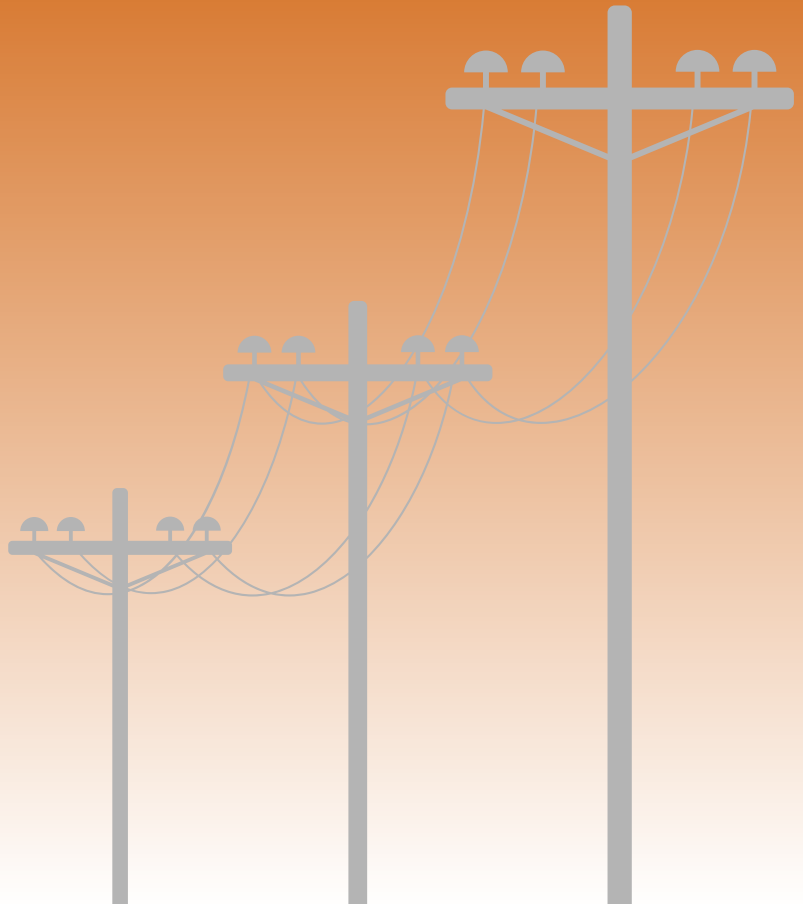
Power Outages

EDISON INTERNATIONAL® x MISSA Business Technology Network



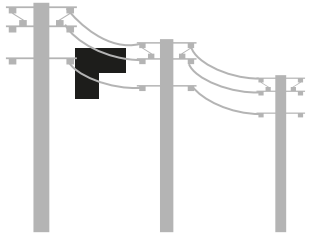
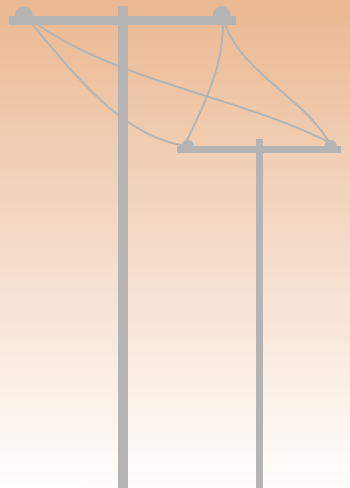


Table of contents

01

Background



Negative Impact of Power Outages

Black-outs cause significant

Health Risks

(Lack of heating & cooling, interruption to healthcare facilities, patients in critical care, food and water safety)

One black out can cost the U.S Economy

$150 billion

annually ("Bloom")

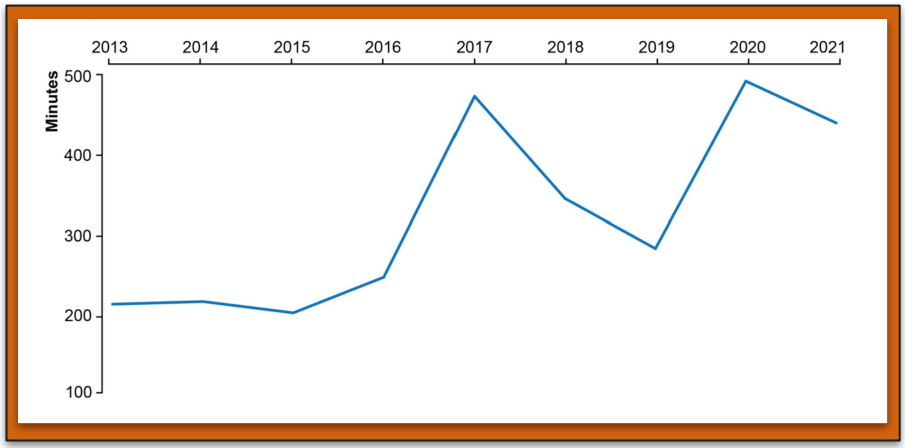
Black-outs risk

Safety and Security

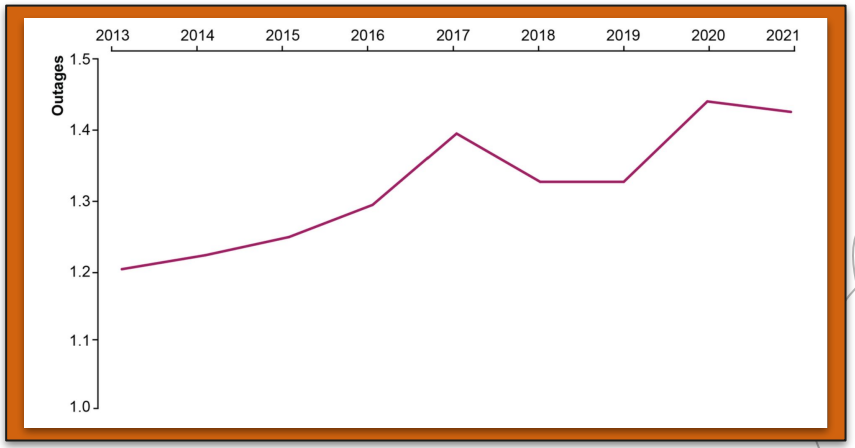
(Impair lighting and security systems, increasing risks of accidents and crime.)

Power Outage Trends Over the Years

Average Duration of a Power Outage

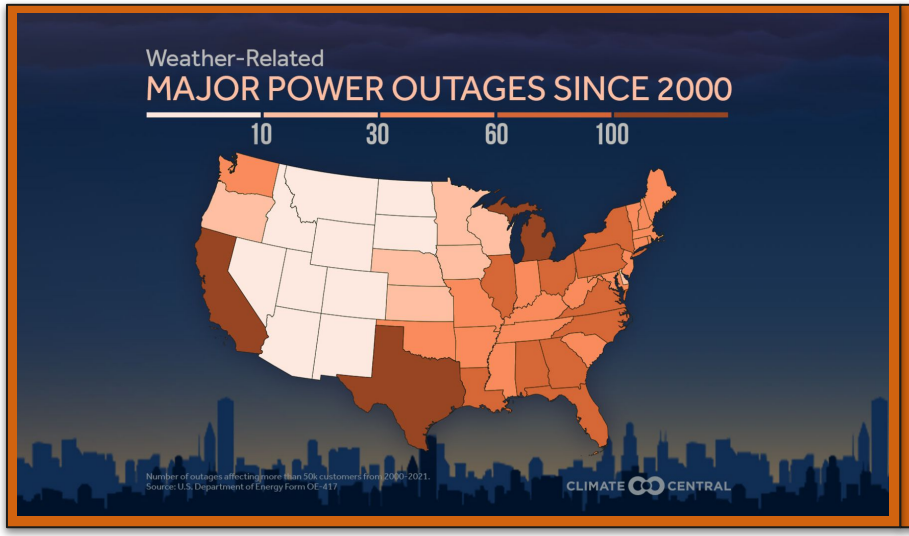


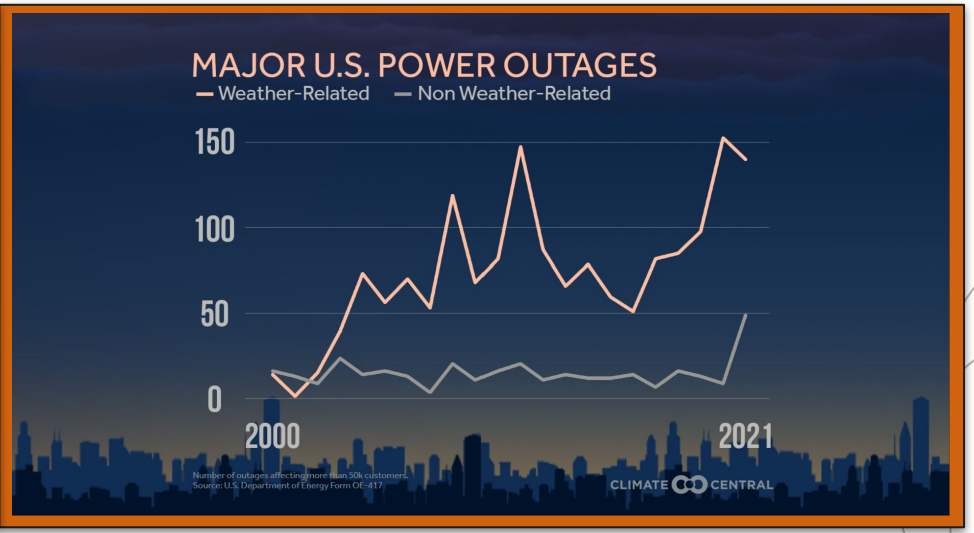
Average Number of Outages for a Customer



