Storm Damage Assessment with Weather Forecasting to Determine a Utility's Restoration Efforts

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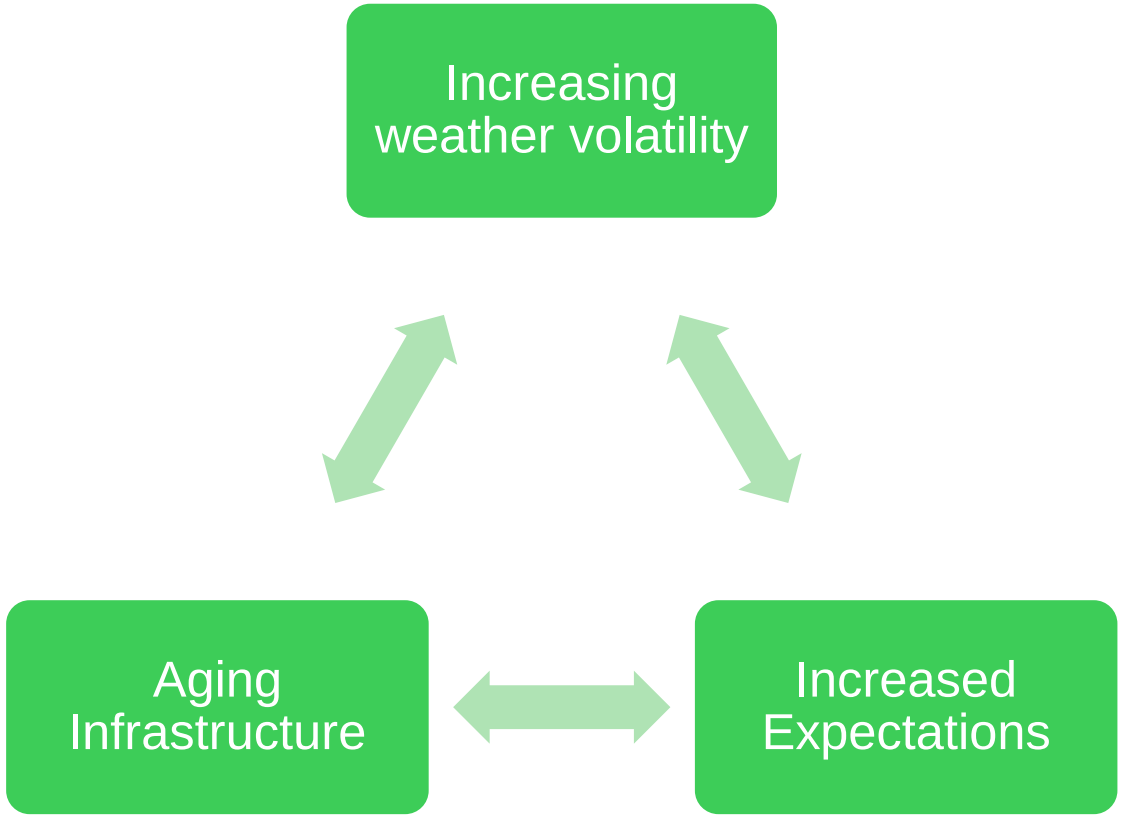
Presented by: Marcus Smith

Life Is On Schneider Electric

Utilities are under pressure to tackle severe weather risk to their operations

Why?

- It’s a perfect storm of:



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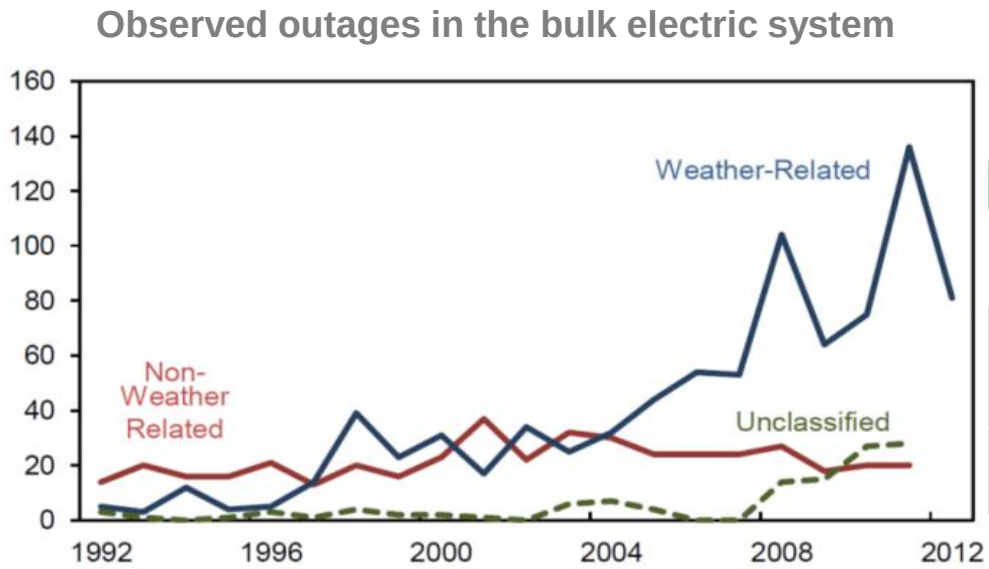

