



Protecting grid reliability with next-generation modeling

North American Energy Resilience Model

THE OPPORTUNITY

Complex, multiscale interactions are at the core of today's rapidly changing energy landscape. These interdependencies mean greater complexity in energy delivery. Couple this complexity with aging infrastructure and the threat of outages caused by natural disasters, malicious attacks, and climate change and it means vulnerability in the nation's electricity system, putting millions of Americans at risk who rely on the system's consistent operation.

Complexity and vulnerability in energy delivery necessitates a new generation of modeling tools that can ensure power system reliability. The need for forward-looking modeling tools is further validated by the nation's shift toward clean energy and the uncertainty associated with variable renewable generation.

THE SOLUTION

To meet the nation's electricity resiliency needs, the Department of Energy (DOE), Office of Electricity created the North American Energy Resilience Model (NAERM). NAERM is a comprehensive modeling system for U.S. energy and communications infrastructure for use by energy system planners, operators, and government stakeholders. NAERM supports electricity reliability by modeling the associated resiliency of numerous U.S. energy sources.

NAERM helps to ensure electricity system reliability by::

- Identifying key interdependencies between different parts of the nation's energy system and their vulnerabilities.
- Understanding the impacts of natural disasters, such as wildfires and earthquakes, as well as man-made threats to the U.S. energy system.
- Reconstructing natural disasters and exploring additional mitigation options for future preparation.
- Utilizing modeling data, in light of increasingly intense and frequent weather patterns, to better guide investments in energy resiliency.
- Supporting national efforts to integrate renewable energy, distributed energy resources, and other elements of grid modernization.

NAERM was developed to answer the hardest reliability challenges specific to the nation's energy sector. It builds on numerous DOE tools and data sets, bridging the gap to combine multiple modeling and analysis capabilities and creating a full, comprehensive solution for analyzing threats.



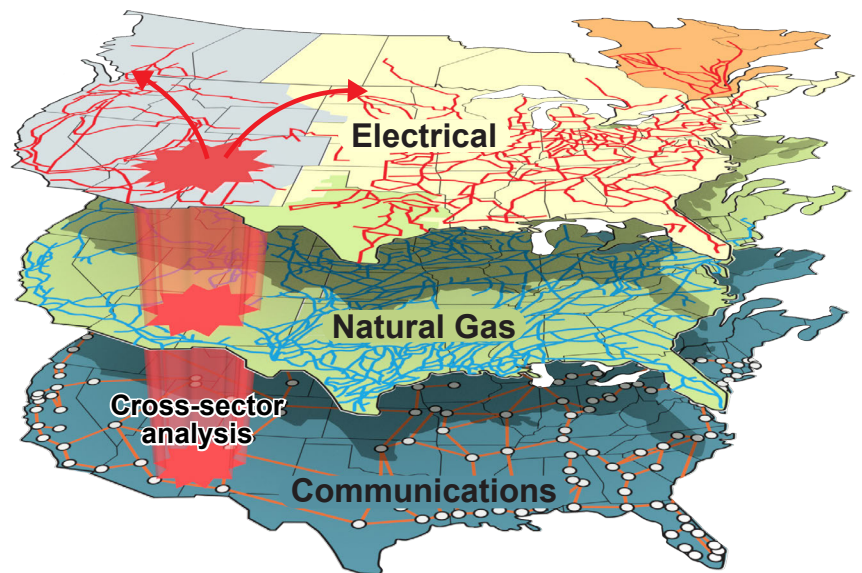
The nation's energy resilience depends on national-scale energy planning and situational awareness capabilities for rigorous and quantitative assessment, prediction, and improvement. An ambitious initiative led by DOE, NAERM will provide this unique and ground-breaking capability to ensure reliable and resilient energy delivery across multiple sectors, spanning multiple organizations and authorities, while considering a range of large-scale, emerging threats.

– Presidential Policy Directive—Critical Infrastructure Security and Resilience

THE APPLICATION

NAERM combines multiple energy and interdependent infrastructure models with system data and realistic threat scenarios to provide actionable information. By providing cross-sector analysis of the nation's electrical, natural gas and communications systems, NAERM can rapidly predict energy system interdependencies, consequences, and responses to reduce risk of extreme events at a national scale.

Government agencies and energy system planners and operators can utilize NAERM to better guide their planning and decision-making.



System Planners

Energy system planners have the tools to understand how their decisions can impact the resilience of their energy delivery systems and make more robust plans for responding to threats. NAERM allows them to engineer more robust solutions to enable rapid restoration and recovery.



