Tech Saksham
Case Study Report

Data Analytics with Power BI

"ANALYSIS OF COMMERCIAL ELECTRICITY CONSUMPTION IN INDIAN STATS"

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ABSTRACT

This study presents an analysis of commercial electricity consumption within a specific state in india, focusing on key factors influencing consumption patterns and trends. The analysis encompasses various dimensions including usage patterns, sectoral distribution, temporal variations, economic influences, policy frameworks, infrastructure considerations, comparative assessments, and environmental implications. By synthesizing these factors, the study aims to prove insights into optimizing commercial electricity consumption, enhancing efficiency, and fostering sustainable energy practices within the state. This research contributes to informed decision-making for policymakers, energy regulators, utility providers, and commercial stakeholders, facilitating the formulation of targeted strategies to address electricity consumption challenges and promote

sustainable development   .

INDEX

CHAPTER 1

INTRODUCTION

1.1 Problem Statement

Analyze commercial electricity consumption in Indian states to identify patterns, trends, and factors influencing consumption, ultimately providing insights for efficient resource allocation and policy formulation.

1.2 Proposed Solution

Analyzing commercial electricity consumption in India requires a multifaceted approach, considering various factors such as industrial growth, infrastructure development, energy policies, and environmental concerns. Here's a structured analysis along with proposed solutions:

❖ **Energy Audits**:

Conducting mandatory energy audits for commercial establishments can identify energy-intensive processes and areas for improvement. This can include recommendations for adopting energy-efficient technologies and practices.

❖ **Incentivizing Energy Efficiency**:

Introduce incentive programs such as subsidies or tax breaks for commercial entities that invest in energy-efficient equipment and technologies. Implement time-of-use tariffs to encourage energy consumption during off-peak hours.

❖ **Regulatory Measures:**

Enforce building codes and regulations that mandate energy-efficient designs and construction practices for new commercial buildings. Retrofitting existing buildings with energy-efficient systems should also be encouraged.

❖ **Public Awareness Campaigns**:

Educate commercial property owners, managers, and occupants about the benefits of energy conservation and how simple behavioral changes can lead to significant energy savings.

1.3 Feature

Sectoral Distribution:

❖ Commercial electricity consumption in India encompasses various sectors such as hospitality, manufacturing, retail, services, and others. Understanding the distribution of electricity consumption among these sectors provides insights into the dynamics of economic activities within the state.

❖ **Urban-Rural Disparities:**

Disparities in commercial electricity consumption exist between urban and rural areas due to differences in infrastructure, economic development, and business activities. Analyzing these disparities helps in identifying areas for targeted interventions and infrastructure development.

❖ **Peak Demand Management:**

Commercial establishments often contribute significantly to peak electricity demand. Analyzing peak demand patterns and implementing demand

management strategies can alleviate stress on the electricity grid, reduce costs, and improve overall system reliability.

Seasonal Variations:

- ❖ Commercial electricity consumption exhibits seasonal variations influenced by factors such as climate, holidays, festivals, and tourism. Understanding these variations aids in capacity planning, resource allocation, and tariff structuring.

- ❖ **Energy Efficiency Measures:**

  Assessing the adoption of energy-efficient technologies and practices among commercial consumers is crucial for promoting sustainability and reducing overall energy consumption. This includes measures such as LED lighting, efficient HVAC systems, and energy management systems.

1.4 Advantages

❖ **Economic Development:**

States with higher levels of economic development tend to have greater commercial electricity consumption due to increased industrial activity, commercial establishments, and services.

States like Maharashtra, Karnataka, Tamil Nadu, Gujarat, and Delhi are known for their robust industrial and commercial sectors, leading to higher electricity consumption.

❖ **Infrastructure:**

Availability and quality of infrastructure, including power transmission and distribution networks, influence commercial electricity consumption.

States with well-developed infrastructure can support a higher number of commercial establishments and industries, leading to increased electricity usage.

❖ **Policy Support:**

State government policies play a crucial role in promoting commercial activities and thereby impacting electricity consumption.

