Plugging into the future: An Exploration of Electricity Consumption Patterns

Team ID: LTVIP2026TMIDS80013

Team Size: 03

Name	Role
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Nemani Ramya Sri	Team Member
Siddireddy Dinesh Karthik	Team Member

1. INTRODUCTION

1.1 Overview

Electricity consumption represents the amount of electrical energy that has been consumed over a specific time. The consumption pattern of energy shows the percentage use of different sources (solar energy, wind energy, geothermal energy, biogas, and tidal power). The consumption pattern of energy changes over time. Commercial sources of energy: Commercial energy makes up about 65% of the total energy consumed in India.

1.2 Purpose

The purpose of electricity is to provide a reliable and efficient source of energy to power modern society. Electricity is a form of energy that is generated from various sources, such as fossil fuels, nuclear power, hydroelectric power, wind power, solar power, and others. The primary purpose of electricity is to power homes, businesses, industries, transportation, and communication. It provides light, heat, and cooling, runs appliances and electronics, powers factories and assembly lines, supports transportation systems, and enables communication technologies.

Electricity has become an essential component of modern life and plays a crucial role in supporting economic and social development. It has revolutionized the way we live, work, and communicate, and it has contributed to many technological advancements that have improved the quality of life for people around the world. Electricity has significant environmental implications, and its production and consumption have a significant impact on the environment. Therefore, the purpose of electricity also includes the need to generate and use it in a sustainable and responsible manner, minimizing its impact on the environment.

2. IDEATION PHASE

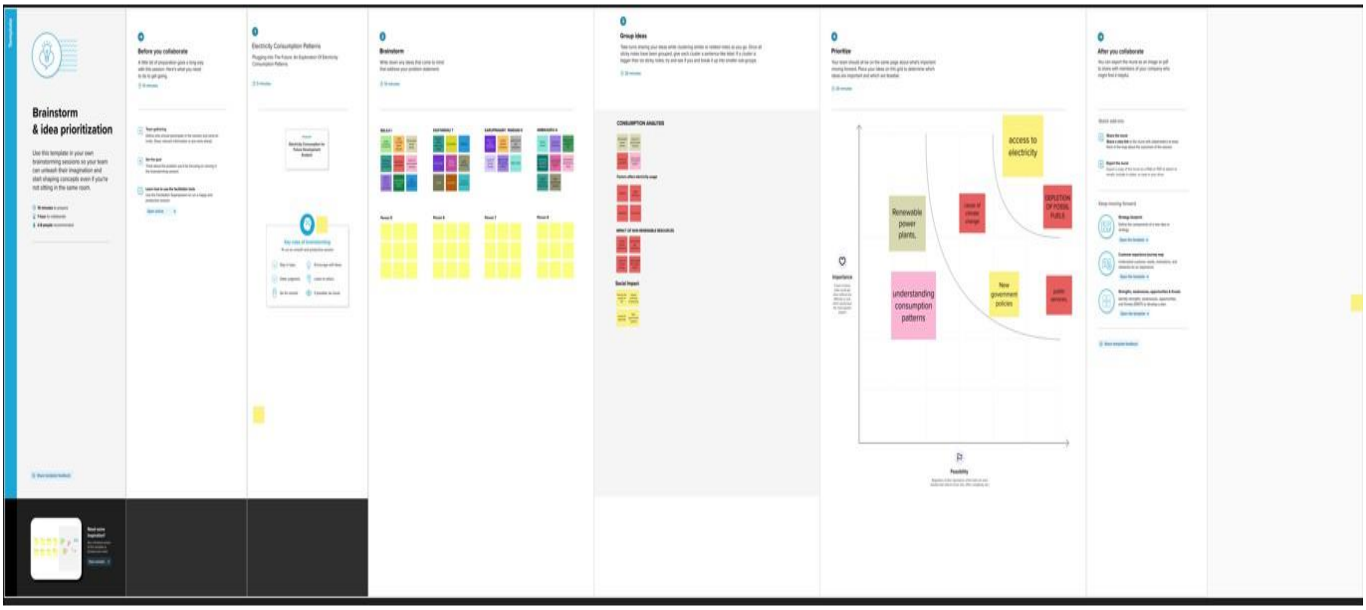
2.1 Problem statement:

Electricity consumption is increasing rapidly across different regions and sectors in India. However, there is limited visibility into how electricity usage varies by time, region, and sector. Without proper data visualization and analysis, it becomes difficult for utility companies, policymakers, and stakeholders to identify peak demand periods, regional disparities, and long-term consumption trends.

The lack of interactive analytical tools restricts effective decision-making for energy optimization, resource planning, and sustainable power management. Therefore, there is a need to analyze electricity consumption data using an interactive visualization platform like Tableau to uncover meaningful insights and support informed energy planning