System Operators

Energy system operators rely on NAERM capabilities to better identify, respond, and curtail potential threats. Operators can make risk-informed decisions during and after an event, as well as minimize large-scale impacts during an event.



Federal and State Agencies

Federal and state agencies can use NAERM to provide national-scale insights to inform and coordinate emergency response, including for rapid recovery from disasters. Agencies can better determine what help is needed before, during, and after the threat occurs.

THE USE CASES

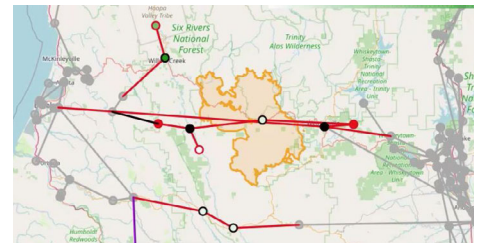


Wildfires

NAERM's identification and analysis of high-impact contingencies associated with wildfires ultimately supports optimal allocation of budget toward hardening infrastructure.

Monument Wildfire

The Monument Wildfire was caused by lightning in Northern California in July 2021. The resulting wildfire exhibited a full spectrum of potential impacts to numerous individuals and fire and emergency facilities in surrounding area. It became critical to enable straightforward verification and validation. NAERM was used to analyze associated extreme events and contingencies and perform critical component identification to optimize investments toward hardening existing assets.

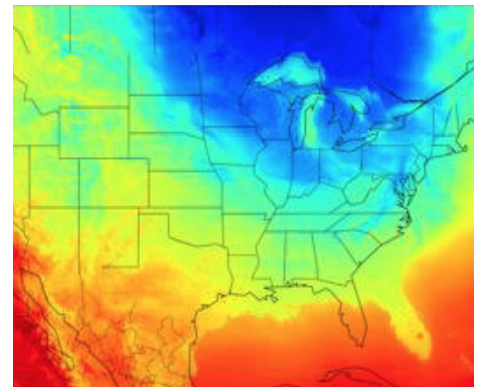


Extreme Cold Weather

With NAERM's cold weather characterization capabilities, co-simulation of potential power delivery failures, and resilience evaluation users can accurately develop contingency scenarios and evaluate mitigation and investment options.

Northeastern Cold Wave

New England continues to experience extreme cold weather events that have tightened electric power generation and gas supplies. It became necessary to assess the resilience of combined power and natural gas systems during this type of extreme weather and evaluate the resiliency and benefit of mitigation and investment options. NAERM was used to identify contingencies that would exacerbate capacity limitations during cold weather events. Co-simulation was then performed to evaluate electric power and natural gas systems and analyze proposed mitigation, such as dual fuel units, wind turbine winterization, and more. NAERM helped to inform energy planners on the compounding risks of cold weather impacts to generation infrastructure and increased demand, as well as guide mitigation strategies.



THE TECHNOLOGY

NAERM was developed using a secure, cloud-based architecture to provide analysts with state-of-the-art modeling tools. These tools quantitatively assess impacts from current and future risks by integrating numerous government and commercial computer models, databases and sensor streams to present a comprehensive picture of the nation's energy delivery systems.

NAERM is organized around three major capabilities:



Multi-Infrastructure Planning Modeling

Analyze options to affect energy resilience, improve rapid restoration and recovery, and enable risk-informed planning and coordination to mitigate large-scale energy disruptions (e.g. earthquakes, wildfires).



Data and Analytics

Store and analyze wide-range of data to support resilience analysis. Data layers include modeling databases for bulk electric system, generation, natural gas pipelines; cell, fiber communications; weather forecasts, icing; hospitals, roads. Analytics include graph analysis and machine learning.



Software and Computing Architecture

Enable a complex, multi-component software system focused on security, integration, scalability, and open architecture that leverages existing commercial and open-source software and commercial and government cloud services.

THE TEAM

NAERM leverages the capabilities and know-how of subject matter experts across eight national laboratories and partners at federal agencies, Power Marketing Administrations, and the private sector to deliver NAERM's national-scale energy modeling capabilities.



PARTNERS

- Partnered Institute or Other
- Partnered Institute or Other
- Partnered Institute or Other

LEARN WHAT NAERM CAN DO FOR YOU

Interested in how NAERM can provide you with accurate and timely information to improve energy delivery resilience?

Contact DOE for more information, a presentation, webinar, or in-person meeting.