



# Weather Guard® Overview



## DISTRIBUTION RELIABILITY EXCELLENCE

TR<sup>x</sup> Weather Guard® responds to fast moving long-term storms and extreme weather events, generating reports and alerts to identify most probable service areas and circuits impacted. It facilitates resource dispatch to high-risk locations, saving utilities: time, money, and improving customer satisfaction with quicker responses.

## COMMON CHALLENGES

- Utilities have been trying for years to harness weather and reliability data to predict outages and damage levels for storm preparation. Results using average weather data and simple outage statistics, even at the circuit level, are inadequate for the level of accuracy needed for solid predictions and improved response times.
- Most companies plan conservatively, incurring higher costs, and then react post-storm to identified damage sites, rather than mobilizing crews and materials to the right locations pre-storm

## KEY STAKEHOLDER BENEFITS



### Field Operations

Predict outage and potential fire ignition locations, along with resource and material requirements, to position crews in safe areas close to where damage is expected to occur, rather than waiting until after the event to assess damage locations and materials needed.



### Customers

Integrate predictive weather analytics with your customer website/portal including PSPS notification to alert customers in advance of potential storm impacts, e.g., show fast moving storms, where to expect outages to occur, and expected restoration times (prior to an event).



### Asset Management

Determine which assets are most critical to protect from wind-driven fires. Identify optimum storm hardening investments based on asset characteristics/weaknesses, current asset condition, Veg Trim cycle, and consequential vulnerability to outages.

## ACCURATE PREDICTIONS WITH DETAILED DATA



### Triangulate Wind/Wildfire Data

Refine weather and ignition data to identify conditions when each outage began - mining 10+ years of data from multiple weather stations and triangulating for localized wind direction, speed, gusts, temp, precipitation, etc.



### Impact of Specific Outage Causes vs. Weather

Look at 10+ years of outage data in terms of very specific cause codes in combination with weather data to document system response to various storm events / parameters at a circuit and segment level.



### Include Asset Age and Characteristic Analysis

Define asset characteristics that are more susceptible to weather as a function of differentiating asset characteristics (e.g., pole type, size, age, and condition, and host/guest loading.)



### Utilize Machine Learning

Apply advanced statistical modeling and machine learning to retrain/ automatically update the underlying algorithms as new data becomes available.

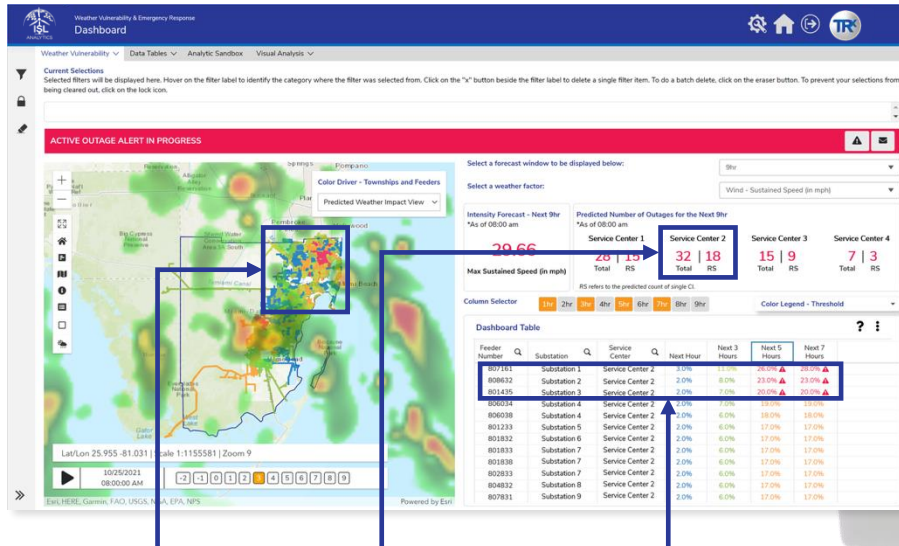
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## WEATHER VULNERABILITY DASHBOARD

