Tech Saksham

Case Study Report

Data Analytics with Power BI

“Analysis of commercial electricity consumption in Indian state”

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ABSTRACT

This study aims to investigate and analyze the patterns of electrical consumption across various states in India. With the increasing demand for electricity due to rapid urbanization, industrialization, and population growth, understanding consumption trends becomes imperative for effective energy planning and policy formulation. The analysis encompasses both residential and industrial sectors to provide a comprehensive overview.The methodology involves collecting and analyzing extensive data on electricity consumption, demographic factors, economic indicators, and regional characteristics for different states in India. Statistical techniques such as regression analysis, time series analysis, and clustering methods are employed to identify key factors influencing consumption patterns and to classify states based on their electricity usage behavior. Furthermore, the findings contribute to the discourse on energy planning and provide valuable insights for future research in the field of energy economics and policy.

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CHAPTER 1

INTRODUCTION

Today, commercial electricity consumption remains a cornerstone of modern economies, supporting a wide range of industries including retail, healthcare, hospitality, finance, and technology. However, as concerns about environmental sustainability grow, there's an increasing focus on energy efficiency and the adoption of renewable energy sources to power commercial operations, aiming to reduce carbon emissions and mitigate climate change impacts.

1.1 PROBLEM STATEMENT:

"Despite advancements in technology and efforts towards energy efficiency, commercial electricity consumption continues to rise, posing challenges related to sustainability, cost management, and grid reliability. Businesses face pressure to reduce their environmental footprint while ensuring reliable power supply for operations. This necessitates innovative solutions to optimize electricity usage, integrate renewable energy sources, and implement smart grid technologies. Addressing these challenges is critical for fostering sustainable economic growth and mitigating the impacts of climate change."

1.2 PROBLEM SOLUTION:

The problem of rising commercial electricity consumption can be addressed through a combination of strategies aimed at improving energy efficiency, integrating renewable energy sources, and implementing smart grid technologies. Here's a proposed solution framework:

Employee Engagement and Behavioral Changes:

Educate employees on energy-saving practices and encourage behavioral changes such as turning off lights and equipment when not in use.

Implement employee incentive programs to reward energy-saving behaviors and foster a culture of sustainability within the organization.

Policy Support and Incentives:

Advocate for supportive policies at the local, state, and federal levels that promote energy efficiency, renewable energy adoption, and grid modernization.Take advantage of financial incentives, rebates, and tax credits available for energy efficiency upgrades and renewable energy investments.By implementing these solutions in a coordinated manner, businesses can effectively manage their electricity consumption, reduce costs, minimize environmental impact, and contribute to a more sustainable energy future.

1.3 FEATURES:

When considering features for addressing the issue of commercial electricity consumption, several key components are crucial for an effective solution. Here are the essential features:

Energy Monitoring and Analytics:

Real-time monitoring of electricity consumption across commercial facilities.

Advanced analytics to identify patterns, trends, and opportunities for energy optimization.

Demand Response Integration:

Integration with demand response programs to enable automated load shedding or shifting during peak demand periods.

Renewable Energy Integration:

Compatibility with off-site renewable energy procurement options like power purchase agreements (PPAs) or renewable energy certificates (RECs).

Energy Efficiency Recommendations:

Automated recommendations for energy efficiency measures based on energy audit findings and real-time data analysis.

Guidance on optimal settings for HVAC systems, lighting controls, and equipment operation to minimize energy consumption.

Smart Building Controls:

Integration with smart building systems to control lighting, HVAC, and other energy-consuming devices based on occupancy, schedules, and energy demand.

Remote access and control capabilities for facility managers to adjust settings and optimize energy usage.

Predictive Maintenance:

Predictive analytics to anticipate equipment failures and maintenance needs, reducing downtime and optimizing energy efficiency.Integration with asset management systems to schedule maintenance activities proactively.

Scalability and Integration:

Scalable architecture to accommodate growth and expansion of commercial operations.Integration with existing building management systems, energy management systems, and enterprise software platforms.

Regulatory Compliance:

Features to ensure compliance with energy efficiency regulations, building codes, and sustainability standards.Alerts and notifications for upcoming regulatory changes and deadlines.

By incorporating these features into a comprehensive solution, businesses can effectively manage their electricity consumption, optimize energy usage, and achieve their sustainability goals.

