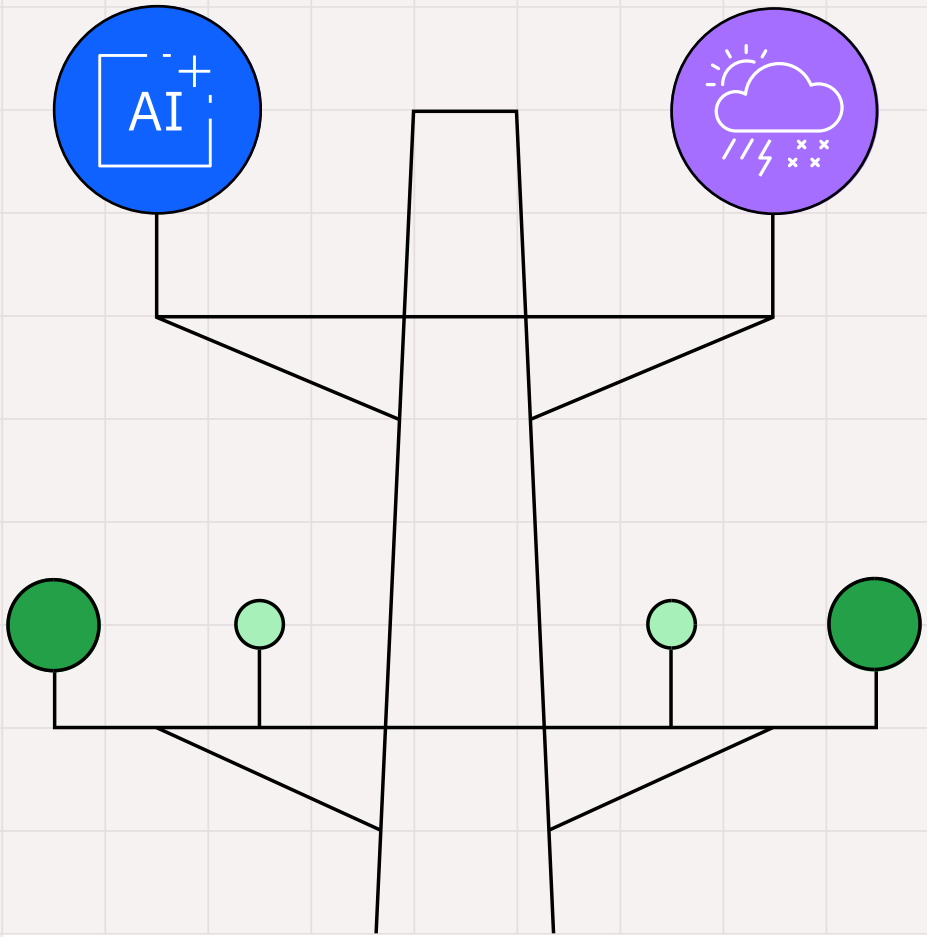
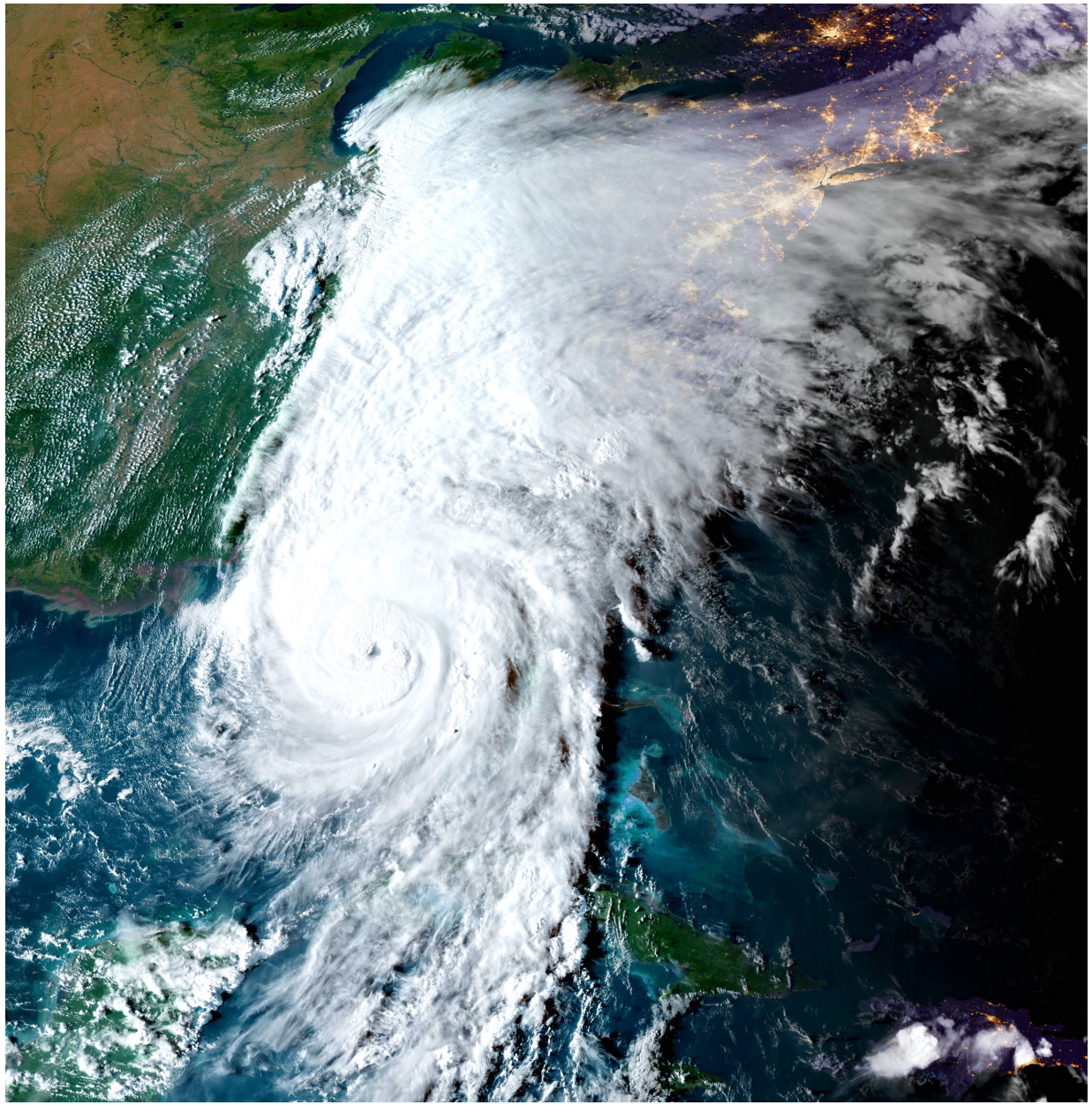


AI for Grid Resilience:

Leveraging weather intelligence and AI to enhance grid resilience and reliability

Prepared for: NARUC National Association of Regulatory Utility Commissioners

April 24, 2026



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IBM

Today’s Agenda

00 **Introduction** [0:05]
Who is Rob D’Arienzo?

01 **Who is IBM?** [0:05]
The 114-year old startup || IBM Consulting || The business of weather

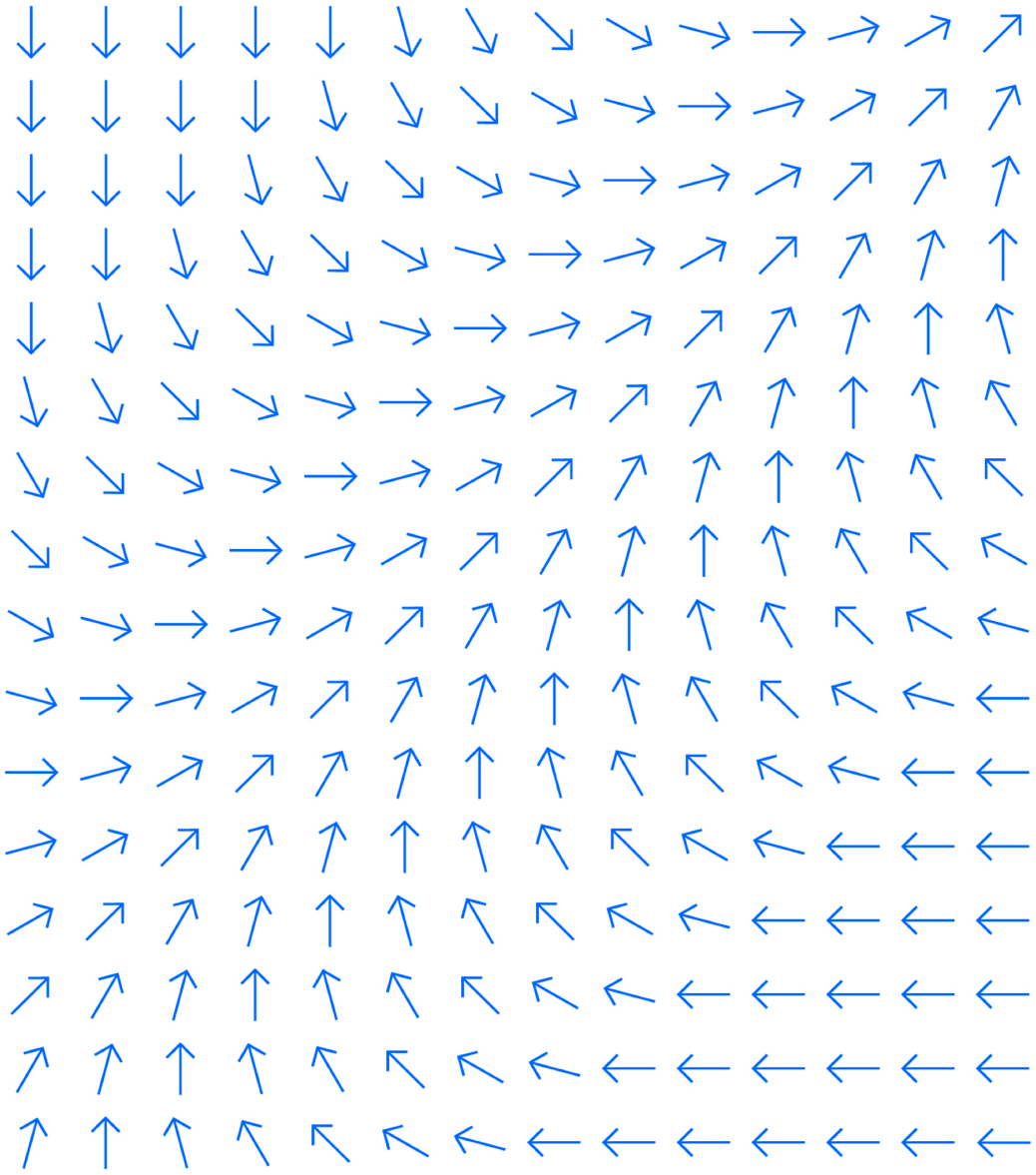
02 **AI Era** [0:10]
The opportunity || The challenge || The AI-first utility

03 **State of the Climate & Grid** [0:10]
Weather and outage trends || Grid resilience vs. reliability

04 **AI for Weather & Grid** [0:15]
Weather & AI POV || Capabilities

05 **Open Weather Tools** [0:05]

06 **Q&A** [0:10]

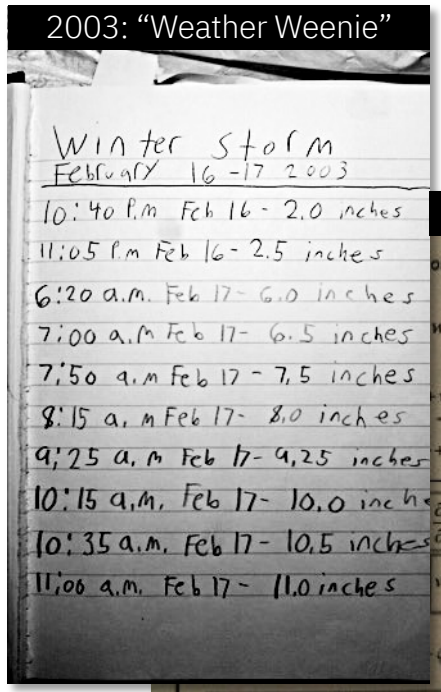


Introduction

Who is Rob D'Arienzo?

