

Storm-DEPART (Damage Estimate Prediction and Recovery Tool)

Product/category

- Software/Services
- Special Recognition – Market Disruptor-Products

Primary submitting organization:

Idaho National Laboratory

Product/services brand name:

Storm-DEPART (Damage Estimate Prediction and Recovery Tool)

When product was introduced to the market:

January 2023

Abstract:

Hurricanes, ice storms, and other severe weather events are incredibly destructive to the power grid, but efficient, targeted planning for response and recovery can dramatically mitigate much of the damage that follows in their wake. Storm-DEPART is an incident-tested, data-driven tool designed to improve decision-making when preparing for major tropical and ice weather disasters and focus restoration resources where the need is anticipated once they happen.

Executive summary:

Storm-DEPART is the most-comprehensive tool yet for helping electric-service utilities prepare for weather-related disasters and respond to and recover from hurricanes and major ice storms. By aligning situational awareness and decision making, the outcome is quicker restoration of businesses and communities to normal, preserving lives and millions of dollars.



Figure 1: Storm-DEPART helps utilities improve their decision-making for anticipated extreme weather events.

Utilities now have the capability to better prepare for and respond to disruptive events, increasing the overall resilience of the nation's electric-power grid. Improved recovery times and shorter restoration times offer a widespread and equitable benefit, helping community members at every economic level.

Additional supporting materials:

[Storm-DEPART article](#)

Video:

https://youtu.be/EsVHVpWQIFw?si=cYzK3zHmr_iIV_iM

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What does this product or technology do?

In the aftermath of any weather-related major disaster, time is what determines the human and economic toll of extended power outages. Storm-DEPART's power is to get the electric grid in an expanded impact area back on as fast as possible by reducing the restoration time with a priority on such major community-lifeline sectors as health care, drinking water, wastewater treatment, emergency services and communications. Developed at the Idaho National Laboratory, Storm-DEPART—short for Storm Damage Estimate Prediction and Recovery Tool—is a platform that uses historic incident-response data and utility provider's unique response profile to forecast where hurricanes and ice storms are likely to do the most damage and where the right resources will be needed. It gives its users the ability to predict and estimate in pinpoint, time-phased response detail the personnel and materials needed to restore normal operations and the length of time required for optimal recovery.

To shorten power outages and associated essential-services impacts, Storm-DEPART pairs reliable modeling capabilities with an electric utility's unique storm-response configurations—i.e., how the provider deploys predetermined crews and materials (poles, power lines, etc.) within and across service areas. In the face of a severe storm or ice event, it assesses potential damage to power plants, transmission grids and distribution networks. With this detailed information, communities and utilities are equipped to efficiently allocate resources and optimize recovery efforts for the critical services on which customers depend.

In addition to predicting the severity of the impact to the power grid of an impending severe weather event, Storm-DEPART can model hypothetical



Figure 2: Storm-DEPART uses historic incident-response data to forecast damages to critical utility resources.

“While many modeling tools exist to help utilities plan and recover from such events, Storm-DEPART fills a unique gap: supporting electric utility providers in predicting damage and optimizing personnel and resource deployment at the individual company level.”

— Tom Moran, Executive Director, All Hazard Consortium

scenarios arising from major weather events during steady-state operations to inform resilience enhancements and incident-response plans. What this means is that Storm-DEPART can calculate a range of damage and recovery estimates for weather events of varying severity. This not only gives stakeholders a tool for preparation and mitigation; it supplies data that can aid and inform electric-grid resilience investments.

The cost is beyond simple economics. Storm-related electric-service disruptions have cascading effects on critical services such as drinking water, transportation, communications, healthcare and emergency-services response. They also put critical supply chains at risk. In addition to hurricanes, winter ice storms and other weather events disrupt service to millions.

In 2024, 11 hurricanes, five of them Category 3 or higher, caused an estimated \$129.5 billion dollars in damage in the United States. Because of the size and strength of some of the storms, even inland communities found themselves affected. The proportion of hurricanes reaching Category 3 or higher (considered major hurricanes) has increased significantly since 2010, and hurricanes are now observed to rapidly intensify more quickly, making them harder to predict and prepare for as the nation's limited response and recovery resources are expended at accelerated rates. Given the rising toll of devastation, the need for a tool like Storm-DEPART grows more urgent every year.

How does the product operate?

To restore power as quickly as possible, nothing helps more than reliable modeling based on electric-service providers' detailed storm-response configuration data. What makes Storm-DEPART innovative is its ability to pair utility providers' infrastructure data sets with algorithms that can guide effective and efficient response and recovery. Storm-DEPART can both predict and estimate the level of recovery support needed to restore normal operations, including time, materials and resources, based on a utility provider's restoration priorities. It can identify materials and personnel needed to recover based on target restoration days and produce an arrival and availability-to-work schedule for these resources.

