

Plugging into the future- An Exploration Of Electricity Consumption Patterns Using tableau

Final Project Report

Submitted on:
28 June 2025

By:

Kothapalem Vijaya Vardhini
Addepalli Nikhitha
Chavadi Kiran Ganesh
Kondireddy Sravani
Depuru Joshika Reddy

Team ID: LTVIP2025TMID47482

CONTENTS

| CHAPTER | DESCRIPTION | | PAGE NO |
|----------------|-----------------------------|----------------------|----------------|
| 1 | INTRODUCTION | | 4-5 |
| | 1.1 | Project Overview | 4 |
| | 1.2 | Purpose | 5 |
| 2 | IDEATION PHASE | | 6-11 |
| | 2.1 | Problem Statement | 6 |
| | 2.2 | Empathy Map Canvas | 7-8 |
| | 2.3 | Brain Storming | 9-11 |
| 3 | REQUIREMENT ANALYSIS | | 12-19 |
| | 3.1 | Customer Journey Map | 12-13 |
| | 3.2 | Solution Requirement | 13-14 |
| | 3.3 | Data Flow Design | 15-17 |
| | 3.4 | Technology Stack | 17-19 |
| 4 | PROJECT DESIGN | | 20-23 |
| | 4.1 | Problem Solution fit | 20-21 |
| | 4.2 | Proposed Solution | 21-22 |

| | | | |
|-----------|---|-----------------------|-------|
| | 4.3 | Solution Architecture | 23 |
| 5 | PROJECT PLANNING AND SCHEDULING | | 24-25 |
| | 5.1 | Project Planning | 24-25 |
| 6 | FUNCTIONAL AND PERFORMANCE TESTING | | 26-27 |
| | 6.1 | Performance Testing | 26-27 |
| 7 | RESULTS | | 28-34 |
| | 7.1 | Output Screenshots | 28-34 |
| 8 | ADVANTAGES AND DISADVANTAGES | | 35 |
| 9 | CONCLUSION | | 36 |
| 10 | FUTURE SCOPE | | 37 |
| 11 | APPENDIX | | 38 |

1. INTRODUCTION

1.1 PROJECT OVERVIEW

Electricity is one of the most fundamental resources driving the progress of modern civilization. It fuels every sector of society, from industries and transportation to residential homes and educational institutions. With increasing urbanization and digital dependency, the demand for electricity continues to rise significantly. Monitoring and understanding how electricity is consumed are crucial for ensuring sustainable energy development, efficient resource management, and robust infrastructure planning.

This project is centred on the theme "Plugging into the Future: An Exploration of Electricity Consumption Patterns Using Tableau." The objective is to create a comprehensive and interactive data visualization model that highlights patterns in electricity consumption using Tableau. The visualizations aim to make the data understandable, insightful, and accessible to a wide range of stakeholders, including policymakers, utility companies, analysts, and the general public.

The project utilizes real-world electricity consumption datasets and transforms them into visual dashboards. Through these dashboards, users can observe trends over time, make regional comparisons, and analyze sector-wise electricity usage. Special attention is given to identifying peak usage periods, seasonal variations, and patterns that could inform future planning and optimization strategies. Tableau's intuitive interface and powerful features make it the ideal platform for delivering this analytical capability.

In essence, the project not only provides a tool for better comprehension of electricity usage but also promotes data-driven decision-making and encourages proactive engagement in energy efficiency and sustainability efforts.

1.2 PURPOSE

The purpose of this project is to address the growing need for clear, actionable insights into electricity consumption data. In a rapidly digitizing and energy-dependent world, raw data alone is insufficient for informed decision-making. There is a crucial need to convert this data into meaningful visualizations that can be easily interpreted by a wide audience, ranging from government agencies to private sector analysts and ordinary citizens.

By leveraging Tableau, the project aims to bridge the gap between complex electricity usage data and accessible insights. Tableau's capacity for creating interactive dashboards enables users to explore data dynamically, apply filters, and uncover trends that might otherwise remain hidden in spreadsheets or static charts. This not only helps in understanding past and present consumption patterns but also plays a role in forecasting future needs and supporting proactive planning.

Another key purpose is to enhance public and institutional awareness about energy efficiency. Visualization fosters transparency and understanding, empowering users to identify inefficiencies, peak usage periods, and region-specific issues. The project ultimately promotes data-driven governance and encourages collaborative efforts in energy conservation and sustainable development.

Key Points – Purpose of the Project:

- To convert complex electricity consumption data into clear, interactive visualizations.
- To support decision-makers in identifying trends, inefficiencies, and forecasting energy demand.
- To enhance accessibility and understanding of energy data for a wide range of stakeholders.
- To promote data-driven governance and sustainable energy planning.
- To raise awareness about energy efficiency through engaging visual tools.

2. IDEATION PHASE

2.1 PROBLEM STATEMENT

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" they 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 |

Example:

| | | | | |
|----------------------------|---|--|--|---|
| I am a city planner | I'm trying to analyze electricity usage trends | But i can't get actionable insights | Because the data is scattered and lack visual clarity | which makes me feel Overwhelmed and frustrated |
|----------------------------|---|--|--|---|

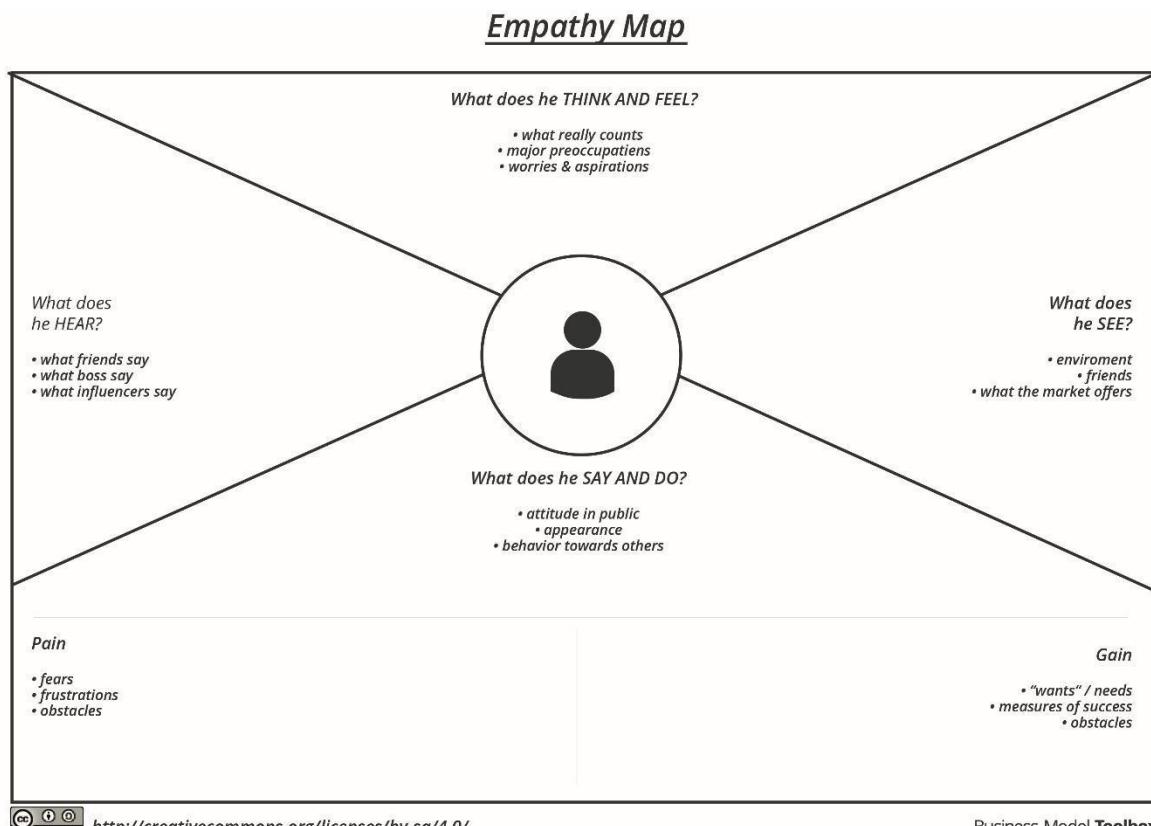
2.2 EMPATHY MAP CANVAS

Empathy Map Canvas:

The Empathy Map Canvas is a valuable tool used in this project to better understand the experiences, thoughts, and behaviours of the primary users engaging with electricity consumption data. This mapping helps identify user-centric needs and frustrations and guides the creation of meaningful, intuitive solutions in the visualization process.

It is a useful tool to help 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.

Example:

