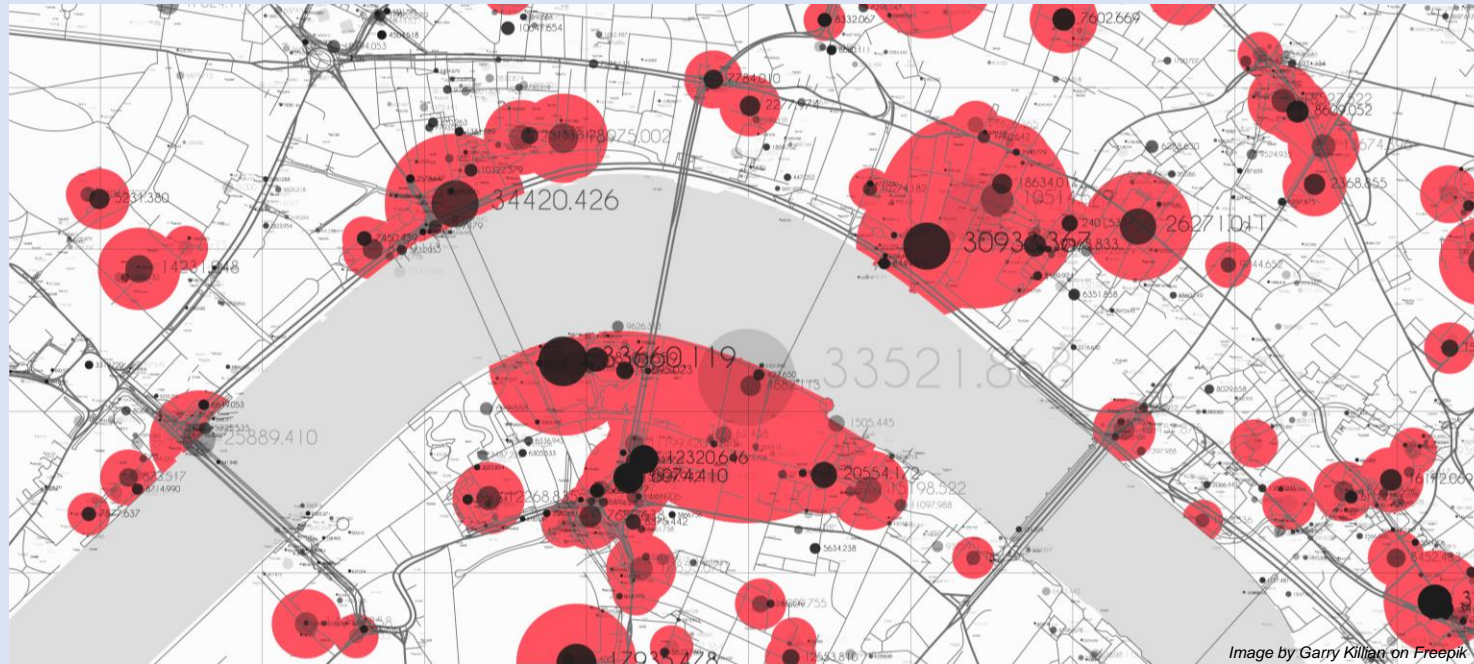# Beta-testing of the Agent-Based Model for Estimating Time to Restoration and Development of Resilience Metrics

Image by Garry Killian on Freepik

09 February 2024

Prof. Diego Cerrai, *University of Connecticut*

Industry Relevance & Need

The UConn OPM allows to predict distributed weather-related power outages in advance of storms.

After estimating power outages, utilities need to estimate restoration needs, and specifically to:

- **Allocate crews** before the storm
- **Distribute resources** efficiently
- **Correctly handle the restoration** to avoid regulatory sanctions.

Outage restoration is a complex process which involves optimal crew deployment, travel path minimization and outage prioritization (e.g., emergency outages vs most customers affected).

An informed estimation of restoration time at the town level allows utilities to:

- **Meet state mandates**
- **Optimize crew deployment**
- **Devise optimal restoration strategies**

Image by macrovector on Freepik

Eversource Energy Center

EVERSOURCE

Project Goals and Objectives

This project has two main goals:

- **Goal #1:** Complete, improve, and operationalize the **Agent Based Model (ABM) for Estimating Time to Restoration (ETR)**.
  The ABM will provide pre- and post-storm restoration information to Eversource emergency preparedness and response managers, in addition to the quantitative outage information provided by the OPM.
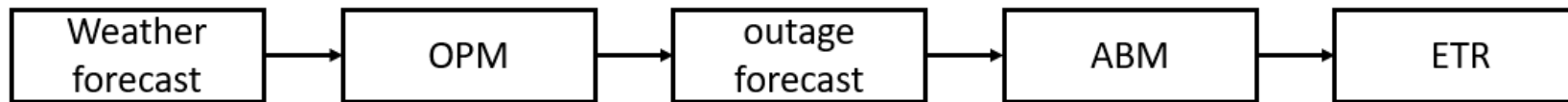
- **Goal #2:** Develop new **resilience metrics** for damage duration and frequency.
  The newly developed metrics will allow to assess historical damage duration by taking into account varying storm intensity and predict future improvements brought about by enhanced storm preparedness and response.

Modeling Restoration

The ABM, simulates ETR using geolocated information of road and electric distribution networks, area work centers, historical or predicted power outage locations, actual or proposed crew allocations, and decision rules.

We will _improve the ABM_ by:
- Implementing varying crew travel speed on roads
- Including dynamic restoration time by damage type
- Shortening model runtime

Figure 2: Connecticut road network as modeled in the current version of the ABM.

Then, we will _develop an automated system_ capable of delivering restoration time and scenarios predictions through a dedicated and secure website.

System Resilience Metrics

Based on preliminary metrics proposed to PURA in 2021, we will develop and test resilience metrics for system _damage duration and frequency_ which will consider different levels of weather intensity and specifically: (i) **normalized trouble spots** numbers or duration for different **weather intensity levels**, (ii) **duration and intensity** of severe weather events.
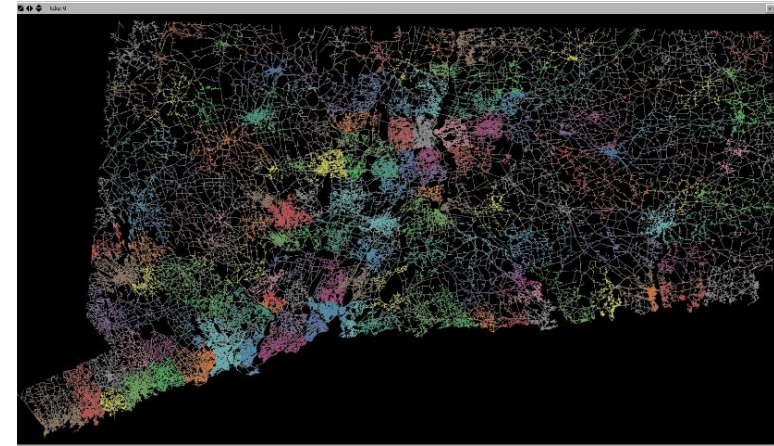
Outcomes and Deliverables

Date	Activity Reports
02/2024	• **Kick-off of the project.** • **Discussion of the project plan and deliverables.**
06/2024	• ABM improvements report: trucks travel speed & model runtime.
11/2024	• ABM improvements report: integration of different crew types & restoration time for each outage type. • Resilience metrics for duration and frequency developed
02/2025	• Presentation and discussion of the preliminary results at the EEC Annual Meeting • ABM system and website ready: beta-testing starts
09/2025	• Preliminary report after 6 months of beta-testing and plan to address issues • Historical assessment of damage duration reduction
02/2026	• Presentation and discussion of the results at the EEC Annual Meeting • End of beta-testing
04/2026	• Final beta-testing report and finalization of the model • Quantification of future damage duration reduction due to OPM and ABM
08/2026	• **Resilience metrics are published** • **ABM becomes operational**

☐ Completed Activity

Modeling Restoration

- Interfacing the ABM for ETR with the OPM will create a unique decision support tool for storm preparedness and outage restoration management, which will allow for the simulation of crew and equipment allocation and deployment scenarios.

- Improvements in outage prediction and restoration allows utilities to gain enhanced situational awareness.

- Scientifically based and explainable models (compared against usual "black box" models) allows utilities to explain to the public, the regulators, and the press the reasons behind pre-storm decisions, and to be transparent throughout the entire process.

System Resilience Metrics

- The newly developed metrics will allow utilities, regulators, and any interested stakeholders to assess the effectiveness of resilience improvements by accounting for varying storm intensity and climate change trends across the years.