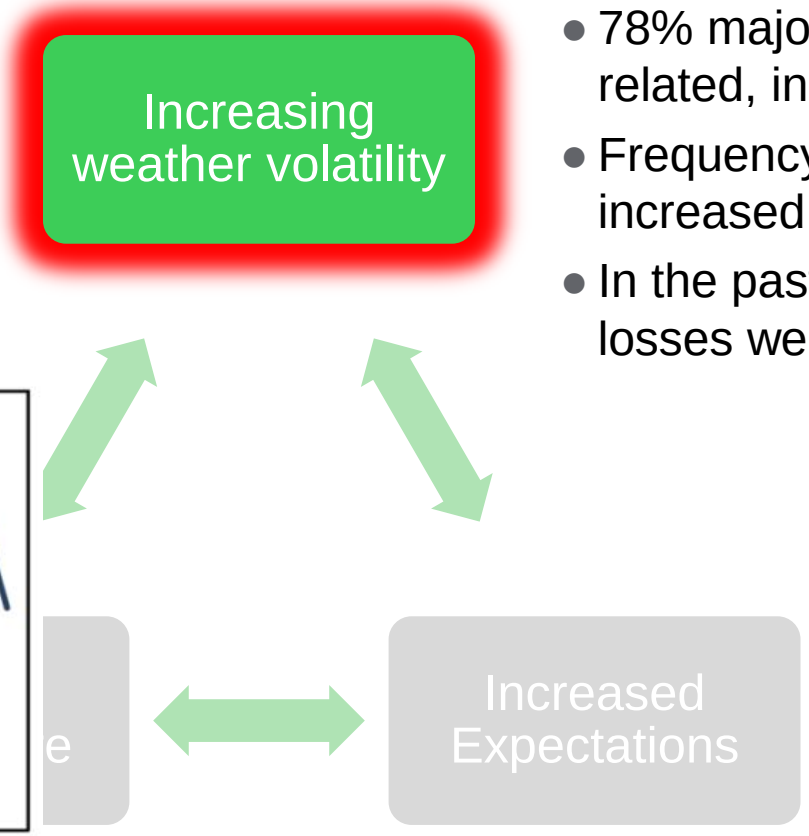

- 44% of outages due to weather
- 78% major grid disruptions weather-related, increasing
- Frequency of major outages "has increased six-fold in the past 20 years."
- In the past decade, extreme weather losses were $476 Billion

Sources:
UVM 2008 study of 20 years of NERC data
Berkeley Labs report, 2012
IEEE Spectrum 2013
2013 IDC Report

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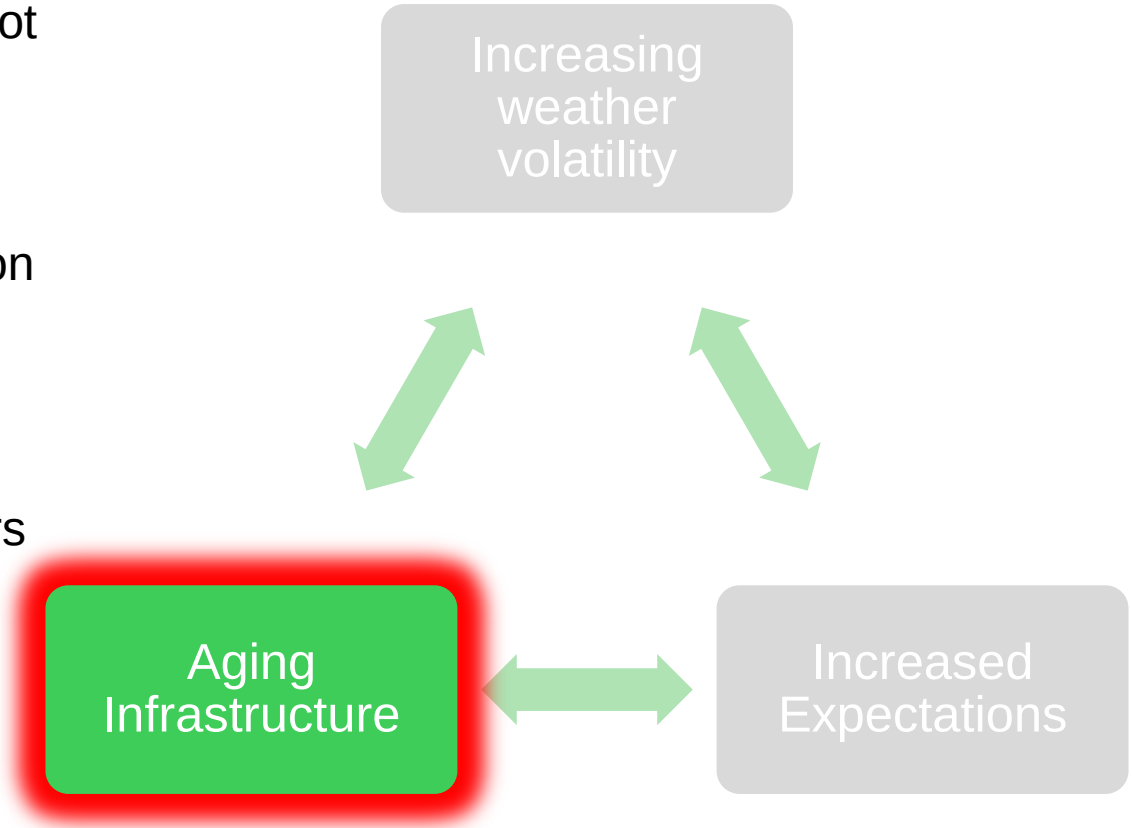
It's a perfect storm of:

- Infrastructure replacements not at scheduled pace
- By 2020, investment gap in distribution = $57 Bn and Investment gap in transmission = $37 Bn
- "Do more with less"
  - Smaller staffs
  - More reliance on contractors & mutual assistance



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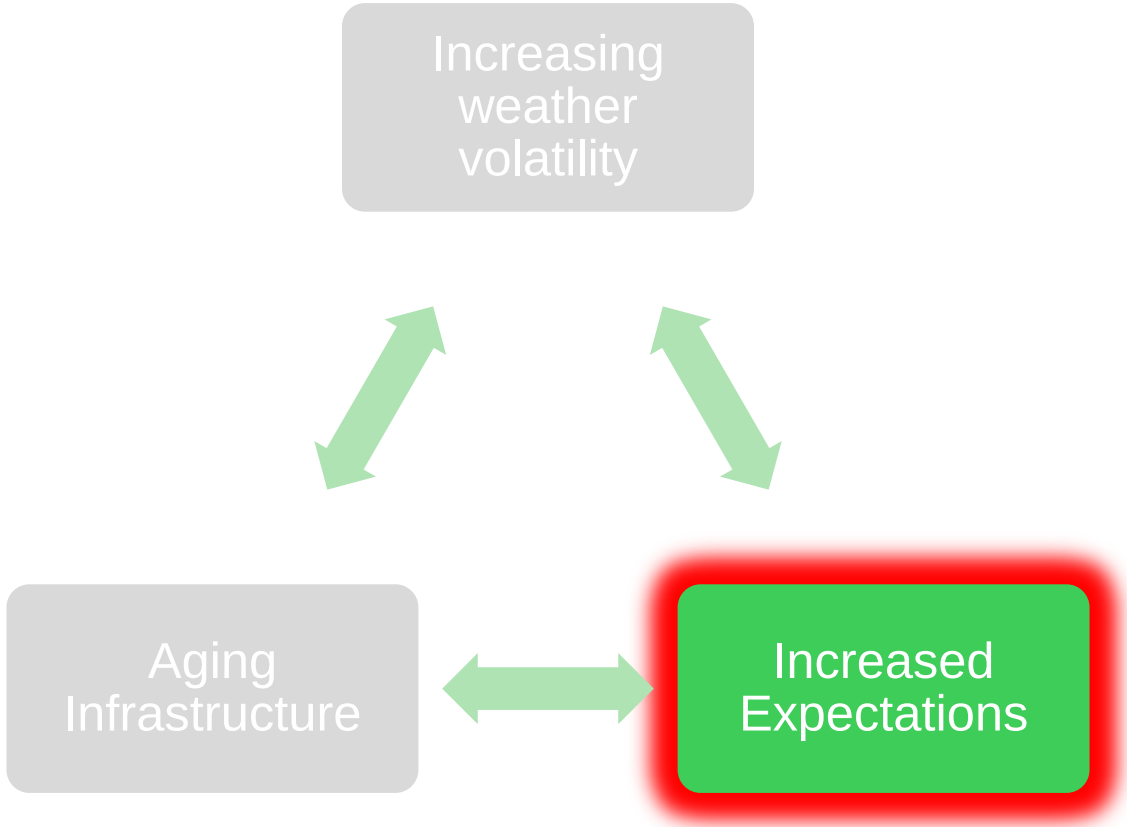