### DASHBOARD VIEW

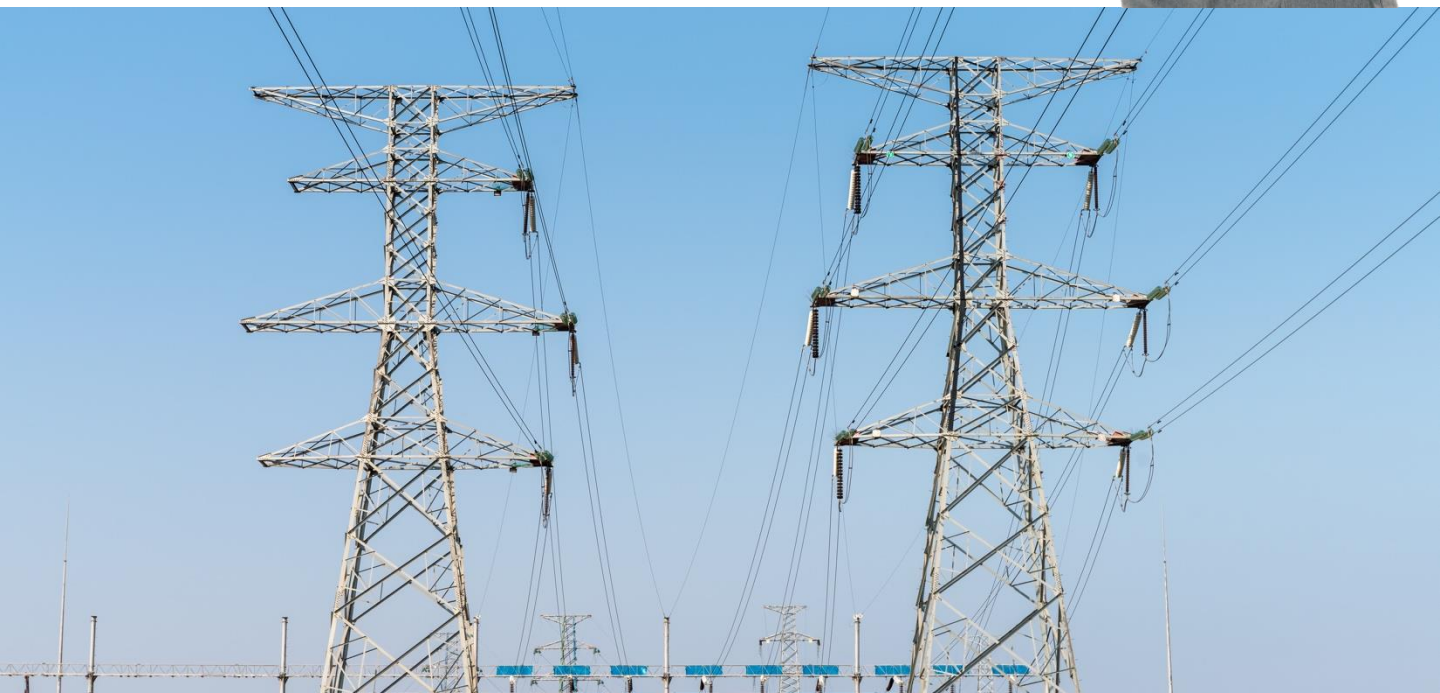
#### Weather Vulnerability Dashboard View

Recent client tests have suggested TR<sup>x</sup> can predict with up to 80% accuracy which circuits are likely to experience an outage as a result of a particular storm with incoming storm severity assessment, sustained wind speed and wind gust, wind direction, humidity, precipitation, and lightning forecast data.



With sustained wind speeds at 29 mph and wind gusts up to 45 mph, the northern part of the service territory will experience the most expected outage tickets in the next 5 hours.

Circuits with the highest probability of failure are also identified



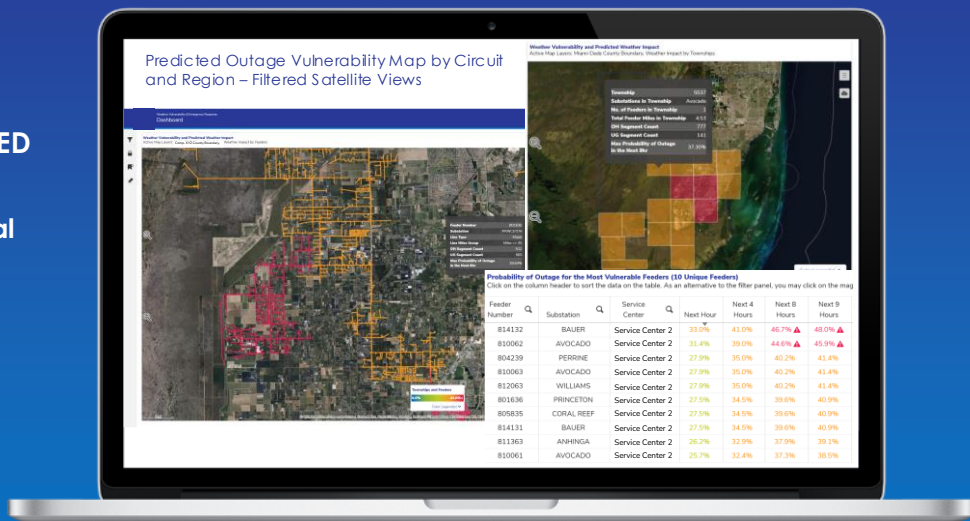
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## WEATHER VULNERABILITY DASHBOARD

