policy and Economics at The Pennsylvania State University—developed a model to identify where to build distributed gas storage capability in New England. To increase reliability of the interdependent gas and electricity grids, Blumsack and his students identified economically optimal sites for distributed gas storage in the region. They concluded that power plant sites might be the optimal locations for gas storage.

In this study, researchers analyzed a database of historical power plant failures, using data from the North American Electric Reliability Corporation—NERC—a not-for-profit international reliability organization. They determined what the cost of on-site fuel storage at natural gas power plants would have to be to mitigate the worst gas shortages in New England during the seven years studied.

The study assessed 54 gas-fired units operating within ISO New England that had NERC reports of full or partial outages due to unscheduled fuel shortages between 2012 and 2018. For each unit, researchers calculated the overnight capital, fuel carrying, and land costs (when applicable) required for gas generators in the region to assure that fuel supplies using fuel storage systems were sized according to their most extreme fuel shortage failure during the study period. They also examined distributed compressed natural gas storage at generator sites and dual fuel capabilities with oil storage. The researchers compared these costs to those of installing batteries with enough capacity to cover historically observed fuel outages.

The researchers found that approximately 2.4 gigawatts (GW) of ISO New England's gas-fired capacity failed one or more times per year due

to fuel shortages; up to 0.5 GW of these units failed simultaneously on three separate occasions. Of these, approximately 2 GW of gas-fired capacity could be mitigated by on-site fuel storage. Furthermore, gas plants would recoup their investment in oil backup fuel if they were compensated with an additional $3 to $7 per megawatt-hour (MWh) during their normal operations.

Using on-site compressed natural gas storage is more expensive ($7 to $16/MWh). The capital expenses associated with either on-site fuel storage option would be less than installing battery backup for resource adequacy at current battery prices, the study concluded.

"Our estimates differ from previous studies because they are based on actual failure events rather than arbitrary fuel supply durations," explains Gerad Freeman, an Energy Systems Research Engineer at Pacific Northwest National Laboratory, the study's lead author. "As such, they have implications for moving forward on increasing dual fuel capacity to increase the resilience of power systems in New England and other regions with similar gas supply constraints."

The authors note that limitations to this research include that they may oversize the dual fuel storage by basing fuel storage tank sizes on the longest observed gas outage at each unit, that batteries can receive some revenue by providing grid services during non-emergencies, and that compressed natural gas storage might help balance gas supply and demand.

More information: Gerad M. Freeman et al, Could on-site fuel storage economically reduce power plant-gas grid dependence in pipeline constrained areas like New England?, *The Electricity Journal* (2021). DOI: 10.1016/j.tej.2021.106956

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