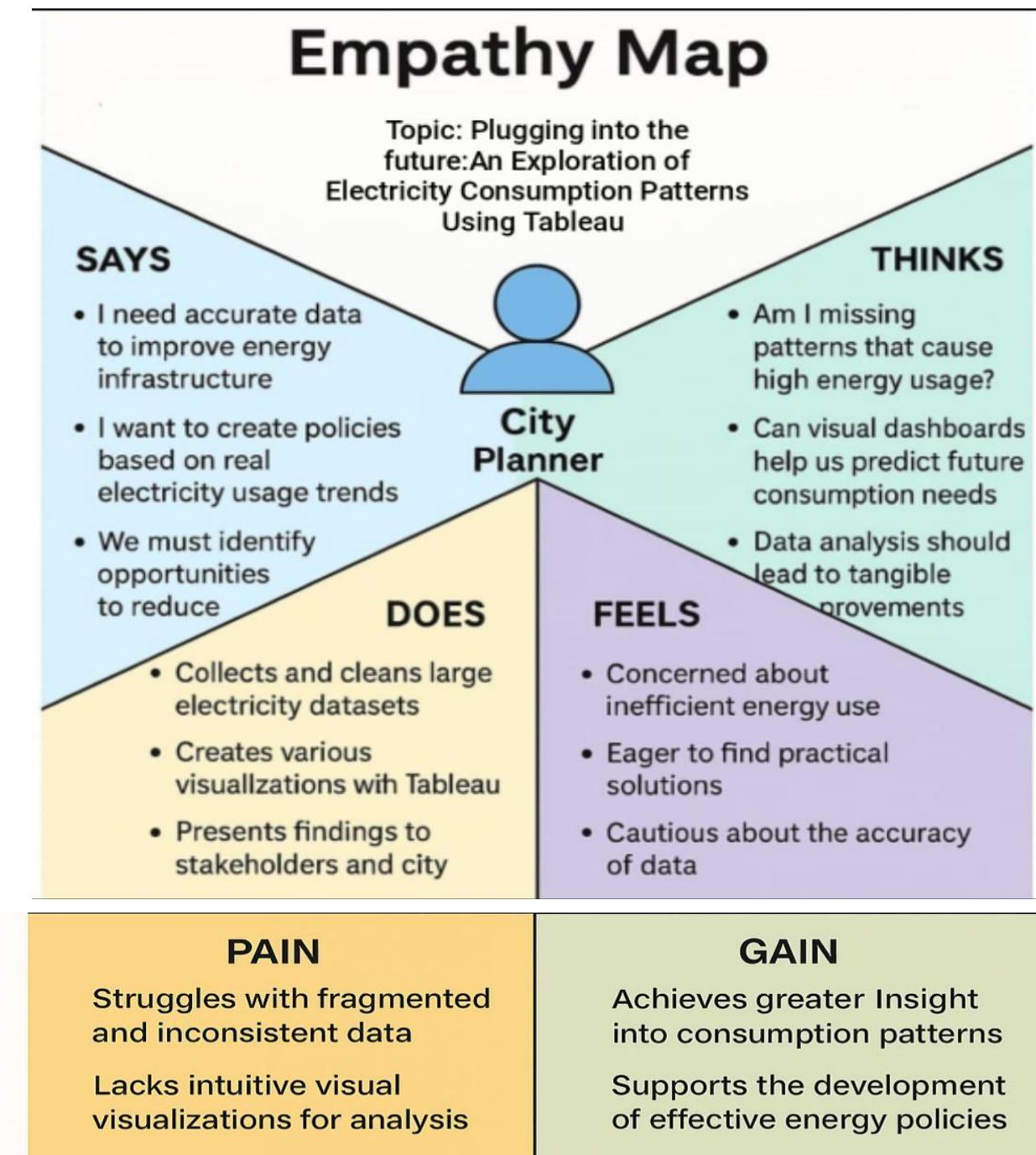


Business Model Toolbox

Example: Consider a **city planner** who manages urban electricity infrastructure. They often say, "I need to know which neighbourhoods are seeing the highest power demand."

They think about seasonal spikes and whether the data can help with future planning. They may feel overwhelmed by raw spreadsheets and often rely on outdated tools. What they truly need is a visual, interactive dashboard to monitor usage trends efficiently.

By addressing these practical needs and emotional responses, the project ensures its solutions are aligned with real-world user contexts and behaviours. An intuitive platform to visualize electricity usage clearly.



2.3 BRAINSTORMING

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.

Template



Brainstorm & idea prioritization

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.

⌚ 10 minutes to prepare
⌚ 1 hour to collaborate
👤 2-5 people recommended

Before you collaborate
A little bit of preparation goes a long way with this session. Here's what you need to do to get going.
⌚ 10 minutes

A Team gathering
Determine stakeholders (data analysts, energy experts, domain specialists, Tableau users) who should participate in analyzing electricity consumption. Sending invitations and sharing pre-reading materials on the project's objectives and available data sources.

B Set the goal
Clearly articulate the specific questions we aim to answer regarding electricity consumption patterns (e.g., identifying peak usage times, understanding seasonal trends, comparing consumption across different demographics/regions, impact of external factors). Defining what insights we expect to gain using Tableau.

C Learn how to use the facilitation tools
Familiarize yourselves with the collaborative features of Tableau (e.g., sharing dashboards, commenting, version control) and any other virtual collaboration tools (e.g., screen sharing, digital whiteboards) that will enhance our data exploration and brainstorming sessions. Reviewing best practices for remote data analysis and visualization collaboration.

[Open article →](#)

Define your problem statement
What key insights or understanding are we trying to gain from electricity consumption data? Frame this challenge as a "How Might We" statement that will guide our exploration and visualizations using Tableau
⌚ 5 minutes

PROBLEM
How might we visualize electricity consumption patterns in Tableau to reveal key insights?

Key rules of brainstorming
To run a smooth and productive session

- Stay in topic.
- Encourage wild ideas.
- Defer judgment.
- Listen to others.
- Go for volume.
- If possible, be visual.

Step-2: Brainstorm, Idea Listing and Grouping

The image shows a two-column worksheet for the Brainstorm and Idea Listing and Grouping phases.

Phase 2: Brainstorm

Brainstorm

Brainstorm all potential ideas related to visualizing and analyzing electricity consumption patterns using Tableau. Think about data sources, types of visualizations, key metrics, potential insights, and analytical approaches that address our problem statement: "How might we visualize electricity consumption patterns in Tableau to reveal key insights?"

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

10 minutes

Person 1 Person 2 Person 3 Person 4 Person 5

Yellow sticky notes for each person to write down ideas.

Phase 3: Group ideas

Group ideas

Share your brainstormed ideas aloud. As ideas are presented, collaboratively cluster similar or related notes into logical groups. For each cluster of ideas, collaboratively define a clear, concise, sentence-long label that summarizes its theme (e.g., "Data Sources & Preparation," "Key Visualizations," "Insight Generation," "User Interactivity"). If any cluster becomes too large, consider breaking it down into more specific sub-groups to ensure clarity and actionable focus within our Tableau exploration.

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

20 minutes

Ideas generated during the ideation phase included:

- Heatmaps for region-wise electricity usage
- Line charts for monthly/annual usage trends
- Sectoral comparison (residential, industrial, commercial)
- Interactive filters to analyze data by region, time, and sector
- Integration of weather or demographic data to explain usage patterns

Step-3: Idea Prioritization

4

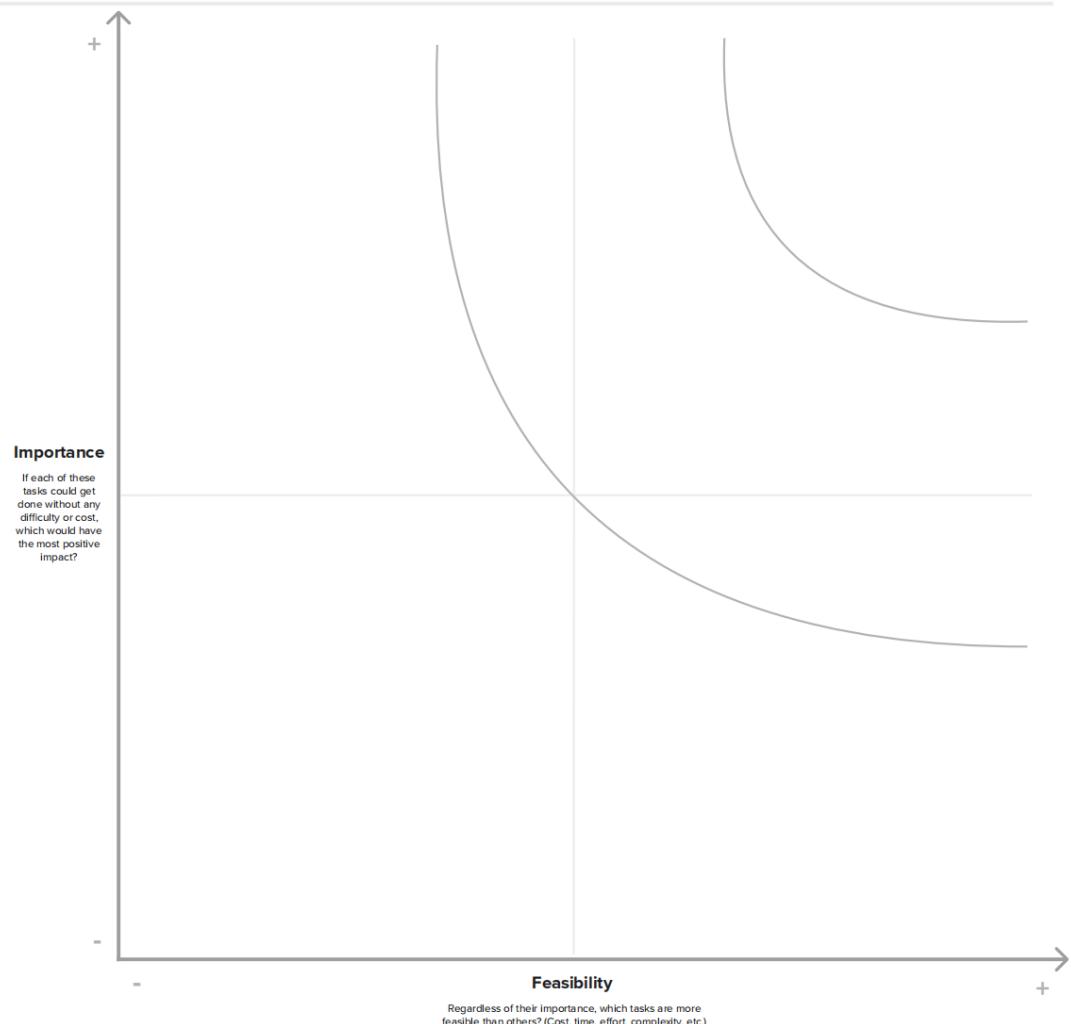
Prioritize

Prioritizing Solutions for Electricity Consumption Insights: Now that we have a range of ideas for exploring electricity consumption patterns with Tableau, it's time to prioritize them. As a team, collaboratively plot each idea on this Importance-Feasibility matrix. This will help us identify which ideas are most critical for achieving valuable insights and are realistically implementable given our resources and time.

⌚ 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

3.1 CUSTOMER JOURNEY MAP

The Customer Journey Map is a strategic visualization that outlines the steps users take when interacting with electricity consumption data. In this project, the journey highlights how users transition from being unaware of data visualization tools to fully utilizing Tableau dashboards for informed decision-making. Mapping this journey helps ensure that user needs are met at each stage and identifies opportunities to improve the user experience.

In the context of this project, the journey typically begins when users become aware of the need to analyze electricity usage. This awareness may arise from challenges such as rising energy costs, operational inefficiencies, or regulatory reporting requirements. At this stage, users often feel confused or overwhelmed due to the complexity and volume of raw data available.

During the consideration phase, users begin exploring possible solutions. They may compare traditional spreadsheets, static reports, and modern visualization tools. As users are introduced to Tableau dashboards, they become more interested due to the tool's interactive features, visual clarity, and ease of use. Users start to see the value of visualizing electricity consumption trends and begin to trust the platform as a reliable resource.

The decision phase is where users adopt Tableau dashboards as their primary tool for analysis. At this point, they feel more confident and empowered. They engage with interactive filters, regional comparisons, and sector-based charts to extract meaningful insights.

Finally, in the action phase, users apply the insights to make impactful decisions—such as infrastructure upgrades, conservation strategies, or reporting improvements. This phase also includes sharing dashboards with teams, stakeholders, or the public, enhancing collaboration and transparency.

The Customer Journey Map helps align the project's features with user expectations and reveals areas for enhancement, such as better onboarding materials, responsive support, and advanced filtering capabilities.

