



Fraunhofer Institute for Algorithms
and Scientific Computing SCAI

Protecting the power grid from extreme wind events

Increasing resilience by protecting critical lines

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07.06.2023



Energy Transition/Electrification



<https://www.bu.edu/>

Energy Transition/Electrification

Example: Europe



15% in 2018

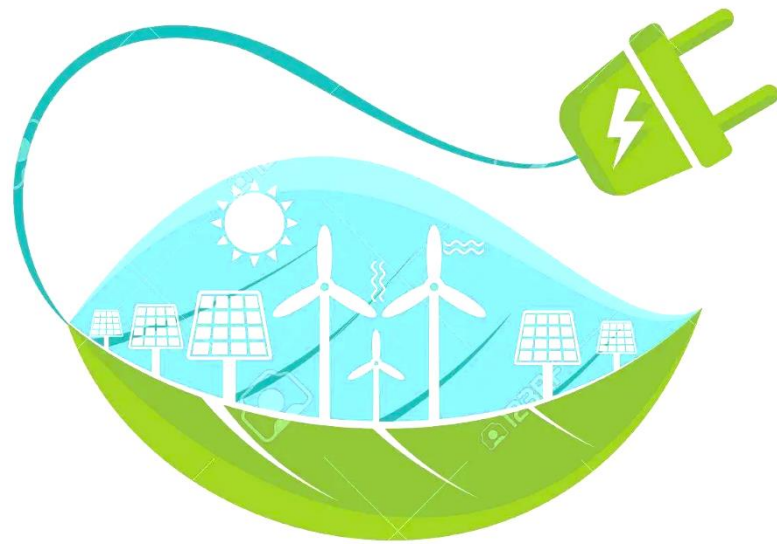


73%-82% in 2050

ENTSO-E 2019 & 2022 Report

Energy Transition/Electrification

Example: Europe



15% in 2018



73%-82% in 2050



2% in 2019



67% in 2040

ENTSO-E 2019 & 2022 Report

Energy Transition/Electrification

Example: Europe



15% in 2018



73%-82% in 2050



2% in 2019



67% in 2040



38% in 2022

ENTSO-E 2019 & 2022 Report

Extreme Weather Events

Power outages/Blackouts

<https://www.youtube.com/watch?v=8cXdI3sQAPO>



Energy Transition/ Extreme Weather Events



Chapter 16: Key Risks across Sectors and Regions

<https://www.ipcc.ch/report/ar6/wg2/chapter/chapter-16/>

Energy Transition/ Extreme Weather Events

What is the role of extreme weather events in the risks we face from climate change?

Climate change has often been perceived as a slow and gradual process, but by now it is abundantly clear that many of its impacts arise through shocks, such as extreme weather events. Many places are facing more frequent and intense extremes, and also more surprises. The impact of such shocks is shaped by exposure and vulnerability, where we live, and how we are prepared for and able to cope with shocks and surprises.