- Less public tolerance
- Increased media attention
- Social media
- Regulatory and political scrutiny
- Fines, denied cost recovery/rate increase
- Executive concerns about reputation

Evolution of utility weather decision support

Utility Focused Online Weather Support Portal

- Generic observation and forecasts
- Alerting for specific locations
- Manual comparisons with asset locations

Severe Weather Threat index

- Weather variables impacting assets
- 1-5 severity scale over time and regions
- Confidence Levels and Meteorologist comments

Storm Impact Analytics

- Aligned to utility needs
- Identification of impact at asset-level for a utility
- Damage estimates
- Crew requirement
- Restoration time estimates

Online Weather Support Portal → **Severe Weather Threat specific to asset locations** → **Impact Modelling and damage analytics**

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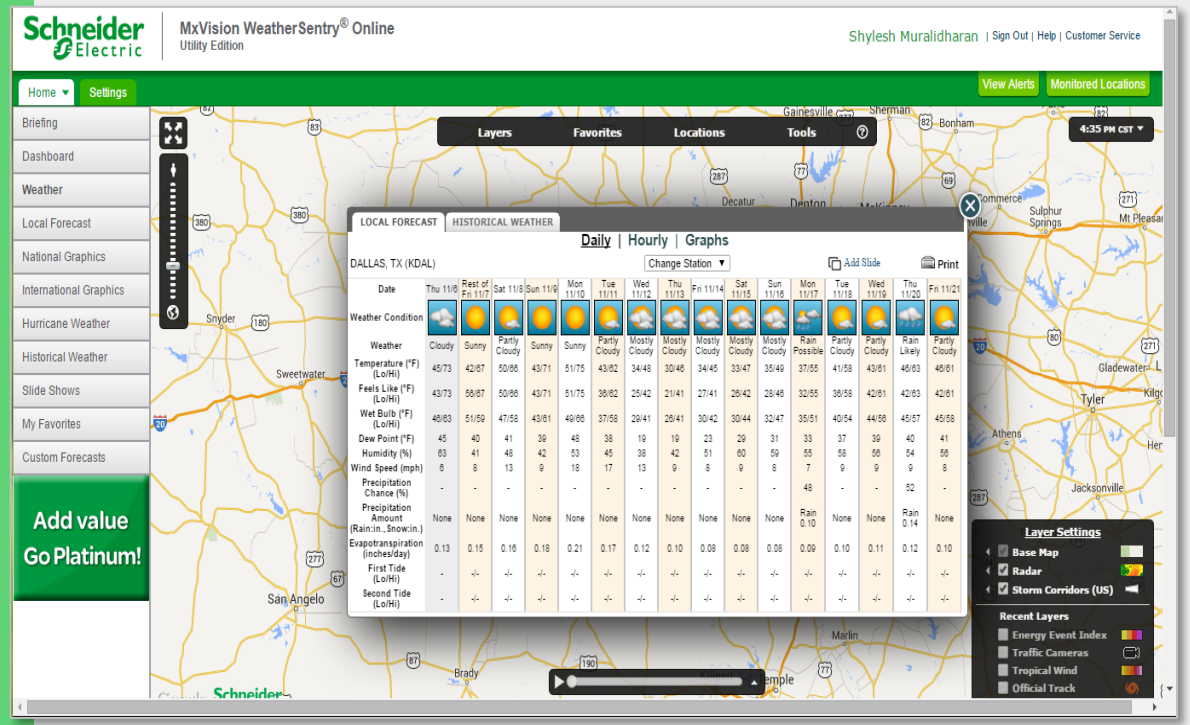
Online weather support portal

- Provides a quick view of weather for a requested location
- Observed weather parameters
- Forecasts – both daily and hourly
- Full situational awareness through a geospatial platform
- Location-specific alerting
- Visually displays a path of a storm and shows where severe weather is headed to



