UCONN

EVERSOURCE
ENERGY CENTER

Annual Report 2025

Contact

Eversource Energy Center

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Welcome

Dear Friends,

As the new Interim Director of the Eversource Energy Center (EEC), I am pleased to extend you a warm welcome to the 2025 EEC Annual Report, which spotlights the Center's projects, celebrates our new achievements, and shares the latest news about our steady and continuous progress.

Today, the Eversource Energy Center serves as a premier partnership between Eversource Energy and the University of Connecticut, fostering a dynamic, interdisciplinary environment in which faculty, postdoctoral scholars, and graduate and undergraduate students collaborate with industry professionals to address the evolving challenges faced by the electric power sector. The Center's mission is to advance electric utility preparedness and response, strengthen and modernize infrastructure, and support the development of an intelligent, interactive, automated, reliable, and secure electric grid. This work is ever more vital as the Center responds to the growing frequency and severity of extreme weather events, the expansion of electrification and automation, the heightening of cyber and physical security risks, and a changing regulatory and policy landscape.

The year 2025 was a transformative one for the Center, filled with great accomplishments and exciting new developments. Our founding director, Professor Emmanouil Anagnostou, advanced to a leadership role as Director of the Institute of the Environment and Energy (IoEE), to whose mission the EEC now actively contributes. Our experienced faculty successfully pursued new directions and secured several competitive awards, demonstrating resilience and innovation in the wake of unprecedented funding reductions. Our students published a record number of scholarly articles, showcasing the international visibility and significance of the Center's research.

We invite you to explore this Annual Report as a reflection of the dedication and collaboration that defines us. As you will read here, the Center is continuing to advance cutting-edge research and interdisciplinary innovation, delivering solutions that will shape a more resilient, secure, and intelligent future energy system.

Diego Cerrai, Ph.D.
Interim Director, Eversource Energy Center

Contents

Who We Are

We are a hub for innovative and progressive thinking to build the electric grid of the future, today.

The **Eversource Energy Center** is the United States' leading partnership between an energy utility and a University. A trusted source of energy expertise, we strive to advance new research and technologies to ensure reliable power during extreme weather and security events. The Center takes a consortium approach, creating partnerships, developing next-generation technology and software, and collaborating to meet current and future reliability and energy needs.

Our Team

Principal Investigators

Department of Agriculture & Resource Economics

Kimberly Rollins, Emeritus Professor, Department Head

Shinsuke Tanaka, Assistant Professor, Director of Graduate Studies

Department of Anthropology

Eleanor Shoreman-Ouimet, Assistant Professor, Associate Director of the Institute of the Environment and Energy

School of Civil and Environmental Engineering

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Amvrossios Bagtzoglou, Professor, Grid Resilience Team Lead

Diego Cerrai, Assistant Professor, Interim Director of the Eversource Energy Center

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Guiling Wang, Professor

Wei Zhang, Associate Professor

School of Computing

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Fei Miao, Associate Professor

Dongjin Song, Associate Professor

Department of Ecology and Evolutionary Biology

Mark Urban, Professor

Department of Electrical and Computer Engineering

Ali Bazzi, Professor

Yang Cao, Professor

Sung-Yeul Park, Associate Professor

Zongjie Wang, Assistant Professor, Associate Director of the Eversource Energy Center

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Department of Natural Resources and the Environment

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Wei Ren, Associate Professor

Chandi Witharana, Assistant Professor

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Lyle Scruggs, Professor

Institute for Rural and Regional Research & Connecticut Center for Economic Analysis

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Ning Ding

Yingrui Fan

Shaya Abou Jawdeh

Kalinath Katuri

Yue Li

Yitong Liu

Yongjie Lu

Arman Moradpour

Yansong Pei

Niranjan Raghunathan

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Ellios Manos

Harshana Wedegedara

Zhengxuan Wu

Brandon Younan

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Bendong Tan

Kingsley Udeh

Altan Unlu

Tasnim Zaman

Center Research Staff

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Malaquias Peña, Associate Research Professor

Xinxuan Zhang, Assistant Research Professor, jointly with Department of Civil and Environmental Engineering, Manager of the Eversource Energy Center

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Tyler Justice, Pre-Award Specialist

Natalka Tuczkewycz, Grants and Contracts Associate

Collaborators

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Platon Patlakas, Adjunct Assistant Research Professor

Osvaldo Pensado, Program Manager, Southwest Research Institute

Raymond V. Petniunas, Member, Academy of Distinguished Engineers

Giulia Sofia, Adjunct Assistant Research Professor, University of Connecticut

Craig Tremback, Scientific Consultant, RAMS & WRF

Peter Watson, Scientist, Los Alamos National Lab

Feifei Yang, Adjunct Assistant Research Professor

Milestones 2025

Our Center originated from a partnership between Eversource Energy and the University of Connecticut, with the purpose of enhancing electric utility preparedness, hardening infrastructure, and embracing the grid of the future: intelligent, interactive, automated, reliable, and safe! The Center comprises experts at universities, state organizations, and the electric utility industry, collaborating within the framework of a Center of Excellence. Marshaling the expertise of these various stakeholders through an integrated analytical approach enables us to advance forecasting tools, proactively manage risk landscapes, and embrace new technologies, yielding strategies and actions to manage severe weather hazards. Importantly, research at the Center features a dynamic vision: It accounts for climate evolution, as well as the changes in exposure and vulnerability to extreme weather events associated with different societal activities and demographics.

Key Initiatives

Several projects funded by federal agencies and by industry partners were awarded in FY2025 to faculty affiliated with the Eversource Energy Center. Our faculty also continued to work on projects awarded in previous years, as well as on the Eversource projects started in 2023.

Eversource Projects

Eversource Energy supported 20 projects in FY2025, covering five thematic areas:

- Grid Resilience in a Warming Climate
- Grid Reliability in a Changing Demand Environment
- Renewable Energy Integration
- Cyber-Physical System Security
- Workforce Training, Outreach, and Policy

Sustainable Clean Energy Summit

On October 27, 2025, the University of Connecticut and Eversource hosted the fourth annual Sustainable Clean Energy Summit in conjunction with the 57th North American Power Symposium (NAPS 2025). Participants included UConn students and faculty, as well as federal program directors, public utility commissioners, and senior leaders from utilities and independent system operators (ISOs). The Clean Energy and Sustainability Innovation Program (CESIP) award was conferred upon graduate students Azeem Sarwar, Maham Liaqat, and Muhammad Hassan for their research entitled, "UConn's Wastewater to Bioenergy: Integrated Chlorella Cultivation and Pyrolysis." They will receive additional funding from Eversource to continue their work.

Grid Modernization Certificate

The Power Grid Modernization Certificate Program continues to strengthen its mission, engaging utility professionals through a curriculum focused on emerging power-sector challenges. Since Spring 2022, the Certificate Program has enrolled twenty-five participants. Two have earned their Master of Engineering degrees, and three are currently enrolled in the master's program.

Our Sponsors

Eversource (principal sponsor)
Avangrid
Connecticut Department of Emergency Management and Homeland Security
Connecticut Department of Energy & Environmental Protection (DEEP)
Connecticut Department of Public Health
Dominion Energy
Electric Power Research Institute (EPRI)
Exelon
Federal Emergency Management Agency (FEMA)
Goeppert
Google
Housatonic Valley Association
Hydro One
ISO New England
Johnson & Johnson
Lenovo
National Academy of Engineering
National Aeronautics and Space Administration (NASA)
National Geographic Society
National Oceanic and Atmospheric Administration (NOAA)
National Science Foundation (NSF)
New York City Housing Authority
New York State Energy Research and Development Authority (NYSERDA)
Puerto Rico Electric Power Authority (PREPA)
Schmidt Futures
Schneider Electric
Sloan Foundation
Sony
South Central Connecticut Regional Water Authority
Town of Lenox, Madison County, New York
Travelers
TRC Companies
United Illuminating Company
U.S. Department of Agriculture (USDA)
U.S. Department of Defense (DOD)
U.S. Department of Energy (DOE)
U.S. Department of Homeland Security (DHS)
U.S. Department of the Interior (DOI)
U.S. Environmental Protection Agency (EPA)
U.S. Geological Survey (USGS)
Weather and Marine Engineering Technologies
Woodwell Climate Research Center

Strategic Partnerships

The Center is continuing its collaboration with the Electric Power Research Institute and the University at Albany Atmospheric Research Center in the areas of offshore wind energy, water conservation, and grid vulnerability and the operations of the newly established NSF Industry-University Cooperative Research Center (IUCRC) on Weather Innovation and Smart Energy and Resilience (WISER). The Center is also continuing its partnership with Exelon for developing an outage prediction model and estimating the effectiveness of grid resilience initiatives for southeastern Pennsylvania, southern New Jersey, Maryland, Delaware, the District of Columbia, and Illinois. In addition, we have developed an institutional partnership with the National Renewable Energy Laboratory (NREL) that will facilitate joint appointments for UConn faculty in this national lab.

Avangrid

Avangrid serves more than 3.3 million customers across the New York and New England regions. It cosponsors with NYSERDA a project to develop and demonstrate an outage prediction model for power outages caused by rain-wind, thunderstorm, and snow-ice events across the New York service territory. The Center collaborates with the University at Albany Atmospheric Research Center on this project.

Electric Power Research Institute

The Electric Power Research Institute (EPRI) is an independent, nonprofit organization in the public interest that conducts research on electricity generation, delivery, and use in collaboration with the electricity sector, its stakeholders, and others focusing on electric power safety, reliability, and affordability and the nexus between electric power and the environment. In 2020, the Center established a research collaboration with EPRI to provide complete and accurate information on the vulnerability of the electric grid to weather extremes and assess trends in power outages and efforts needed to maintain reliable energy delivery. After demonstrating our methodology over the northeastern United States, for which our team holds many years' worth of outage and electric infrastructure data from Eversource Energy and the United Illuminating Company, we have been working to extend this effort nationwide.

Exelon

Exelon Corporation, with its 10 million customers across six states, is the largest regulated electric utility in the United States. Exelon owns six subsidiaries: Atlantic City Electric, Baltimore Gas and Electric (BGE), Commonwealth Edison (ComEd), Delmarva Power, PECO Energy Company (PECO), and Potomac Electric Power Company (Pepco). In 2023, BGE sponsored a project for performing research on weather and resilience analysis and for developing and piloting the UConn OPM for outage forecasting and resilience improvement assessment in the contiguous Exelon territories along the North Atlantic Coast. In 2024, ComEd sponsored a project to conduct outage prediction modeling research in its Illinois service territory.

National Laboratory of the Rockies (NLR)
NLR is a research and development center funded by the U.S. Department of Energy and operated by the Alliance for Sustainable Energy, located in Golden, Colorado. It is home to the National Center for Photovoltaics, the National Bioenergy Center, and the National Wind Technology Center. The UConn-NLR Partnership for Clean Energy Innovation and Grid Resilience will leverage scientific knowledge and state-of-the-art facilities to solve complex, multidisciplinary challenges in energy efficiency and resiliency, renewable energy technologies, and smart grid innovation.

University at Albany Atmospheric Sciences Research Center
The Atmospheric Sciences Research Center (ASRC), of the State University of New York at Albany, was established in 1961 by the Board of Trustees of SUNY as a systemwide resource for developing and administering programs in basic and applied sciences related to the atmospheric environment. In 2020, ASRC and the Eversource Energy Center submitted a proposal to the National Science Foundation for a planning grant to form an Industry-University Cooperative Research Center (IUCRC) for Weather Innovation and Smart Energy and Resilience (https://wiser-iucrc.com/). Following the awarding of the grant, planning activities took place between 2021 and 2022. The WISER Center was established in 2023 and is supporting research in the areas of renewable energy, outage management, grid resilience, and climate change.

2025 Center by the Numbers

Publications and Patents 2016-2025

Peer-reviewed papers	317
Patents	7

Awarded Amounts

2016-present	$67,351,746
Proposals pending	$48,246,916

Students 2025

Undergraduates	4
Graduates	75

Expenditures 2025

FY2016	$998,059
FY2017	$2,158,683
FY2018	$2,423,839
FY2019	$2,454,938
FY2020	$2,156,234
FY2021	$2,366,012
FY2022	$3,508,000
FY2023	$3,418,186
FY2024	$3,426,085
FY2025	$3,723,502

Storm Readiness

As ever, predicting outages and severe weather and enabling utilities to cope with storm impacts lie at the heart of the Eversource Energy Center's mission. Here is the latest in those crucial areas.

Rain-wind	APE_50	Thunderstorm	APE_50	Winter	APE_50
CT	36%	CT	32%	CT	39%
EMA	41%	EMA	34%	EMA	45%
NH	38%	NH	38%	NH	36%
WMA	37%	WMA	36%	WMA	49%
All territories	38%	All territories	34%	All territories	36%

Performance evaluation table for OPMs, including different storm models across Eversource Energy service territories. The models are assessed using a major key accuracy measure—Median Absolute Percentage Error (APE_50), which is the middle value for prediction errors. As the table shows, the OPM project has already delivered significant improvements over prior models on the median absolute percentage error across all storm types.

In All Kinds of Weather, Everywhere
The OPM Project Marches On

Extreme weather can knock out electricity for thousands of homes and businesses, disrupting lives and critical services. In the United States, weather-related power outages cost the economy an estimated $18 billion to $70 billion annually, with the frequency and severity of multi-billion-dollar disasters steadily increasing over the past two decades.

Ten years ago, Eversource Energy Center researchers at the University of Connecticut introduced the Outage Prediction Model (OPM) to address the serious problem of power outages caused by severe weather. This initiative has since grown into a sophisticated strategy that models the interplay of weather, land conditions, infrastructure, vegetation, and power outages to ensure consistent power supply during extreme events.

Using high-resolution datasets, the OPM project develops machine learning models tailored to different storm types for utilities that so far include Avangrid in New York; Dominion Energy in Virginia and North Carolina; Eversource Energy in Connecticut, Massachusetts, and New Hampshire; and Exelon Energy in the mid-Atlantic. These models predict outages up to 120 hours in advance, strengthening resource planning and speeding up restoration efforts. The result is reduced economic losses and more reliable service, with emergency managers better equipped to assess weather impacts and improve their communication with customers and regulators.

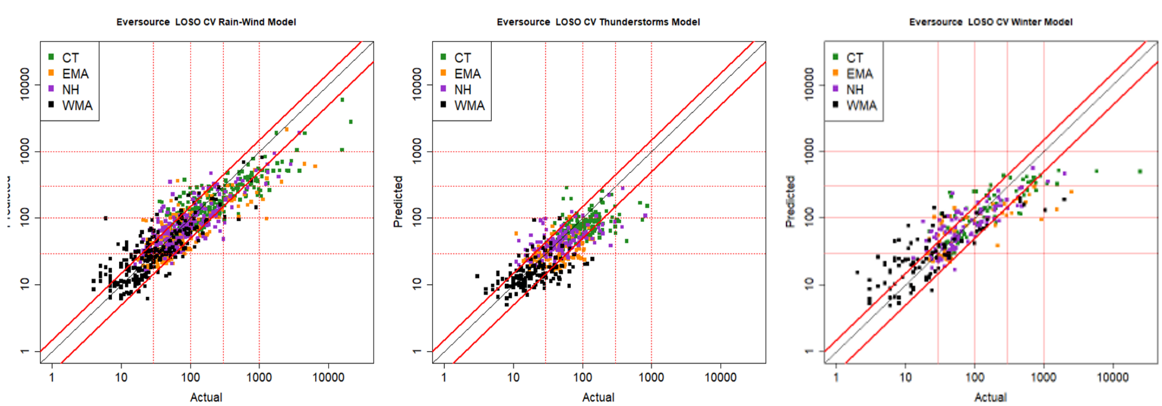
Recent advances by the OPM project have centered on enhancing the accuracy and reliability of these predictive models. While the core objectives of improving outage prediction and utility readiness remain unchanged, the methodology has evolved. The project now emphasizes customizing models to address the distinct challenges of each utility's geographical and infrastructural context by integrating into them specific storm characteristics unique to the utilities' service areas, starting with territories served by Eversource. By categorizing input features for different storm types in their designs, the models can be fine tuned accordingly. Following this approach, the winter OPM has evolved into separate models for dry, snowy, and rainy conditions. Likewise, the thunderstorm and rain-wind OPMs were trained using carefully chosen features and well-tuned machine learning tools. As a result, the errors found in earlier models have been greatly reduced.

The OPM project is actively improving how we measure and evaluate system performance, with a focus on enhancing the reliability of power management. Our team is also exploring innovative techniques to ensure more consistent and efficient energy delivery.

***Machine learning** is a branch of artificial intelligence (AI). It involves developing algorithms that allow computers to identify and learn from patterns in sample (training) data, based on which they can make predictions whose accuracy increases as they learn.*

In the upcoming phase, we aim to deliver valuable insights and technical advancements that will benefit Eversource service areas. This includes, first, addressing issues with data accuracy, particularly where storm codes overlap across different territories, and, second, mitigating the risk of data leakage during the development and training of predictive models. These efforts are designed to strengthen the integrity of our data systems and improve the overall resilience of power management operations.

In short, the future holds great potential for transforming how utilities manage and respond to severe weather events, as the OPM project continues to advance and improve the prediction of storm-related power outages.

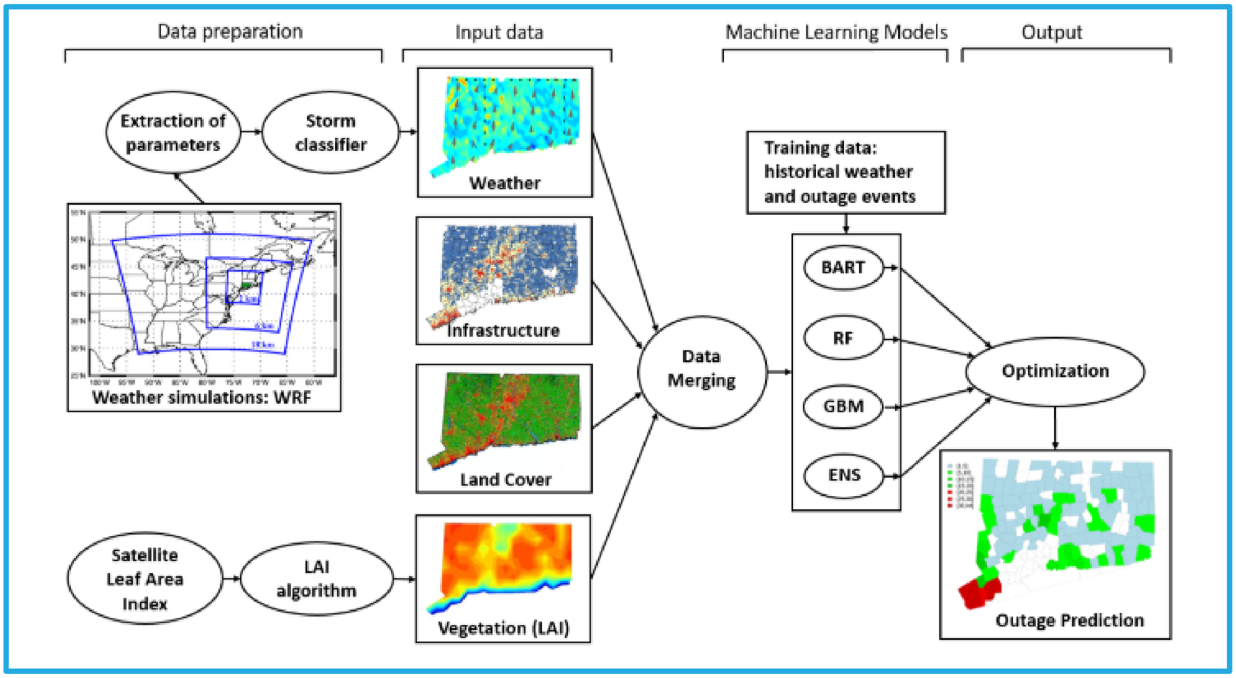


Scatterplots showing the accuracy of outage predictions for different storm models across Eversource service territories during storms; from left to right they include rain and windstorms (929 events), thunderstorms (544 events), and winter storms (321 events). The black line represents perfect predictions, while the red lines show a range of acceptable predictions (within 50 percent of the perfect line). Points outside the red lines are less accurate. This helps us understand how well the prediction models work for making decisions during storms.

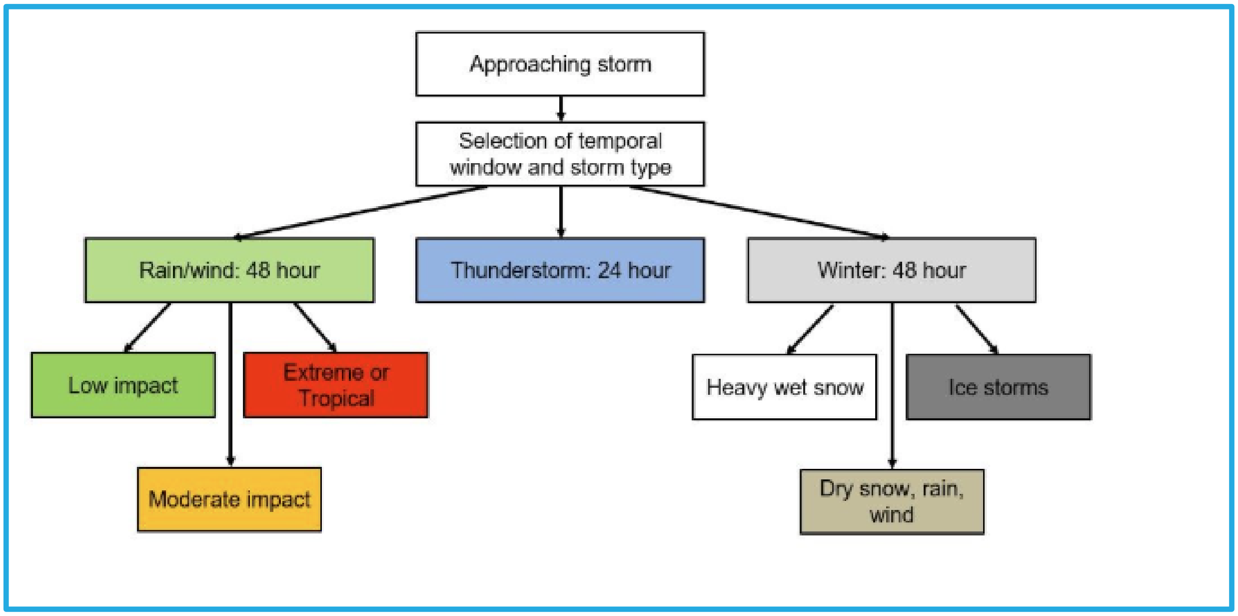
The University of Connecticut Outage Prediction Model

The OPM is a statistical framework developed by researchers at the Eversource Energy Center that integrates weather predictions with infrastructure, land cover and vegetation characteristics, and historical power outage data to predict, through the use of machine learning models, the number and locations of storm power outages across utility service territories in the northeastern United States. Predictive modules of the OPM—some of which are discussed in this report—are developed separately for different types of storms.

OPM Architecture



OPM Storm Classifier



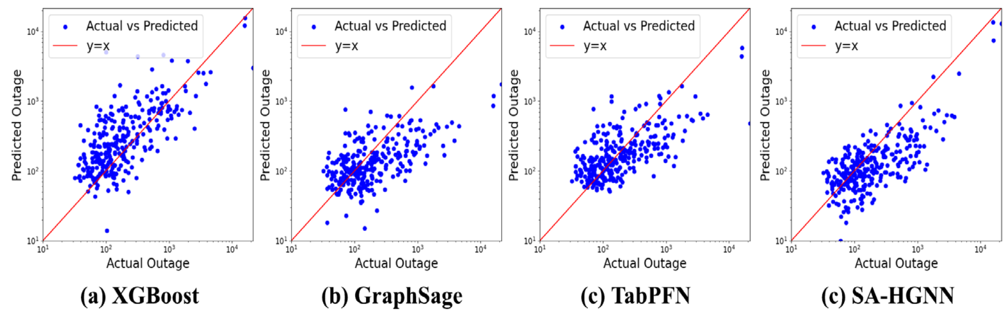
Outperforming Existing Outage Prediction

The University of Connecticut's Outage Prediction Model (OPM), developed by researchers at the Eversource Energy Center, uses Spatially Aware Hybrid Graph Neural Networks (SA-HGNN) to address the challenge of power outages caused by extreme weather. This approach accounts for geographical relationships, as well as both static and dynamic features across affected regions.

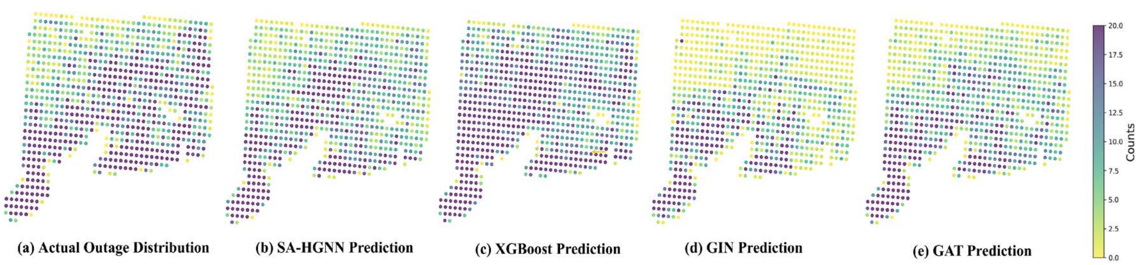
The OPM combines several advanced machine learning methods to predict outages. The main idea is the use of a spatiotemporal graph neural network (GNN) that models how storm impacts evolve. Each location is treated as a node in a graph, with edges capturing spatial relationships, such as geographical proximity or similarity in environmental features, enabling the model to understand how damage patterns propagate over the region. In addition, the model incorporates static features, which describe permanent attributes of each location, such as land cover, infrastructure, and population density, and dynamic features, which change with each storm event and include real-time weather conditions, like wind speed, rainfall, and soil moisture. By combining these two types of information, GNN can learn how storm effects vary based on both the physical environment and current weather. To improve the prediction accuracy further, especially in regions with limited outage history, we apply contrastive learning—a technique that helps the model distinguish between conditions that appear similar but lead to different outcomes, refining its ability to generalize across different scenarios.

The model is currently in an advanced stage of development and evaluation, with extensive testing underway using data from hundreds of past storms in New England. Our results demonstrate that the OPM significantly outperforms existing approaches in predicting outage locations. In a real-world case study using data from Connecticut, for instance, the model accurately identified the most heavily affected areas in advance, enabling quicker deployment of crews for power restoration and more efficient resource allocation.

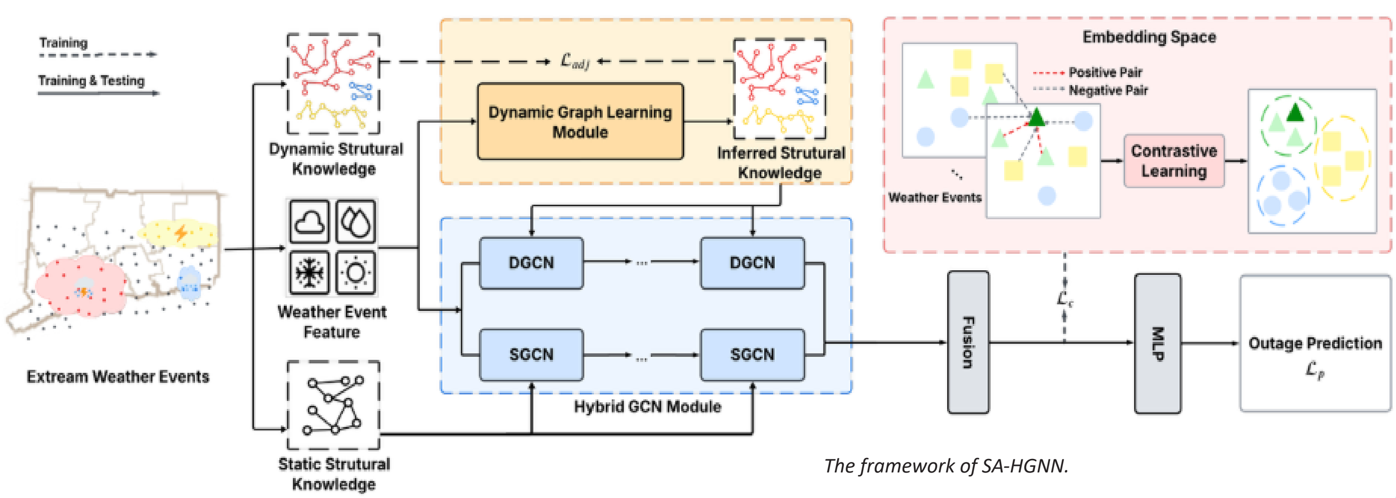
Future work will concentrate on scaling up the OPM to account for broader geographical regions and incorporating real-time data streams for operational deployment. This innovation represents a crucial step toward proactive outage management that will help utilities mitigate damage, shorten restoration times, and better serve communities during extreme weather.



Comparison of the performance of four models with respect to actual outages versus predicted outages, based on extreme weather data from Connecticut.



Actual outage distribution versus the distribution predicted by SA-HGNN (our model) following Hurricane Irene (August 28, 2011), using the Connecticut dataset.



The framework of SA-HGNN.

Outage Prediction Where Data Are Scarce

Although severe storms pose a major threat to electric power infrastructure, the most damaging ones—such as hurricanes, windstorms, and heavy rain events—are relatively rare. As a result, we often lack enough historical data to train models that can reliably predict their impact. This data scarcity is a major obstacle to the development of accurate and resilient outage prediction systems.

During the past year, researchers at the Eversource Energy Center used an approach based on generative artificial intelligence (AI) to address this limitation by generating synthetic storm events that are statistically and physically consistent with real historical storms. We produced these synthetic events using a stable diffusion model, a technique capable of learning the underlying structure of complex data and producing high-dimensional storm scenarios that reflect the complexity and variability of real weather events.

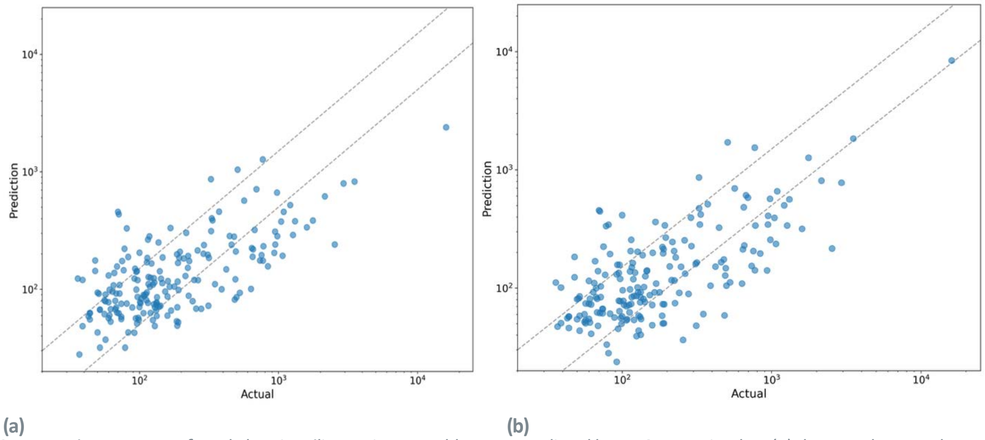
Generative AI *is a type of artificial intelligence that can create new content, such as text or images, by learning patterns from existing data.*

After generating a large pool of synthetic storms, we applied a series of evaluation metrics to assess their quality. These metrics allowed us to rank the events based on their physical consistency with and similarity to real storm data. Only the most realistic and scientifically credible synthetic events were selected to augment the original dataset, with a focus on improving the representation of rare, high-impact storms.

Graph attention networks (GATs) *are neural networks that work with graph-structured data. GATs use an attention mechanism when aggregating information in the network to weight the relative importance of different inputs, enabling the model to focus on the most relevant information.*

We then trained a graph attention network (GAT) to predict the number of power grid "trouble spots" (locations requiring repair after a storm) and evaluated the model's accuracy. The result was that the model trained on the enriched dataset (real plus synthetic events) performed significantly better than the one trained only on real data. The improvements were especially notable for the largest, most disruptive storms.

Synthetic events research demonstrates the potential of generative AI to enhance predictive models in data-scarce domains. By simulating rare but critical events, we can help infrastructure systems become more adaptive and be better prepared for future extreme weather scenarios.



Comparative accuracy of total electric utility territory trouble spots predicted by an OPM trained on (a) the actual events dataset versus (b) the enriched dataset. Dashed lines indicate ±50 percent absolute error bounds.

From Days to Minutes
Next-Generation Storm Restoration

When tropical storm Isaias struck Connecticut in 2020, restoration took days as crews navigated blocked roads and prioritized repairs. The restoration period could have been greatly reduced had Eversource had UConn's agent-based model available to them. Now, building on their ABM from last year, researchers at the Eversource Energy Center have developed a revolutionary tool that transforms restoration planning. Featuring an intuitive interface and lightning-fast performance, the enhanced UConn ABM helps utility managers explore "what-if" scenarios and optimize crew deployment—all in minutes rather than days.