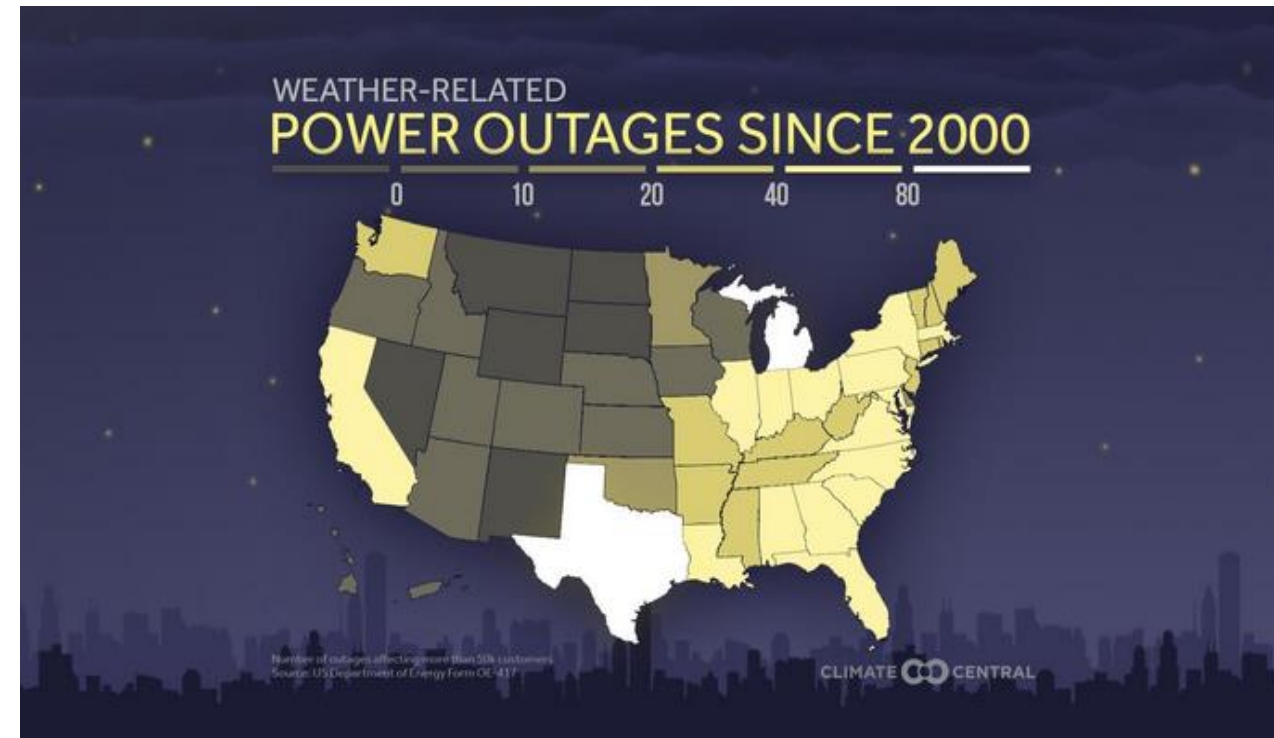


Weather-related Power Outages

Power outage statistics

United States

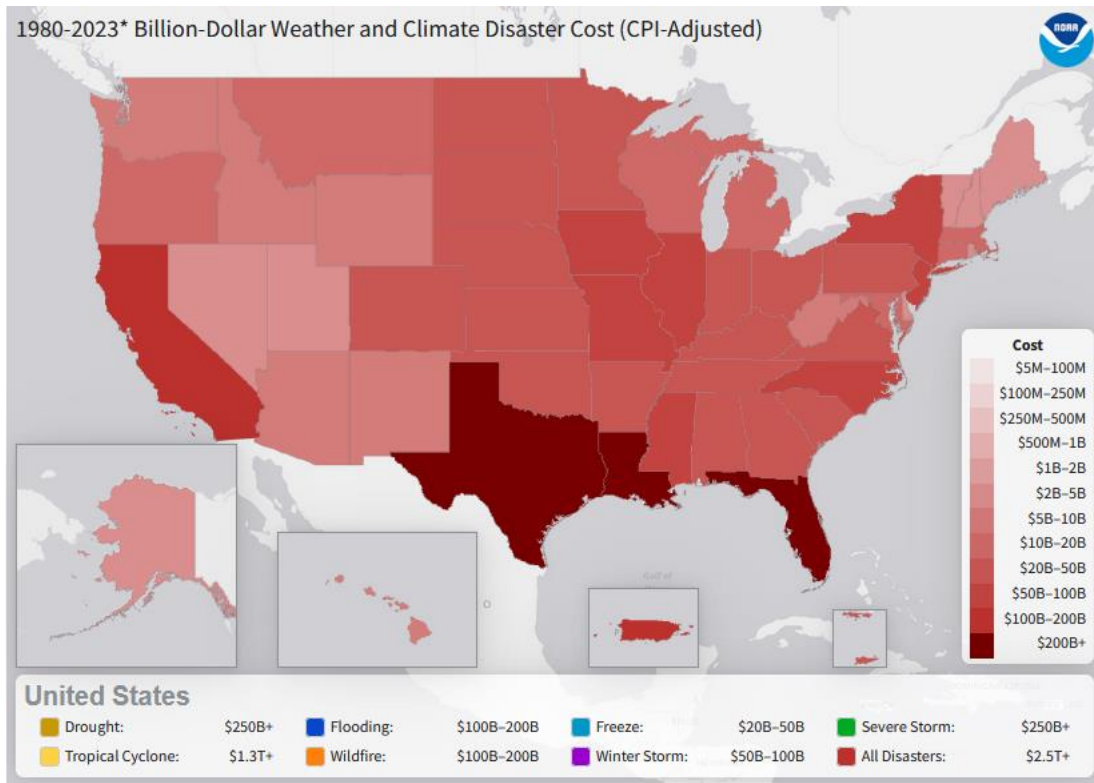
<https://www.climatecentral.org/climate-matters/power-outages>



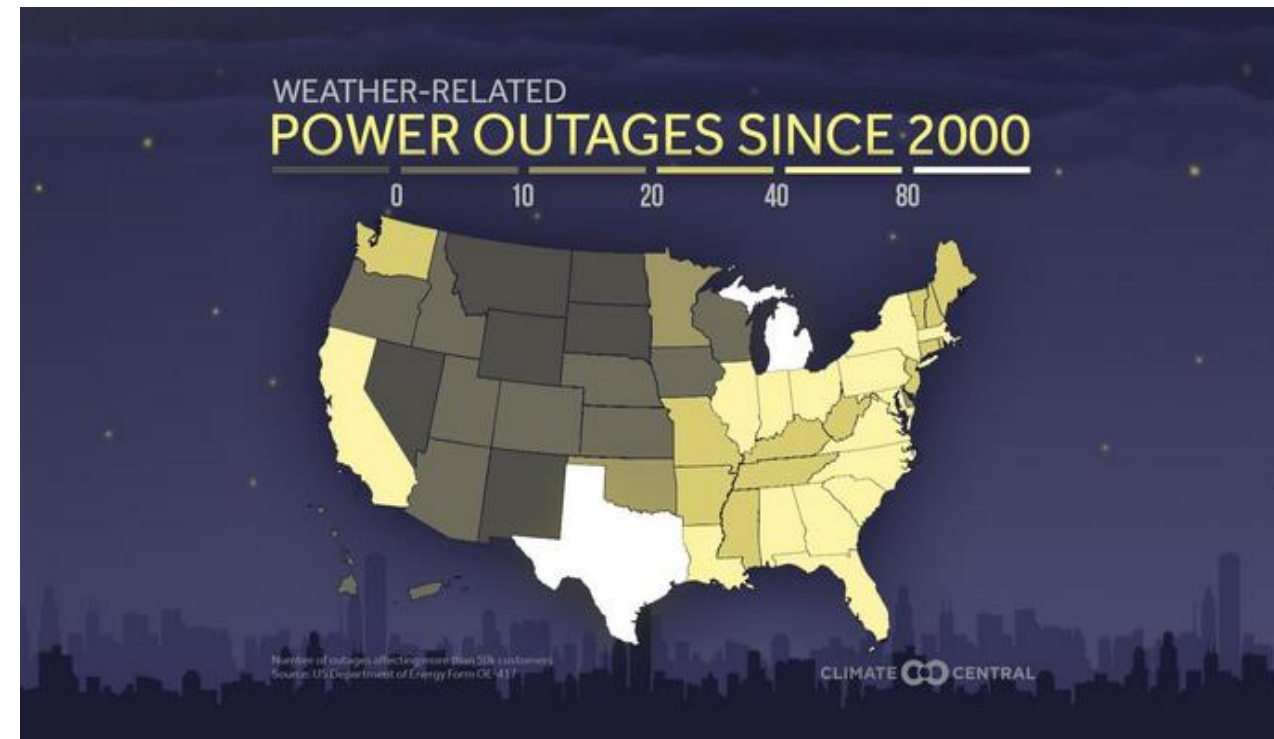
Power outage statistics

United States

<https://www.ncei.noaa.gov/access/billions/mapping>



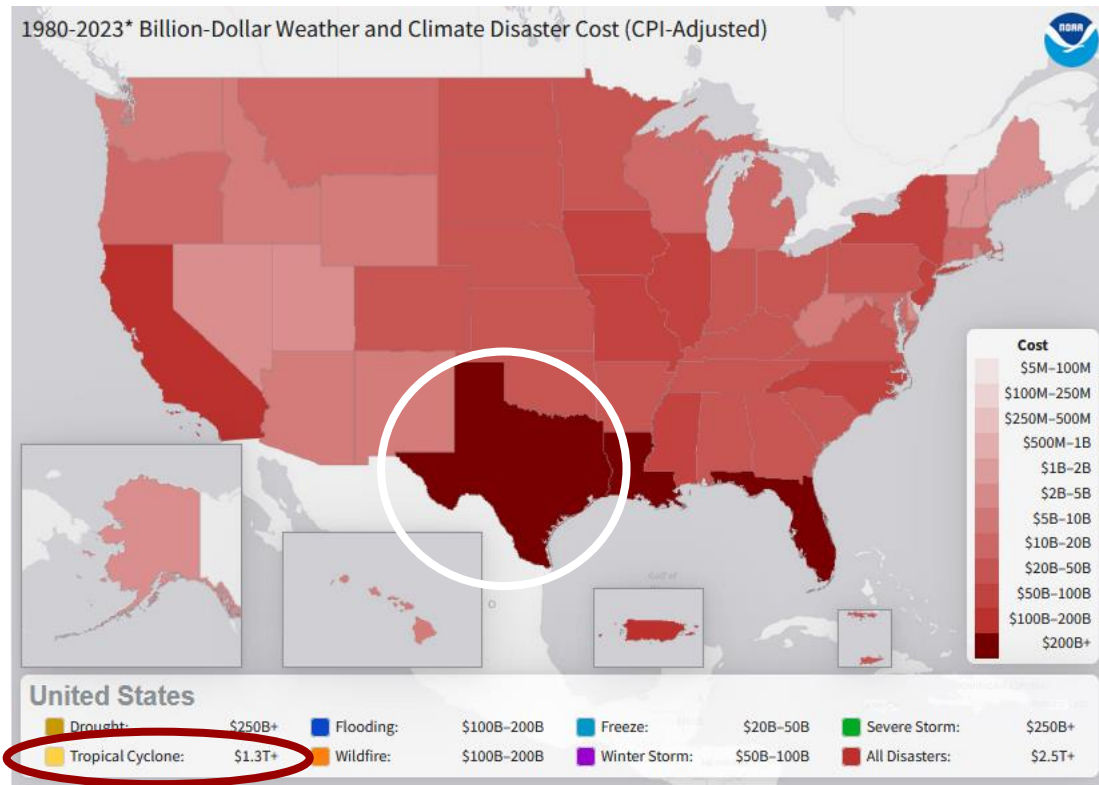
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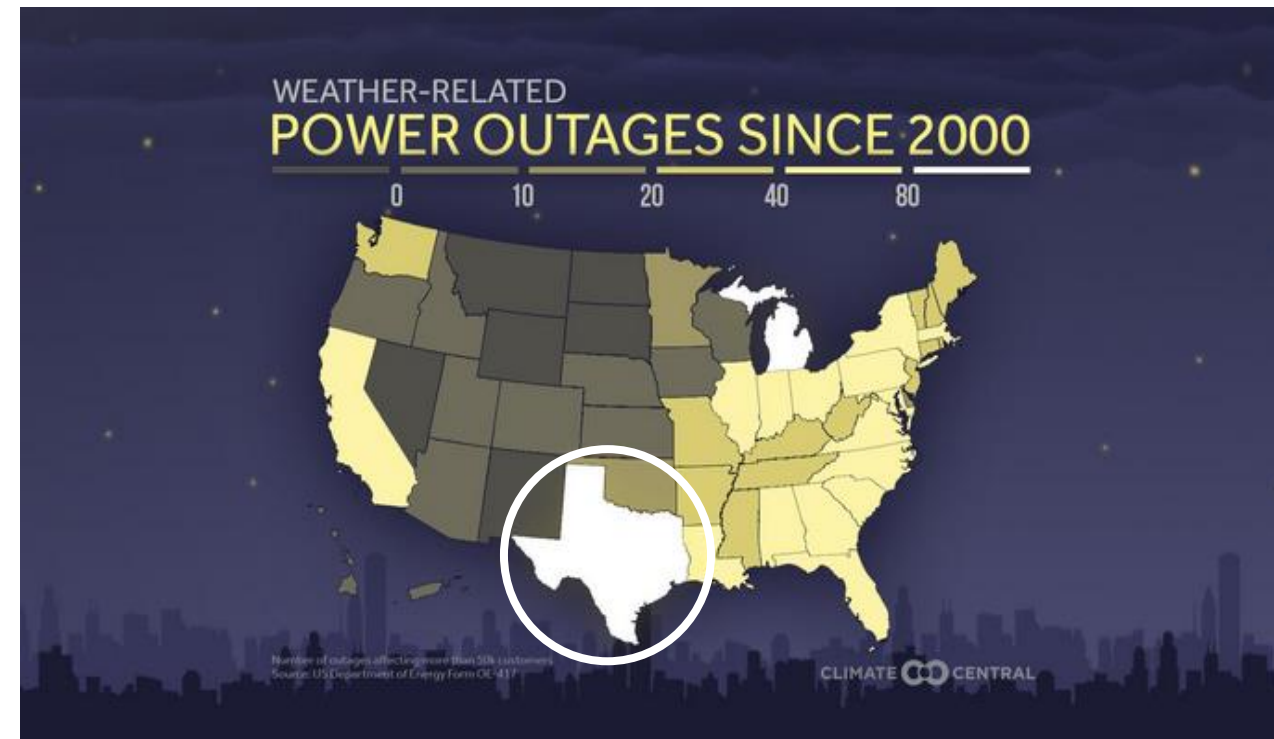
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Extreme Wind-Induced Failures & their Spread in the Power Grid