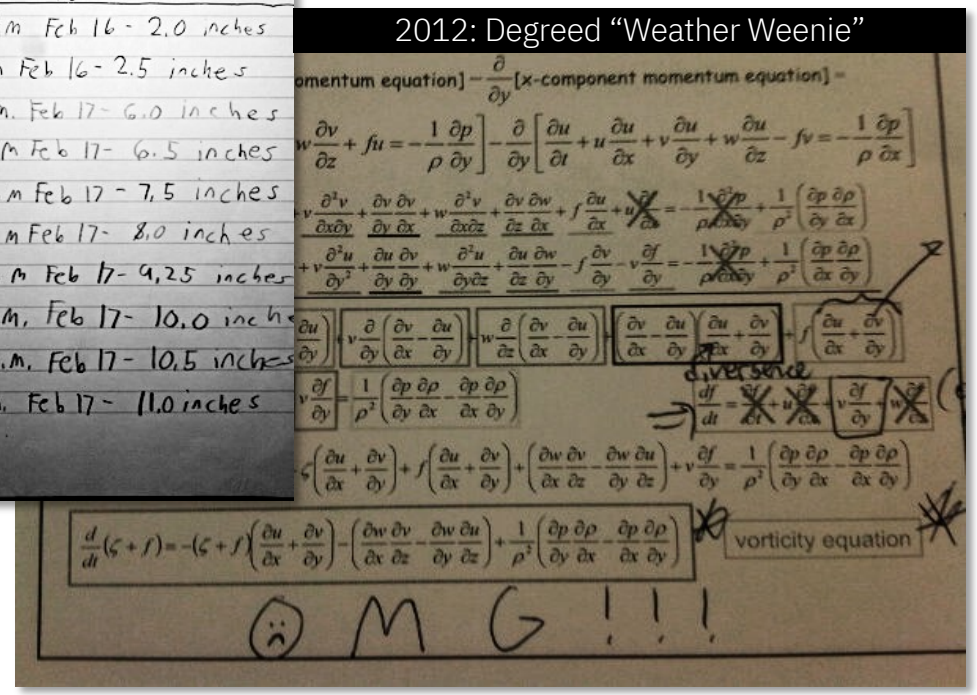
The Early Years

2003: "Weather Weenie"



B.S. in Meteorology
Rutgers University (2012)

2012: Degreed "Weather Weenie"



The Professional Years

2012 – 2014: ConEd (NYC)
Assistant Meteorologist

2014 – 2016: VELCO (Vermont)
Lead Meteorologist/Data Analyst

M.S. in Business Analytics
Quinnipiac University (2017)

2017 – Present: IBM (NYC/Global)

- Managing Consultant
- Sr. Managing Consultant
- Associate Partner (Data & AI for Utilities)

Who is IBM?

Who is IBM?

The 114-year old startup

5 x Transformations in 60 years

1 Mainframe (1964-1980)

- 1911 — CTR Scales
- 1914 — CTR becomes IBM
- 1924 — 1st Disabled Employee
- 1928 — IBM School-house Established
- 1931 — Translator System
- 1933 — IBM 80 Column Punch Card
- 1935 — 1st Electric Typewriter
- 1944 — Mark 1 calculator
- 1953 — Policy Letter #4
- 1956 — 1st Heart & Lung Machine • Fortran
- 1957 — RAMAC Data Storage
- 1961 — Selectric Typewriter • IBM Research
- 1962 — Sabre
- 1964 — System/360
- 1969 — Apollo 11 • Speech Recognition
- 1971 — Floppy Disc
- 1973 — ATM's • Nobel Prize (Physics)
- 1975 — Fractal Geometry
- 1976 — U.S. Space Shuttle Program
- 1979 — UPC Barcode
- 1980 — PC • RISC

2 PC (1981-1990)

- 1981 — Excimer Laser Surgery
- 1986 — Nobel Prize (Physics)
- 1987 — Nobel Prize (Physics)
- 1990 — 6th Nobel Prize (Economics) • Wimbledon
- 1992 — PC division Divestiture • IBM Consulting Group

3 Services (1992-2008)

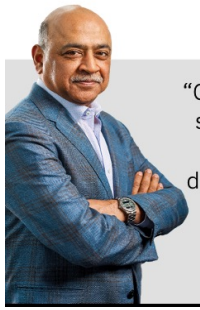
- 1993 — Blue Gene • Lou Gerstner *"Solutions, Systems, Software & Services"*
- 1996 — Net. Commerce • Masters Golf Partnership
- 1997 — Deep Blue
- 1999 — U.S. Open Partnership
- 2000 — eServer
- 2002 — PwC Consulting
- 2006 — IBM Information Server
- 2008 — IBM Watson x Jeopardy! • P-TECH
- 2011 — IBM Garage
- 2012 — Ginni Rometty
- 2014 — *"Roadrunner"* World #1 Super Computer • Smarter Planet

4 Software (2011-2018)

- 2016 — Watson IoT Platform
- 2017 — Munich IoT Center
- 2018 — Weather Company
- 2019 — IBM Quantum (Falcon: 27Q) • Project Debater • Red Hat • Code + Response

5 Hybrid-Cloud, AI & Quantum (2019-2025)

- 2020 — Climate Leader • Summit & Sierra • Quantum: Hummingbird (65Q) • Arvind Krishna
- 2021 — COVID Solutions • 28 Yrs #1 Patents • 1st 2-Nanometer chip • Quantum: Eagle (127Q) • Kyndryl • IBM SkillsBuild • Mayflower AI Ship
- 2022 — Quantum: Osprey (433Q) • IBM Quantum System Two • $20Bn NY Investment • NASA.Climate x IBM • IBM Sustainability Accelerator
- 2023 — watsonx • North Pole AI Chip • Condor (1,121Q) • 1st EU Quantum Data Center • 1st Quantum Computer for Healthcare
- 2024 — IBM Granite AI Model • Heron 156Q • IBM Consulting Advantage
- 2025 — Ferrari • Hakkoda Inc. • HashiCorp • Quantum Loon • Agentic AI



"Our clients' systems support modern society. In making them faster, more productive, and more secure, we don't just make business work better. We make the world work better."

Arvind Krishna, Chairman & CEO

Our Purpose

To be the catalyst that makes the world work better.

Our Mission

We believe that through the application of intelligence, reason and science, we can improve business, society and the human condition.

Our Values

- Dedication to every client's success.
- Innovation that matters—for our company and for the world.
- Trust and personal responsibility in all relationships.

Who is IBM?

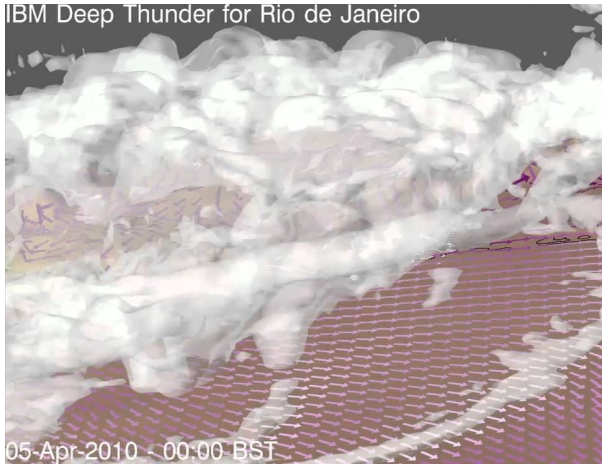
The business of weather

8 out of 10 power outages are caused by the weather. IBM's commitment to weather dates to the **1950s** and includes decades of building, maintaining, and supporting **high-performance computing systems** to generate **state-of-the-art weather forecasts.**

The Early Era
1950s-60s

Control panel for the IBM Stretch computer at the U.S. Weather Bureau in 1962

The Deep Thunder Era
1990s-2010s

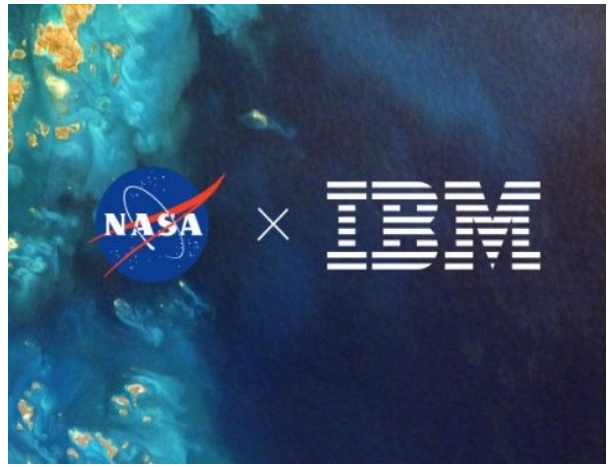


IBM Deep Thunder running over Rio in 2010 for city emergency operations

The TWC Era
2016-2023

IBM acquires The Weather Company in 2016; 700+ weather services engagements

The AI Era
2024-Present



IBM partners with NASA and industry partners to develop environmental and grid foundation models

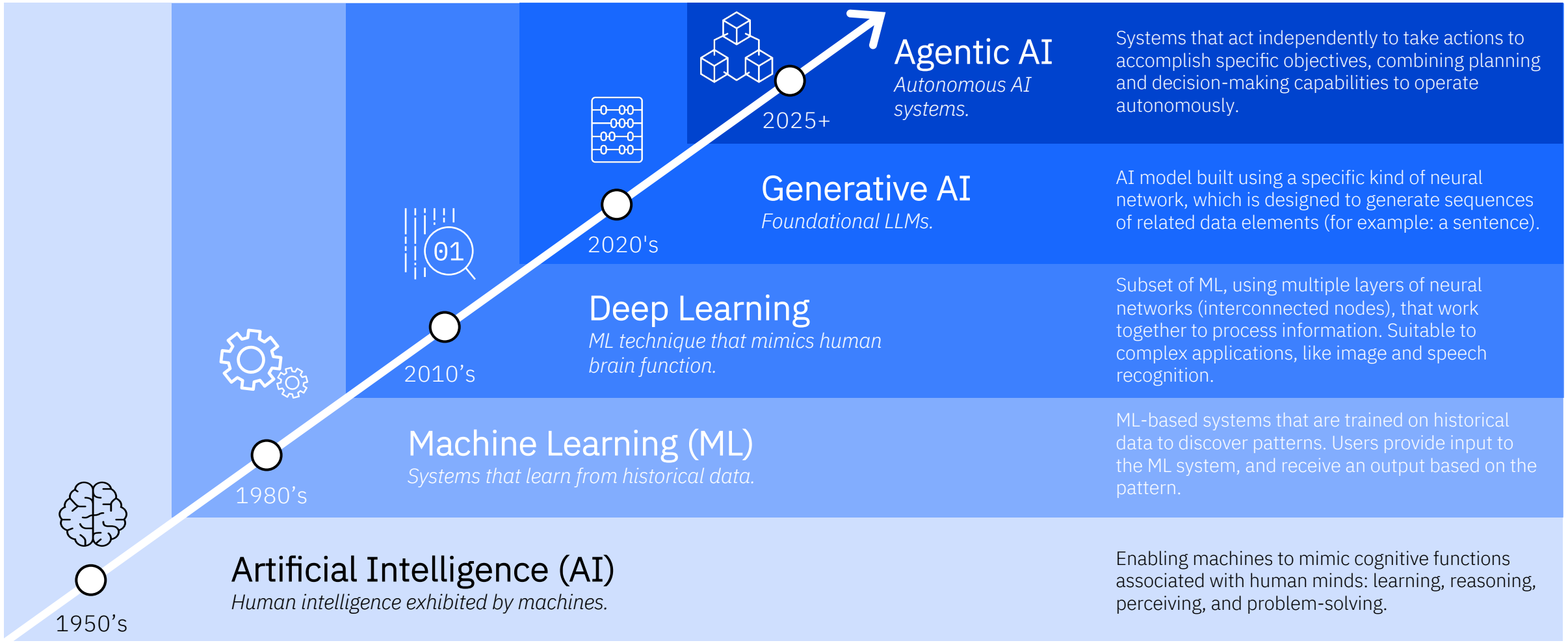
Today, IBM has evolved into one of the world's largest, most innovative **systems integrator of weather and climate intelligence**, powered by leading **generative AI solutions, AI and weather scientists, dedicated research arm**, and **distinguished industry SMEs.**