Agent-based modeling *is a computational technique that simulates human decisions while also representing technical conditions. The ABM under development at the Eversource Energy Center provides a virtual environment where utility managers can test their restoration decisions before implementing them. The model can also be used in real time to provide an estimate of the time to restoration, given available resources.*

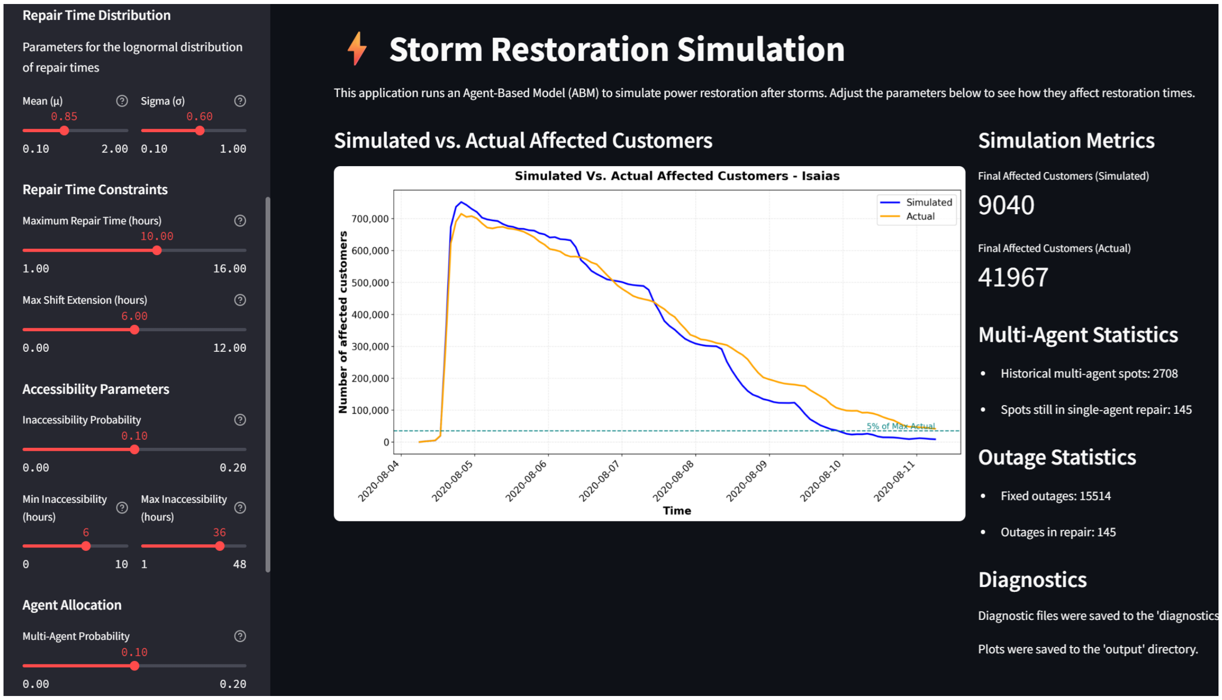
Our breakthrough combines two game-changing improvements. First, a new interactive dashboard lets managers adjust parameters—crew numbers, storm severity, and road conditions—and instantly see predicted restoration timelines. No programming is required; users just move sliders and click buttons.

Second, we've supercharged the engine: A simulation process that previously took from 16 to 24 hours to complete now finishes in under 15 minutes. This 96-fold improvement in speed means managers can test dozens of scenarios during a single planning session, comparing strategies like prioritizing customer density versus maximizing geographical efficiency. The system even accounts for specialized tree crews and dynamically adjusts strategies as virtual restoration progresses.

The model works by creating virtual repair crews that navigate a digital storm-damaged landscape. All of the crews follow intelligent rules: Early in restoration, they tackle nearby outages for quick wins; later, they shift to high-impact repairs affecting more customers. Since last year, we have added to the system the tree-clearing crews that must precede line crews at certain locations. Throughout the simulation, the model tracks which roads become accessible, which crews need to rest, and where bottlenecks develop. Managers can watch restoration unfold on interactive maps and graphs, pausing to test different resource allocations.

Early testing shows that the enhanced model can reduce restoration times through advance crew acquisition and resource pre-positioning. The tool's speed enables unprecedented planning agility—managers can now evaluate contingencies for approaching storms in real time. And, by learning from historical events like Isaias while incorporating new capabilities, this system helps utilities prepare for increasingly severe weather, ultimately leading to shorter outages for customers and more resilient communities.

Future development will integrate the ABM into the UConn OPM and explore artificial intelligence–driven optimization, transforming reactive restoration into proactive resilience planning.



The storm restoration dashboard allows utility managers to use intuitive sliders to adjust key parameters and view predicted restoration curves.

Forecasting Outages before the Storm

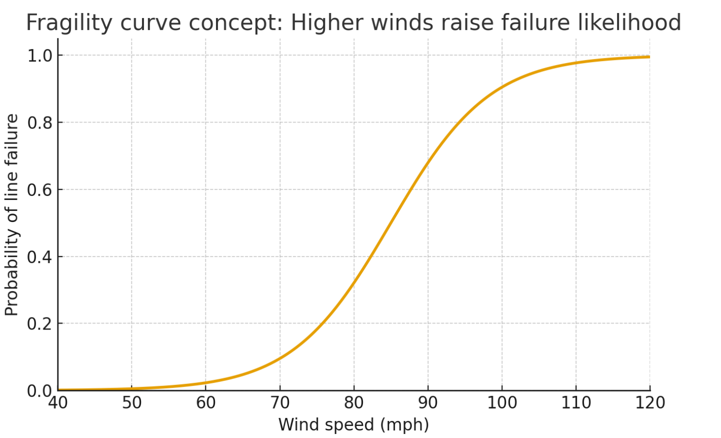
How AI + Physics Help Keep the Lights On

When powerful windstorms hit New England, trees and powerlines can fail quickly, causing outages that ripple across neighborhoods and critical services. Researchers at the Eversource Energy Center are working on a practical way to "look ahead" by teaching computer models to predict before the weather hazard arrives where powerlines are likely to fail. Our approach blends physics (fragility curves that describe how likely equipment is to fail as wind intensifies) with machine learning (algorithms trained on thousands of realistic storm scenarios) to classify each line as "likely to fail" or "likely to hold."

Across the industry, research has progressed from early hurricane-outage models for the U.S. coastline to utility-specific efforts that fuse data on weather, vegetation, soils, and assets. The problem is that, to be accurate,

*A **fragility curve** is the statistical expression in graphic form of the probability that a given structure will fail under a given type and amount of stress.*

these models need to be trained on utility outage records that are both sensitive and scarce.

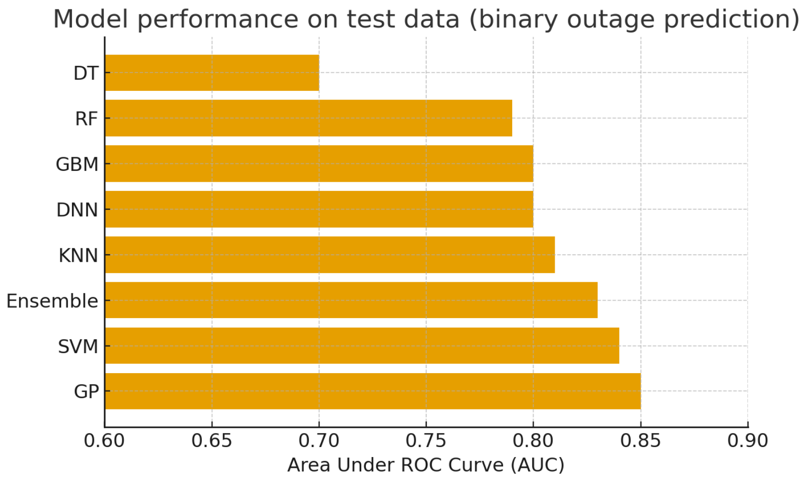


A "fragility curve" in plain sight. As wind speed climbs, the probability that a line will fail rises sharply. Fragility curves capture this relationship so artificial intelligence (AI) can translate tomorrow's winds into today's actionable risk map.

Our models sidestep the need for such records by generating realistic, physics-informed training data from fragility curves and wind scenarios, creating synthetic, yet realistic, data from what is known about wind speed distributions and the vulnerability of equipment, along with computer-generated scenarios. This makes the method readily customizable and easy to adapt across regions.

As we continue our research, our next steps will include adding more environmental factors to the models, deploying real-time prediction, exploring transfer learning and time-series deep learning, and—crucially—quantifying uncertainty so planners can act with confidence. Cluster analysis is also suggested, to "sharpen targeting"—that is, to make recommended actions more precise so time and money go where they matter most.

By turning physics and AI into actionable outage-risk maps ahead of a storm, this work contributes to recovery in many important ways. It allows utilities to pre-position crews and materials on the right circuits to speed up restoration; to plan switching and restoration to cut the amount of time customers are without power; to prioritize vegetation patrols and the removal of hazardous trees where they will prevent the most damage; to improve storm room situational awareness with uncertainty bands that support safer, faster decisions; and to guide investments in grid hardening measures, such as selective undergrounding and stronger structures, based on consistent, data-driven evidence. The net result will be fewer outages, quicker restorations, lower costs per event, and a more resilient system for customers during extreme weather.



In head-to-head tests, three methods analyzed in this experiment rose to the top for telling "fail versus no fail." The bar chart shows the test-set AUC (higher is better). The Gaussian Process classifier (0.85), a Support Vector Machine (SVM; 0.84), and an ensemble model that votes across several algorithms (0.83) led the pack in distinguishing failures from nonfailures. Together these models have delivered the best balance of accuracy and outcome discrimination.

Deep learning *is an artificial intelligence method that teaches algorithms to process data in complex ways, as the human brain does.*

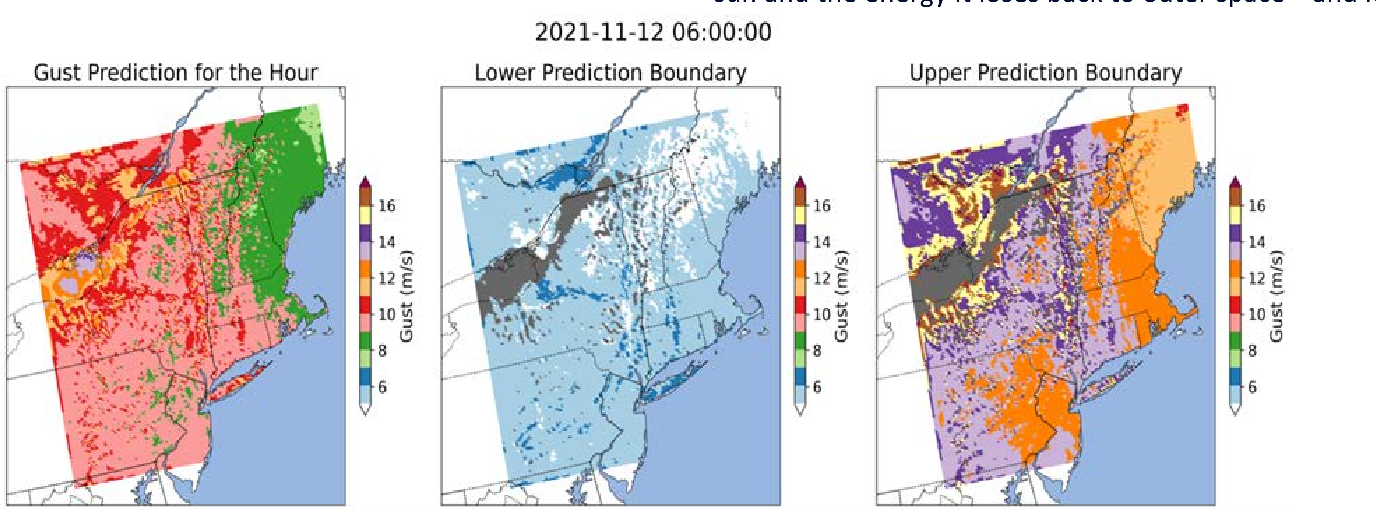
Ever Better
Wind Gust and Snow Prediction

In 2023, researchers at the Eversource Energy Center commenced a new project—Improving Extreme Weather Forecasting Capabilities in Support of Power Outage Prediction Activities—as the continuation of a previous three-year project. The goals were to improve the forecasting of wind gust and snowfall, which significantly affect the reliability of the power outage predictions that are issued by the Center and used directly by managers at Eversource Energy, and to quantify the influence of these weather prediction improvements on power outage predictions.

During the second year of Phase II, we finalized the uncertainty quantification of gust predictions with an evidential deep learning model—that is, a type of artificial neural network designed to provide reliable estimates of uncertainty in predictions. We were able to demonstrate that the evidential neural network reduced gust error by 47 percent compared to the original gust predictions produced by the Weather Research and Forecasting (WRF) Model and allowed the construction of gust prediction intervals, successfully matching at least 95 percent of observed gusts at 179 out of the 266 weather stations in the northeastern United States.

In addition, we developed an automated operational system to download National Weather Service forecasts so we could investigate how official NWS predictions differ from our in-house storm forecasts. This enabled us in turn to investigate in real time biases in winter weather temperatures that were influencing our snowfall forecasts.

At the same time, we discovered that the winter temperature bias, which influenced snowfall accumulation, originated from our weather model's handling of the earth's radiation budget—that is, the balance between the energy the earth receives from the sun and the energy it loses back to outer space—and its



The plot on the left provides an example of hourly wind gust prediction, with its lower and upper prediction boundaries (shown in the middle and right plots, respectively) at peak intensity for a storm that took place in November 2021. Areas marked as gray are considered to have highly uncertain and untrustworthy wind gust predictions.

connection to precipitation formation. We are actively exploring alternative radiation schemes to ensure the error in the model will be corrected for the new snow season.

During the upcoming last year of the project, we will finalize the winter temperature bias correction to improve the forecasting of winter storms. We will also finalize the operational application of our machine learning–generated wind gust forecasts, including completing the connection between those forecasts and operational power outage prediction.

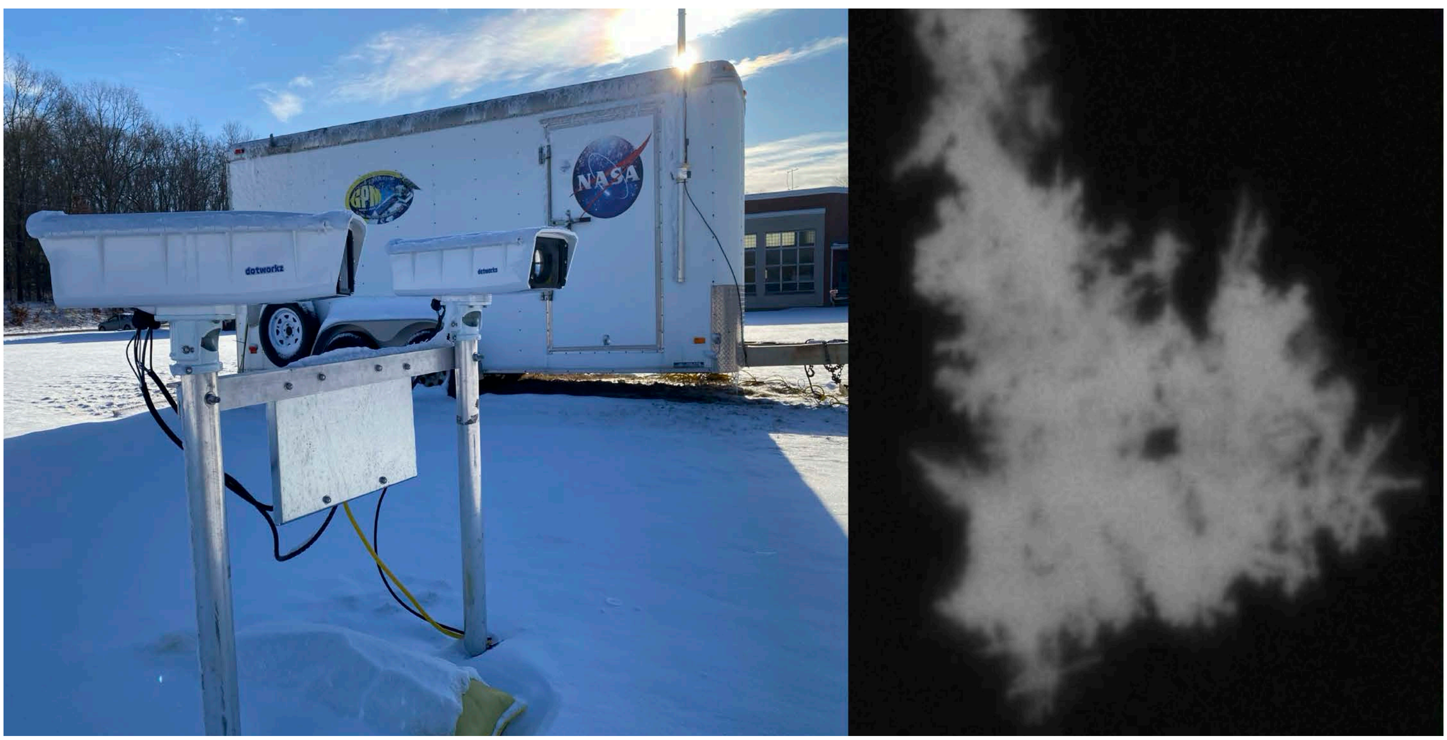
Snow, Snow, and More Snow

Forecasting the impacts of winter weather can be difficult because of the many assumptions that must go into the process, such as the type of precipitation or how much snowfall occurs. Especially difficult is predicting accumulating ice and wet snow, which are significant causes of power outages. Observations of such unique weather events can provide a better understanding of how and when these conditions occur.

In 2021, the Eversource Energy Center began collaborating with the National Aeronautics and Space Administration (NASA) in the deployment of a wide variety of instruments to measure all the types of winter weather experienced by people—and utilities—in Connecticut. A period of collaborative observations conducted with another NASA field campaign, Investigation of Microphysics and Precipitation for Atlantic Coast-Threatening Snowstorms (IMPACTS), included aircraft flyovers and around thirty instruments deployed across two sites at the University of Connecticut. From it emerged a clear picture of the near-surface conditions during winter weather, with measurements from the instruments supplying information about clouds, precipitation amount and intensity, temperature, humidity, wind speed, and characteristics of falling precipitation, such as size, speed, and density.

