
# ALLOCATING INVESTMENTS TO ENHANCE ELECTRIC GRID RESILIENCE: AN EQUILIBRIUM FRAMEWORK

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## OVERVIEW


Large-area, long-duration power outages are increasingly common in the United States, and cost the economy billions of dollars each year. Building a strategy to enhance grid resilience requires a better understanding of the optimal mix of preventive and corrective actions, the inefficiencies that arise when self-interested parties make resilience investment decisions, and the conditions under which regulators may facilitate the realization of efficient market outcomes. We develop a bi-level model to examine the mix of preventive and corrective measures that enhances grid resilience to a severe storm. The model represents a Stackelberg game between a regulated utility (leader) that may harden distribution feeders before a long-duration outage and/or deploy restoration crews after the disruption, and utility customers with varying preferences for reliable power (followers) who may invest in backup generators. We show that the regulator's denial of cost recovery for the utility's preventive expenditures, coupled with the misalignment between private objectives and social welfare maximization, yields significant inefficiencies in the resilience investment mix. Allowing cost recovery for a higher share of the utility's capital expenditures in preventive measures, extending the time horizon associated with damage cost recovery, and adopting a storm restoration compensation mechanism shift the realized market outcome towards the efficient solution. If about one fifth of preventive resilience investments is approved by regulators, requiring utilities to pay a compensation of $365 per customer for a three-day outage (about 7 times the level of compensation currently offered by U.S. utilities) provides significant incentives towards more efficient preventive resilience investments.


## BIO

**Dr. Chiara Lo Prete** is an associate professor of energy economics in the John and Willie Leone Family Department of Energy and Mineral Engineering. Her research centers on the economics of energy markets, with a focus on the areas of competition and design of electricity markets, the economics of energy infrastructure resilience, and the impacts of environmental regulations on power generation. Recent work has focused on the development of mathematical models and application of empirical methods to study emission leakage, market structures for wind energy integration, resilience of interdependent natural gas and electric power systems, and cross-product manipulation.