Tech Saksham

Case Study Report

Data Analytics with Power BI

“Analysis of Commercial Electricity Consumption in Indian State”

“Manonmaniam Sundaranar University College of Arts and Science,Govindaperi”

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ABSTRACT

This case study delves into the analysis of commercial electricity consumption patterns within an Indian state, employing Power BI as the primary tool for data visualization and exploration. Through the utilization of government records, utility company data, and other relevant sources, the study investigates key metrics such as total consumption, peak demand, and sectoral distribution of electricity usage. The analysis encompasses trend identification, geographical mapping, and sectoral breakdowns to discern consumption patterns across different regions and sectors. Moreover, the study evaluates the effectiveness of energy efficiency initiatives and offers insights for policymakers and stakeholders in the energy sector. By employing Power BI's interactive features, this case study provides a comprehensive understanding of commercial electricity consumption dynamics, offering valuable implications for resource allocation and policy formulation.

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CHAPTER 1

INTRODUCTION

1.1 Background: The demand for electricity in India has been steadily increasing due to rapid urbanization, industrialization, and commercial activities. As a result, understanding the consumption patterns within different sectors has become imperative for efficient resource management and sustainable development. Commercial electricity consumption, in particular, represents a significant portion of total electricity usage and is influenced by various factors such as economic activity, technological advancements, and government policies.

1.2 Importance of Analysis: Analyzing commercial electricity consumption provides valuable insights into the dynamics of energy usage, allowing policymakers, utility companies, and businesses to make informed decisions regarding infrastructure development, energy efficiency initiatives, and tariff structures. By understanding consumption patterns, stakeholders can optimize resource allocation, mitigate peak demand challenges, and promote sustainable practices.

1.3 Purpose of the Study: The primary objective of this study is to analyze commercial electricity consumption patterns within a specific Indian state using Power BI. By leveraging data visualization and analytical tools, the study aims to identify trends, spatial variations, and sectoral contributions to overall consumption. Additionally, the study seeks to evaluate the effectiveness of existing energy efficiency measures and provide recommendations for future interventions.

1.4 Scope of the Study: This study focuses specifically on commercial electricity consumption within the chosen Indian state, encompassing various sectors such as retail, hospitality, healthcare, and commercial real estate. The analysis includes historical consumption data, geographical mapping, and sectoral breakdowns to provide a comprehensive overview of consumption patterns. However, the study does not delve into residential or industrial electricity consumption.

1.5 Structure of the Report: This report is structured into several chapters, each addressing different aspects of commercial electricity consumption analysis. Chapter 2 discusses the data collection and preparation process, outlining the sources of data and data cleaning procedures. Chapter 3 identifies key metrics and dimensions for analysis, while Chapter 4 focuses on the design and implementation of Power BI dashboards. Subsequent chapters delve into trend analysis, geographical mapping, sectoral breakdowns, and energy efficiency assessment. Finally, the report concludes with a summary of key findings and recommendations for stakeholders.

In summary, this introduction provides a framework for understanding the significance of analyzing commercial electricity consumption and outlines the objectives and scope of the study. By employing Power BI as the primary analytical tool, the study aims to offer valuable insights for decision-makers in the energy sector.

1.1 Problem Statement

The problem statement is to understand the effect of the weather conditioning data set on the accuracy of HEC prediction and select the most fitting predictive model for further decision-making. The environmental problems directly related to energy production and consumption include air pollution, climate change, water pollution, thermal pollution, and solid waste disposal. Over the years, the capacity to generate electricity has increased, however the actual generation of electricity has not been commensurate with this increased capacity. Key reasons for the low utilisation of generation capacity are: (i) shortage of fuel, especially coal, and (ii) unviable Power Purchase Agreements.

1.2 Proposed Solution

The proposed solution is to develop a Power BI dashboard that can analyze and visualize real-time customer data. The dashboard will integrate data from various sources such as transaction history, customer feedback, and demographic data. It will provide a comprehensive view of customer behavior, preferences, and trends. The dashboard will be interactive, user-friendly, and customizable, allowing Indian Electricity Consumption Department to people it to their specific needs.