With the return of the NASA instruments for 2024–25, a new instrument began to provide more high-resolution information about snow. OSCRE, the Open Snowflake Camera for Research and Education, is a high-resolution, high-frequency camera paired with a strobe light that can take images of falling snowflakes at remarkable resolution. These images provide important details about the size and types of snowflakes, which, when combined with the other sensor information, can help us understand important properties of wet snow, a major factor in winter power outages.

The partnership with NASA has continued to provide high-quality measurements of winter weather that can be used in many relevant research applications. Using these observations to validate weather models, researchers at the Center have found that the main driver of precipitation differences from numerical models' starting



The newest instrument deployed at UConn, OSCRE (left), pictured after a snowfall event in January 2025. During this event, OSCRE captured high-resolution pictures of snowflakes, like the one shown at right. The image of a cluster of needle-shaped snowflakes aids our understanding of how we might predict the environment in which the snowflakes are formed.

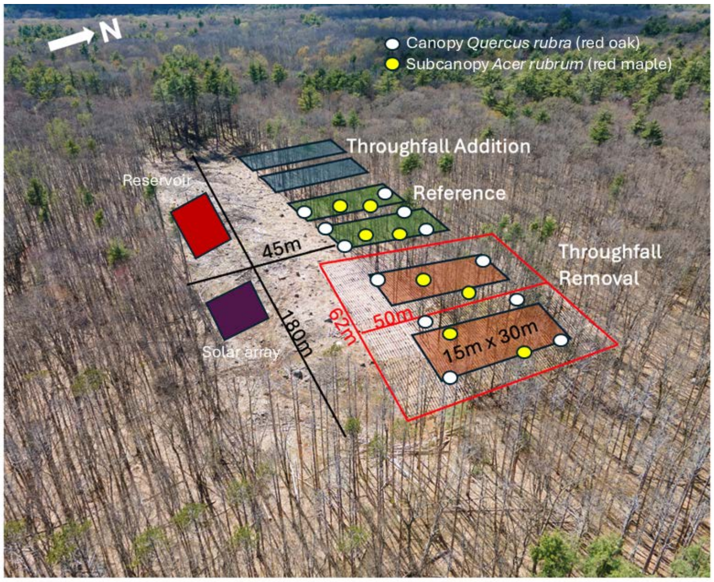
conditions is the starting amount of water present in the atmosphere. Ongoing work is using high-resolution observations of snowfall to improve our understanding of important snow characteristics and estimates of when wet snow will occur in our weather models. The results from this work will be used to upgrade the model output used in the UConn Outage Prediction Model.

Tree and Forest Management

New and ongoing projects at the Eversource Energy Center are studying the relationships between vegetation and powerlines and exploring ways to maximize the efforts of the people who manage them.

Like Boats, Straws, and Planets
How Drought Affects Trees

The Climate and Forest Fragmentation (CLIFF) experiment, funded by the National Science Foundation, is a collaborative research effort being conducted by the Applied Forest Ecology Lab (AFEL) at the Eversource Energy Center and the Reinmann Lab at the City University of New York. CLIFF is in Harvard Forest, a 4,000-acre ecological research area in Petersham, Massachusetts, owned by Harvard University. The experiment is designed to manipulate water availability in a newly formed forest edge using a rain capture and application system that simulates drought and torrential rainfall, two extreme weather conditions that are increasing in New England. The goal is to understand how forest removal interacts with climate in human-dominated landscapes.



CLIFF experimental layout overlaid on May 2024 imagery. The white and yellow circles indicate the approximate locations of trees with canopy-mounted sway sensors. CLIFF displaces throughfall—that is, the rainfall that reaches the forest floor through the canopy—from one plot ("Throughfall Removal" in the image) to another ("Throughfall Addition)." The throughfall removal structure (the white gridlines) form a roof that keeps rainfall out. The rainfall is deposited into gutters that feed the reservoir downhill, the water from which is then sprayed by solar-powered sprinklers located throughout the throughfall addition plot.

To examine the role played by drought in tree-caused utility damage, the AFEL will, along with the Stormwise project, focus on tree stability and canopy structure at the forest edge. The effect of drought on tree stability during storms is largely unknown, but it has been implicated as a factor in past events, notably tropical storm Isaias, which caused extensive damage in Eversource's territory in 2020. We will measure forest structural response through several approaches, including the use of terrestrial laser scanning (TLS) and tree sway biomechanics sensors.

Tree biomechanics is the study of how trees deal with forces like wind. Trees are like boat sails, straws, and heavenly bodies. Much like sails, trees are pushed on by wind and, like closing a sail, behaviors like losing leaves help them survive strong winds. Much like straws, trees draw up water and then become more flexible as water empties, so those subject to drought tend to bend more. Much like heavenly bodies, trees orbit, and when subjected to wind, their crowns sway in an approximately elliptical path. Those that bend over more and make big, slow revolutions are more likely to snap off or uproot.

Through repeated TLS, we can create 3D tree models that can be compared over time, while biomechanics sensors can measure the tilt of the tree crown several times a second. Using these measurements, we expect to find the least structural integrity in trees under the greatest combined drought and wind stress. The unknown of the experiment lies in how the trees will balance multiple responses to environmental stress over time.

__Stormwise__ is the Eversource Energy Center's innovative and multifaceted forest management and public education initiative that aims to reduce the risk of power outages and other damage caused by wind-related tree failure, especially along wooded roadsides and electricity distribution lines. A combined forest management demonstration, outreach effort, and discipline-spanning research program, Stormwise applies what we know about growing trees to develop management strategies for more storm-resistant roadside woodlands that maintain the functions of forest ecosystems and preserve their beauty, while reducing or at least shortening tree-related outages and extending intervals between trimming or management treatments.

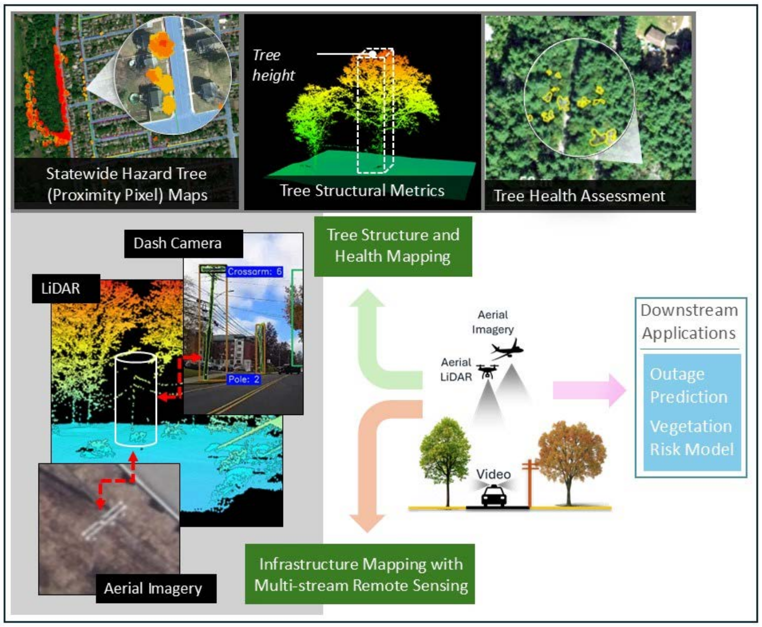
The development of tree sway dynamics research that is sensitive to the roles played by location, climate, and timing in regulating wind resistance could prove useful in the development of new models for predicting tree-caused outages. Through this research, we hope to advance the understanding of wind resistance in places where trees can be managed to reduce the threat to powerlines.

No Single Source
Fusing Remote Sensing Data to Assess Tree Risk

The task of identifying vulnerable trees that are structurally weak, in poor health, and within striking distance of powerlines is essential but highly complex. Remote sensing technologies, such as satellite imagery, aerial photographs, aerial LiDAR, and dashcam videos, all provide useful insights. No single source, however, can completely capture the structural and health characteristics of trees needed for accurate, large-scale risk assessment.

By integrating these complementary data sources, it becomes possible to generate detailed, multidimensional layers of information about vegetation and utility infrastructure. This fusion of data not only supports the development of a tree risk model that identifies vegetation-related threats to the electric grid over broad geographical regions; it delivers fine-resolution insights into risk at the individual utility pole level.

Building on earlier 2016 work, which utilized low-density



Remote sensing data from various sources are combined to map electric utility infrastructure and extract metrics related to roadside vegetation.

LiDAR to map tree proximity to powerlines across Connecticut, researchers at the Eversource Energy Center have now created a far more detailed proximity map using 2023 high-density LiDAR data. Moreover, this latest dataset has enabled us to generate detailed metrics of tree structure and terrain features with greater precision and to investigate the underlying conditions that contribute to tree failure during storms. Advanced artificial intelligence models we have also developed predict tree health conditions, including dead or defoliated canopies, using high-resolution aerial imagery. In parallel, we are using street-level imagery collected from vehicle-mounted dashcams to identify and localize trees and utility poles that may be obscured from overhead views. Our current innovation integrates aerial LiDAR and imagery to detect electric utility infrastructure using AI. These efforts will enable utility providers to enhance and update their infrastructure maps with greater precision and detail.

> ***LiDar*** *(Light Detection and Ranging) is a remote-sensing technology that determines distances by targeting an object or a surface with a laser and measuring the time for the reflected light to return to the receiver.*

Using this integrated dataset, we are now developing version 2.0 of our vegetation risk model. This enhanced model will provide a spatially explicit and highly detailed vegetation risk profile along powerlines, supporting more proactive and data-informed vegetation management strategies.

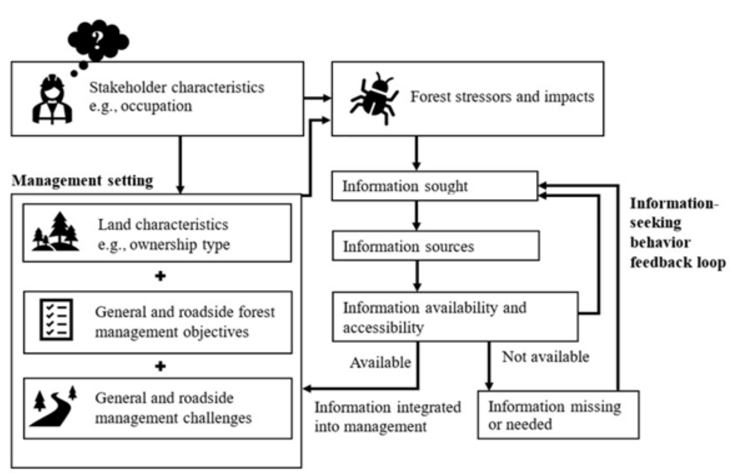
Knowledge Is Power
Information Seeking by Forest Managers

Diverse land uses and forest stressors, such as severe weather, drought, excessive rainfall, and spongy moth, create challenges for the management of roadside forests. To mitigate stressors that occur at the landscape level, roadside vegetation managers are required not only to address concerns about powerline vulnerability but to work with other landowners who are doing the same. During earlier human dimensions (social science) research on this topic conducted as part of the interdisciplinary Stormwise project, researchers at the Eversource Energy Center learned that, for numerous reasons, many members of the Connecticut forest management community avoid active management along roadsides, and that professional biases related to public perspectives may be adding to those challenges.

We built upon previous work from that recent data collection, which involved semi-structured interviews with thirty-nine members of the Connecticut forest management community. Our objective was to examine the information sources used by members of that community, how individuals actively sought information, and how a conceptual model describing information-seeking behavior might aid the development of practical strategies for sharing knowledge about roadside forest management.

Participants' tenure in their occupations ranged from a few years to decades, with the participants managing public or private land or both. Among a total of nineteen management objectives identified, participants reported they were balancing between one and nine concurrently. Twenty different forest stressors were mentioned, with emerald ash borer, spongy moth, and severe weather named most frequently. Participants sought eleven categories of information; those most frequently mentioned included forest conditions (for example, site-specific conditions), general and current information and advice about management, and forest pests and diseases. Participants consulted a variety of information sources to gain knowledge, and most frequently noted Society of American Foresters outlets, such as The Forestry Source, DEEP State Forestry, and the Connecticut Agricultural Experiment Station. Participants stated that the amount of information could be overwhelming and time consuming to read and interpret. Among other important sources for information were professional relationships, as well as opportunities for networking and casual conversation with other forest managers.

Finally, participants identified topics on which they desired more information. These included research on stressors and roadside vegetation management, public outreach, knowledge dissemination, and climate science and carbon forestry. Knowledge about local conditions and management strategies that have been successful elsewhere for validating local, regional, and state-level decision making were also of particular interest. Overall, information-seeking behavior was an iterative process, in which many sources and personal experience contributed to decisions to apply information to management.



Conceptual model of information-seeking behavior assessed by the research. Boxes present factors that may influence the flow (indicated by arrows) of information-seeking behavior. Adapted from Crocker and Morzillo (2025)

Grid Vulnerability and Resilience

Threats to electric systems come in a variety of forms, both physical and virtual. Work at the Eversource Energy Center spans fields that range from cyber security to diagnosing faults to making the best use of resources to protect the grid.

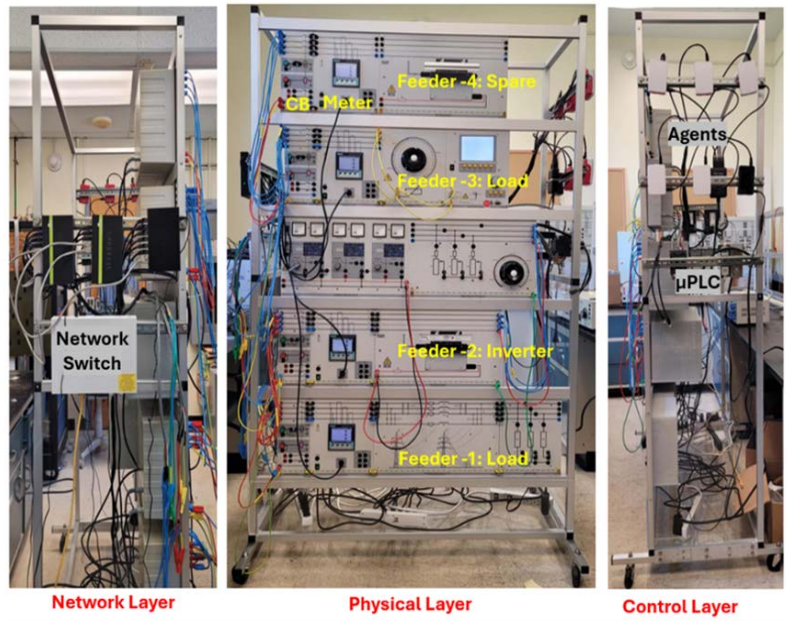
Pick-Proofing the Lock
Cyberattacks on Energy Meters

The electric power system today includes many smart devices, like meters and sensors, that are used to monitor the health and performance of equipment in real time. These devices continuously collect and send important data to a control center, where operators use it to make informed decisions. It's not just the collection of the data that matters, however; their trustworthiness is equally important. If communication between the devices and the control center is compromised, it can lead to incorrect decisions and even inaccurate system operations.

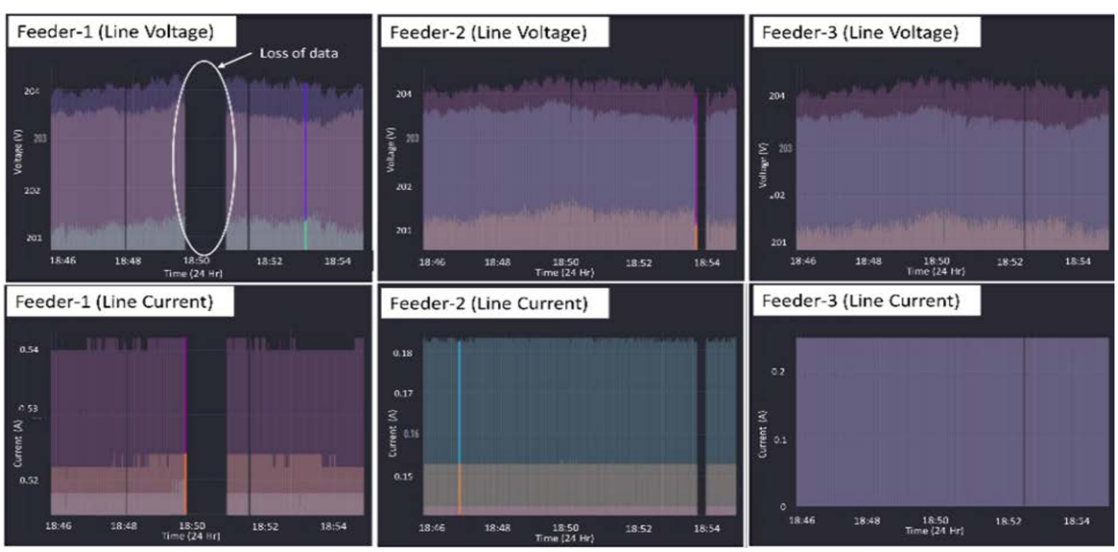
Many of the devices still in use today were developed and installed several decades ago and run on outdated systems. Just as old-fashioned door locks are easier to pick than newer ones, these older devices are more vulnerable to cyber threats, especially given today's advanced computing power and deep understanding of network vulnerabilities. This makes it more challenging to protect the electric grid from cyberattacks. If an attacker gains access to the communication network, the consequences for the safety and reliability of the grid could be severe.