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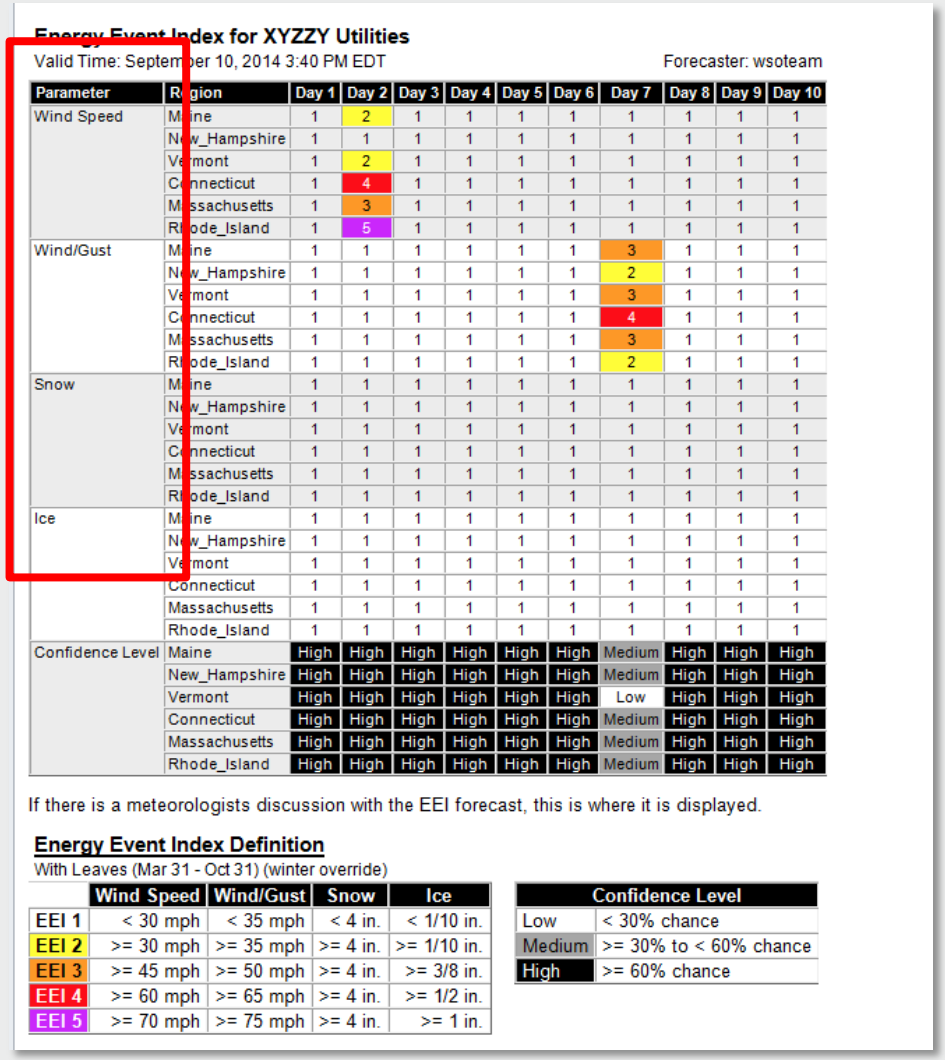
Severe weather threat index

- Utility-specific forecast with a 1-5 weather risk categorization
- Customized to utility's service territory and operational risk thresholds
- Seasonal thresholds due to vegetation
- Includes confidence level of forecast and meteorological input
- Weather variables for consideration:
  - Winter
    - Wind speed is for any sustained winds, including tropical storms/hurricanes
    - Wind gusts – thunderstorm winds
    - Snow
    - Ice
  - Summer:
    - Wind parameters
    - Flooding
    - Lightning



Energy Event Index for XYZZY Utilities

Valid Time: September 10, 2014 3:40 PM EDT — Forecaster: wsoteam

Parameter	Region	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
Wind Speed	Maine	1	2	1	1	1	1	1	1	1	1
	New_Hampshire	1	1	1	1	1	1	1	1	1	1
	Vermont	1	2	1	1	1	1	1	1	1	1
	Connecticut	1	4	1	1	1	1	1	1	1	1
	Massachusetts	1	3	1	1	1	1	1	1	1	1
	Rhode_Island	1	5	1	1	1	1	1	1	1	1
Wind/Gust	Maine	1	1	1	1	1	1	3	1	1	1
	New_Hampshire	1	1	1	1	1	1	2	1	1	1
	Vermont	1	1	1	1	1	1	3	1	1	1
	Connecticut	1	1	1	1	1	1	4	1	1	1
	Massachusetts	1	1	1	1	1	1	3	1	1	1
	Rhode_Island	1	1	1	1	1	1	2	1	1	1
Snow	Maine	1	1	1	1	1	1	1	1	1	1
	New_Hampshire	1	1	1	1	1	1	1	1	1	1
	Vermont	1	1	1	1	1	1	1	1	1	1
	Connecticut	1	1	1	1	1	1	1	1	1	1
	Massachusetts	1	1	1	1	1	1	1	1	1	1
	Rhode_Island	1	1	1	1	1	1	1	1	1	1
Ice	Maine	1	1	1	1	1	1	1	1	1	1
	New_Hampshire	1	1	1	1	1	1	1	1	1	1
	Vermont	1	1	1	1	1	1	1	1	1	1
	Connecticut	1	1	1	1	1	1	1	1	1	1
	Massachusetts	1	1	1	1	1	1	1	1	1	1
	Rhode_Island	1	1	1	1	1	1	1	1	1	1
Confidence Level	Maine	High	High	High	High	High	High	Medium	High	High	High
	New_Hampshire	High	High	High	High	High	High	Medium	High	High	High
	Vermont	High	High	High	High	High	High	Low	High	High	High
	Connecticut	High	High	High	High	High	High	Medium	High	High	High
	Massachusetts	High	High	High	High	High	High	Medium	High	High	High
	Rhode_Island	High	High	High	High	High	High	Medium	High	High	High

If there is a meteorologists discussion with the EEI forecast, this is where it is displayed.

Energy Event Index Definition

With Leaves (Mar 31 - Oct 31) (winter override)

	Wind Speed	Wind/Gust	Snow	Ice
EEI 1	< 30 mph	< 35 mph	< 4 in.	< 1/10 in.
EEI 2	>= 30 mph	>= 35 mph	>= 4 in.	>= 1/10 in.
EEI 3	>= 45 mph	>= 50 mph	>= 4 in.	>= 3/8 in.
EEI 4	>= 60 mph	>= 65 mph	>= 4 in.	>= 1/2 in.
EEI 5	>= 70 mph	>= 75 mph	>= 4 in.	>= 1 in.