### DASHBOARD VIEW – DETAILED MAPPING CAPABILITIES

#### Detailed Mapping of Potential Fire Impact Areas

Forecast wind and fire impacts at both the region and circuit level and easily drilldown on the most vulnerable areas

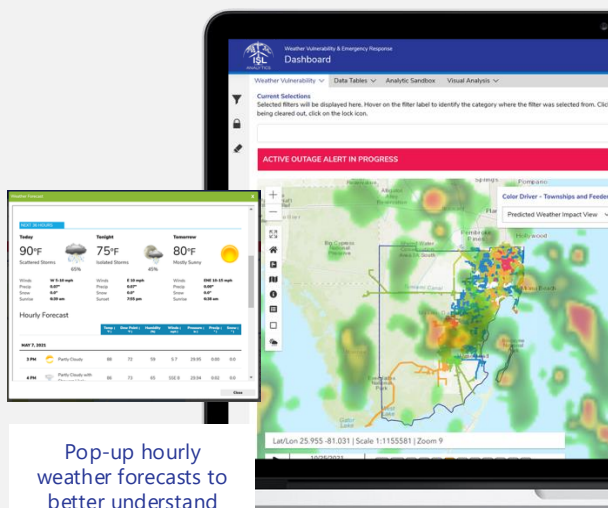


### DASHBOARD VIEW – ENHANCED ANALYTIC CAPABILITIES AT YOUR FINGERTIPS

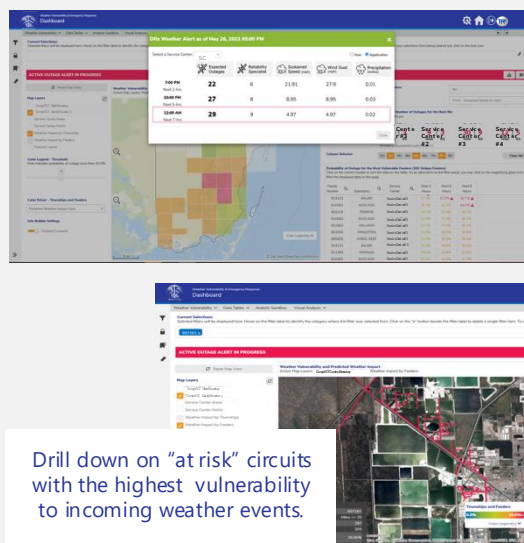
#### Next Level of Data Driven Insights...

Activate Real Time Satellite Forecast Layers, including Radar, Wind Speed, Wind Gust, Temperature Views, etc., as well as Advanced Fire Modeling (e.g., Technosylva)

View All Active Alerts for Each Service Center (Office or Region) and See Circuits by Color Coded Vulnerability Level



Pop-up hourly weather forecasts to better understand upcoming weather events and "at risk" areas of the system



Drill down on "at risk" circuits with the highest vulnerability to incoming weather events.

Identify optimal intervention points (crew staging, switching points, etc.)



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## REAL TIME AUTOMATED ALERTS

We focus on getting knowledge to users sooner with real-time text alerts, email alerts, and scheduled daily expected outage reports, enabling immediate action to mobilize resources.

### TEXT ALERTS



### EMAIL ALERTS

Email Alerts provide real time weather mapping, expected outages per service center (office or region) and key weather metrics, a list of most vulnerable circuits, and a direct access link to the TR<sup>x</sup> application.