To gain a better understanding of these risks, researchers at the Eversource Energy Center built a small-scale version of a power grid using real energy meters, communication devices, and power grid components. This setup emulates how a typical power system operates. Using the Python programming language, we collect power system data in real time from the meters, store them, and display them on a screen, similar to what a control room operator would see. Together, this system is referred to as a cyber-physical testbed.

To study how it would affect the power grid system, we also designed and demonstrated for research purposes a "denial of service" (DoS) cyberattack and tested it on one of the meters. The goal of the attack was to overload the communication network, causing delays or data loss. Such an attack can lead to missing data from the targeted meter and can even briefly T\ disrupt nearby devices.



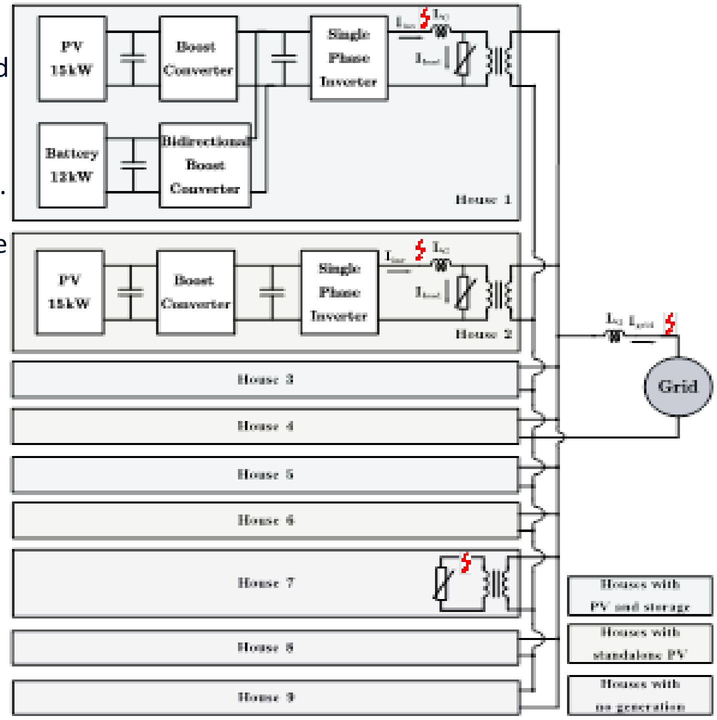
This experimental testbed helps us to validate the efficacy under control conditions of detection tools developed to alert power system operators to cyberattacks. In the future, we plan to develop more sophisticated cyberattack algorithms and expand this system into a hands-on training platform for utility workers on which they can practice incidence response to cyberattacks.



Behind the Meter

Innovation in Diagnosing Faults

The penetration into the U.S. electric grid of power electronic converters, especially through solar photovoltaic inverters and electric vehicle (EV) chargers, is rapidly on the rise. Each of these power converters inherently has several voltage and current sensors that capture thousands of data points every second—data that can be transformative for grid operations and planning. Because those converters are on the customer (house) side, or "behind the meter," however, the data are not currently available to or utilized by utilities. Such large amounts of information also pose a "big-data problem" that prevents the grid from weeding through all second-scale data points.

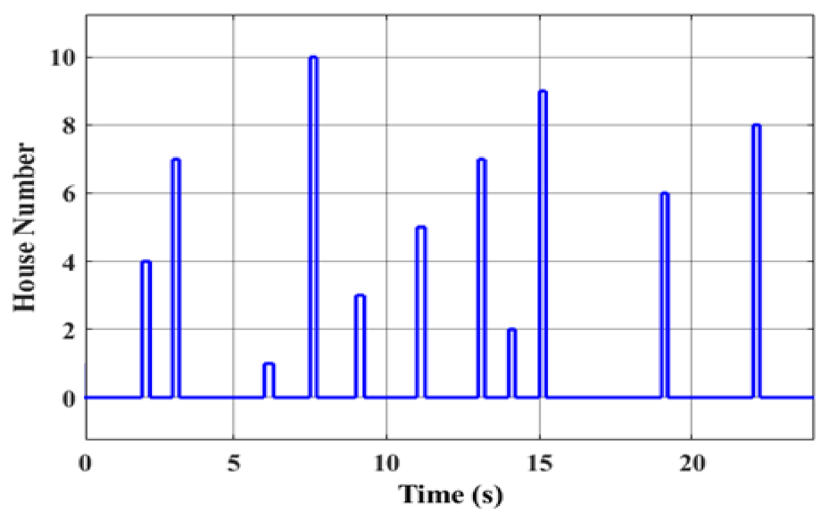


Simulated residential microgrid system with grid connection.

Researchers at the Eversource Energy Center are engaged in a project showing that having such data can help in diagnosing behind-the-meter faults as well as grid-side line-to-line or line-to-ground faults. Such fault diagnosis can be done at high speed on the house side, with results transmitted to the grid at a low frequency of 1 Hz. Alternatively, the utility can have access to high-frequency sensor data and process fault diagnosis if it can handle such large data sizes. We have illustrated this for a neighborhood of nine houses forming a microgrid—three with solar panels and batteries, three with solar panels without batteries, and three without solar panels or batteries—using simple logic-based diagnosis, without the need for advanced artificial intelligence algorithms.

> *A **microgrid** is a local electricity network that can operate independently or connect to the larger grid.*

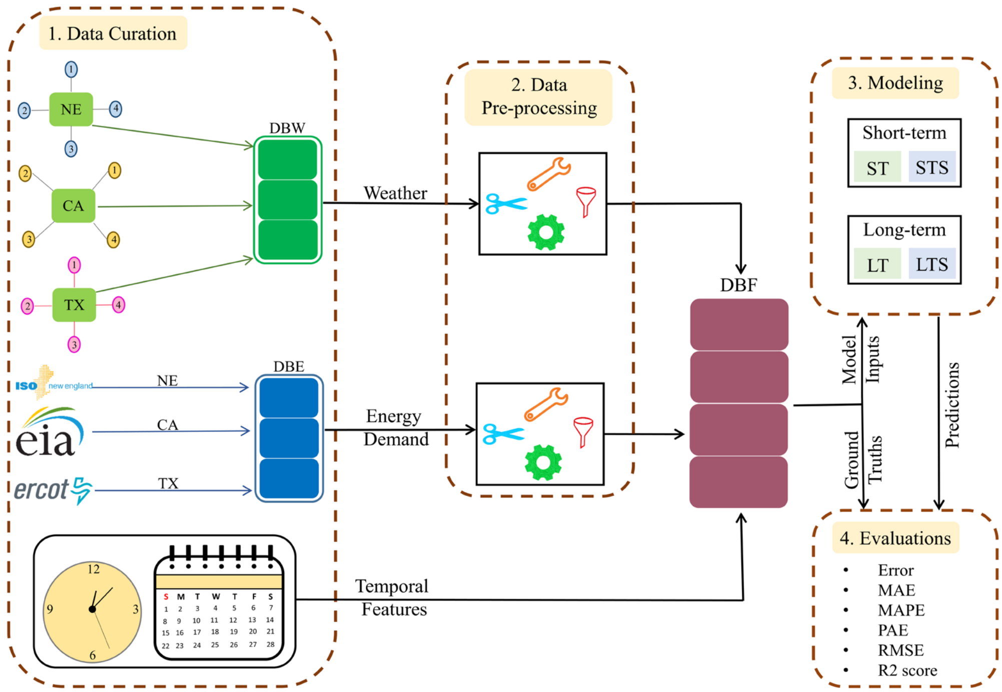
Our project has also shown it is possible for households to share power from residential solar photovoltaic and battery installations with each other just as well as they can share it with the grid. Since power sharing is currently not being explored when residential microgrids "island"—that is, when they disconnect from the main grid and operate independently as a result of extreme weather events or other disruptions, such as cyberattacks—this finding can open the door for a future project on peer-to-peer energy sharing in residential and commercial microgrids.



An example of diagnosis of faults occurring in different parts of the residential microgrid. Faults are actively injected and cleared back to-back to illustrate how the fault diagnosis algorithm can accurately determine their locations. Note that house number 10 is not an additional house but another label for a grid-side line-to-ground fault.

When Models Tell Us What They Don't Know

Predicting how much electricity will be needed tomorrow is a daily challenge for grid operators. If they overestimate demand, energy is wasted. If they underestimate it, the lights could go out. In support of the Eversource Energy Center's mission to enhance grid reliability through data-driven innovation, Center researchers have been exploring a new approach to forecasting day-ahead energy demand using weather data and machine learning. Our work focuses not just on predictions, but on how confident we can be in those predictions.



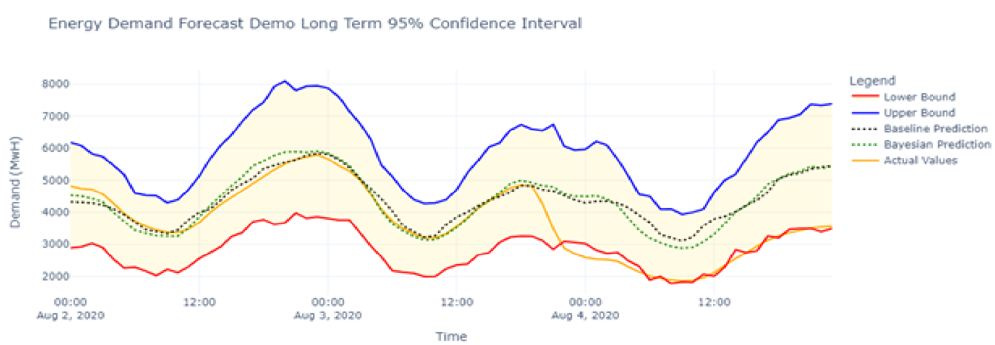
Pipeline of the study, showing the weather database (DBW), the energy demand database (DBE), and the final database (DBF) created.

Working with data from ISO New England, the nonprofit organization that oversees the region's bulk electric power system, we began by training neural networks—models designed to handle time series data—on past weather conditions and real-time demand outputs. We then applied a technique called Monte Carlo dropout, which allows the model to simulate uncertainty by randomly disabling parts of the network during prediction. This generates a range of possible outcomes, giving us a confidence interval rather than a single estimate.

Getting the models to work well requires careful tuning to balance accuracy and uncertainty. A 95 percent confidence interval, for instance, should include the actual demand 95 percent of the time—no more, no less. We tested how different histories—one week versus several years—affected model performance. The longer-term models performed better in extreme conditions, such as during Hurricane Isaias in 2020, when demand patterns dropped sharply. Even under stress, the models provided credible estimates and realistic uncertainty bounds.

This kind of forecasting tool could be valuable for energy forecasters, grid operators, and even electricity traders, especially when preparing for unusual weather or demand shifts. In the future, we plan to apply our approach to broader problems, including power outage prediction, restoration planning, and energy forecasting under climate change scenarios and technology innovations and adoption rates—anywhere that probabilistic modeling can add insight.

***Confidence interval** is a statistical term denoting a range of values within which the true value of an estimate is expected to lie with a specified level of confidence. A higher confidence level corresponds to a wider range, reflecting greater certainty in terms of where the estimate is expected to lie but increased uncertainty in precision.*



Model results for Hurricane Isaias in August 2020. The lower bound of the Bayesian long-term model (the red line) accounted for the decrease in demand from wind-based power outages.

Grid Resilience Assessment

A Strategic Guide for Stakeholders

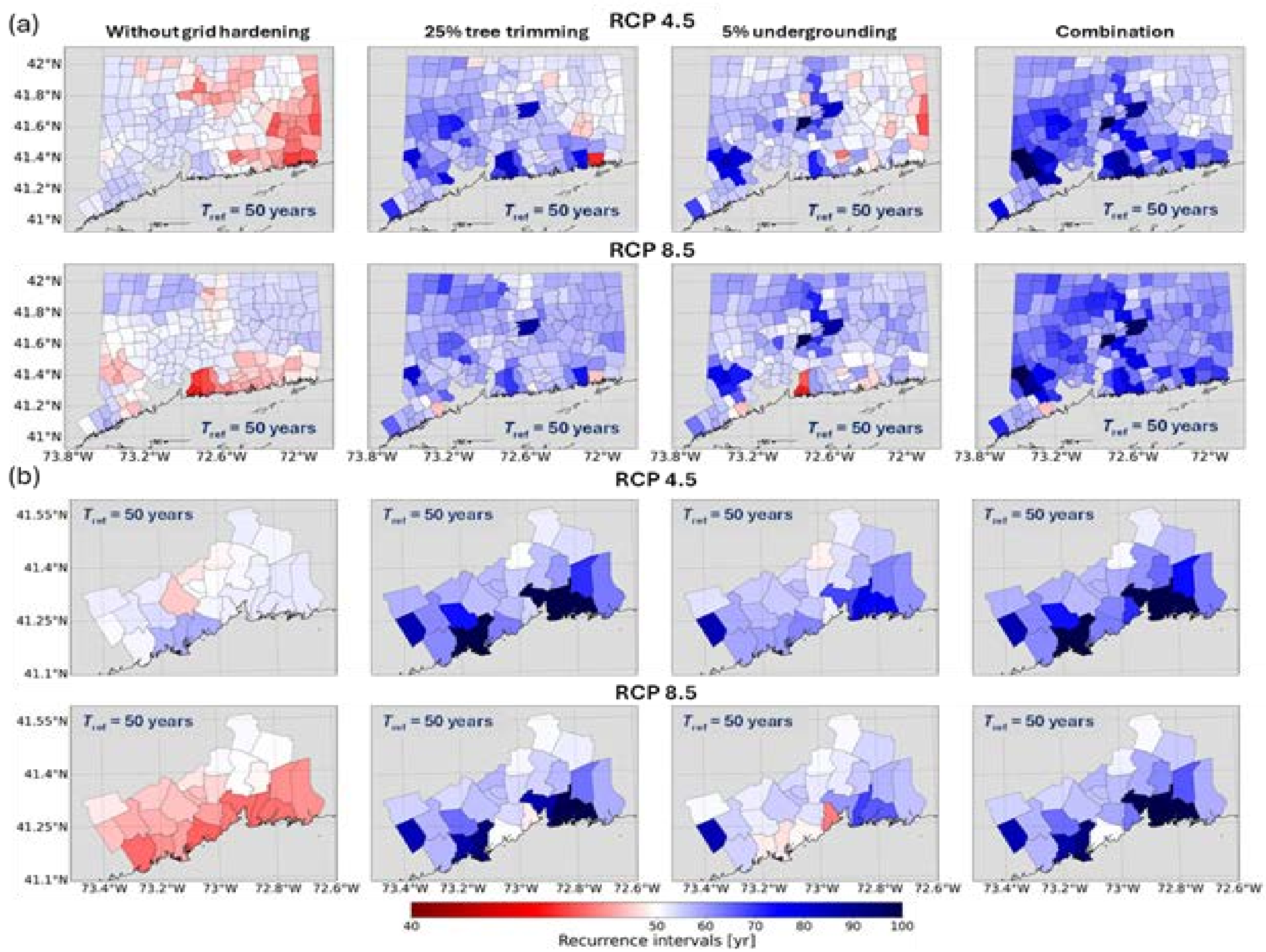
As power outages in the northeastern United States become longer and costlier, state leaders need guidance for steering resources to the places and people most at risk. With funding from the U.S. Department of Energy Grid Deployment Office, researchers at the Eversource Energy Center, collaborating with the Atmospheric Research Center at the State University of New York at Albany, have synthesized multiple evidence streams to create a comprehensive Grid Resilience Analysis and Climate Change Impacts guide. GRACI integrates downscaled climate projections, historical outage records, infrastructure impact and restoration modeling, customer surveys, and social vulnerability mapping to identify where and for whom climate-driven hazards are most likely to cause prolonged outages and how to turn evidence into practical investment guidance.

In our research, we project a raised likelihood of cold snaps brought about by an intensification of damaging wind gusts, especially in winter, across northern and central Connecticut, the upland regions of Massachusetts, and the Hudson Valley in New York. Predictive modeling shows these hazards often overlap with places that already endure long outages and slow recovery.

Many of the persistent outage hotspots revealed by spatial analysis of historical performance also rank high on a social vulnerability index, indicating that low-income, minoritized, and otherwise underserved households disproportionately experience the longest and most frequent interruptions. In customer surveys, households with annual incomes below $50,000 report the greatest willingness to pay for reductions in outage frequency and duration, reflecting higher exposure to outages and limited capacity for coping with them, while those making more than $200,000 a year are next most willing to pay, likely due to high productivity and service expectations. Middle-income groups often show lower or statistically insignificant values, perhaps because they invest in private means of preparedness, such as generators and batteries.

GRACI's innovative combination of interdisciplinary analyses delivers a practical roadmap to reduce outage impacts and advance energy equity. Recommended actions include targeted grid hardening, enhancement of predictive operations, the strategic installation of microgrids, and metrics-driven funding that shifts investment from uniform systemwide upgrades to place- and population-specific ones.

GRACI is already informing regulatory and investment decisions across service territories in three states. The research aligns with ongoing policy priorities, including, in Connecticut, the Public Utilities Regulatory Authority's transition to performance-based regulation and the Department of Energy and Environmental Protection's 2025 Climate Resilience Fund expansion; the Massachusetts Department of Energy Resources' grid innovation program; and the New York State Energy Research and Development Authority's grid modernization program. Through our work, we are positioning the region to protect the households most at risk while improving reliability for all.