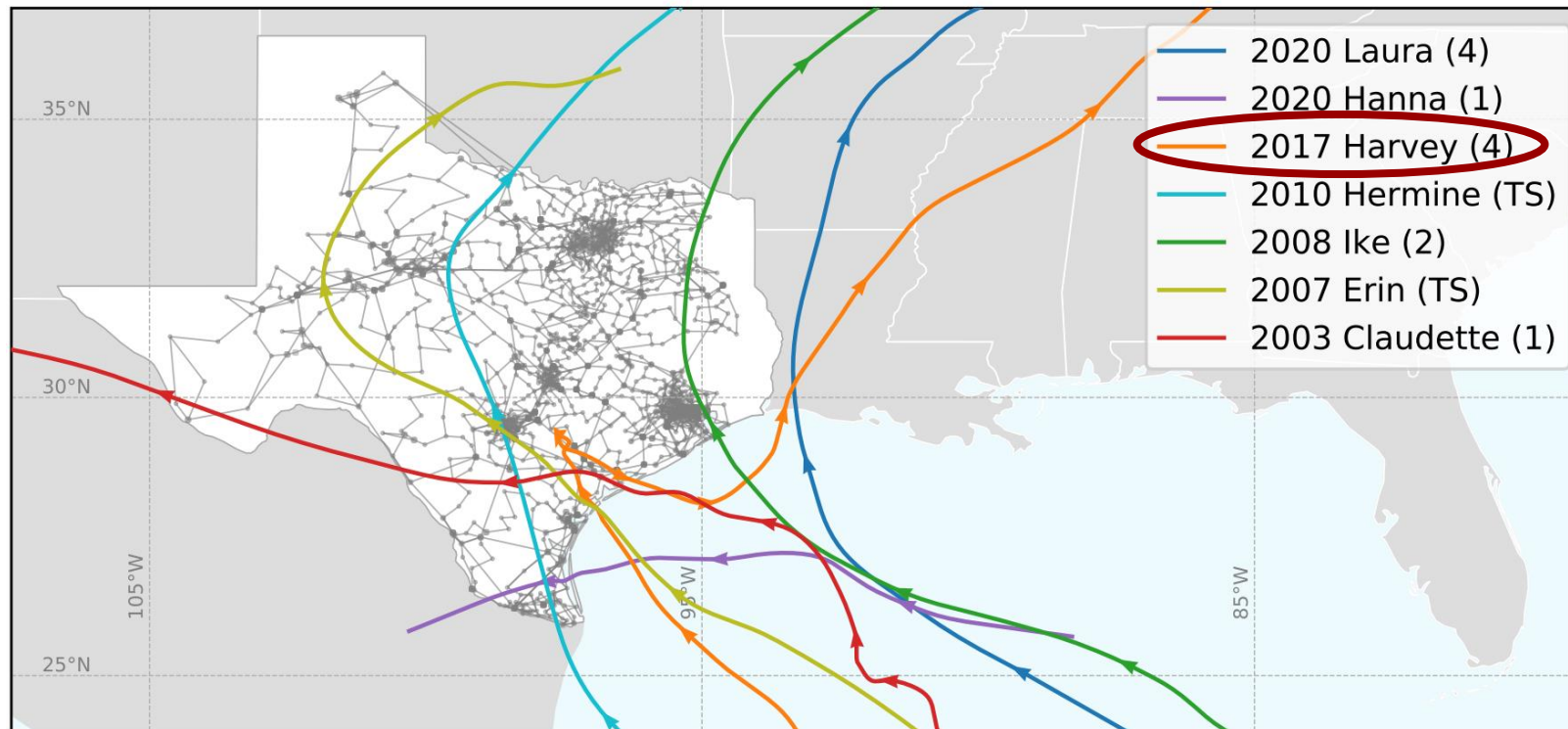
Extreme Wind-Induced Failures & their Spread in the Power Grid



https://en.wikipedia.org/wiki/Electrical_grid

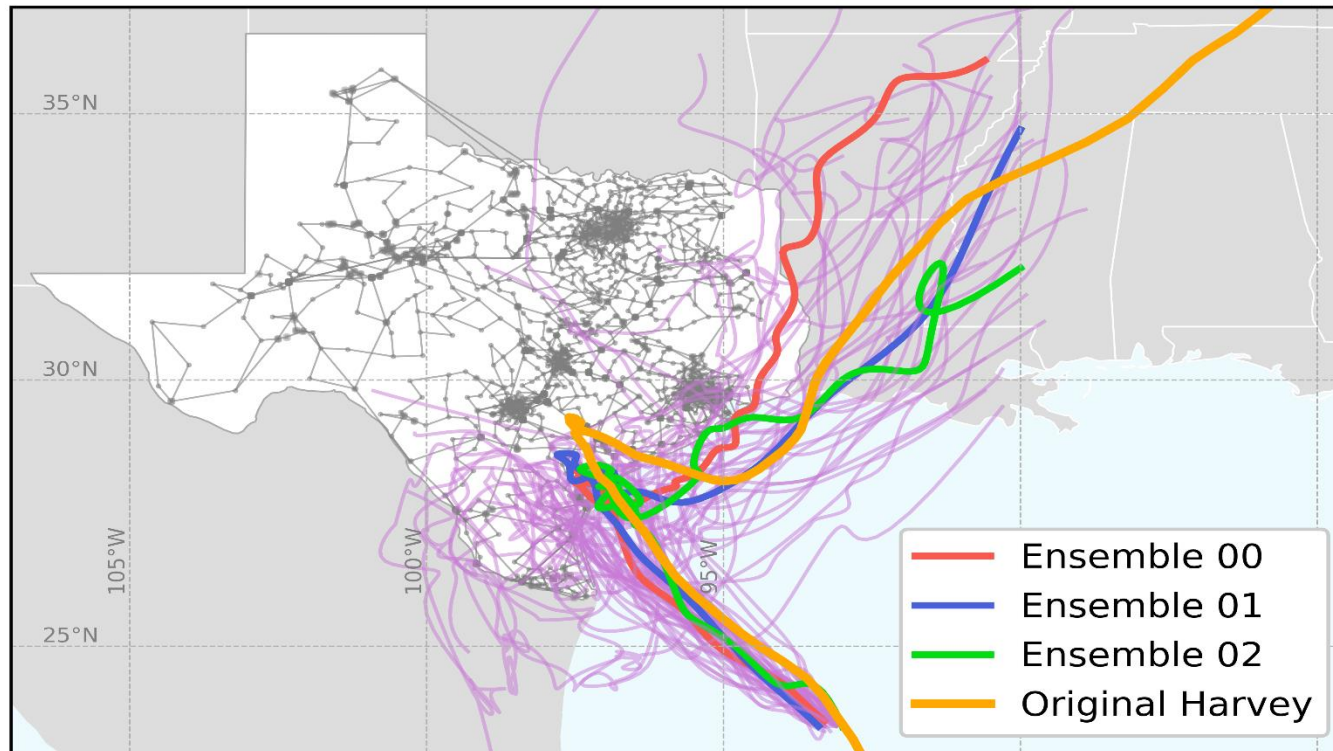
Tropical Cyclons (TCs)