### DAILY SCHEDULED EXPECTED OUTAGE REPORTS

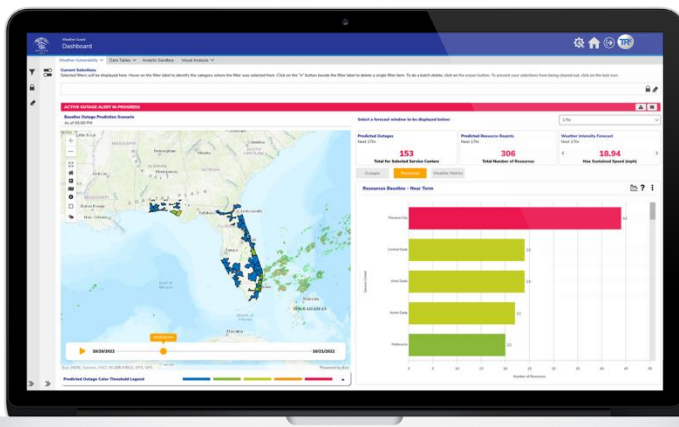


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## DAMAGE FORECASTING & RESOURCE PROJECTIONS

### WEATHER VULNERABILITY, DAMAGE FORECASTING, AND RESOURCE PROJECTIONS ...

Leverage data regarding vegetation, asset condition, real-time weather forecasts to define impact of rapidly approaching storms or extreme weather events. Generate automated alerts/reports of forecast damage, identifying circuits most likely to be impacted. This can facilitate pro-actively de-energizing assets or dispatching resources to locations with highest likelihood of damage--- saving time and money and improving restoration performance!



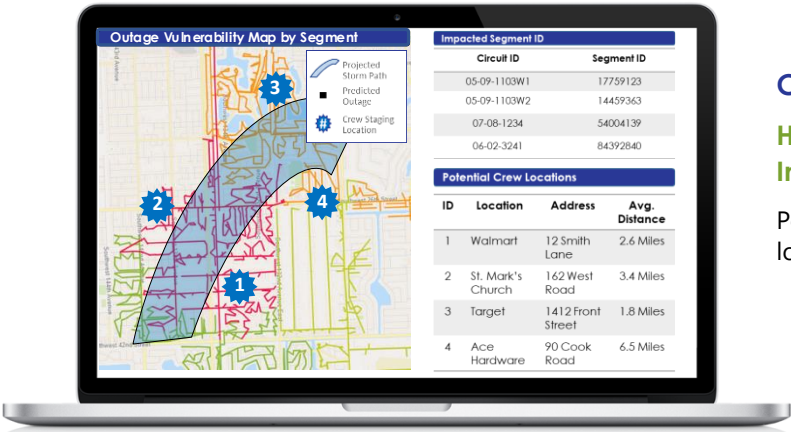
### REAL LIFE APPLICATION

Know how bad the storm is going to be

Prior to a fast-moving storm or more severe weather event our TR<sup>x</sup> Guard<sup>®</sup> Module can quickly recalculate predicted outage impacts and resourcing needs:

|                                    |                                                                                                   |               |
|------------------------------------|---------------------------------------------------------------------------------------------------|---------------|
| <b>Projected Storm Impacts</b><br> | Modeled Circuit Outages (on xyz circuits)                                                         | 8             |
|                                    | Modeled Avg. Circuit Outage Likelihood                                                            | 79%           |
|                                    | Modeled Prob. Adj. Customers Out                                                                  | 17,500        |
|                                    | Estimated Additional Scattered Outages*<br>(*due to unexpected circumstances, e.g., danger trees) | 1-3           |
|                                    | Estimated Additional Customers Out                                                                | 5,000         |
|                                    | <b>TOTAL PREDICTED CUSTOMERS OUT</b>                                                              | <b>22,500</b> |
|                                    | <b>Projected Crews Needed</b><br>(safe mobilizing locations will also be identified)              | 17            |
|                                    | Number of Depots/Service Centers Impacted                                                         | 3             |

This can be delivered as a storm prep report directly out of TR<sup>x</sup> for crews and potentially to share with affected municipalities, regulators, etc. to demonstrate competence and robust preparation. Benefits span community outreach, regulatory relationships, system operations and local crew management.