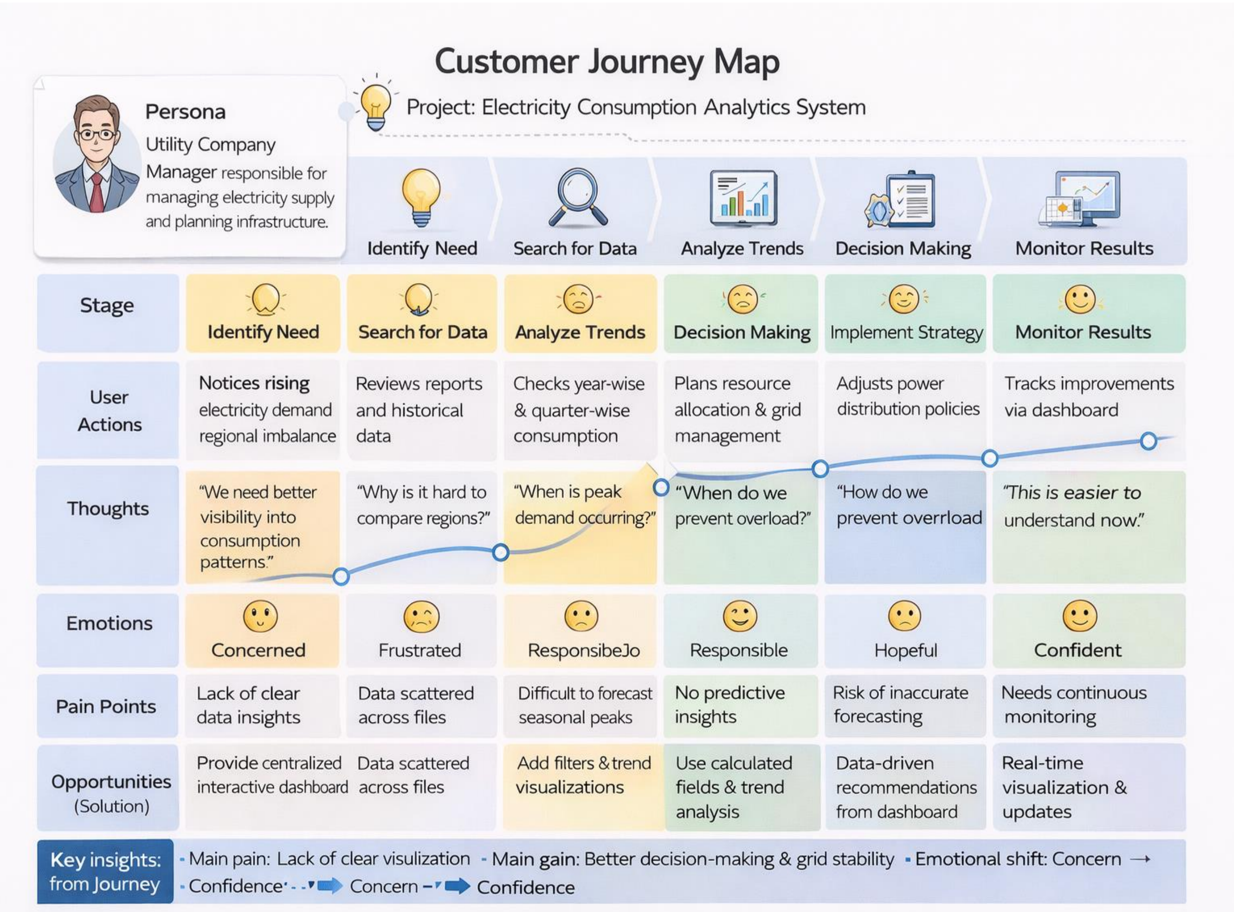
2.2 Empathy map

2.3 Ideation & Brainstorming Map



3. REQUIREMENT ANALYSIS

3.1 Customer Journey Map:

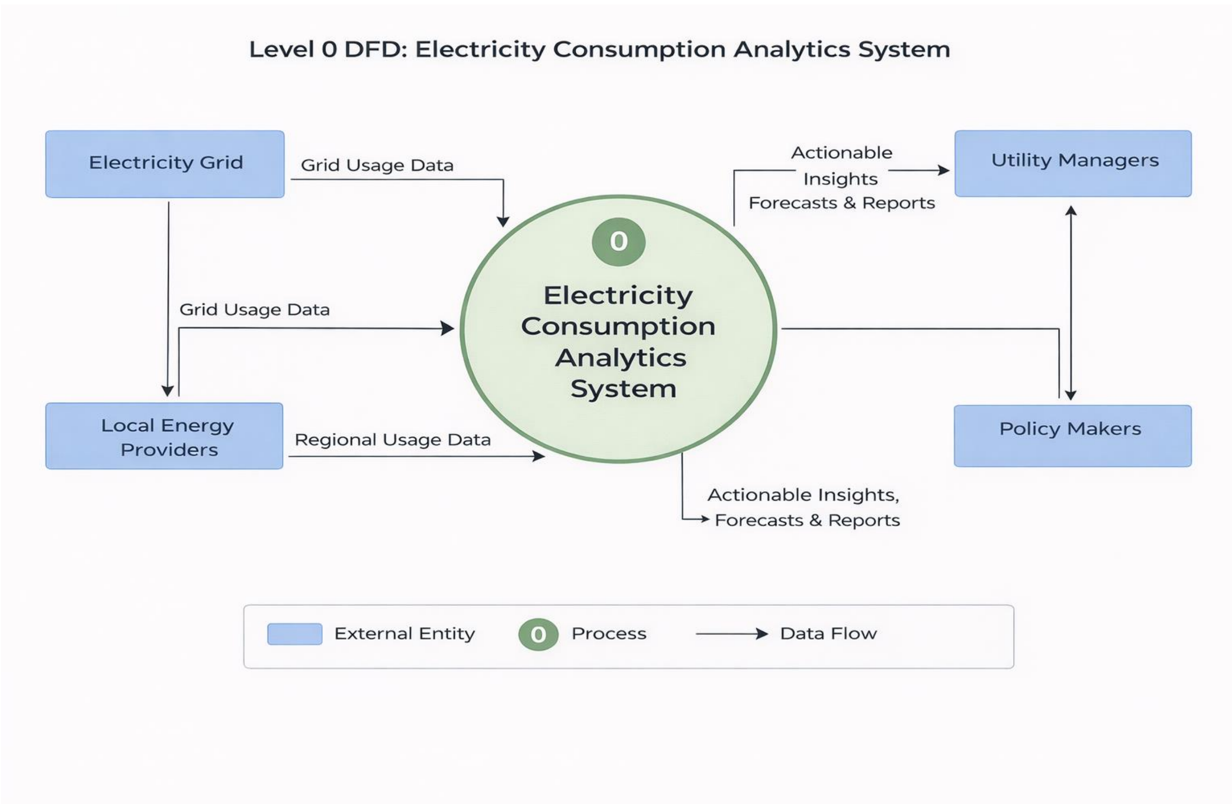


3.2 Solution Requirement

Functional Requirements of the Proposed Solution

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	**Data Collection** Data Collection	• Upload public electricity datasets • Import Excel/CSV files
FR-2	**Data Preprocessing** Data Prepocessing	• Clean and handle missing data • Format for Tableau use
FR-3	**Visualization Design** • Design dashboard layout • Format for Tableau use	• Design dashboard layout • Create charts for sectors/regions • Enable filtering options
FR-4	**Insight Generation** • Generate summaries	• Generate summaries • Highlight usage trends
FR-5	**Publishing** • Export dashboard to Tableau Public	• Export dashboard to Tableau Public • Enable sharing via link
FR-5	**Publishing** • Export dashboard to Tableau Public	• Enable sharing via link

3.3 Data Flow Diagram



The Level 0 Data Flow Diagram represents the overall Electricity Consumption Analytics System as a single main process. The system collects electricity usage data from external entities such as the Electricity Grid and Local Energy Providers. The collected data is processed and analysed to generate insights, reports, and forecasts. These outputs are then provided to Utility Managers and Policy Makers to support decision-making, energy planning, and efficient power distribution.

3.4 Technological Stack

1️⃣ Data Layer - Public Electricity Datasets (Excel / CSV)

- Source of electricity consumption data
- Contains year-wise, quarter-wise, regional, and sector-wise usage data
- Used as the primary input for analysis

2️⃣ Data Processing Layer - SQL Workbench (MySQL)

- Used for data cleaning and preprocessing
- Handled missing values and formatting
- Performed data filtering and aggregation
- Prepared structured datasets for visualization

3️⃣ Visualization Layer - Tableau Desktop

- Created interactive dashboards
- Designed charts (bar charts, pie charts, trend graphs)
- Used filters and calculated fields
- Developed story visualization
- Enabled drill-down analysis.

4️⃣ Publishing Layer - Tableau Public

- Published dashboards online
- Generated embed code
- Enabled dashboard sharing via public link

5️⃣ Web Integration Layer - Flask (Python)