Historical datasets



Tropical Cyclons (TCs)

Short-term forecasting datasets

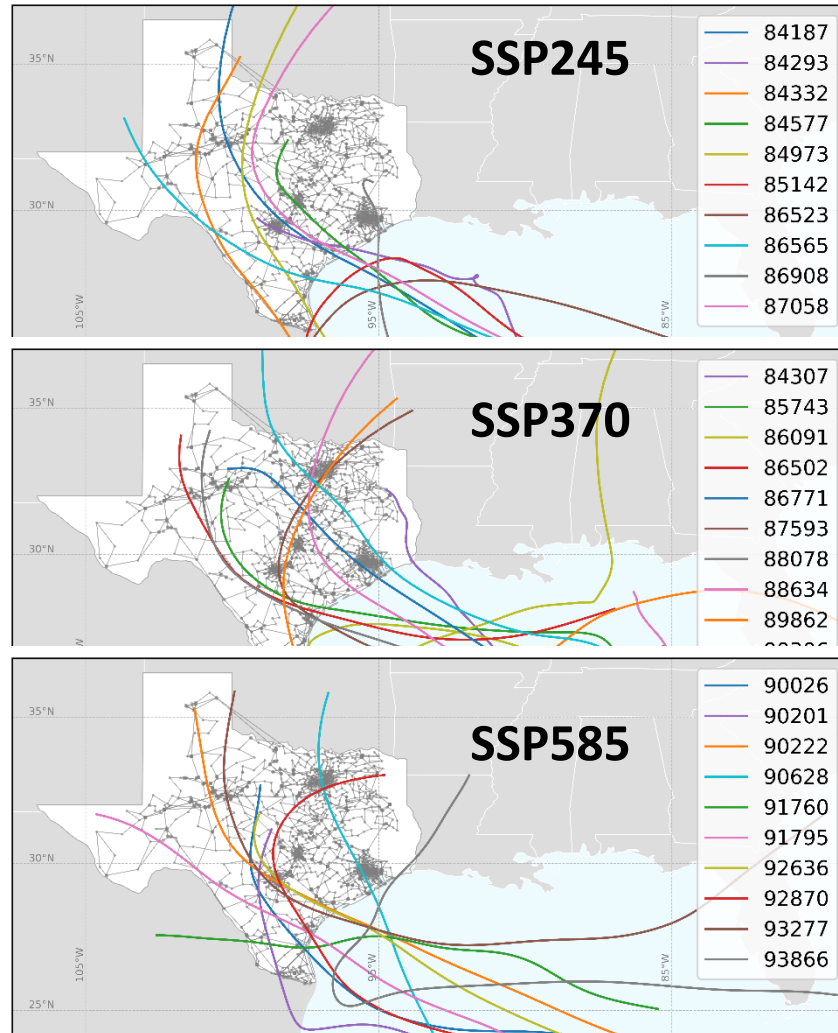


Hurricane Harvey

- 51 ensembles
- 39 hours before Harvey made landfall

Tropical Cyclons (TCs)

Long-term forecasting datasets



Hurricane datasets for 2071-2100

- ISIMIP3 datasets:
<https://www.isimip.org/protocol/3/>
- 5 Climate models: **GFDL, IPSL, MPI, MRI, UKMO**
- 3 different warming scenarios: **ssp245, ssp370, ssp585**:
<https://www.dkrz.de/en/communication/climate-simulations/cmip6-en/the-ssp-scenarios>

Tropical Cyclons (TCs)