In several coastal municipalities of Connecticut, historically rare outage events appear to recur more frequently in forward-looking scenarios, implying a higher cadence of disruptive storms and stress on restoration resources. The figure shows change in the recurrence interval of a power outage event with an estimated 50-year average return period, according to the moderate- and worst-case Representative Concentration Pathways (RCP4.5 and RCP8.5, respectively), for the Eversource Energy (panel a) and United Illuminating (panel b) service territories, covering the period from 2037 to 2057.

Wildfire

Eversource Energy Center researchers are conducting wildfire research that aligns closely with the Center's mission to enhance energy reliability, safety, and sustainability in the face of evolving environmental challenges

Where's the Fire?

Wildfire Ignition Mapping and Modeling

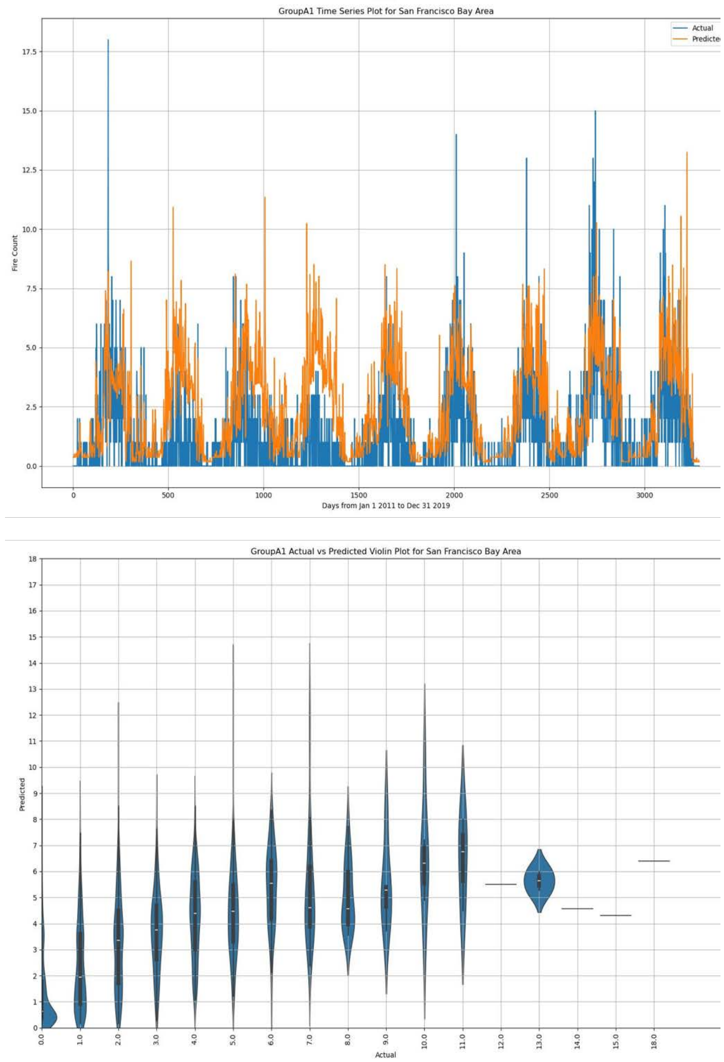
As wildfires become more frequent and severe across the United States, electric utilities face mounting challenges in protecting both infrastructure and communities. At the Eversource Energy Center, researchers are advancing tools that strengthen grid resilience and reliability by using machine learning and geospatial analysis to assess the risks of wildfire ignition and the vulnerabilities of transmission lines.

The objective of the Wildfire Ignition Mapping and Modeling project is to forecast the risk of wildfires starting before disasters occur, enabling utilities to make proactive decisions that will reduce outages and shorten restoration times. Forewarned of the danger, utilities can better allocate resources, minimize infrastructure damage, and protect public safety.

The modeling framework for the project is based on conditions in two parts of the continental United States: the Northeast, including New York State, and California. In the past year, we focused on analyzing wildfire threats in the Northeast and developed a comprehensive, high-resolution wildfire dataset, CONFEX, for the continental United States and Alaska, using the 375 meter Active Fire Data Product from the Visible Infrared Imaging Radiometer Suite (VIIRS) instrument on the Suomi National Polar-orbiting Partnership (SNPP) satellite. CONFEX characterizes clustered fire events with attributes, such as ignition and containment locations, start and end times, and spatial extent, and its perimeters closely match data for California fires from the California Department of Forestry and Fire Protection.

In California, the machine learning model makes use of infrastructure data, environmental and topographical variables, and historical wildfire ignition counts to forecast risks at the county, regional, and state levels. The current model has demonstrated strong performance, particularly in capturing peak wildfire activity beyond simple seasonal patterns. Notably, it achieves this using a relatively small number of predictive features, which, since it requires less computation time, is more efficient.

So far, the model has successfully highlighted high-risk counties during recent fire seasons and shows promise for operational use. The next phase of development involves moving toward finer-scale forecasts by increasing spatial and temporal resolution and the implementation of 72-hour predictive windows. Ultimately, the innovation achieved by the project could help utilities and emergency agencies make faster, more informed decisions in the face of climate-driven wildfire threats.



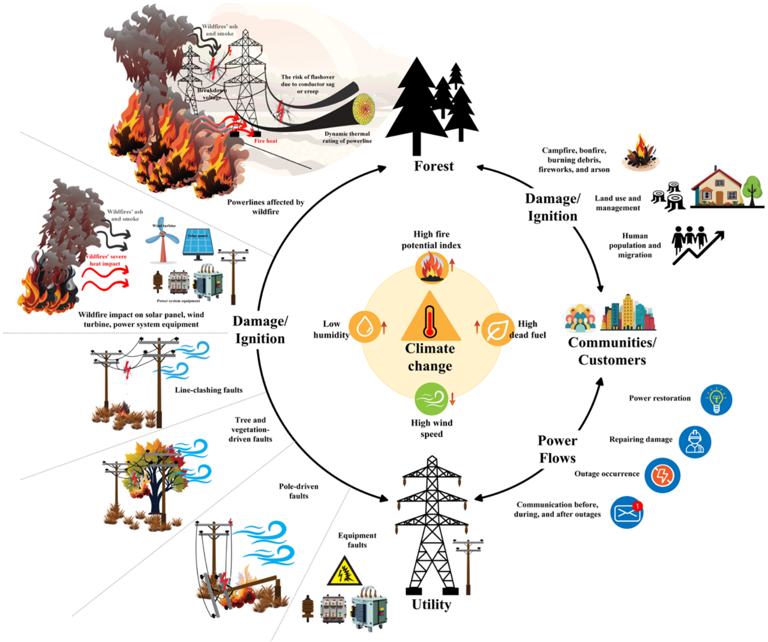
Caldor Fire perimeter showing fire growth period, extent of burned area, centroid position, ignition point, and the number of ignition sources detected within the boundary.

Nexus

Where Wildfire Meets the Grid

Wildfires and power systems have a complex, intertwined relationship that is becoming increasingly critical to understand and manage as climate change intensifies the risks of wildfire that threaten power infrastructure. Fires that rage uncontrolled through wildlands and rural areas can ignite electrical faults, damage equipment, and cause widespread outages. At the same time, electric infrastructure can itself spark wildfires under certain conditions—for example, when a downed powerline during dry, windy weather ignites dry vegetation—creating a dangerous feedback loop that then jeopardizes additional grid assets and customer safety.

In collaboration with leading experts from the University of Connecticut, Lawrence Berkeley National Laboratory, Sandia National Laboratories, and the University of California, Santa Barbara, researchers at the Eversource Energy Center are working to clarify these bidirectional interactions and identify the factors that drive these risks. Through the Wildfire–Power Grid Nexus project in a changing climate, we are examining how wildfire risks are amplified by environmental conditions,



Interactions that underscore the complex, bidirectional relationship between wildfires and power systems. The figure combines subfigures that show how wildfires affect power system operations and infrastructure, and how the power system itself can ignite wildfires, further complicating response. The orange icons represent conditions exacerbated by climate change that increase the risks. High wind speed is denoted by a green icon. Also emphasized are human activities and the cascading effects of power outages on communities and power restoration efforts.

such as a high fire potential index, low humidity, and dry fuels, that are being worsened by climate change. These conditions create a tinderbox scenario in which small sparks can lead to catastrophic fires. An additional factor—high wind speed—is not increasing as a direct result of climate change, but it significantly spreads fires and can intensify fire events.

Also being investigated by the project is how human activities, like campfires and the burning of debris, add to the risks. Importantly, the cascading effects of wildfire-related power outages ripple through communities, affecting emergency response, communication, and daily life, making timely restoration a top priority.

Our research, currently well underway, combines climate data, wildfire modeling, and power grid analysis to improve risk assessments and develop better wildfire mitigation strategies. We focus on innovative solutions, such as vegetation management, grid hardening, and advanced fault detection technologies, to reduce the chances of ignition.

Ultimately, this work will help utilities and policymakers implement smarter wildfire risk management plans that protect both the power system and the communities it serves. By understanding and visualizing the complex interactions between wildfire and power systems, we are supporting the development of safer, more resilient energy infrastructure, which benefits everyone—especially as climate change continues to increase wildfire threats.

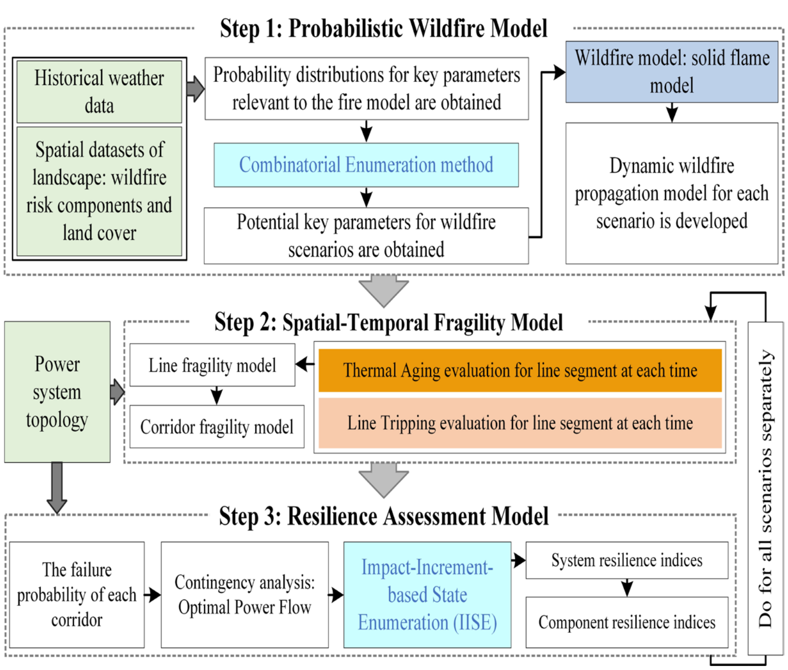
Powerlines under Wildfire Threat

Among the power system elements under growing threat from more frequent and intense wildfires are power transmission networks. At the Eversource Energy Center, researchers are developing a new, scenario-based assessment framework that accounts for how wildfires spread across space and time, and how those dynamics affect powerlines. Supported by the U.S. Department of Energy and developed in collaboration with Sandia National Laboratories in Albuquerque, New Mexico, and Lawrence Berkeley National Laboratory in Berkeley, California, the project—Wildfire-Driven Resilience Assessment of Power Transmission Networks—will equip utilities with a forward-looking, data-driven approach to assessing and enhancing system resilience when wildfires break out.

Unlike traditional risk assessments that rely on static hazard maps or aggregated data on wildfire risk along the transmission corridor, our method simulates thousands of possible wildfire events based on historical weather patterns and vegetation data. By integrating real-world parameters like wind speed, flame length, and terrain, it calculates how each event might affect individual transmission corridors. If, for example, a wildfire ignites 500 meters from a powerline during high winds, the model can estimate how much heat the conductor will absorb, how fast its capacity will degrade, and the probability that it will fail. The probabilities are aggregated across the entire system to identify which lines are most vulnerable and what the cascading impact would be—such as loss of power to entire regions or the need for costly restoration.

So far, we have applied this method to the RTS-GMLC grid test system, which represents a regional network similar to those used across the southwestern United States. Preliminary results reveal that some corridors previously considered “low risk” are actually more vulnerable under realistic wildfire scenarios, while others assumed to be at high risk show greater resilience.

The findings from our project promise to inform both operational decision making and long-term grid planning by electric utilities. Looking ahead, the same framework could be adapted to assess grid resilience under other extreme weather hazards, such as hurricanes.



The proposed resilience assessment framework.

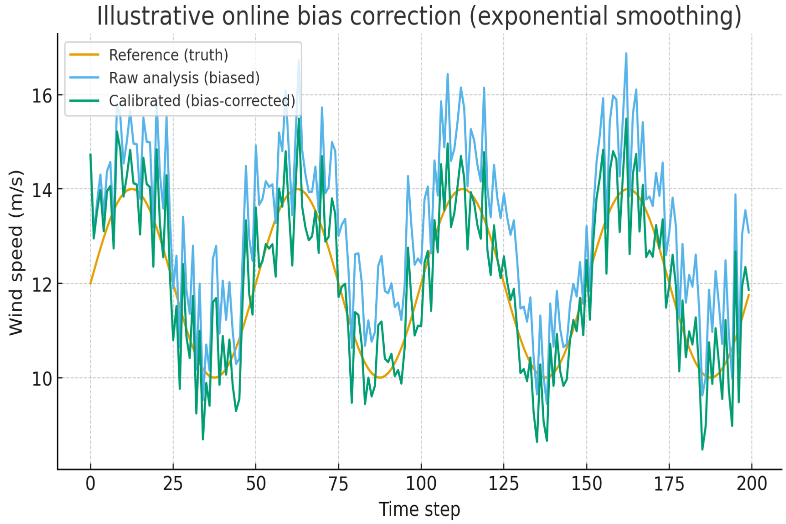
Wind and Water

The winds and the seas cannot be controlled, but they can be harnessed. Eversource Energy Center researchers are seeking and applying knowledge that will enable utilities to make the most of these renewable energy resources.

Simple Fixes, Big Gains
Calibrating Wind Analyses in Real Time

To plan wind power production, schedule maintenance, and manage safety in onshore and offshore wind farms, utilities and wind farm operators need maps they can trust—timely ones—that show how fast and in what direction the wind is blowing. At the Eversource Energy Center, researchers have conducted a short study that shows how a quick, low-cost, real-time calibration can make ensemble wind analyses both more accurate and more honest about their uncertainty. The study solves issues common in wind maps, like drift and unreliability, that can lead to costly, unsafe, or inefficient decisions.

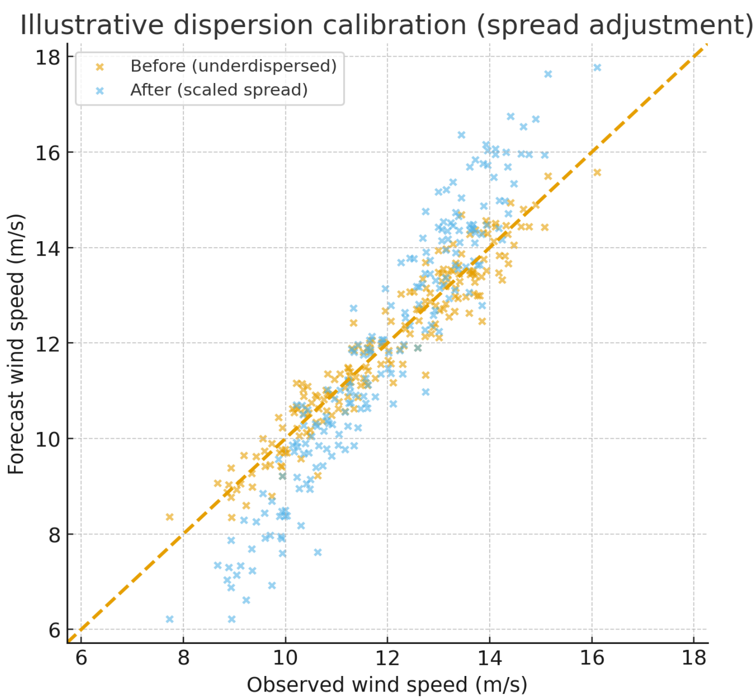
The idea is straightforward: Compute the wind speed mean and dispersion (with respect to that mean) from the model's east–west and north–south wind components, then apply two real-time adjustments as new verification arrives. First, an online bias correction subtracts an average estimate of recent error, so that persistent over- or underestimates don't linger. Second, a dispersion correction scales the ensemble dispersion so predicted uncertainty matches reality. Both updates use a weighted time average that gives more weight to the most recent value, so the updates are fast, numerically stable, and easy to run at the pace of incoming observations—hallmarks of real-time systems.



Online bias correction in action. In this framework, the calibration handles a crucial accuracy adjustment of wind maps between analysis times. The time series compares the reference (truth; orange line) with the raw analysis (biased; blue) and the calibrated, bias-corrected analysis (green). The calibrated curve tracks the reference more closely while preserving real wind variability—reducing persistent over- and underestimation without flattening the signal. In practice, a data processing flow (1) ingests new incoming measurements, (2) updates the bias and dispersion factors per zone or regime (coast versus offshore), and (3) publishes calibrated wind maps and uncertainty layers to the same dashboard already consulted by crews. Streaming bias removal (orange → teal) aligns the analysis with the reference while preserving real variability.