1.4 ADVANTAGES:

Advantages of implementing solutions for managing commercial electricity consumption:

Cost Savings: By optimizing energy usage and reducing waste, businesses can lower their electricity bills and operational expenses, leading to significant cost savings over time.

Environmental Sustainability: Decreasing electricity consumption helps to reduce greenhouse gas emissions and environmental impact, contributing to broader sustainability goals and corporate responsibility initiatives.

Regulatory Compliance: Implementing energy-efficient measures and renewable energy integration can help businesses comply with energy regulations, building codes, and sustainability standards, avoiding potential fines or penalties.

Improved Operational Efficiency: Monitoring and managing electricity consumption enable businesses to identify inefficiencies and optimize processes, leading to improved operational efficiency and productivity.

Innovation and Technological Advancement: Investing in energy management solutions fosters innovation and drives technological advancement, leading to the development of new energy-efficient technologies and solutions.

1.4 DISADVANTAGES:

Disadvantages and challenges associated with managing commercial electricity consumption:

Upfront Costs: Implementing energy management solutions and adopting renewable energy technologies often require significant upfront investment, which may pose a barrier for some businesses, especially small and medium-sized enterprises (SMEs).

Complexity of Implementation: Integrating energy management systems with existing infrastructure and processes can be complex and challenging, requiring careful planning, coordination, and expertise.

Technical Limitations: Some energy efficiency measures and renewable energy technologies may have technical limitations or compatibility issues with certain types of equipment or facilities, limiting their effectiveness.

Despite these challenges, the benefits of managing commercial electricity consumption often outweigh the drawbacks, particularly inthe long term, as businesses strive to reduce costs, mitigate risks, and demonstrate environmental stewardship.

1.5 SCOPES:

The scope of managing commercial electricity consumption encompasses a wide range of activities and considerations aimed at optimizing energy usage, reducing costs, and promoting sustainability. Here are the key scopes involved:

Energy Audits and Assessments:

Conducting comprehensive energy audits and assessments to identify areas of high energy consumption and inefficiencies within commercial facilities.

Energy Efficiency Measures:

Implementing energy-efficient technologies and practices such as LED lighting, HVAC system upgrades, insulation improvements, and equipment optimization to reduce electricity consumption.

Renewable Energy Integration:

Exploring opportunities for integrating renewable energy sources such as solar, wind, or geothermal power to offset grid electricity consumption and promote clean energy generation.

Demand Response and Load Management:

Participating in demand response programs and implementing load management strategies to adjust electricity usage during peak demand periods, reducing strain on the grid and lowering costs.

Smart Grid Technologies:

Deploying smart meters, advanced metering infrastructure (AMI), and grid management systems to enable real-time monitoring, analysis, and optimization of electricity distribution and consumption.

Energy Management Systems (EMS):

Implementing EMS platforms to monitor, control, and optimize energy usage across commercial facilities, integrating with building automation systems for seamless operation.

Employee Engagement and Training:

Educating employees on energy-saving practices and encouraging behavioral changes to promote energy conservation within the workplace.

Data Monitoring and Analytics:

Collecting and analyzing energy consumption data to identify trends, patterns, and opportunities for improvement, enabling data-driven decision-making and continuous optimization.

By addressing these scopes comprehensively, businesses can develop holistic strategies for managing commercial electricity consumption, achieving cost savings, reducing environmental impact, and enhancing overall operational efficiency.

CHAPTER 2

SERVICES AND TOOLS REQUIRED

2.1 Services Used:

Smart Meters: Many commercial properties are equipped with smart meters that provide real-time data on electricity usage. These meters offer detailed insights into consumption patterns, peak usage times, and can help identify areas for optimization.

IoT Sensors and Devices: Internet of Things (IoT) sensors and devices can be deployed within commercial buildings to monitor electricity usage at a granular level. These sensors can track usage by individual equipment or areas within the building, providing valuable data for optimization efforts.

Energy Management Systems (EMS): EMS software solutions help businesses monitor, control, and optimize their energy usage. These systems integrate data from various sources, such as smart meters and IoT devices, and provide analytics tools to identify trends, set goals, and implement energy-saving strategies.

2.2 Tools and Software used:

Tools:

- **PowerBI**: The main tool for this project is PowerBI, which will be used to create interactive dashboards for real-time data visualization.
- **Power Query**: This is a data connection technology that enables you to discover, connect, combine, and refine data across a wide variety of sources.

