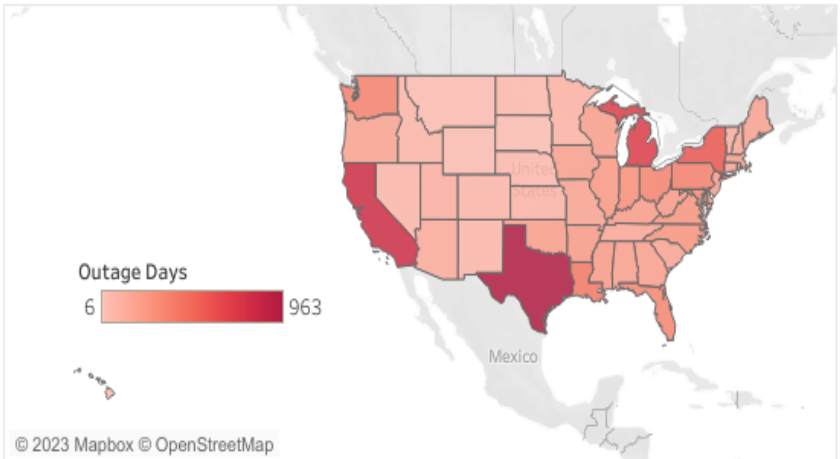
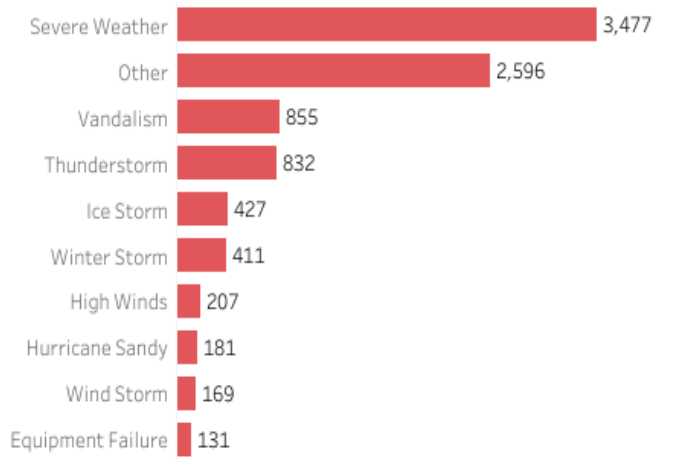
US ELECTRIC GRID OUTAGES

Average Outage Duration	Total Outage Days	Total Customers Affected	Total Demand Loss (MW)
16:04:17	10,724	292M	1.2M

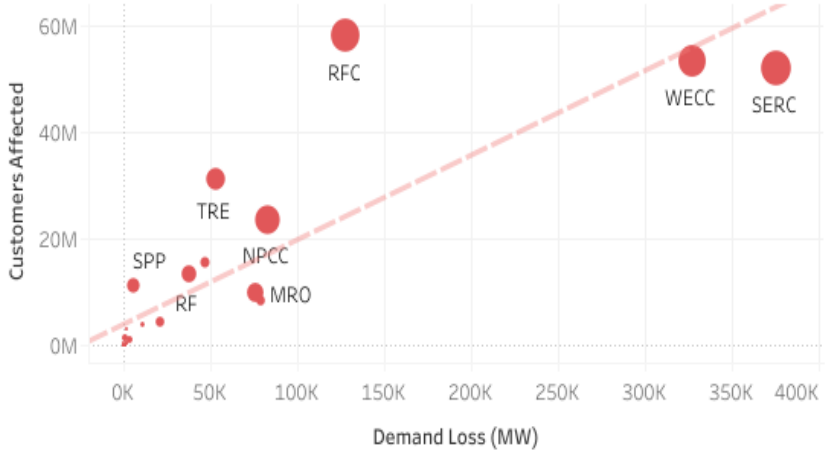
Outage Days per State



Outage Days per Disturbance



Customers Affected vs. Demand Loss



Outage Days per Year

Outage Days per Hour

Abstract

- I played the role of a Senior Analytics Consultant for the US Department of Energy
- My task was to analyze power outage data from 2002-2023 to do the following:
  - Determine patterns and trends around power outages across the United States.
  - Quantify their impact on communities.
  - Identify possible weak points in the grid.
- The scope of my analysis was done at the state level.
  - I did not analyze any specific cities and geographic locations.
- I cleaned the raw data using Power Query.
- I built a dashboard using Tableau that summarized the following:
  - Power Outages by state, disturbance, year, and hour.
  - Customers Affected vs. Demand Loss per NERC region.
- I have uploaded all the files for this project onto my GitHub.

Data-Cleaning Strategy

- I am working with unstructured data for this project.
- There were sheets for each year of outage data.
- My goal was to combine all the data in each sheet into one table.
- The tables had different column names.
  - I consolidated all the tables to the same column names and added some calculated fields.
- The table had several null values and inconsistent date formats.
  - I removed completely null rows.
  - I made the dates have consistent formats.
- I removed the extra text in all numeric values.
  - Approx, peak, etc.

Assumptions

- Some data had null and confusing values.
  - I assumed a user error in recording these power outage logs.
    - I filtered out these power outage logs to avoid any uncertainties in my analysis.
  - I assumed zero for these lost power and customers affected values.
  - I assumed “unknown” for these types of disturbances.
- Some numeric values had ranges.
  - I assumed the average value of the bounds for interval ranges.
  - I assumed the smallest value for ranges that are over a number.
  - I assumed the largest value for ranges that are under a number.
- Some areas affected had multiple locations listed.
  - To simplify my analysis, I assumed an equal distribution of the following:
    - customers affected
    - power outage wattage

Geographic Insights

- The following states experienced very long outage days.
  - Texas (963 days)
  - California (802 days)
  - New York (571 days)
  - Michigan (693 days)
  - Washington (355 days)
- Bible Belt and New England states experienced about 100 outage days on average.
- States along the Mid-West experienced less than 100 outage days on average.

Disturbance Insights

- Weather-related issues were the most frequent causes of power outages.
  - Severe Weather caused the longest outage days (3477 days).
- The following non-weather-related issues that caused significant power outages:
  - vandalism (855 days)
  - equipment failure (131 days)

Time Series Insights

- The number of outage days peaked during these years:
  - 2008 (655 days)
  - 2011 (874 days)
  - 2021 (855 days)
- The number of outage days peaked during these times:
  - 8 AM (651 days)
  - 4 PM (794 days)
  - 6 PM (770 days)

NERC Region Insights

- The customers affected and demand loss for each NERC region show a strong direct correlation (73%).
  - The total outage days tend to be larger for NERC regions with larger customer affected and demand losses.
- RFC, WECC, and SERC had the largest customers affected, demand loss, and outage days.
- SPP, RF, and MRCO had the lowest customers affected, demand loss, and outage days.

Recommendations

- Prioritize power restoration in states along the coast.
  - Hurricanes tend to land in these areas of the country.
  - According to my analysis, these areas will likely have the longest power outages.
- Prioritize power restoration during the morning and afternoon hours.
  - These hours had the longest outage days, so this is when the longest power outages will likely occur.
- Be proactive on power restoration during hurricane season.
  - The worst hurricanes made landfall during the 2008, 2011, and 2021 seasons:
    - Hurricane Ike (2008)
    - Hurricane Irene (2011)
    - Hurricane Ida (2021)
  - These hurricane seasons saw some of the longest power outage days.