Confidence Level	
Low	< 30% chance
Medium	>= 30% to < 60% chance
High	>= 60% chance

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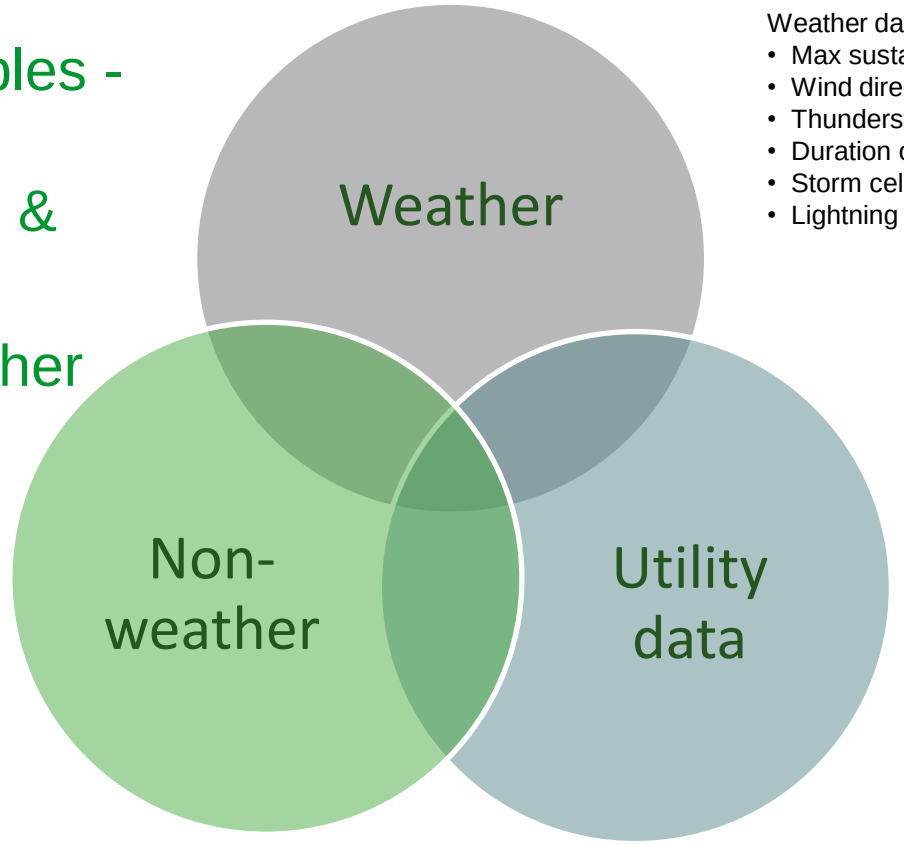
Predictive damage modelling

> Advancing the severe weather threat index

> More than weather variables - vegetation, tree trimming schedules, asset location & directions, soil conditions

> Combination of non-weather variables and utility data



Weather data:
- Max sustained wind speed
- Wind direction during the event (at max wind speed)
- Thunderstorm intensity
- Duration of rain during/preceding the event
- Storm cell data
- Lightning data

Utility GIS data
- Overhead Distribution facility data
- Feeders, Transformers, Fuse, switches, etc.
- No of customers impacted by each asset

- Vegetation density
- Vegetation type
- Soil characteristics at the time of the event

Weather Variables and nature of impact

Direct variables

Summer

- Lightning – electrical damage
- Wind – mechanical damage
- Rain – electrical damage, combination w/ lightning, sustained – mechanical damage
- Temperature – mechanical damage – low impact variable

Winter

- Snow/Ice – mechanical damage (in addition to summer variables)

Advanced variables

- Thunderstorm intensity
- Duration of thunderstorm at various intensities
- Forecasted and actual ice accretion
- Continuous duration of rainfall at various intensities
- Direction of wind in relation to the direction of assets

Impact analytics

- Pole upend algorithms
- Asset failure points
- Restoration effort correlations
- Crew availability
- Inventory stocking rules
- Equipment maintenance schedules

Thunderstorm Intensity

The thunderstorm intensity is a model derived index that takes into account the numerical forecast of the environment at a grid cell to determine the potential for high impact severe weather.

Severe Weather Attributes of Concern:

- Storm Winds
- Hail
- Tornadoes

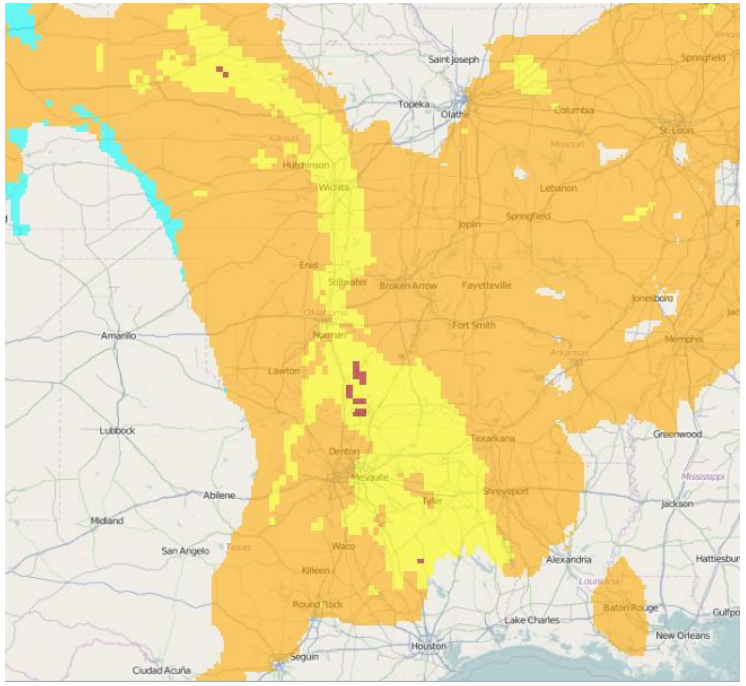
Scale is from 1-6 with the following characteristics per index number:

> Scale derived from a series of scores related to the model forecast development of the severe weather attributes listed above during both warm and cool seasons