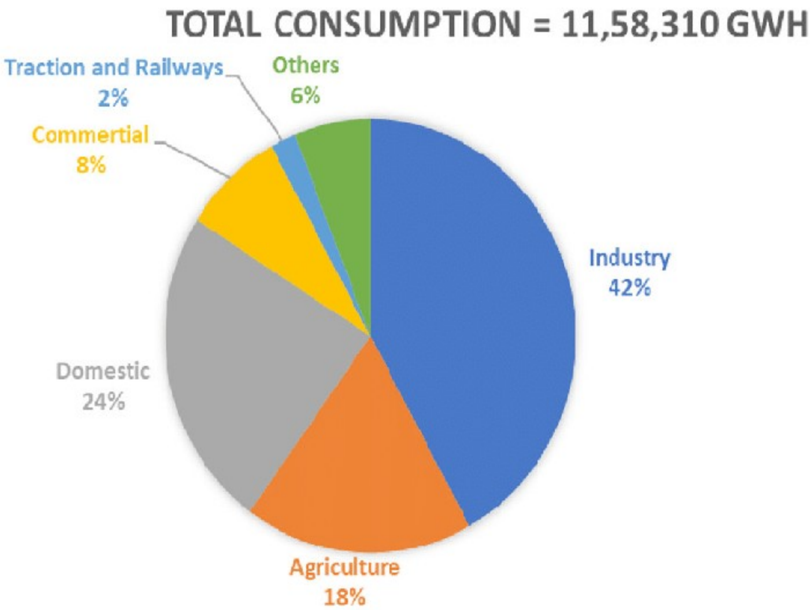
Software Requirements:

- **PowerBI Desktop**: This is a Windows application that you can use to create reports and publish them to PowerBI.
- **PowerBI Service**: This is an online SaaS (Software as a Service) service that you use to publish reports, create new dashboards, and share insights.
- **PowerBI Mobile**: This is a mobile application that you can use to access your reports and dashboards on the go.

CHAPTER 3

PROJECT ARCHITECTURE

3.1 Architecture



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

1. **Data Storage:** Store the collected data in a scalable and reliable data storage system, such as a data lake or a cloud-based storage solution like Amazon S3 or Google Cloud Storage.

2. **Data Ingestion:** Set up a data ingestion pipeline to collect data from various sources mentioned above. This could involve APIs, data scraping, or direct data feeds, depending on data availability and accessibility.

3. **Data Processing**: Preprocess the raw data to handle missing values, outliers, and inconsistencies. Perform data cleaning, normalization, and aggregation to prepare the data for analysis.

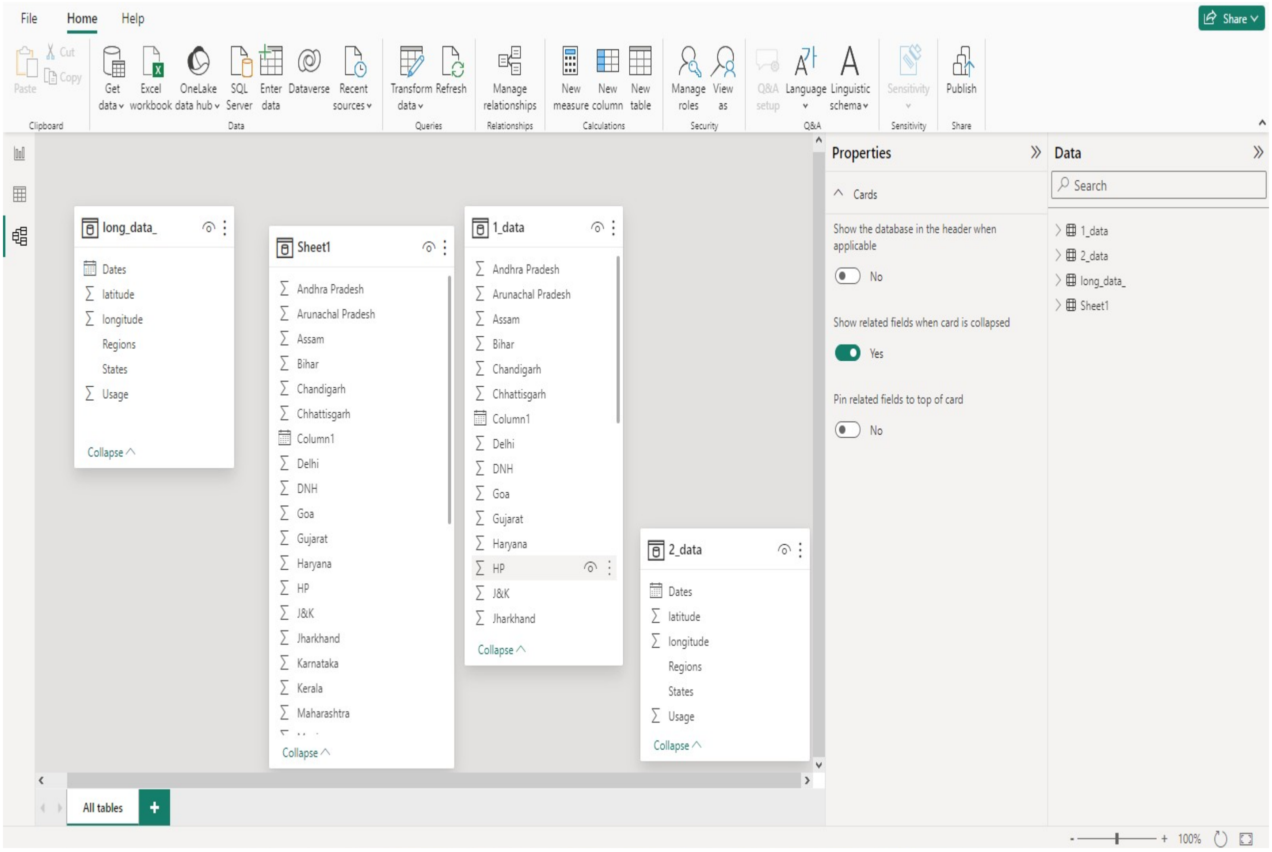
4. **Scalability and Maintenance**: Design the architecture to be scalable and adaptable to accommodate future changes in data volume, sources, or analysis requirements.

CHAPTER 4

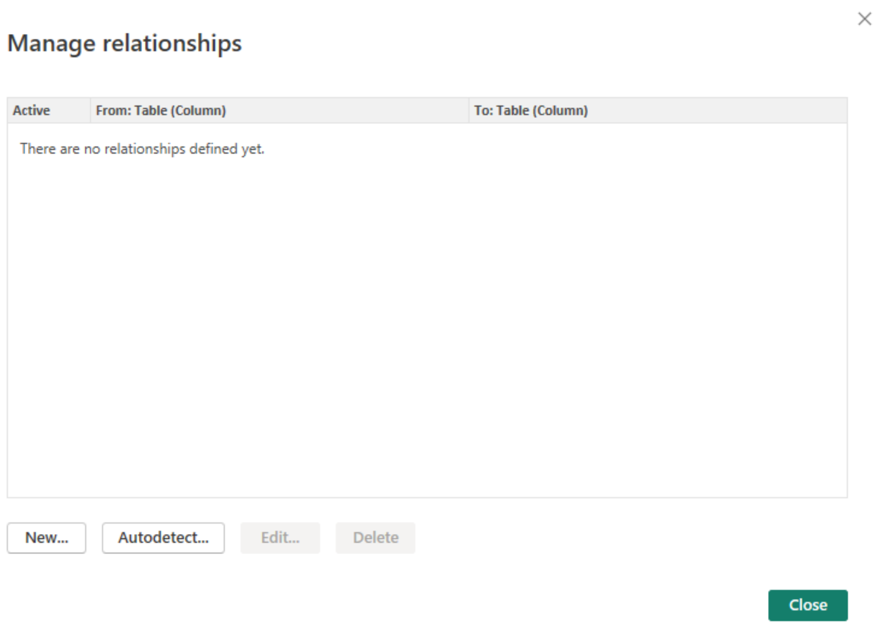
MODELING AND RESULT

Manage relationship

The “sheet” file will be used the contains keys (states and column1) which can be use to relates the four data files together. The “long_data” file is use to sum the states where high consumption take place.we using five type of attributes(longitude,latitude,region,states,usage).



In this dataset has no relationship between any columns and rows .these dataset does not manage tables relation



Some coding to calculate the electricity bills ,in condition to find the charges and which units consumed electricity.