This innovation matters especially for offshore winds, as crew transfer and maintenance windows hinge on short-term wind thresholds. Under- or overconfident analyses can lead to unnecessary standdowns or risky dispatches. By continuously nudging away bias and calibrating the wind dispersion, operators get a clearer picture of current winds and a more reliable sense of what the model does—and doesn't—know. The method is simple, convenient, and applicable to any ensemble prediction system, such as numerical weather prediction, ocean wave models, or hybrid artificial intelligence models because it only needs recent pairs of data, "model versus reference," at points where truth is available, as gathered by buoys, LiDAR, scatterometers, or masts.

So, what comes next, and how will it be used? As a result of our work, utilities can expect better forecasts and smoother operations by inserting these real-time calibration methods into the pipeline of a modern data processing system. As the work continues, we will add to our framework regime-aware detection algorithms to detect, for example, the passage of cold fronts or transitions to slower flows, to predict, in real time, wind power ramps and further sharpen the decision-making abilities of utilities and wind farm operators.



Getting uncertainty right. Dispersion calibration inflates an underdispersed ensemble (blue) to match better observed variation (green), shown against the 1:1 line.

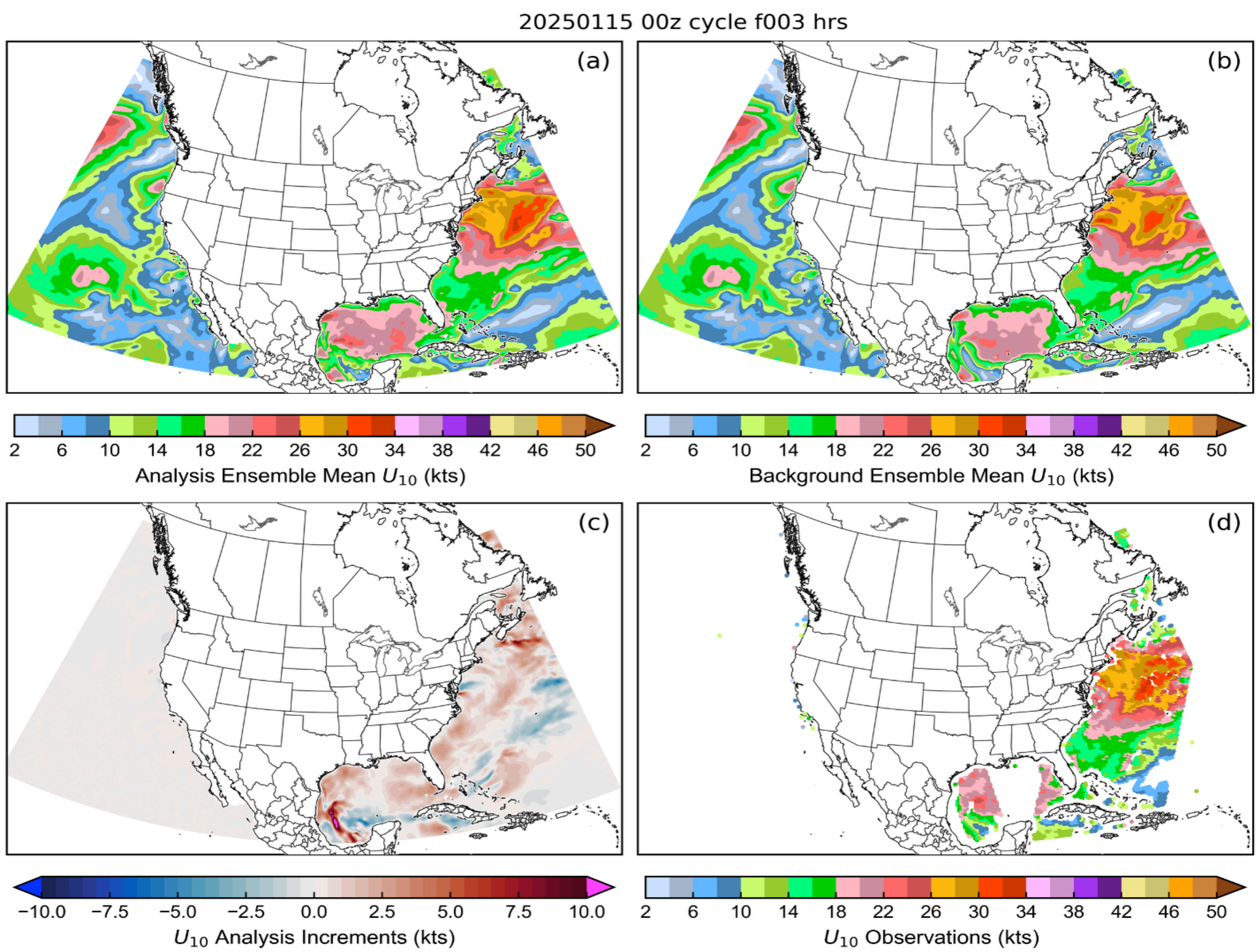
Winds and Seas, Right Now

When people talk about "real-time analysis," they mean information maps describing the state of the atmosphere and the ocean to guide decisions now. Data assimilation is the engine that generates such analysis maps of weather and ocean variables. Data assimilation schemes continuously blend the best available observations (from satellites, buoys, radars, and so on) with a physics-based forecast, generated earlier and validated at the present time to coincide with the observation times. This process produces the most likely picture of current conditions—that is, the analysis. For offshore wind and wave energy, that analysis is gold. It tells operators where winds and seas are right now, improves short-term forecasts, and helps them schedule everything from turbine maintenance windows to crew transfers and cable laying in safer, more productive seas.

At the Eversource Energy Center, researchers are showing how real-time data assimilation sharpens the view of the wind–wave environment that underpins reliable, weather-resilient power. In our study, a data assimilation scheme called the Local Ensemble Transform Kalman Filter ingests sequentially, every three hours, satellite observations over the continental U.S. ocean domains, making use of ten altimeters that measure significant wave height and five scatterometers—a type of radar—that sense near-surface wind speed. By comparing analyses against independent (nonassimilated) observations, we find that adding satellite data reduces error statistics and reveals regional weather patterns that would otherwise be missed.

What does this mean in practice for offshore wind and wave renewables? Better analyses feed better short-term forecasts, which directly improve go/no-go calls for crew transfers, turbine curtailment decisions in severe winds, and planning for operations to tow, lift, or jack up turbines. For wave energy sites, tighter wave-height analyses improve estimates of power capture and survivability windows.

The next steps for our research include moving to a fully real-time ingestion of data, expanding our collection of observations to additional sensors, and extending the weakly coupled setup toward tighter wind–wave coupling so wave data can help improve wind estimates and vice versa. Ultimately, by integrating these analysis maps into dashboards alongside maintenance schedules and market bids, utility planners and operators will be able to turn spaceborne measurements into day-to-day gains in reliability, both on the water and on the grid.



Four-panel snapshot of the 10 meter wind analysis cycle (CONUS ocean domain): (a) analysis ensemble mean wind speed; (b) background (first-guess) ensemble mean; (c) analysis increments (analysis–background), highlighting where observations nudge the model most; and (d) the scatterometer wind observations used at analysis time. The analysis tightens winds near active weather systems, guided by the satellite passes and scaled by local ensemble uncertainty.

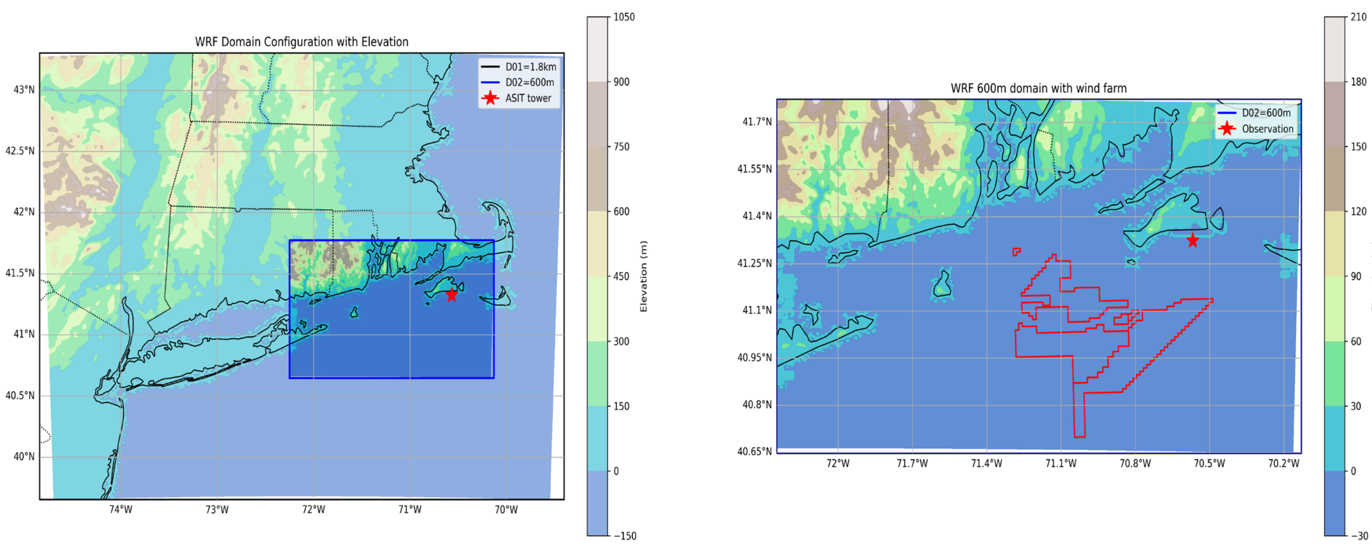
On High
Wind Prediction at the Turbine Hub

To plan, site, and operate offshore wind farm facilities, developers must have the ability to assess and predict wind speed and direction, wind variability, atmospheric stability, and wind shear up to the height of the turbine hub. In the first phase of a five-year (2022–27) project, researchers at the Eversource Energy Center developed a high-resolution prediction system to simulate localized winds for the South Fork Wind Farm facility in the North Atlantic. The objective of the second phase is to deploy the system operationally.

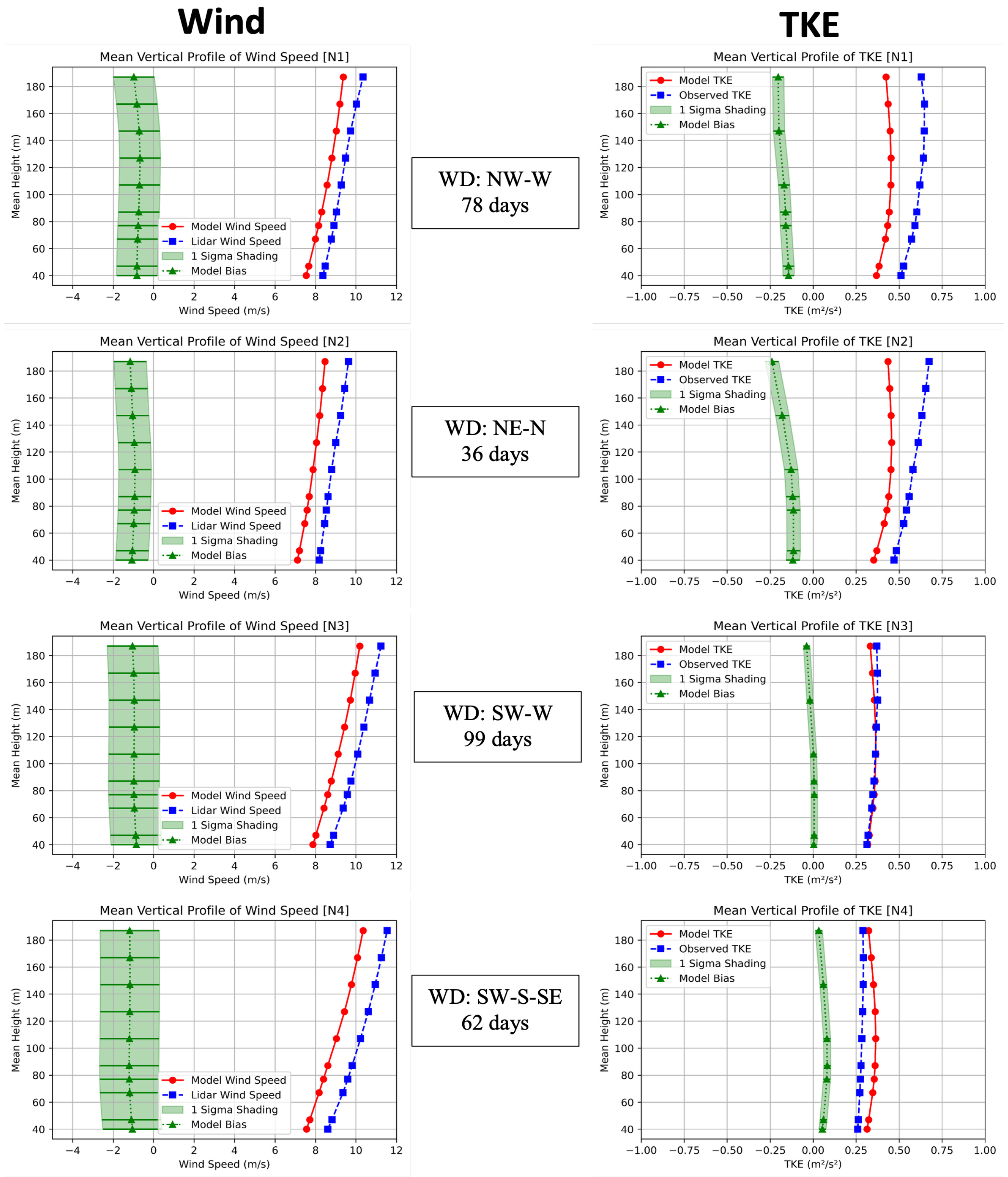
Last year we finalized the analysis of an annual model simulation, the main interest of which was to determine the accuracy of predicting wind speed and turbulence at the level of the wind turbine rotor on a sub-kilometer scale, using data from an offshore tower maintained by the Woods Hole Oceanographic Institution. For the first time, we used a three-dimensional planetary boundary layer (the lowest part of the atmosphere, also called the "weather layer") scheme over an oceanic area at a grid resolution of 600 meters for an entire year.

The results showed strong agreement between modeled and observed wind speed and direction at hub height, with correlations close to or above 0.9. (A correlation of 1 designates a perfect agreement between measured and predicted variables.) Although an underestimation of stable stratification caused turbulence to be overpredicted under stable conditions, the model performed well in weakly forced, northerly flow regimes, regardless of stability. These findings can inform future improvements in the atmospheric boundary layer representation for the weather model.

The next two years involve automating the exchange of data and integration between high-resolution offshore wind prediction and wind prediction at the turbine level.



The weather model domain. Parts of the North Atlantic wind farm lease areas are outlined in red, and a red star marks the location of the Woods Hole Oceanographic Institution's air–sea interaction tower.



Mean vertical profiles of hub height wind speed and turbulence at the tower location from observations and the model. The model bias (model-observations) is shown in green, with the shading indicating one-sigma deviation. Wind direction (WD) and number of days are shown for each synoptic node.

Money Matters

For electric utilities, it is a whole new world of renewable energy sources that pose significant challenges to the continued smooth and safe functioning of the grid. Researchers at the Eversource Energy Center are developing innovative ways to prevent, detect, and solve the issues that come with the integration of these resources into both transmission and distribution systems.

Worth the Investment?
Benefits of Household Grid Resilience Improvements

Power outages cost electricity customers money in many ways, from food spoilage to the catastrophe of bursting pipes. But how can we go about assigning a dollar value to such losses and determine what investments will be most effective for reducing and preparing for outages?

At the Eversource Energy Center, researchers have created a model that uses survey data to assess economic impacts of outages to households, the effects of steps they take to reduce costs, and their capacity to recover by considering household size, income, and other demographic and geographical variables. Developed for application to Connecticut households, it is easily generalized to communities in other states, with results comparable across them.

Initial findings for Connecticut demonstrate the value of the model in determining what investments by both utilities and individuals will do the most good. We found, for example, significant variation across income groups in the costs they incur from outages and, consequently, how much they would benefit from grid resilience efforts. These costs were highest for households making less than $50,000 a year, at an estimated $45.61 per household for each outage event and $33.33 for each outage hour. This implies that improvements to the grid resulting in a reduction of ten outage hours and five outage events a year would benefit each of these households by $558.33 a year. Multiplied by 1,000 low-income households affected by a given grid improvement, the total annual benefits would amount to $55,833.33; and multiplying that by how long the improvement would last—say 20 years—the investment would be worth over $1 million to these 1,000 households alone.

We might also conclude that the lower outage costs to middle-income households result from their greater capacity to prevent loss (in part because they are more likely to own their homes) and greater access to coping resources. Many such homeowners, for instance, have invested in generators.

These findings suggest cost-effective planning to mitigate outage effects would be made possible by a targeted investment strategy that weights the value of improvements by the numbers of households of each demographic type. Data-driven and transparent sets of weights are easily applied to different locations by obtaining demographic information from census data, with results that can be used to compare the costs and benefits of proposed grid improvements in different locations. Findings indicating who is trusted most to evaluate effective investments suggest they should be made with clear cooperation between utility companies and public entities or structured as public–nonprofit partnerships.