Following three hurricanes in 2020 and 2021 (Laura, Delta and Ida), Entergy, a Louisiana-based utility serving 3 million customers across three states, asked INL to help them develop modeling for damage-estimate prediction and recovery support. The utility shared vital data, including distribution, transmission-infrastructure, and power-generation information.

Considering such factors as wind speed, pole and transmission-line types and attachments and repair requirements, Storm-DEPART helps utilities predict damage to transmission, distribution and power-generation infrastructure. Storm-DEPART takes all that information—in this case, more is always better—and provides detailed predictions of the resources required for the fastest response and recovery, based on the unique restoration priorities of each service area and community. Particularly valuable is its ability to predict damage to transformers, the most-expensive and difficult to replace pieces of equipment in any disaster.

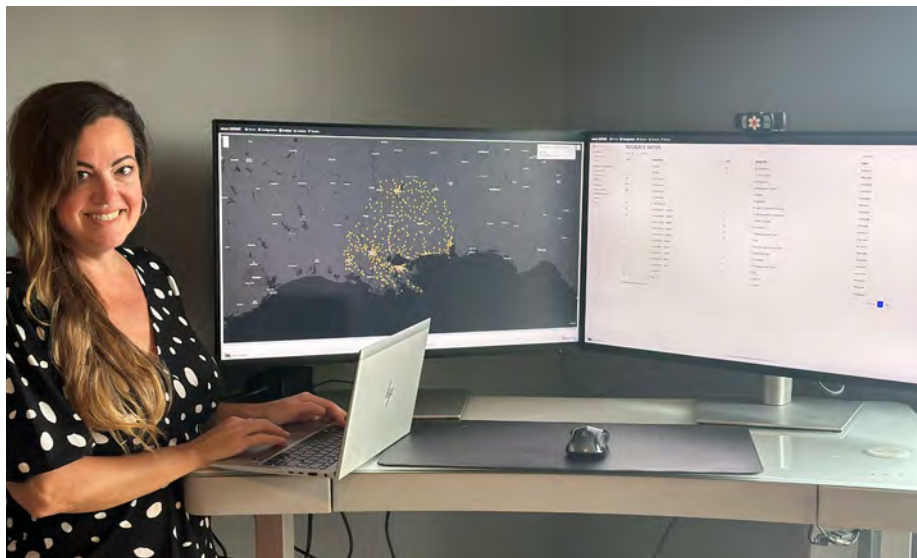


Figure 3: Storm-DEPART can estimate the level of recovery support needed to restore operations.

"I commend INL for developing a unique solution to Entergy's challenge of effectively modeling damage estimate prediction and recovery support after experiencing three hurricanes in two years. Fortunately, electric service utilities now have capability to better prepare for and respond to disruptive events impacting critical infrastructure across the country, saving millions of dollars in disaster response expenditures annually, by increasing the overall resilience of the Nation's electric power grid serving millions of customers. More importantly, critical service providers dependent on electricity and communities of all economic standing benefit from reduced restoration times."

— Tom Moran, Executive Director, All Hazard Consortium

A sample scenario: Storm-DEPART predicts that a given region in eastern Louisiana in a Category 4 storm is likely to sustain damage to 1,500 poles, 600 transformers and 1,000 crossarms. The tool then lays out the resources required to fix that damage, including the number and type of personnel, the materials needed and the time required to complete the job.

Over the past two years, Storm-DEPART has served as Entergy's primary response-and-recovery tool for two hurricanes and four winter ice incidents. In its first hurricane-related use—and its first use beyond modeling

historical storms—Entergy in 2024 used Storm-DEPART in its response to Beryl (July 8, Category 1, landfall near Matagorda, Texas) and Francine (September 11, Category 2, landfall near Terrebonne Parish, Louisiana).

"[Storm-DEPART] helps us define materials needed, along with resource allocation modeling for optimized recovery from weather events," said Pete Norgeot, Entergy's chief operating officer. "We believe that this tool will have far-reaching impacts in Entergy and across the broader utility industry."

How does the product improve upon competitive products or technologies?

Storm-DEPART diverges from the conventional approach by emphasizing a model focused on each service provider's unique response configuration. Its focus is not weather but infrastructure-restoration complexities.

A 2024 industry review stated Storm-DEPART was the only storm-damage prediction capability that addresses all six key modeling requirements: organization modeling, geospatial weather-forecast input, tropical-and winter-storm modeling, logistics scheduling, resource-needs calculation, and distribution-, transmission- and generation-damage prediction.

Two crucial components serve as Storm-DEPART's foundation: damage prediction and response-resources allocation. In contrast to traditional weather-event approaches, Storm-DEPART can adjust restoration times based on a storm's unique impact characteristics and the communities being impacted. By adjusting the number of restoration days, it automatically adjusts the resources (crews, materials, etc.) needed to restore services over a selected time period.

In addition to meteorological data provided by organizations such as the National Hurricane Center and National Oceanic and Atmospheric Administration (NOAA), Storm-DEPART accesses granular utility resource data—things as simple as available personnel (crews) and materials (poles, vehicles, etc.)



Figure 4: Storm-DEPART addresses all key modeling factors to accelerate recovery time.

“The tool is unique in that it predicts damage, identifies material needs, and estimates resource requirements to meet a desired restoration time frame. The tool also provides us a unique opportunity to predict customer outages in a manner that is useful to customers and community officials.”

— Louis Dabdoub III, Vice President, Incident Response, Entergy

By reducing a community's power-restoration time, Storm-DEPART's most-important benefit is reduced post-incident loss of life and the lessening of aggravated medical conditions attributed directly or indirectly to extended power outages. Afterward, millions of dollars can be saved by avoiding the over-deployment of resources from across the country,

deployed under mutual-aid compacts. Starting in 2025, Storm-DEPART is now a core capability under the Department of Energy, Grid Deployment Office's program to provide damage-mitigation technical assistance to electric utility providers, which is executed by INL.

Provide a matrix demonstrating how key features compare to other products:

Product	Organization Modeling	Geospatial Weather Forecast Input	Tropical and Winter Storm Modeling	Distribution, Transmission and Generation Damage Prediction	Logistics Scheduling	Resource Needs Calculation
Storm-DEPART	✓	✓	✓	✓	✓	✓
GE's Disruption Prepare GridOS® protect-against-disruption.pdf (ge.com) Power Grid Disruption Software GE Vernova	✗	✓	✓	Partial – shows what is in the path and historical trends	✓	No
Hurricane Outage Prediction Model Improving the Hurricane Outage Prediction Model by including tree species - ScienceDirect	✗	✓	Tropical storm only	No – predicts outage areas and not damages	✗	✗
Hazus Hurricane Model Hazus FEMA.gov FEMA Hazus Factsheet: Hazus for Hurricane Modeling Hazus Hurricane Model User Guidance (fema.gov) Rapid Assessment of Hurricane Damage and Disruption to Interdependent Civil Infrastructure Systems Journal of Infrastructure Systems Vol 21, No 4 (ascelibrary.org)	✗	✓	Tropical storm only	Power generation buildings only	✗	✗
Spatially Generalized Hurricane Outage Prediction Model Improving Hurricane Power Outage Prediction Models Through the Inclusion of Local Environmental Factors – PubMed (nih.gov) Predicting Storm Outages Through New Representations of Weather and Vegetation (nrel.gov) untitled (ieee.org)	✗	✓	Tropical storm only	No – predicts outage areas and not damages	✗	✗
HurrD https://unocity.us/#!/HurrD	✗	✓	Tropical storm only	No – predicts outage areas and not damages	✗	✗
DTN Storm Risk https://www.dtn.com/weather/utilities-and-renewable-energy/storm-risk/	✗	✓	✓	Has damage prediction listed, but not what types covered	✗	✗

What are the limitations of the product/service?

As is the case with any modeling tool, the chief limitation Storm-DEPART faces is the quality of the data provided by utilities. Because it applies its damage prediction methodology against an organization or entity's asset inventory, the more data it has, the more accurate its predictions and prescriptions will be. There is still information to be integrated, such as vegetation concentrations impacting the wind damage to infrastructure. At present, these data points are merely snapshots in time that are periodically updated by the electric-service provider. To fine-tune the methodology, developers are in the process of incorporating a direct feed as well as a loop back to follow damage assessment.

Storm-DEPART calculates resource needs for post-landfall response and recovery based on the number of target days required for restoration of each service area within the overall impacted disaster area. After using historical-storm weather and damage data in exercises and post-incident reviews, participating utilities determined it would be useful to have an additional method for prioritizing the redistribution of resources while determining the number of restoration days needed by network. There have been ongoing discussions regarding prioritization with an eye toward adding this feature in future releases.



Figure 5: Storm-DEPART has been used by the Louisiana-based utility Entergy to improve their response to two hurricanes.

“Storm-DEPART directly addresses the significant challenge of providing reliable modeling capabilities focused on each electric utility’s unique storm response configurations to reduce power restoration times effectively and efficiently.”

— Brian E. Hoff, VP of Product Management, GE