CREW POSITIONING

High Probability Circuits Impacted and Crew Positioning

Position crews ahead of time in safe locations with necessary materials

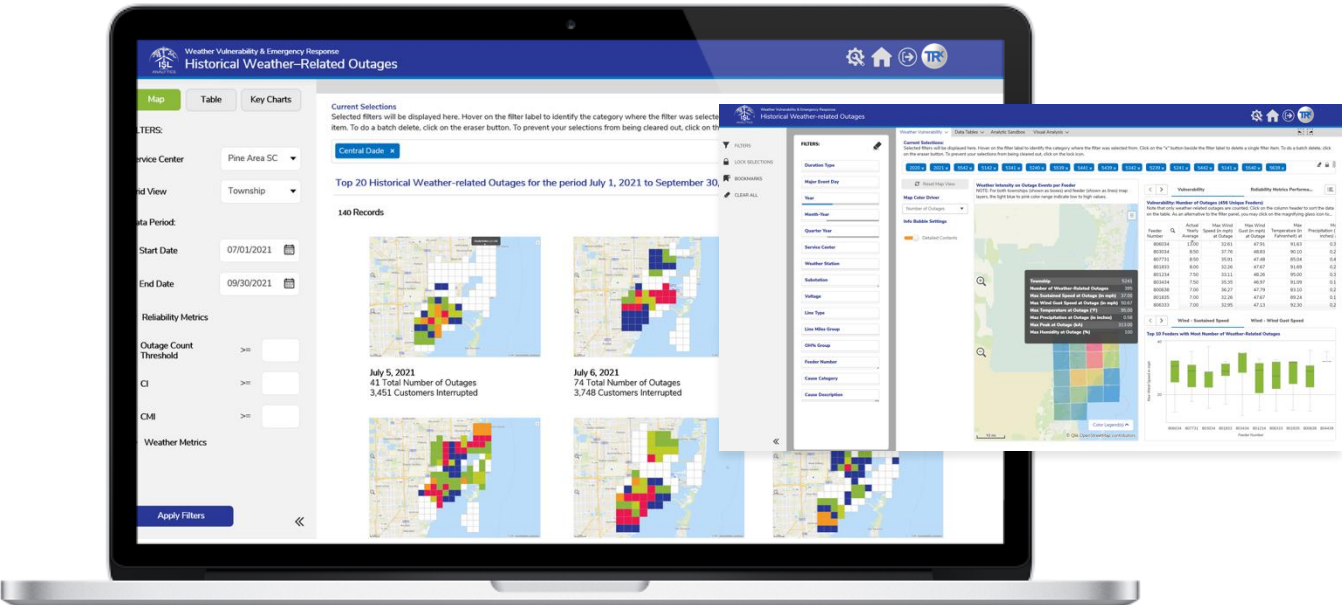


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HISTORICAL DATA VIEWS

HISTORICAL ANALYSES

Explore historical fire and outage data (storm severity, wind speed, wind gusts, precipitation, lightning, etc.).

Advanced searching, filtering and drilldowns allow better understanding of ongoing risk and vulnerabilities on the system



## WEATHER TRENDS AND FORECASTS

Utilizing historical weather factors and outcomes, the Weather Trends and Forecasts section **provides insights into the variation from average for a number of weather factors** by month. This insight allows the user to see those months of the year historically that their network is both most and least exposed to the selected weather factor.

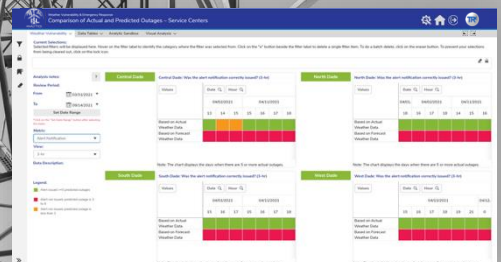


## ACCURACY ANALYSES

The **Accuracy Dashboard** page provides an overview of the indicators that are used to measure the effectivity of the outage prediction model. The Alerting Notification view displays the accuracy of the application in issuing alerts across the various time windows while the Outage Prediction view displays the analysis conducted on measuring the accuracy of the number of outages predicted.

The **Weather Date and Outage Prediction** analysis page allows the cross-referencing of the weather metric options (sustained speed, gust speed, and precipitation) to either the outage prediction analysis or the alert notification analysis table.

The **Comparison of Actual and Predicted Outages – Service Centers** page is similar in terms of the data content but provides a different presentation of the analysis, displaying information for each of the Service Centers.





### ANALYTIC SANDBOX, WORST PERFORMING CIRCUITS, VM ANALYSIS AND VISUAL ASSET REGISTER

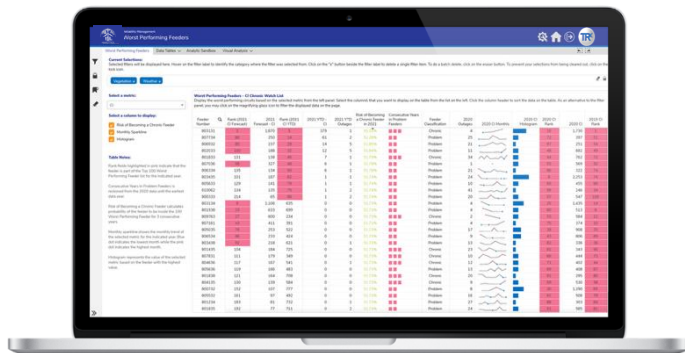
1

Use the **Analytic Sandbox** for deep dive analyses using countless combinations of chart types, metrics and filtering. In the below example, we are trying to gain more insight on weather and vegetation caused outages.



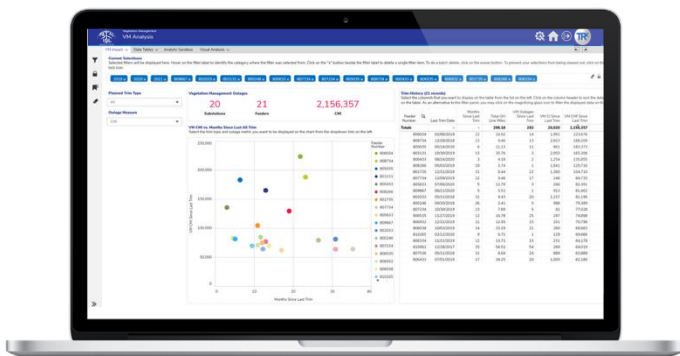
2

Analyze and Sort Circuits on **Worst Performing Feeders** criteria. In the below example, we are again focusing on only weather and vegetation caused outages and have identified circuit 803131 as a problematic feeder requiring further investigation.



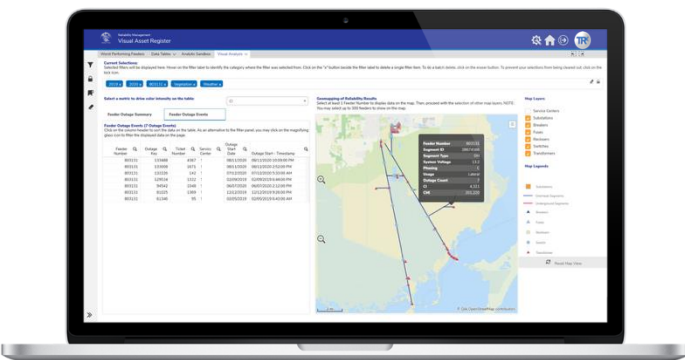
3

The **VM Analysis** screen provides us some additional insight on Feeder 803131. We can see that the last trim was on 13 months ago, yet this circuit is the 4th worst based on CMI since last trim.



4

We can further use drilldown mapping for Feeder 803131 in the **Visual Asset Register** to see individual vegetation and weather caused outage events and the location/design of the circuit.





## Provide **ACCURATE** weather-related outage predictions using real-time forecasts:

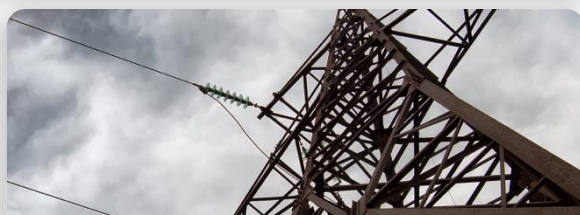
- Real-time weather forecasts, triangulating data from multiple weather stations, used to create asset localized wind direction, speed, gusts, temp, precipitation, etc.
- Modeling based on 10+ years of outage and weather data from closest weather stations to identify conditions when each outage began and document system response to various storm events / parameters at a circuit and segment level.
- Asset Age and characteristic analysis included to identify assets most susceptible to weather (e.g., pole type, size, age, and condition, and host/guest loading.)
- Advanced statistical modeling and machine learning used to retrain/ automatically update the underlying algorithms as new data becomes available.



Leverage your favorite source for **real time weather projections** with automated outage model simulations based on those projections. Automatically generate **alerts based on projected outages and locations**.

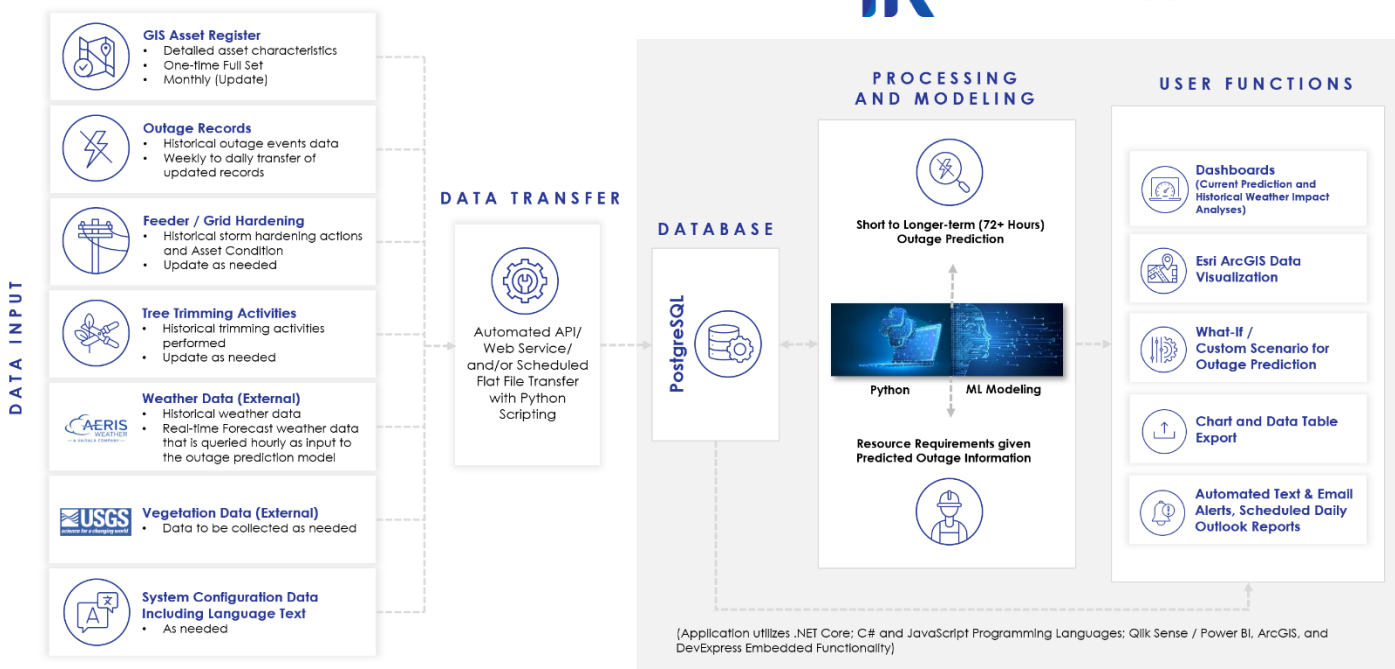


**Reduce overtime costs and eliminate unnecessary truck rolls** by forecasting the likely number and location of outage events on each circuit and **pre-mobilizing crews and materials** to safe locations.



**Reduce CAIDI and SAIDI** for the majority of smaller storms experienced each year. **Model danger tree caused storm failure probability** as a function of tree age, species, growth and weather conditions (wind speed, direction, prior period rainfall, etc.) **and effects on adjacent line segments/ circuits.**

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## ABOUT TR<sup>x</sup>

*"TRANSMISSION RELIABILITY EXCELLENCE"*

Our solution helps executives, managers, and reliability engineers to manage key metrics and essential data. The Emergency Response Module utilizes the latest modeling techniques along with detailed historical and real-time outage and weather data to predict outage locations and severity, allowing companies to mobilize crews and materials to safe locations ahead of the storm, saving time and money and reducing restoration times (CAIDI).

## WHY INFRASHIELD LABS

We pride ourselves on being a strategic partner - external experts / consultants with broad industry experience in helping utilities adapt and drive sustainable change and performance gains across their business. Data scientists in our analytics & tool dev center use machine learning / AI to embed our strong operating expertise into advanced decision support tools that eliminate 70-80% of the analyst work required to get answers.



"InfraShield Labs' TR<sup>x</sup> platform helped advance our efforts to accurately predict outage damage locations/sites from incoming weather. That was a key enabler of securing field organization buy-in for changes to our storm preparation process. The UMS team was very knowledgeable and easy to work with."

– Senior Manager Asset Analytics, Large southern electric utility



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