

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:-

Electricity consumption in the commercial sector plays a crucial role in India's economy, reflecting the vibrancy of businesses and industries across the country. Understanding the patterns and trends of commercial electricity usage is essential for policymakers, energy planners, and businesses to make informed decisions regarding energy efficiency, infrastructure development and sustainability initiatives. Commercial electricity consumption began to surge during the late 19th and early 20th centuries, coinciding with the expansion of urban areas and the rise of industrialization.

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.

1. Energy Audits and Efficiency Measures:

- Conduct comprehensive energy audits to identify areas of high energy usage and inefficiencies within commercial facilities.
- Implement energy-efficient technologies such as LED lighting, energy-efficient HVAC systems, and power management systems to reduce electricity demand.

2. Renewable Energy Integration:

- Invest in on-site renewable energy generation systems such as solar panels, wind turbines, or geothermal heat pumps to offset grid electricity consumption.
- Explore opportunities for off-site renewable energy procurement through power purchase agreements (PPAs) or community solar initiatives.

3. Demand Response Programs:

- Participate in demand response programs that incentivize businesses to reduce electricity consumption during peak demand periods.
- Deploy energy storage systems to store excess energy during off-peak hours for use during peak demand times.

4. Smart Grid Technologies:

- Deploy smart meters and advanced metering infrastructure (AMI) to enable real-time monitoring of electricity consumption and optimize grid operations.
- Implement demand-side management technologies to enable automated load shedding or shifting during peak demand events.

5. Energy Management Systems (EMS):

- Deploy EMS platforms to monitor, analyze, and optimize energy usage across commercial facilities in real-time.
- Utilize predictive analytics and machine learning algorithms to forecast energy demand and optimize energy consumption patterns.

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:

1. Energy Monitoring and Analytics:

- Real-time monitoring of electricity consumption across commercial facilities.
- Advanced analytics to identify patterns, trends, and opportunities for energy optimization.

2. Demand Response Integration:

- Integration with demand response programs to enable automated load shedding or shifting during peak demand periods.
- Ability to adjust energy usage based on grid conditions and price signals.

3.Renewable Energy Integration:

- Support for integrating on-site renewable energy generation systems such as solar panels or wind turbines.
- Compatibility with off-site renewable energy procurement options like power purchase agreements (PPAs) or renewable energy certificates (RECs).

4.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.

5.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.

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 AND DISADVANTAGES:

Advantages of implementing solutions for managing commercial electricity consumption:

- Identifying patterns and trends in electricity usage, which can inform decisions about energy supply and demand management.
- Understanding the price and income elasticity of electricity demand, which can help in setting tariffs and pricing policies.
- Highlighting the differences in electricity consumption between different consumer categories, which can inform cross-subsidy policies and open access regulations.

Disadvantages and challenges associated with managing commercial electricity consumption:

- The need for accurate and reliable data on electricity consumption, which can be difficult to obtain and may vary in quality across different regions and consumer categories.
- The complexity of the electricity sector in India, which is characterized by a mix of public and private utilities, cross-subsidies, and open access regulations.
- The potential for bias in the estimation of price and income elasticities of electricity demand, which may be influenced by factors such as consumer behavior, market power, and regulatory mechanism.

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

1.5 SCOPE:

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:

1. Energy Audits and Assessments:

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

2. Energy Efficiency Measures:

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

3. Renewable Energy Integration:

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

4. Demand Response and Load Management:

- o 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.

5. Smart Grid Technologies:

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

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.

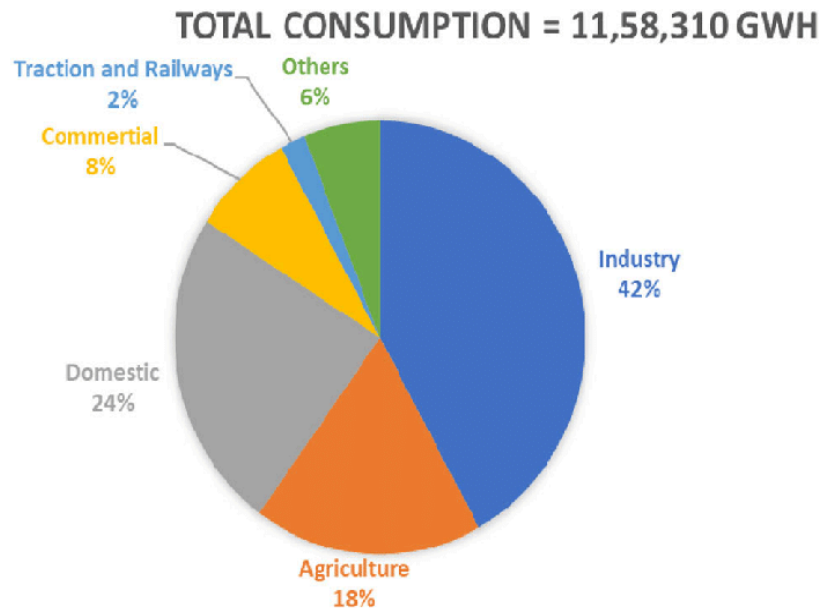
Software Requirements:

- **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:

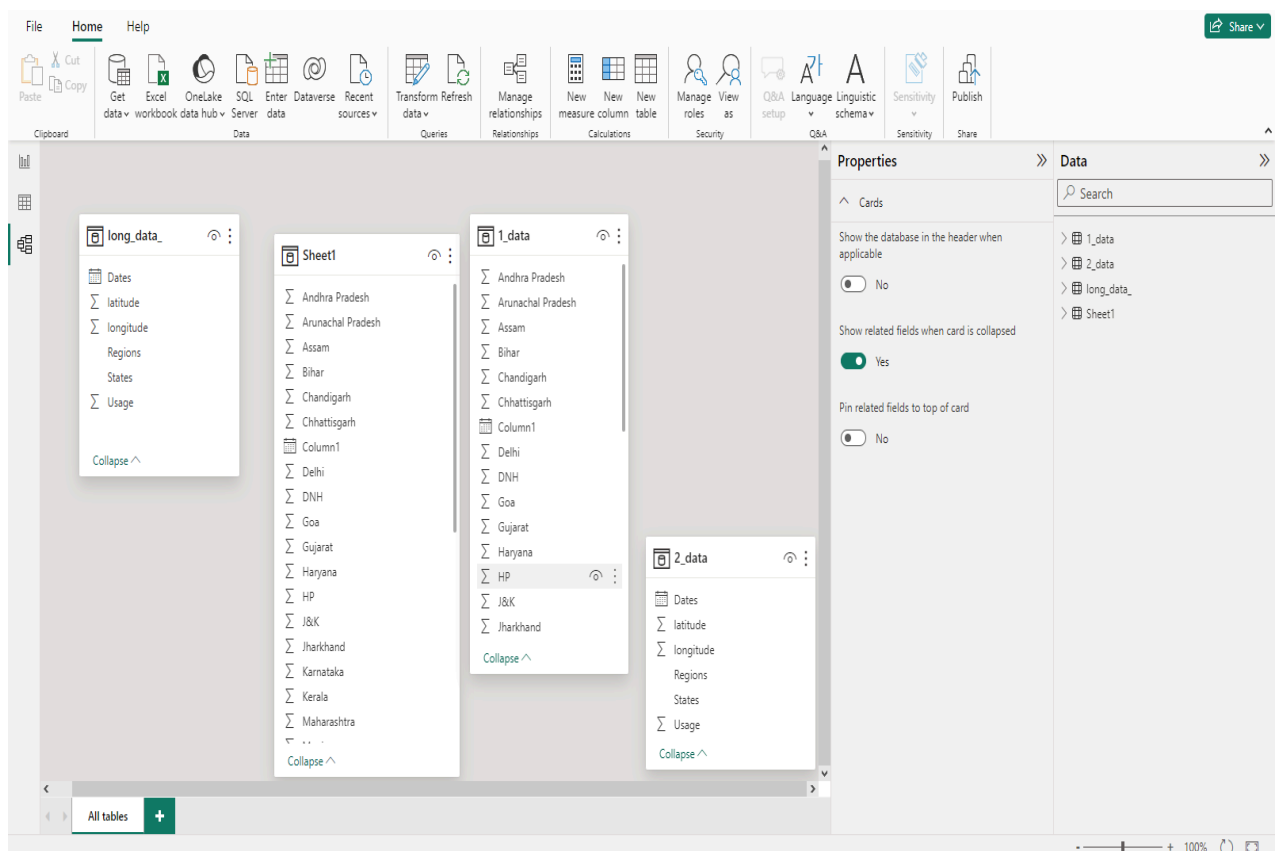
Design the architecture to be scalable and adaptable to accommodate future changes in data volume, sources, or analysis requirements.

CHAPTER 4

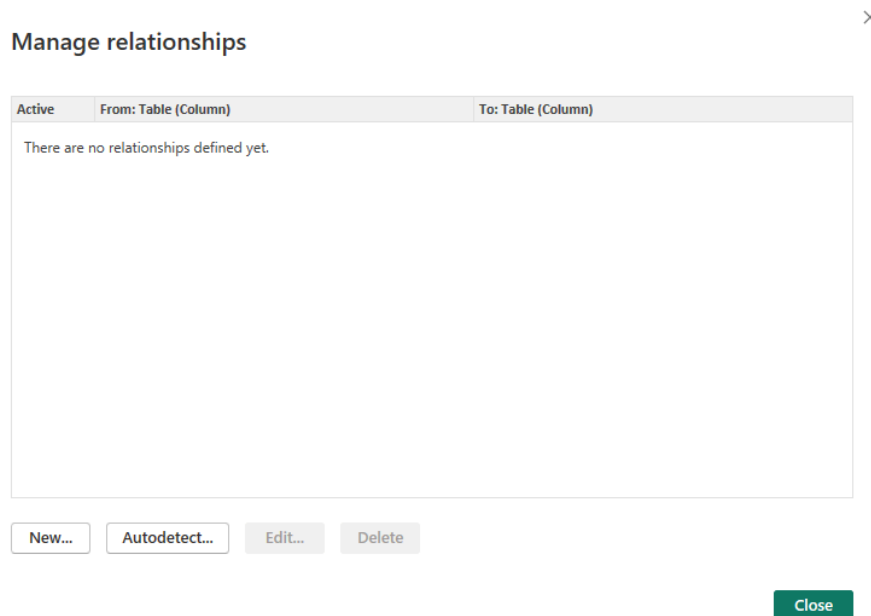
MODELING AND RESULT

Manage relationship

The “sheet” file will be used the containskeys (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:

```
Total Electricity Bill = (units * 10)
```

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

```
Total Electricity Bill = (100 * 10) + (units - 100) * 15
```

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

```
Total Electricity Bill = (100 * 10) + (100 * 15) + (units - 200) * 20
```

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

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

```
// 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:

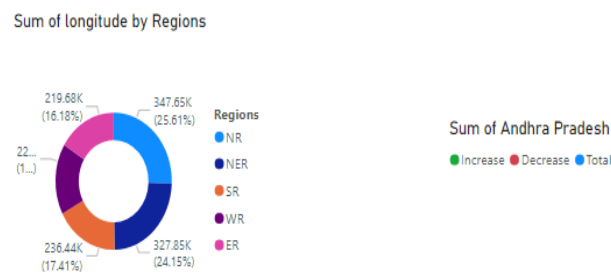
3500

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

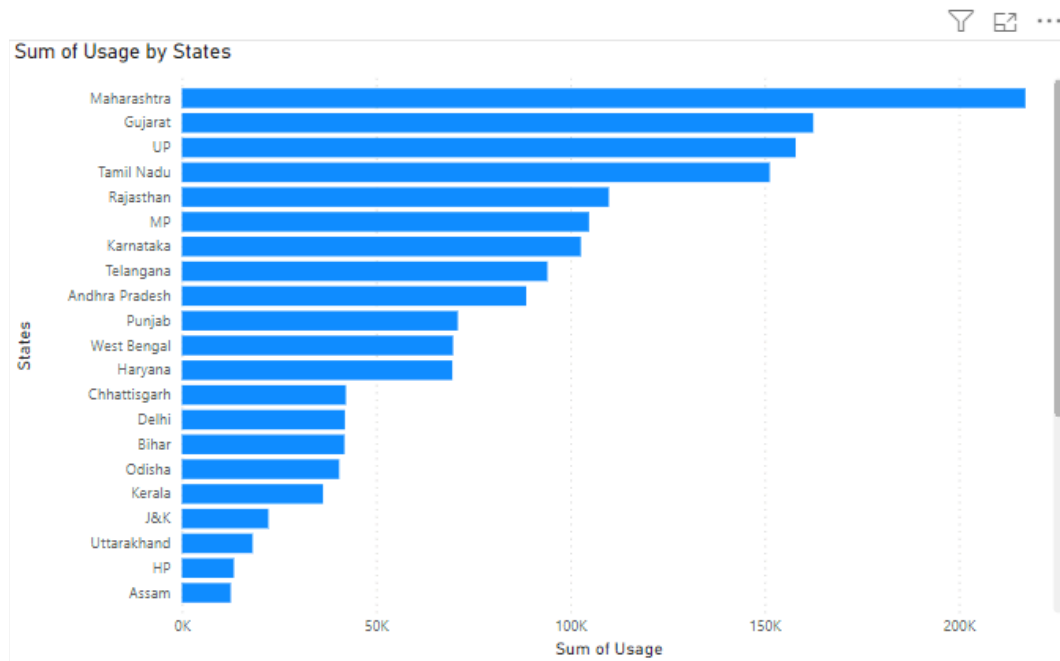
Modeling electricity consumption in India requires a multidisciplinary approach, incorporating domain knowledge, data analytics expertise, and an understanding of the socio-economic and environmental factors shaping energy demand in the country.

Dashboard

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



Sum of usage of theelectricity by states in India

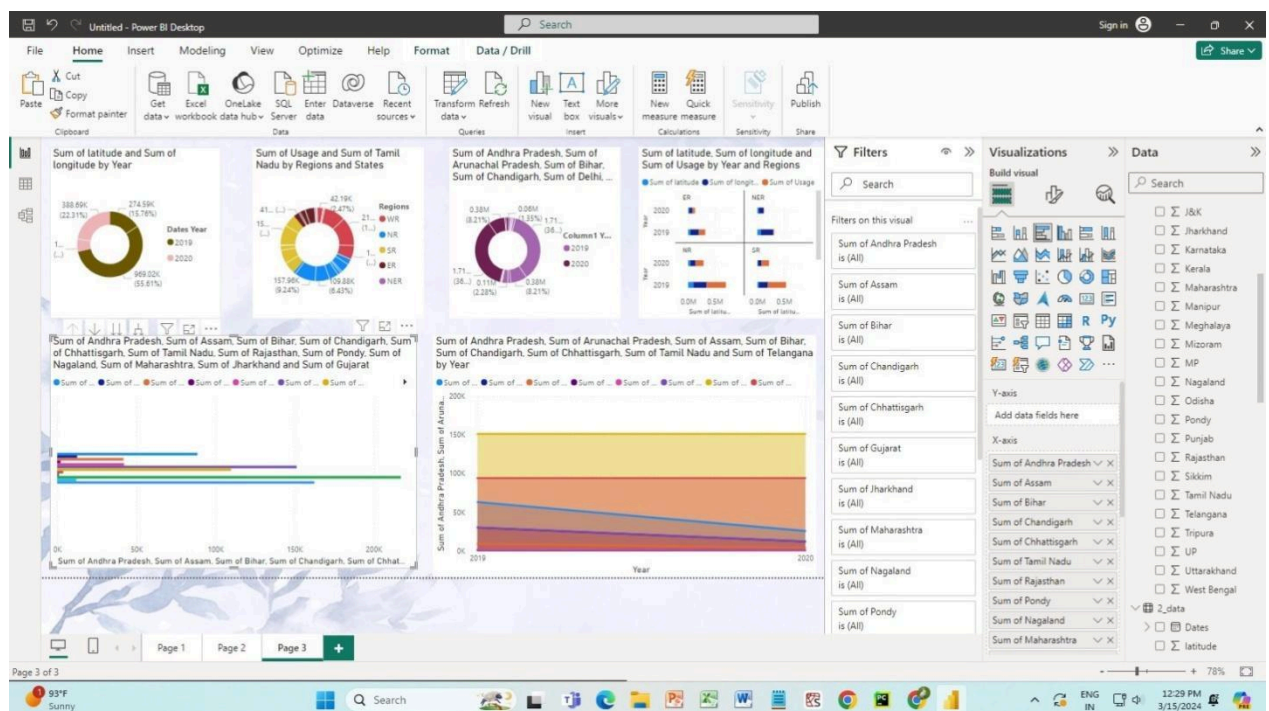


In the bar chart ,x-axis is sum of usage and y-axis is states where located in india.consumption the electricity in state.

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

NR	13,363.80	69,581.80	Uttarakhand	16,167.00
Regions	Sum of HP	Sum of Haryana	States	Sum of Usage
SR	13,363.80	69,581.80	Andhra Pradesh	88,604.40
Regions	Sum of HP	Sum of Haryana	States	Sum of Usage
SR	13,363.80	69,581.80	Karnataka	102,665.70
Regions	Sum of HP	Sum of Haryana	States	Sum of Usage
SR	13,363.80	69,581.80	Kerala	36,312.80
Regions	Sum of HP	Sum of Haryana	States	Sum of Usage
SR	13,363.80	69,581.80	Pondy	3,758.90
Regions	Sum of HP	Sum of Haryana	States	Sum of Usage
SR	13,363.80	69,581.80	Tamil Nadu	151,271.50
Regions	Sum of HP	Sum of Haryana	States	Sum of Usage
SR	13,363.80	69,581.80	Telangana	94,065.30
Regions	Sum of HP	Sum of Haryana	States	Sum of Usage
WR	13,363.80	69,581.80	Chhattisgarh	42,190.20
Regions	Sum of HP	Sum of Haryana	States	Sum of Usage
WR	13,363.80	69,581.80	DNH	8,264.60
Regions	Sum of HP	Sum of Haryana	States	Sum of Usage
WR	13,363.80	69,581.80	Goa	5,579.90
Regions	Sum of HP	Sum of Haryana	States	Sum of Usage
WR	13,363.80	69,581.80	Gujarat	162,488.90
Regions	Sum of HP	Sum of Haryana	States	Sum of Usage
WR	13,363.80	69,581.80	Maharashtra	217,079.80
Regions	Sum of HP	Sum of Haryana	States	Sum of Usage

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.

REFERENCES:

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<https://chat.openai.com/c/9411f637-f23d-4769-9857-bac0f437f5c6>

https://en.wikipedia.org/wiki/Electricity_sector_in_India

LINKS: