U.S. ELECTRIC GRID OUTAGE ANALYSIS

2002:2023

Presented to: Eng. Sherihan Ali

Project Roadmap

Project Objective

Data Cleaning

Data Modeling

KPIS

Calculation

Dashboard

Presentation
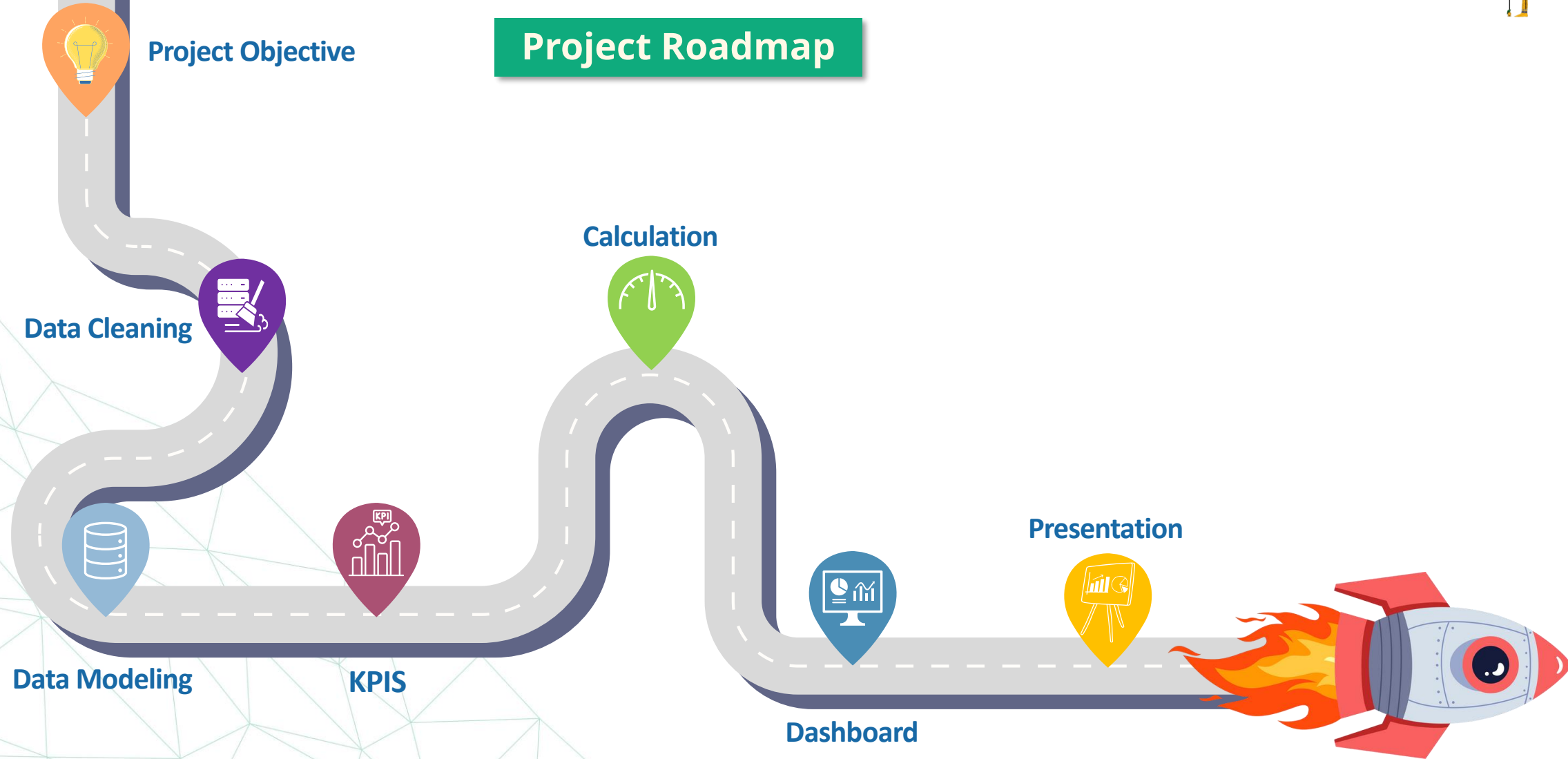
Project Overview

The dataset includes electric outage incidents in the U.S. power grid from January 2002 to July 2023, collected via Form DOE-417, with details on event times, locations, demand loss, and affected populations.

