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Grid Modernization for Community Resilience

New Orleans, LA

Sandia National Laboratories, with the encouragement of the National Academy of Sciences, has been working on a mathematical framework to calculate, project, and improve resilience.

Sandia has also developed a method for analyzing and improving urban resilience wherein Sandia, in conjunction with stakeholders, analyzes vulnerabilities and either suggests or provides feedback on resilience enhancing solutions.

Sandia implemented this framework and methodology in a case study of New Orleans to improve community resilience through grid modernizations. Sandia-developed infrastructure models were implemented in this analysis to serve the unique needs of the community to improve their resilience against natural hazards.

Motivation

The electric grid is central in the web of interconnected systems that must operate resiliently to serve the community during times of extreme disruption. Nearly every service that citizens depend on – from medical treatment to dry shelter, food, and clean water – are heavily dependent on electricity.

In the summer of 2005, Hurricane Katrina caused devastating losses to the city of New Orleans and surrounding communities. Challenges that the city faced during the hurricane and its aftermath were exacerbated by electric grid failures. The city of New Orleans recognizes that enhancing the resilience of its power grid infrastructure is essential to improving the overall resilience of its community.

For Katrina alone, total economic losses due to power outages are estimated at \$108 billion. Even more devastating has been the physical and emotional impact to the citizens of New Orleans and other areas wrought by Katrina and other major disasters. Many of these negative consequences can be avoided in the future through effective modernization of the grid.

Community Resilience Analysis

Sandia National Laboratories worked in conjunction with Los Alamos National Laboratories, Entergy, and the City of New Orleans to provide the city with the cost and benefits associated with grid resilience investments. The City of New Orleans' resilience goal is to provide their citizens with critical infrastructure services after a major storm. By connecting grid performance to the performance of multiple

interdependent infrastructures, this work delivered an assessment of techniques to improve community resilience through investments in grid resilience. Sandia applied its Urban Resilience Analysis Process to answer the following questions:

- What are the characteristics of extreme events that would result in the worst consequence to the community?
- In the case of these events, what infrastructure services are disrupted and what is the consequence?
- What are the grid modernization options that will minimize this consequence and improve resilience?

Key Findings

The resilience metrics chosen for this study focus on lifeline services and the ability to support lifeline needs of the community. Sandia analyzed distinct infrastructure subsectors within the lifeline infrastructure services to test their performance subject to the design basis threat.

"Lifeline" Infrastructure Services essential to community resilience	
<ul style="list-style-type: none"> • 911 System • City Emergency Response • Shelter • Finances • Transportation 	<ul style="list-style-type: none"> • Medical Services • Food • Drinking Water • Wastewater • Dewatering

Sandia used three criteria to select areas as candidates for grid modernization upgrades.

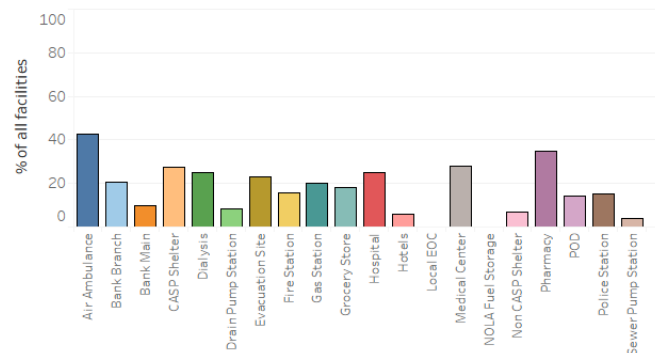
1. The area should have a low probability of inundation.
2. The area should house a large population that needs infrastructure services
3. The area should have a cluster of less inundated infrastructure facilities that would benefit from backup power.

Using these three criteria, Sandia developed a tool to highlight the most impactful areas within the city to build microgrids.



In order to prioritize portfolios of resilience-focused grid modernization solutions in the various analysis zones, Sandia analyzed the fraction of facilities in each zone that would be supported by the suggested resilience nodes. City-wide, there are a wide range of services covered at a considerable level by these resilience solutions.

Percentage of Total Infrastructure Supported by Resilience Nodes



This approach, which includes the urban resilience improvement process developed at Sandia, applies the latest in resilience science and requires a high level of technical assistance. The benefit will be resilience investments that result in decreasing the number of citizens without critical services during the next major storm in New Orleans, meaning that taxpayer dollars are spent more beneficially and with a positive long-term return on investment.

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