- Integrated Tableau embedded dashboards
- Designed project website structure

- Managed routing and static files
- Rendered HTML templates

HTML, CSS & Bootstrap

- Structured website layout
- Designed responsive UI

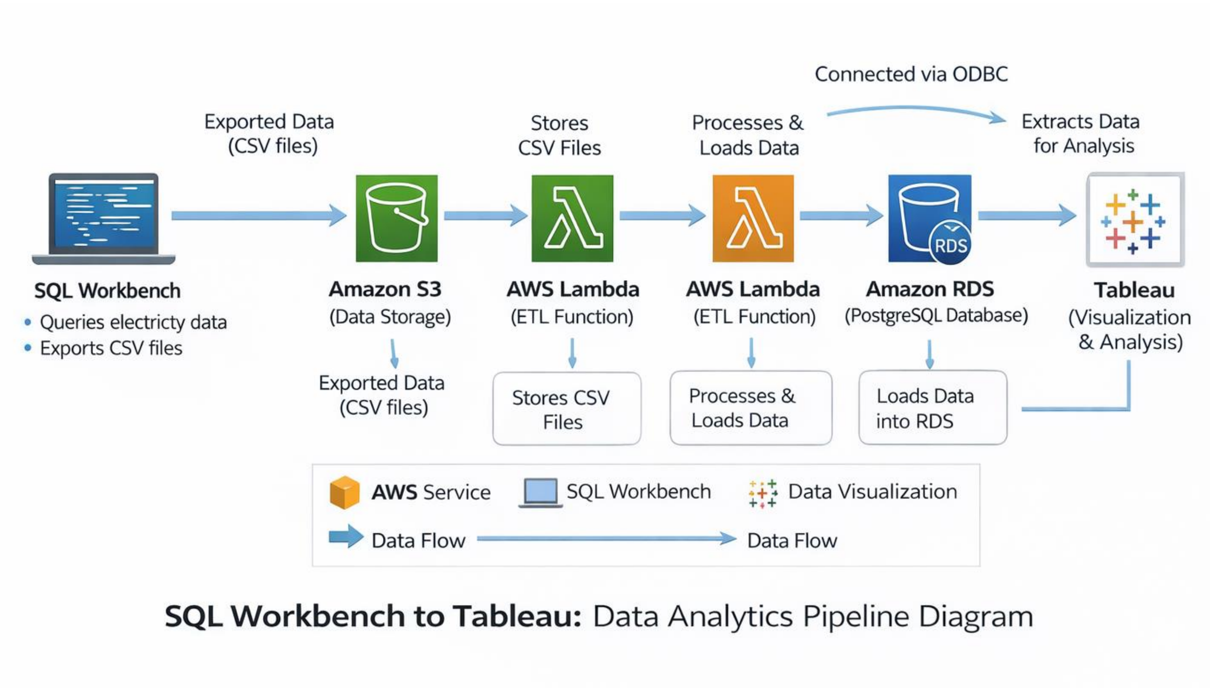
4. PROJECT DESIGN

4.1 Problem Solution fit:

4.2 Proposed Solution:

S. No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	Electricity consumption data is often underutilised due to its complexity, lack of visualization, and accessibility challenges. Stakeholders such as policymakers, analysts, and citizens lack clear insights to identify consumption trends or inefficiencies.
2.	Idea / Solution description	Develop an interactive Tableau dashboard that visualizes electricity consumption patterns across regions, sectors (residential, industrial, commercial), and time periods. The dashboard will enable stakeholders to explore, compare, and make informed energy decisions through clear, user-friendly visuals.
3.	Novelty / Uniqueness	While electricity data exists, our solution uniquely combines open data, advanced visualization, and interactivity in Tableau. It brings together seasonal patterns, sector-wise breakdowns, and geographic comparisons in one unified tool.
4.	Social Impact / Customer Satisfaction	The solution empowers government bodies and citizens to make energy-efficient decisions, supports environmental sustainability, and promotes awareness through intuitive visual storytelling. Households can see usage trends; planners can optimize policy.
5.	Business Model (Revenue Model)	The solution can be extended as a subscription- based analytics service to municipalities or utility companies. It could also be offered as a freemium public dashboard with advanced features for enterprise or government use.
6.	Scalability of the Solution	The dashboard can be scaled to incorporate national or international datasets, integrate predictive analytics, and include additional KPIs such as carbon emissions or cost forecasts. It can also be adapted for other utilities like water or gas.

4.3 Solution Architecture



SQL Workbench → CSV Export → Tableau Desktop → Tableau Public → Web Integration

- Efficient visualization
- Interactive analysis
- Easy sharing and deployment

5. PROJECT PLANNING & SCHEDULING

5.1 Project Planning - Agile Methodology

The Electricity Consumption Analytics using Tableau project was planned and executed using an Agile-based sprint approach. The project was divided into three structured sprints to ensure systematic development, continuous progress monitoring, and timely completion.

Sprint 1 – Data Preparation Phase

The first sprint focused on data collection and preprocessing activities. Public electricity consumption datasets were collected from reliable open sources. The collected data was then cleaned, formatted, and structured to ensure compatibility with Tableau. Missing values and categorical inconsistencies were identified and handled appropriately. This phase ensured that the dataset was accurate, complete, and ready for visualization.

Sprint 2 – Dashboard Development Phase

The second sprint concentrated on dashboard design and visualization development. A structured wireframe layout was created to define the visual arrangement of dashboards. Interactive visualizations were developed to display region-wise electricity usage, sector-wise comparisons, and year-wise as well as trend-based analysis. Special focus was given to trend analysis to identify peak demand periods and consumption patterns over time. This sprint transformed processed data into meaningful visual insights.

Sprint 3 – Interactivity, Deployment, and Review Phase

The third sprint focused on enhancing user interaction and final deployment. Filters were implemented to allow users to analyse data by region and sector dynamically. The dashboards were published to Tableau Public and integrated into a web application. An insight summary was prepared to highlight key findings and recommendations. Finally, a comprehensive review was conducted to validate functionality, accuracy, and overall project quality before submission.

6. FUNCTIONAL AND PERFORMANCE TESTING

6.1 Performance Testing:

The objective of performance testing is to evaluate the responsiveness, stability, and loading speed of the Electricity Consumption Analytics Dashboard under normal usage conditions. This ensures that the system performs efficiently when users interact with dashboards, apply filters, and access visualizations.

Performance Test Scope

The performance testing covered:

- Dashboard loading time
- Filter response time
- Chart rendering speed
- Data refresh performance
- Web integration responsiveness (Flask + Tableau Public)

3. Test Environment

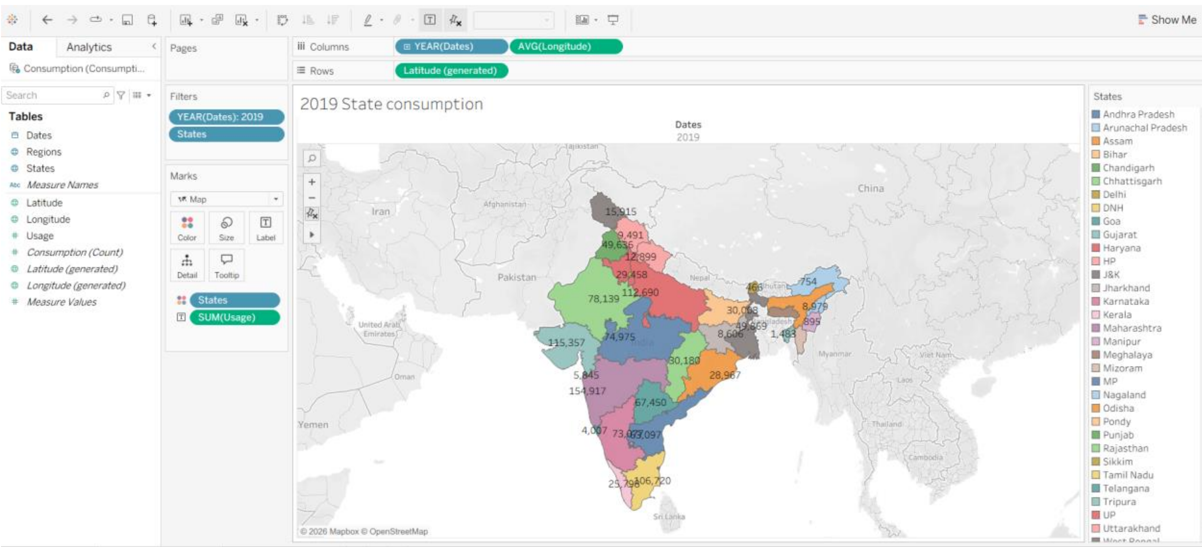
- Visualization Tool: Tableau Desktop / Tableau Public
- Backend Integration: Flask
- Dataset Type: Public electricity consumption dataset

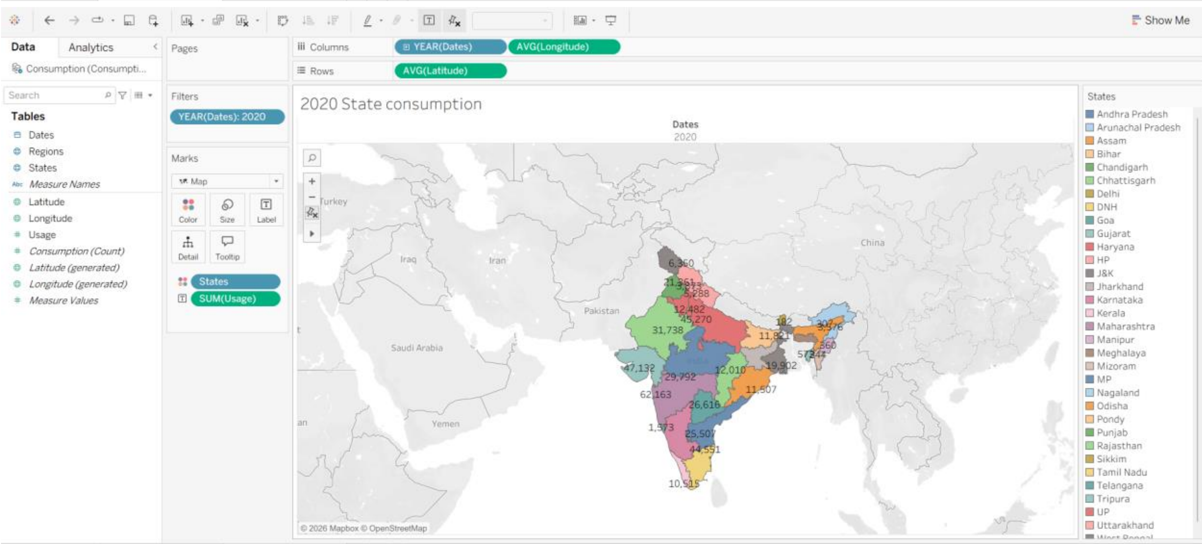
4. Performance Test Results

Parameter	Expected Result	Actual Result	Status
Initial Dashboard Load Time	< 5 seconds	3–4 seconds	Pass
Filter Application Response	< 2 seconds	1–2 seconds	Pass
Chart Rendering Time	< 3 seconds	2 seconds	Pass
Story Navigation	Smooth transition	No lag observed	Pass
Web Page Loading (Flask)	< 4 seconds	3 seconds	Pass

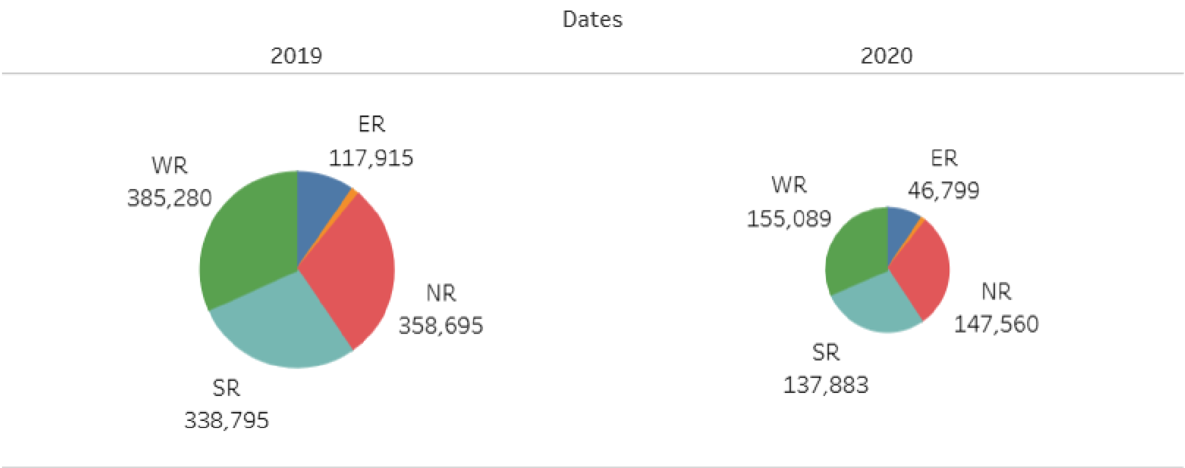
7. RESULTS

7.1 Output Screenshots:

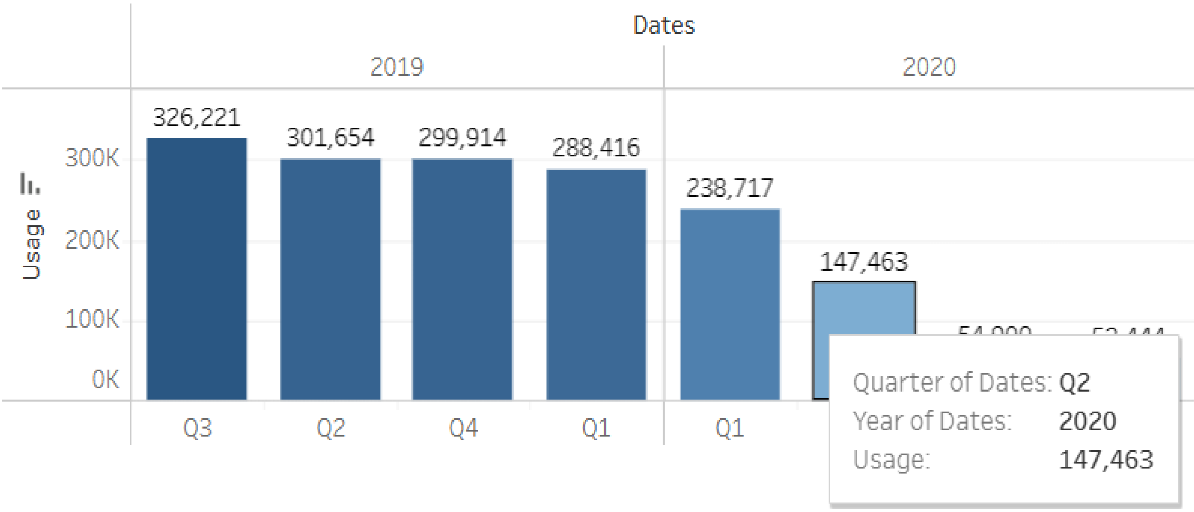




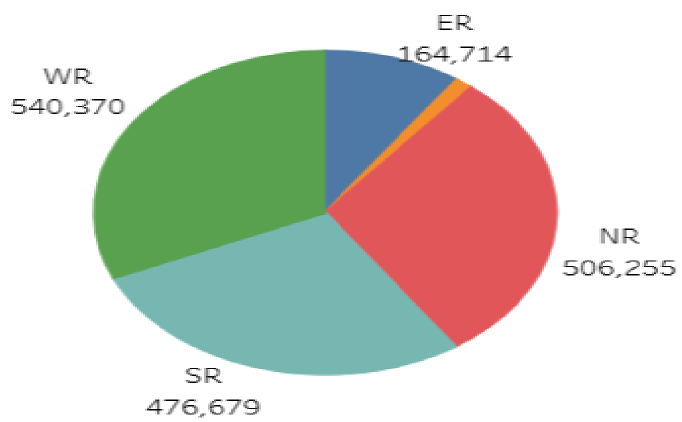
Yearwise Consumption in regions



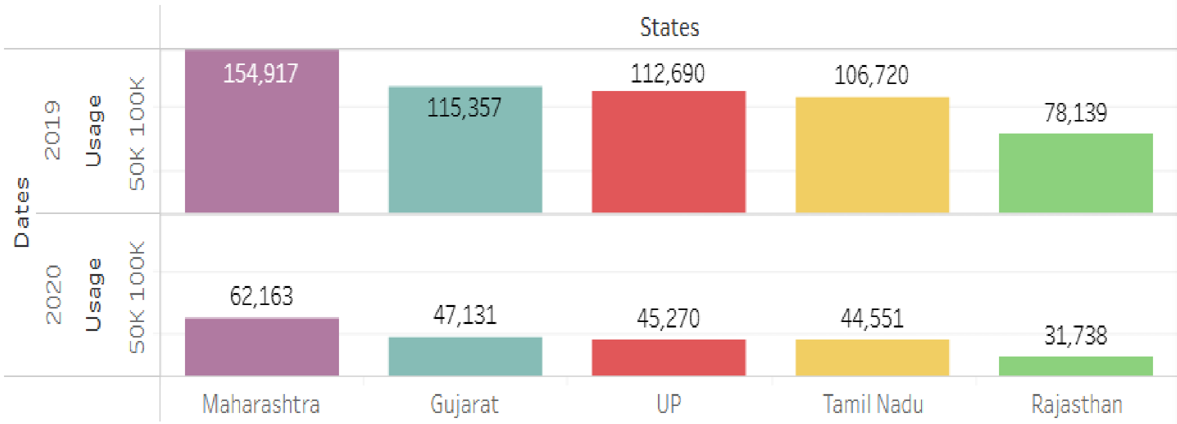
Quarterwise Usage



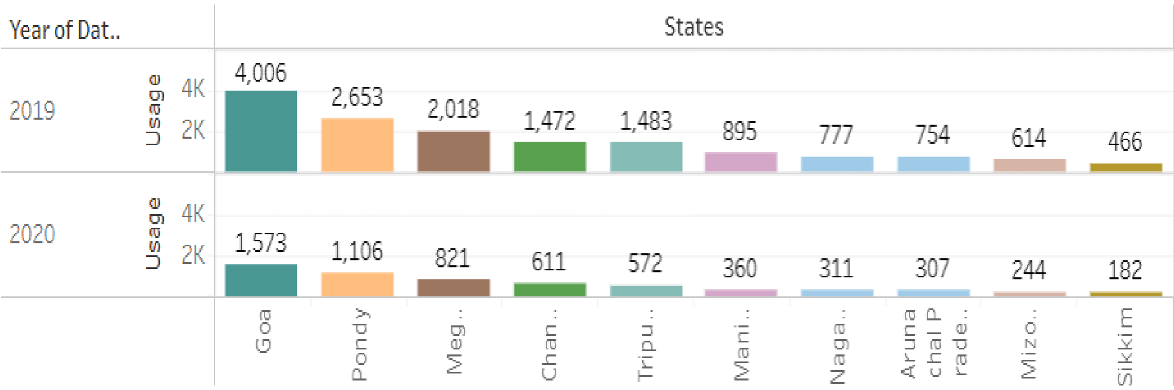
Total Region Consumption



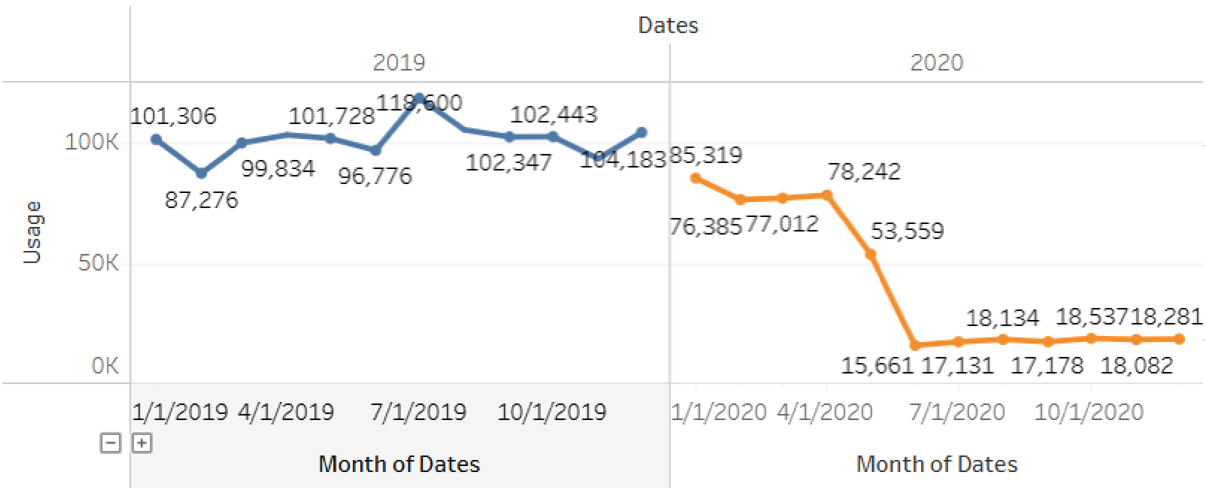
Top N

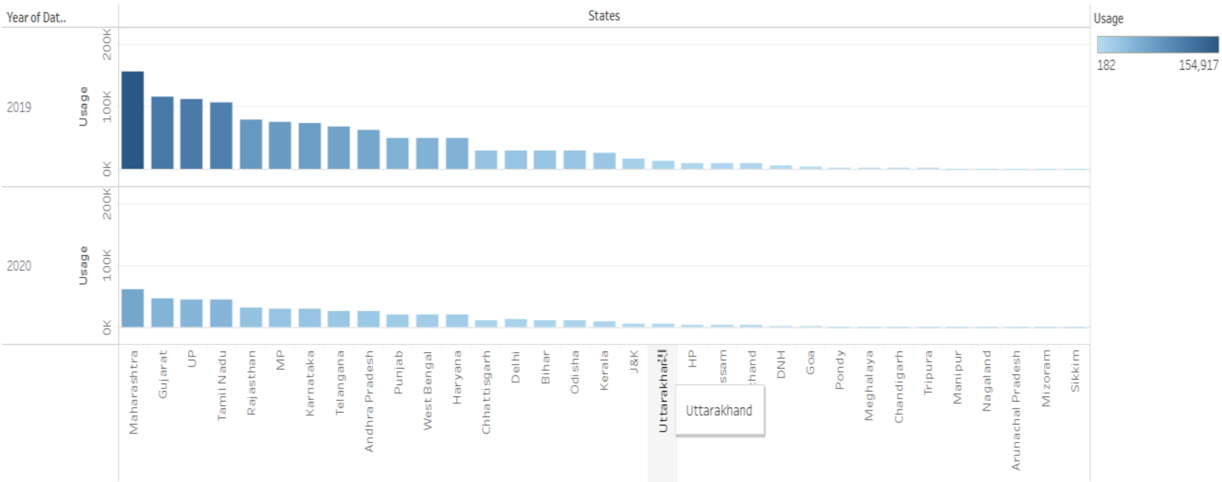


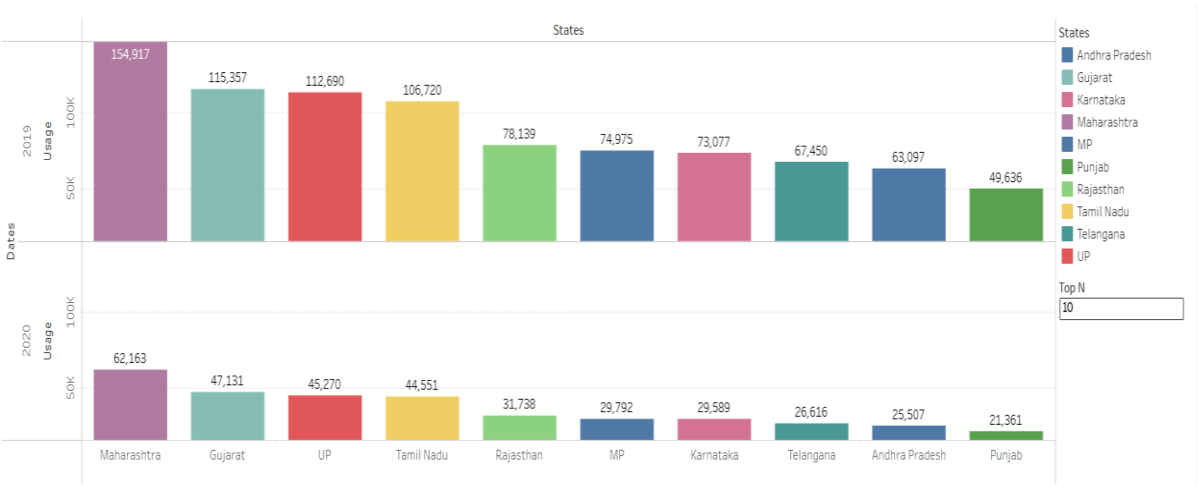
Bottom N

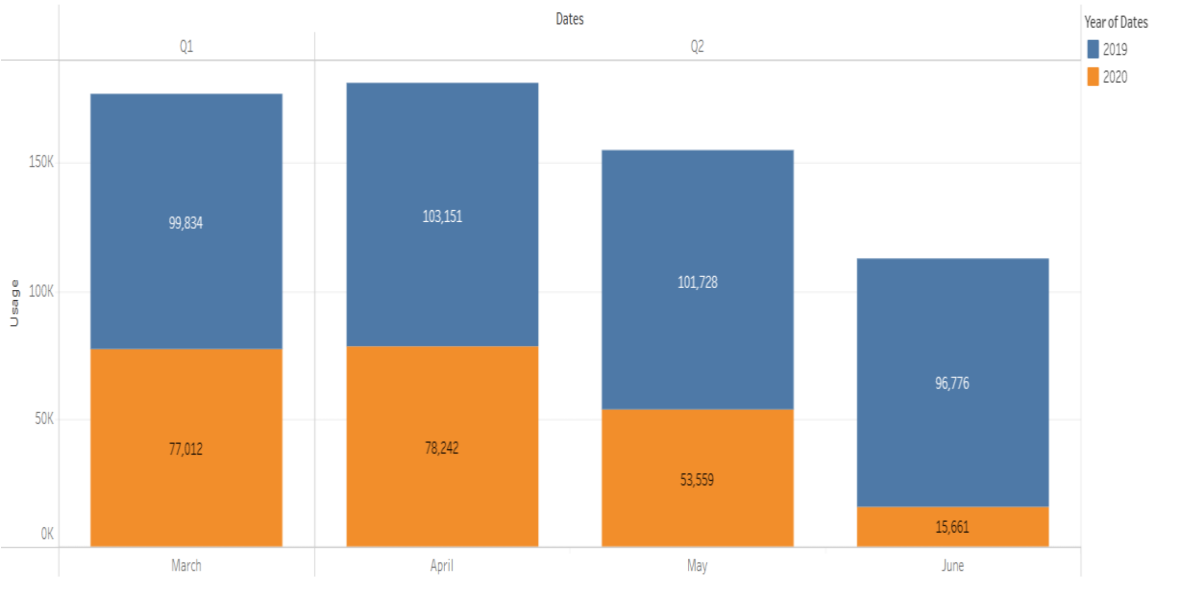


Usage by Year

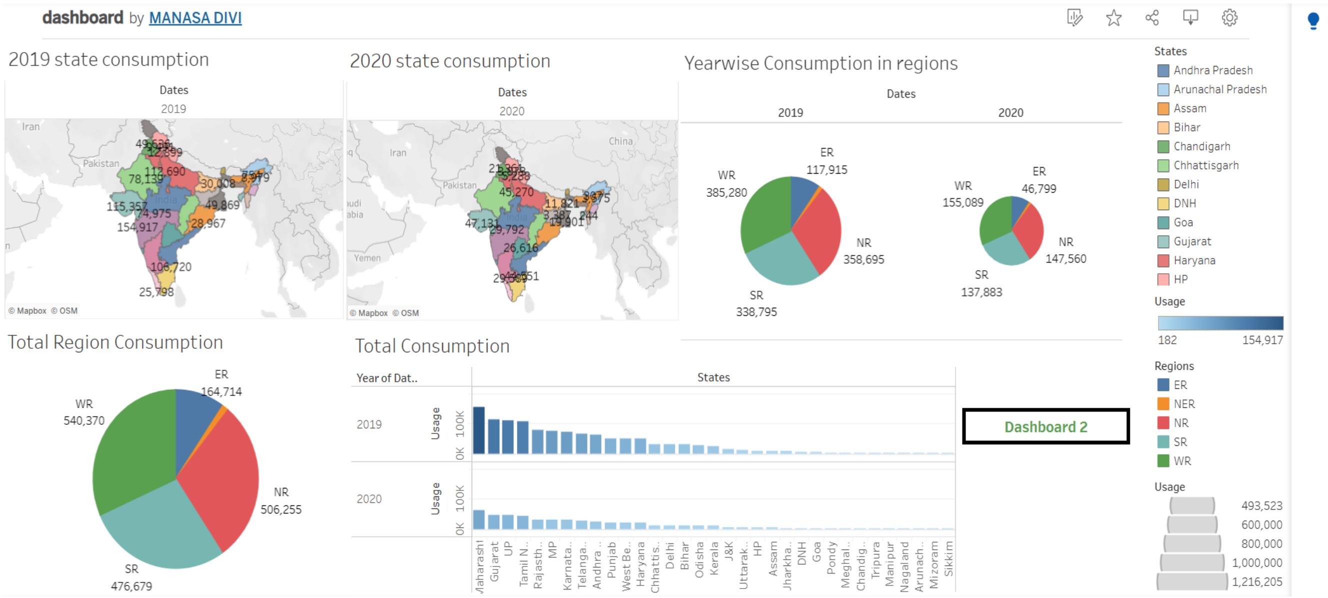


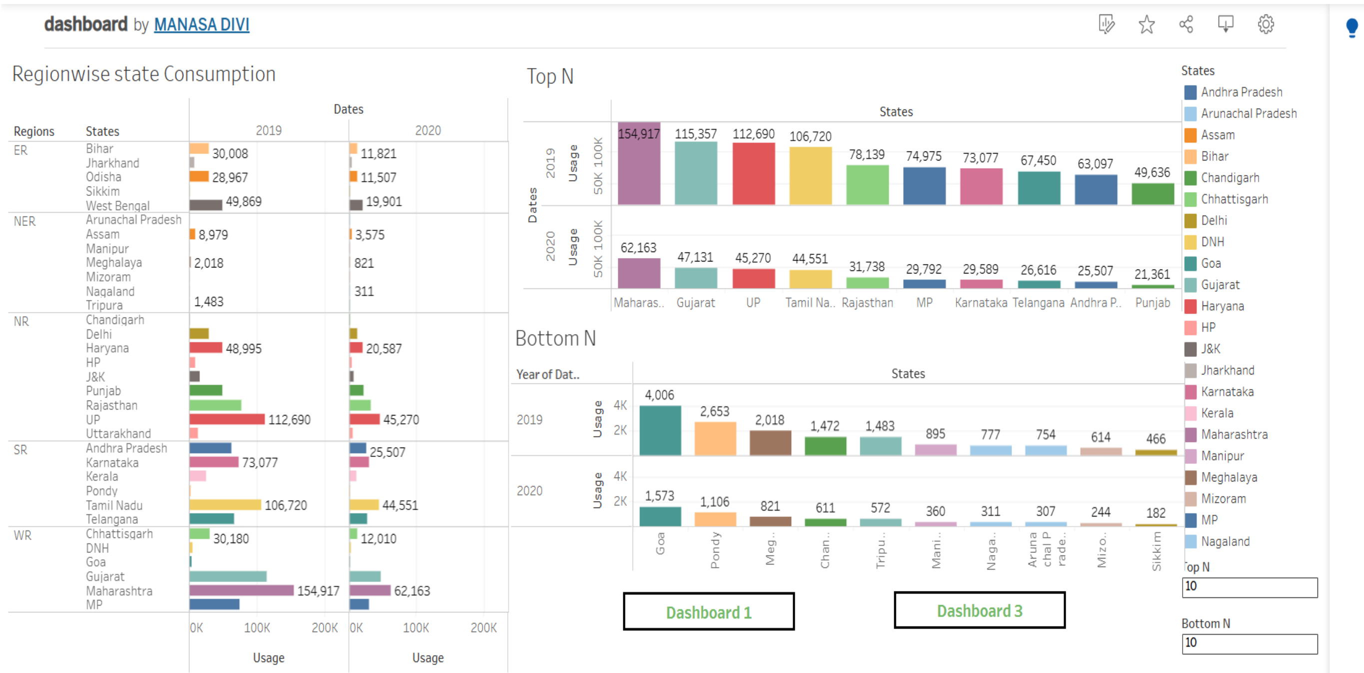

Year of Dat..
States
Usage
182
154,917
2019
2020
Usage
0K
100K
200K
Maharashtra
Gujarat
UP
Tamil Nadu
Rajasthan
MP
Karnataka
Telangana
Andhra Pradesh
Punjab
West Bengal
Haryana
Chhattisgarh
Delhi
Bihar
Odisha
Kerala
J&K
Uttarakhand
HP
DNH
Goa
Pondy
Meghalaya
Chandigarh
Tripura
Manipur
Nagaland
Arunachal Pradesh
Mizoram
Sikkim

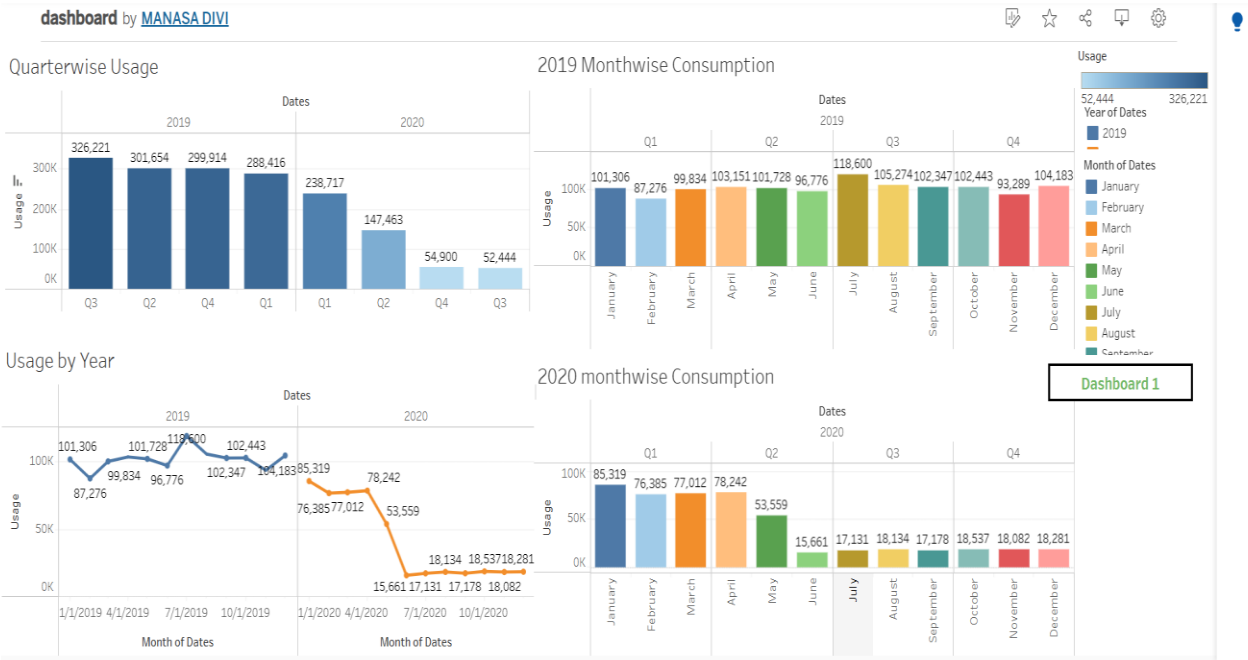

States
Dates
2019
2020
Usage
50K
100K
154,917
115,357
112,690
106,720
78,139
74,975
73,077
67,450
63,097
49,636
62,163
47,131
45,270
44,551
31,738
29,792
29,589
26,616
25,507
21,361
Maharashtra
Gujarat
UP
Tamil Nadu
Rajasthan
MP
Karnataka
Telangana
Andhra Pradesh
Punjab
States
Andhra Pradesh
Gujarat
Karnataka
Maharashtra
MP
Punjab
Rajasthan
Tamil Nadu
Telangana
UP
Top N
10


Dates
Q1
Q2
Year of Dates
2019
2020
Usage
0K
50K
100K
150K
99,834
77,012
103,151
78,242
101,728
53,559
96,776
15,661
March
April
May
June

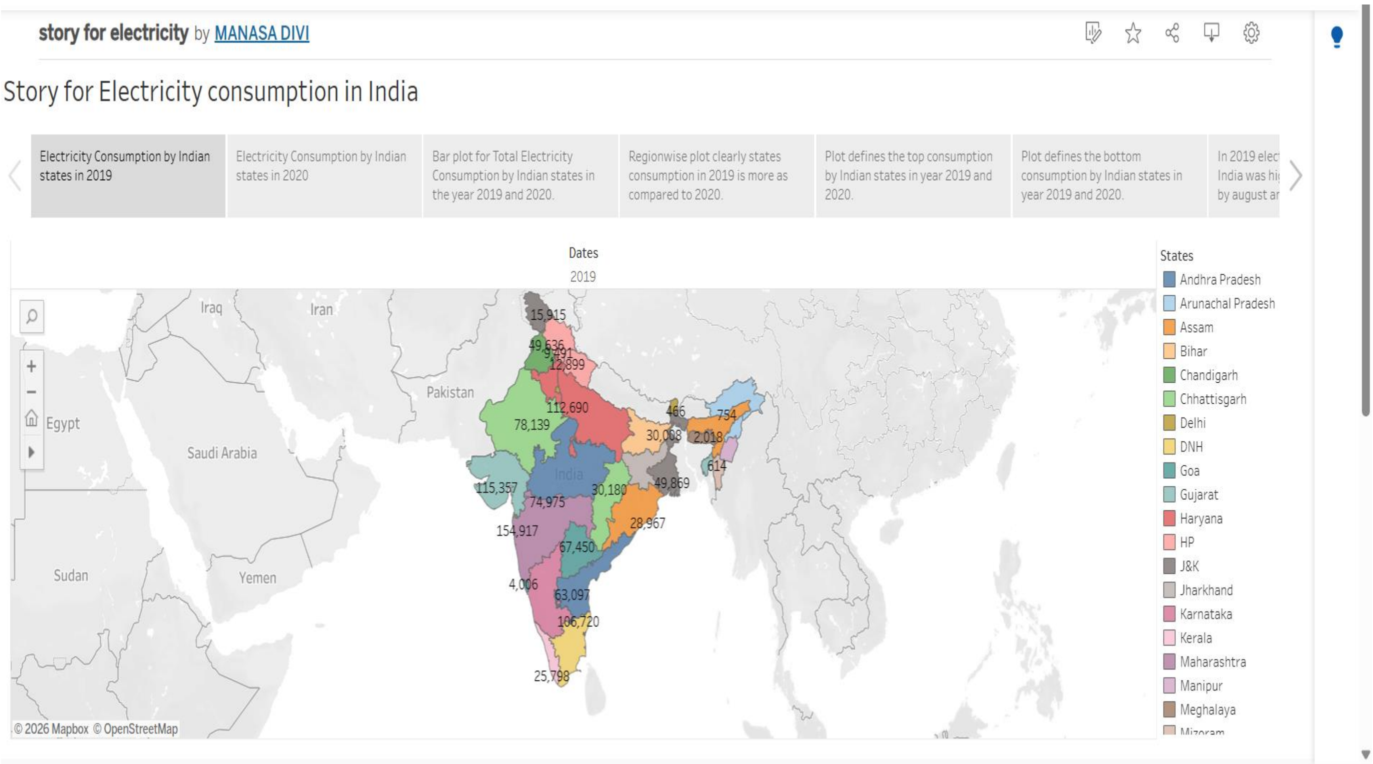
DASH BOARDS:


dashboard by MANASA DIVI
2019 state consumption
2020 state consumption
Yearwise Consumption in regions
Dates
2019
2020
WR
385,280
ER
117,915
NR
358,695
SR
338,795
WR
155,089
ER
46,799
NR
147,560
SR
137,883
Total Region Consumption
ER
164,714
WR
540,370
NR
506,255
SR
476,679
Total Consumption
Year of Dat..
States
Usage
Dashboard 2
States
Andhra Pradesh
Arunachal Pradesh
Assam
Bihar
Chandigarh
Chhattisgarh
Delhi
DNH
Goa
Gujarat
Haryana
HP
Usage
182
154,917
Regions
ER
NER
NR
SR
WR
Usage
493,523
600,000
800,000
1,000,000
1,216,205
© Mapbox © OSM


dashboard by MANASA DIVI
Regionwise state Consumption
Top N
Bottom N
Regions
States
Dates
2019
2020
Usage
Year of Dat..
States
154,917
115,357
112,690
106,720
78,139
74,975
73,077
67,450
63,097
49,636
62,163
47,131
45,270
44,551
31,738
29,792
29,589
26,616
25,507
21,361
Maharas..
Gujarat
UP
Tamil Na..
Rajasthan
MP
Karnataka
Telangana
Andhra P..
Punjab
4,006
2,653
2,018
1,472
1,483
895
777
754
614
466
1,573
1,106
821
611
572
360
311
307
244
182
Dashboard 1
Dashboard 3
Top N
10
Bottom N
10


dashboard by MANASA DIVI
Quarterwise Usage
Dates
2019
2020
326,221
301,654
299,914
288,416
238,717
147,463
54,900
52,444
Q3
Q2
Q4
Q1
Q1
Q2
Q4
Q3
2019 Monthwise Consumption
101,306
87,276
99,834
103,151
101,728
96,776
118,600
105,274
102,347
102,443
93,289
104,183
January
February
March
April
May
June
July
August
September
October
November
December
Usage
52,444
326,221
Year of Dates
2019
Month of Dates
Usage by Year
Month of Dates
2020 monthwise Consumption
85,319
76,385
77,012
78,242
53,559
15,661
17,131
18,134
17,178
18,537
18,082
18,281
Dashboard 1

STORY:


story for electricity by MANASA DIVI
Story for Electricity consumption in India
Electricity Consumption by Indian states in 2019
Electricity Consumption by Indian states in 2020
Bar plot for Total Electricity Consumption by Indian states in the year 2019 and 2020.
Regionwise plot clearly states consumption in 2019 is more as compared to 2020.
Plot defines the top consumption by Indian states in year 2019 and 2020.
Plot defines the bottom consumption by Indian states in year 2019 and 2020.
Dates
2019
States
Andhra Pradesh
Arunachal Pradesh
Assam
Bihar
Chandigarh
Chhattisgarh
Delhi
DNH
Goa
Gujarat
Haryana
HP
J&K
Jharkhand
Karnataka
Kerala
Maharashtra
Manipur
Meghalaya
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8. ADVANTAGES

- **Convenience**: Electricity allows us to power appliances and devices that make our lives more comfortable and convenient, such as refrigerators, air conditioners, and computers.
- **Economic benefits:** Electricity consumption contributes to economic growth by powering industries, creating job opportunities, and improving the standard of living.
- **Safety:** Electricity is a safer and more convenient form of energy compared to other sources, such as fossil fuels, which can be hazardous to handle and transport.
- **Accessibility:** Electricity can be distributed over long distances, making it accessible to people living in remote areas.
- **Environmentally friendly:** Electricity generated from renewable energy sources such as wind, solar, and hydropower is environmentally friendly and sustainable, reducing greenhouse gas emissions and contributing to a cleaner environment.
- **Flexibility:** Electricity can be easily stored and transported, making it a flexible and versatile source of energy.

DISADVANTAGES

- **Environmental impact**: The generation and consumption of electricity contribute to air and water pollution, deforestation, and climate change.
- **Cost:** The cost of electricity can be high, especially for low-income households and businesses, leading to affordability issues.
- **Dependence on fossil fuels:** Most electricity is still generated from fossil fuels, which are finite resources and have negative environmental impacts.
- **Power outages:** Power outages can occur due to natural disasters, equipment failures, and other factors, causing inconvenience and disruption to daily life.
- **Safety hazards:** Electricity can be hazardous if not handled or used properly, leading to electrical shocks, fires, and other accidents.
- **Distribution challenges:** Electricity transmission and distribution networks can be challenging to maintain and upgrade, especially in rural or remote areas.

9. CONCLUSION

The project successfully analyses electricity consumption patterns using interactive Tableau dashboards. It identifies peak demand periods, regional consumption differences, and sector-wise usage trends. The visualization highlights year-wise and quarter-wise variations, providing clear insights into electricity demand behavior. Interactive filters and calculated fields enhance user experience and analytical depth. The findings reveal that industrialized and highly populated regions consume more electricity compared to others. A noticeable decline in 2020 reflects changes in economic activity. The dashboards convert raw data into meaningful and actionable insights.

The project supports better decision-making for energy optimization and grid management. Overall, it meets all project objectives and demonstrates effective use of data analytics and visualization tools.

10. FUTURE SCOPE

The project can be further enhanced by integrating real-time electricity consumption data for live monitoring and analysis. Advanced predictive analytics and machine learning models can be applied to forecast future demand trends. Additional datasets such as weather conditions, population growth, and industrial expansion can be incorporated to improve correlation analysis. The system can be expanded into a full-scale web application with user authentication and role-based access. Mobile-responsive dashboards can be developed for wider accessibility. Integration with smart grid systems can support automated energy optimization. Renewable energy contribution analysis can also be included to promote sustainable energy planning.

Dataset Link:

https://drive.google.com/file/d/1JxIkHNwXxjFztKq7ad0_KtkukCqTckNy/view

Video Demo Link:

https://drive.google.com/file/d/1OfEHmCld0iQ-TjWt27IG9ZngbaAp8mOj/view