As Senior Analytics Consultants hired by the U.S. Department of Energy, the objective is to clean the data and create a Power BI dashboard that visualizes trends and key insights over 21 years of outage data, including summaries of events and impacts however, they used different systems within those years such as from 2002:2010 / 2011:2014 / 2015:2022 / 2023.
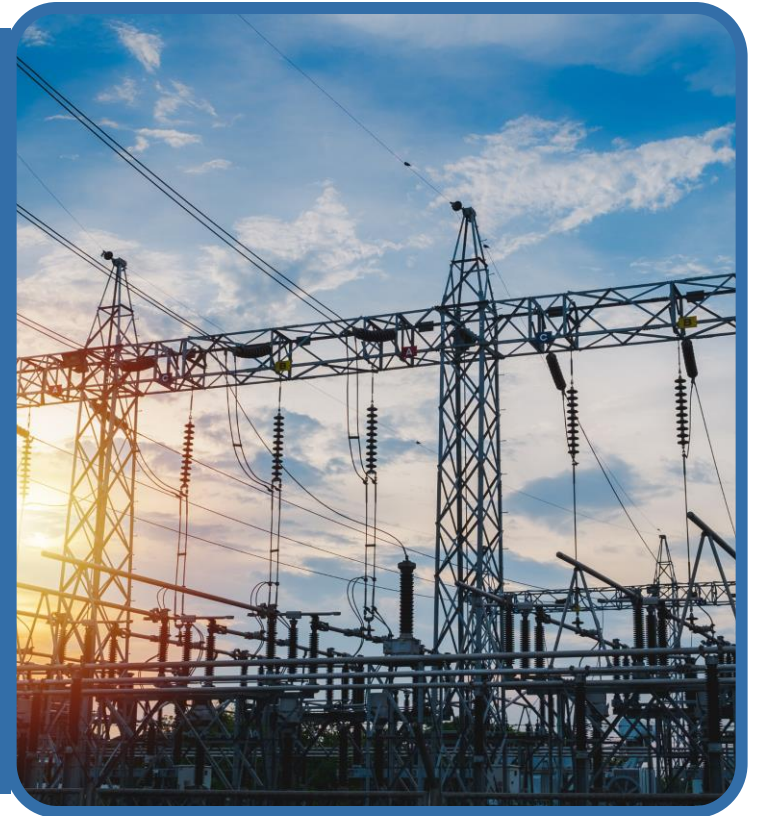
Project Objective

The goal of this project is to analyze event-level power outage data from 2002 to 2023 and provide insights to the U.S. Department of Energy (DOE).

By consolidating, cleaning, and visualizing the data using Power BI, the project aims to uncover patterns and trends in electricity outages, quantify their impacts on affected communities, identify potential weak points in the U.S. power grid, and also propose recommended solutions to help them in making data driven decisions.

Based on insights, actionable recommendations will be made to enhance grid performance, reduce outage durations, and improve communication strategies with affected customers during outages.

Project Idea

The objective of analyzing this dataset is to **evaluate the impact of electric outages** across various dimensions

and provide actionable insights to improve system resilience, operational efficiency, and customer satisfaction.

By examining outage trends, root causes, and restoration over time, the analysis objectives include:

1 Identify Key Outage Trends

Analyze historical power outage data to uncover patterns, frequency, and common causes of outages.

2 Understand Outlier Events

Investigate significant or unusual power outage incidents that deviate from normal trends.

3 Pinpoint Significant Event Types

Categorize outages by event type, such as weather-related, operational issues, or fuel supply issues to target root causes.

4 Quantify the impact on Customer

Assess the scale and duration of power outages and their effect on resident customers.

5 Identify the impact on Demand Loss

This includes understanding changes in demand patterns during outages and how they affect the grid's ability to manage capacity efficiently.

6 Provide Recommendations

Suggest solutions to improve grid performance, reduce outage durations, Advanced threat detection systems and speeds up response to attacks.

Problem:
With the rising demand for energy and increasing climate-related disasters, electricity outages pose a critical challenge to infrastructure resilience. The DOE has accumulated extensive data on power outage incidents but faces difficulties in deriving insights due to severe data quality issues, inconsistencies, and gaps in the dataset. This lack of clarity hinders timely analysis of outage trends, weak points in the grid, and the overall impact on the population.

Key Issues:
• Raw data contains numerous quality and integrity issues (inconsistencies, missing values, and unstructured formats).
• Difficulty in tracking long-term trends or pinpointing significant patterns in outage events.
• Inability to quantify the true impact of outages on demand loss and the affected population.
• Limited visibility into event types, duration, and other critical metrics across the years.
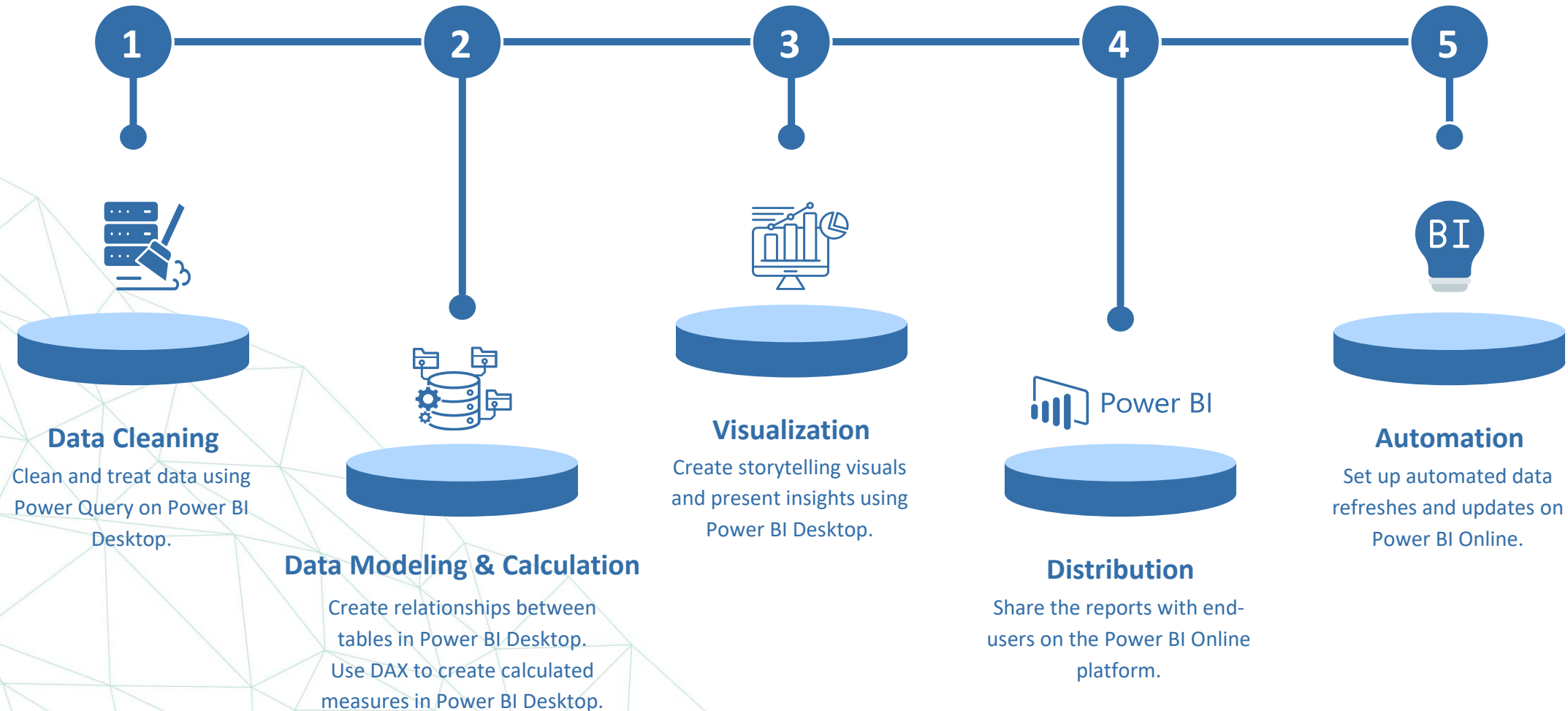
Proposed Solution:
Using Power BI, this project will:
• Clean and consolidate the raw event-level data from multiple files (Systems).
• Build a comprehensive dashboard to visualize trends in outages over time, highlight significant event types, and quantify their impacts.
• Identify and highlight outliers, anomalies, or special events that may skew the analysis.
• Provide clear insights into power grid vulnerabilities, along with any assumptions or alerts related to data quality issues.

Project Process

1 **2** **3** **4** **5**

Data Cleaning
Clean and treat data using Power Query on Power BI Desktop.

Data Modeling & Calculation
Create relationships between tables in Power BI Desktop. Use DAX to create calculated measures in Power BI Desktop.

Visualization
Create storytelling visuals and present insights using Power BI Desktop.

Power BI

Distribution
Share the reports with end-users on the Power BI Online platform.

Automation
Set up automated data refreshes and updates on Power BI Online.

Data Cleaning

Rows Cleanup

- Remove empty rows.
- Remove unnecessary rows (e.g., "null" values).
- Promote proper rows to headers.
- Replace values with standardized terms.

Columns Cleanup

- Filter Columns & Replace Values
- Exclude blank values in key columns (e.g., NERC Region, Date, Time Event Began).
- Extract month and year from the date columns.
- Rename columns for clarity and consistency.
- Remove unnecessary columns.
- Handling errors with "null" in relevant columns.
- Apply unique transformations for each year (2002-2023).
- Split datetime columns by delimiters to date and time columns.

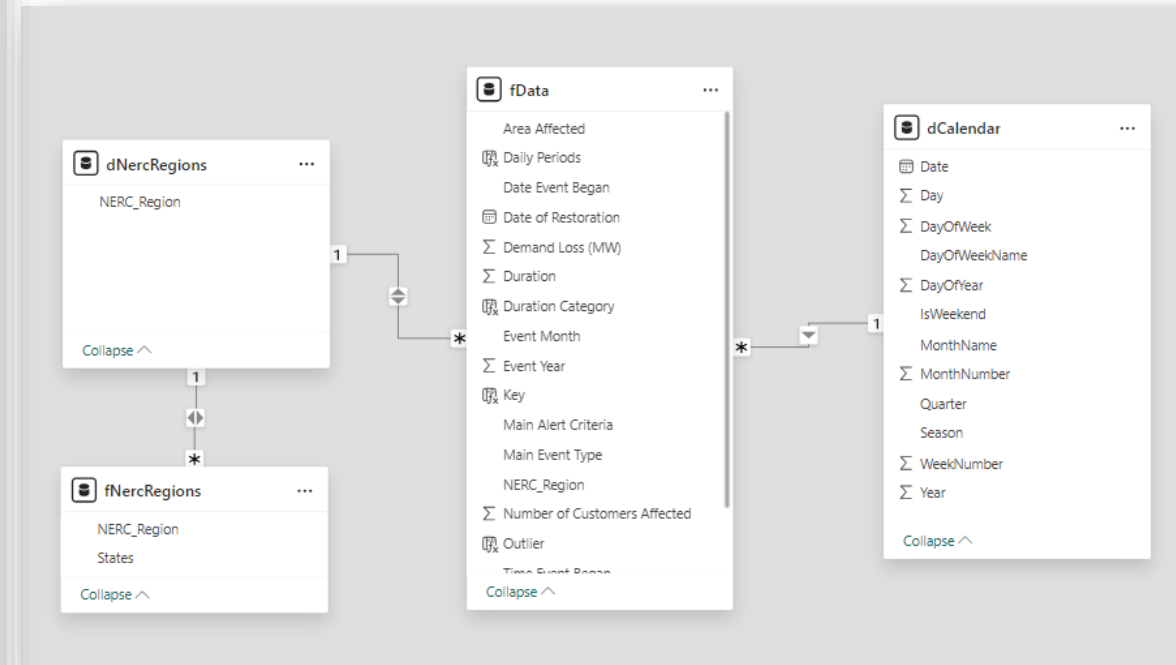## Post-Appending Cleaning Steps

- Update data types for columns such as Date and Time (Event Began, Restoration).
- Use conditional "IF else" logic for cleaning key columns (e.g., Date, Time, Customers Affected and Demand Loss).
- Categorize event types.
- Extract text before delimiter in Demand Loss.
- Ensure correct data types for all fields.
- Categorize alert criteria.
- Calculate duration column in days.
- Filter out invalid or negative values in event duration columns (12 Events).
- Replace invalid data in all columns.
- Remove duplicate rows or values
- Add custom columns for calculating durations in hours.
- Trim and clean NERC Region based on the latest standards.
- Remove unused or obsolete columns (e.g., old NERC Region, Event Type, Alert Criteria).

DAX SUMMARY

- #Events.
- #Main Event Type.
- #NERC Regions.
- Total Demand Loss.
- Total Customers Affected.
- Total Duration.
- Extreme Events Detection.
- Average Duration (Hours).
- Average Customers Affected.
- Season (Column).
- Daily Periods (Column).
- % YOY outages reported.
- Average, Mode and Median of Event Duration.
- Duration Category (Column).
- Rolling 12-Month Averages (Demand Loss and Customers Affected).
- % YOY (Customers Affected, Demand Loss).

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Recommendations

Enhance Grid Stability

- Invest in weather-resistant infrastructure.
- Implement predictive maintenance for equipment.
- Diversify power sources with renewable energy.

Reduce Outage Durations

- Use real-time monitoring and advanced sensors.
- Strengthen and equip quick response teams.
- Automate restoration processes with self-healing grids.

Improve Customer Communication

- Implement proactive, real-time outage notifications.
- Provide transparent outage information via online platforms.
- Offer safeguard warnings for high-risk weather events.

Optimize Capacity Planning

- Analyze demand fluctuations for better load management.
- Upgrade aging infrastructure in high-outage areas.

Project Team

Asmaa Khattab
Senior BI Analyst

Ahmed Abdel Naeem
Senior Supply Planner

Esraa Ahmed
Medical Sales Representative

Ghada Ragab
S.r Talent Acquisition Specialist

Lamiaa Mohamed
Head of data managment

Mennatulah Ashraf
Global Payroll Generalist

Project Team Roles

Aa Task name	Status	Assignee	Due	Priority
▼ Cleaning	● Done	Asmaa - Lamiaa - Esraa	September 23, 2024 → September 30, 2024	High
Assumptions	● Done	Ahmed - Lamiaa	September 24, 2024 → September 26, 2024	High
Processes Report	● Done	Esraa - Menna	September 24, 2024 → September 26, 2024	Medium
Power BI File	● Done	Asmaa - Lamiaa	September 25, 2024 → September 27, 2024	High
Data Source	● Done	-	September 25, 2024 → September 27, 2024	Medium
+ New sub-item				
▼ KPIS	● Done	Ghada - Menna	September 30, 2024 → October 3, 2024	High
Questions Answer	● Done	Ghada - Lamiaa - Asmaa	September 25, 2024 → September 29, 2024	High
+ New sub-item				
▼ Dashboard	● Done	Ahmed	October 3, 2024 → October 11, 2024	High
Design	● Done	Ahmed - Menna	October 3, 2024 → October 10, 2024	High
Measures	● Done	Asmaa - Esraa - Ghada	October 4, 2024 → October 8, 2024	High
Charts	● Done	Asmaa - Ghada - Lamiaa	October 3, 2024 → October 11, 2024	High
+ New sub-item				
▼ Presentation	● Done	Ghada - Ahmed	October 11, 2024 → October 22, 2024	High
Problem Definition	● Done	Lamiaa - Menna	October 11, 2024 → October 12, 2024	High
Dashboard	● Done	Ahmed - Asmaa - Ghada	October 11, 2024 → October 16, 2024	High
Cleaning	● Done	Team	October 15, 2024 → October 17, 2024	Medium
Recommendations	● Done	Ghada - Esraa	October 18, 2024 → October 19, 2024	Medium
Online Visualization	● Done	Ahmed	October 19, 2024 → October 20, 2024	Medium

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