Hurricane-induced Cascading failures

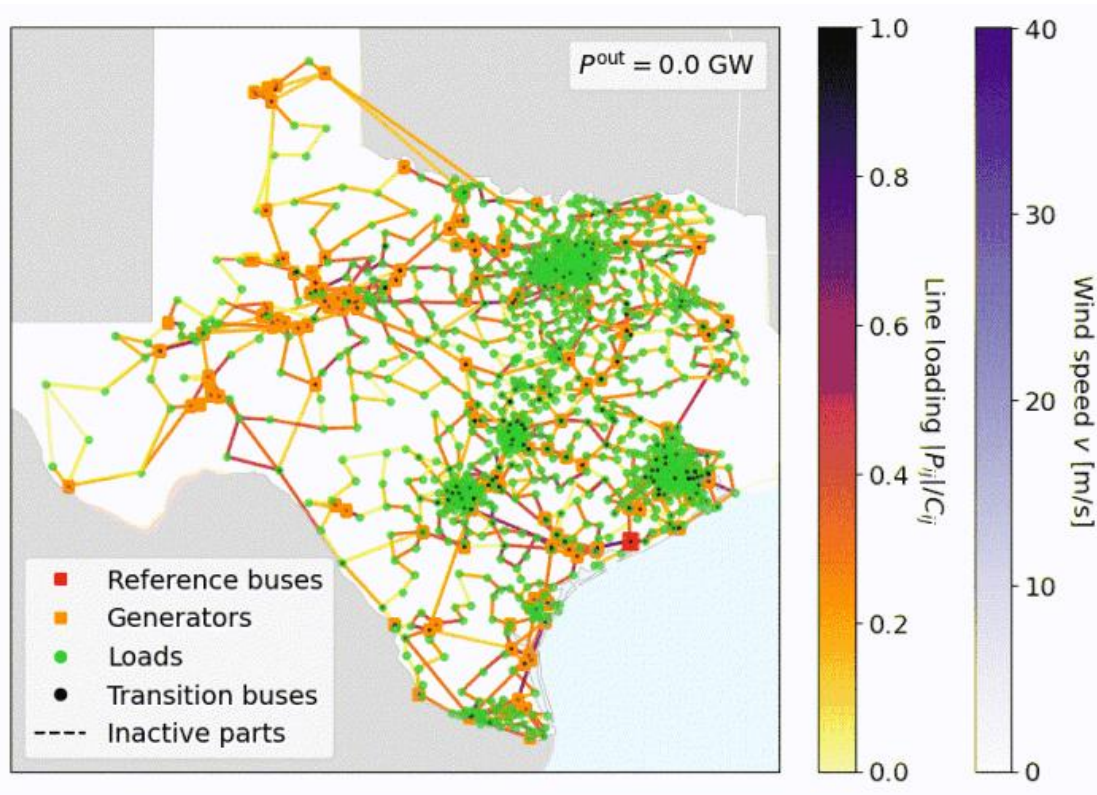


Image credit: Julian Stürmer, M.Sc.
arXiv:2301.13793 (2023)

Tropical Cyclons (TCs)

Hurricane-induced Cascading failures

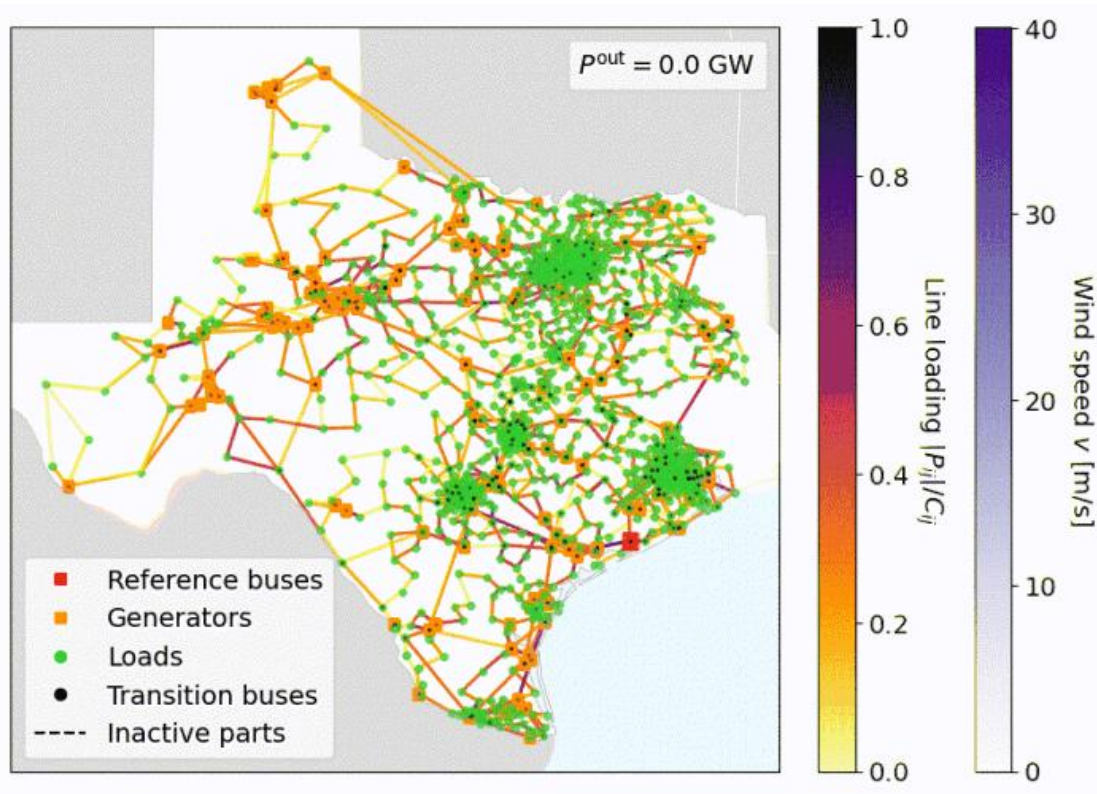
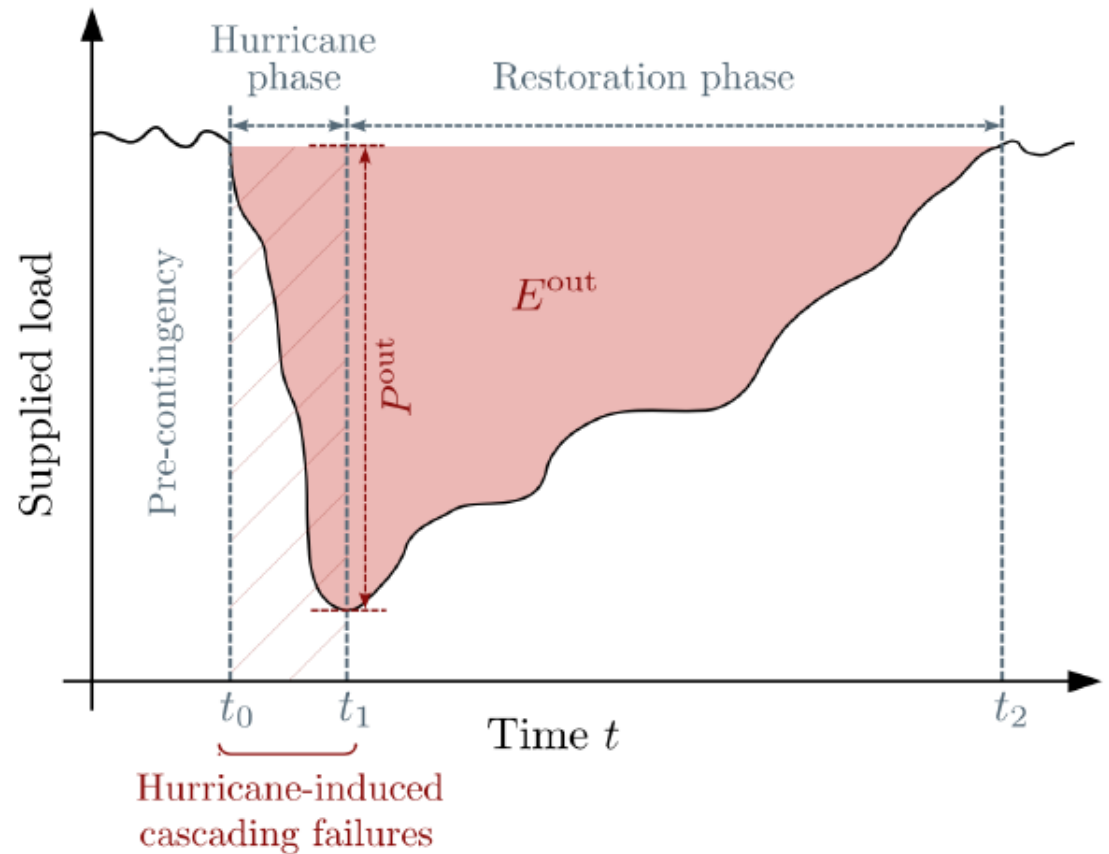