States offering incentives, subsidies, and favorable policies for industries and commercial enterprises attract more investments, leading to higher electricity consumption.

❖ **Sectoral Analysis:**

Commercial electricity consumption can vary across different sectors such as retail, hospitality, manufacturing, IT, etc.

States with a diverse industrial base and a thriving services sector typically exhibit higher commercial electricity consumption.

For example, states like Karnataka, with technology hubs like Bangalore, see significant electricity consumption from the IT and services sector.

❖ **Urbanization:**

Urban areas typically have higher commercial electricity consumption due to the concentration of businesses, offices, and commercial activities.

States with rapidly urbanizing cities experience a surge in commercial electricity demand.

States like Maharashtra (Mumbai), Karnataka (Bangalore), and Tamil Nadu (Chennai) have metropolitan cities driving their commercial electricity consumption.

1.5 Scope

❖ Data Collection:

Gather data on electricity consumption incommercial sectors from reliable sources such as government reports, utility companies, and research organizations. Access data for individual states to conduct a comprehensive analysis. This data should include consumption trends over time, seasonal

variations, and regional disparities.

❖ Data Preprocessing:

Clean the data to remove any inconsistencies, missing values, or outliers that may skew the analysis. Normalize the data if necessary to make comparisons across states more meaningful, especially if the states have varying population sizes or levels of economic development.

❖ Descriptive Analysis:

Calculate basic statistics such as mean,median, and standard deviation to understand the central tendency and dispersion of commercial electricity consumption in each state.

❖ **Comparative Analysis:**

Compare commercial electricity consumption across differentstates to identify outliers or regions with unusually high or low consumtion dates.

❖ **Communication:**

Present the findings of the analysis in a clear and accessible manner through reports, presentations, and data visualizations. Engage with stakeholders, including government agencies, policymakers, businesses, and advocacy groups, to facilitate informed discussions and decision-making.

CHAPTER 2

SERVICES AND TOOLS REQUIRED

2.1 Services Used

❖ **Sector Identification:**

Identify the key sectors within the commercial category where electricity is consumed. This typically includes:

- **Retail establishments (e.g., malls, shops, supermarkets)**

- **Hospitality industry (e.g., hotels, restaurants, resorts)**

- **Office spaces (e.g., corporate offices, business parks)**

- **Healthcare facilities (e.g., hospitals, clinics)**

- **Educational institutions (e.g., schools, colleges, universities)**

- **Entertainment venues (e.g., cinemas, theaters, stadiums)**

❖**Data Collection:**

Gather data on electricity consumption for each sector from reliable sources such as government reports, utility companies, and industry associations.

Ensure data is available at the state level to perform a detailed analysis.

❖ **Data Preprocessing:**

Clean and preprocess the data to remove any inconsistencies or outliers.

Aggregate the data for each sector and state to facilitate analysis.

❖ **Descriptive Analysis:**

Calculate and compare the total electricity consumption of each sector across different states.

Use descriptive statistics and data visualization techniques to understand consumption patterns and variations.

❖ **Sector-wise Analysis:**

Analyze electricity consumption patterns within each sector to identify the primary drivers of consumption.

- Assess factors such as operational hours, equipment usage, facility size, and energy efficiency measures adopted by businesses within each sector.

❖ **Communication:**

\- Present the findings of the analysis in a clear and accessible manner through reports, presentations, and data visualizations.

\- Engage with stakeholders, including policymakers, industry associations, and businesses, to discuss implications and potential strategies for managing commercial electricity consumption effectively.

2.2 Tools and Software used

Tools:

1.Data Collection Tools:

❖ **Smart Meters**:

These are advanced energy meters that record consumption data at frequent intervals, providing granular insights into usage patterns.

❖ **Energy Management Systems (EMS):**

EMS software collects, stores, and analyzes energy consumption data from various sources, including meters and sensors.

❖ **Utility Bills**:

Historical electricity bills provide valuable data for understanding past consumption patterns and trends.