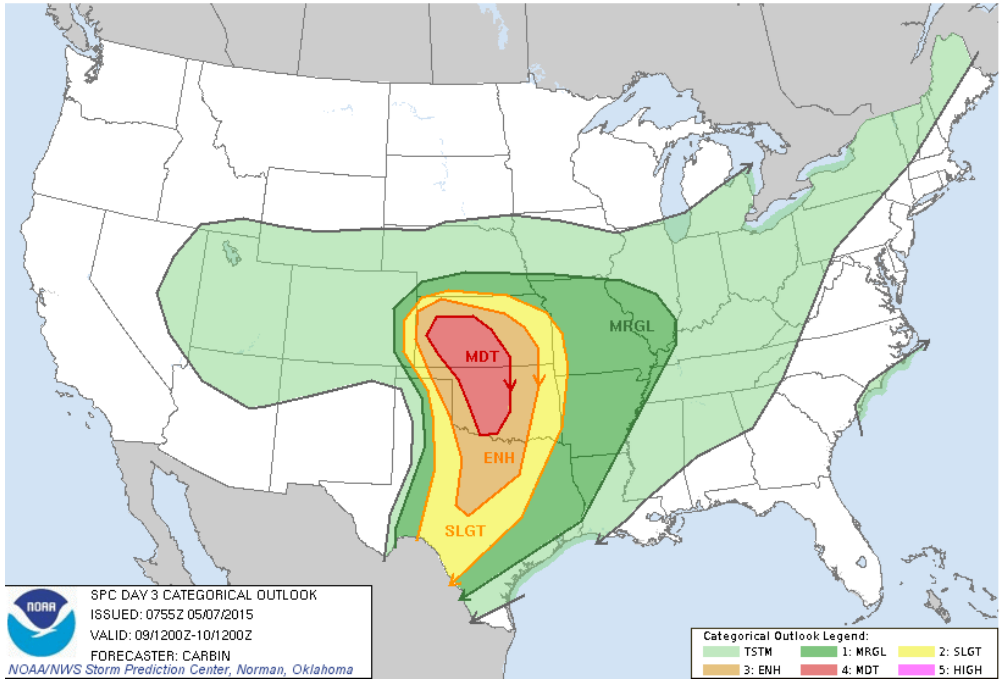
1. No thunderstorms
2. Weak thunderstorms
3. Strong but sub severe
4. Strong and minimally severe
5. Very strong with some damage likely
6. Extremely severe with damage likely

How does the Thunderstorm Index compare to SPC(Storm Prediction Center)?

- Model derived Thunderstorm Index uses a “finer brush” than SPC to forecast the areas of greatest potential for the strongest storms
- The goal is to provide the Utilities with a general idea spatially and temporally of predicted severe weather activity and estimate the level of impact

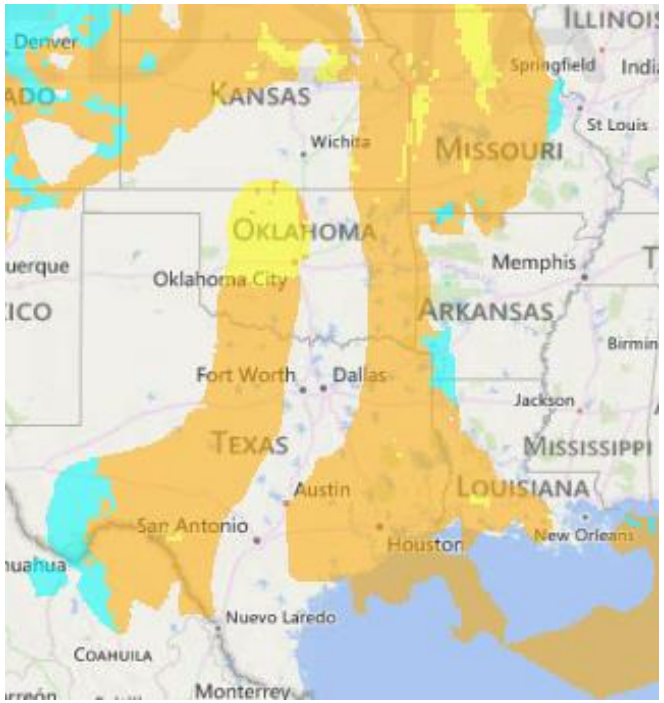


Day 3 Model derived thunderstorm index versus the SPC day 3 Categorical Outlook

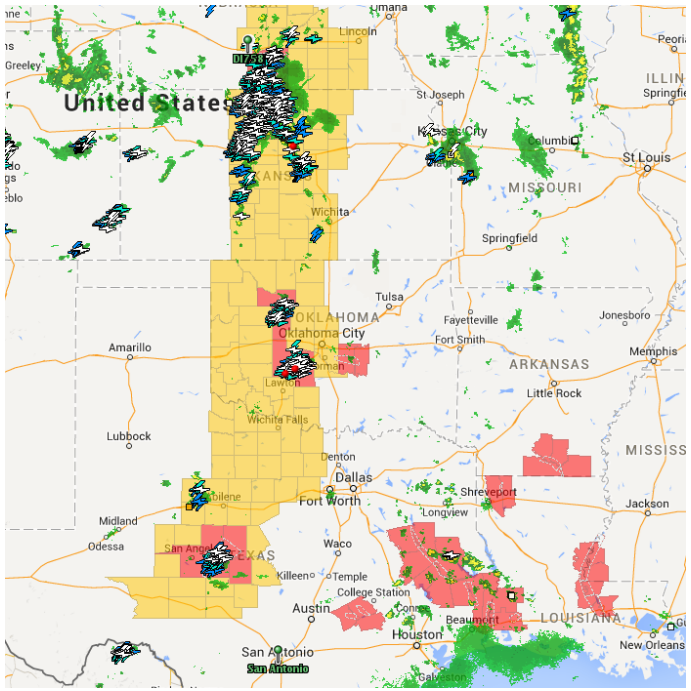


How does the Thunderstorm Index Verify?

- The Thunderstorm Index (TI) indicates that there is a general risk of strong to severe weather
- Some areas are excluded in parts of Kansas because the TI forecast requires the conditions below to be greater than zero
  - forecast precipitation >= 0.01”
  - forecast convection is likely if precipitation develops

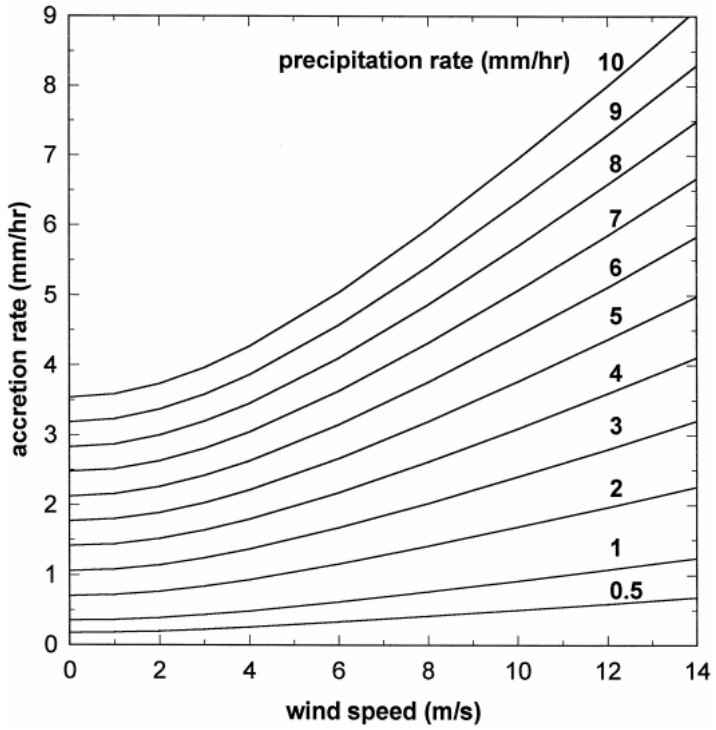


Day 1 Thunderstorm Index forecast versus a tornado watch area with embedded severe thunderstorm warnings.

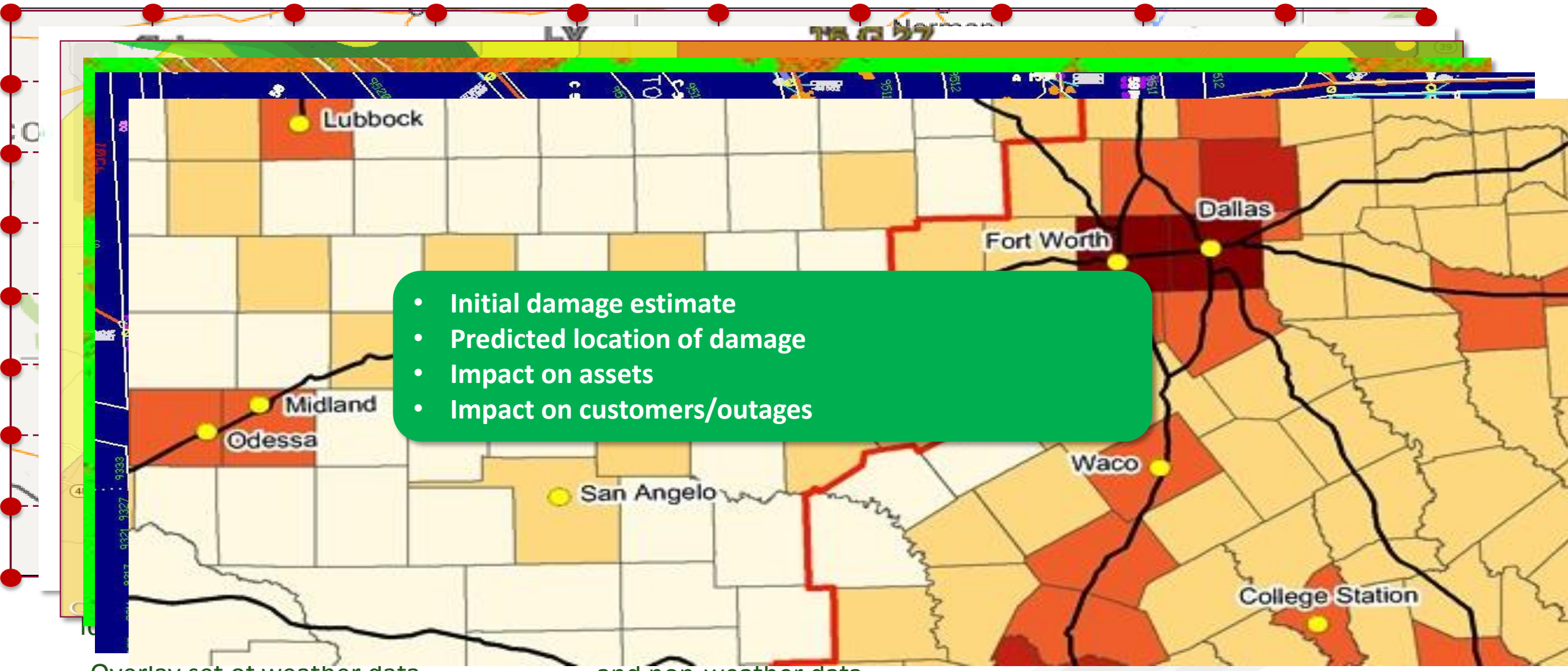


Ice Accretion Forecasting

- Ice accretion forecast model we have implemented forecasts radial ice thickness on a circular cylinder and is depended on factors such as:
  - hours of freezing rain/drizzle
  - precipitation rate
  - wind speed
  - liquid water content



Proposed design of a storm damage prediction application



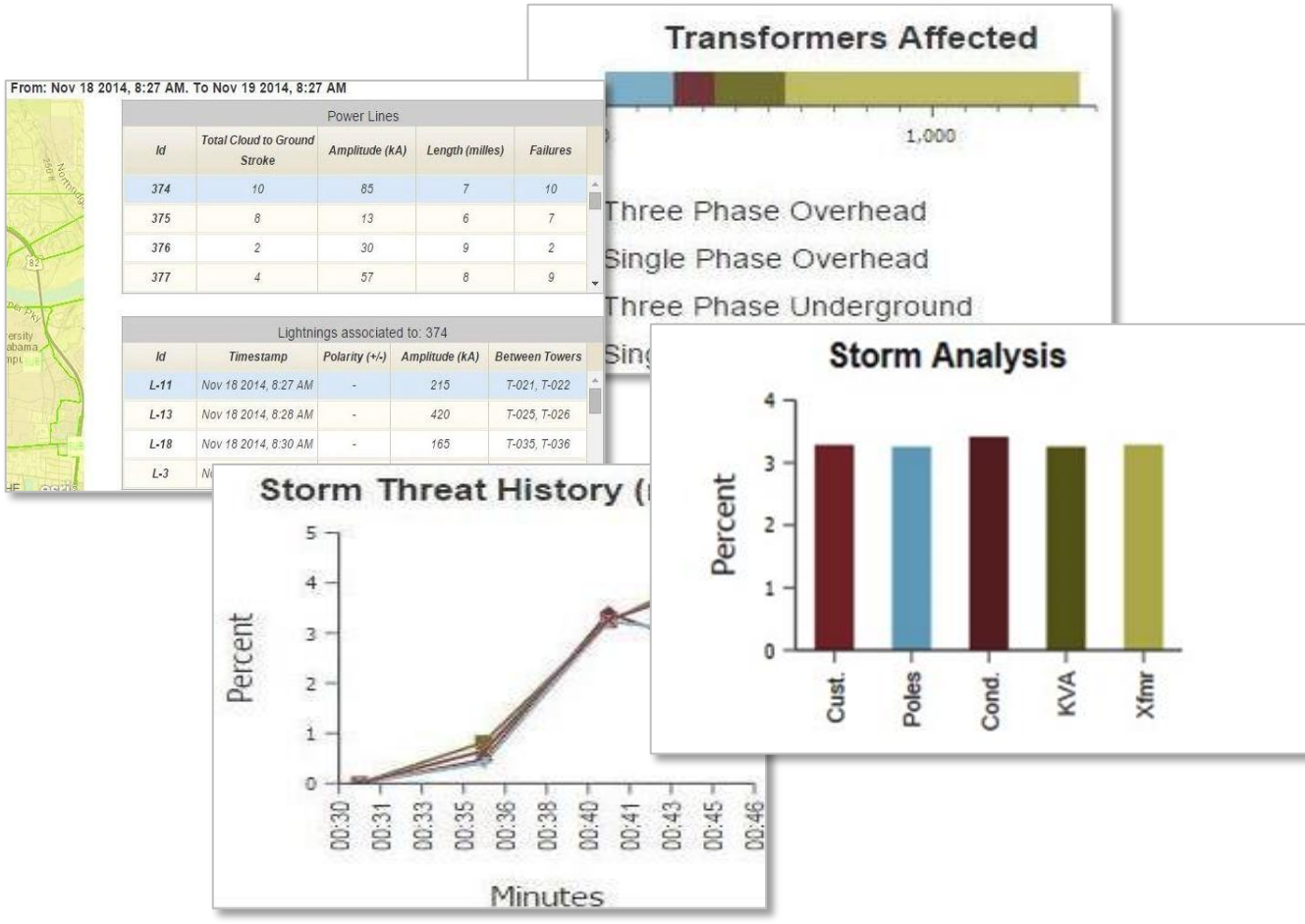
Overlay set of weather data …and non-weather data

…and intersect it with asset/user/outage data

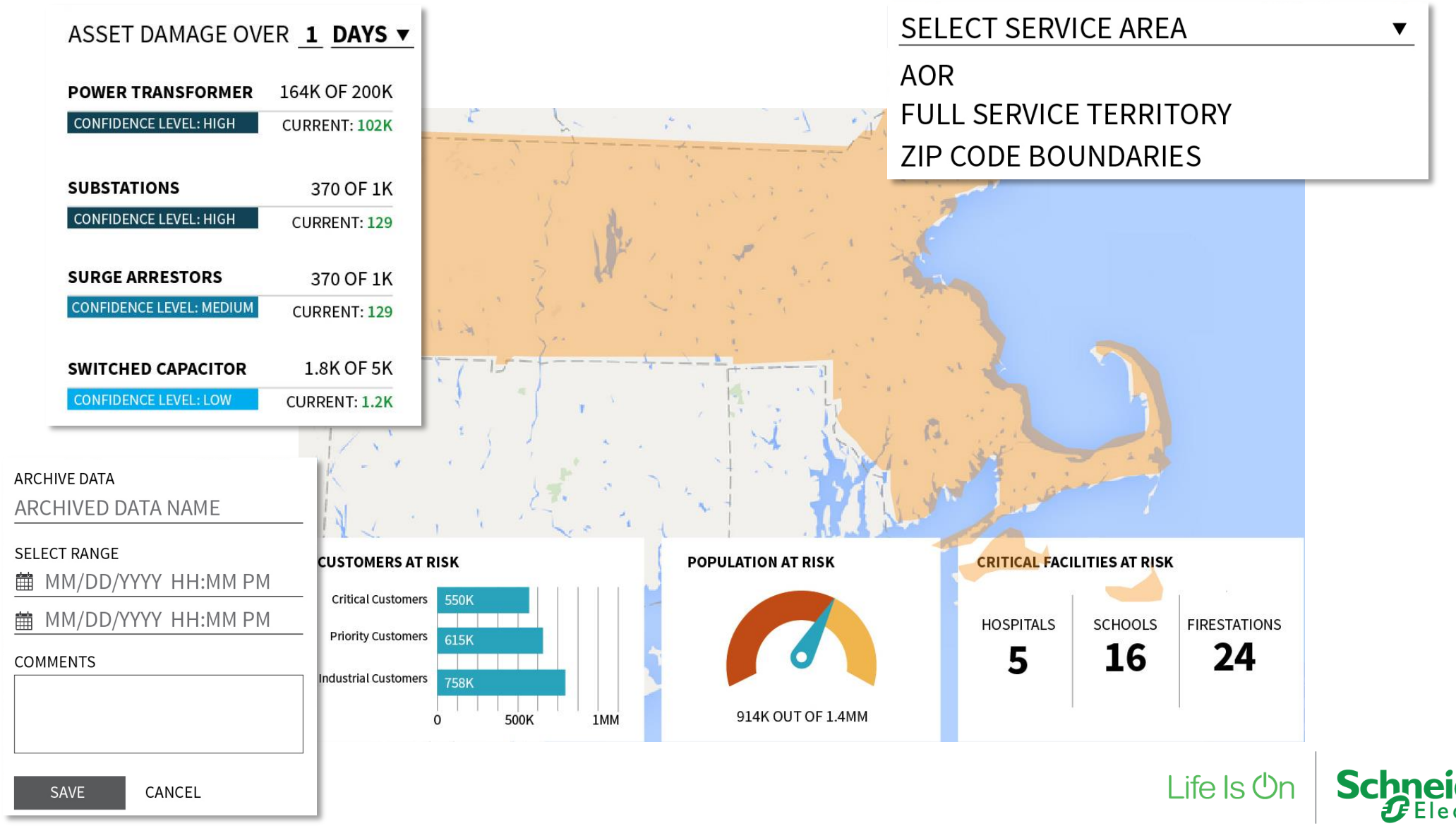
What The Solution is designed to deliver

The Output

- How much asset damage is predicted and where?
- A probabilistic metric (confidence level) on the chance of predicted damage
- Ability to look at multiple scenarios for comparison
- Type of assets and nature of damage?
- What resources and materials will be needed to repair the damage?
- What requests for help and commitments for helping others should be made for mutual assistance?



The final user-facing solution can be customized as per the Utility's needs



Questions?

Thank You

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