AI Era

AI Era

The opportunity: AI evolution

AI has disrupted productivity over decades; now, agentic AI introduces a new horizon



AI Era

The challenge: Utilities today are facing a diverse, complex risk landscape

Extreme weather

- More intense and frequent severe storms, wildfires, and floods
- Poor emergency response is causing reliability challenges

Rising technology demand

- Large-scale AI data centers
- Digital manufacturing
- Crypto mining

Aging Infrastructure

- 70% of U.S. power transformers are over 25 years old
- Grid reliability issues due to outdated infrastructure

Energy Price Volatility

- Natural gas price fluctuations impact electricity costs
- Geopolitical risks affecting oil & gas markets

Cybersecurity Threats

- Increase in cyberattacks on energy infrastructure
- Investment in AI-driven cybersecurity solutions needed

Lack of senior Power Engineering capacity

- Many new programs requiring deep experience
- Aging workforce

In order to **strengthen grid reliability**, **accelerate clean energy integration**, and drive **intelligent operations**, utilities must move quickly to **operationalize AI** throughout their enterprise

AI Era

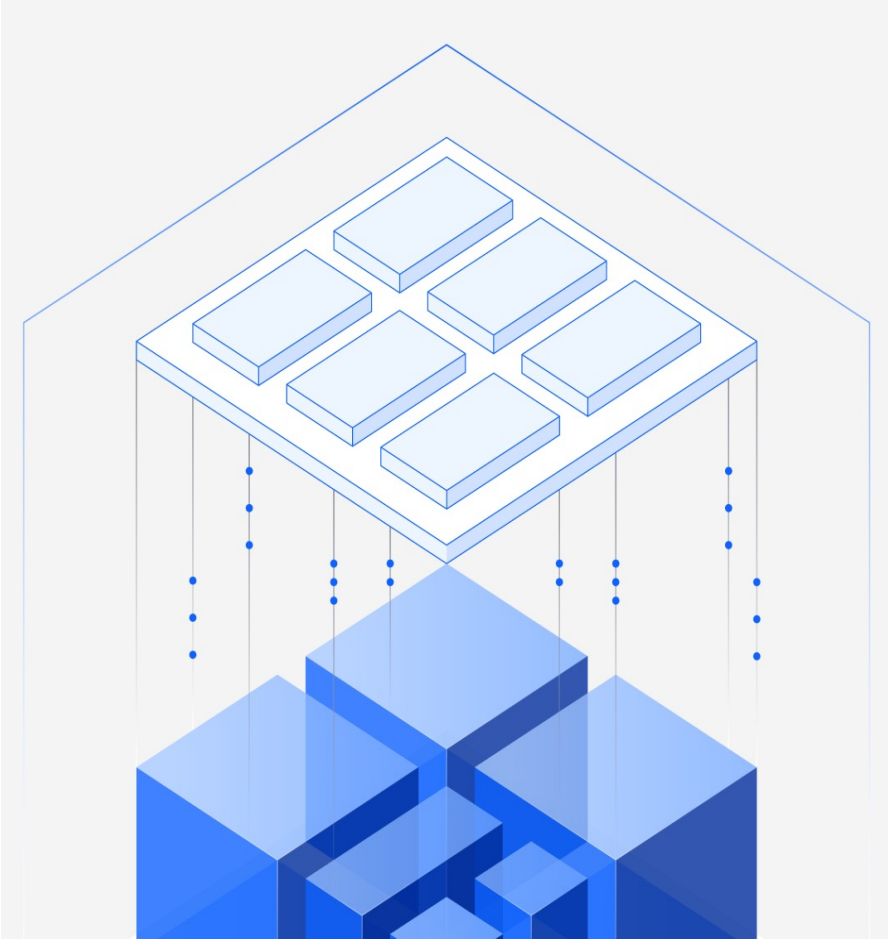
The challenge: AI is a priority but value realization is underperforming

94%

of utility executives say that AI will contribute significantly to their revenue in 2028...

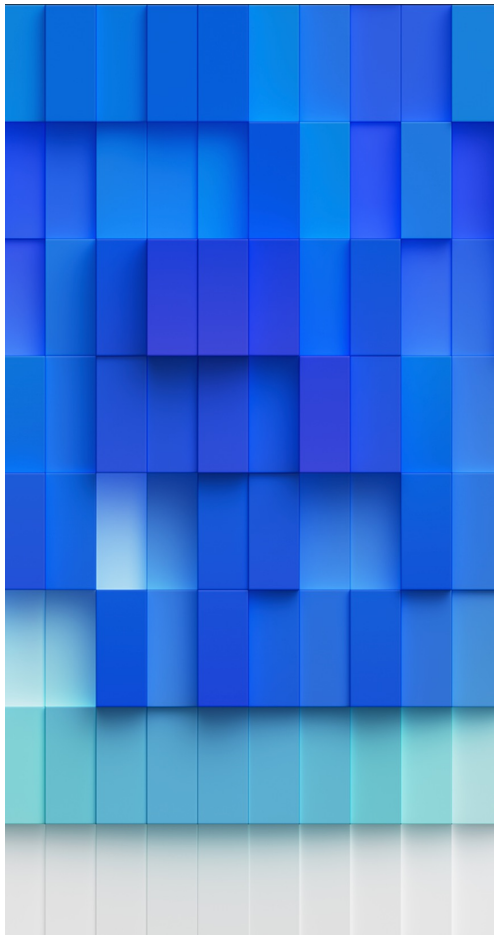
...but only 25% are seeing significant value from AI

Recent studies (MIT, 2025) suggests this figure is closer to ***only 5%***



AI Era

The challenge: Doing AI right requires changes to data, processes, and platforms



Data challenge

AI models struggle with unreliable, outdated data due to lack of modernization, affecting availability, quality, and accessibility.

Process challenge

AI initiatives are currently aimed at minor process enhancements within flawed and siloed systems, limiting their potential ROI.

Platform challenge

Outdated legacy systems, (GIS, OMS, EAM, ERP) hinder AI integration into business operations, leading to operational silos and stifling business case value realization.

The AI Era

The AI-first utility: Grid resilience roles are being enhanced with the power of AI

Powered by decades of meteorological and AI expertise, proven technologies, and next-generation models, IBM is ready to support every utility's vision to become the **smartest, most efficient and resilient utility.**

Utilities Today

Meteorologist 1.0
Meteorologists are constrained by manual, time-intensive data handling and static, one-size-fits-all products, leaving them acting more as workflow managers than decision-support experts.

Storm Director 1.0
Storm directors manually synthesize fragmented forecasts, operational data, crew availabilities, and field reports to make high-investment decisions before and during storm activation.

Vegetation Manager 1.0
Vegetation managers rely largely on manual inspections, periodic surveys and validation, and siloed and static data to prioritize work and mitigate risk before storm events.

System Operator 1.0
System operators must monitor vast streams of grid data and weather impacts through manual interpretation and static alerts to keep the electric system stable.

Utilities Tomorrow

Meteorologist 2.0
AI will **automate data discovery and fusion**, generate rapid scenario-ready forecasts, produce dynamic decision-specific weather products, and elevate meteorologists into strategic collaborators who combine expert judgment with AI-scaled intelligence to drive faster, more proactive storm planning and response.

Storm Director 2.0
AI will streamline data visibility and reporting, enhance predictive insight, and deliver scenario-based guidance that enables faster, more accurate, and more confident storm resource planning decisions.

Vegetation Manager 2.0
AI will integrate enhanced vegetation, remote sensing, weather, and asset data to predict emerging threats, optimize work plans, and enable faster, more targeted actions that strengthen grid reliability before and after storms.

System Operator 2.0
AI will deliver real-time predictive insights, automated anomaly detection, and scenario-driven guidance that enhance situational awareness and enable faster, more confident decisions during storm events.

The State of the Climate & Grid

The State of the Climate & Grid

Weather and outage trends

#1

Extreme weather events are the #1 global risk in terms of impact over the next 10 years.

Source: World Economic Forum, 2026

+90%

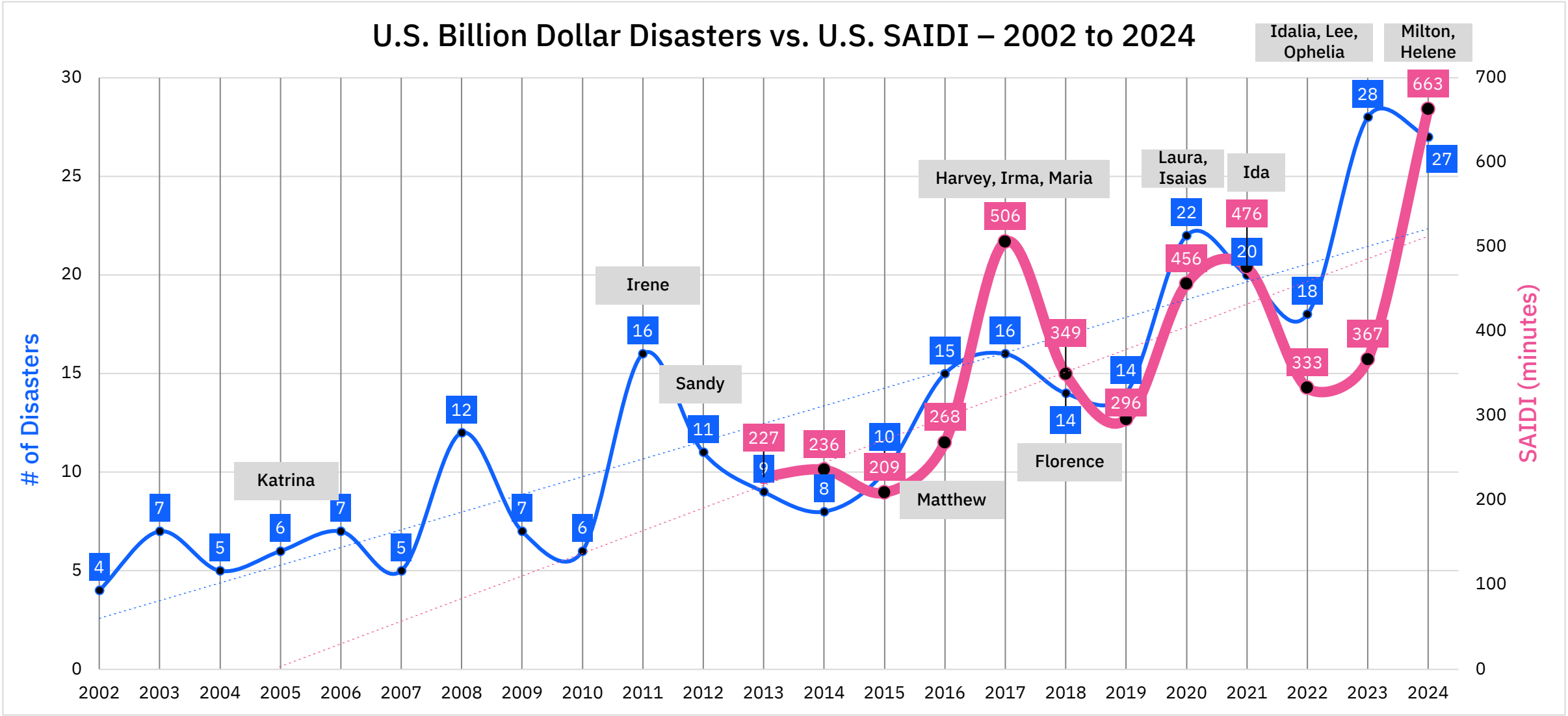
In 2024, the average outage duration (SAIDI) in the U.S. increased to over **11 hours**; *This represents a 90% increase from the 10-year average of ~6 hours*

Source: EIA Annual Electric Power Industry Report, 2025

"Everybody talks about the weather, but *nobody does anything about it.*" - **Charles Dudley Warner**

The State of the Climate & Grid

Weather and outage trends



Data Sources

1. NOAA/NCEI Billion-Dollar Weather & Climate Disasters: https://www.ncdc.noaa.gov/billions/
2. EIA Annual Electric Power Industry Report (Form EIA-861): https://www.eia.gov/electricity/data/eia861/

The State of the Climate & Grid

Grid resilience vs. reliability

Resilience

The North American Electric Reliability Corporation (NERC) defines resiliency is the grid's ability to withstand, adapt to, and rapidly recover from extreme or disruptive event, particularly high-impact, low-frequency (HILF) hazards that go beyond normal planning assumptions.

Events are largely environmental (i.e. hurricanes, wildfires, severe storms, and extreme heat/cold waves), but also include cyberattacks, coordinated physical attacks, and simultaneous infrastructure failures

NERC emphasizes that resiliency involves:

- Absorbing the impact of severe disturbances
- Limiting the scope and duration of outages
- Rapidly restoring critical functions
- Adapting or hardening to prevent future recurrence

In simple terms: Resiliency is about surviving the big, unusual shocks to the electric system and bouncing back quickly to prevent large-scale impact to infrastructure and customers.

Reliability

NERC defines grid reliability as grid's ability to provide uninterrupted power under normal operating conditions, and to do so without overloading equipment or violating operating limits.

NERC breaks reliability into two parts:

- Adequacy: The system has enough resources (generation, transmission, reserves) to meet expected demand

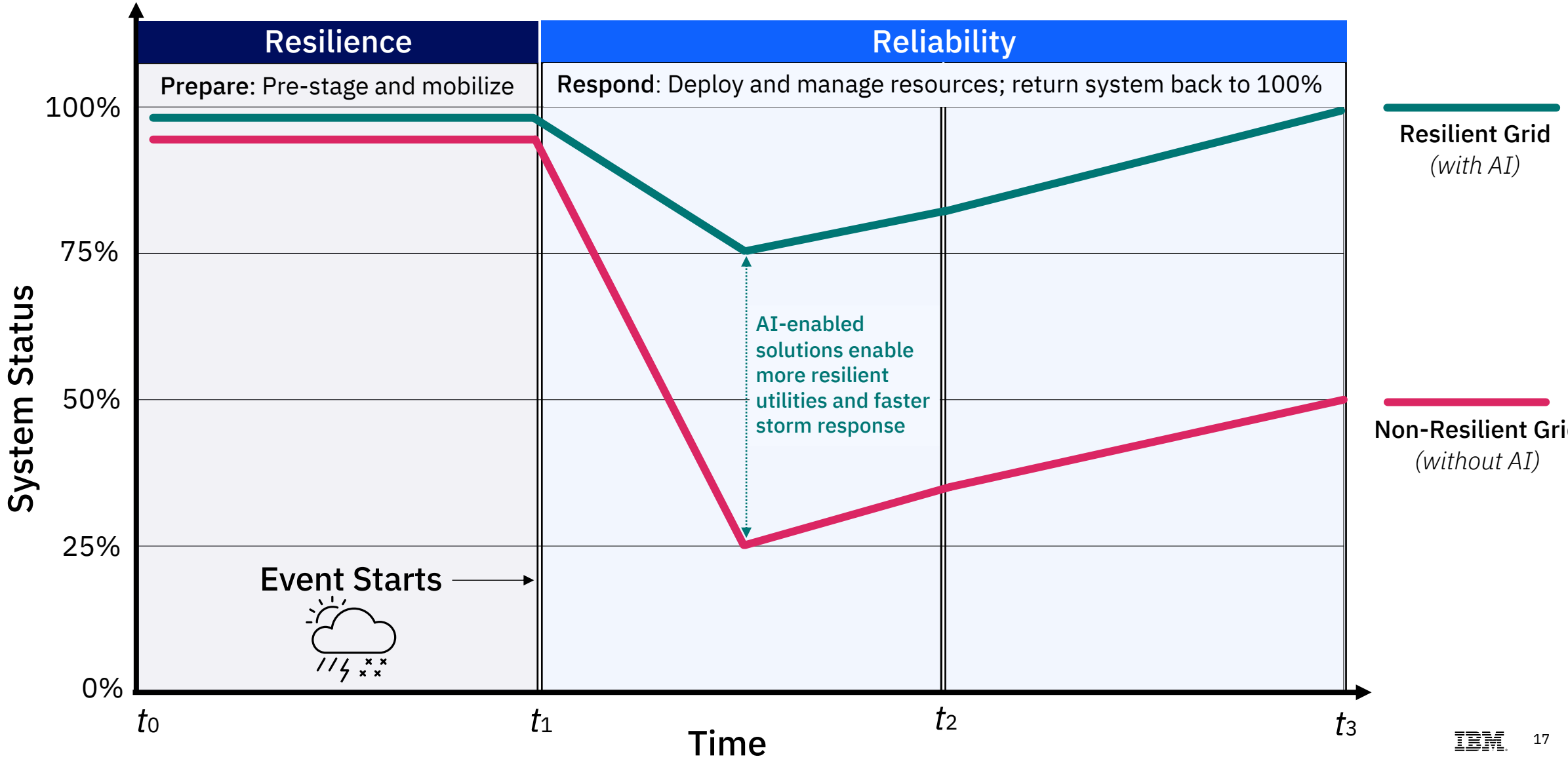
- Operating Reliability: The system can withstand sudden disturbances (outages, faults, equipment failures) and continue operating within acceptable limits

In simple terms: Reliability is about keeping the lights on day-to-day and ensuring the system performs safely and predictably under expected conditions and typical disturbances.

"Resilience is directly linked to the concept of reliability; *you cannot be resilient if you are not first reliable*. Resilience encompasses additional concepts – preparing for, operating through and recovering from significant disruptions, no matter what the cause. It is about our ability to withstand extreme or prolonged events." - **Andy Ott**, CEO PJM

The State of the Climate & Grid

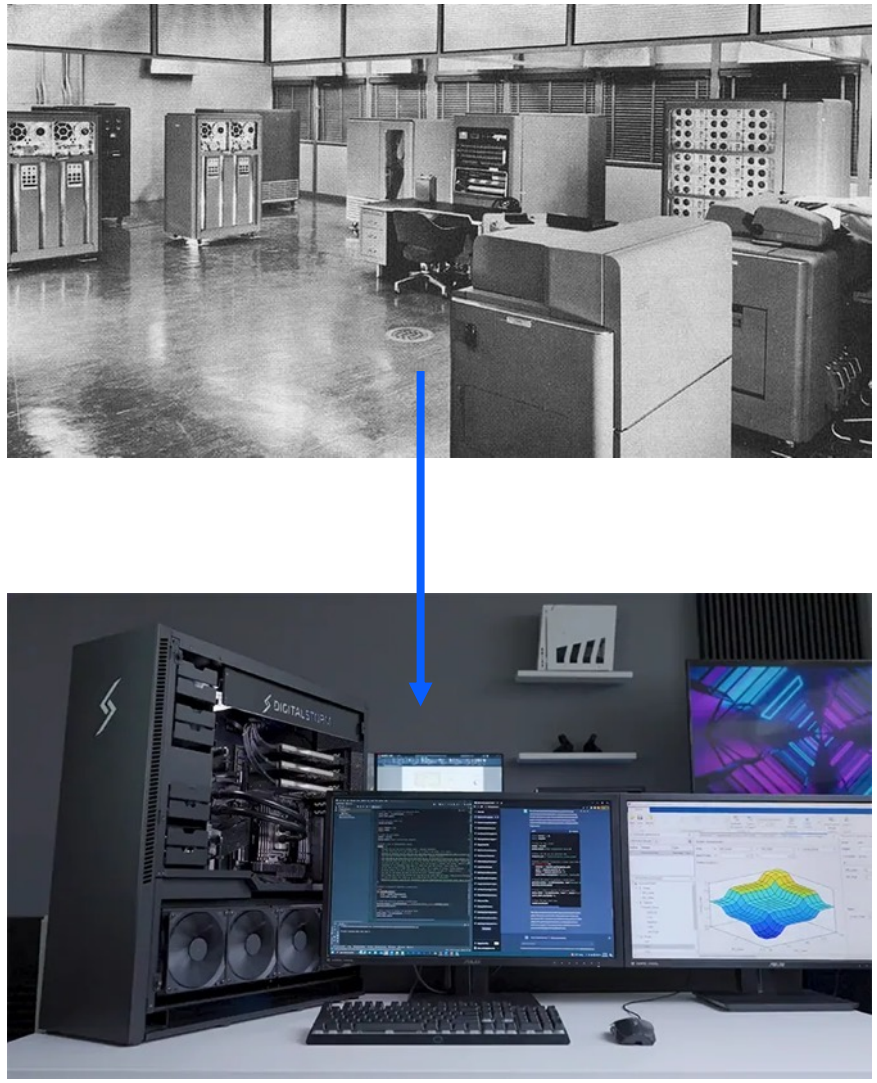
Grid resilience vs. reliability

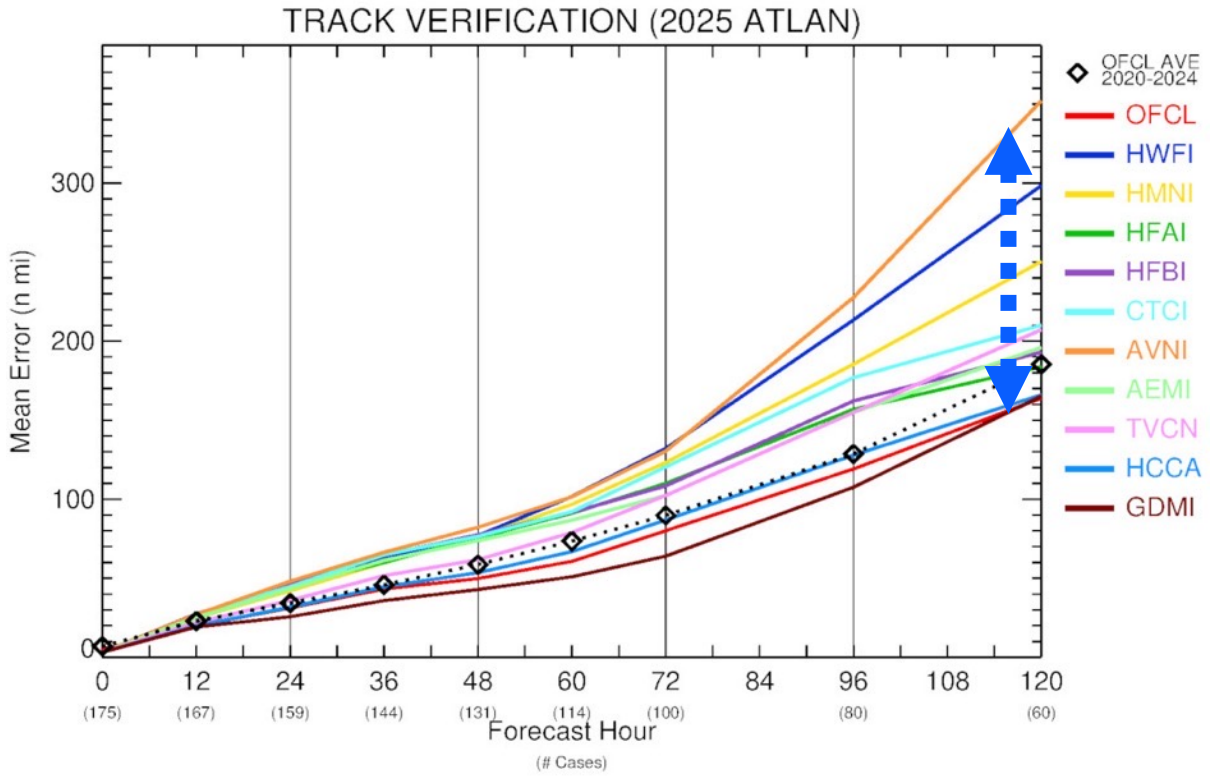


AI for Weather & Grid

AI for Weather & Grid

State of AI & Numerical Weather Prediction (NWP)

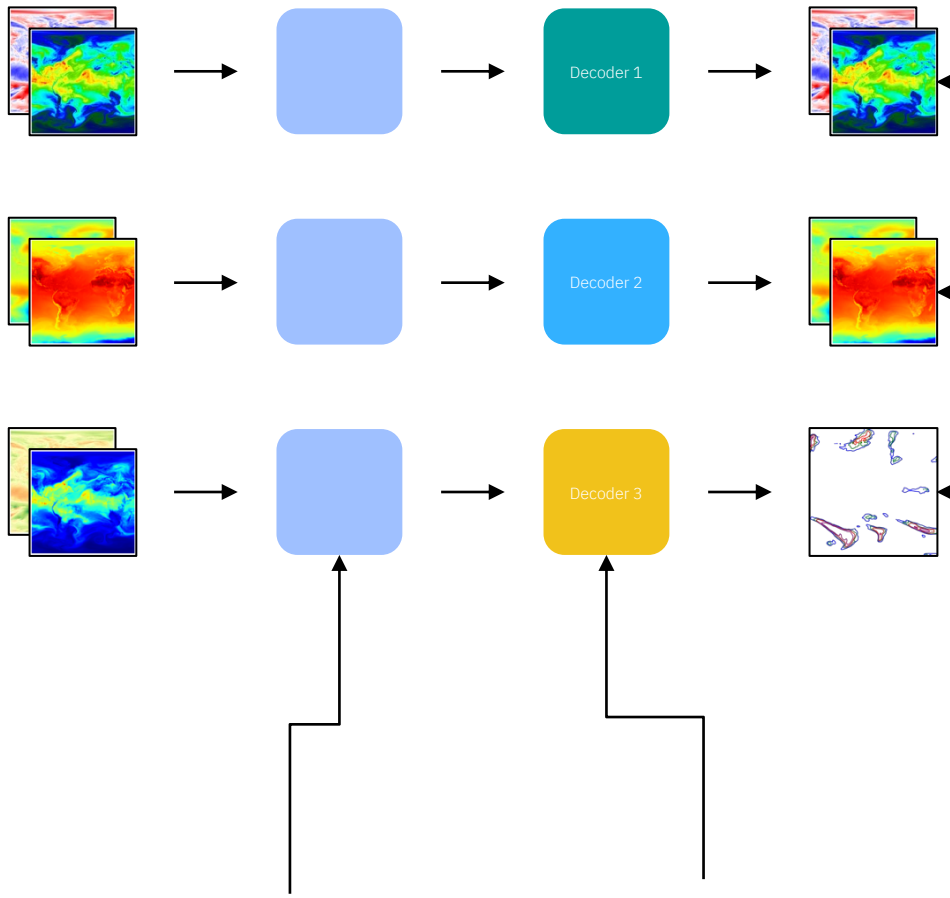




- 1st Generation NWP AI Models (Pangu-Weather, Graphcast) match or exceed SOTA full-physics NWP (e.g., IFS)
- New models coming online virtually every week
- No unified platform for deployment or verification
- They still struggle to beat “traditional” NWP in predicting extremes consistently…but the promise is there!

AI for Weather & Grid

Weather foundation models



Flexibility for data sources
Pre-train and fine-tune on different data sets.
"Pre-train on 40 years of ERA5. Fine-tune with 5 years of HRRR."

Data efficiency
Fine-tuning on small data volumes without overfitting.

Accuracy
Downstream tasks tend to exhibit higher accuracy at constant model size and data volume.

Efficient use of GPU resources
Large models (encoders) are only trained once.

Training speed
Fine-tuning happens in hours or days.

AI for Weather & Grid

Meteorologist 2.0

Meteorologist 1.0

- Long model runs/high compute cost
- Manual analysis
- Fixed products
- Human mets = workflow managers

Meteorologist 2.0

- Rapid model runs/customization – minutes, not hours
- Agent-aided data discovery, ingestion and fusion
- Tailored products
- Human mets = strategic scenario designers and decision collaborators

AI for Grid Resilience

Embedding AI across the entire storm lifecycle

Proven Business Value of AI & Grid Resilience

- Minimize outages by **5%**
- Reduce cost management effort up to **15%**
- Reduce mobilization costs by **$5-15M+/year**
- Pay 3rd party suppliers faster up to **75%**
- End-to-end Team visibility

Vegetation Management
Current and future-state vegetation analytics to proactively reduce disruptions

AI Weather
Next-generation weather forecasting embedded throughout storm preparedness

Storm Callout
Full automated, scalable callout platform run on Salesforce

Outage Prediction & Resource Optimization
Accurately predict outages and their severity up to 7 days in advance

Storm Setup
Enables the Utility to set up the storm and perform inventory

Resource Acquisition
Enables the Utility to request workers from 3rd parties for storm events

Resource Management
Manages resources, mobilization and work distribution.

Lodging and Logistics
Handles lodging requests and assignments, and facilitates hotel communication

Time & Expense Management
Enables Time and expenses submission and approval

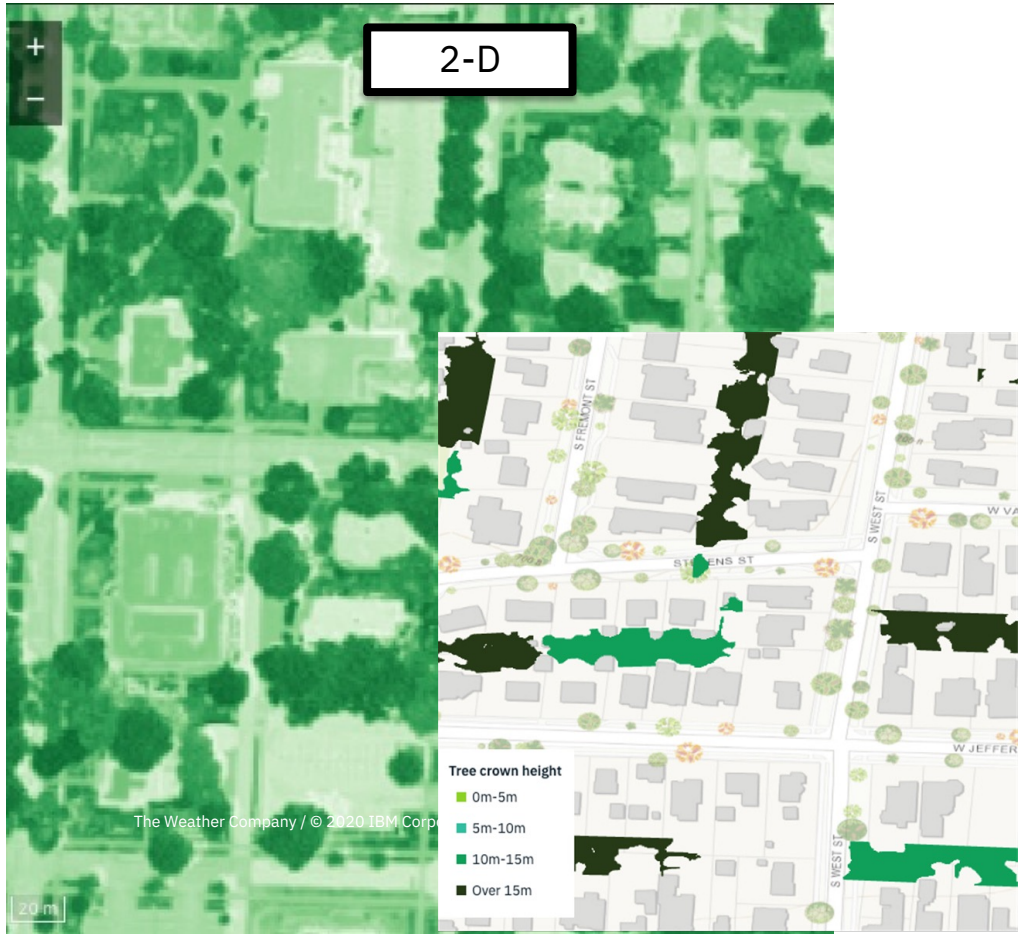
Invoicing
Enables PO Creations, Invoice generation and approval processes

PREDICT | RESPOND | RECONCILE

Vegetation Management

The AI Approach

30-50cm **Aerial/Satellite**: Spectral Analytics to identify Vegetation Attributes where tree heights are “Estimated” and canopy under/over wire is not discernable



LIDAR – Point Cloud 30 ppsm to identify Vegetation Attributes where tree heights and Shape are fully detected and usable for KPIs

Outage Prediction

The AI Approach

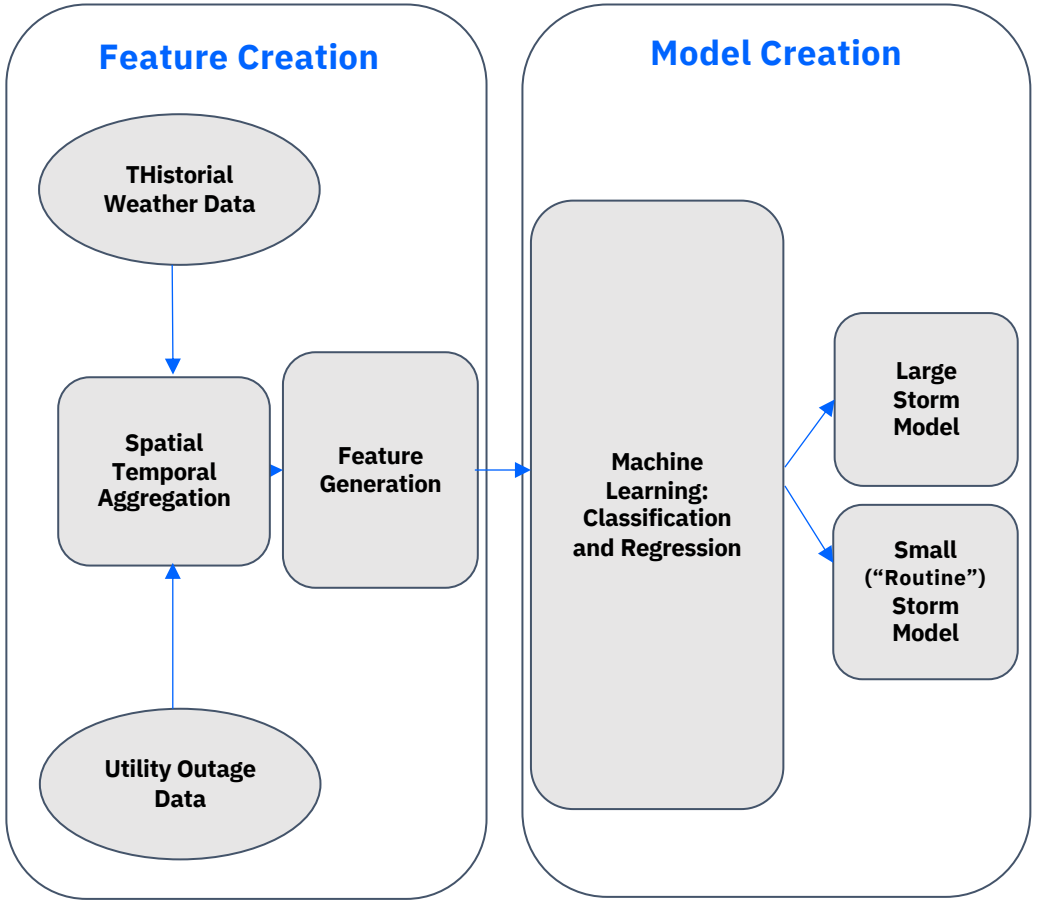
Data | **Forecasting** | **User Interface**

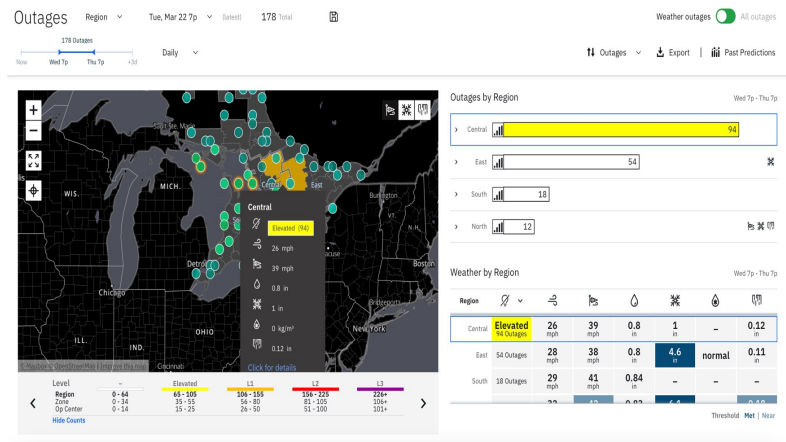
Raw Weather
- Wind gust speed
- Wind speed
- Surface pressure
- Sea level pressure
- Temperature
- Total precipitation

Derived Weather
- Accumulated daily rainfall
- Average wind direction
- Snow and Ice
- Soil moisture

Outage
- Outage location/timestamp
- Outage type

Other
- Time of year
- Foliage
- Time since last event

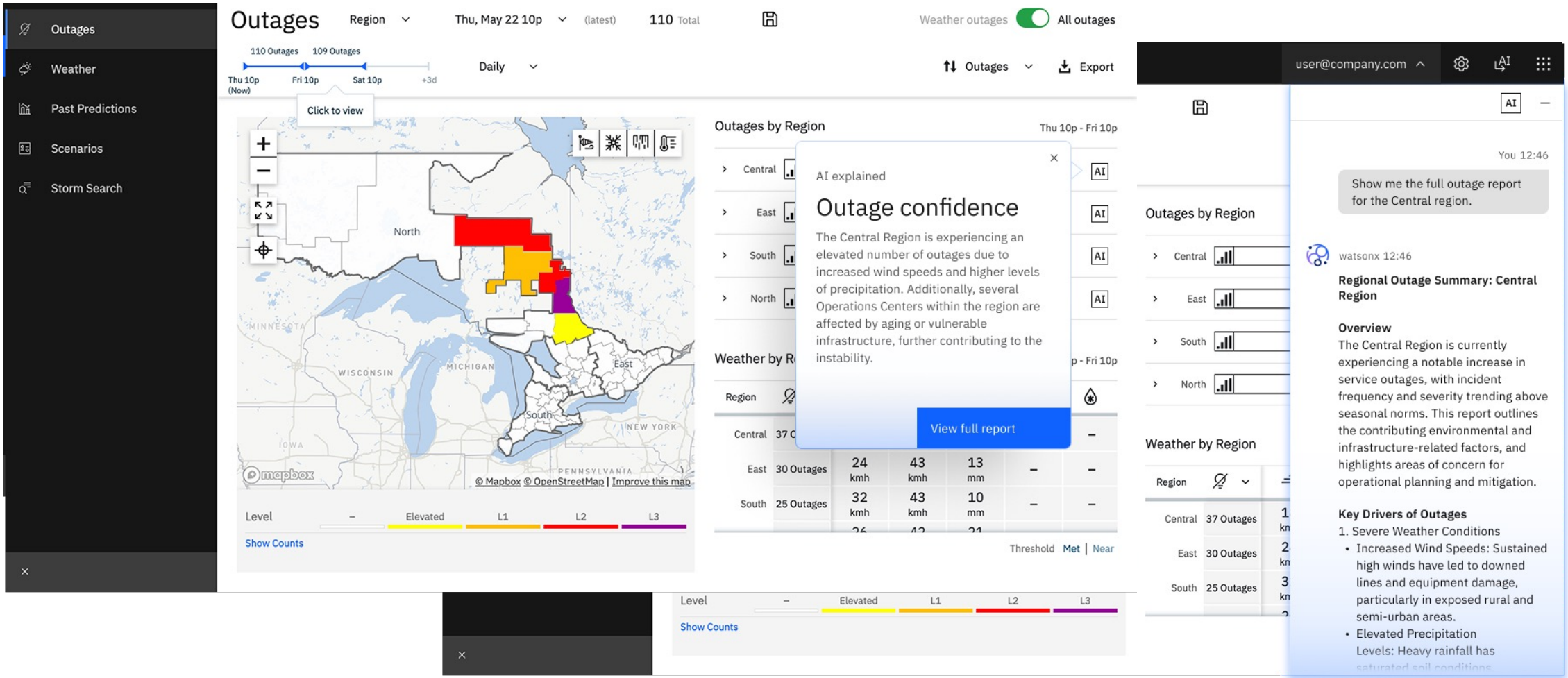




Outages Connected to Utility Mobilization Procedures

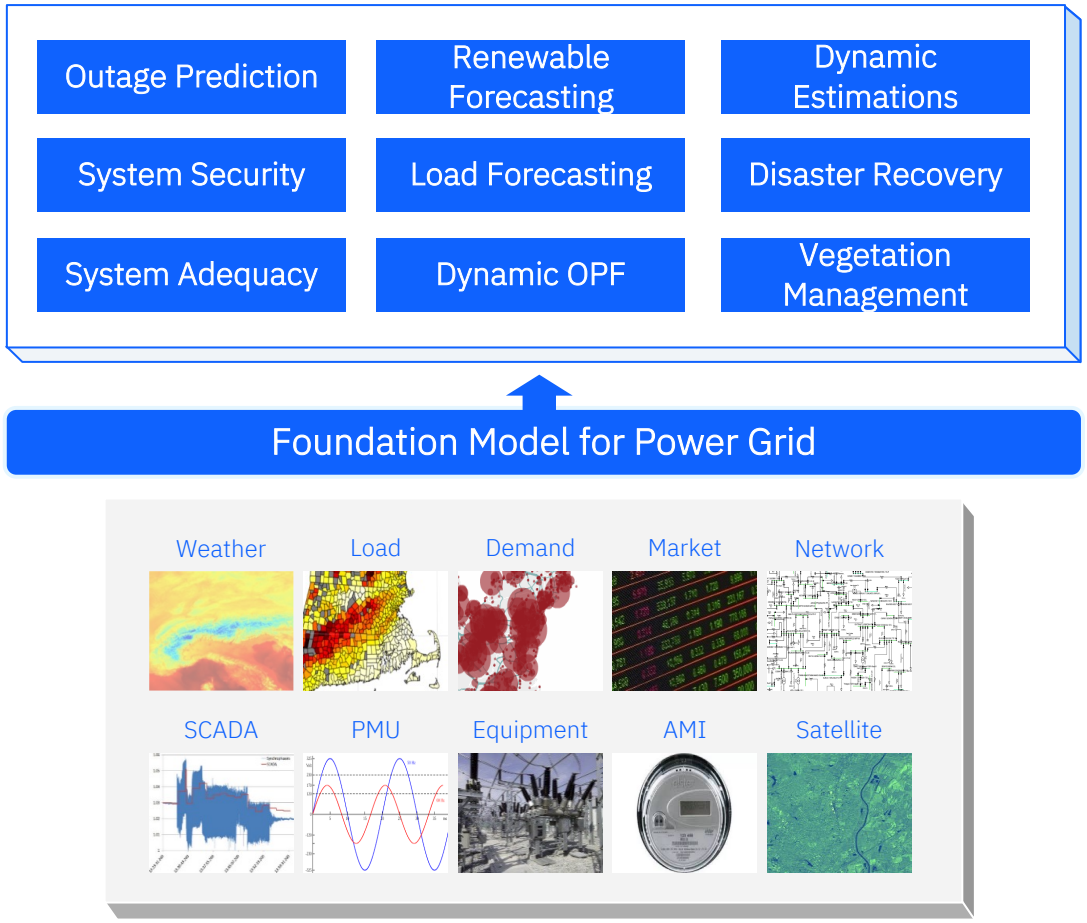
Outage Prediction

The AI Approach (Explainable AI or XAI)

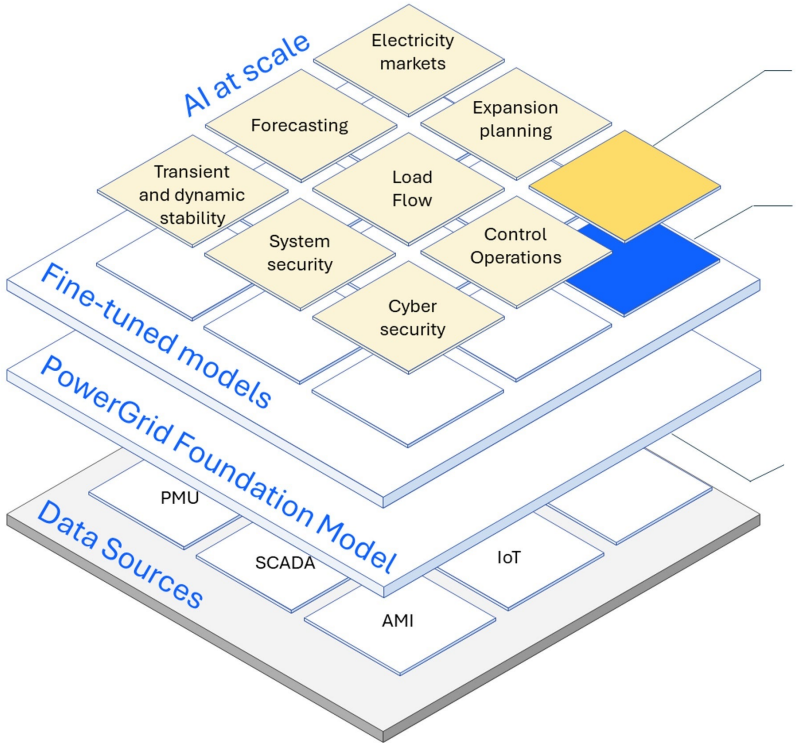


Grid Foundation Models

Grid foundation models allow simulation of the power grid's state and prediction of anomalies in near real-time



LF ENERGY GridFM



Leveraging AI at scale across the energy value chain to reduce uncertainty and speed up the simulations

Specialized models to solve specific tasks at scale:
- Data efficiency
- Computing efficiency
- Acceleration
- Ability to generalize

Foundation Models excelling at:
- Time Series imputation
- Hourly prediction and nowcasting
- N-M simulations

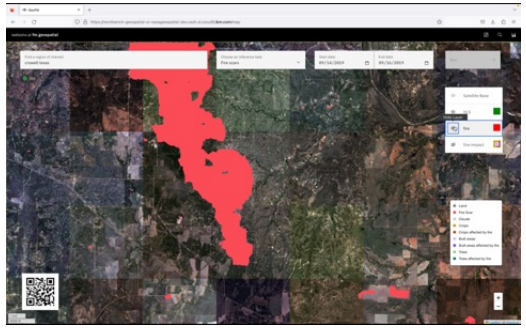
Geospatial Foundation Models

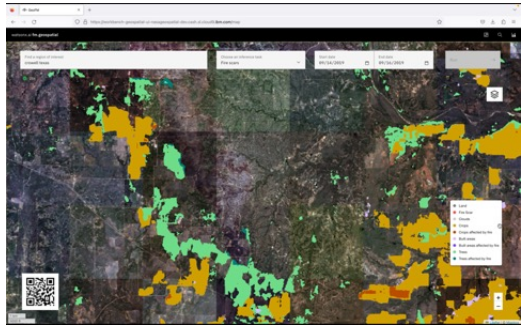
AI and change detection

Fire Scar Detection	Flood Zone Map	Crop Yield/ Soil Moisture	Forestry Projects
Fire Impact	Flood Impact	Renewable Energy transition planning	Agriculture related biomass growth

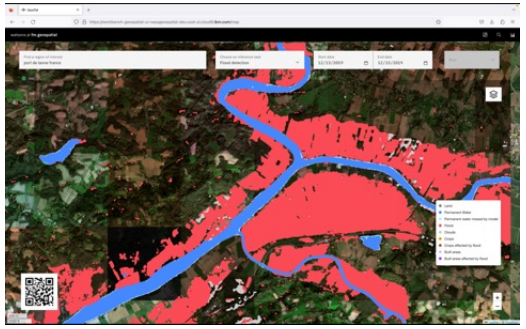
Geospatial Foundation Model

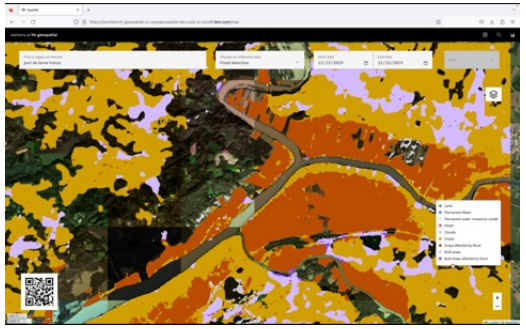
Fire Scars



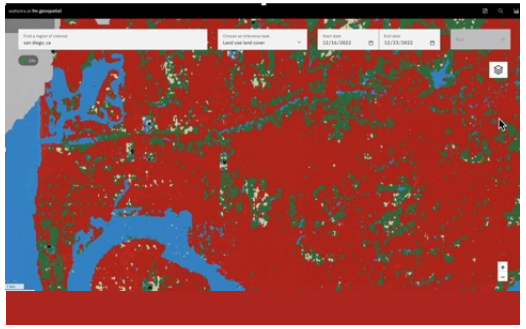


Flood Detection

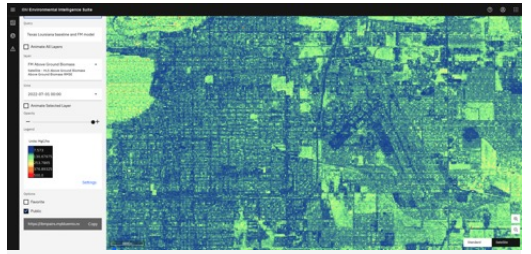




Land Use Land Change



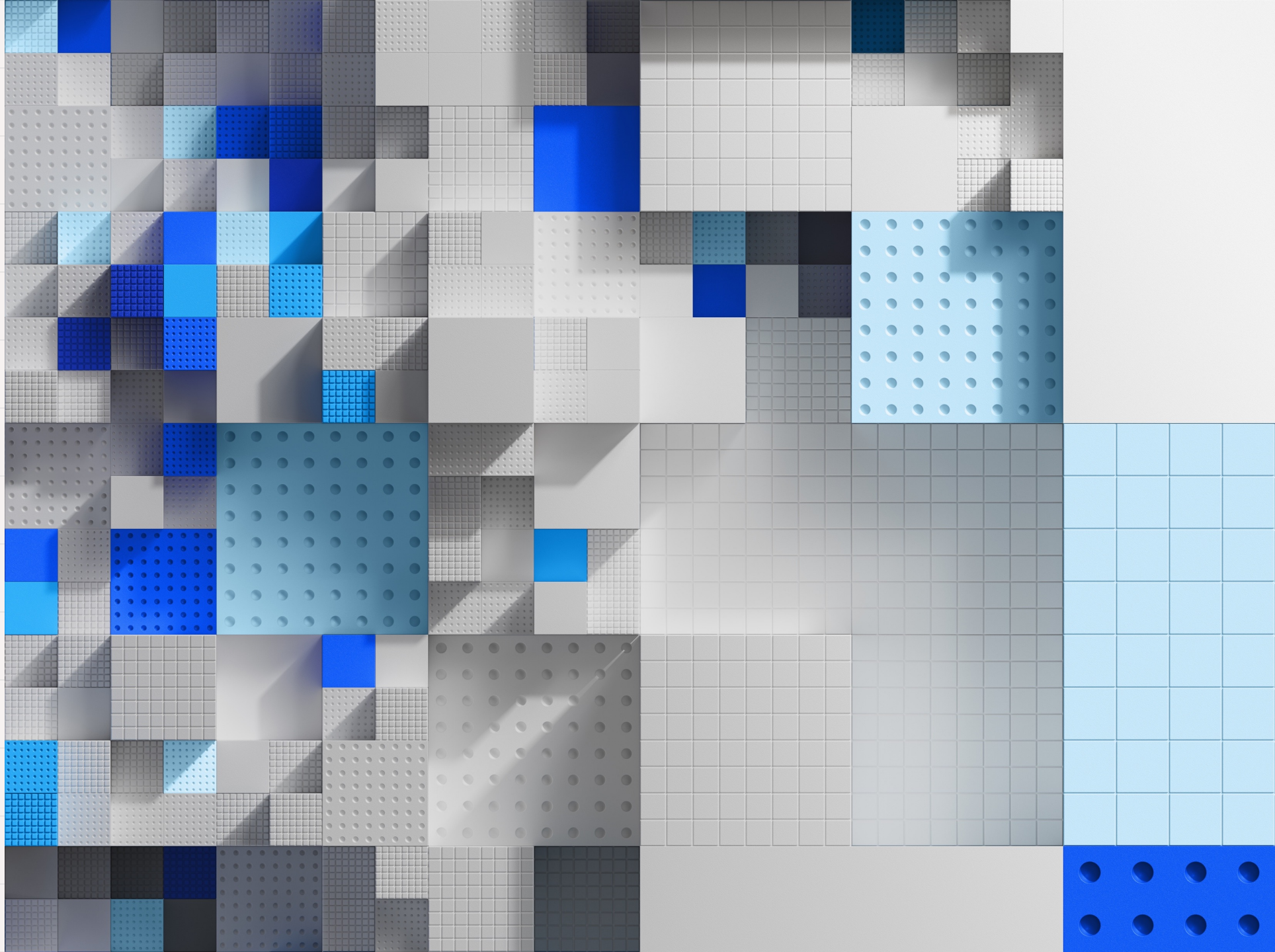
Above Ground Biomass



July 2022 Urban Area, Texas, USA

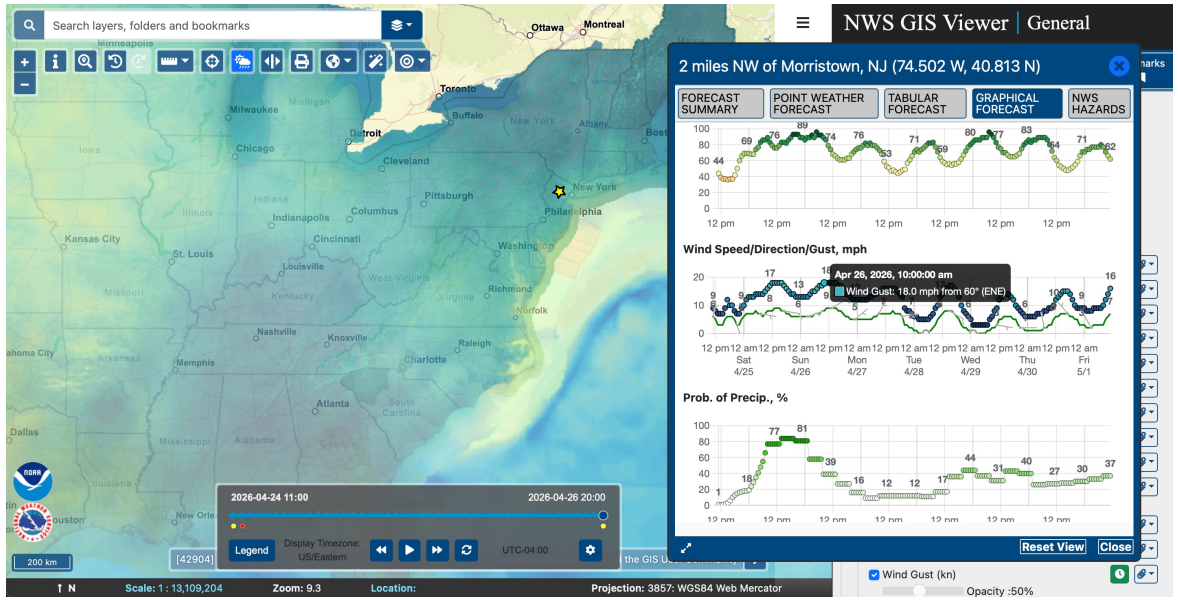
July 2022 Forested Area Texas, USA

Open Weather Tools



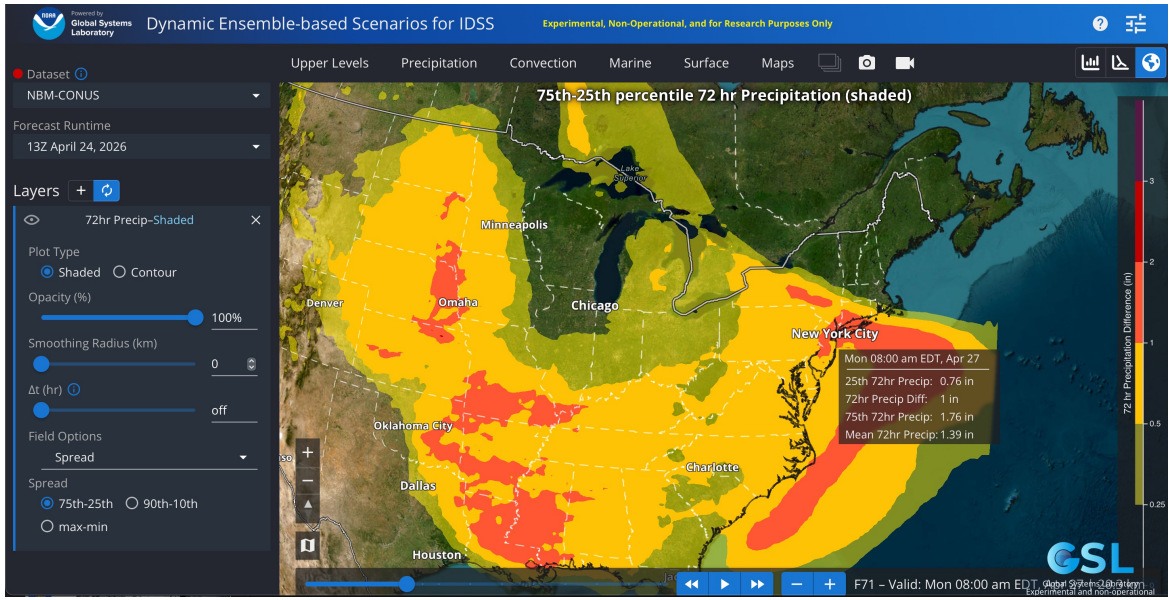
Open Weather Tools

Forecasts

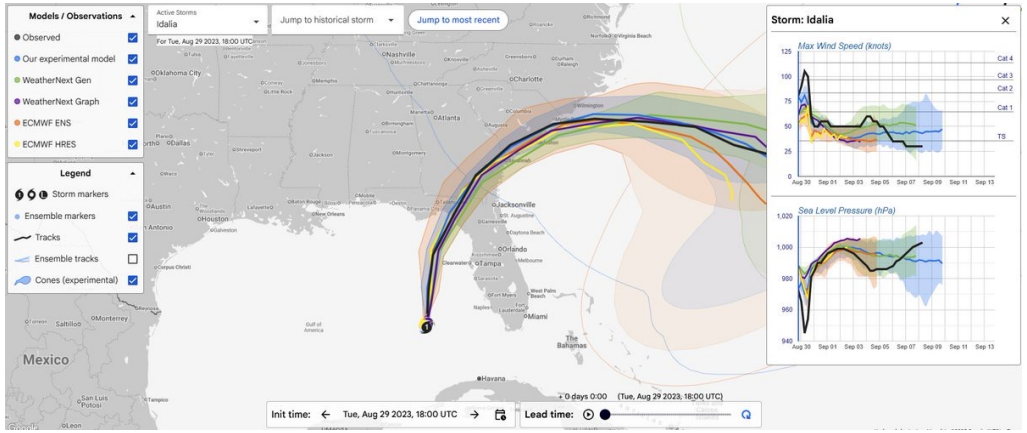


[NWS GeoHub – Interactive weather forecasts](#)

Raw data via API: https://api.weather.gov



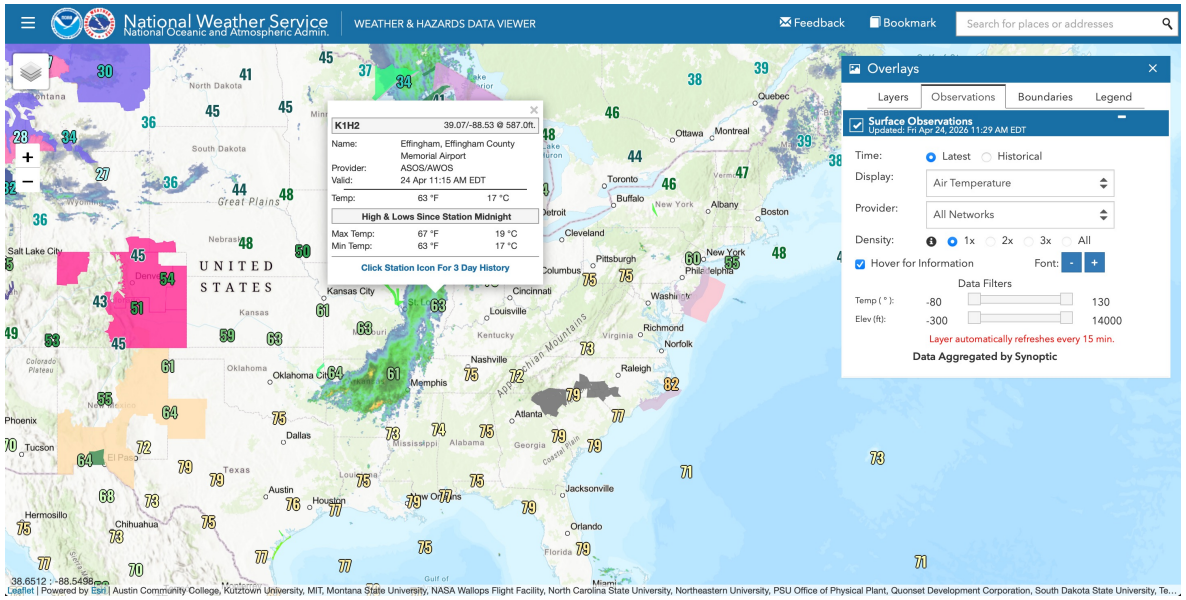
[NOAA Impact-Based Decision Support Services (IDSS) viewer](#)



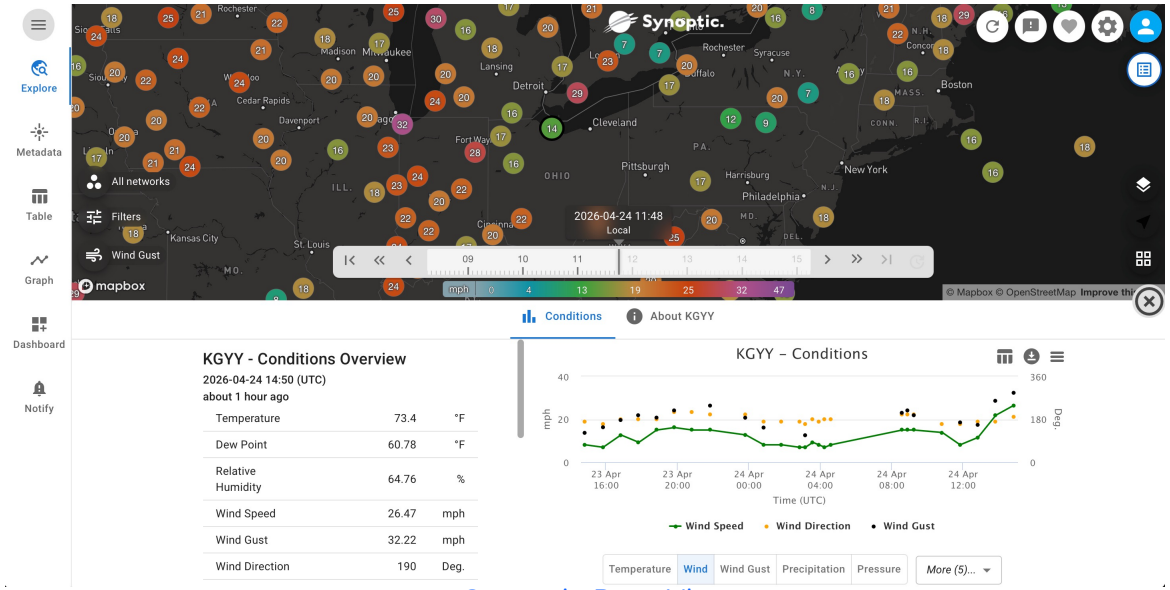
[Google Weather Lab](#)

Open Weather Tools

Observations



[NOAA/NWS Weather & Hazards Data Viewer]

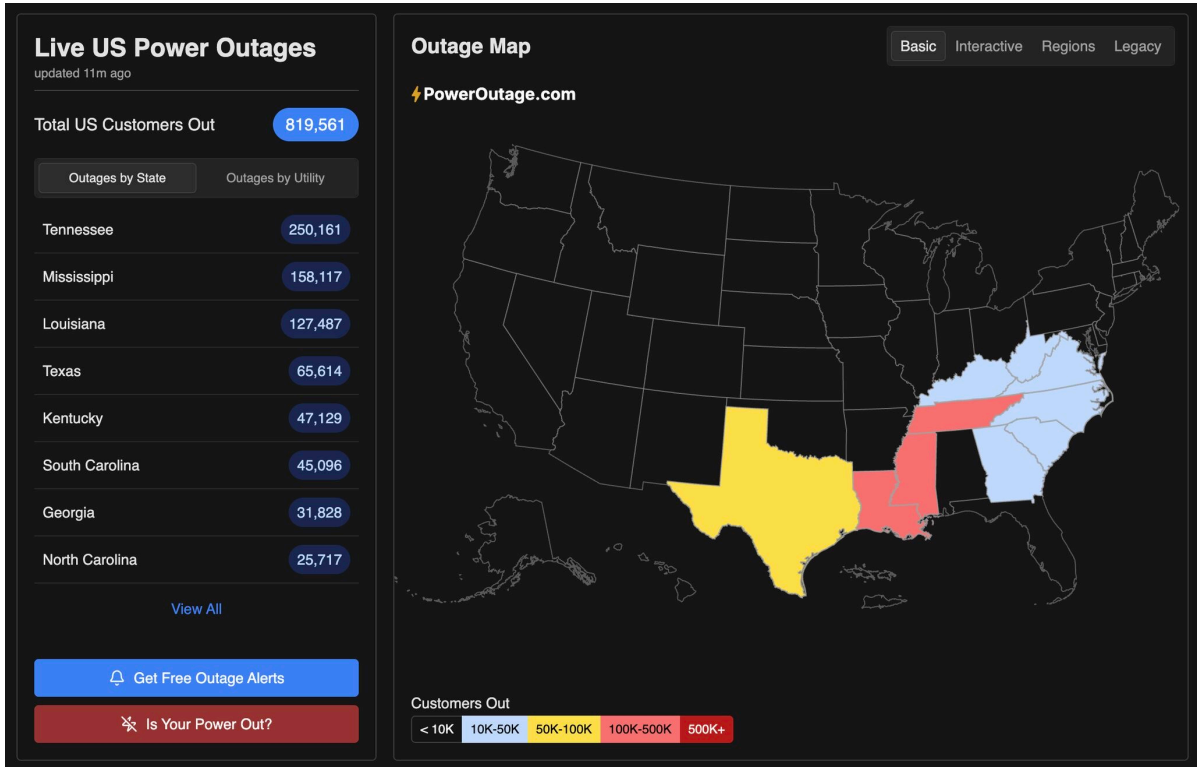


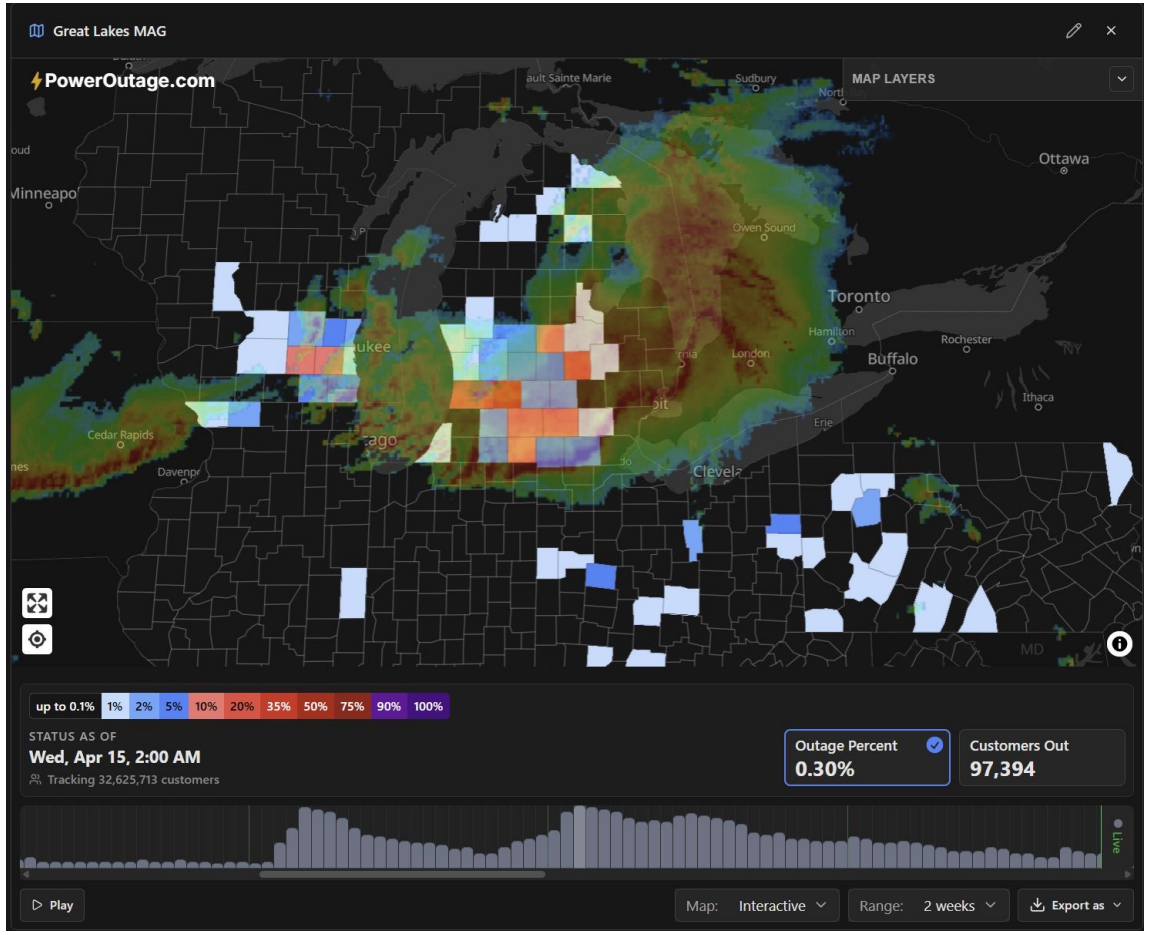
[Synoptic Data Viewer]

Open Weather Tools

Outages

PowerOutage.com





Q&A

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