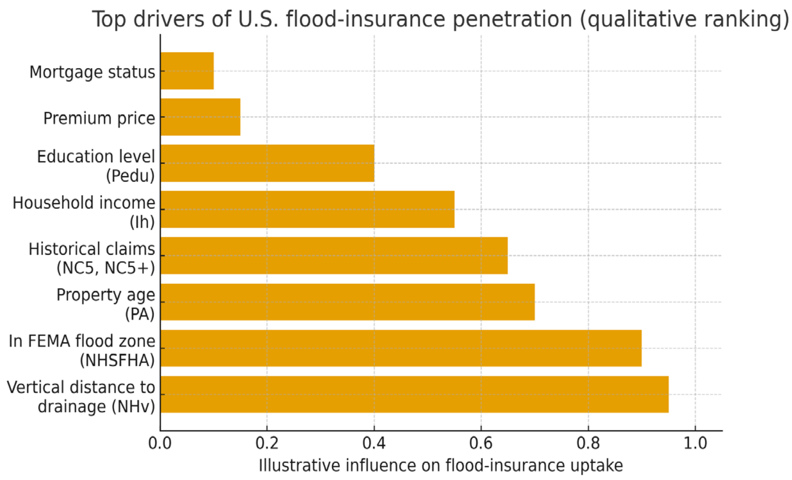
Altogether, our economic model provides a powerful tool for utilities and communities to make investments in electrical infrastructure with the greatest possible societal benefits and the lowest possible costs.

Who Buys Flood Insurance—and Why?

Flood losses are rising, yet many households still don't carry flood insurance. Much of the research to determine why has relied on surveys or county-level studies in single states or small regions, leaving information gaps throughout the United States. At the Eversource Energy Center, researchers have sought to fill these gaps by looking across the entire country—at the census-tract level—to find out which local factors most strongly explain whether or not people buy flood insurance contracts.

To uncover these patterns, we assembled "big data" spanning 37 predictors and trained a random forest model to predict yearly flood insurance penetration (policies per household unit) for every tract in the contiguous United States. We found that two geohydrological signals lead the list of reasons for households to have insurance: how high a home's main floor sits relative to the nearest drainage and whether the property falls inside a designated FEMA flood zone. After those, several community and property factors matter, with older housing stock, a history of local flood claims, and household income playing roles. Surprisingly, the sticker price of the premium and mortgage status shows little influence compared to these physical and historical risks.

Our model provides further insight into the question of who buys insurance and why by capturing nonlinear relationships and showing that the most important



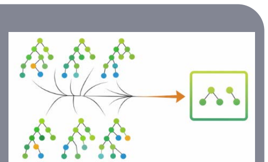
Selected drivers of flood insurance penetration in the United States, ranked qualitatively, with respect to flood insurance uptake. They are local hazard proximity (comprising height above nearby drainage and FEMA flood zone status), property age, total prior claims, and income. Premium price and mortgage status (not included in the figure) are comparatively weak signals.

drivers can shift by region—a reminder that flood risk and risk perception are local. By elevating both hazard proximity and social context, the work clarifies where outreach and tailored insurance products (including, for example, higher coverage limits, expanded coverage, or customizable deductibles) can move the needle on resilience, particularly for marginalized communities. More people buying insurance contracts lessens the burden on public disaster aid, freeing up resources for other critical infrastructure needs.

Our results also point to practical next steps for continuing to develop the model: Keep the decision trees current with updated flood maps and parcel elevations; fold in education and trust-building outreach; and test policy pilots that target the neighborhoods at highest risk first. For implementation, agencies and insurers can integrate parcel elevation, FEMA zone status, and local claims history into simple, privacy-respecting, census tract–level dashboards. Outcomes can then be evaluated following targeted campaigns for risk communication and insurance enrollment, such as flood-risk awareness messaging, renewal reminders, or community-based engagement initiatives. Periodic retraining of the model will track shifting exposure to flooding as development and climate change redraw risk.

For utilities, the ultimate benefit of our work is that pairing physical hazard signals with community context offers a scalable path to close protection gaps—before the next flood.

Random forest *is an ensemble machine-learning model that constructs and combines the output from many smaller models called decision trees during training to produce a single, more accurate result.*



One Driveway at a Time

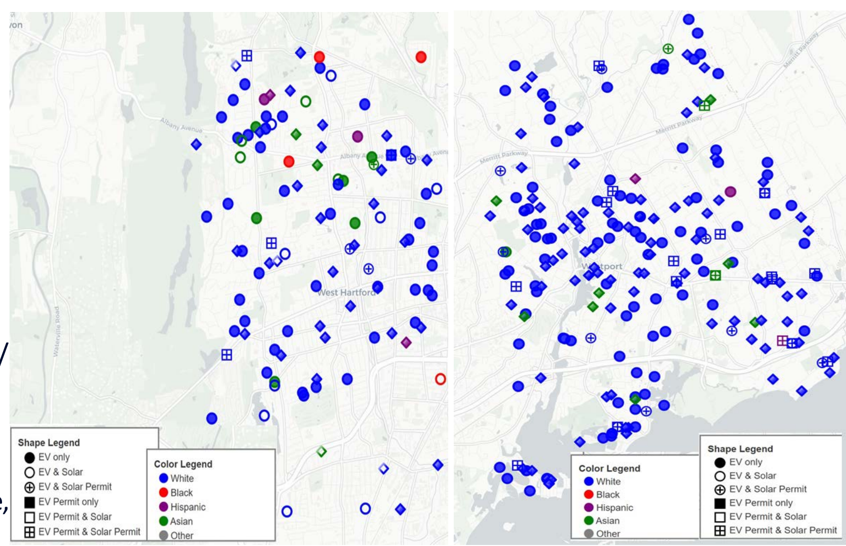
EV Charging and Housing Prices

As electric vehicles (EVs) have become increasingly popular, the infrastructure that supports them—particularly at the residential level—is gaining importance. Having an off-grid energy source (such as onsite solar) to support the EVs can contribute to utilities' efforts to manage energy demand. According to the Eversource–UConn Partnership Research Pillar Five, no metrics currently are available that can be used to identify "equity in resilience"—that is, equal access to investments in reliable electricity distribution—among different groups of customers. One way to quantify equity is by measuring differences in the adoption of or access to renewables across various income, gender, and/or other groups. Since renewables may be more resilient than nonrenewable energy sources, understanding the demographics of customers with renewables in their homes can help demonstrate whether access to resilience technology is equitable in terms of, for example, an even distribution across racial groups.

In addition to highlighting demographic disparities in access to renewable energy, it is important to consider how these differences translate into unequal access to resilience-enhancing technologies, such as residential EV charging. Home EV chargers—particularly when paired with onsite solar generation—can strengthen a household's ability to withstand grid disruptions, reduce dependence on centralized infrastructure, and better manage energy costs. Yet despite the rapid rise in EV ownership, little empirical work has examined who has access to these chargers or how their presence contributes to household resilience (and, in turn, raises house values). Understanding these dynamics is essential for evaluating whether the benefits associated with EV charging—both in terms of energy reliability and potential effects on housing values—are equitably distributed, as well as for helping guide investment by both homeowners and utilities in renewable energy technologies.

To address these issues, researchers at the Eversource Energy Center are exploring the relationships among single-family homeowners' Level 2 EV charging stations, distributed photovoltaics (residential solar panels), and the race or ethnicity of single-family homeowners, along with corresponding house prices. The innovative aspect of our pilot study is to obtain the necessary data by combining local permit records (showing the locations of houses with solar panels and/or EV charging stations), real estate transaction data, and demographic estimation tools to identify meaningful patterns. We then merge some of these variables at the street address level to generate useful information for a visual analysis and perform a statistical analysis to demonstrate empirical relationships between renewables and house prices. The resulting maps show the overlap of demographics and EV chargers across locations.

This pilot research holds the potential to help homeowners, realtors, and local governments make informed decisions, both about buying and selling homes and investing in renewable energy, and to achieve equitable access to resilient energy supply technology. Although early in its impact, it opens a path for similar analysis in other geographical locations, toward understanding how green technologies directly affect personal wealth and property markets—one driveway at a time.



Among the main findings of the research, Westport, Connecticut (left), demonstrated less demographic diversity than West Hartford in terms of which homeowners had solar and/or Level 2 EV charging permits between 2017 and 2023. We also found that homes with EV charging sold for an average of 7.3 percent more than those without. Data on solar panel locations originate from the Connecticut Green Bank and from municipal permits databases; Level 2 EV charging permits data originate from municipal permits databases; and race/ethnicity demographics are approximated with R software code.

People in Power

The Eversource Energy Center does its part in preparing the utility workforce of today to maintain, protect, and improve the grid of the future.

SUSTAIN-CT

Preparing the Utilities Workforce

With 45 percent of its workforce aged 55 years and over, Connecticut is among the U.S. states with the most senior workers. This aging of the labor force will hit public utilities especially hard, as at least one-third of workers in the sector are scheduled to retire within the next five years.

Despite fluctuations at the national level, Connecticut remains committed to a green energy transition. The state can seize these opportunities, however, only if it is able to attract, train, and retain a workforce with the necessary skills. An Eversource Energy Center project called SUSTAIN-CT (Sustainable Up-Skilling for Transitioning and Achieving Inclusive and Just Energy in Connecticut) delves deeply into the labor dynamics of this sector. Its analysis of labor demand and supply supports the other work being conducted by Center researchers as they develop new technologies whose implementation will require a diversity of expertise.

Our analysis for SUSTAIN-CT began with an in-depth literature review and quickly moved to a more data-driven approach. By merging the Occupational Information Network (O*NET) and National Laboratory of the Rockies (NLR) databases, we were able to identify occupations important to the utilities sector, both now and in the future, and organized the information according to six stages of the energy transition: generation (19 jobs), transmission (6), resilience (19), distribution (24), storage (3), and energy efficiency (9). Positions ranged from highly educated engineers to occupations requiring specialized skills, such as solar photovoltaic installers and wind turbine technicians.

Next, we mapped these occupational requirements against programmatic offerings from Connecticut's 37 accredited post-secondary institutions. Programs at Yale University and the University of Connecticut had the greatest depth (offering higher degrees) but less breadth in their subject area offerings. Other institutions offered a range of programs with fewer educational requirements and relatively quick completion.

Recommendations from this exploration include investment by institutions in real-time labor market analysis tools, as well as the establishment of green energy business partnerships to develop programs that align with the needs for specific skills. Funding is needed for targeted job training programs to increase access, and curricula should be updated and broadened to cover more practical areas, such as knowledge of environmental policy for students who wish to become policy analysts.

A future objective includes a quantitative supply and demand analysis, including exploration of the demand for workers without traditional training, such as through apprenticeships, high school, and on-the-job training, to be rounded out by qualitative data collection through interviews with human resource personnel. These findings will be disseminated through videos, peer-reviewed articles, and briefs.

Stage of Electricity Transition	Job Sector	Specific Jobs	Primary Training Type	Duration (SVP Range)	Training Providers	Outcome
Generation	Renewable Energy	Mechanical Engineers	Bachelor's Degree/5+ Years of Training	(7.0 to < 8.0)	Central Connecticut State University, Fairfield University, University of Bridgeport, University of Connecticut, University of Hartford, University of New Haven, Wesleyan University, Yale University	Bachelor's Degree or Higher
	Energy	Solar Energy Systems Engineers	Bachelor's Degree/5+ Years of Training	(7.0 to < 8.0)	University of Bridgeport, University of Connecticut, University of Hartford, University of New Haven, Wesleyan University, Yale University	Bachelor's Degree or Higher
Transmission	Construction and Installation	Quality Control Systems Managers	Bachelor's Degree	(7.0 to < 8.0)	University of Bridgeport, University of Connecticut, University of Hartford, University of New Haven, Yale University	Bachelor or Master
	Construction and Installation	Electrical Power-Line Installers and Repairers	High School Diploma or Equivalent	(4.0 to < 6.0)	Apprenticeships-offerred High Schools or Vocational Schools	Cerficate
Resilience	Manufacturing	Wind Energy Operations Managers	Associate's Degree	(6.0 to < 7.0)	12 CT State Communities Colleges	Associate Degree
	Operation and Maintenance	Maintenance Workers, Machinery	High School Diploma or Equivalent	(6.0 to < 7.0)	Apprenticeships-offerred High Schools or Vocational Schools	Cerficate
Distribution	Renewable Energy	Polar Photovoltaic installers	High School Diploma or Equivalent	(4.0 to < 6.0)	Apprenticeships-offerred High Schools or Vocational Schools	Cerficate
	Building and Construction	Construction Labourers	High school Diploma or Equivalent	(4.0 to < 6.0)	Apprenticeships-offerred High Schools or Vocational Schools	Cerficate
Storage	Renewable Energy	Electrical Engineers	Bachelor's Degree	(7.0 to < 8.0)	Central Connecticut State University, Fairfield University, University of Bridgeport, University of Connecticut, University of Hartford, University of New Haven, Wesleyan University, Yale University	Bachelor's Degree or Higher
	Equipment Manufacture and Distribution	Transportation, Storage, and Distribution Managers	Bachelor's Degree	(7.0 to < 8.0)	Central Connecticut State University, Fairfield University, University of Bridgeport, University of Connecticut, University of Hartford, University of New Haven, Yale University	Bachelor's Degree or Higher
Efficiency	Cross-cutting/Enabling Activities	Career/Technical Education Teachers, Postsecondary	Associate's degree	(6.0 to < 7.0)	12 CT State Communities Colleges	Associate Degree
	Renewable energy	Energy Conservation and Efficiency Specialists	Bachelor's degree	(7.0 to < 8.0)	Central Connecticut State University, Connecticut College, Eastern Connecticut State University, Fairfield University, Quinnipiac University, Sacred Heart University, Southern Connecticut State University, University of Bridgeport, University of Connecticut, University of Hartford, University of New Haven, Wesleyan University, Yale University	Bachelor's Degree or Higher

NAPS 2025

Following a competitive proposal process in 2022, the University of Connecticut was selected to host the 57th North American Power Symposium (NAPS), an annual conference primarily sponsored by the Institute of Electrical and Electronics Engineers (IEEE) and the National Science Foundation (NSF). The conference took place in October 2025 at the Hartford Marriott Downtown in Hartford, Connecticut, and was cosponsored by the Eversource Energy Center.

Founded in 1969, NAPS is one of the longest running power engineering conferences in North America, attracting students, faculty, and industry professionals from across the United States, Canada, and abroad. It serves as a significant forum for advancing research in power systems, electric grid operations, renewable energy integration, and distribution–transmission coordination. NAPS 2025 featured technical paper presentations, poster sessions, expert panel discussions, technical tutorials, and extensive industry networking opportunities.

NAPS has consistently been recognized as a student-centered conference, and the 2025 symposium further extended this tradition through new undergraduate-focused awards and expanded engagement of international students. Numerous UConn undergraduate students have attended NAPS, with some earning awards. By providing a platform to build students' confidence, highlight their research, and facilitate internships and employment opportunities in the energy sector, the symposium directly supports the Eversource Energy Center's mission to advance workforce development and strengthen collaboration between industry and academia.

NAPS Conference 2025

Grid Modernization Certificate Program Update

The Power Grid Modernization Certificate Program continues to advance its mission of bringing together utility professionals through a comprehensive curriculum designed to address the evolving challenges of the power sector. The program offers flexible delivery formats, including online, hybrid, and intensive weekend sessions, blending technical expertise with leadership development. Industry partners such as Eversource, Avangrid, and National Grid actively contribute, ensuring the curriculum remains relevant and effective.

The certificate program is structured around four main courses, totaling twelve college credits. Last semester the program offered the course Distribution Management Systems, and Communication Systems in Smart Grids is currently underway. Predictive Analysis for Scientists and Engineers will be offered next fall. The program also provides noncredit training options tailored for practicing engineers seeking career advancement. The initiative exemplifies the Eversource Energy Center's commitment to workforce development and industry collaboration, equipping professionals with the skills and knowledge they need to be leaders in the future of grid modernization.

Since Spring 2022, the Certificate Program has enrolled twenty-five participants. Two have earned their master of engineering degrees, and three are currently enrolled in the master's program.

For more details, visit the program's website at Certificate - Power Grid Modernization | Center for Advanced Engineering Education.

*The **Power Grid Modernization Graduate Certificate** was first offered by the Eversource Energy Center at the University of Connecticut in response to the specific need of the utility industry to prepare for its transition to the grid of the future by providing training each year to cohorts of early-career engineers on the technical aspects of grid modernization. Based on this need, the EEC designed a program that increases human expertise on predictive analytics, microgrids, communication systems, and distribution management systems to enable higher-level control functions and schemes to manage the increasing levels of distribution energy resources (DER) penetration. The four courses in the study plan cover the fundamentals required to address industry's new challenges: integrating renewable energy sources into the grid; predicting future electricity demands, capacity, smart grid designs, and operations; and confronting issues surrounding physical and cyber security.*

Center Productivity

Newest Patent

Cerrai, Diego, Sita Nyame, William Taylor, Aaron Spaulding, Marika Koukoula, Feifei Yang, and Emmanouil Anagnostou. "System and Method for Wildfire Ignition Modeling." 2025. U.S. Patent Application 18/962,608.

Publications

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