Check units consumed is less than equal to the 100, If yes then the total electricity bill will be:

$$\text{Total Electricity Bill} = (\text{units} * 10)$$

Else if, check that units consumed is less than equal to the 200, if yes then total electricity bill will be:

$$\text{Total Electricity Bill} = (100 * 10) + (\text{units} - 100) * 15$$

Else if, check that units consumed is less than equal to the 300, if yes then total electricity bill will be:

$$\text{Total Electricity Bill} = (100 * 10) + (100 * 15) + (\text{units} - 200) * 20$$

Else if, check that units consumed greater than 300, if yes then total electricity bill will be:

$$\text{Total Electricity Bill} = (100*10)+(100*15)+(100*20)+(\text{units}-300)*25$$

```cpp
// C++ implementation to calculate the
// electricity bill
#include<bits/stdc++.h>
using namespace std;

// Function to calculate the
// electricity bill
int calculateBill(int units)
{

    // Condition to find the charges
    // bar in which the units consumed
    // is fall
    if (units <= 100)
    {
        return units * 10;
    }
    else if (units <= 200)
    {
        return (100 * 10) +
               (units - 100) * 15;
    }
    else if (units <= 300)
    {
        return (100 * 10) +
               (100 * 15) +
               (units - 200) * 20;
    }
    else if (units > 300)
    {
        return (100 * 10) +
               (100 * 15) +
               (100 * 20) +
               (units - 300) * 25;
    }
    return 0;
}

// Driver Code
int main()
{
    int units = 250;
    cout << calculateBill(units);
}

// This code is contributed by spp____
```

Output:

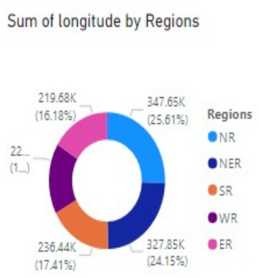
```
3500
```

In this coding we calculate the bills for electricity consumption.thesemodeling and result of the electricity consumption in india. Obtaining commercial electricity consumption datasets can vary depending on your location and access to data sources

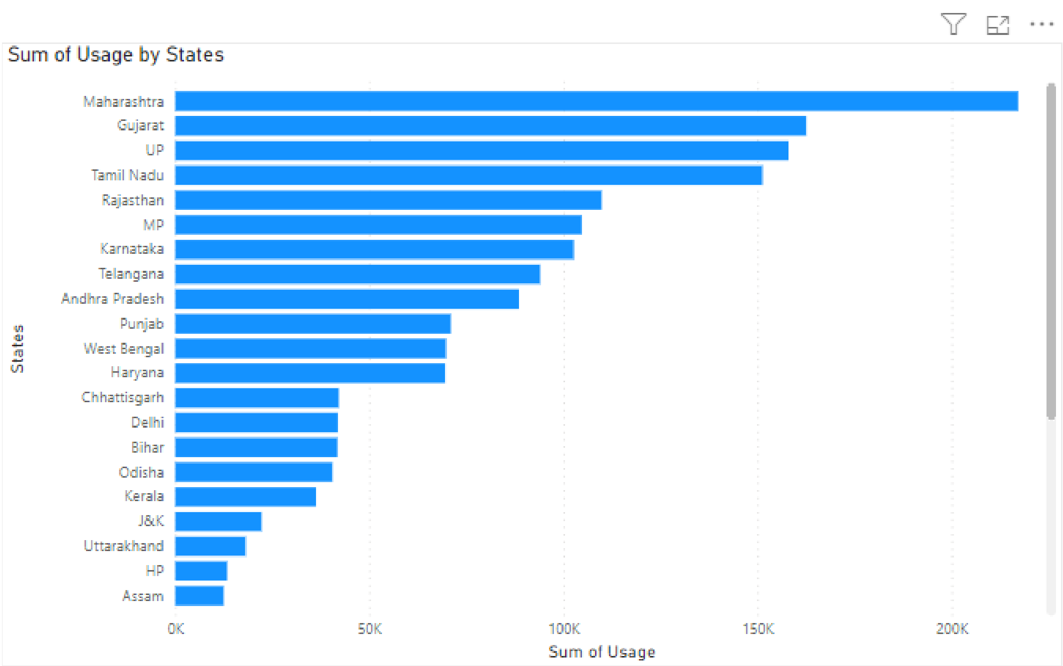
Modeling electricity consumption in India requires a multidisciplinary approach, incorporating domain knowledge, data analytics expertise, and an understanding of the socio-economic and environmental factors shaping energy demand in the country