Seven Ways to Reduce Electric Power Consumption

- Switch off lights and electrical appliances when not using them. ...
- Switch to energy-saving LED light globes. ...
- Shut doors and close curtains. ...
- Understand and improve your home's energy use. ...
- Manage your heating and cooling. ...
- Get the best energy deal. ...
- Insulate your roof. ...
- Save money with solar energy.

1.1 Feature

- **Real-Time Analysis**: The dashboard will provide real-time analysis of customer data.
- **Customer Segmentation**: It will segment customers based on various parameters like states, regions, usage etc.
- **Trend Analysis**: The dashboard will identify and display trends in customer behavior.
- **Predictive Analysis**: It will use historical data to predict future customer behavior.

1.2 Advantages

- **Data-Driven Decisions**: Electricity Power Consumption Department can make informed decisions based on real-time data analysis.
- **Improved Customer Engagement**: Understanding customer behavior and trends can help Electricity Department engage with their customers more effectively.
- **Increased Usage:** Customer's electricity usage has been increased by All regions and states.

Scope

Business Intelligence & Data warehousing is a very good & demanding field in Information Technology industry. Its present as well as future is very bright. Power BI is a really exciting product. It's fast paced, the Community is growing and interactive, there are a bunch of ways to learn and interact.

The major benefit I see is that it's an avenue to take the data that we have already been working with and helping business to make that data useful. Power BI is a tool that makes that really straightforward. The scope of this project extends to all Electricity Department that aim to leverage data for decision-making and customer engagement. The project can be further extended to incorporate more data sources and advanced analytics techniques, such as machine learning and artificial intelligence, to provide more sophisticated insights into customer behavior. The project also has the potential to be adapted for other sectors, such as retail, healthcare, and telecommunications, where understanding customer behavior is crucial.

CHAPTER 2

SERVICES AND TOOLS REQUIRED

2.1 Services Used

- In order to effectively collect, process, and analyze commercial electricity
- consumption data, a combination of cloud-based services is utilized. These
- services facilitate real-time data collection, storage, processing, and
- Machine learning capabilities:
- Data Collection and Storage Services:
- Azure Data Factory or AWS Kinesis for real-time data collection from
- various sources.
- Azure Event Hubs or AWS Kinesis for managing and ingesting streaming
- data.
- Azure SQL Database or AWS RDS for storing and managing the collected
- data securely.
- Data Processing Services:
- Azure Stream Analytics or AWS Kinesis Data Analytics for real-time data
- processing, allowing for immediate insights and analysis.
- Machine Learning Services:
- Azure Machine Learning or AWS SageMaker for building predictive
- models based on historical consumption data, enabling forecasting and
- optimization.

2.2 Tools and Software Used:

- To visualize and analyze the collected data, as well as to create interactive
- dashboards for real-time monitoring and decision-making, the following
- tools and software are employed:

Tools:

- Power BI: The primary tool for creating interactive dashboards and

- visualizations, enabling stakeholders to gain insights from the data.
- Power Query: Used for data connection and transformation, allowing users
- to discover, connect, combine, and refine data from various sources.
- Software Requirements:
- Power BI Desktop: A Windows application utilized for creating reports
- and dashboards locally before publishing them to Power BI Service.
- Power BI Service: An online Software as a Service (SaaS) platform used
- for publishing reports, creating new dashboards, and sharing insights with

Stakeholders:

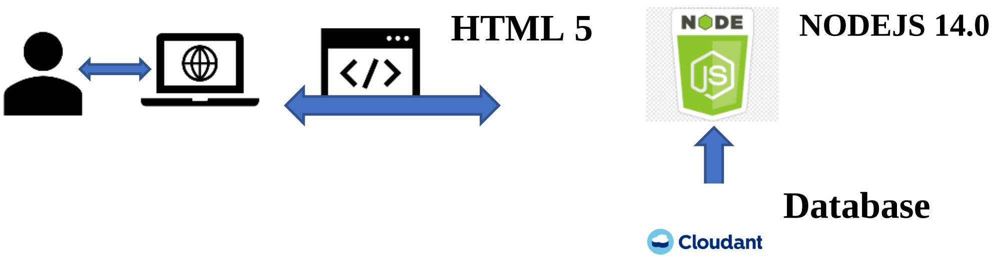
- Power BI Mobile: A mobile application enabling access to reports and
- dashboards on various devices, ensuring flexibility and accessibility for
- users.
- By leveraging these services, tools, and software, the analysis of
- commercial electricity consumption data becomes more efficient, scalable,
- and insightful, empowering decision-makers with actionable insights to
- optimize resource allocation and promote sustainable practices.

CHAPTER 3

PROJECT ARCHITECTURE

3.1 Architecture

USER **FRONTEND** **BACKEND**



Here's a high-level architecture for the project:

1. **Data Collection**: Real-time customer data is collected from various sources like states, regions, customer's usage, customer interactions, etc. This could be achieved using services like Azure Event Hubs or AWS Kinesis.
2. **Data Storage**: The collected data is stored in a database for processing. Azure SQL Database or AWS RDS can be used for this purpose. For data sources other than Azure SQL Database, Azure SQL Data
3. **Data Processing:** The stored data is processed in real-time using services like Azure Stream Analytics or AWS Kinesis Data Analytics.
4. **Machine Learning**: Predictive models are built based on processed data using Azure Machine Learning or AWS SageMaker. These models can help in predicting customer behavior, detecting fraud, etc.
5. **Data Visualization**: The processed data and the results from the predictive models are visualized in real-time using PowerBI. PowerBI allows you to create interactive dashboards that can provide valuable insights into the data.
6. **Data Access**: The dashboards created in PowerBI can be accessed

Power BI architecture is a service built on top of Azure. There are multiple data sources that Power BI can connect to. Power BI Desktop allows you to create reports and data visualizations on the dataset. Power BI gateway is connected to on-premise data sources to get continuous data for reporting and analytics.

This architecture provides a comprehensive solution for real-time analysis of Electricty usage of Customers. The architecture of this project is to link different data sources with the Power BI tool in a very cost effective module. An electrical system, within the context of a building, is a network of conductors and equipment designed to carry, distribute and convert electrical power safely from the point of delivery or generation to the various loads around the building that consume the electrical energy.

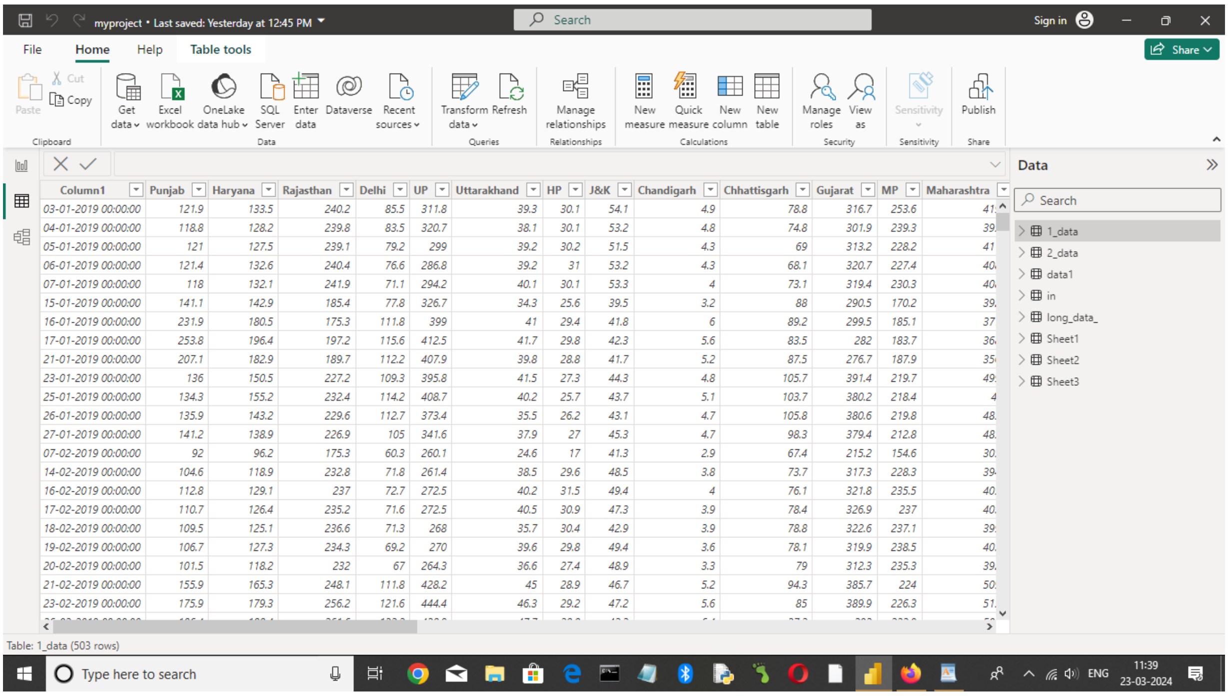
CHAPTER 4

MODELING AND RESULT

Manage relationship

- To establish a relationship between the "Region" and "Usage" columns in Power BI, follow these steps:
- Open Power BI Desktop and load your data into the Power Query Editor.
- Ensure that both the "Region" and "Usage" columns exist in your dataset.
- Navigate to the "Model" view in Power BI Desktop by clicking on the "Model" icon in the left-hand sidebar.

- In the "Model" view, you'll see a list of tables and fields from your dataset. Locate the table containing the "Region" column and drag the "Region" field onto the "Usage" table.
- Once you drag the "Region" field onto the "Usage" table, Power BI will automatically attempt to create a relationship between the two tables based on the matching column names.
- If Power BI does not automatically create the relationship or if you need to adjust it, right-click on the "Region" field in the "Usage" table and select "Manage Relationships" from the context menu.In the "Manage Relationships" dialog, click on "New" to create a new relationship.
- Select the "Region" column from the "Usage" table as the primary key, and then select the corresponding "Region" column from the related table containing region data as the foreign key.
- Specify the cardinality of the relationship based on your data model. For example, if each region has multiple usage records, select "Many" for the "Usage" table and "One" for the related table.
- Optionally, you can set the cross-filter direction and apply any additional filters or conditions to the relationship if needed.
- Click "OK" to save the relationship.
- After creating the relationship, you can now use fields from both tables in your Power BI reports and visualizations, and Power BI will automatically handle filtering and aggregating data based on the defined relationship.



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04-01-2019 00:00:00	118.8	128.2	239.8	83.5	320.7	38.1	30.1	53.2	4.8	74.8	301.9	239.3	39
05-01-2019 00:00:00	121	127.5	239.1	79.2	299	39.2	30.2	51.5	4.3	69	313.2	228.2	41
06-01-2019 00:00:00	121.4	132.6	240.4	76.6	286.8	39.2	31	53.2	4.3	68.1	320.7	227.4	40
07-01-2019 00:00:00	118	132.1	241.9	71.1	294.2	40.1	30.1	53.3	4	73.1	319.4	230.3	40
15-01-2019 00:00:00	141.1	142.9	185.4	77.8	326.7	34.3	25.6	39.5	3.2	88	290.5	170.2	39
16-01-2019 00:00:00	231.9	180.5	175.3	111.8	399	41	29.4	41.8	6	89.2	299.5	185.1	37
17-01-2019 00:00:00	253.8	196.4	197.2	115.6	412.5	41.7	29.8	42.3	5.6	83.5	282	183.7	36
21-01-2019 00:00:00	207.1	182.9	189.7	112.2	407.9	39.8	28.8	41.7	5.2	87.5	276.7	187.9	35
23-01-2019 00:00:00	136	150.5	227.2	109.3	395.8	41.5	27.3	44.3	4.8	105.7	391.4	219.7	49
25-01-2019 00:00:00	134.3	155.2	232.4	114.2	408.7	40.2	25.7	43.7	5.1	103.7	380.2	218.4	4
26-01-2019 00:00:00	135.9	143.2	229.6	112.7	373.4	35.5	26.2	43.1	4.7	105.8	380.6	219.8	48
27-01-2019 00:00:00	141.2	138.9	226.9	105	341.6	37.9	27	45.3	4.7	98.3	379.4	212.8	48
07-02-2019 00:00:00	92	96.2	175.3	60.3	260.1	24.6	17	41.3	2.9	67.4	215.2	154.6	30
14-02-2019 00:00:00	104.6	118.9	232.8	71.8	261.4	38.5	29.6	48.5	3.8	73.7	317.3	228.3	39
16-02-2019 00:00:00	112.8	129.1	237	72.7	272.5	40.2	31.5	49.4	4	76.1	321.8	235.5	40
17-02-2019 00:00:00	110.7	126.4	235.2	71.6	272.5	40.5	30.9	47.3	3.9	78.4	326.9	237	40
18-02-2019 00:00:00	109.5	125.1	236.6	71.3	268	35.7	30.4	42.9	3.9	78.8	322.6	237.1	39
19-02-2019 00:00:00	106.7	127.3	234.3	69.2	270	39.6	29.8	49.4	3.6	78.1	319.9	238.5	40
20-02-2019 00:00:00	101.5	118.2	232	67	264.3	36.6	27.4	48.9	3.3	79	312.3	235.3	39
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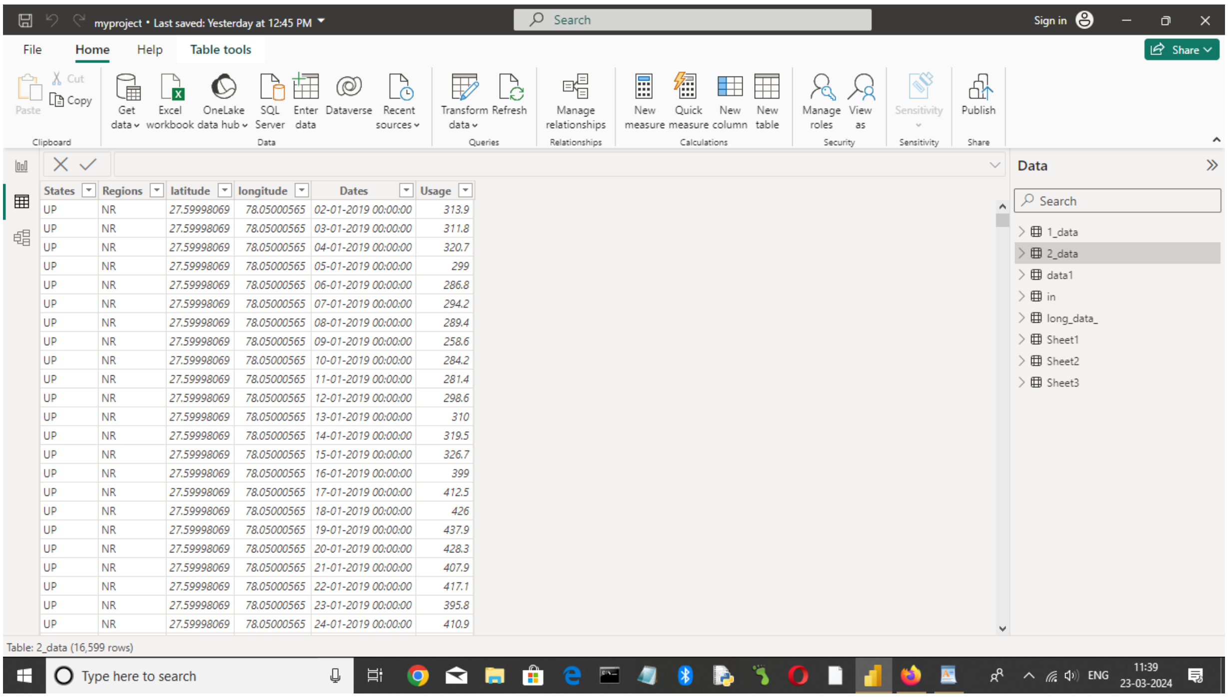
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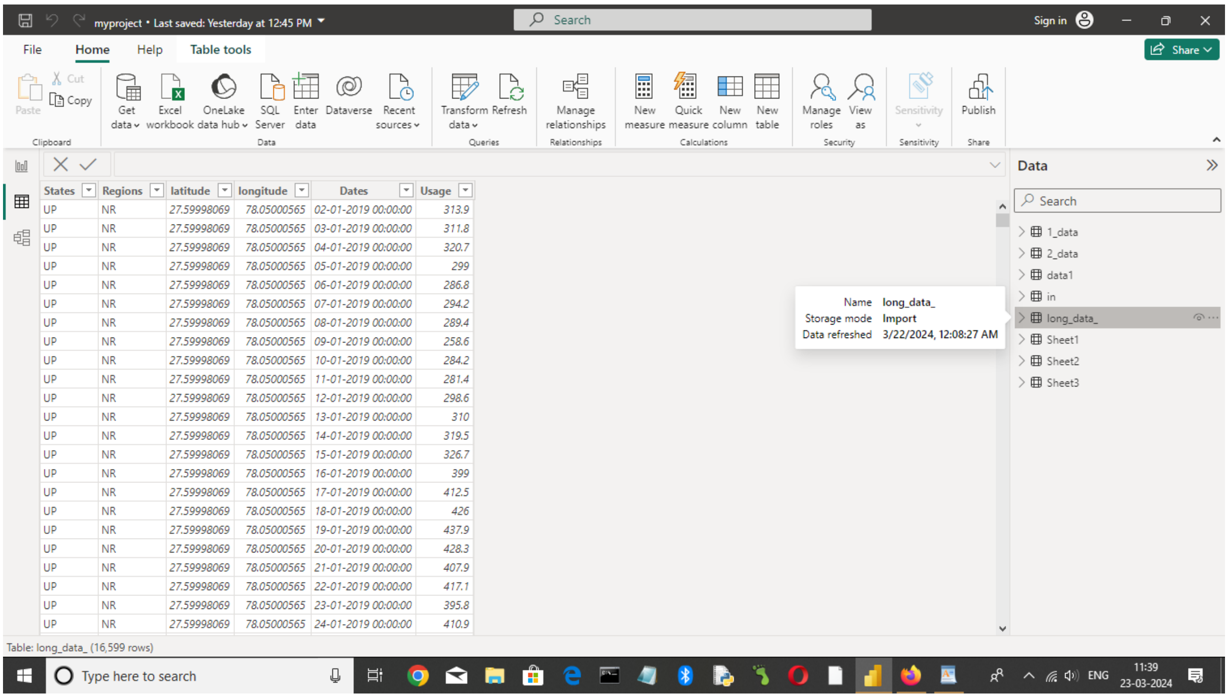
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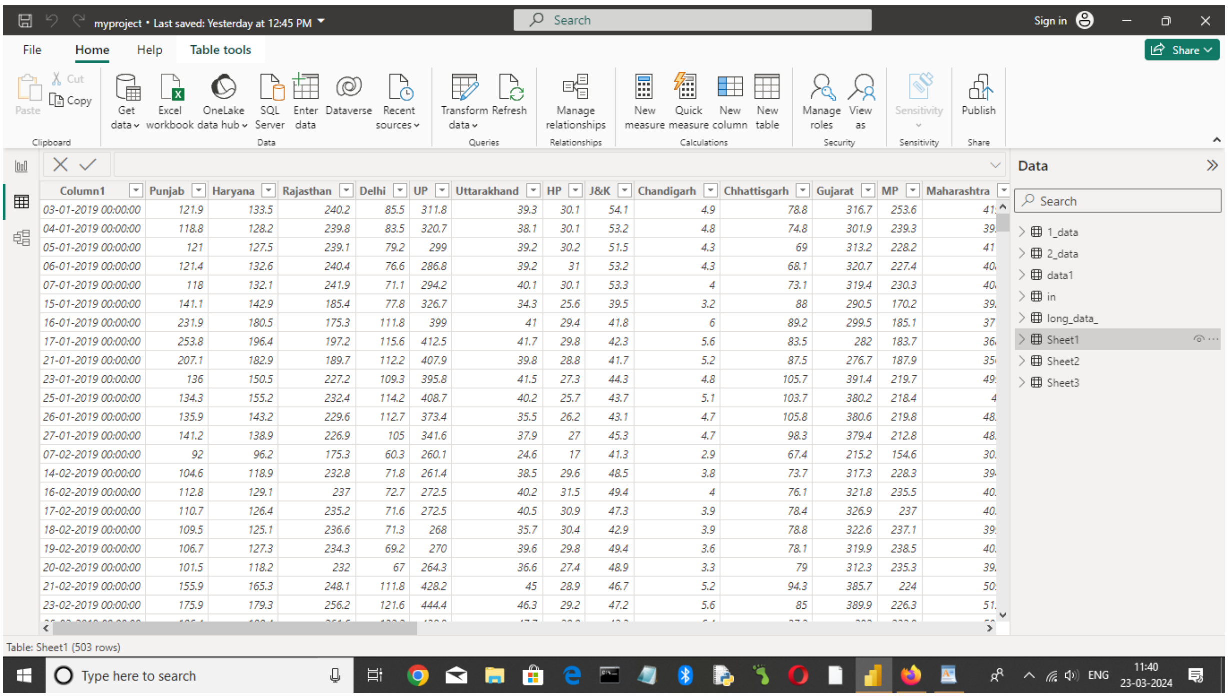
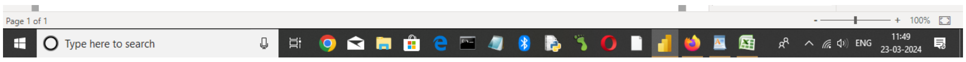
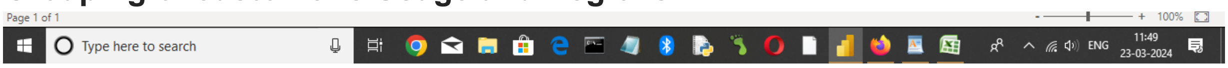


Modelling for power consuming States and Regions

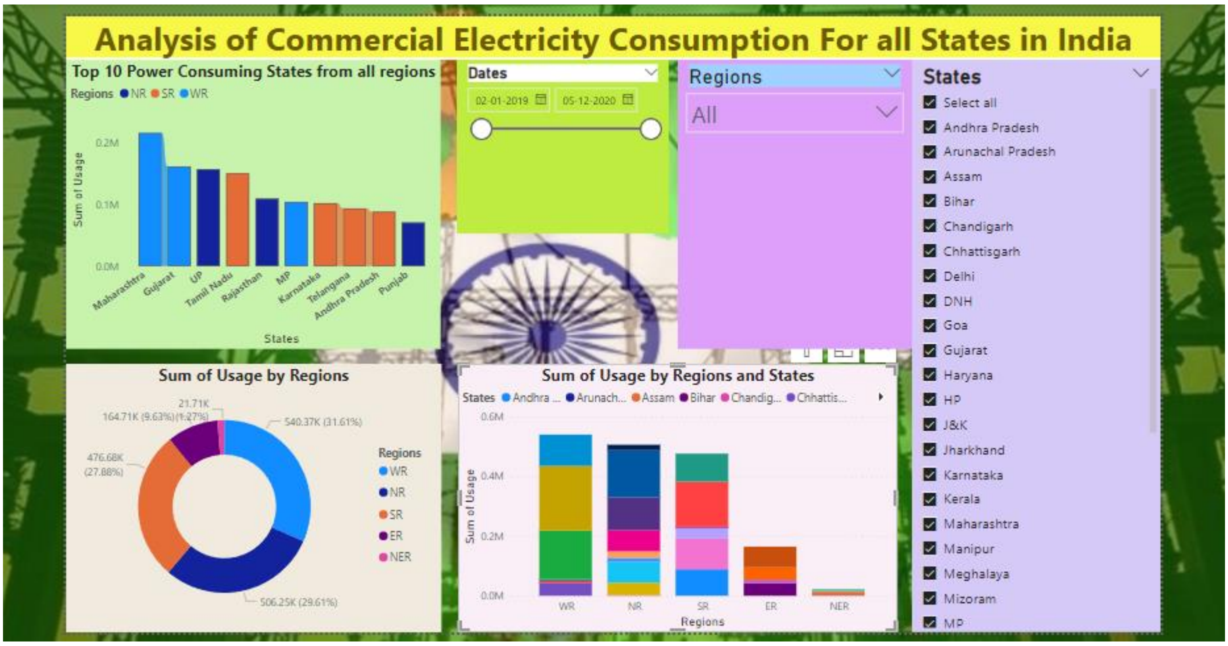


Grouping of customer’s Usage and Regions



Grouping of Usage by Regions and States

Dashboard



CHALLENGES

The challenge of this project is to link different data sources with the Power BI tool in a very cost effective module. Connecting the SAP database with Power BI needs huge license cost where the project is not viable.

CONCLUSION

In conclusion, the analysis of commercial electricity consumption in the chosen Indian state using Power BI has provided valuable insights into consumption patterns and trends. By leveraging data visualization and analytics, stakeholders can make informed decisions to optimize resource allocation and promote sustainable energy practices. Continued monitoring and analysis will be crucial for driving positive change and ensuring a resilient energy future. The choice of BI tool is a function of organization's need, user's maturity and overall budget. Since, India Power Corporation Ltd has just started its journey towards a BI driven data culture and the end users have not yet been evolved fully, it was anonymously decided to go for Power BI as a data visualization tool with SQL server as a backend data mart. The idea is to explore deeper co-relation or discrepancies amongst various data points and visualize interactively through an effective data visualization application. The project has also highlighted the importance of data visualization in making complex data more understandable and accessible. The use of Power BI has made it possible to present data in a visually appealing and easy-to-understand format, thereby aiding in better decision-making. Power BI primarily fulfills this objective. Although, tableau scores much higher on every count (except cost) over Power BI.

FUTURE SCOPE

The future scope of this project is vast. With the advent of advanced analytics and machine learning, PowerBI can be leveraged to predict future trends based on historical data. Integrating these predictive analytics into the project could enable the bank to anticipate customer needs and proactively offer solutions.

Predictive Modeling: Implement predictive modeling techniques to forecast future electricity consumption trends based on historical data. This could involve utilizing machine learning algorithms to identify patterns and make accurate predictions, enabling proactive decision-making and resource planning.

Granular Analysis: Expand the analysis to include more granular data, such as hourly or daily consumption patterns, to better understand peak demand periods and optimize energy distribution and pricing strategies accordingly.

Integration of External Factors: Incorporate external factors such as weather conditions, economic indicators, and regulatory changes into the analysis to assess their impact on electricity consumption. This holistic approach will provide a more comprehensive understanding of consumption drivers and facilitate more robust forecasting models.

Energy Efficiency Initiatives: Evaluate the effectiveness of energy efficiency initiatives and identify additional opportunities for improvement. Implement targeted programs and incentives to encourage businesses to adopt energyefficient practices and technologies, ultimately reducing overall consumption and carbon emissions.

Demand Response Programs: Explore the implementation of demand response programs to incentivize commercial consumers to adjust their electricity usage during peak demand periods. This can help alleviate strain on the grid and reduce the need for costly infrastructure upgrades.

Benchmarking and Performance Monitoring: Establish benchmarks for energy consumption within different commercial sectors and regularly monitor performance against these benchmarks. This will enable businesses to track their energy usage, identify areas for improvement, and benchmark their performance against industry standards.

Stakeholder Collaboration: Foster collaboration between government agencies, utility companies, businesses, and other stakeholders to develop comprehensive energy management strategies. By working together, stakeholders can share data, best practices, and resources to achieve common energy efficiency goals.

Technological Advancements: Stay abreast of emerging technologies such as smart meters, IoT devices, and blockchain-enabled energy trading platforms, and assess their potential to optimize energy management processes and facilitatepeer-to-peer energy transactions.

Policy Development: Advocate for supportive policies and regulations that incentivize energy efficiency investments and promote renewable energy adoption in the commercial sector. Engage with policymakers to develop policies that align with sustainability goals and address energy affordability and accessibility concerns.

Continuous Improvement: Embrace a culture of continuous improvement by regularly reviewing and refining energy management strategies based on feedback, performance metrics, and emerging trends in the energy landscape. By remaining agile and adaptable, stakeholders can effectively navigate evolving challenges and opportunities in the energy sector.