❖ **Surveys and Interviews**:

Surveys and interviews can supplement quantitative data with qualitative insights, such as energy usage behaviors and operational practices.

2. Data Analysis Tools:

❖ **Statistical Software**:

Tools like R, Python with libraries such as Pandas, NumPy, and SciPy can perform statistical analysis on consumption data to identify trends, correlations, and anomalies.

❖ **Data Visualization Tools**:

Platforms like Tableau, Power BI, or Python libraries like Matplotlib and Seaborn help create visualizations (e.g., line charts, histograms, heatmaps) to represent consumption patterns effectively.

❖ **GIS (Geographic Information System):**

GIS software can spatially analyze electricity consumption data, identifying regional variations and clustering of high consumption areas.

❖ **Time Series Analysis Tools**:

Tools like Prophet, Statsmodels, or specialized time series databases can be used to model and forecast electricity consumption patterns over time.

3.Energy Audit Tools:

❖ **Energy Audit Software:**

These tools help assess energy performance, identify inefficiencies, and recommend strategies for energy optimization in commercial buildings.

❖ **Benchmarking Tools:**

Tools that compare a building's energy performance against industry standards or similar buildings can help identify areas for improvement.

❖ Building Simulation Software:

Tools like EnergyPlus or OpenStudio simulate building energy performance under different scenarios, aiding in identifying opportunities for energy savings.

Software Requirements:

❖ **Data Collection and Management**:

Software like PostgreSQL, MySQL, or MongoDB to store and manage large volumes of consumption data efficiently.

❖ **ETL (Extract, Transform, Load) Tools**:

Tools such as Apache NiFi, Talend, or Informatica for extracting data from various sources, transforming it into a usable format, and loading it into the database.

❖ **GIS Software**:

Geographic Information System software like QGIS or ArcGIS for spatially organizing and analyzing consumption data, particularly useful for understanding regional variations.

2.Data Analysis and Modeling:

❖ **Statistical Analysis Tools:**

Software like R, Python with libraries such as Pandas, NumPy, and SciPy for conducting statistical analysis to identify consumption trends, correlations, and anomalies.

❖ **Time Series Analysis Tools:**

Tools like Prophet, Statsmodels, or specialized time series databases for modeling and forecasting electricity consumption patterns over time.

❖ **Machine Learning and AI Tools:**

Frameworks like TensorFlow, PyTorch, or scikit-learn for building predictive models to forecast consumption and detect anomalies.

❖ **Optimization Software:**

Tools for conducting optimization analysis to identify energy-saving opportunities and recommend efficient consumption strategies.

3. Data Visualization and Reporting:

❖ **Dashboarding Tools:**

Platforms like Tableau, Power BI, or Grafana for creating interactive dashboards to visualize consumption data and track key performance indicators.
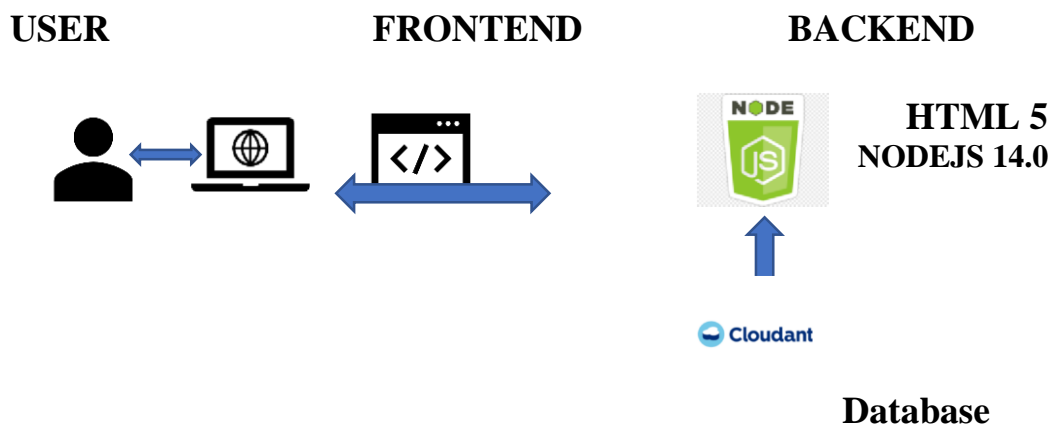
❖ **Geospatial Visualization Tools:**

Integration with GIS software for mapping consumption data and visualizing spatial patterns.

CHAPTER 3

PROJECT ARCHITECTURE

3.1 Architecture

USER	FRONTEND	BACKEND

HTML 5
NODEJS 14.0

Cloudant

Database

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

1.Data Collection:
- Acquire data from various sources such as electricity distribution companies, government databases, smart meters, IoT devices, etc.
- Data could include consumption records, tariff rates, weather data, demographic information, economic indicators, etc.
- Establish data pipelines to collect, clean, and preprocess the data for analysis.

2.Data Storage:
- Utilize a scalable and reliable database system to store the collected data.

- Consider using a combination of relational databases (e.g., PostgreSQL, MySQL) for structured data and NoSQL databases (e.g., MongoDB, Cassandra) for semi-structured or unstructured data.
- Implement appropriate data partitioning and indexing strategies for efficient querying.

3.Data Processing:
- Employ distributed processing frameworks like Apache Hadoop or Apache Spark for handling large volumes of data.
- Use batch processing for analyzing historical consumption patterns and real-time/stream processing for monitoring and alerting.
- Implement data aggregation, filtering, transformation, and enrichment as needed.

4.Analysis:
- Develop analytical models and algorithms to identify trends, anomalies, and insights in electricity consumption data.
- Apply statistical methods, machine learning techniques (e.g., regression, clustering, time series forecasting), and domain-specific knowledge for analysis.

5.Visualization:
- Build interactive dashboards and visualizations to present the analysis results in a user-friendly manner.
- Utilize tools and libraries such as Tableau, Power BI, matplotlib, Plotly, etc., for creating charts, graphs, maps, etc.
- Enable drill-down capabilities, filtering options, and real-time updates for better exploration of data.

6.Security and Compliance:
- Implement robust security measures to protect sensitive data and prevent unauthorized access.
- Comply with relevant data privacy regulations (e.g., GDPR, HIPAA) and industry standards.
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7.Scalability and Performance:
- Design the architecture to scale horizontally to accommodate growing data volumes and user loads.
- Utilize cloud services (e.g., AWS, Azure, Google Cloud) for elastic scalability and resource provisioning.
- Optimize data processing pipelines and algorithms for performance and efficiency.

8.Monitoring and Maintenance:
- Implement monitoring and logging mechanisms to track system performance, data quality, and uptime.

- Set up alerts for detecting anomalies, errors, or performance degradation.
- Establish a maintenance schedule for regular updates, patches, and improvements to the system.

9.Integration:
- Integrate with other systems and applications as required, such as billing systems, GIS platforms, energy management systems, etc.
- Ensure interoperability and data exchange through standardized APIs or data formats.
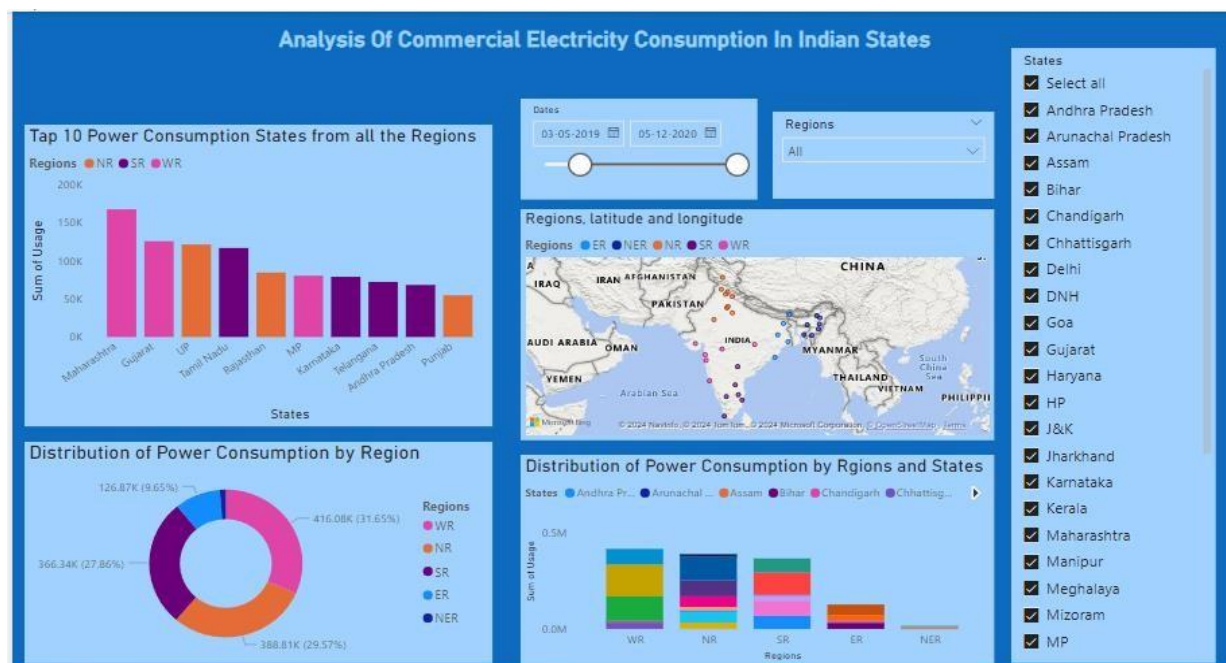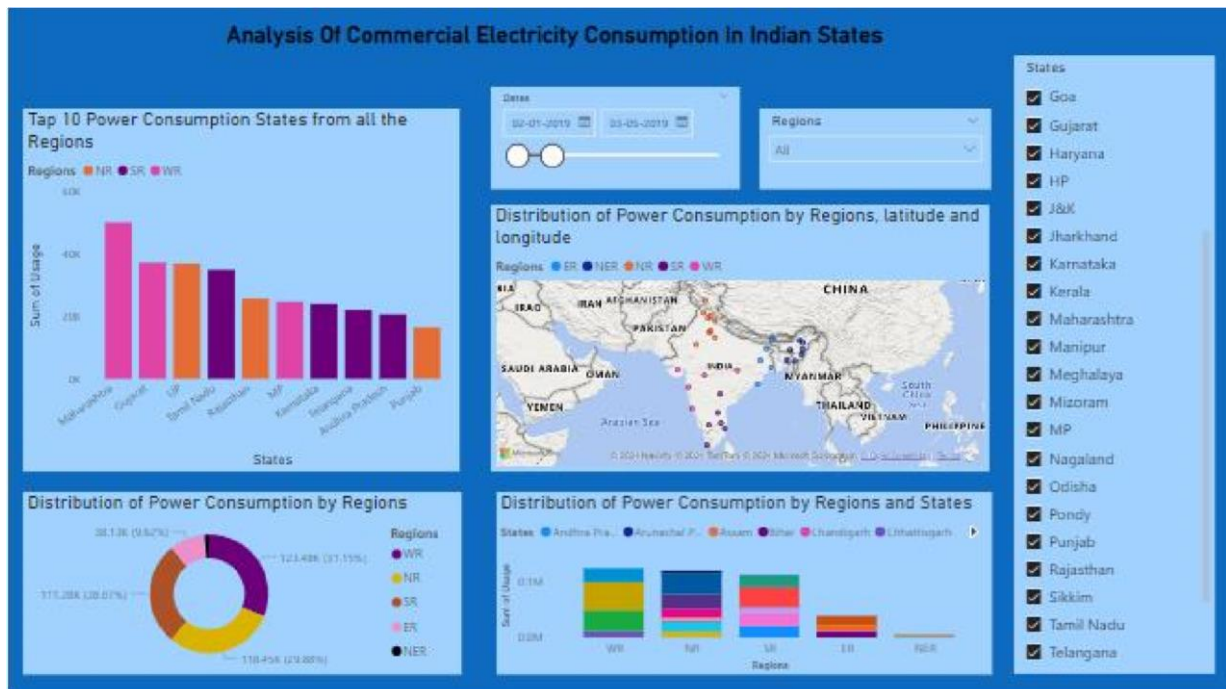
CHAPTER 4

MODELING AND RESULT

Manage relationship

The data file will be usd as the main connector as it contains most key identifier (States,Regions) which can be used to relare the 2 data files together. The state file is use to to link the clent profile geography with State it.
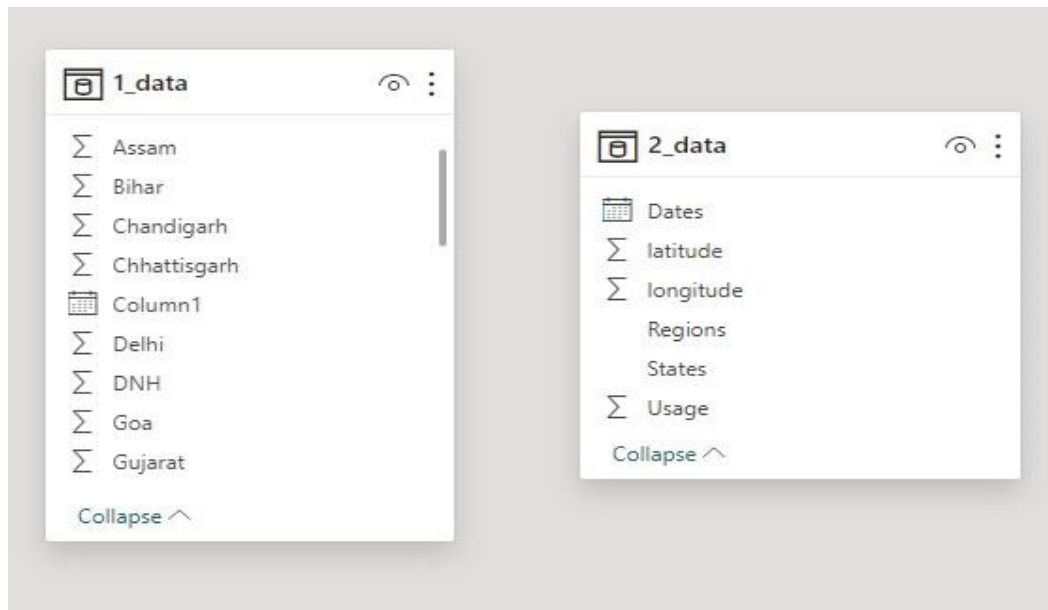
Dashboard

BEFORE LOCKDOWN

Analysis Of Commercial Electricity Consumption In Indian States

CONCLUSION

The project titled "Analysis of Commercial Electricity Consumption in an Indian State" has meticulously utilized Power BI to dissect and understand the commercial electricity consumption patterns during the critical period of 2019–2020, marked by the COVID-19 lock downs. The analysis has illuminated the stark changes in energy usage, providing a narrative of resilience and adaptability within the commercial sector. By leveraging Power BI advanced data visualization and analysis capabilities, the project has offered actionable insights that are crucial for strategic energy management and policy formulation. This study not only reflects on the past but also equips stakeholders with the knowledge to navigate future challenges, ensuring sustainable energy consumption in the evolving commercial landscape.

FUTURE SCOPE

To meet growing demand, the power sector must undergo continuous evolution. Projections for capacity addition consider factors such as the expected growth in demand, technological advancements, and the need for a diversified energy mix. As per the latest projections, India aims to add 150GW of new capacity by 2030.

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LINK

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