Dashboard

We are apply sum of longitude of region given in the dataset

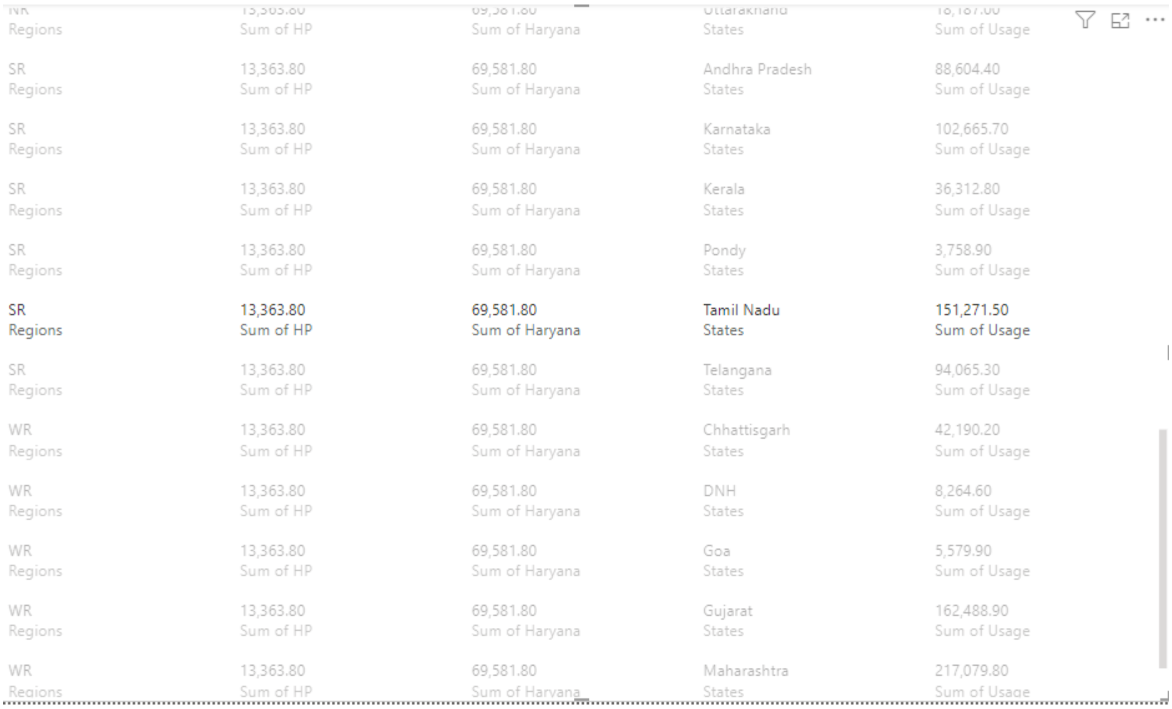


Sum of usage of the electricity by states in India



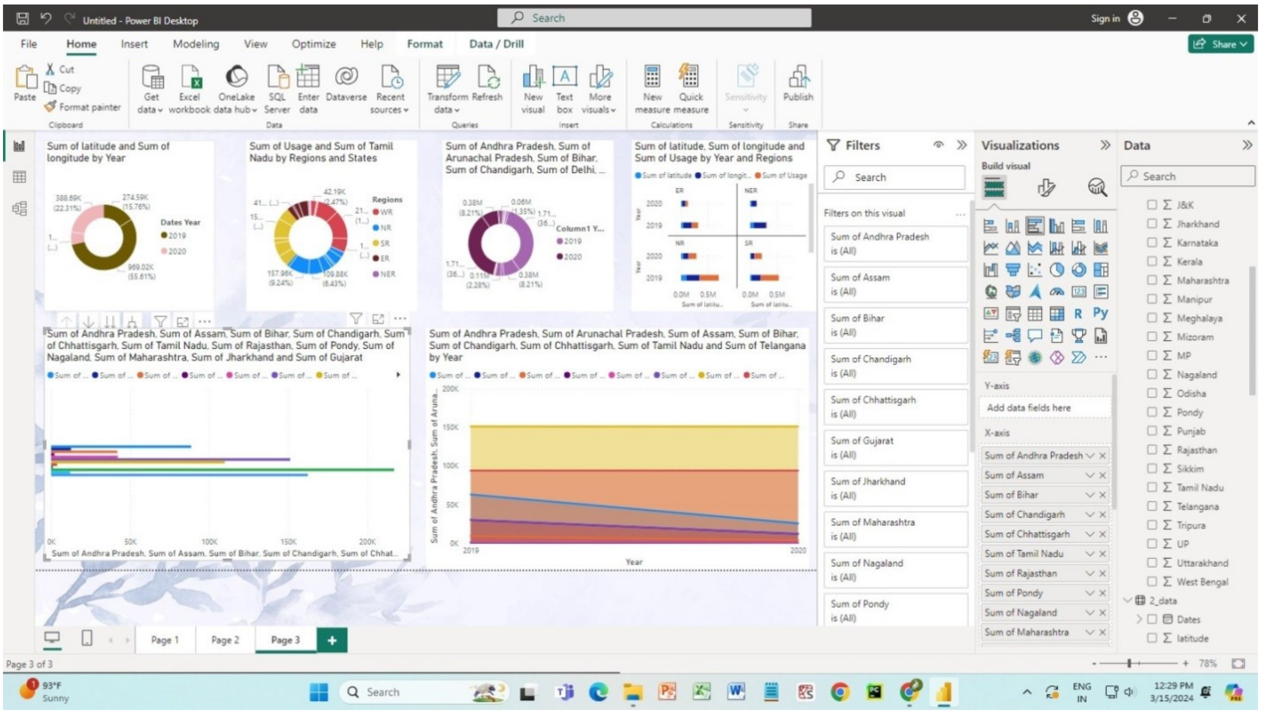
In the bar chart ,x-axis is sum of usage and y-axis is states where located in india.consumption the electricity in state.

In tamilnadu SR region tamilnadu states in 151,271,50 sum of usage



Regions	Sum of HP	Sum of Haryana	States	Sum of Usage
NR	13,363.80	69,581.80	Uttarakhand	18,187.00
SR	13,363.80	69,581.80	Andhra Pradesh	88,604.40
SR	13,363.80	69,581.80	Karnataka	102,665.70
SR	13,363.80	69,581.80	Kerala	36,312.80
SR	13,363.80	69,581.80	Pondy	3,758.90
SR	13,363.80	69,581.80	Tamil Nadu	151,271.50
SR	13,363.80	69,581.80	Telangana	94,065.30
WR	13,363.80	69,581.80	Chhattisgarh	42,190.20
WR	13,363.80	69,581.80	DNH	8,264.60
WR	13,363.80	69,581.80	Goa	5,579.90
WR	13,363.80	69,581.80	Gujarat	162,488.90
WR	13,363.80	69,581.80	Maharashtra	217,079.80

In this we use the application to create the dashboard in powerBI,using the dataset of electricity consumption



CONCLUSION:

The conclusion regarding commercial electricity consumption in Indian states would depend on various factors such as economic activity, industrialization, infrastructure development, and government policies. As businesses expand and new commercial establishments emerge, the demand for electricity increases. States with greater industrialization and commercial activity, such as Maharashtra, Gujarat, Tamil Nadu, and Karnataka, likely have higher consumption rates compared to less developed states. Government policies and initiatives play a crucial role in shaping commercial electricity consumption patterns, while there are general trends and considerations to be made regarding commercial electricity consumption in Indian states, the specific situation would vary from state to state based on individual socio-economic factors and policy environments.

FUTURE SCOPE

Here's a look at the future scope for analyzing commercial electricity consumption:

Granular Data & AI:

Deeper insights from high-resolution smart meter data. AI can analyze consumption patterns to identify inefficiencies and optimize energy use.

Electrification Trends:

The shift towards electric vehicles and heat pumps will impact commercial energy demand. Analysis can predict these impacts and inform grid planning.

Sustainability & Renewables:

Businesses will increasingly focus on reducing their carbon footprint. Analyzing consumption patterns can help identify opportunities for on-site renewables and energy efficiency measures.

Dynamic Pricing & Demand Management:

Time-of-day pricing will incentivize businesses to shift energy use to off-peak hours. Analysis can help optimize energy use based on these pricing structures.

Overall:

The electrical equipment market in India is poised for remarkable growth,with a projected CAGR of 11.68% between 2022 and 2027.This growth is expected to translate into a substantial increase of USD 52.97 billion in the market size.

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links: