FINAL REPORT

Date	29 June 2025
Team ID	LTVIP2025TMID51709
Project Name	Plugging into the future:An exploration of electricity consumption patterns using tableau

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1. INTRODUCTION

1.1 Project Overview

In an increasingly energy-dependent world, understanding electricity consumption patterns is critical for both sustainability and economic planning. This project, *"Plugging into the Future: An Exploration of Electricity Consumption Patterns Using Tableau,"* utilizes data visualization to analyse electricity usage across various dimensions—such as time, region, and sector. By transforming raw electricity consumption data into interactive dashboards and visual stories using Tableau, the project highlights trends, identifies inefficiencies, and uncovers valuable insights that can aid decision-makers in optimizing energy policies and consumption behaviours.

This exploration not only provides a comprehensive view of how electricity is used but also promotes data-driven awareness for energy conservation and smarter infrastructure development.

1.2 Purpose of the Project

The primary purpose of this project is to analyse and present electricity consumption data in a clear, interactive, and insightful manner using Tableau. Through this visualization, the project aims to:

- Help stakeholders understand when, where, and how electricity is being consumed.
- Detect consumption peaks, seasonal variations, and usage inefficiencies.
- Enable interactive exploration through filters and calculated insights.
- Support utility companies, policymakers, and consumers in making informed, energy-conscious decisions.
- Encourage sustainability through greater transparency and awareness of electricity usage patterns.

By providing a visual platform to interpret complex consumption data, this project contributes to the larger goal of building a more energy-efficient and informed future.

2. Ideation Phase

Customer Problem Statement Template:

Create a problem statement to understand your customer's point of view. The Customer Problem Statement template helps you focus on what matters to create experiences people will love. A well-articulated customer problem statement allows you and your team to find the ideal solution for the challenges your customers face. Throughout the process, you'll also be able to empathize with your customers, which helps you better understand how they perceive your product or service.

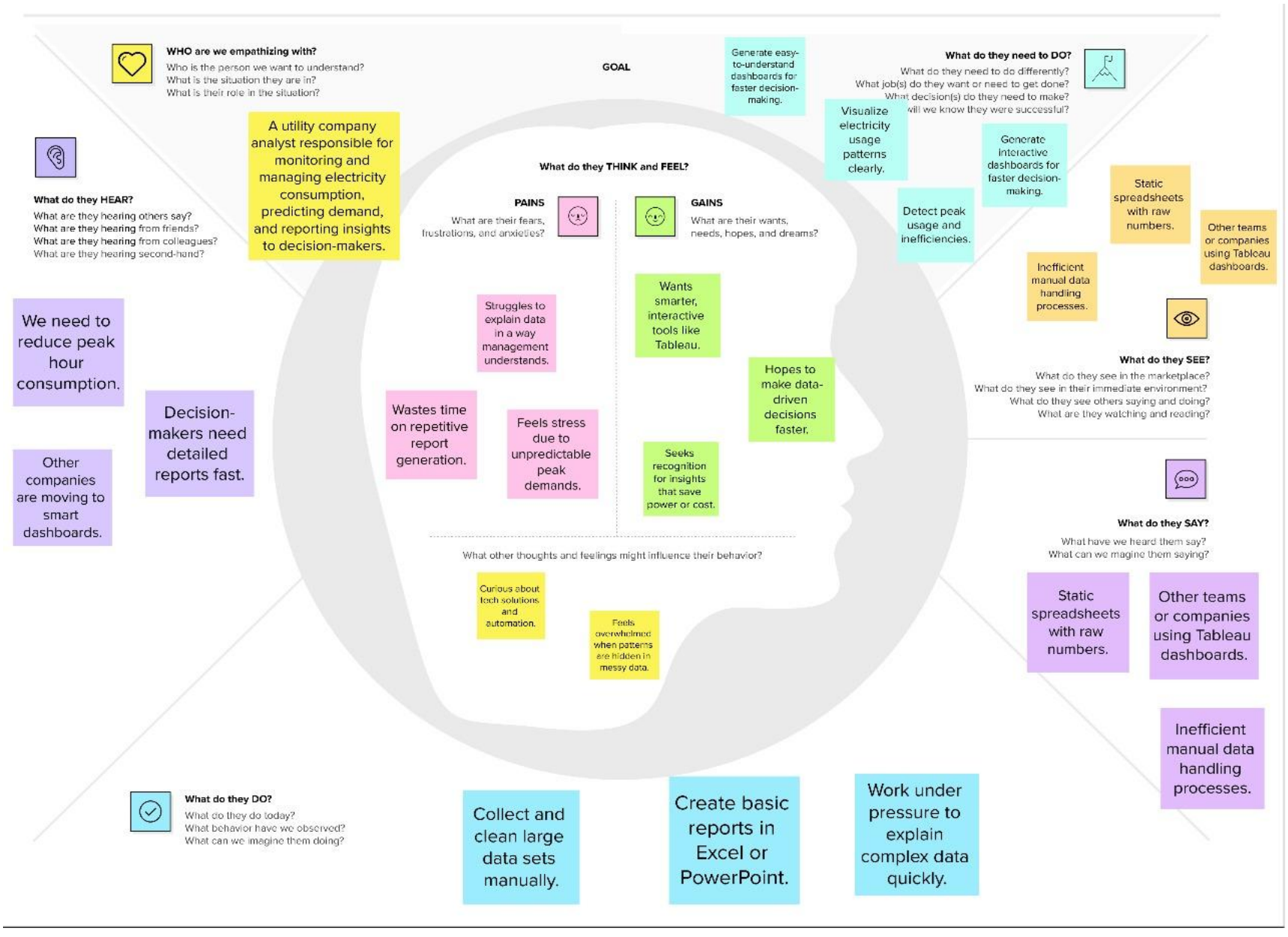
I am	Describe customer with 3-4 key characteristics - *who are they?*	Describe the customer and their attributes here
I'm trying to	*List their outcome or "job" the care about - what are they trying to achieve?*	List the thing they are trying to achieve here
but	Describe what problems or barriers stand in the way – *what bothers them most?*	Describe the problems or barriers that get in the way here
because	Enter the "root cause" of why the problem or barrier exists – *what needs to be solved?*	Describe the reason the problems or barriers exist
which makes me feel	Describe the emotions from the customer's point of view – *how does it impact them emotionally?*	Describe the emotions the result from experiencing the problems or barriers

2.1 Problem Statement

Problem Statement (PS)	I am (Customer)	I'm trying to	But	Because	Which makes me feel
PS-1	Utility company analyst.	Understand electricity usage patterns across sectors and seasons.	I can't get real-time insights from the current data reports.	They are static, unorganized and lack visual clarity.	Frustrated, uncertain and unprepared to make efficient energy decisions.

2.2 Empathy Map Canvas:

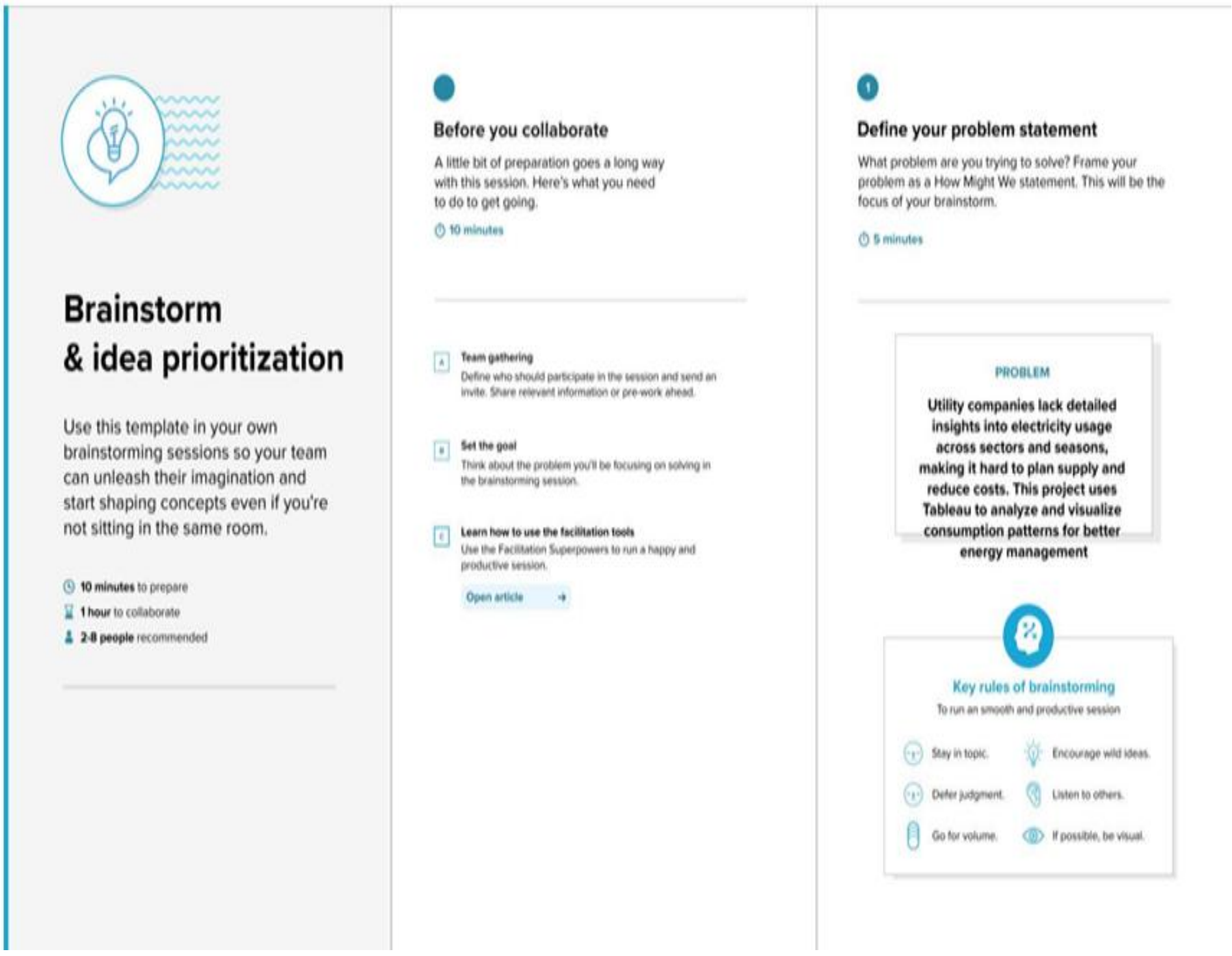
An empathy map is a simple, easy-to-digest visual that captures knowledge about a user's behaviours and attitudes. It is a useful tool to helps teams better understand their users. Creating an effective solution requires understanding the true problem and the person who is experiencing it. The exercise of creating the map helps participants consider things from the user's perspective along with his or her goals and challenges



2.3 Brainstorm & Idea Prioritization Template:

Brainstorming provides a free and open environment that encourages everyone within a team to participate in the creative thinking process that leads to problem solving. Prioritizing volume over value, out-of-the-box ideas are welcome and built upon, and all participants are encouraged to collaborate, helping each other develop a rich number of creative solutions. Use this template in your own brainstorming sessions so your team can unleash their imagination and start shaping concepts even if you're not sitting in the same room

Step-1: Team Gathering, Collaboration and Select the Problem Statement



Step-2: Brainstorm, Idea Listing and Grouping

2

Brainstorm

Write down any ideas that come to mind that address your problem statement.

10 minutes

TIP

You can select a sticky note and hit the pencil [switch to sketch] icon to start drawing!

Person 1

- Track electricity consumption hourly across a day t find peaks times
- Compare weekday vs weekend usage trends.
- Show time-of-day usage across regions.
- Add alerts/ indicators for peak times.

Person 2

- Visualize sector-wise electricity usage (residential, industrial, commercial).
- Highlight energy-wasting sectors.
- Show monthly bills or usage per sector to identify high-demand patterns.
- Compare energy efficiency between sectors.

Person 3

- Recommend energy-saving tips during high-usage seasons.
- Forecast peak load months using past data.
- Show how weather affects electricity usage.
- Analyze seasonal variation in usage across years.

Person 4

- Add user-friendly tips based on usage patterns.
- Include gamification to encourage off-peak usage.
- Recommend customized energy-saving plans for consumers.
- Visualize renewable energy usage vs traditional sources.

3

Group ideas

Take turns sharing your ideas while clustering similar or related notes as you go. Once all sticky notes have been grouped, give each cluster a sentence-like label. If a cluster is bigger than six sticky notes, try and see if you and break it up into smaller sub-groups.

20 minutes

TIP

Add customizable tags to sticky notes to make it easier to find, browse, organize, and categorize important ideas as themes within your mural.

Time-of-Day Analysis Focus

- Track electricity consumption hourly across a day t find peaks times
- Compare weekday vs weekend usage trends.
- Show time-of-day usage across regions.
- Add alerts/ indicators for peak times.

Sector-Based Focus

- Visualize sector-wise electricity usage (residential, industrial, commercial).
- Highlight energy-wasting sectors.
- Show monthly bills or usage per sector to identify high-demand patterns.
- Compare energy efficiency between sectors.

Seasonal & Predictive Focus

- Recommend energy-saving tips during high-usage seasons.
- Forecast peak load months using past data.
- Show how weather affects electricity usage.
- Analyze seasonal variation in usage across years.

User Engagement & Optimization Focus

- Add user-friendly tips based on usage patterns.
- Include gamification to encourage off-peak usage.
- Recommend customized energy-saving plans for consumers.
- Visualize renewable energy usage vs traditional sources.