Image credit: Julian Stürmer, M.Sc.
arXiv:2301.13793 (2023)

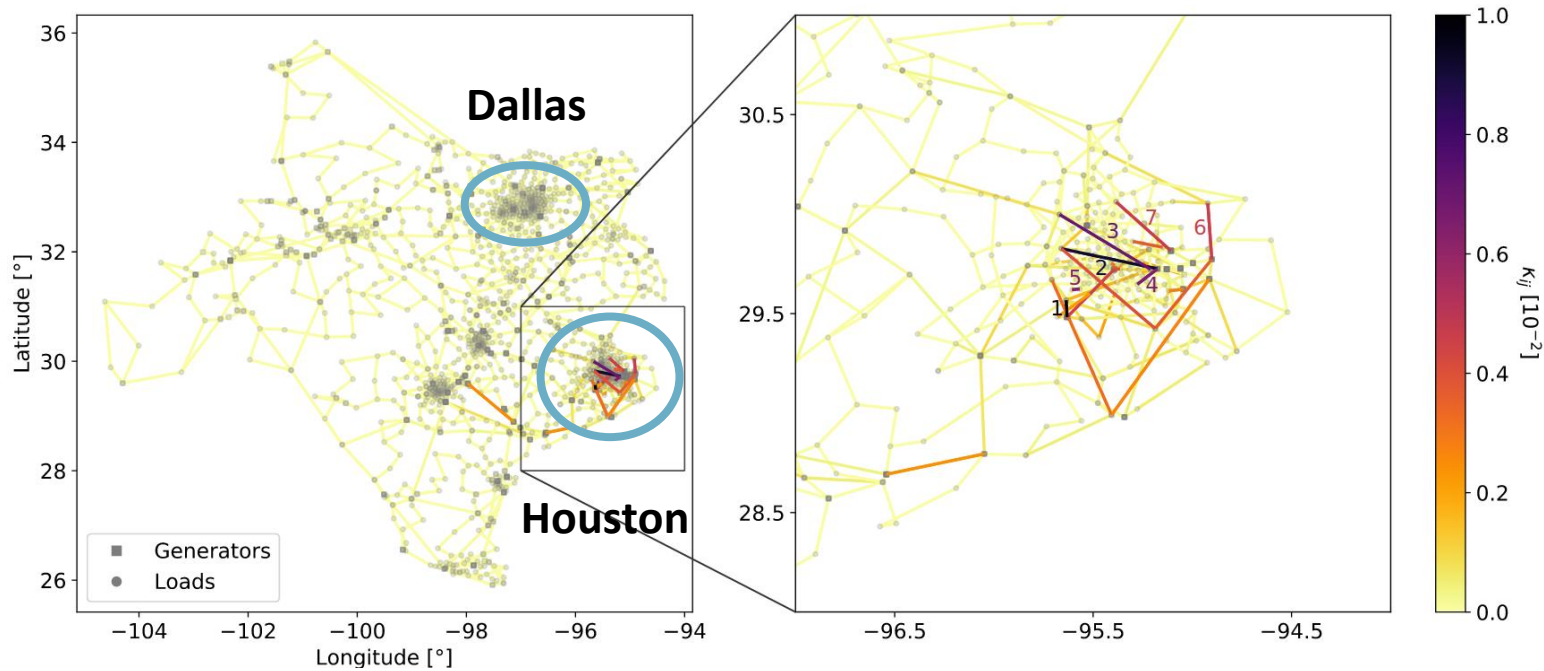




Increase the System Resilience

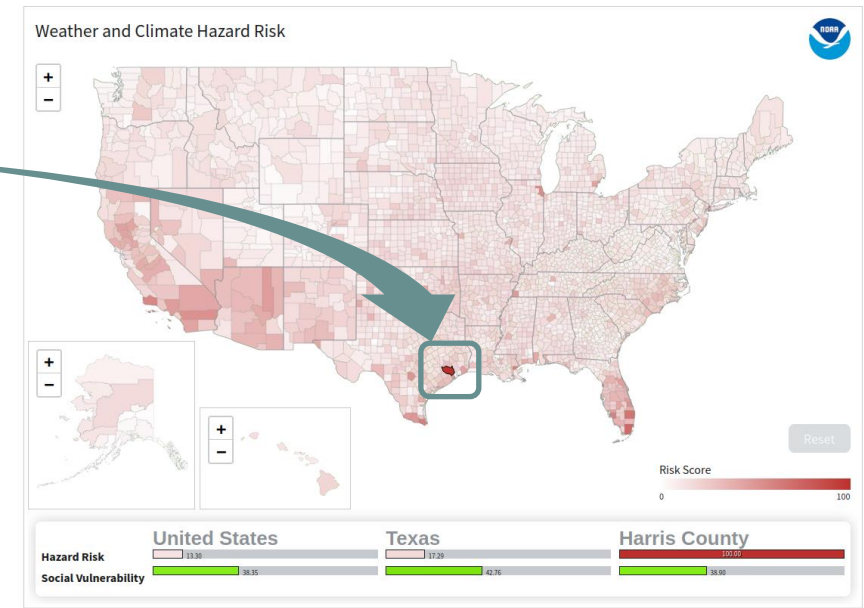
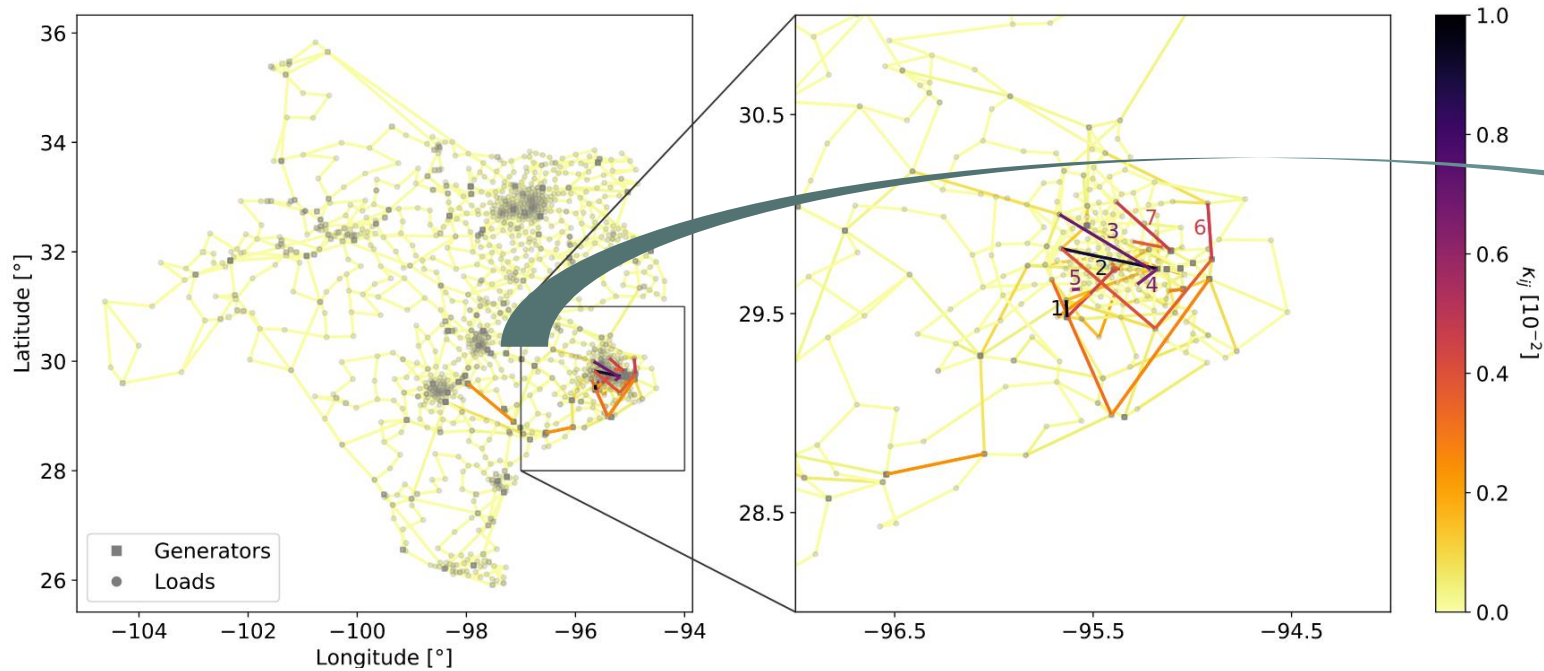
Power Grid

Critical lines (priority index)



Power Grid

Critical lines (priority index)



<https://www.ncei.noaa.gov/access/billions/mapping>

Thank You!

Collaborators:

- › Martin Kuehn, B.Sc.
- › Paulina Renz, B.Sc.
- › Julian Stürner, M.Sc.
- › Tobias Ohlinger, M.Sc.
- › Dr. Anton Plietzsch
- › Dr. Frank Hellmann
- › Dr. Sabine Pott
- › Dr. Thomas Vogt
- › Dr. Christian Otto
- › Dr. Katja Frieler
- › Prof. Dr. Jürgen Kurths

References:

- › arXiv:2301.13793 (2023)
- › The Eleventh International Conference on SmartGrids, Green Communications and IT Energy-aware Technologies (2021)
- › <https://gitlab.pik-potsdam.de/stuermer/itcpg.jl>



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- I. <https://www.pik-potsdam.de/members/anvari>
- II. <https://www.scai.fraunhofer.de/de/geschaeftsfelder/network-evaluation-technologies.html>

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