Credit: June Kim; Source: Reliability Metrics of U.S. Distribution System, U.S. Energy Information Agency

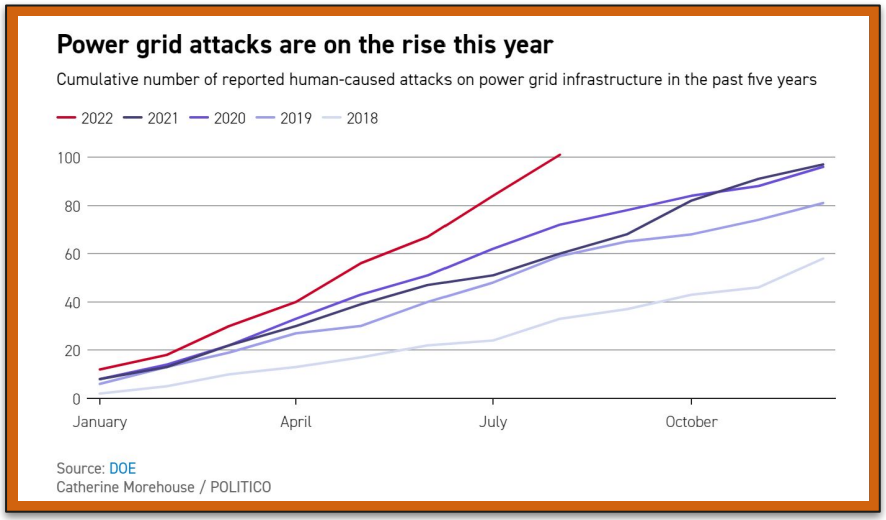
Weather-Related Power Outages

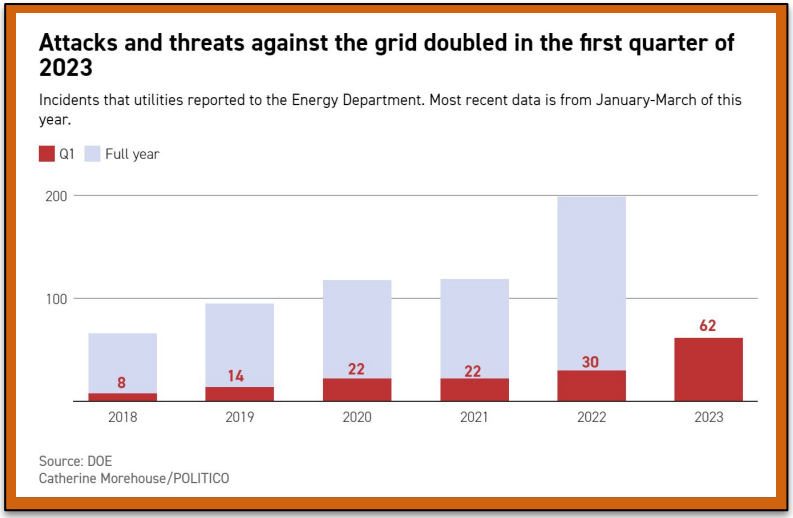




"Between 2011 and 2021, there was a **significant increase** in the average annual number of weather-related power outages across the U.S., and similar trends have been observed in California ("Surging", 2022)".

Vandalism-Related Power Outages





"Grid attacks that led to power outages increased **71 percent** from 2021 to 2022. That increase was primarily due to a rise in gunfire assaults against critical infrastructure (Morehouse, 2023)."

SWOT ANALYSIS

STRENGTHS

- High investment in power outage prevention
- Planned maintenances to spot potential vulnerabilities
- Advanced data collection methods

WEAKNESSES

- Aging infrastructure
- Customer satisfaction issues
    - *Net Promoter Score* is -28 (on a scale from -100 to 100)

OPPORTUNITIES

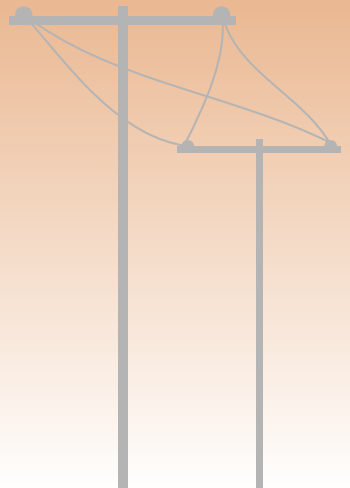
- Technological Advancements
    - Predictive analytics
    - Advanced weather forecasting
- Grid Hardening and Resilience
- Enhanced Security and Surveillance

THREATS

- Climate Change
    - Increase in severe weather
        - Wildfires, rainstorms, floods
- Increase in crime
    - Vandalism
        - Damage to power lines and transformers

02

Problem Statement



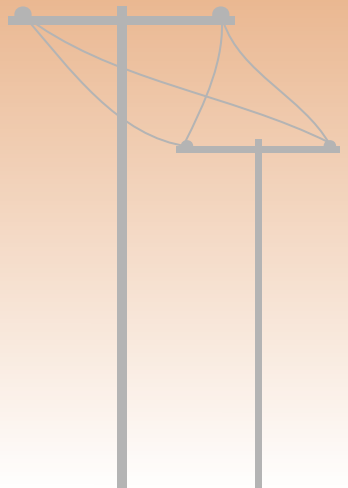
Problem Statement

Southern California Edison **must address** the escalating frequency of power outages, intensified by severe heat waves, rainstorms, and rising instances of vandalism.

Our goal is to leverage machine learning and data analysis to enable SoCal Edison to rapidly **identify** the outage type and **expected duration** of a power outage.

03

Severe Weather



Weather-Related Power Outages

AUTUMN

- Strong Winds (Santa Ana Winds)
- Wildfire Risk

WINTER

- Severe Storms
- Landslides
- Increase of Natural Gas Prices / Shortage of Natural Gas

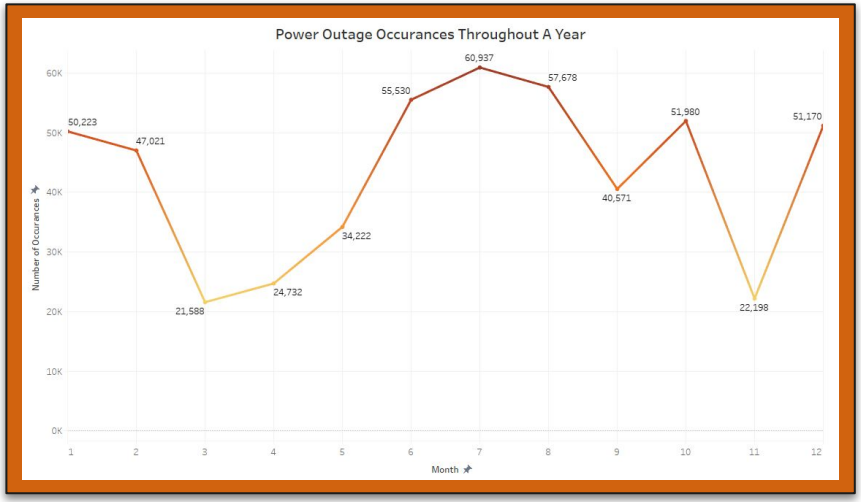
SUMMER

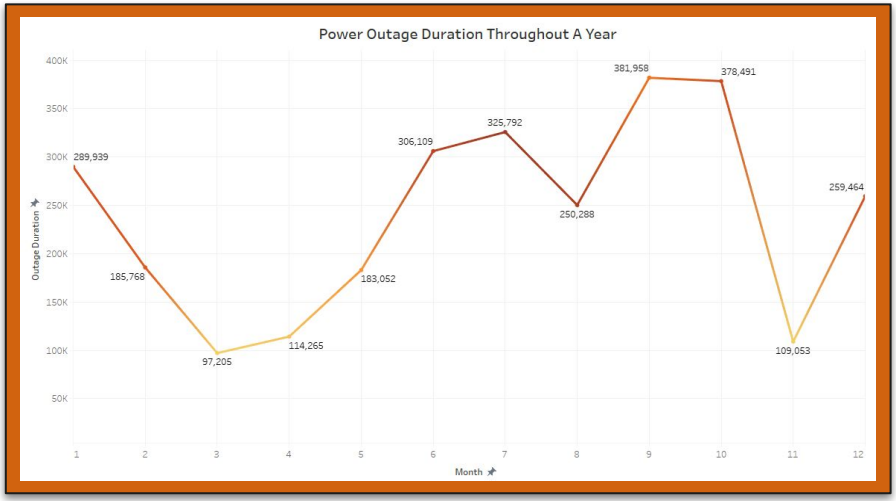
- Extreme Heat
- Wildfires
- Dry Air

SPRING

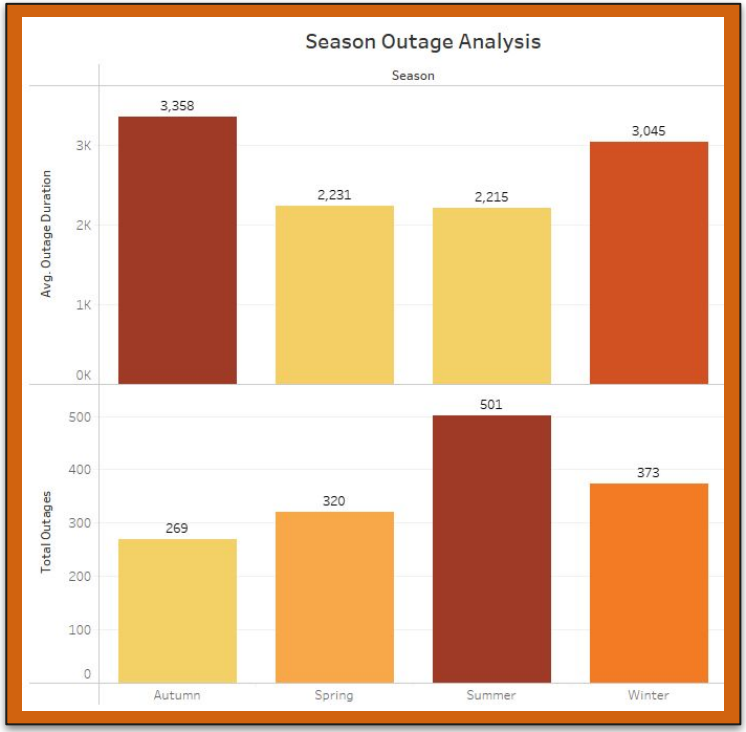
- Moderate Rains
- Brush Fire Risk
- Temperature Fluctuations

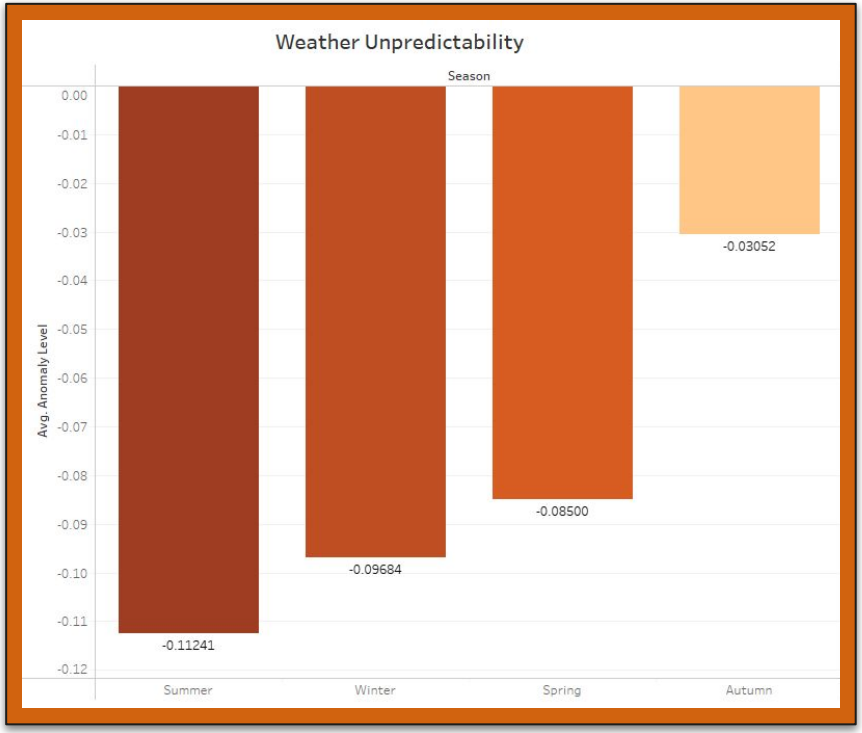
Outages Throughout a Year



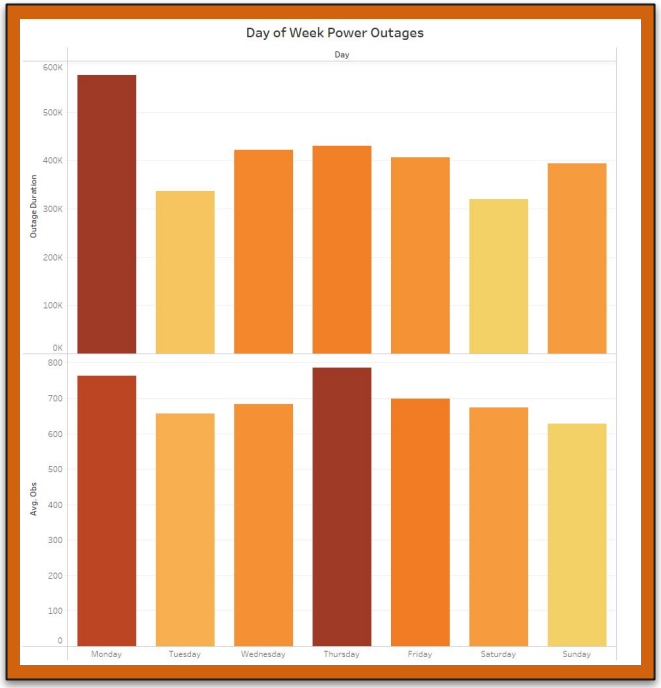


Seasonal Analysis





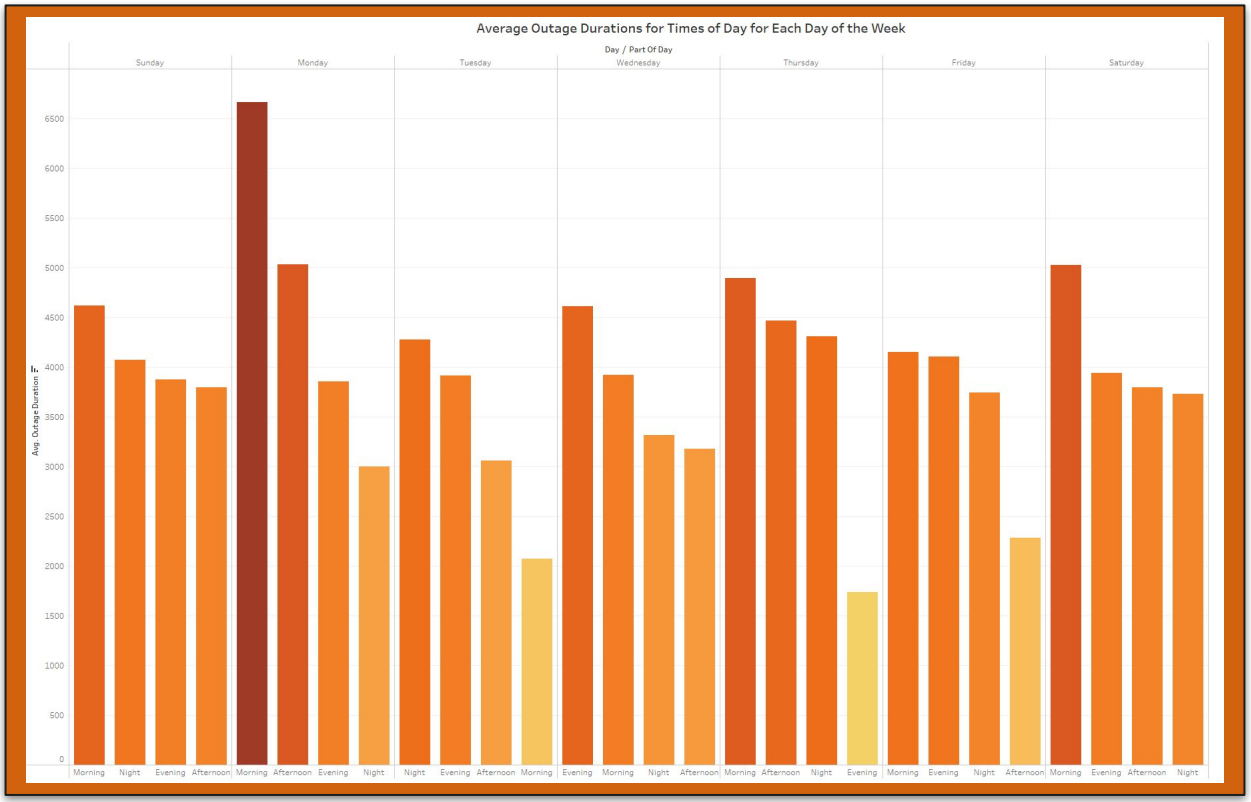
Outages Throughout a Week



Outage Duration Heatmap

Season	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
				Day			
Autumn	5,680	5,268	5,717	5,618	6,120	4,567	7,944
Spring	2,555	4,264	3,496	3,653	2,909	2,233	3,794
Summer	2,961	5,299	2,968	2,570	2,526	3,051	2,713
Winter	4,473	3,287	2,665	2,939	4,682	4,583	4,246

Outages Throughout a Day/Week



Yearly/Seasonal Key Insights

Most Severe

Fall
(Sep-Oct)

Higher Number of Outages
Longest Outage Durations
Most Predictable

Most Frequent and Unpredictable

Summer & Winter

Highest Number of Outages
Shorter Outage Durations
Least Predictable

Least Affected

Spring

Low of Outages
Shortest Outage Durations
Average Predictability

Severity = Outage Duration
Risk = Number of Outages

Key Insights by Day/Week

Highest Risk and Severity

Monday

Highest Number of Outages

Highest Severity

Low Risk

Tuesday & Saturday

Low Number of Outages

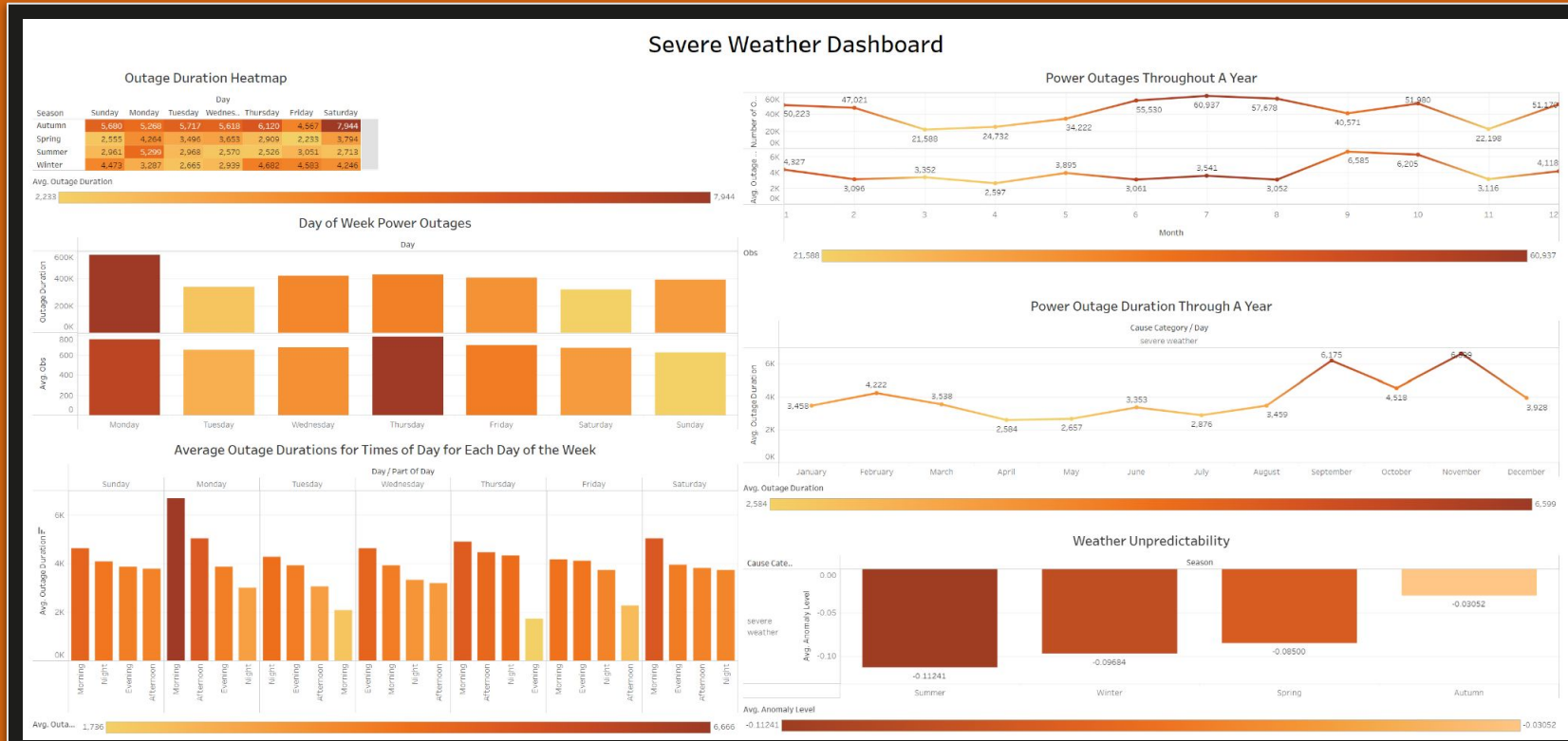
Lowest Severity

Most Severe

Thursday

Longest Total Outage Duration

High Number of Outages



Click the image to view the full dashboard

Our Predictive Model

Logistic Regression Model

What does it do?

Predicts whether an outage was caused by **severe weather** or **not**.

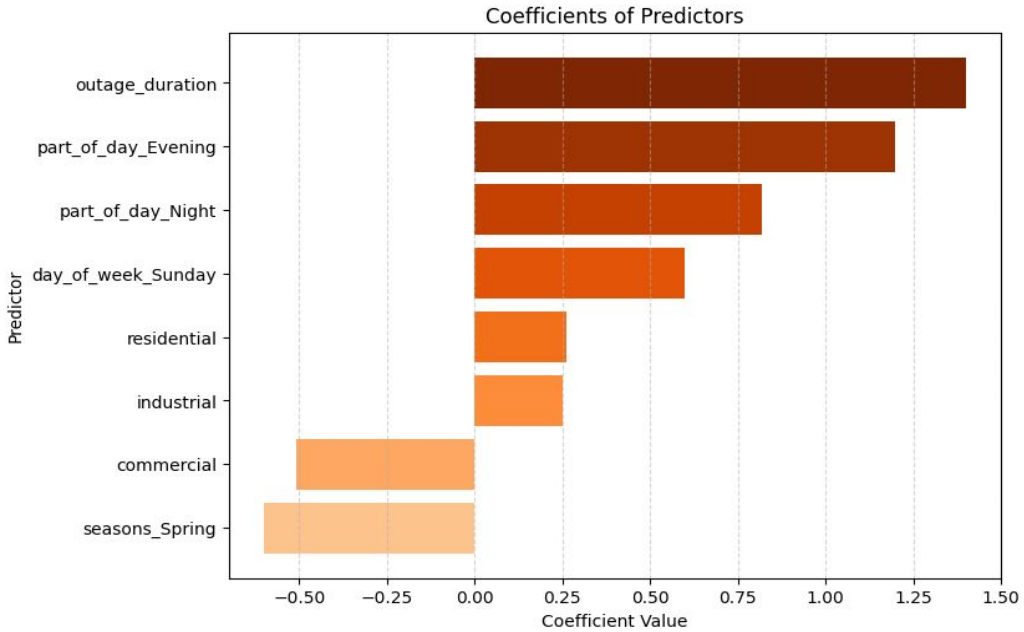
How does it work?

Calculates probability based on feature coefficients for any given outage.

$$h\theta(X) = \frac{1}{1 + e^{-(\beta_0 + \beta_1 X)}}$$

- Probability >= 0.5
  - Classification: Severe Weather
- Probability < 0.5
  - Classification: Not Severe Weather

Logistic Regression Model - Coefficients



76% accuracy

Demo

A power outage has occurred and you want to know if it was caused by severe weather

Features

- INTERCEPT:
  - 0.00584248
- Outage Duration
  - 3
- Night
  - YES (1)
- Commercial
  - -2
- Residential
  - 2.4
- Industrial
  - 0.3
- Sunday
  - YES (1)
- Spring
  - YES (1)

All values are normalized
"Dropped" values are represented in the intercept (EX: Weekday)

Calculation

$$p = \frac{1}{1+e^{-7.12584248}}$$

=

0.999221562009

=

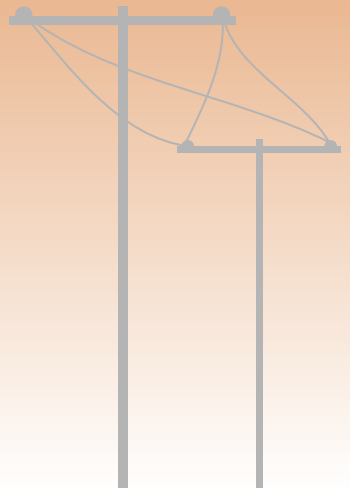
There is a 99.92% chance this power outage was due to severe weather

Action Plans

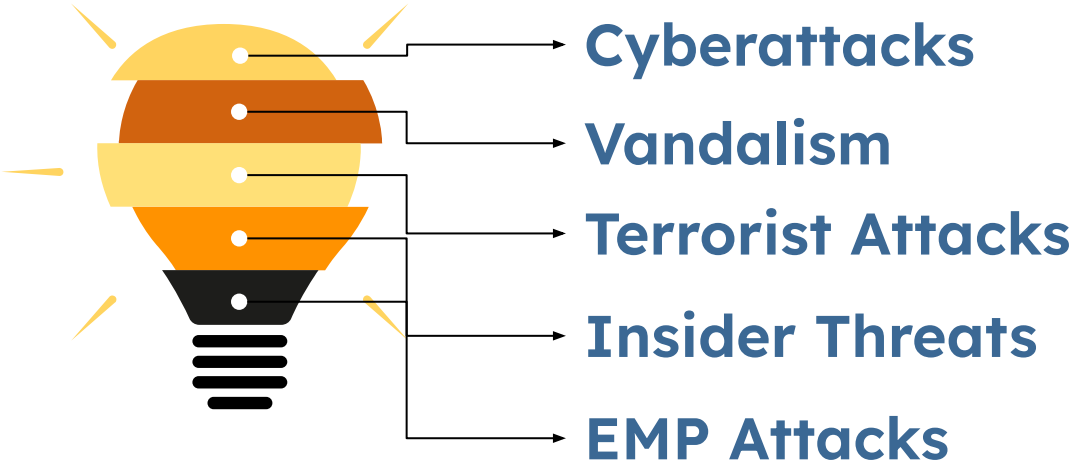
- **Strengthen** grid infrastructure like transformers, power lines, and other components.
- **Improve** weather forecasting and response time to existing outages.
- **Educate** the general public on the potential outages posed by severe weather.

04

Intentional Attacks

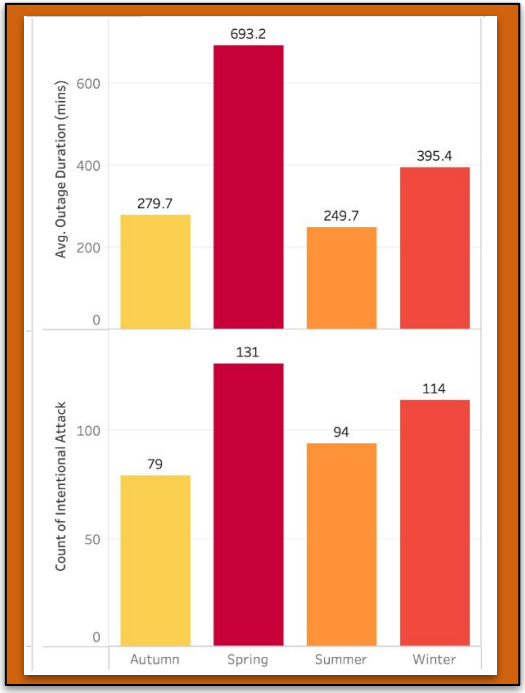


Types of Intentional Attacks

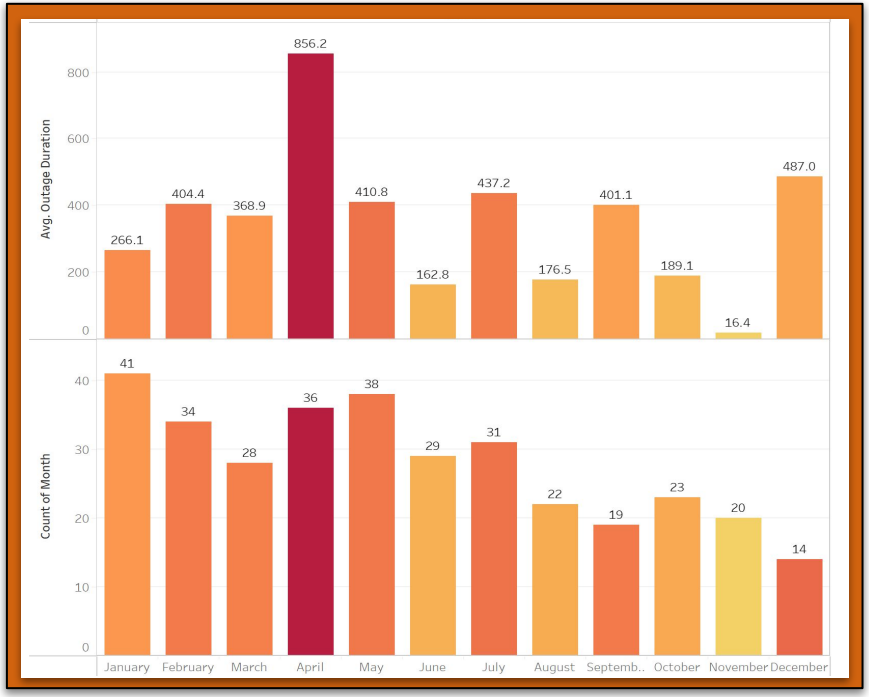


Number of Outages and Duration Time Throughout a Year

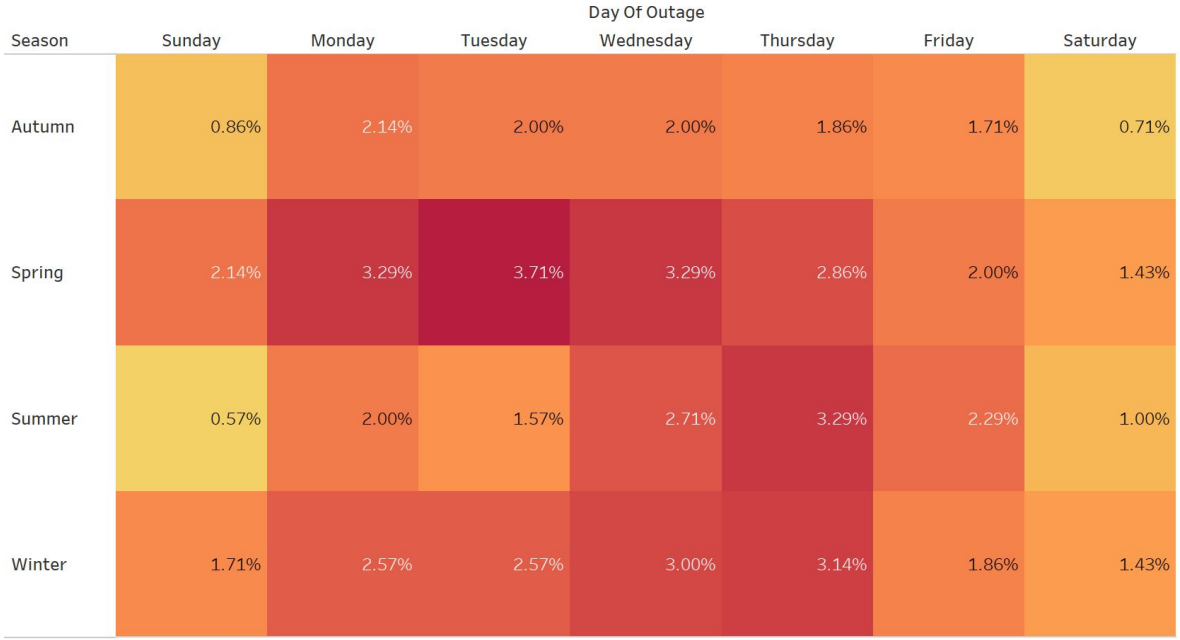
Season

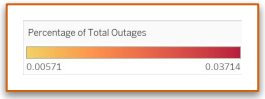


Monthly

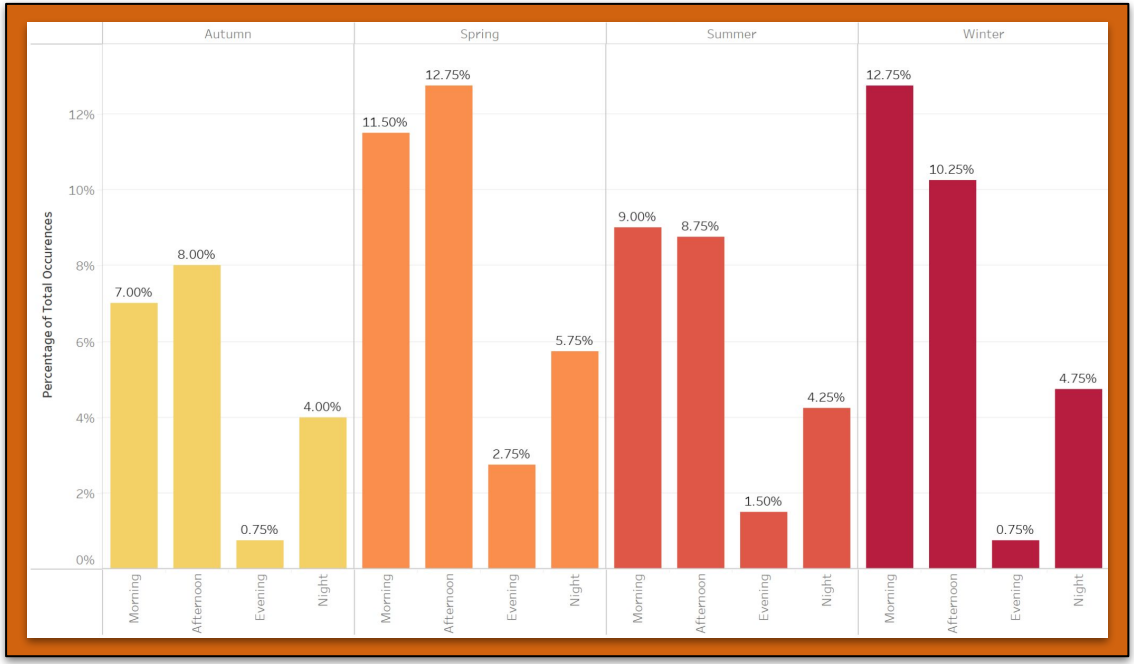


Percentage of Outages Throughout a Week for Each Season





Percentage of Power Outages Throughout a Day for Each Season



Key Insights

Severity = Outage Duration
Risk = Number of Outages

Spring

Most Severe, Highest Risk

- **Longest Outages**
- **Most Outages**

Highest Risk Months
→ April & May
Highest Risk Days
→ Mon - Thurs
Highest Risk Time of Day
→ Morning - Afternoon
Most Severe Month
→ April

Winter

Moderate Severity, High Risk

- **Moderate Outage Duration**
- **High Amount of Outages**

Highest Risk Months
→ January to February
Highest Risk Days
→ Mon - Thurs
Highest Risk Time of Day
→ Morning - Afternoon
Most Severe Month
→ December

Summer

Low Severity, Moderate Risk

- **Low Outage Duration**
- **Moderate Amounts of Outages**

Highest Risk Months
→ June - July
Highest Risk Days
→ Wed - Fri
Highest Risk Time of Day
→ Morning - Afternoon
Most Severe Month
→ July

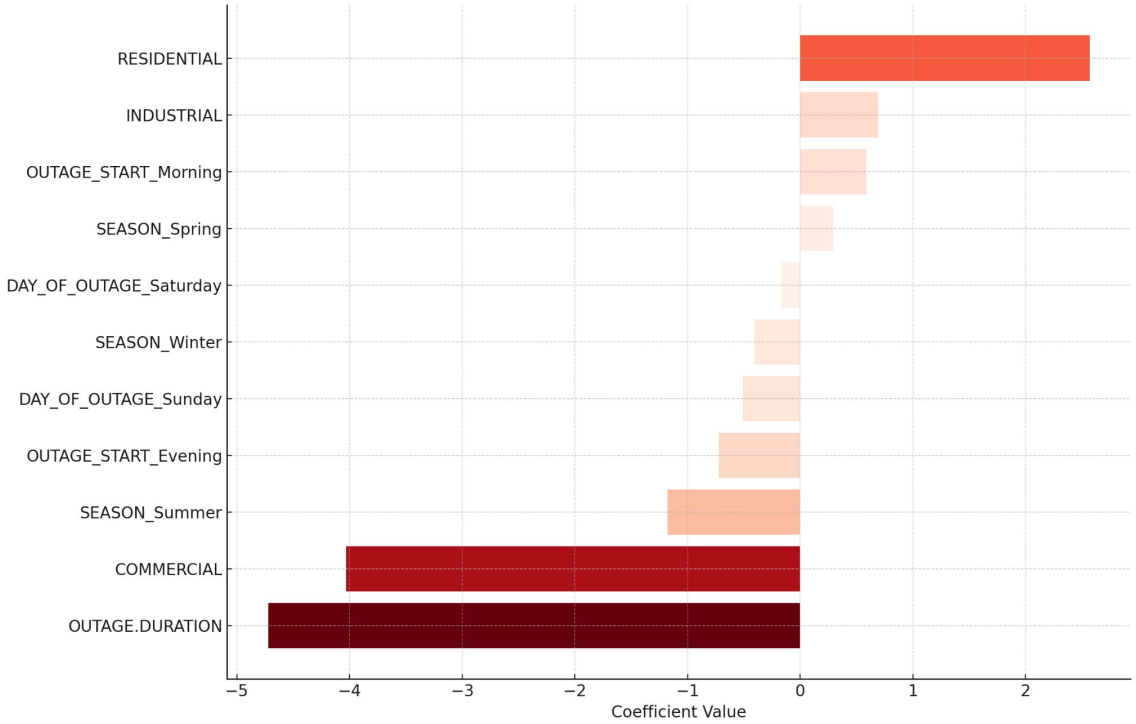
Fall

Low Severity, Low Risk

- **Low Outage Duration**
- **Least Outages**

Highest Risk Months
→ Aug & Oct
Highest Risk Days
→ Mon - Wed
Highest Risk Time of Day
→ Morning - Afternoon
Most Severe Month
→ December

Logistic Regression Model - Coefficients



intercept
-2.1151312129716024

82%
accuracy

Demo

A power outage has occurred and you want to know if it is an intentional attack

Features → Calculation → Action Plans

- **Outage Day - Morning**
  - YES (1)
- **Residential**
  - 2.3
- **Commercial**
  - -0.15
- **Industrial**
  - -0.15
- **Outage Duration**
  - -0.5
- **Spring**
  - YES (1)
- **Intercept**
  - –2.115

$$\hat{y} = \frac{1}{1+e^{-(-2.1151312129716024+0.586934+5.90453+0.292132+2.360861+0.0225+0.0225)}}$$

=

0.99916

=

There is a 99.9% chance this power outage was caused by an intentional attack

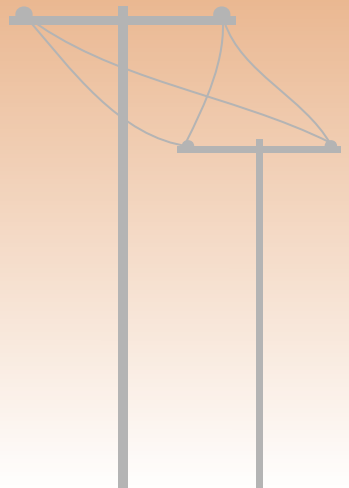
- **Quickly** inform law enforcement & authorities
- **Rapid** resource deployment
- **Swiftly** notify citizens of safety concerns

Intentional Attacks Dashboard

Click to view our dashboard

05

Predicting Power Outage Duration



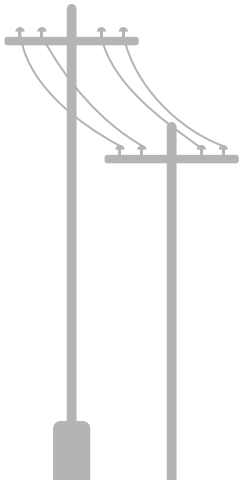
Why This is Important

Prevention

- **Adjusts over time** based on new data
  - See current factors that cause the long power outages
    - ➔ Understand how to prevent long outages based on those factors

Rapid Response

- **Identify** longer outages and allocate resources quickly
  - **Prioritize** critical outages for immediate action
- Quickly inform **customers** how long the outage will last

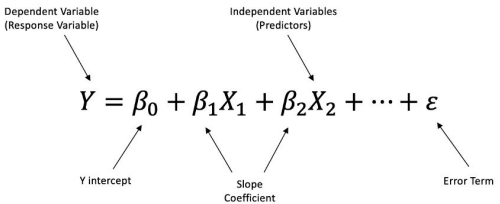


How Can We Predict Power Outage Duration?

Multiple Linear Regression Model

What does it do?

Predicts how long an outage will last based on a power outage's attributes

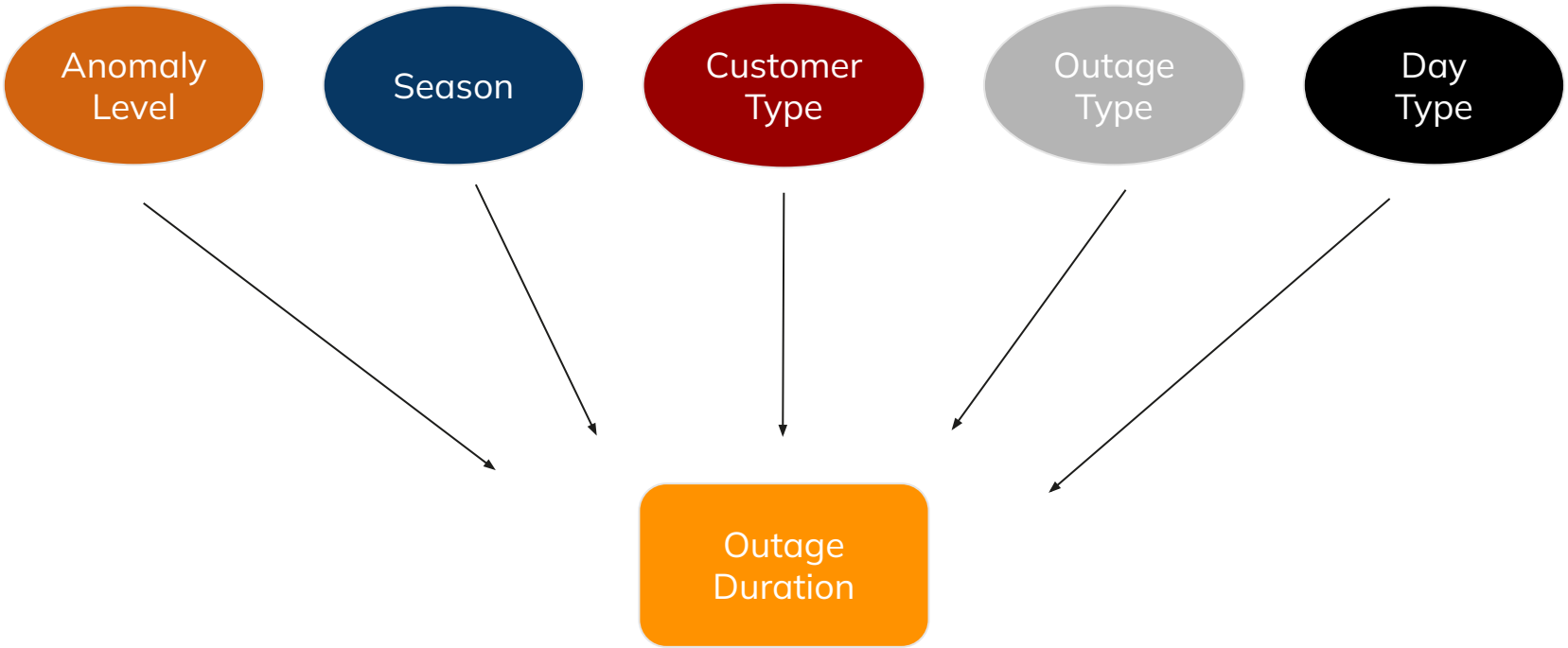


How does it work?

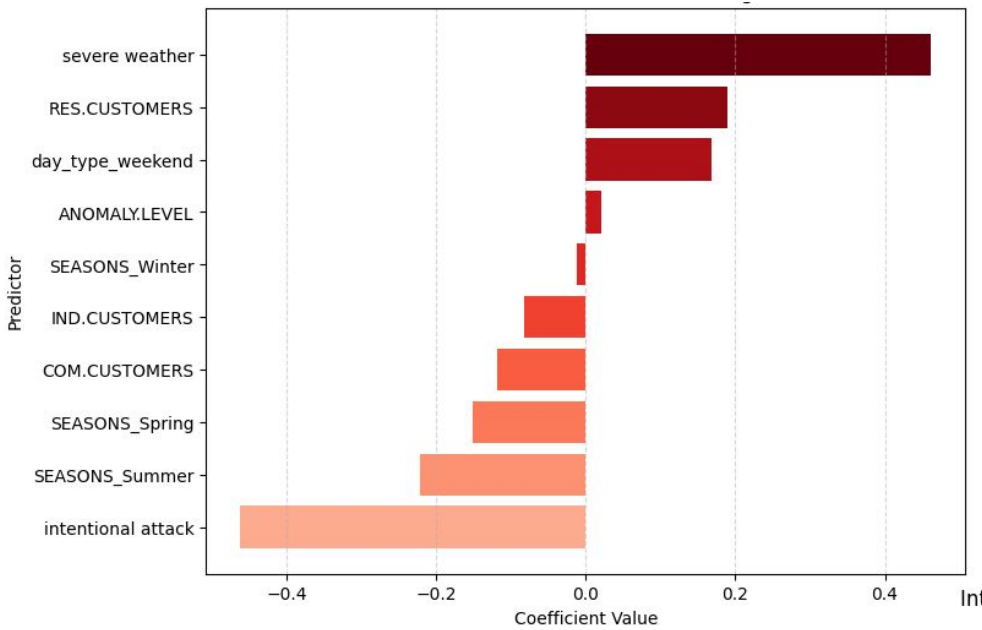
Each **unique attribute for each factor is given a coefficient** that shows how much it affects the outage time.

The **coefficients are** combined and multiplied by the values of the attributes to give an estimated duration of the power outage

Our Factors


Anomaly Level
Season
Customer Type
Outage Type
Day Type
Outage Duration

MLR Model - Coefficients



Intercept: -0.061323153715508

- Coefficients are Normalized
  - Range is Between -3 and 3

Demo

A power outage has occurred and you want to know whether it will be short or long

Features

- **Intentional Attack**
  - YES (1)
- **Anomaly Level**
  - -0.1
- **Number of Commercial Customers in the Area**
  - 0.5
- **Number of Residential Customers in the Area**
  - -0.2
- **Number of Industrial Customers in the Area**
  - 0.1
- **Spring**
  - YES (1)
- **Weekend**
  - YES (1)

All values are normalized
"Dropped" values are represented in the intercept (EX: Weekday)

Calculation

$$y = (1 \times -0.461527) + (-0.1 \times 0.020233) + (0.5 \times -0.1181) + (-0.2 \times 0.189174) + (0.1 \times -0.083097) + (1 \times -0.151216) + (1 \times 0.168216) + -0.061323153715507714$$

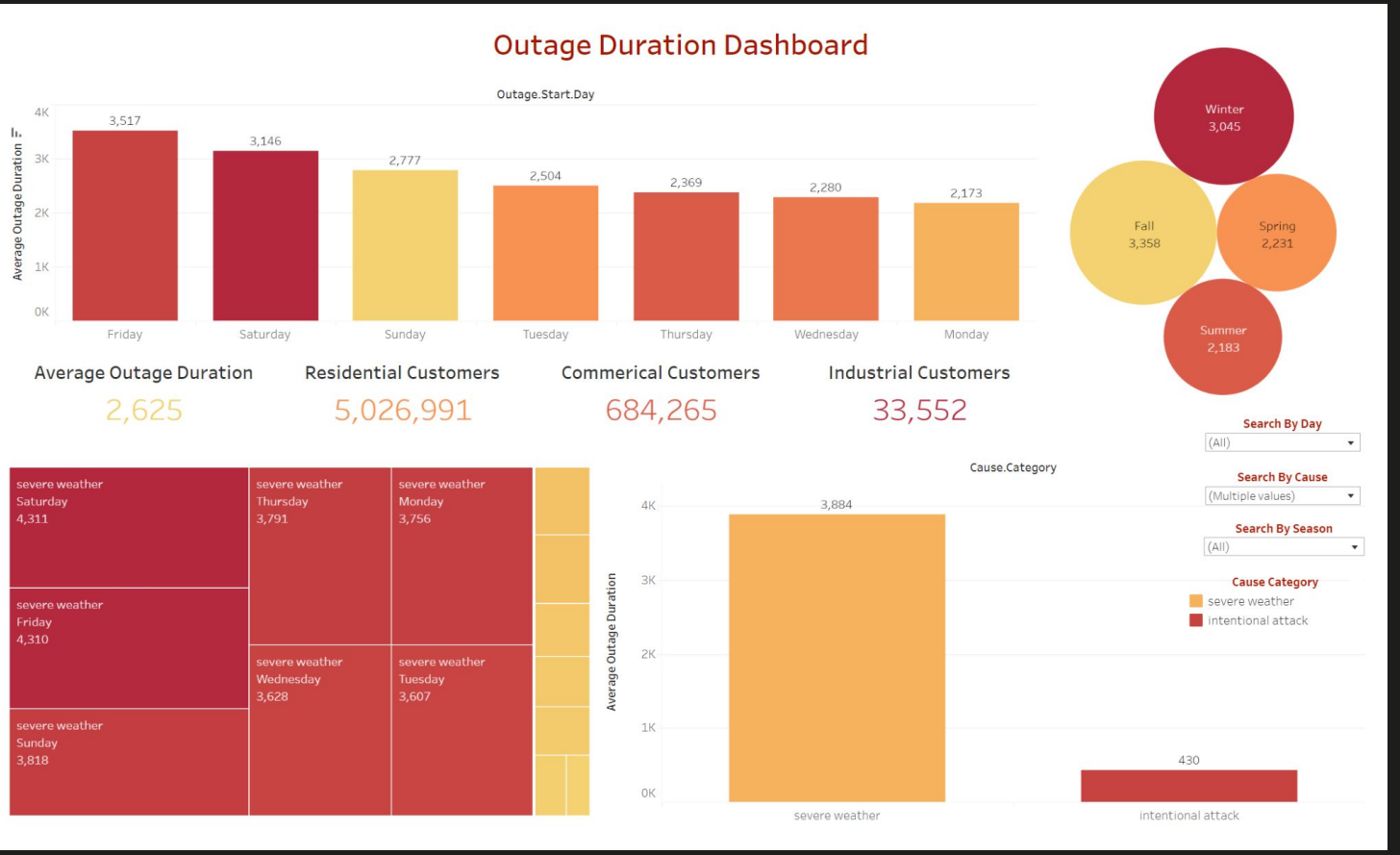
=

-0.614

Action Plans

- **Reassure** customers that it will be a short outage
- **Prioritize** longer, more serious outages
- **Quickly identify** features for rapid resource deployment

Click to view our dashboard



Key Insights

Cause Category

Severe Weather

Biggest impact on power outage time

Day of the Week

Weekends

Friday, Saturday, and Sunday have the longest outages

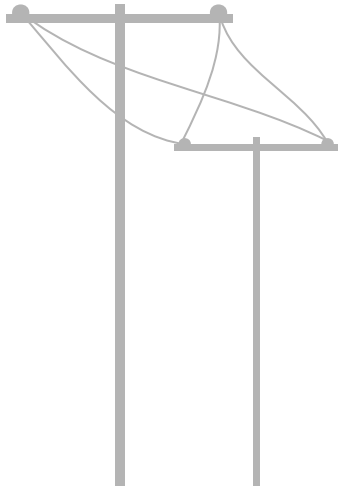
Season

Fall

Power outages are **longest** in the Fall

06

Recommendations



Outage Duration

Weather Resistance

Reinforce infrastructure to protect against severe weather.

Weekend Maintenance

On weekends, maintenance will stay ready for repairs during outages.

Annual System Upgrades

Upgrade/upkeep infrastructure in preparation for Fall outages.

Surround Residential Areas

Maintenance will reside near residential areas to stay ready for outages.

Severe Weather

Upgrade Equipment

Prevent outages from outdated or eroded equipment.

Maintain Staffing

Keep enough staff on hand during high risk time to respond to potential outages quickly.

Monitor Conditions

Use forecasted measurements to predict when weather events may impact equipment, and prepare appropriately.

Seasonal Testing

Continuously test the resilience of equipment and response times of crews to reduce potential outage time as much as possible.

Intentional Attacks

Seasons to Watch Out For

Spring

Winter

Month to Watch Out For

Increase vigilance in April

Time of Day to Watch Out For

Mornings and Afternoons

Least Susceptible Months

Fall

Thank you for listening!

View our Project Code Here:

Logistic Regression - Severe Weather Code

Logistic Regression - Intentional Attacks

Multiple Linear Regression - Outage Duration Code

Click each one to view our entire code

GitHub

Works Cited

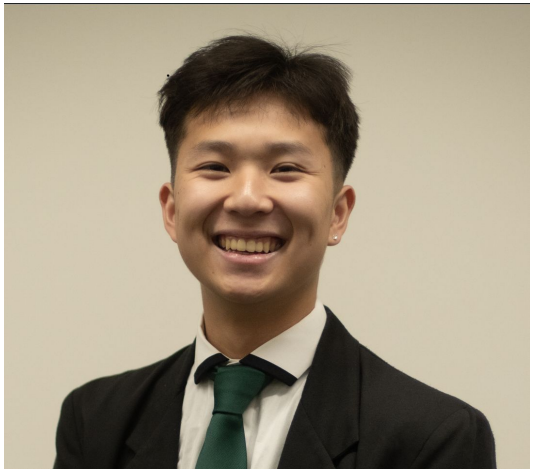
"Bloom Energy Outage Map." Bloom Energy, Bloom Energy Corporation, accessed April 21, 2024, https://www.bloomenergy.com/bloom-energy-outage-map/.

Morehouse, Catherine. "Power Grid Attacks Surge to New Peak." POLITICO, POLITICO, 10 Sept. 2023, www.politico.com/news/2023/09/10/power-grid-attacks-00114563.

"Surging Weather-related Power Outages." Climate Central, 13 Sept. 2022, climatecentral.org/climate-matters/surging-weather-related-power-outages.

Meet the Team!

Dylan Ton



Project Manager

- 3rd year Computer Information Systems Major
  - Incoming Product Analytics Intern @ MyFitnessPal

Career goals:

- Work at a FAANG Company in the Data Science Field

Kevin Yuen

Data Analyst

- 3rd year Computer Information Systems Major
- 2023-2024 Member of Data Analytics @ MISSA
- Incoming Director of Membership @ MISSA

Career goals:

- Become a Data Analyst or Flight Analyst

Samyam Pyakurel

Data Analyst

- 4th year Computer Information Systems
- 2023-2024 Member of Data Analytics @ MISSA
- Process Improvement Specialist @ ASI CPP
- Platoon Leader @ United States Marine Corps Reserve

Career goals:

- Become a Data Analyst for a Government contractor company

Larissa Domingo

Data Analyst

- 4th year Computer Information Systems and Marketing Major
- 2023-2024 Member of Data Analytics @ MISSA
- 2022-2024 Secretary @ CPP Volleyball Sports Club
- Social Media and Marketing Assistant @ ASI CPP

Career goals:

- Become a Sports Data Analyst for a major professional sports team

Diego Cabral

Data Analyst

- 4th year Information Security & Forensics Major
- 2023-2024 Member of Data Analytics @ MISSA
- Experienced Tax and Immigration Professional

Career goals:

- Network Engineer / Information Security Analyst

Supriya Siwakoti

Data Analyst

- 4th year Computer Information Systems Major
- 2023-2024 Member of Data Analytics @ MISSA
- Experienced as a Tax Professional

Career goals:

- Become a Data Analyst

Nikhitha Vasiraju

Data Analyst

- 1st year Computer Science major
- 2023-2024 Member of Data Analytics @ MISSA

Career goals:

- Become a Data Analyst