Step-3: Idea Prioritization

4

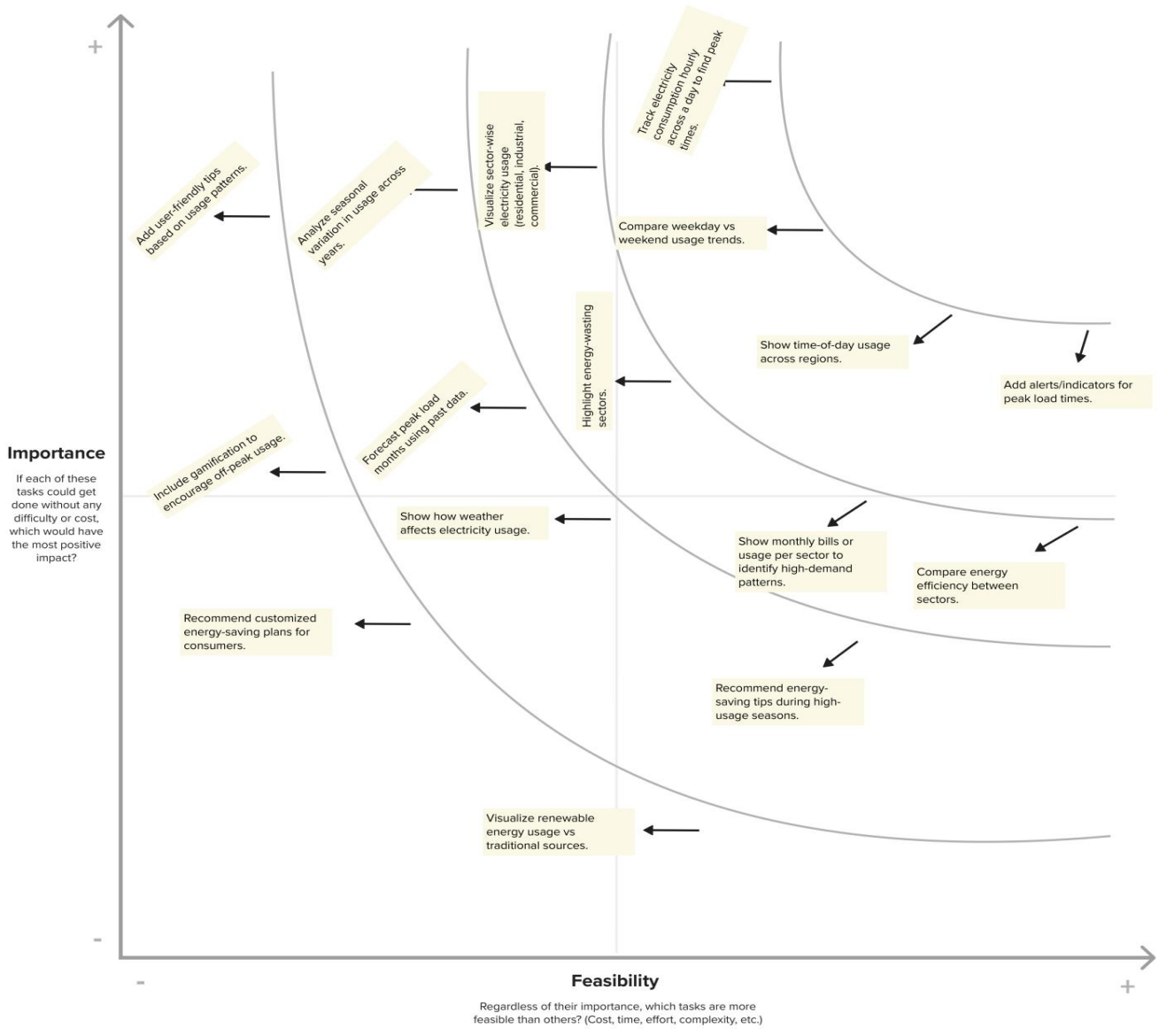
Prioritize

Your team should all be on the same page about what's important moving forward. Place your ideas on this grid to determine which ideas are important and which are feasible.

20 minutes

TIP

Participants can use their cursors to point at where sticky notes should go on the grid. The facilitator can confirm the spot by using the laser pointer holding the **H key** on the keyboard.



3.Requirement Analysis

Functional Requirements:

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story/Sub-Task)
FR-1	Data Import & Integration	Import electricity consumption data from Excel, CSV, or SQL databases.
FR-2	Time-of-Day Usage Analysis	Visualize hourly usage trends across regions and sectors.
FR-3	Sector-wise Consumption Dashboard	Show consumption comparisons between residential, commercial, and industrial sectors.
FR-4	Seasonal Trend Visualization	Display month-wise/seasonal usage changes with forecasting.
FR-5	Interactive Filters	Let users filter data by time, region, and sector dynamically.
FR-6	Report Exporting	Allow users to export chart sand insights in PDF/Image format.

Non-functional Requirements:

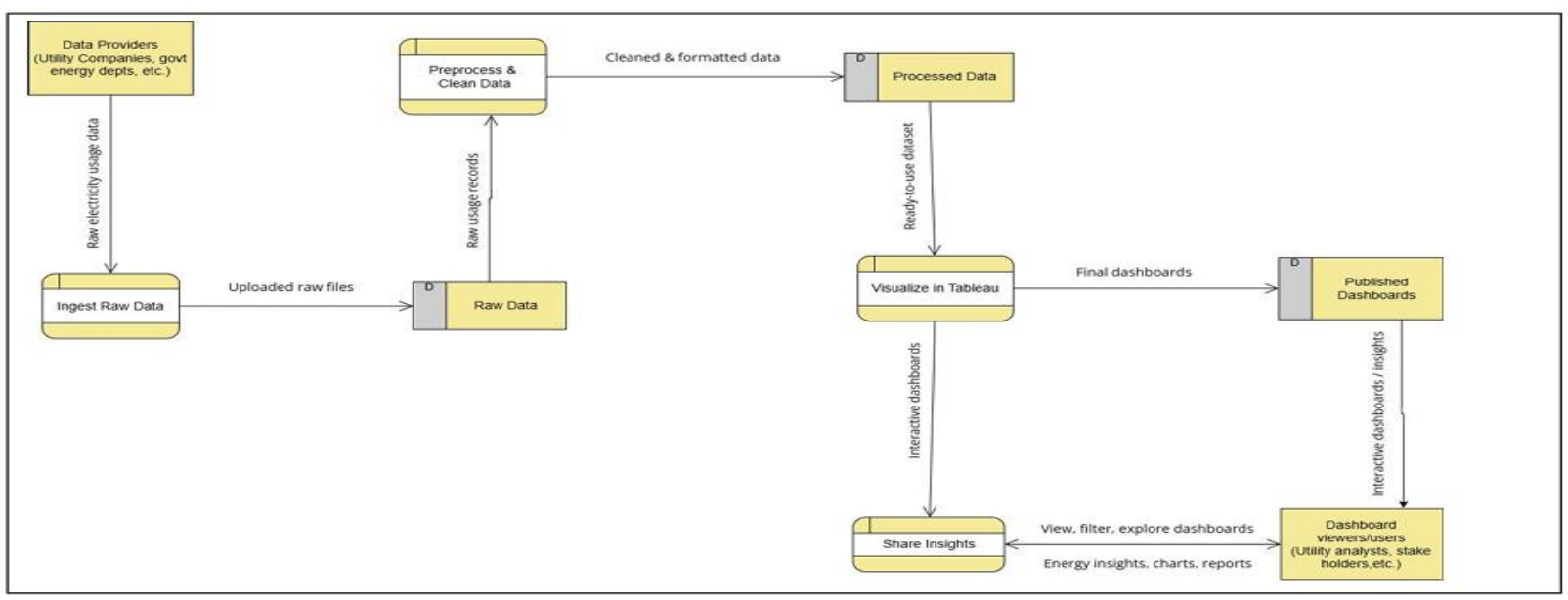
Following are the non-functional requirements of the proposed solution.

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	The dashboard must be clean, user-friendly, and intuitive to operate-even for non-technical users.
NFR-2	**Security**	If deployed on Tableau Serveror Online, data must be protected through authentication and access controls.
NFR-3	**Reliability**	The solution should function correctly under expected usage without crashes or misrepresentation of data.
NFR-4	**Performance**	Dashboards must load within 3-5 seconds for standard datasets (under 1M rows).
NFR-5	**Availability**	Hosted dashboards should be available 24/7 (if public/shared), with minimal downtime.
NFR-6	**Scalability**	The system should handle larger data sets or more filters without performance degradation

Data Flow Diagram:

A Data Flow Diagram (DFD)is a traditional visual representation of the information flows with in a system. A neat and clear DFD can depict the right amount of the

system requirement graphically. It shows how data enters and leaves the system, what changes the information, and where data is stored.



User Stories:

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Utility analyst	Time-of-Day Usage Analysis	USN-1	As a utility analyst, I want to view hourly electricity usage by region	Dashboard shows clear hourly usage trends with filters by region and date	High	Sprint-1
Utility Analyst	Sector-Wise Consumption Breakdown	USN-2	As a utility analyst, I want to compare electricity usage across sectors	Dashboard displays usage for residential, commercial, and industrial sectors	High	Sprint-1
Policy Maker	Seasonal Trend Visualization	USN-3	As a policymaker, I want to see seasonal electricity consumption patterns	Dashboard includes trend lines with month/season filters and forecasting enabled	Medium	Sprint-1
Energy Analyst	Data Import and Cleaning	USN-4	As an energy analyst, I want to upload raw data and pre-process it for Tableau	System accepts Excel/CSV input and prepares clean, structured output for dashboard use	High	Sprint-1
Utility Analyst	Interactive Filters	USN-5	As a utility analyst, I want to filter data by time, region, and sector	Filters dynamically adjust visuals without errors	High	Sprint-1
Policy Maker	Exporting Reports	USN-6	As a policymaker, I want to export dashboards as PDFs for meetings	Users can export dashboards to PDF/Image with proper formatting	Medium	Sprint-1
Utility Analyst	Real-Time Data Integration	USN-7	As a utility analyst, I want live data updates from APIs for real-time monitoring	Dashboard refreshes data automatically every X minute or via refresh button	Low	Sprint-2
Business Stakeholder	Executive Summary Dashboard	USN-8	As a stakeholder, I want a high-level view of usage and key metrics	Summary includes KPIs like peak demand, avg usage, sector share	Medium	Sprint-1

Technical Architecture:

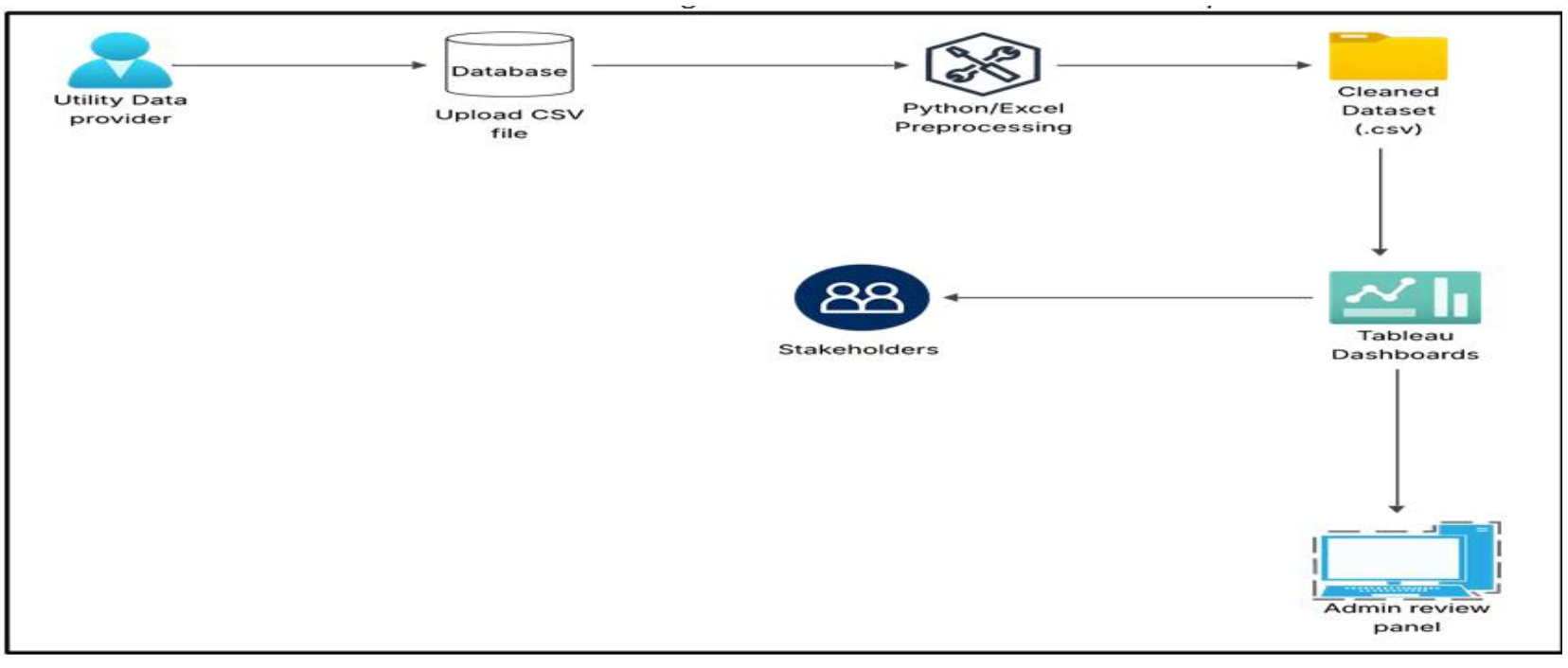


Table-1: Components & Technologies:

S. No	Component	Description	Technology
1.	Data Source	Raw electricity consumption data from various sectors, times, and regions	Excel / CSV / SQL Database
2.	Data Cleaning & Prep	Preprocessing and structuring raw data for analysis	Microsoft Excel / Python (Pandas - optional)
3.	Data Visualization	Creating interactive dashboards to analyse patterns and trends	Tableau Desktop / Tableau Public
4	Data Hosting	Platform to publish dashboards for access by team members or stakeholders	Tableau Public / Tableau Online
5.	Dashboard Interaction	Filters, parameters, and tooltips for exploring specific usage patterns	Tableau Features (filters, slicers, tooltips)
6.	Report Export	Share dashboards and visual insights externally	Tableau export as PDF/Image
7.	Collaboration Tools	Team collaboration and visual planning (ideation, journey maps, DFDs)	Miro / Draw.io / PowerPoint
8.	Documentation	Writing user stories, requirements, and problem statements	Google Docs / MS Word
9.	Presentation	Final project showcase	PowerPoint / Google Slides
10.	Real-Time Data Source	If using live sensor or IoT data in future updates	APIs / Webhooks / Live Excel feed
11.	Automation & Forecast	Optional use of Python for forecasting or scheduling dashboards	Python (fb prophet, pandas)

Table-2: Application Characteristics:

S. No	Characteristics	Description	Technology
1.	Usability	Easy-to-use interactive dashboards for non-technical users	Tableau (drag-and-drop UI, filters, tooltips)
2.	Performance	Dashboards load within seconds for medium-sized datasets	Tableau's in-memory engine + optimized extracts
3.	Scalability	Can handle growing data over time (e.g., more regions, months, sectors)	Tableau extracts / SQL backend
4.	Availability	Dashboards accessible online or shared via link 24/7	Tableau Public / Tableau Online
5.	Maintainability	Easy to update or revise dashboards as new data or requirements emerge	Tableau Workbook (.twbx) format
6.	Security	Optional access control if hosted on secure platforms	Tableau Online / Tableau Server (role-based access)
7.	Portability	Dashboards can be viewed on web browsers, desktops, and exported as PDF/images	Tableau Public, PDF Export
8.	Interactivity	Users can filter data, hover for tooltips, drill down into specific insights	Tableau filters, parameters
9.	Visual Appeal	Clean, engaging visuals using charts, heatmaps, line graphs	Tableau templates and formatting options

References:

https://c4model.com/

https://developer.ibm.com/patterns/online-order-processing-system-during-pandemic/

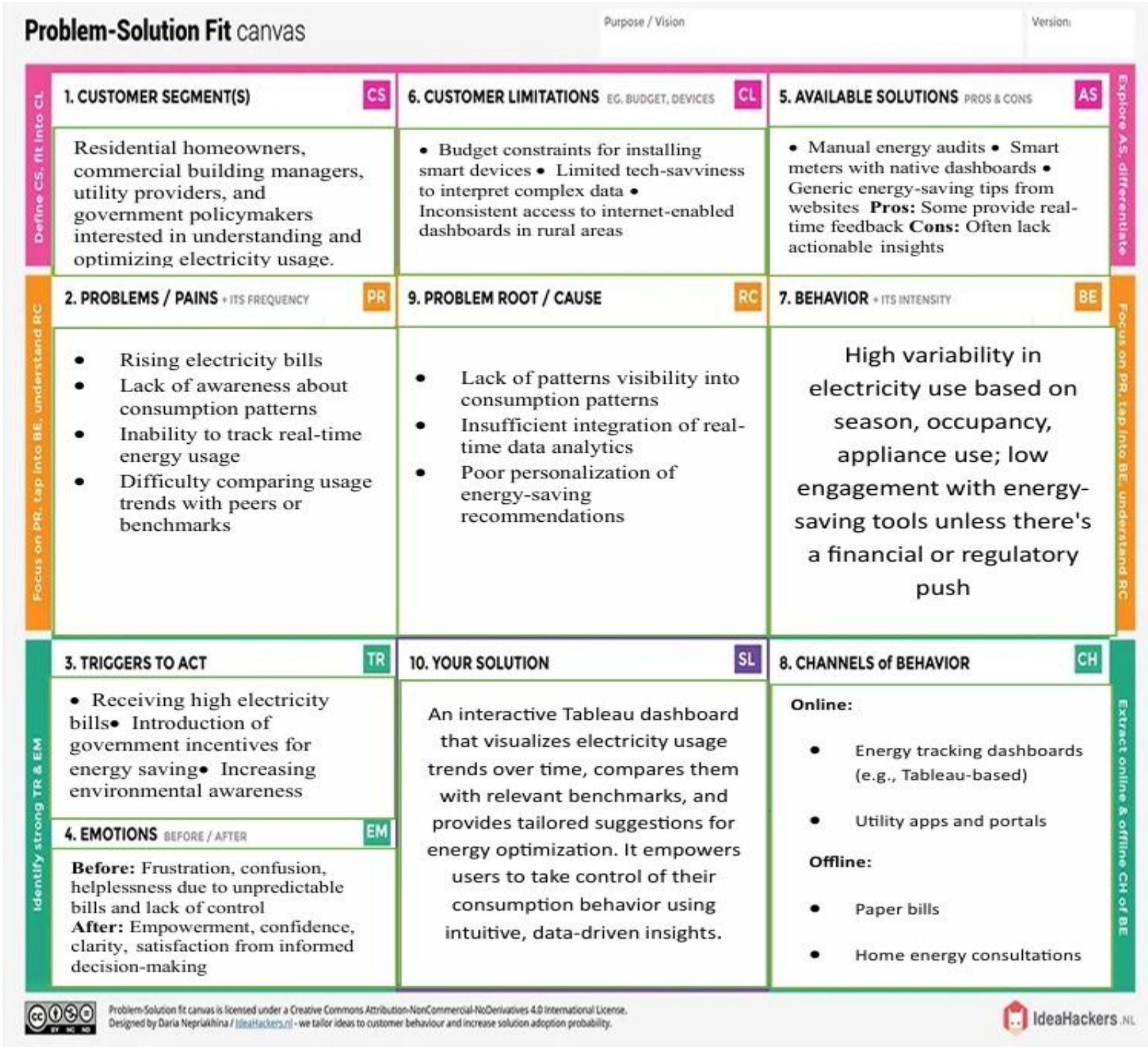
https://www.ibm.com/cloud/architecture

https://aws.amazon.com/architecture

https://medium.com/the-internal-startup/how-to-draw-useful-technical-architecture-diagrams-2d20c9fda90d

1) PROJECT DESIGN

a) Problem Solution Fit



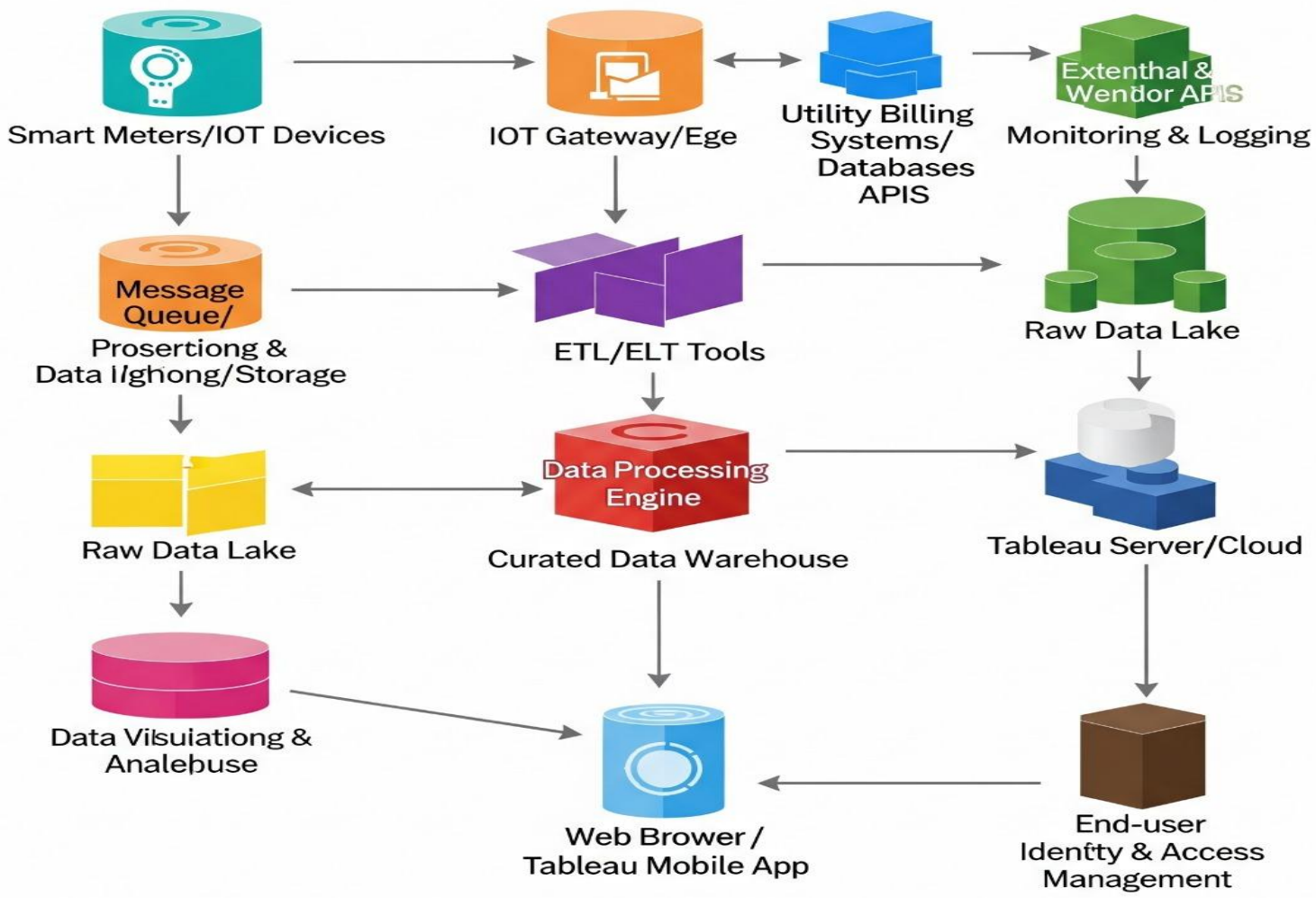
Proposed Solution Template:

S. No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	Many electricity consumers lack visibility and control over their consumption patterns, leading to inefficient usage, unexpected bills, and low adoption of energy-saving practices.
2.	Idea / Solution description	Develop a Tableau-based interactive dashboard that visualizes electricity usage patterns, highlights anomalies, and offers personalized insights for better energy management. The tool will enable users to make data-driven decisions about their electricity use.
3.	Novelty / Uniqueness	Unlike generic energy tips or static reports, this solution offers dynamic, visual, and user-tailored insights using advanced data analytics and dashboards. It combines real-time data with easy-to-understand visuals, making it accessible to non-technical users.

4.	Social Impact / Customer Satisfaction	Enhances energy awareness and promotes sustainable consumption behaviour among households and businesses. It contributes to carbon footprint reduction and helps users save money, increasing satisfaction and engagement.
5.	Business Model (Revenue Model)	Freemium model offering basic insights to all users; advanced analytics, recommendations, and integration with smart devices available under a subscription model. Potential B2B partnerships with utility companies and
6.	Scalability of the Solution	The solution is highly scalable across geographies and consumer types. It can be adapted to various datasets, integrated with smart meters, and customized for regional energy policies or user behaviour patterns.

Solution Architecture:

Example - Solution Architecture Disgram



FUNCTIONAL AND PERFORMANCE TESTING

6.1 Performance Testing:

Model Performance Testing:

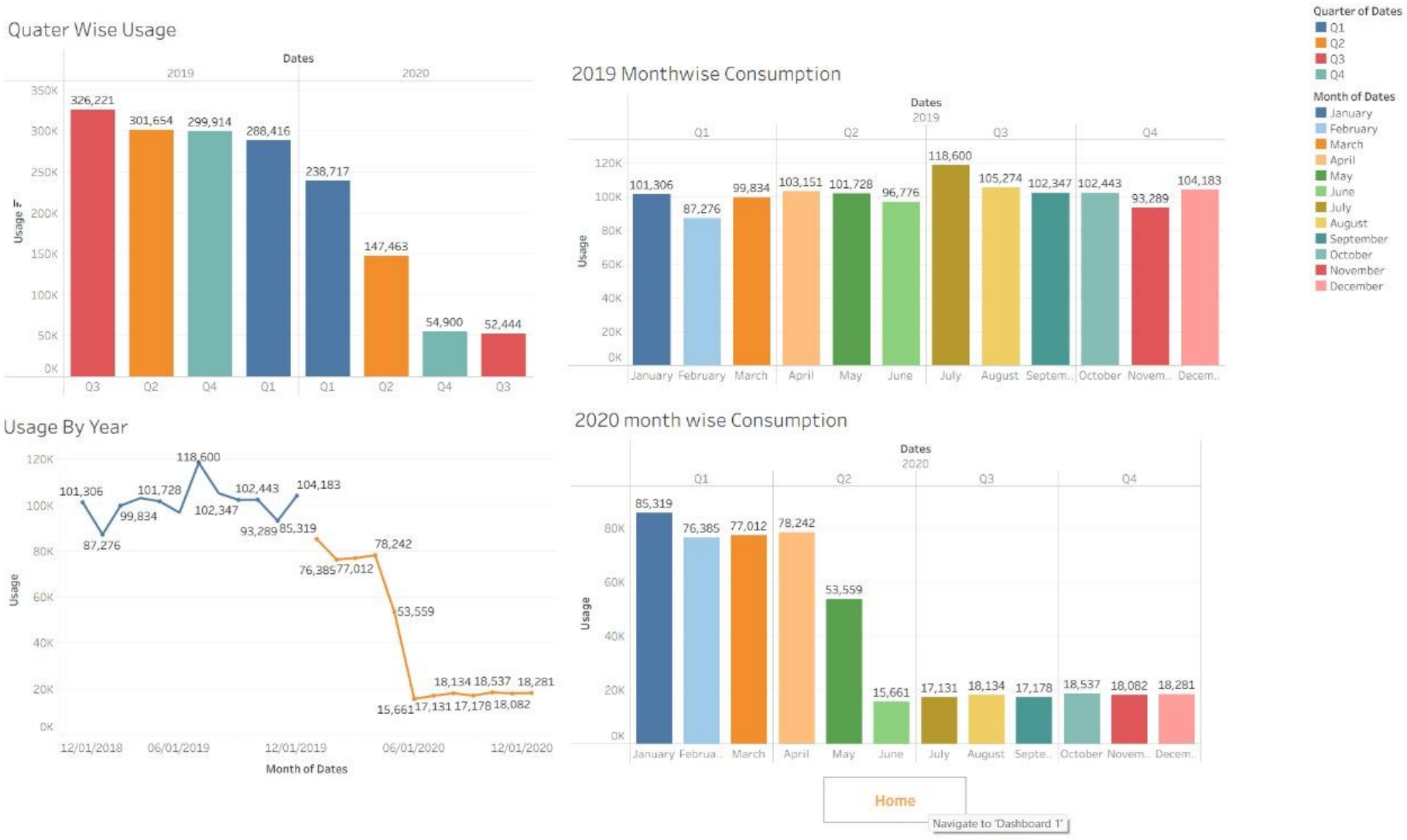
Project team shall fill the following information in model performance testing template.

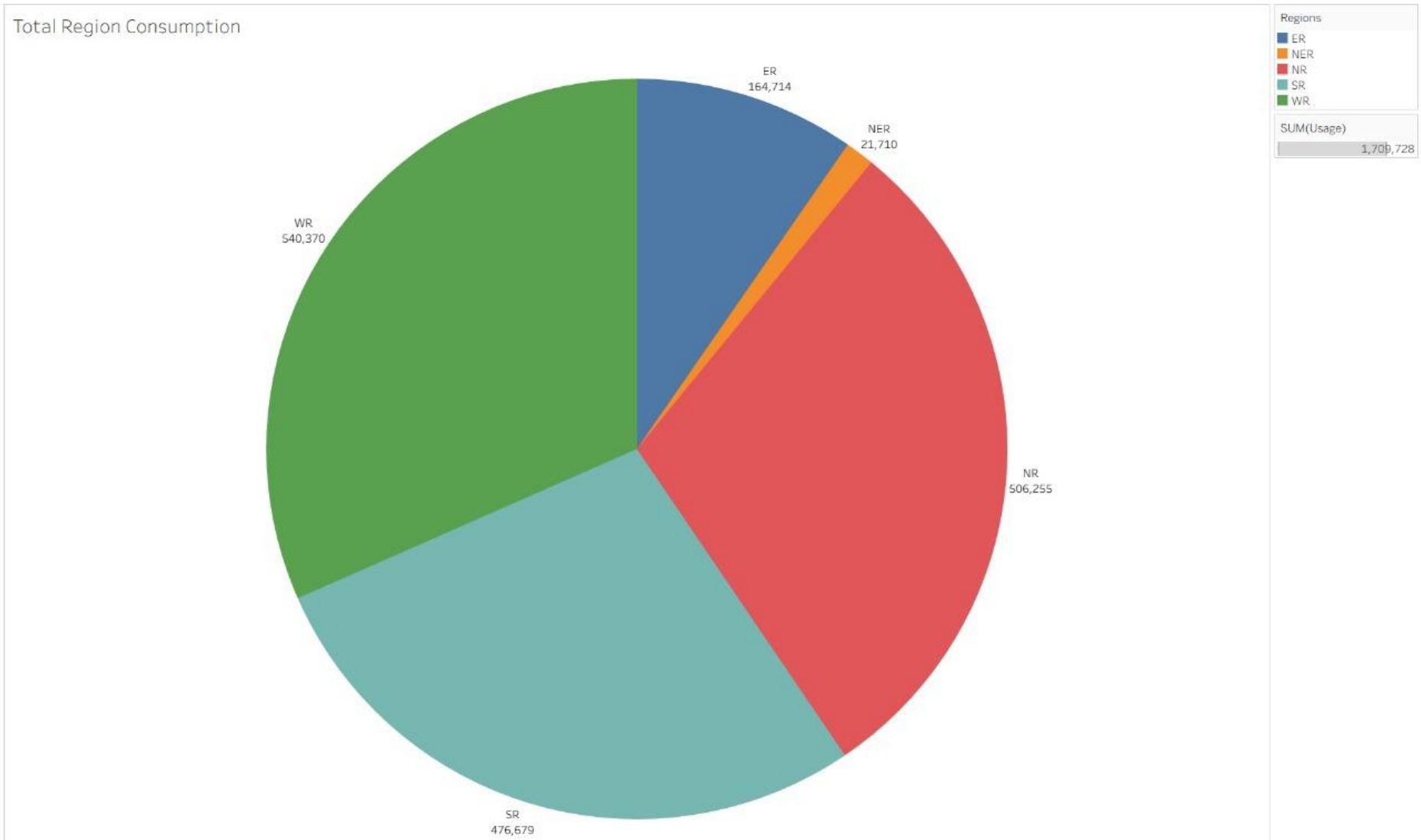
S. No.	Parameter	Screenshot / Values
1.	Data Rendered	The dataset contains electricity consumption records across different regions and sectors over multiple years. It includes attributes like date, location, usage (kWh), time of day, and consumer type (residential, commercial, industrial).
2.	Data Preprocessing	Data was cleaned by removing null values, correcting data types (e.g., converting date columns), and merging datasets (e.g., weather or region names). Redundant columns were removed, and meaningful headers were added.

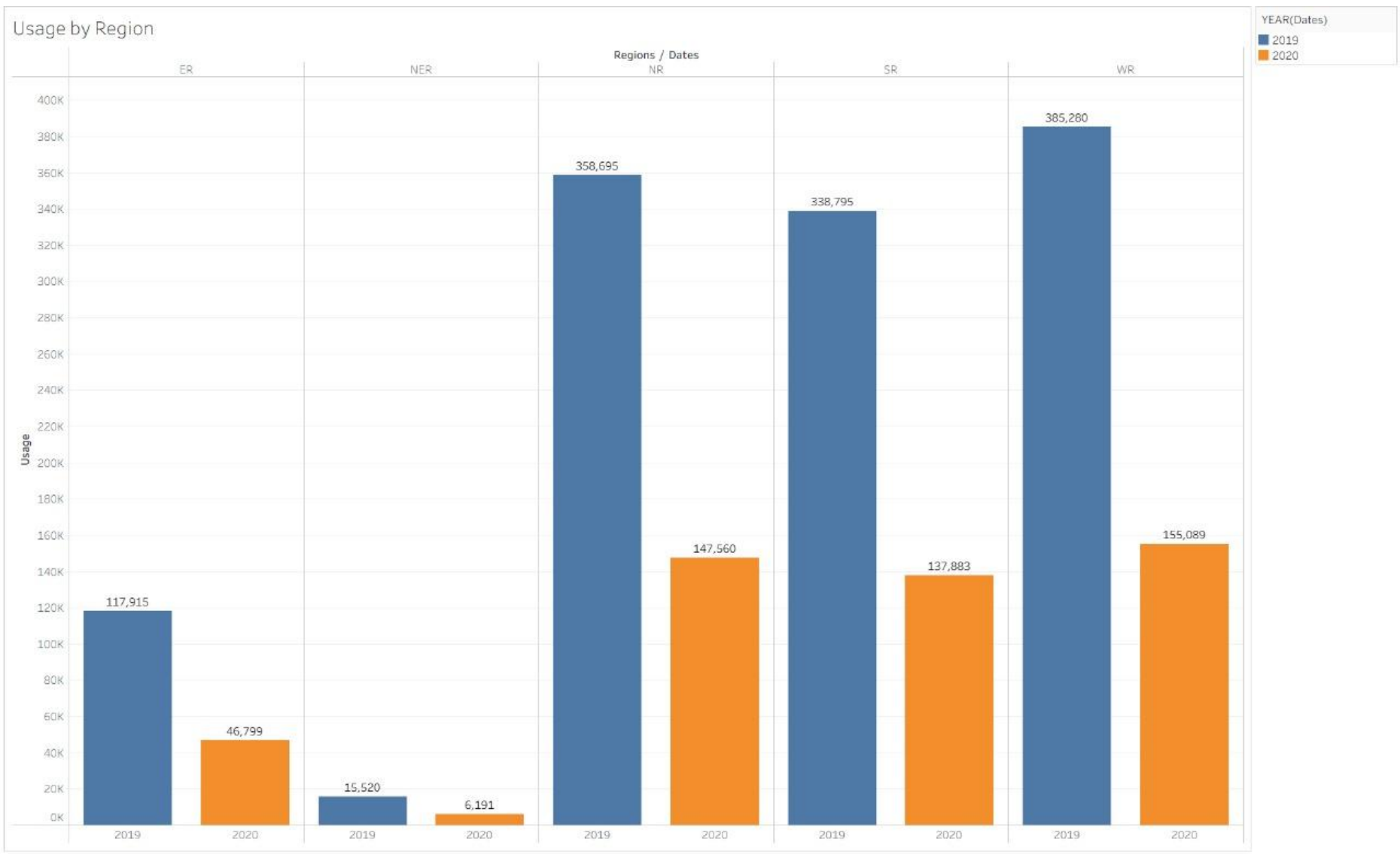
3.	Utilization of Filters	Filters were applied for Year, Region, Sector Type, Month, and Time of Day. These allow users to interactively explore specific consumption patterns.
4.	Calculation fields Used	Examples include: - Peak Hour Indicator (IF statement for usage during peak hours) - Year-over-Year Growth % - Total Consumption aggregated using SUM - Average Daily Usage - Consumption Efficiency Ratio
5.	Dashboard design	No of Visualizations / Graphs - The dashboard includes 6 visualizations: - Time-series line chart - Sector-wise bar chart - Region-wise heatmap - Pie chart by consumer type - Daily usage trend - KPI cards with total consumption and efficiency
6	Story Design	No of Visualizations / Graphs - The story includes 4 story points with 5 visualizations: 1. Overview of Consumption Trends 2. Regional Analysis 3. Sector-Specific Usage 4. Insights & Recommendations

7. RESULTS

7.1 Output Screenshots:

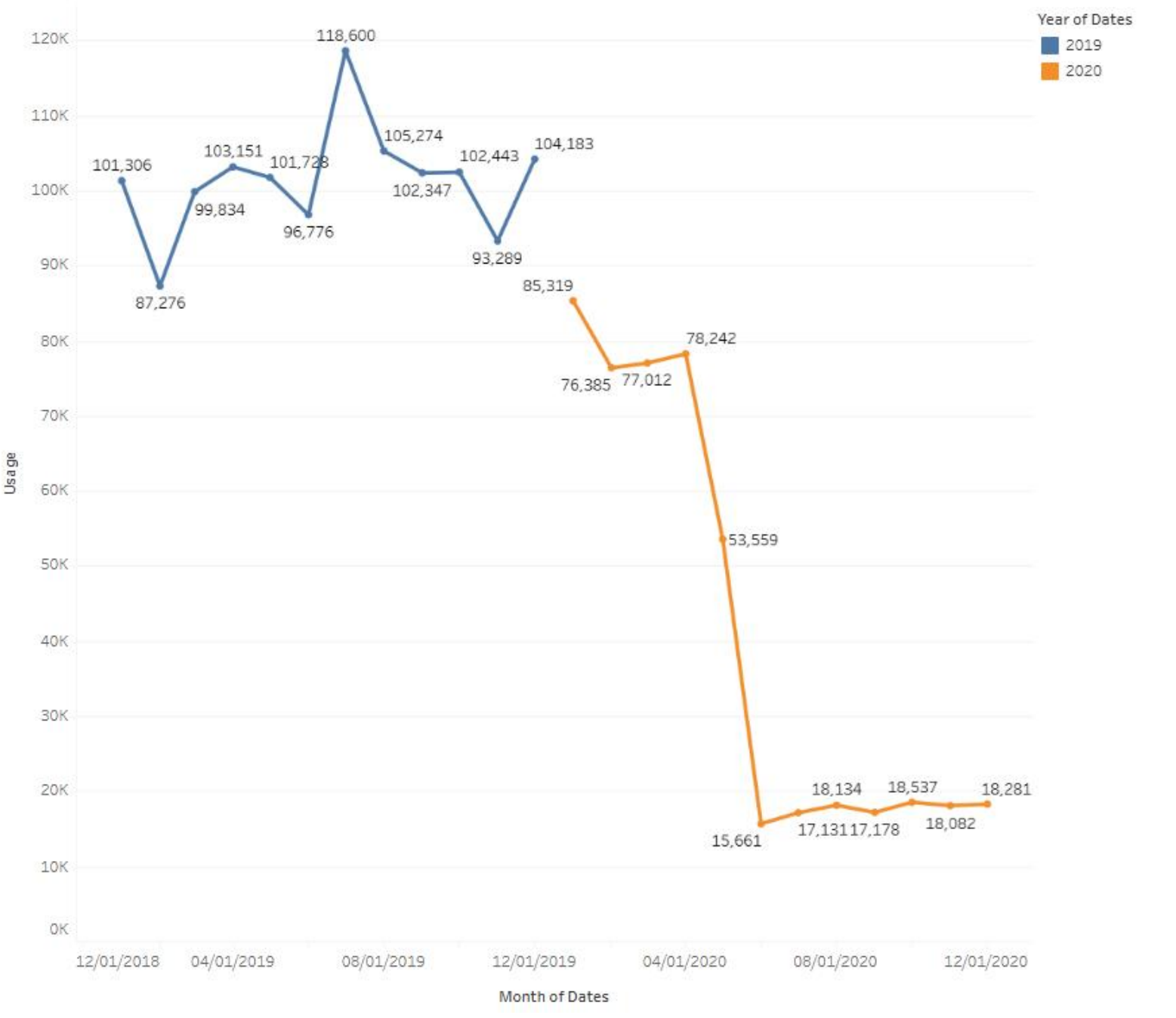


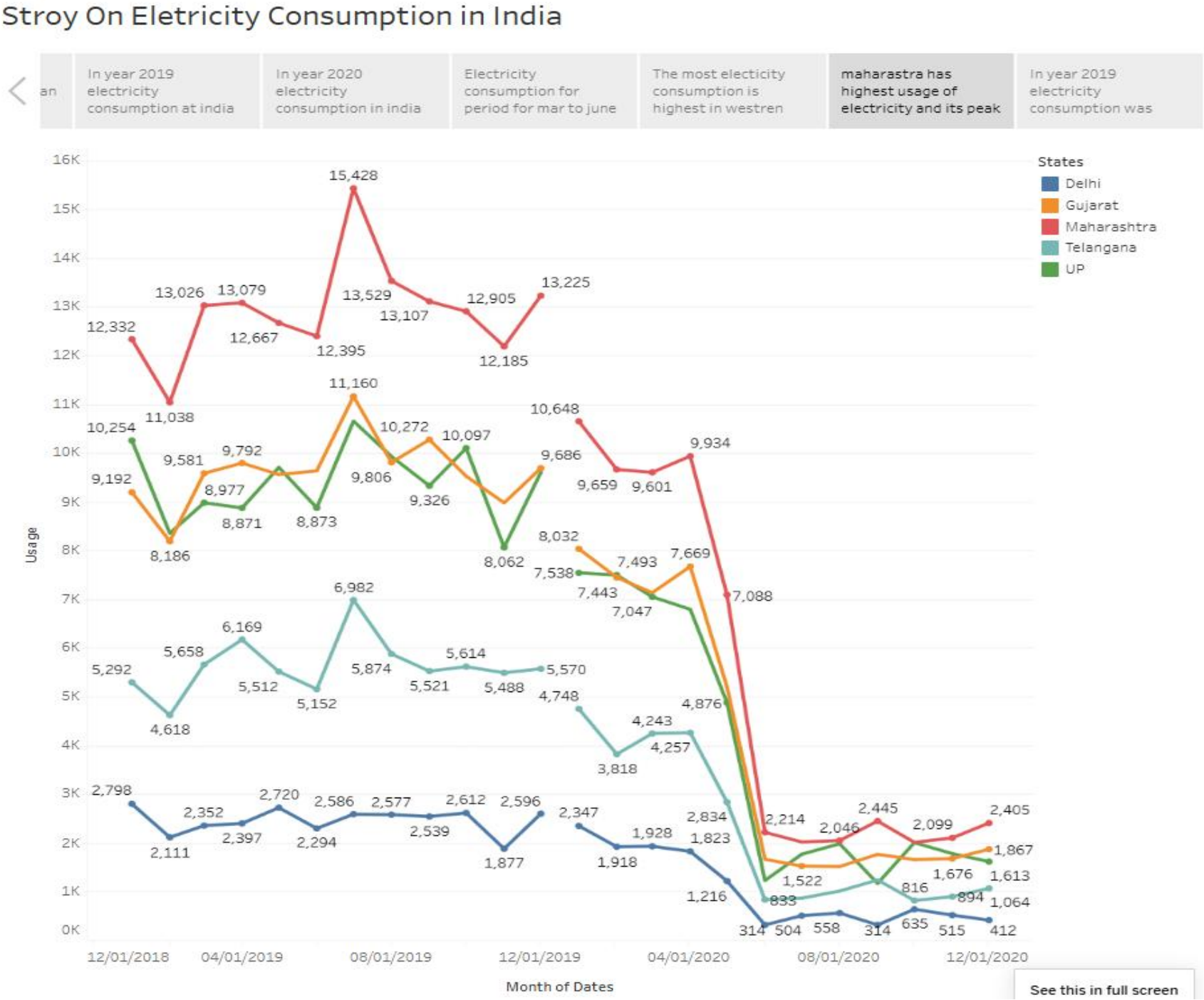

Total Region Consumption
ER
164,714
NER
21,710
NR
506,255
SR
476,679
WR
540,370
Regions
ER
NER
NR
SR
WR
SUM(Usage)
1,709,728


Usage by Region
Regions / Dates
ER
NER
NR
SR
WR
Usage
400K
380K
360K
340K
320K
300K
280K
260K
240K
220K
200K
180K
160K
140K
120K
100K
80K
60K
40K
20K
0K
117,915
46,799
15,520
6,191
358,695
147,560
338,795
137,883
385,260
155,089
2019
2020
YEAR(Dates)
2019
2020

Stroy On Eletricity Consumption in India

an | In year 2019 electricity consumption at india | In year 2020 electricity consumption in india | Electricity consumption for period for mar to june | The most electicity consumption is highest in westren | maharastra has highest usage of electricity and its peak | In year 2019 electricity consumption was





8. ADVANTAGES & DISADVANTAGES

8.1 Advantages

1. **Interactive Visualization:**
   Tableau offers dynamic dashboards that allow users to filter, zoom, and interact with the data, making analysis more intuitive and engaging.

2. **Improved Decision Making:**
   Visual insights into electricity consumption help utility companies and policymakers make informed decisions regarding energy planning and resource allocation.

3. **Trend Identification:**
   Patterns such as seasonal peaks, regional discrepancies, and sector-specific usage can be quickly identified and analysed.

4. **User-Friendly Interface:**
   Tableau's drag-and-drop functionality enables quick design and iteration, even for users with limited programming skills.

5. **Real-Time Data Updates:**
   When connected to live data sources, Tableau dashboards can reflect real-time changes, supporting timely responses to shifting consumption trends.

6. **Customization and Scalability:**
   Dashboards can be customized for different stakeholders (e.g., residential users vs. policymakers) and scaled for large datasets.

8.2 Disadvantages

1. **Data Quality Dependence:**
   Inaccurate, incomplete, or inconsistent data can significantly affect the reliability of insights derived from visualizations.
2. **Learning Curve:**
   While Tableau is user-friendly, mastering advanced features like calculated fields and parameter controls may require training or experience.
3. **Cost Factors:**
   Tableau licenses can be expensive for organizations or individuals with limited budgets, especially if multiple users are involved.
4. **Limited Predictive Capabilities:**
   Tableau excels at visualization but is not designed for complex statistical modeling or predictive analytics without external integration.
5. **Performance with Large Datasets:**
   When handling extremely large datasets or complex joins, Tableau may experience slower performance unless optimized correctly.

9. CONCLUSION

The project *"Plugging into the Future: An Exploration of Electricity Consumption Patterns Using Tableau"* successfully demonstrates the power of data visualization in understanding complex electricity usage behaviours. By transforming raw consumption data into meaningful and interactive visual dashboards, the project provides clear insights into when, where, and how electricity is being consumed across different sectors and regions.

The analysis not only aids in identifying peak usage periods and consumption trends but also promotes data-driven decisions to improve efficiency and reduce waste. Overall, the project highlights how tools like Tableau can bridge the gap between raw data and actionable intelligence in the energy sector.

10. FUTURE SCOPE

This project sets the foundation for more advanced exploration in the field of energy analytics. Potential areas for future development include:

1. **Integration with Real-Time Data:**
   Connecting Tableau dashboards to live electricity grids or smart meter data for real-time monitoring and alerts.
2. **Predictive Analytics:**
   Incorporating machine learning models to forecast future electricity demand and detect anomalies.
3. **Expanded Data Sources:**
   Including additional variables such as weather conditions, population density, and economic activity to enhance context and accuracy.

4. **Geo-Spatial Analysis:**
   Using advanced mapping features to visualize consumption patterns at finer geographic levels (e.g., district, city, or household level).
5. **Mobile and Web Access:**
   Making dashboards accessible via mobile and web platforms for greater reach and usability by consumers and field personnel.
6. **Policy Impact Simulation:**
   Adding tools to simulate how changes in policy or pricing would affect electricity consumption and user behaviour.

   These extensions would further enhance the project's value and applicability in creating a smarter, more sustainable energy ecosystem.

11.APPENDIX

Dataset Link : https://drive.google.com/file/d/1IvK5ISoZtdBsieClDvE1k_nH80cmFrne/view?usp=drive_link

GitHub & Project Demo Link: https://github.com/JyothirmaiBhogireddy/Electricity-Consumption-Patterns-using-Tableau