

SimCenter Community Roundtable

“Simulating Power Infrastructure for Natural Hazard Resilience”

April 16, 2025

This SimCenter Community Roundtable meeting was organized by the **Working Group on Regional Simulations for Lifelines and Transportation**.

This roundtable focused on tools for simulating the performance of power networks during and after natural hazard events. The discussion spanned various aspects of the simulation workflow, from inventory generation to damage simulation, to post-disaster power grid performance, to recovery. As part of the discussion, recently released SimCenter tools to generate power infrastructure inventory and predict damage and losses due to hurricanes were highlighted.

Co-hosts: Matt DeJong and Luis Ceferino, UC Berkeley

Presentations and Key Ideas

1. “Probabilistic Simulation of Power Transmission Lines under Hurricanes”

Presenter: Paolo Bocchini, Lehigh University.

Dr. Bocchini presented on three major topics: advanced simulation of power lines under hurricanes, the significance of such simulations, and class fragility models. He described his multi-scale research efforts, ranging from bolted connections to tower and cable fragility, progressive tower collapse, and monopole fragility. He also covered simulation work in hurricane modeling and power system reliability analysis. In addressing the importance of advanced simulation, he highlighted sensitivity analysis results indicating that factors like wind direction and tower types have greater influence on system reliability than the spatial distribution of towers. Lastly, he introduced class fragility (also known as parameterized fragility) to enable efficient assessment.

2. “AI, Synthetic Distribution Systems, and Power Outage Prediction”

Presenter: Seth Guikema, University of Michigan.

Dr. Guikema discussed both short-term (event-specific) and long-term (risk-oriented) analyses. He began by outlining the response time cycle for utilities in hurricanes. For short-term analysis, his team trained a machine learning model using data from 10 historical hurricane events. The model uses hurricane track and intensity forecasts to calculate wind fields and estimate outage statistics through a six variants random forest approach. For long-term analysis, synthetic tropical cyclones were generated under various projected future climate conditions. The short-term model was then applied to estimate projected changes in the annual proportion of the population experiencing outages at the census tract level.

3. “SCE’s Seismic Resiliency Program”

Presenter: Ken Hudnut, Southern California Edison.

Dr. Ken Hudnut presented tools used by Southern California Edison (SCE), including USGS ShakeCast and SERA, for simulating the performance of power networks. He discussed two major use cases: exercises and retrofit prioritization. He also highlighted a recent SCE initiative evaluating the impact of a hypothetical earthquake doublet and provided an overview of the SCE Seismic Resiliency Program.

4. “Latest Capabilities of SimCenter Tools for Resilience Assessment of Power Networks”

Presenters: Nikola Blagojevic, Stanford University, Sina Naeimi & Barbaros Cetiner, SimCenter.

Drs. Cetiner, Naeimi, and Blagojevic introduced the existing and upcoming simulation capabilities of the NHERI SimCenter for power infrastructure. This includes generation of asset inventory through BRAILS++, performance assessment via R2D, and integrated recovery and resilience analysis across multiple infrastructure systems using PyReCODES-R2D.

Discussion Highlights

1. How to leverage open-source data in power system simulation given that local utility managers often have high quality inventory data?
Dr. Guikema shared examples where synthetic power systems were developed for risk and resilience assessments in areas lacking accessible infrastructure data from utility providers. Dr. Hudnut described situations where open-source data has been valuable—such as in the planning of new generation facilities and in efforts by utility managers to learn from international earthquake case studies.
2. Dr. DeJong asked for the speakers' perspectives on how SimCenter's testbeds and open-source models could be utilized.
Dr. Hudnut highlighted the potential for linking open-source tools with proprietary software while noting that such integration may face challenges related to cybersecurity and data sensitivity.
3. What natural hazards beyond hurricanes and earthquakes may damage power infrastructure?
Dr. Bocchini introduced research investigating the effects of post-hurricane ground instability on the structural performance of transmission towers.

More Information

Additional SimCenter Community Roundtable meetings can be found at <https://simcenter.designsafe-ci.org/collaborate/scr/>.