3.2 SOLUTION REQUIREMENTS

Functional Requirements:

Following are the functional requirements of the proposed solution.

| FR No. | Functional Requirement (Epic) | Sub Requirement (Story / Sub-Task) |
|--------|-------------------------------|---|
| FR-1 | Data Ingestion | Upload consumption data (CSV/API), Connect smart meter data |
| FR-2 | Data Preprocessing | Handle missing values, normalize formats, timestamp conversion |
| FR-3 | Dashboard Visualization | Line/bar graphs, pie charts, interactive filters (region, device, time) |
| FR-4 | Alerts & Insights | Trigger overconsumption alerts, generate daily/weekly insights |

Non-functional Requirements:

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

| FR No. | Non-Functional Requirement | Description |
|---------------|-----------------------------------|--|
| NFR-1 | Usability | Dashboards should be interactive and easy to interpret for all user levels |
| NFR-2 | Security | Data access must be restricted to authenticated users |
| NFR-3 | Reliability | System must consistently process and display accurate consumption data |
| NFR-4 | Performance | Dashboards should load and respond within 2 seconds |
| NFR-5 | Availability | Dashboards should load and respond within 2 seconds |
| NFR-6 | Scalability | Should handle large datasets and multiple user sessions simultaneously |

3.3 DATA FLOW DESIGN

A Data Flow Diagram (DFD) is a traditional visual representation of the information flows within 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.

The Data Flow Diagram (DFD) plays a crucial role in visualizing how electricity consumption data is processed within the project. It serves as a blueprint that maps the flow of data from its initial source to its final presentation in the form of interactive dashboards. This helps stakeholders understand the architecture behind the scenes and how each component contributes to delivering insights.

At the initial stage, raw electricity consumption data is collected from reliable sources such as government databases or utility providers. This raw data often exists in CSV or Excel format and typically contains details like state-wise electricity usage, sectoral consumption, and monthly or annual breakdowns.

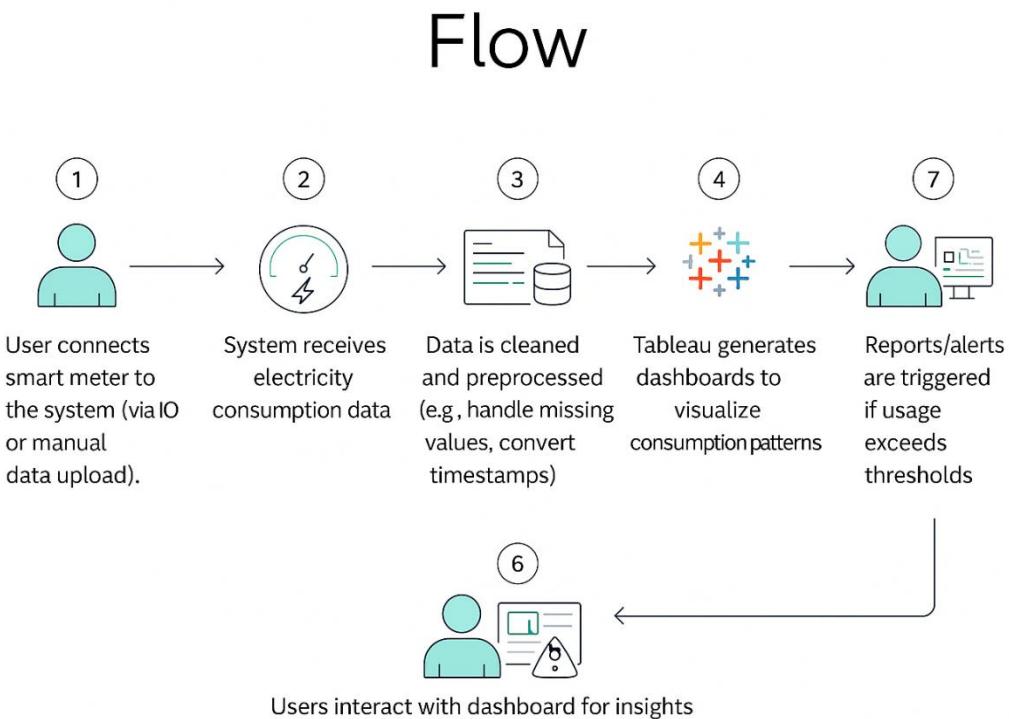
The next step involves preprocessing the data using tools like Microsoft Excel or Python. During this stage, the data is cleaned, formatted, and standardized to ensure consistency and usability. This may include handling missing values, normalizing units, and filtering out irrelevant or duplicate records.

Once cleaned, the processed dataset is imported into Tableau. Here, the data is structured into worksheets and dashboards that support interactive filtering, comparison, and visualization. Tableau allows for creating bar charts, line graphs, maps, and other visual formats that transform raw data into meaningful insights.

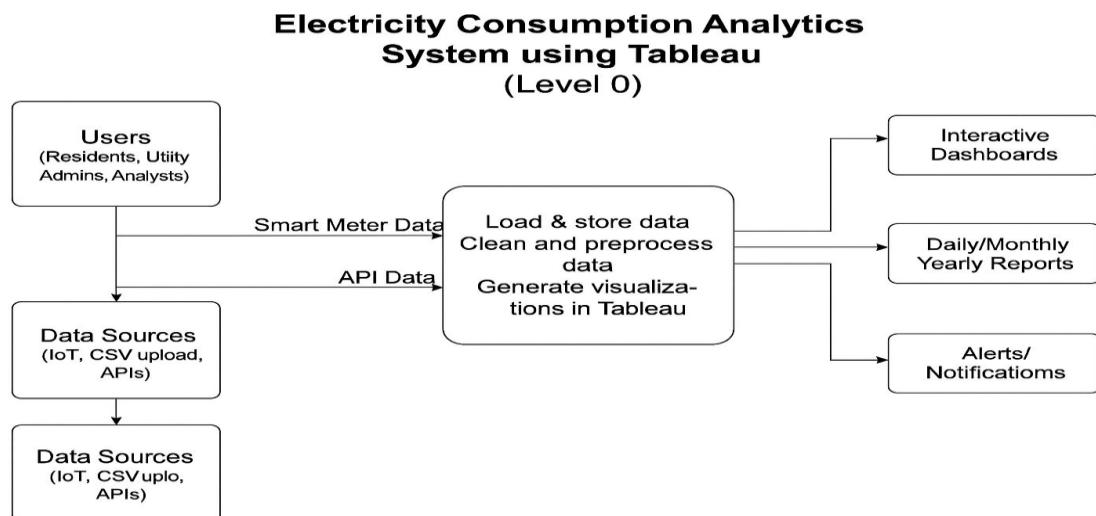
Users interact with the final Tableau dashboard, applying filters such as region, year, or sector to explore specific patterns. This dynamic interface enables stakeholders to extract custom insights based on their needs.

The DFD not only clarifies the data journey but also highlights opportunities for optimization, such as automating the preprocessing step or integrating real-time data feeds in the future.

Example:



Example : DFD (LEVEL 0)



User Stories

Use the below template to list all the user stories for the product.

| User Type | Functional Requirement (Epic) | User Story Number | User Story / Task | Acceptance criteria | Priority | Release |
|---------------|-------------------------------|-------------------|--|--|----------|----------|
| Resident | Data Monitoring | USN-1 | As a user, I want to track my daily electricity usage through a dashboard. | Usage data visible and updated on a daily basis | High | Sprint-1 |
| Analyst | Regional Comparison | USN-2 | As a data analyst, I want to compare electricity usage across cities or zones. | Comparison chart available using filters | High | Sprint-2 |
| Utility Admin | Alerts & Notifications | USN-3 | As an admin, I want to get alerts when a user's consumption exceeds average usage. | Email or dashboard alert generated for threshold breach | Medium | Sprint-2 |
| Resident | Insights | USN-4 | As a user, I want to know which appliances consume the most electricity. | Appliance-level usage shown via visual (if data supports it) | Medium | Sprint-3 |
| Stakeholder | Dashboard Access & Reporting | USN-5 | As a stakeholder, I want downloadable reports from Tableau dashboards for review and meetings. | PDF/CSV report generation enabled | High | Sprint-3 |

3.4 TECHNOLOGY STACK

Technical Architecture:

The technology stack selected for this project ensures efficient data handling, seamless visualization, and an intuitive user experience. It comprises a combination of tools and platforms chosen to support every phase of the data visualization lifecycle—from preprocessing to presentation.

Microsoft Excel is used in the early stages for data cleaning and formatting. It allows for quick inspection, identification of missing or erroneous values, and basic structuring of datasets before they are fed into the visualization tool. For users less familiar

with coding, Excel serves as a user-friendly environment to perform essential data preparation tasks.

Tableau Public is the core visualization tool in this project. Known for its drag-and-drop functionality and ability to connect to a wide variety of data sources, Tableau makes it easy to create interactive and informative dashboards. Users can apply filters, drill down into specific dimensions, and export insights visually without writing any code. Tableau Public also allows sharing dashboards online, increasing accessibility.

CSV/Excel Files serve as the data storage format throughout the process. These formats ensure compatibility across platforms and make it simple to import data into Tableau or other tools.

The Deliverable shall include the architectural diagram as below and the information as per the table1 & table 2

Example: Order processing during pandemics for offline mode

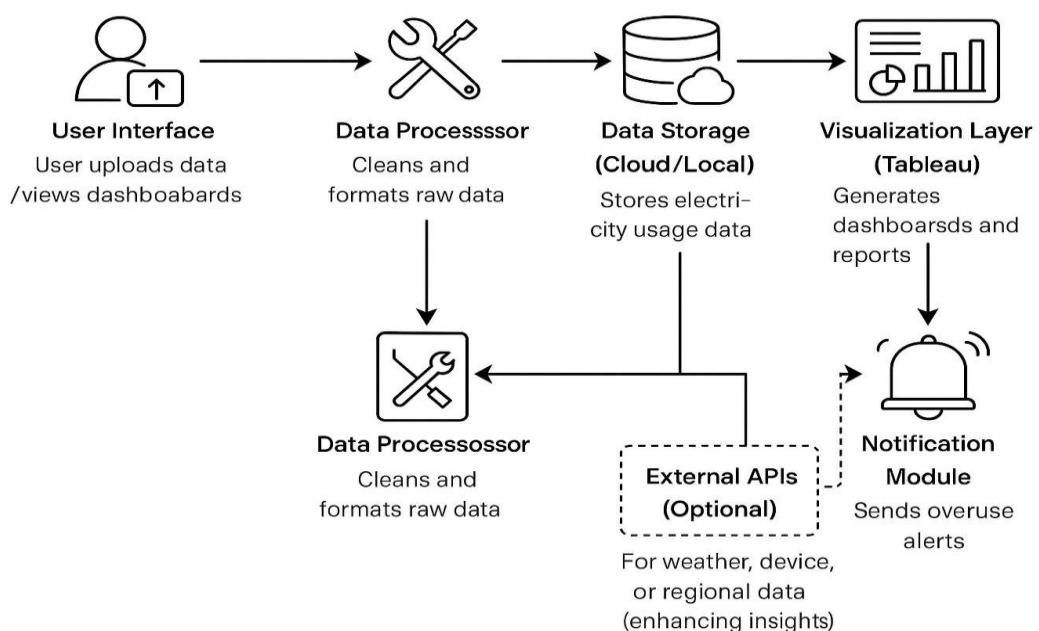


Table-1 : Components & Technologies:

| S.No | Component | Description | Technology |
|------|------------------------|---------------------------------------|---------------------------------------|
| 1. | User Interface | Upload files, interact with dashboard | Tableau Public, HTML/CSS (embedded) |
| 2. | Application Logic-1 | Data Cleaning & Preprocessing | Python (Pandas, NumPy) |
| 3. | Application Logic-2 | Load data to Tableau | Tableau Extract API, CSV Connector |
| 4. | Database | Data Storage | PostgreSQL / Google Sheets / AWS RDS |
| 5. | Cloud Database | File and dashboard hosting | Google Drive / AWS S3 / Azure Storage |
| 6. | External API(optional) | Weather or smart grid data | OpenWeather API / Smart Meter APIs |
| 7. | Notification Service | Alert generation for abnormal usage | Python Script + SMTP / Twilio API |

Table-2: Application Characteristics:

| S.No | Characteristics | Description | Technology |
|------|--------------------------|--|----------------------------------|
| 1. | Open-Source Frameworks | Based on open-source platforms for flexibility | Python, Tableau Public |
| 2. | Security Implementations | Secure data access with user-level permissions | Encrypted Upload, OAuth (if any) |
| 3. | Scalable Architecture | Can handle large data uploads and dashboard scaling | Tableau Server / Cloud Infra |
| 4. | Availability | Dashboard accessible 24/7 via embedded or hosted service | Tableau Public, Cloud Hosting |
| 5. | Performance | Fast loading dashboards and real-time filters | Optimized extracts in Tableau |

4. PROJECT DESIGN

4.1 Problem – Solution Fit Template:

The Problem-Solution Fit simply means that you have found a problem with your customer and that the solution you have realized for it actually solves the customer's problem. It helps entrepreneurs, marketers and corporate innovators identify behavioural patterns and recognize what would work and why .

Purpose:

- Solve complex problems in a way that fits the state of your customers.
- Succeed faster and increase your solution adoption by tapping into existing mediums and channels of behaviour.
- Sharpen your communication and marketing strategy with the right triggers and messaging.
- Increase touch-points with your company by finding the right problem-behaviour fit and building trust by solving frequent annoyances, or urgent or costly problems.
- Understand the existing situation in order to improve it for your target group.

Despite the availability of extensive electricity usage data, stakeholders often lack the tools or expertise to interpret and use this data effectively. This leads to inefficient energy planning, wastage, and missed opportunities for optimization.

Problem Statement: How can electricity consumption data be visualized effectively to reveal usage patterns, identify inefficiencies, and support data-driven energy management decisions?

Plugging into the Future: An Exploration of Electricity Consumption Patterns Using Tableau

| | | |
|---|---|--|
| CUSTOMER SEGMENTS) Urban households Utility companies Smart city planners Policy makers Environmental analysts Energy consultants | 6. CUSTOMER LIMITATIONS (E.G, BUDGET: DEVICES) <ul style="list-style-type: none">Limited tech-savvinessBudget constraints for pare toolsLack of acces to IoT-enabled metersPreference for visual easy-to-use-dashboards | 5. AVAILABLE SOLUTIONS (PLUSSES & MINUSES) <ul style="list-style-type: none">Monthly utility reports (Too late, not detailed)Smart meters (High cost of InstalllEnergy audits (Intrequent, coslty)Mobile energy monitoring app (Lack visual insights, unified compare) |
| PROBLEMS / PAINS & PREQUENCY) Inability to monitor real-time electricity consumption Lack of awareness of high-usage appliances Difficulty in comparing consumption across regions or time periods High clectricity bills with no actionable insights Manual or delayed reporting in energy data analysis | 9. ROOT / CAUSE OF PROBLEM <ul style="list-style-type: none">Lack of actionable, rel-time insightsPoor visibility of usage trendsComplex raw data that users don't understand | 7. BEHAVIOR (ITS INTENSITY) <ul style="list-style-type: none">Sporadic tracing of electricityLow engagement unless bill is unusually highReactive rather than proactive energy management |
| EMOTIONS (BEFORE:/ AFTER) Before: Frustration, confusion, concern about rising costs After: Empowerment confidence in energy-saving decisions | 10. YOUR SOLUTION Interactive Tableau Dashboard <ul style="list-style-type: none">Offers real-time, visual fracking of electricif) consumptionIdentifies peak usage times and high-energy appliances | 8. CHANNELS OF BEHAVIOR Online: Tableau dashboards Offline: Utility portals Energy apps Smart home devices Customer supp centers Printed bills and reports Community workshops or energy-saving seminars |

4.2 PROPOSED SOLUTION

The proposed solution centres on the development of a user-friendly and interactive Tableau dashboard to visualize electricity consumption data. This dashboard includes a variety of visual formats such as time-series charts, sector-wise bar graphs, and geo-based heatmaps to help identify consumption patterns, trends, and anomalies. The system is designed to integrate data from diverse sources and deliver actionable insights.

It stands out for its tailored functionality—supporting specific user needs and behaviours—and is capable of adapting to smart grid data, weather impacts, and other dynamic metrics. Socially, the dashboard encourages sustainable energy use, supports policymaking, and raises awareness among the public. It also enhances customer

satisfaction by offering clear, real-time insights for energy cost savings and operational efficiency.

From a business perspective, the solution allows for scalable implementation via SaaS models, customized dashboard consulting, and premium analytics services. Its scalability is underpinned by Tableau's architecture, which can manage large volumes of data and integrate with a wide range of future data inputs.

| S.No. | Parameter | Description |
|-------|--|--|
| 1. | Problem Statement (Problem to be solved) | Current electricity data analysis is complex and lacks clear visualizations, hindering efficient energy management, forecasting, and waste reduction. There's a need for an intuitive tool to reveal consumption insights. |
| 2. | Idea / Solution description | Develop an interactive Tableau dashboard to visualize and analyze electricity consumption patterns. This includes data preparation and creating various charts (time-series, heatmaps filters to identify trends and anomalies. |
| 3. | Novelty / Uniqueness | Tailored, user-friendly Tableau dashboard for electricity data, integrating diverse sources. It provides specific, actionable insights into consumption behaviour, going beyond generic visualizations and easy user interpretation. |
| 4. | Social Impact / Customer Satisfaction | <p>Social Impact: Promotes energy conservation, aids policy-making, and optimizes grid management for stable supply. Increases public awareness of sustainable energy.</p> <p>Customer Satisfaction: Provides immediate visual insights for cost savings and improved efficiency for energy managers and businesses.</p> |
| 5. | Business Model (Revenue Model) | Potential models include SaaS subscriptions for organizations, custom dashboard development, consulting on energy data analysis, and premium access to aggregated consumption analytics. |
| 6. | Scalability of the Solution | Highly scalable with Tableau's robust architecture, handling large data volumes. Easily adaptable to include more data sources (e.g., smart meters, weather) and features. Can monitor consumption across regions or buildings. |

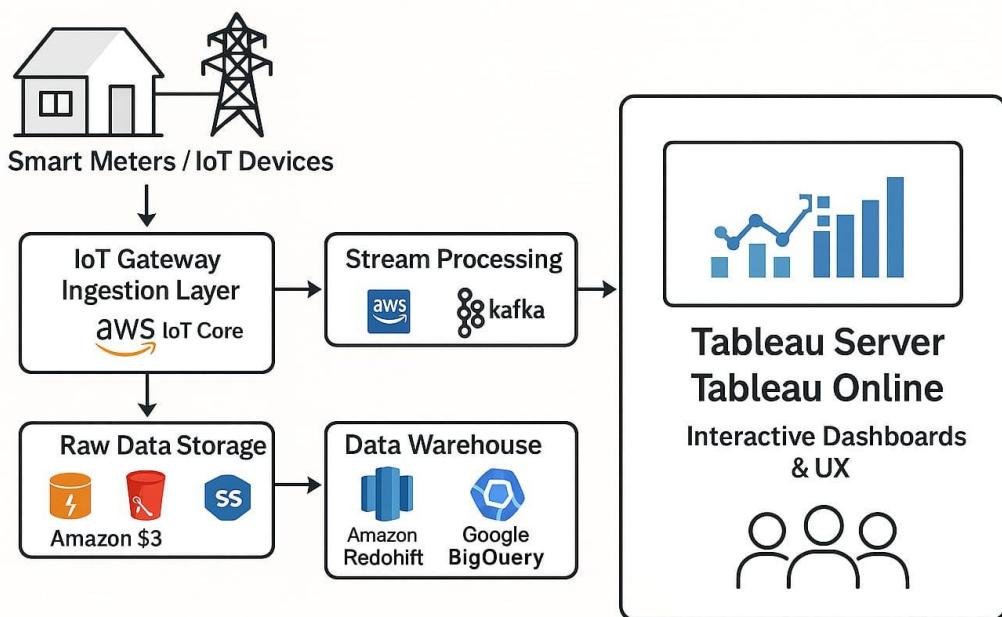
4.3 SOLUTION ARCHITECTURE

Solution architecture is a complex process – with many sub-processes – that bridges the gap between business problems and technology solutions. The solution architecture for this project is designed to ensure smooth integration, scalability, and efficient data processing for visualizing electricity consumption patterns. It follows a modular structure that facilitates data collection, transformation, visualization, and interaction through well-defined stages.

Its goals are to:

- Find the best tech solution to solve existing business problems.
- Describe the structure, characteristics, behaviour, and other aspects of the software to project stakeholders.
- Define features, development phases, and solution requirements.
- Provide specifications according to which the solution is defined, managed, and delivered.

Example - Solution Architecture Diagram:



Solution Architecture Diagram

5. PROJECT PLANNING AND SCHEDULING

5.1 PROJECT PLANNING

The project starts with planning and scheduling to ensure smooth execution and timely delivery. It's divided into clear, manageable stages.

The project begins with collecting electricity consumption data from official sources. The data is then cleaned using Excel or Python for consistency. Next, dashboard layouts and wireframes are designed to guide Tableau development. Visualizations are built, tested, and refined based on feedback. Finally, findings are documented and presented. Each stage is carefully scheduled to ensure smooth execution and timely delivery.

Product Backlog, Sprint Schedule, and Estimation:

Use the below template to create product backlog and sprint schedule

| Sprint | Functional Requirement (Epic) | User Story Number | User Story / Task | Story Points | Priority | Team Members |
|----------|-------------------------------|-------------------|--|--------------|----------|----------------------------|
| Sprint-1 | Data Collection | USN-1 | As a utility admin, I want to collect real-time electricity usage from smart meters. | 3 | High | Chavadi Kiran Ganesh |
| Sprint-1 | Data Storage | USN-2 | As a developer, I want to store raw and processed data securely for analysis. | 2 | High | Kothapalem Vijaya Vardhini |
| Sprint-2 | Data Processing | USN-3 | As an analyst, I want to transform and clean data for better visualization. | 2 | Medium | Depuru Joshika Reddy |
| Sprint-3 | Dashboard Design | USN-4 | As a user, I want to view daily, weekly, and monthly energy usage visually. | 2 | High | Kondireddy Sravani |
| Sprint-3 | Comparative Analysis | USN-5 | As a policymaker, I want to compare consumption across regions in Tableau. | 1 | Medium | Addepalli Nikhitha |
| Sprint-4 | Notifications / Alerts | USN-6 | As a user, I want to receive alerts when energy usage exceeds a threshold. | 2 | Low | Addepalli Nikhitha |

Project Tracker, Velocity & Burndown Chart:

| Sprint | Total Story Points | Duration | Sprint Start Date | Sprint End Date (Planned) | Story Points Completed (as on Planned End Date) | Sprint Release Date (Actual) |
|----------|--------------------|----------|-------------------|---------------------------|---|------------------------------|
| Sprint-1 | 20 | 2 Days | 20-JUNE-2025 | 21-JUNE-2025 | 20 | 21-JUNE-2025 |
| Sprint-2 | 20 | 2 Days | 22-JUNE-2025 | 23-JUNE-2025 | 20 | 23-JUNE-2025 |
| Sprint-3 | 20 | 2 Days | 24-JUNE-2025 | 25-JUNE-2025 | 20 | 25-JUNE-2025 |
| Sprint-4 | 20 | 2 Days | 26-JUNE-2025 | 27-JUNE-2025 | 20 | 27-JUNE-2025 |

Buffer/Presentation:

28-Jun-2025 – Final project compilation and presentation/demo.

Velocity:

Imagine we have a 10-day sprint duration, and the velocity of the team is 20 (points per sprint). Let's calculate the team's average velocity (AV) per iteration unit (story points per day)

$$AV = \frac{\text{sprint duration}}{\text{velocity}} = \frac{20}{10} = 2$$

Burndown Chart:

A burndown chart is a graphical representation of work left to do versus time. It is often used in agile software development methodologies such as scrum. However, burn down charts can be applied to any project containing measurable progress over time.

6. FUNCTIONAL AND PERFORMANCE TESTING

6.1 PERFORMANCE TESTING

Performance testing is a critical part of this project to ensure that the Tableau dashboards operate efficiently, particularly when handling large datasets or serving multiple users. The goal of performance testing is to validate that the visualizations are fast, responsive, and stable under different conditions of data volume and user interaction.

Performance Testing in a database context usually refers to testing:

- How fast queries run.
- How efficient the schema and indexing are.
- How the system handles large volumes of data or complex queries

It includes Data Quality Checks i.e., Querying for NULL values helps identify incomplete data, which can affect performance .Ensures cleaner data before testing system performance.

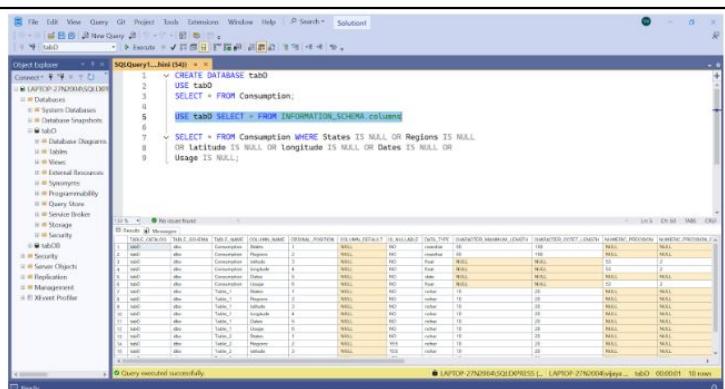
The screenshot shows the Microsoft SQL Server Management Studio (SSMS) interface. On the left is the Object Explorer pane, which shows a tree view of the database structure, including databases like 'tabD' and its tables 'Consumption' and 'Table_1'. The main area has two panes: a code editor at the top and a results grid at the bottom. The code editor contains a T-SQL script that creates a database 'tabD', uses it, and then selects from the 'Consumption' table. It also includes a query to select all columns from the 'INFORMATION_SCHEMA.columns' table. Below this, there's another query to select from the 'Consumption' table where various columns (States, Regions, latitude, longitude, Dates, Usage) are NULL. The results grid displays the results of this last query, showing 18 rows of data for the 'Consumption' table. The status bar at the bottom indicates the query was executed successfully on 'LAPTOP-27N2004\SQLEXPRESS' at '00:00:01'.

| TABLE_CATALOG | TABLE_SCHEMA | TABLE_NAME | COLUMN_NAME | ORDINAL_POSITION | COLUMN_DEFAULT | IS_NULLABLE | DATA_TYPE | CHARACTER_MAXIMUM_LENGTH | CHARACTER_OCTET_LENGTH | NUMERIC_PRECISION | NUMERIC_PRECISION_F |
|---------------|--------------|-------------|-------------|------------------|----------------|-------------|-----------|--------------------------|------------------------|-------------------|---------------------|
| tabD | dbo | Consumption | States | 1 | NULL | NO | nvarchar | 50 | 100 | NULL | NULL |
| tabD | dbo | Consumption | Regions | 2 | NULL | NO | nvarchar | 50 | 100 | NULL | NULL |
| tabD | dbo | Consumption | latitude | 3 | NULL | NO | float | NULL | NULL | 53 | 2 |
| tabD | dbo | Consumption | longitude | 4 | NULL | NO | float | NULL | NULL | 53 | 2 |
| tabD | dbo | Consumption | Dates | 5 | NULL | NO | date | NULL | NULL | NULL | NULL |
| tabD | dbo | Consumption | Usage | 6 | NULL | NO | float | NULL | NULL | 53 | 2 |
| tabD | dbo | Table_1 | States | 1 | NULL | NO | nchar | 10 | 20 | NULL | NULL |
| tabD | dbo | Table_1 | Regions | 2 | NULL | NO | nchar | 10 | 20 | NULL | NULL |
| tabD | dbo | Table_1 | latitude | 3 | NULL | NO | nchar | 10 | 20 | NULL | NULL |
| tabD | dbo | Table_1 | longitude | 4 | NULL | NO | nchar | 10 | 20 | NULL | NULL |
| tabD | dbo | Table_1 | Dates | 5 | NULL | NO | nchar | 10 | 20 | NULL | NULL |
| tabD | dbo | Table_1 | Usage | 6 | NULL | NO | nchar | 10 | 20 | NULL | NULL |
| tabD | dbo | Table_2 | States | 1 | NULL | NO | nchar | 10 | 20 | NULL | NULL |
| tabD | dbo | Table_2 | Regions | 2 | NULL | YES | nchar | 10 | 20 | NULL | NULL |
| tabD | dbo | Table_2 | latitude | 3 | NULL | YES | nchar | 10 | 20 | NULL | NULL |

Then it performs Schema Design Review which will extract Appropriate data types, Nullability, Column lengths and Bad schema design which can slow down performance. It also performs measuring execution time, analyzing query plans, adding indexes if needed, testing with larger data volumes.

Overall, the performance testing phase confirmed that the solution is robust, scalable, and ready for deployment, offering smooth and reliable user experiences.

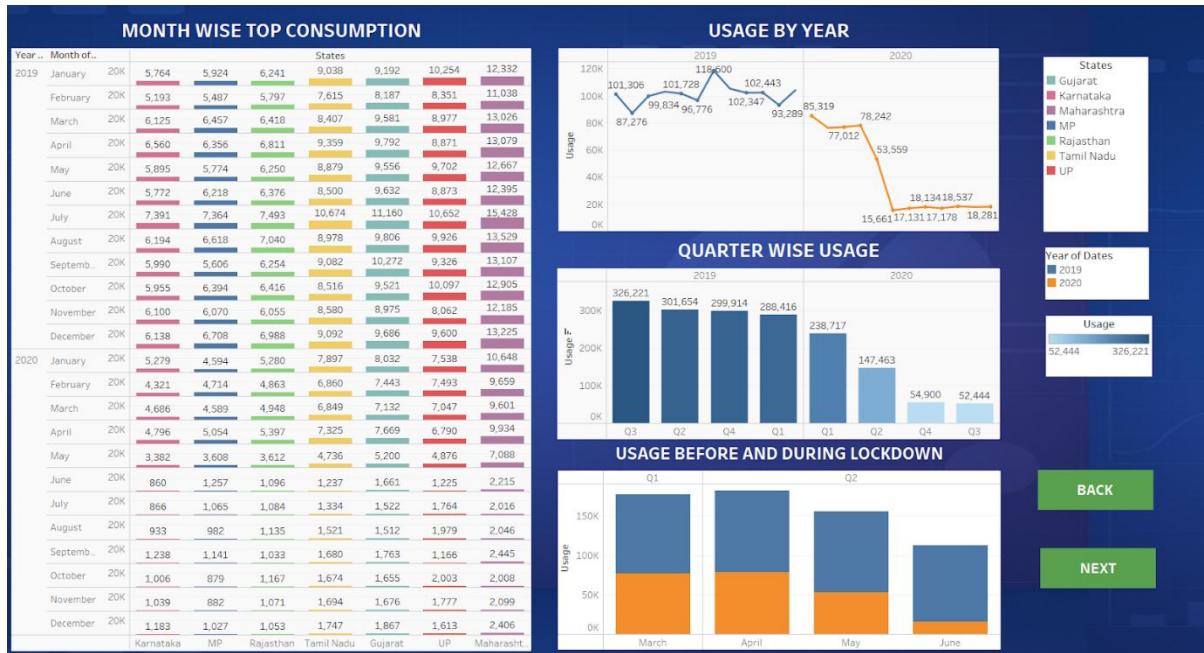
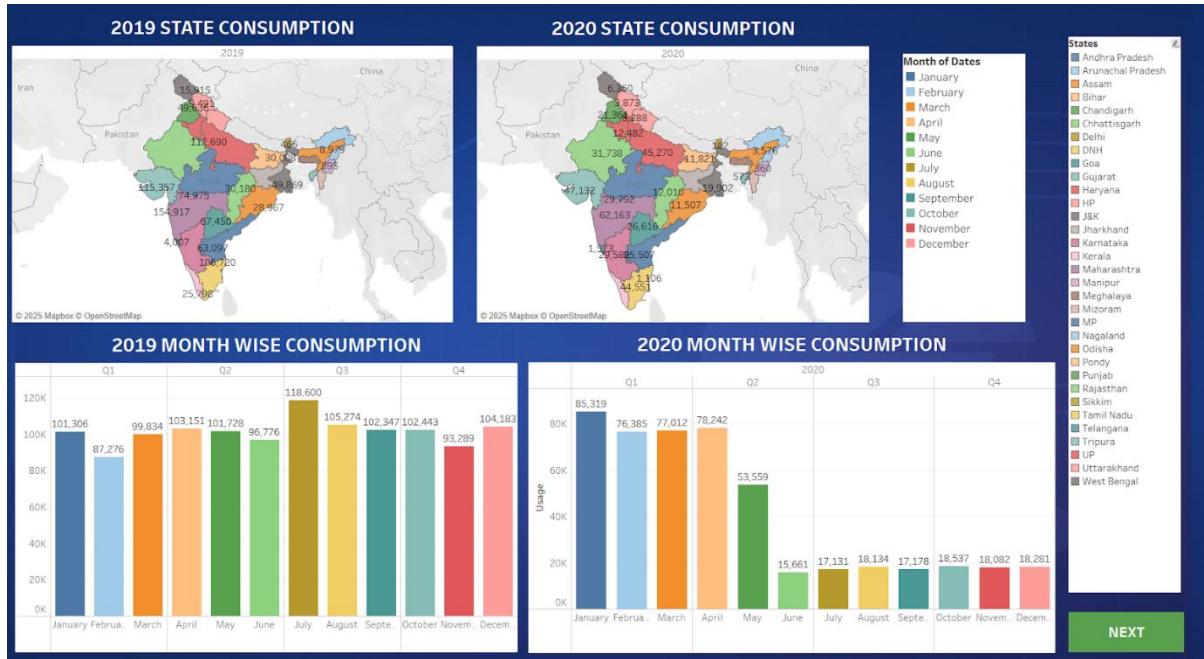
Model Performance Testing:

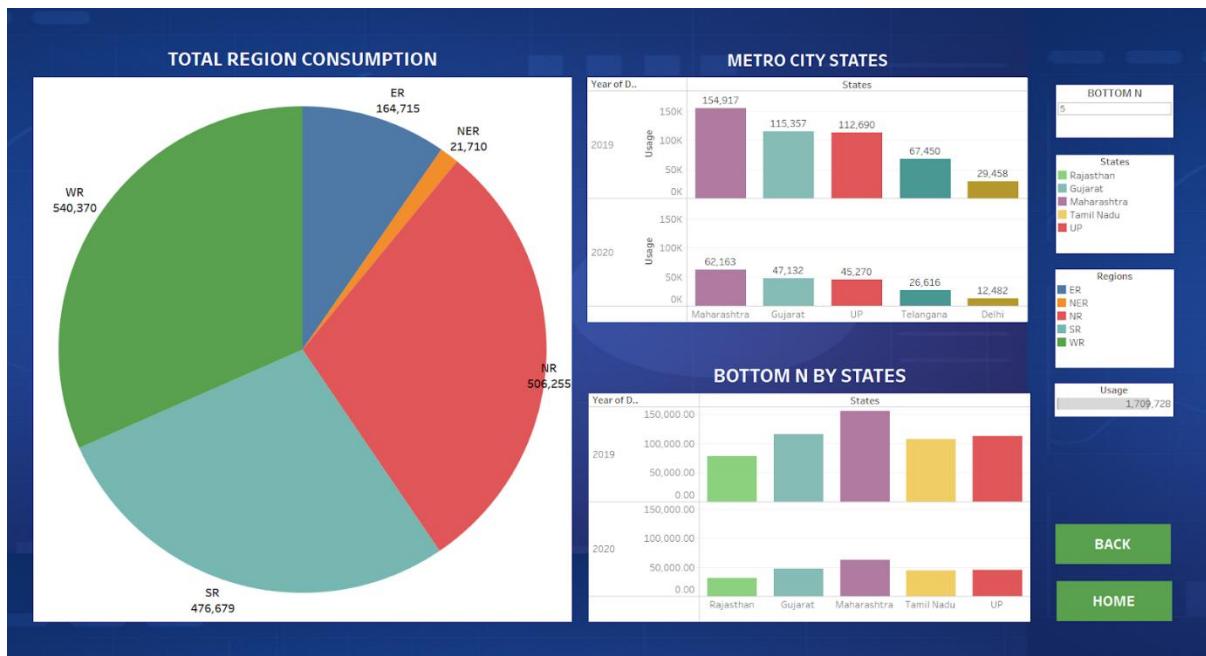
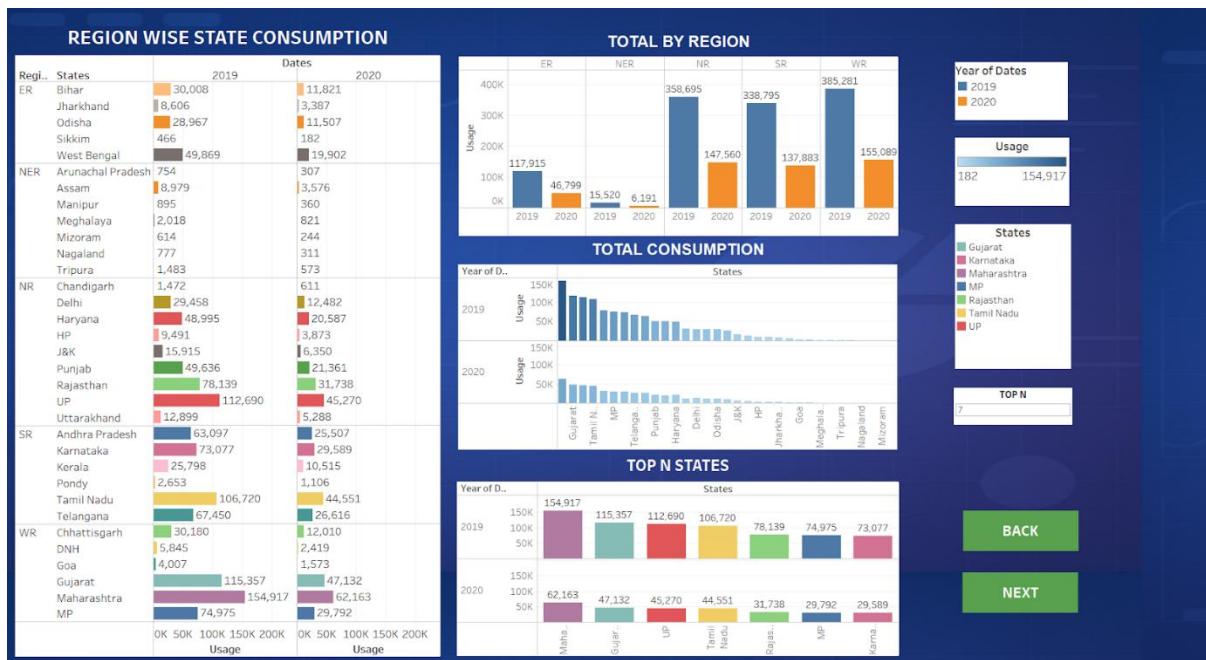
| S.No. | Parameter | Screenshot / Values |
|-------|-------------------------|---|
| 1. | Data Rendered |  |
| 2. | Data Preprocessing | The data is pre-processed initially. |
| 3. | Utilization of Filters | Filters such as States, Year (dates):2020, Year (dates):2019, Month (dates). |
| 4. | Calculation fields Used | No calculation fields are used. |
| 5. | Dashboard design | No of Visualizations / Graphs - 15 |
| 6. | Story Design | No of Visualizations / Graphs - 15 |

7. RESULTS

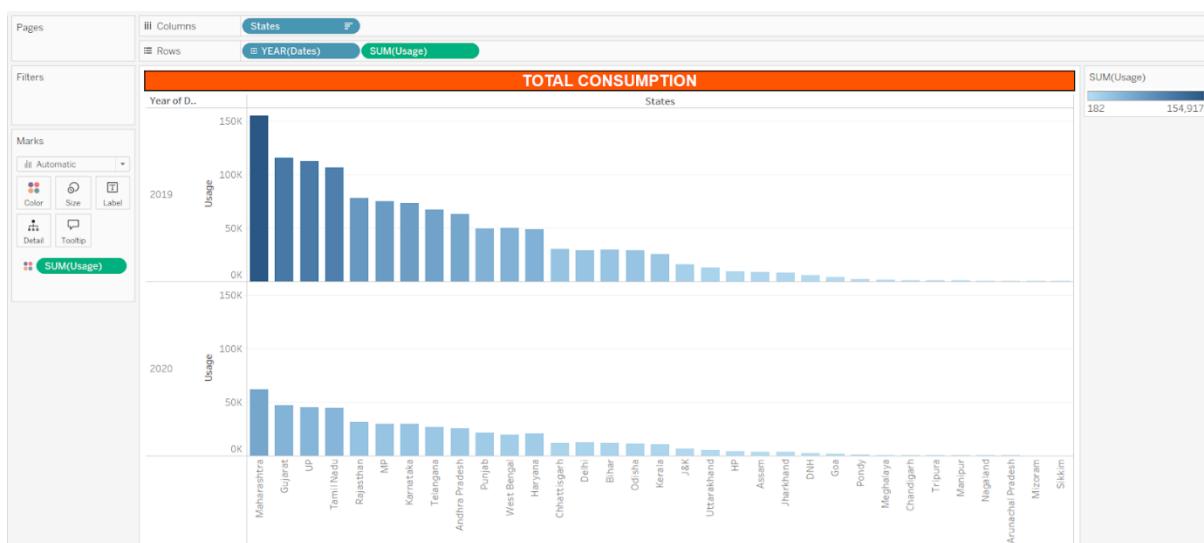
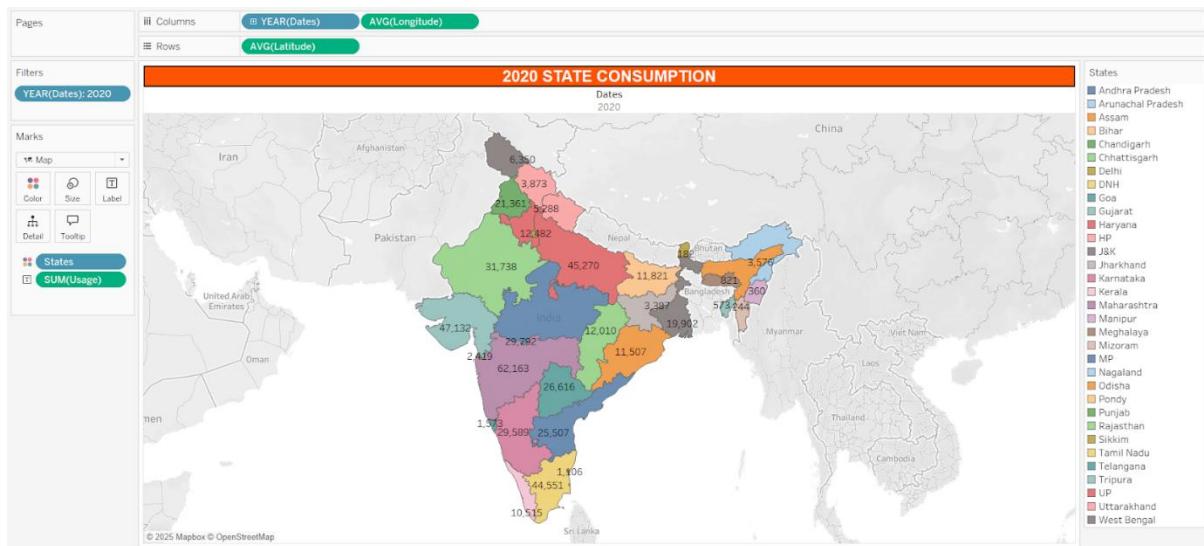
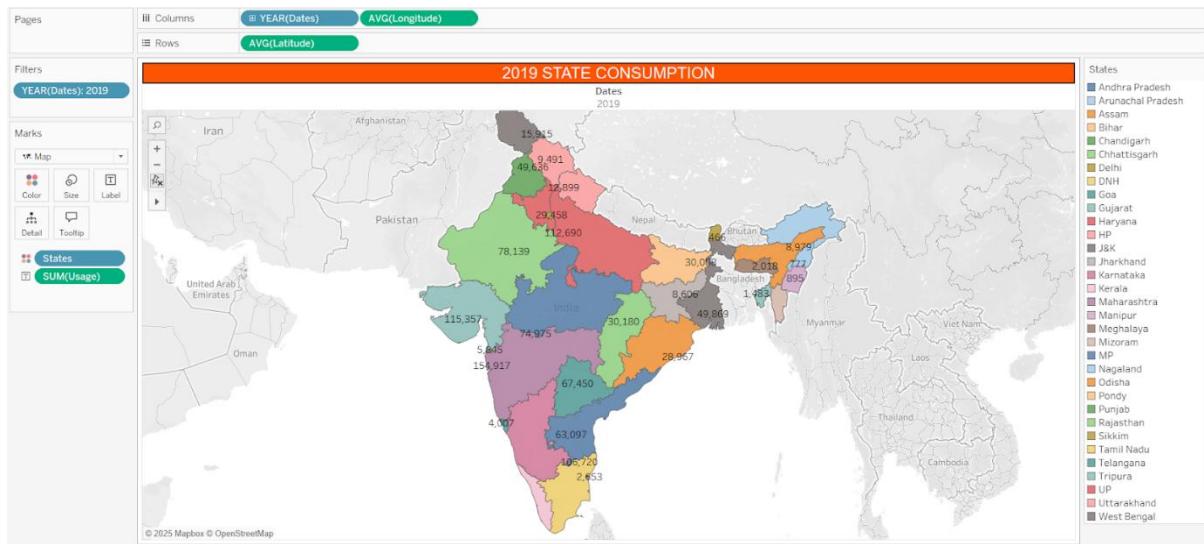
7.1 OUTPUT SCREENSHOTS

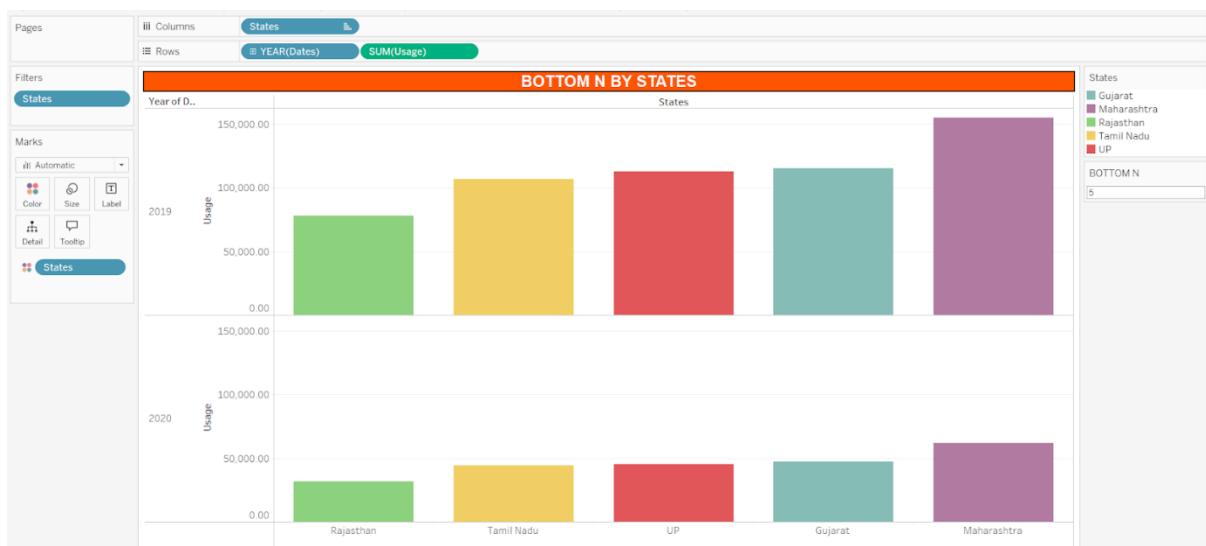
DASHBOARDS

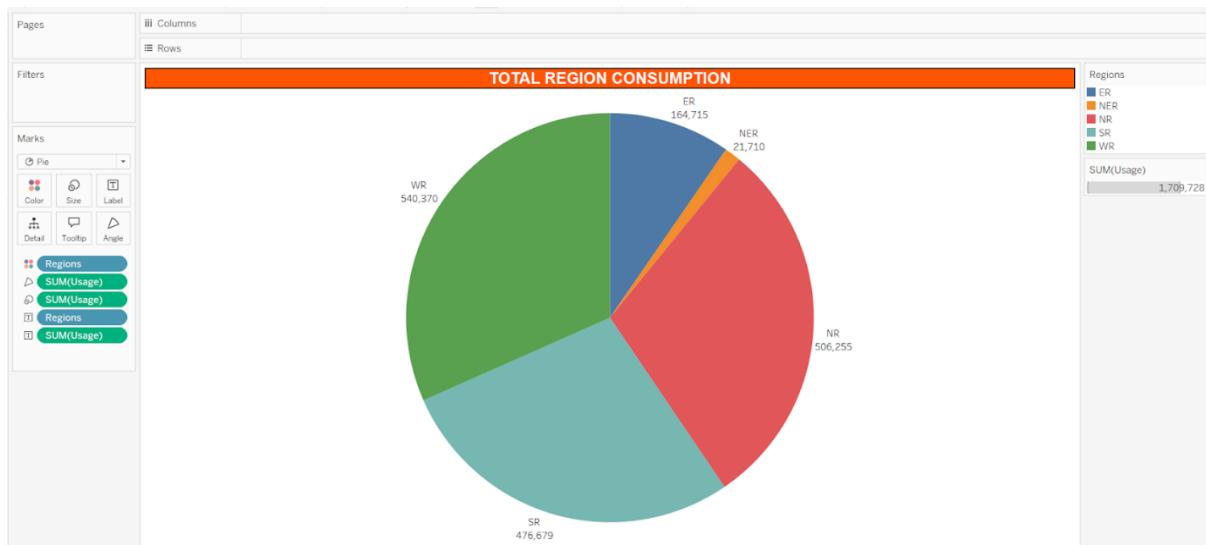


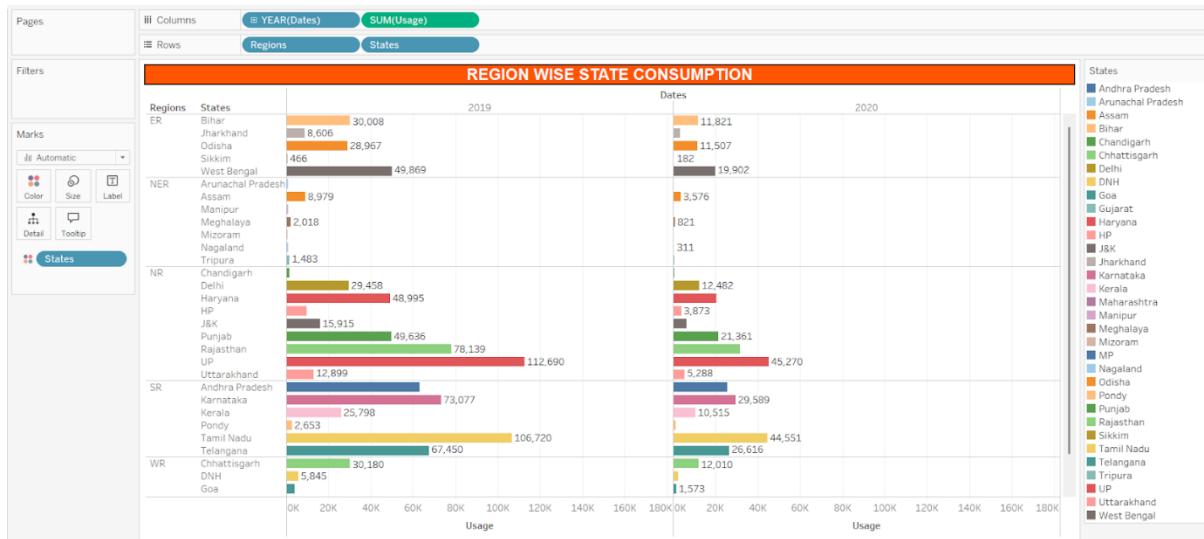
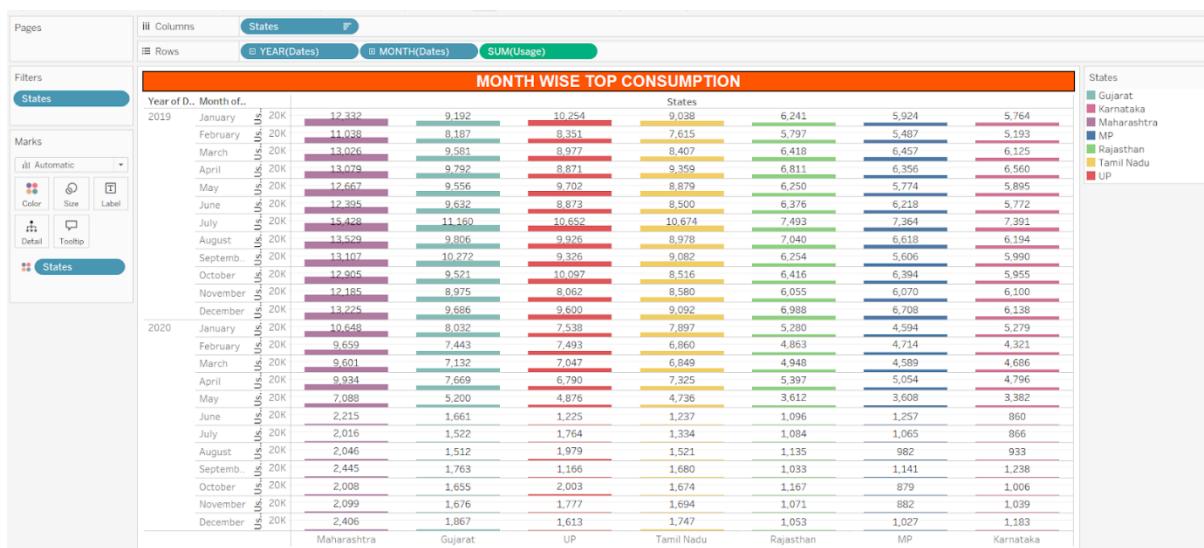
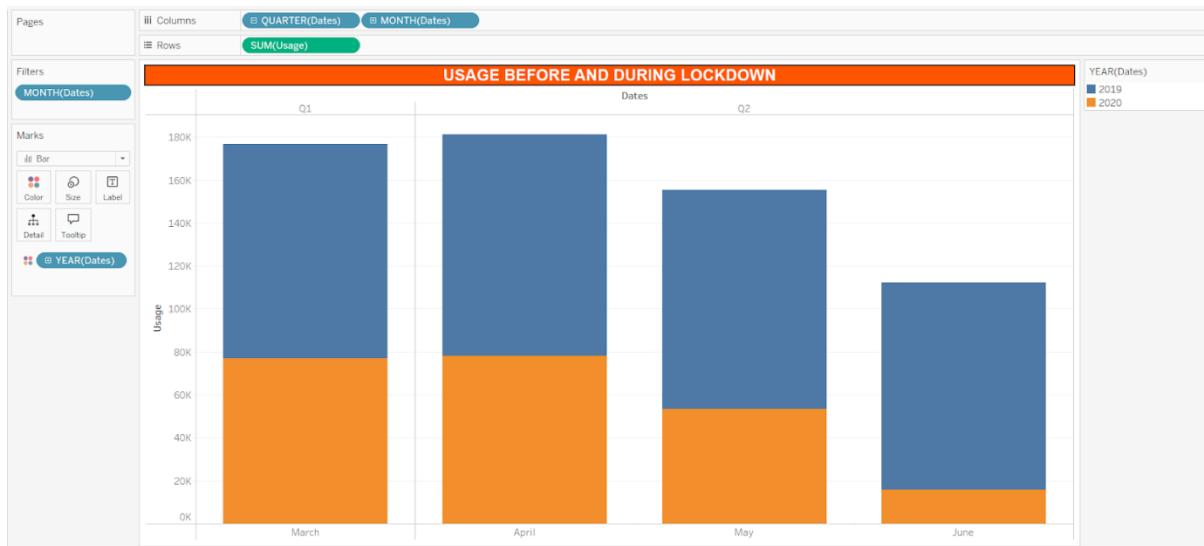


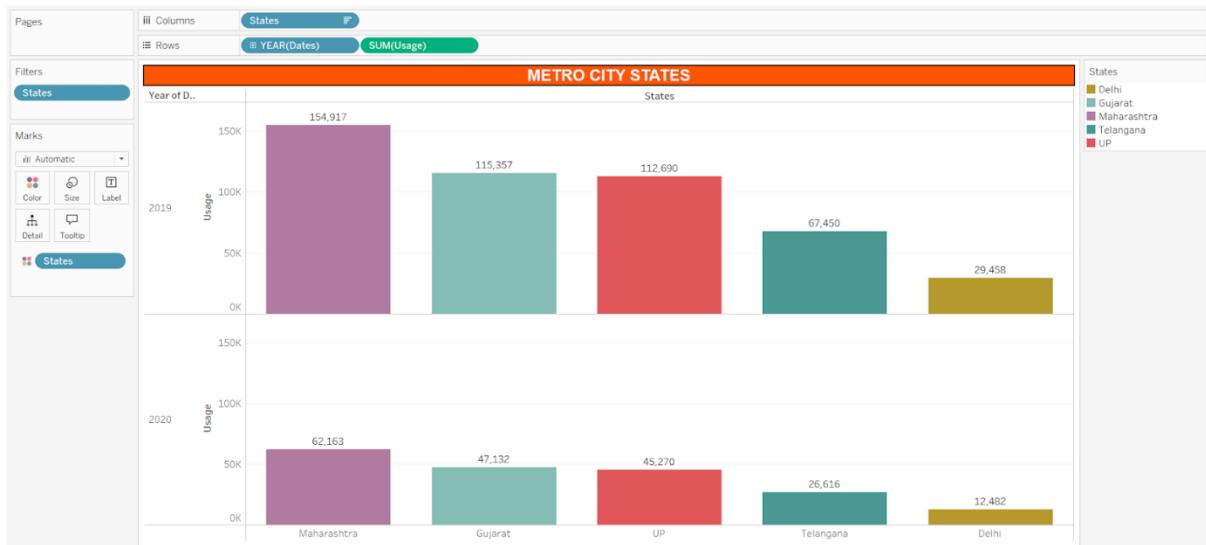
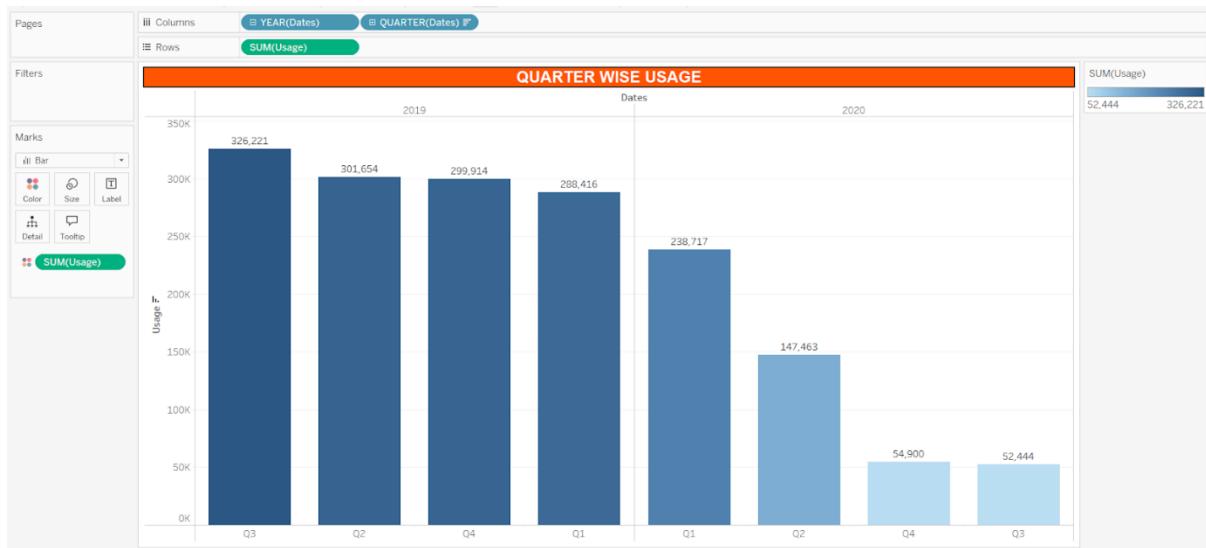
STORY











8. ADVANTAGES AND DISADVANTAGES

ADVANTAGES

- Enables real-time data exploration.
- Presents data in an easy-to-understand visual format.
- Identifies peak and idle usage hours effectively.
- Encourages sustainable and conscious energy practices.
- Offers a user-friendly interface suitable for all users.
- Helps detect anomalies and reduce energy wastage.
- Enhances data transparency and facilitates informed policy decisions.
- Can be integrated with cloud platforms for scalability.

DISADVANTAGES

- Heavily dependent on the quality and freshness of the data.
- Static insights if the dataset is not frequently updated.
- May require initial training to navigate advanced dashboards.
- Tableau Public has limited real-time capabilities and lower data security.
- Requires stable internet connectivity for Tableau Public visualizations.
- May face limitations with very large datasets unless optimized.
- Not all users may have access to Tableau-compatible devices.
- Limited custom scripting capabilities compared to full programming platforms.
- Integration with complex APIs can be restricted without paid Tableau version.
- Exporting and automating dashboards may require third-party tools.

9. CONCLUSION

Through this project, we have demonstrated the power and potential of data-driven tools like Tableau to drive informed energy management. The project titled "*Plugging into the Future*" not only refers to electricity as a central theme but also symbolizes a progressive leap toward smarter, more sustainable decision-making based on data.

By collecting, preprocessing, and visualizing real-world electricity consumption data, we were able to uncover patterns and insights that offer valuable guidance for policymakers, businesses, and consumers alike. These insights include identifying consumption peaks, regional disparities, seasonal behaviours, and usage anomalies. Such information is essential for making energy systems more efficient, cost-effective, and resilient.

The interactive Tableau dashboards developed during this project serve as accessible tools for visual storytelling, transforming raw datasets into digestible and actionable visual narratives. Users can engage with the data dynamically—applying filters, zooming into specific sectors, and uncovering trends that would otherwise remain hidden in spreadsheets.

This initiative also reinforces the broader significance of data literacy and visual analytics in public planning and sustainable energy development. The ability to turn large-scale datasets into strategic insights empowers not only energy managers but also urban planners, researchers, and local governments to take proactive measures.

In essence, this project proves that each meaningful insight—no matter how small—can contribute to a larger vision of energy efficiency and sustainability. *Plugging into the future* thus becomes more than a metaphor; it becomes a mission to use data and technology as levers for building a better, more informed tomorrow.

10. FUTURE SCOPE

The success of this project opens several promising pathways for future enhancement and expansion. While the current implementation effectively visualizes electricity consumption data, there are multiple ways in which the system can be scaled and refined to offer even greater value.

One of the most impactful directions is the **integration of real-time data streams**. By connecting to APIs or smart meter feeds, the dashboards can transition from historical analysis to real-time monitoring. This would provide stakeholders with up-to-the-minute insights into energy usage, allowing for faster responses to anomalies and more proactive energy management.

Another area for development lies in **predictive analytics**. By incorporating machine learning algorithms, the system could forecast electricity demand based on historical trends, weather patterns, and demographic data. Such forecasting would be particularly valuable for energy providers and urban planners in managing load distribution and anticipating infrastructure needs.

Mobile optimization and multilingual support could further increase the accessibility of the dashboard, ensuring it is usable across diverse populations and on various platforms, from smartphones to tablets.

Lastly, there is potential to develop this as a **commercial or public platform**, offering subscription-based access or open-source collaboration for educational institutions, energy research centres, and government bodies.

In summary, the foundation laid by this project provides a versatile base upon which numerous advanced features and applications can be built—transforming a static dashboard into a dynamic, intelligent energy management tool.

11. APPENDIX

DATASET LINK:

https://drive.google.com/file/d/1JxIkHNwXxjFztKq7ad0_KtkukCqTekNy/view

PROJECT DEMO LINK:

https://drive.google.com/file/d/1Lu5Nakh2h3bFD9p3VaHQHly2nIDE-uHG/view?usp=drive_link

GITHUB PROJECT LINK:

<https://github.com/Vijaya-27/Plugging-into-the-Future-An-Exploration-of-Electricity-Consumption-Patterns-Using-Tableau.git>