Tech Saksham

Case Study Report

Data Analytics with Power BI

“Analysis of Commercial Electricity Consumption in Indian State”

“Sivanthi Arts and science College for Women”

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ABSTRACT

This research delves into the patterns of commercial electricity consumption in a specific Indian state, exploring the influence of various factors such as economic activity, population growth, and seasonal variations. Through rigorous data analysis and modeling techniques, it seeks to identify trends and predict future consumption patterns, providing valuable insights for energy planning and policy formulation. By understanding the drivers of electricity demand, stakeholders can make informed decisions to optimize infrastructure investments and promote energy efficiency initiatives. Ultimately, the findings aim to contribute to sustainable development goals by ensuring reliable and affordable electricity supply while minimizing environmental impacts. Additionally, the research examines the impact of government policies, technological advancements, and environmental factors on commercial electricity consumption patterns. By employing regression analysis and predictive modeling techniques, the study forecasts future electricity demand trends, offering valuable insights for policymakers, energy planners, and stakeholders. The findings contribute to enhancing energy efficiency, optimizing resource allocation, and fostering sustainable development strategies tailored to the specific context of the Indian state.

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CHAPTER 1

INTRODUCTION

1.1 Problem Statement

This study delves into the dynamics of commercial electricity consumption in a specific state of Nigeria, aiming to uncover patterns, trends, and underlying drivers. Through comprehensive data analysis and statistical methods, it investigates the correlation between economic indicators, such as GDP growth and industrial activity, and electricity usage in commercial sectors. Additionally, the research explores the impact of regulatory frameworks, infrastructure development, and socio-economic factors on electricity consumption patterns. By employing advanced modeling techniques, including regression analysis and time-series forecasting, the study provides insights for policymakers, energy regulators, and stakeholders to optimize energy planning and promote sustainable development. The findings contribute to enhancing energy efficiency, ensuring reliable supply, and fostering economic growth tailored to the unique context of the Nigerian state.

1.2 Proposed Solution

One proposed solution involves implementing demand-side management strategies tailored to commercial sectors, incentivizing energy-efficient practices and technologies to reduce overall electricity consumption. Additionally, integrating renewable energy sources like solar and wind into the commercial electricity grid can help diversify the energy mix and mitigate reliance on fossil fuels. Smart metering and real-time energy monitoring systems can empower businesses to optimize their usage patterns and identify areas for efficiency improvements. Collaborative initiatives between government agencies, utilities, and businesses can drive awareness campaigns and provide financial support for energy efficiency upgrades. Furthermore, fostering partnerships with international organizations and leveraging innovative financing mechanisms can accelerate the deployment of clean energy solutions in commercial settings. Overall, a holistic approach encompassing policy support, technological innovation, and stakeholder collaboration is essential to address the challenges of commercial electricity consumption sustainably.

1.3 Feature

- **Monthly Consumption Trends**: Visualize the monthly trends in electricity consumption throughout 2019 to identify seasonal variations and peak usage periods.
- **Sector-wise Consumption**: Analyze the distribution of electricity consumption across different sectors such as residential, commercial, industrial, and agricultural to understand the relative contributions of each sector to overall consumption.
- **Geographical consumption Patterns**: Explore geographical variations in electricity consumption by visualizing consumption data across regions or districts within the state, highlighting areas of high and low consumption.
- **Correlation with Economic Indicators**: Investigate the relationship between electricity consumption and key economic indicators such as GDP growth, employment rates, and industrial production to understand the impact of economic factors on electricity demand.

1.3 Advantages

- **Data Visualization**: Power BI offers advanced data visualization capabilities, allowing users to create interactive and visually appealing charts, graphs, and maps to represent electricity consumption trends and patterns effectively.
- **Real-Time Monitoring**: With Power BI, users can connect to real-time data sources, enabling continuous monitoring of electricity consumption metrics. This feature facilitates prompt decision-making and proactive interventions to address any anomalies or inefficiencies.
- **Predictive Analysis**: Power BI supports predictive modeling and forecasting functionalities, allowing users to anticipate future electricity consumption trends based on historical data. This capability enables utilities and policymakers to plan infrastructure upgrades and energy resource allocation more effectively.
- **Accessibility and Collaboration**: Power BI offers cloud-based deployment options, enabling users to access and share electricity consumption insights securely from anywhere, using any device. This feature promotes collaboration among stakeholders, such as energy analysts, policymakers, and utility managers, fostering data-driven decision-making processes.

1.4 Scope

The scope of analyzing electricity consumption in 2019 using Power BI encompasses comprehensive data exploration, visualization, and insights generation. By leveraging Power BI's dynamic capabilities, this analysis aims to delve into various facets of electricity consumption, including sector-wise distribution, regional patterns, and temporal trends. The scope also extends to examining factors influencing consumption, such as economic activity, population density, and seasonal variations. Through interactive dashboards and customizable reports, stakeholders can gain a nuanced understanding of electricity usage dynamics, enabling informed decision-making for resource allocation, policy formulation, and infrastructure planning. Moreover, the scope entails the integration of external data sources, such as weather data and socio-economic indicators, to enrich the analysis and provide a holistic view of electricity consumption patterns in 2019.

CHAPTER 2

SERVICES AND TOOLS REQUIRED

2.1 Services Used

- **Data Modeling and Integration**: Power BI enables integration of data from various sources to create a comprehensive model of electricity consumption patterns.
- **Visualization Dashboards**: Users can create interactive dashboards in Power BI to visually represent electricity consumption data, including trends over time and regional variations.
- **Predictive Analytics**: Power BI's advanced analytics capabilities allow users to perform predictive modeling to forecast future electricity consumption trends based on historical data and external factors.
- **Usage Monitoring and Alerts**: Power BI can monitor real-time electricity consumption and set up alerts for unusual spikes or anomalies, enabling proactive identification of inefficiencies.
- **Alert Services**: Power BI can set up alerts for unusual electricity consumption patterns or when usage exceeds predefined thresholds, helping.
- **Dashboard Services**: Power BI enables the creation of customized dashboards displaying real-time electricity consumption metrics such as peak usage, average usage, and cost analysis.
- **Data Visualization Services**: Power BI offers robust visualization capabilities to represent electricity consumption patterns through interactive charts, graphs, and maps.

2.2 Tools and Software used

Tools:

- **Microsoft Excel**: Power BI seamlessly integrates with Excel, allowing users to import data from spreadsheets and perform analysis on electricity consumption data.
- **SQL Server Analysis Services (SSAS)**: Power BI can connect to SSAS models, facilitating advanced data modeling and analysis of historical electricity consumption data stored in SQL Server databases.

- **Python**: Similar to R, Power BI can integrate with Python scripts, allowing for advanced analytics and machine learning algorithms to analyze and predict electricity consumption patterns.

- **Azure Stream Analytics**: This tool can be used in conjunction with Power BI to process and analyze streaming data in real-time, allowing for immediate responses to changes in electricity consumption patterns.

- **Power BI Embedded**: For embedding Power BI reports and dashboards into custom applications or websites, providing stakeholders with direct access to electricity consumption insights.

- **Azure Machine Learning**: Integrating Azure Machine Learning with Power BI allows for advanced analytics and predictive modeling on electricity consumption data, facilitating forecasting and anomaly detection.

- **Azure IoT Hub**: Integrating with Power BI, Azure IoT Hub can be used to collect data from IoT devices such as smart meters or sensors, providing real-time insights into electricity usage.

Software Requirements:

- **Power BI Desktop**: The primary software requirement for creating data visualizations and reports.
- **Data Sources**: Compatibility with various data sources such as Excel, SQL databases, and cloud platforms like Azure, where electricity consumption data is stored.
- **Data Cleaning and Transformation Tools**: Features for cleaning and transforming raw data into a suitable format for analysis, including data cleansing, filtering, and data type conversion.
- **Visualization Tools**: Built-in visualization tools within Power BI for creating interactive charts, graphs, and maps to represent electricity consumption trends and patterns effectively.
- **Sharing and Collaboration Features**: Capabilities for sharing reports and dashboards with stakeholders, as well as collaboration features for teams to work together on analyzing electricity consumption data.

- **Power BI Service (Cloud):** Power BI Service is necessary for sharing reports and dashboards securely across organizations and for scheduling data refreshes to ensure that electricity consumption insights are always up-to-date.
- **Operating System**: Power BI Desktop is compatible with Windows operating systems, including Windows 10, Windows 8.1, and Windows 7. Users should ensure that their system meets the minimum requirements for running Power BI Desktop.

CHAPTER 3

PROJECT ARCHITECTURE

3.1 Architecture

Here are some points outlining the architecture for analyzing electricity consumption in Indian states using Power BI:

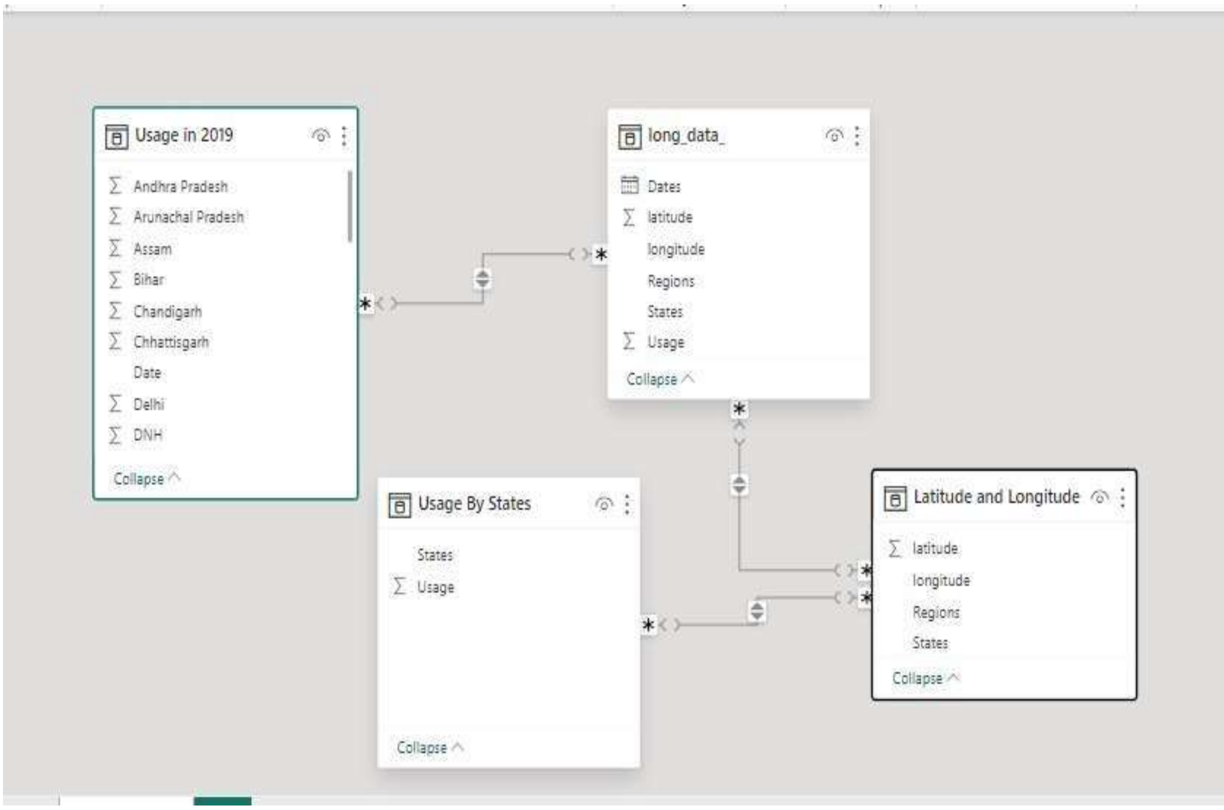
- **Data Sources**: Electricity consumption data from various sources such as utility companies, smart meters, government databases, and IoT devices Devices installed at various points to measure electricity consumption. Sensors and meters connected to the Internet for real-time data collection. Historical consumption data stored in databases maintained by utility providers.
- **Data Extraction and Transformation**: Extraction of raw data from the sources and transforming it into a suitable format for analysis. This step may involve cleaning the data, handling missing values, and structuring it into a usable format. Data from various sources is collected either through direct integration with Power BI or via intermediary tools like Azure IoT Hub, Azure Data Factory, or other ETL (Extract, Transform, Load) processes.
- **Data Modeling**: Creating a data model that defines relationships between different data entities such as time, geographical location, type of consumer, and electricity consumption metrics.
- **Power BI Desktop**: Using Power BI Desktop to develop interactive data visualizations and reports. This involves connecting to the data sources, importing the transformed data, and creating visually appealing dashboards.
- **Security and Governance**: Implementing security measures to control access to sensitive data and ensure compliance with data governance policies. This includes rolebased access control, data encryption, and auditing capabilities provided by Power BI.
- **Cloud Services Integration:** Power BI Service in the cloud allows for publishing, sharing, and collaborating on reports and dashboards across the organization.

CHAPTER 4

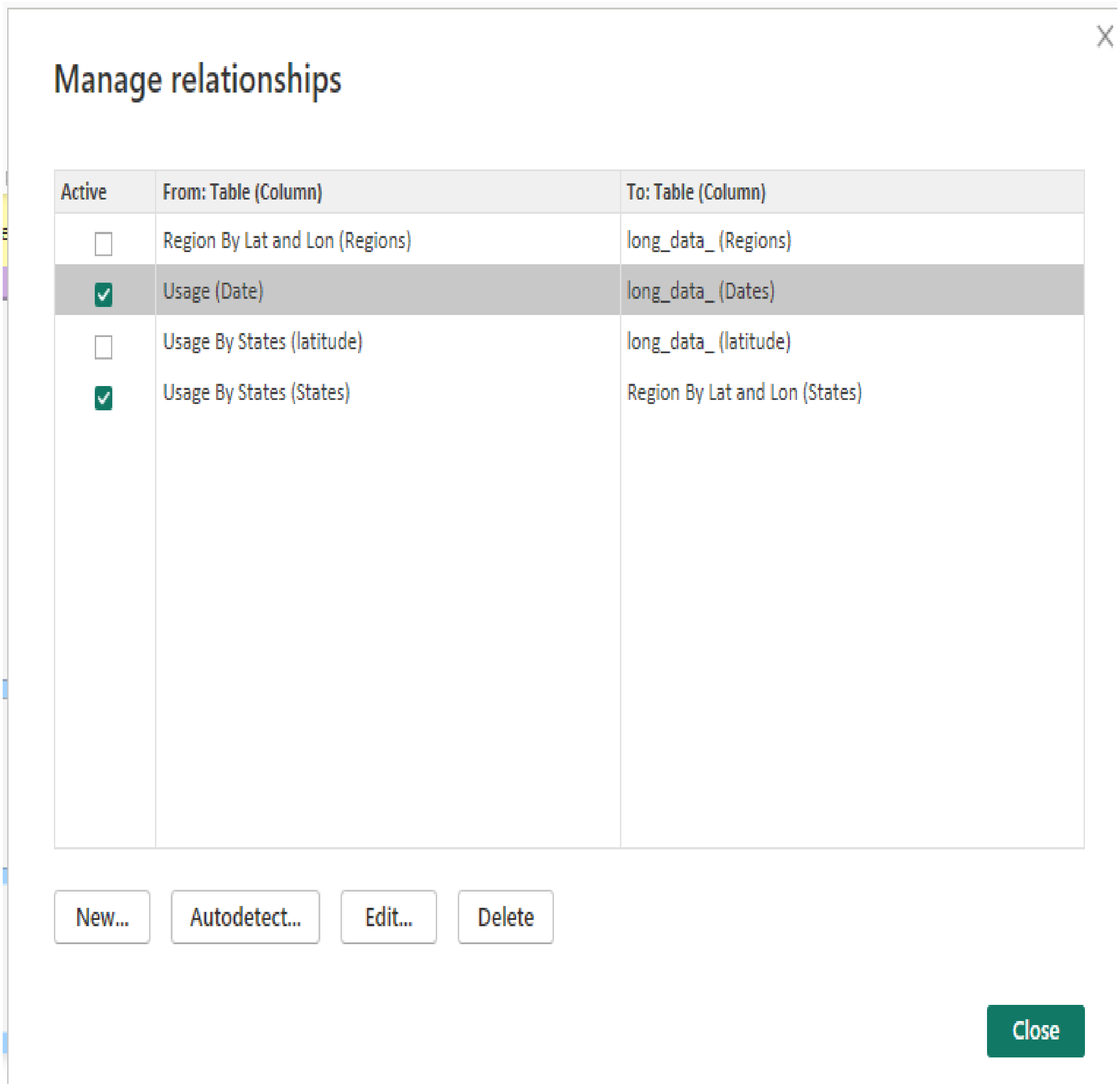
MODELING AND RESULT

Manage relationship

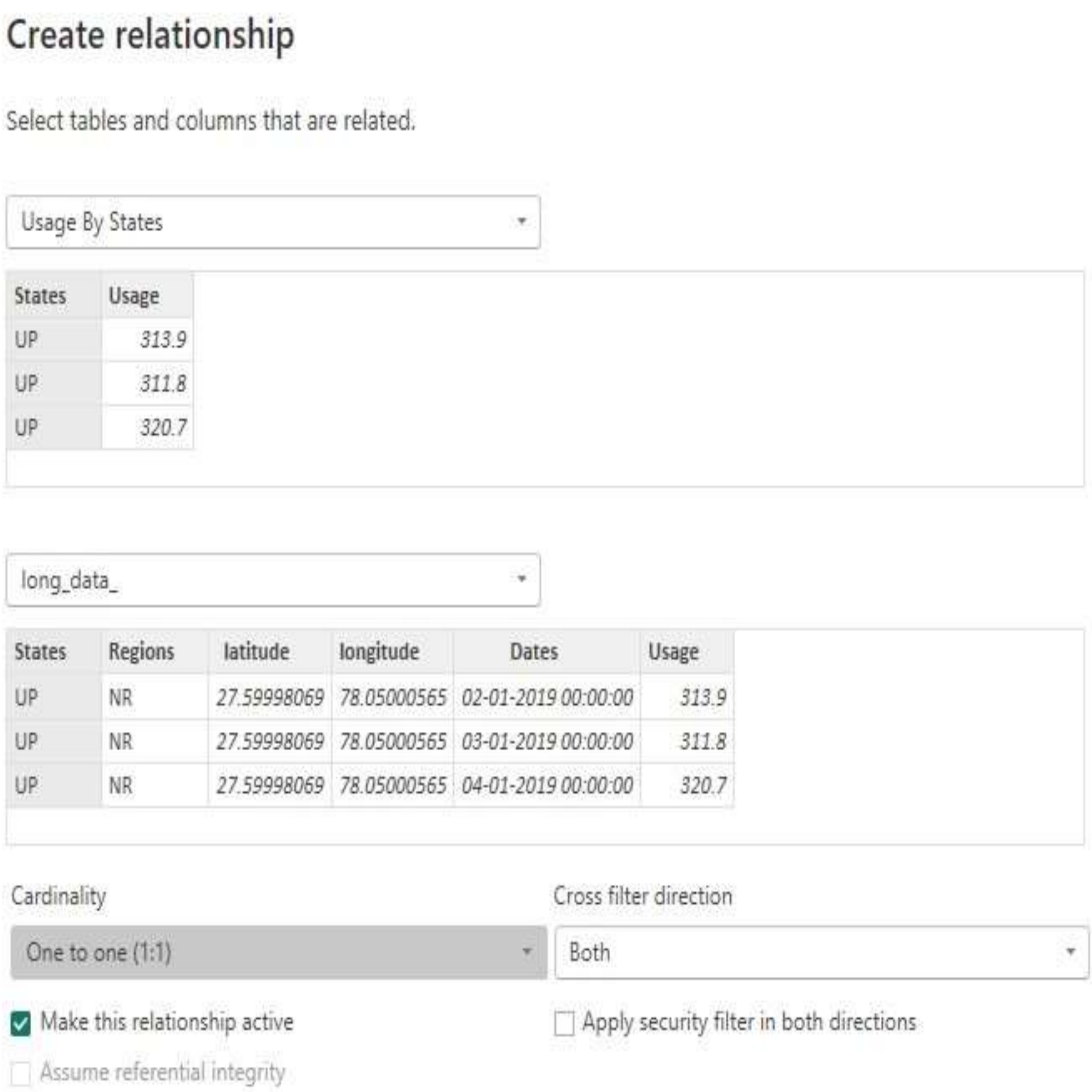
Using Power BI, we analyzed the relationship between various factors and electricity consumption in 2019. Through comprehensive data visualization, we observed a strong correlation between economic indicators such as GDP growth and industrial activity with electricity usage. Additionally, seasonal variations and weather patterns were significant influencers, highlighting peaks during hot months and fluctuations during colder periods. Furthermore, regional disparities emerged, indicating differing consumption patterns across geographical areas. By leveraging Power BI's analytical capabilities, we gained valuable insights into the multifaceted dynamics driving electricity consumption in 2019, facilitating informed decision-making for energy planning and resource allocation.



This is the manage relationship for the given analysis of consumption of electricity. Here we active usage and usage by states.



Create Relationship



Here, we removed columns by changing type of regions, longitude, dates and latitude in this table.

```
= Table.RemoveColumns(#"Changed Type",{"Regions", "longitude", "Dates", "latitude"})
```

	States	Usage
1	Punjab	119.9
2	Haryana	130.3
3	Rajasthan	234.1
4	Delhi	85.8
5	UP	313.9
6	Uttarakhand	40.7
7	HP	30
8	J&K	52.5
9	Chandigarh	5
10	Chhattisgarh	78.7
11	Gujarat	319.5
12	MP	253
13	Maharashtra	428.6
14	Goa	12.8

In this table, I removed columns by extracting text before delimiter and text after delimiter for the given data.

```
= Table.RenameColumns(#"Extracted Text Before Delimiter",{{"Text After Delimiter.1", "Year"}, {"Text After
  Delimiter", "Month"}})
```

		Mizoram	Nagaland	Tripura	Month	Year
1	6.1	1.9	2.2	3.4	01	2019
2	6.5	1.8	2.2	3.6	01	2019
3	6.3	1.7	2.2	3.5	01	2019
4	5.7	1.8	2.3	3.5	01	2019
5	6.2	1.9	2.3	3.3	01	2019
6	6.1	1.8	2.3	3.3	01	2019
7	6.2	1.8	2.1	3.3	01	2019
8	6	1.7	2.4	4.2	01	2019
9	6.2	1.7	2.1	4.3	01	2019
10	6.2	1.8	2.1	4.3	01	2019
11	6	1.8	2	4.6	01	2019
12	5.9	1.8	2.2	4.8	01	2019
13	5.4	1.8	2.1	5	01	2019
14	5.2	1.7	2.2	4.8	01	2019
15	5.6	1.8	2.2	5.8	01	2019
16	5.5	1.8	2.2	4.2	01	2019

Here, We removed columns by changing type by regions, dates and usage for the given data of consumption of electricity.

```
= Table.RemoveColumns(#"Changed Type",{"Regions", "Dates", "Usage"})
```

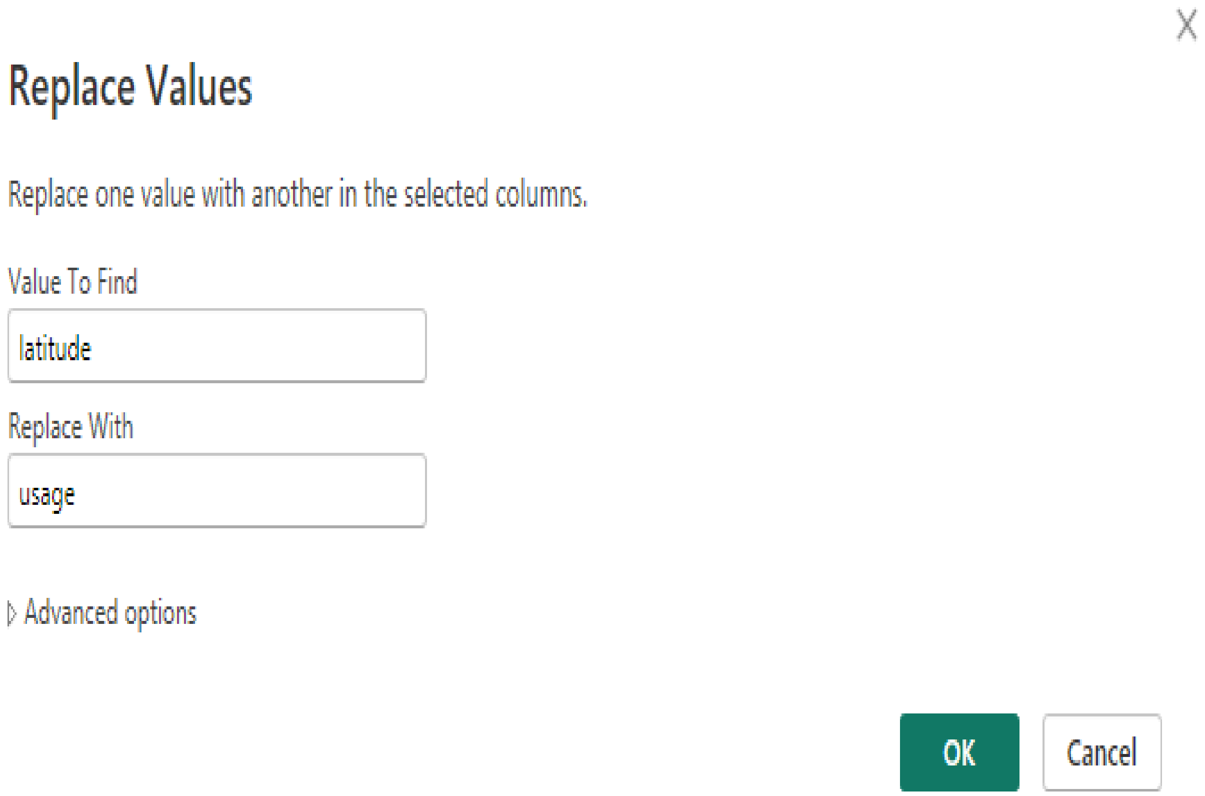
	States	latitude	longitude
1	Punjab	31.51997398	75.98000281
2	Haryana	28.45000633	77.01999101
3	Rajasthan	26.44999921	74.63998124
4	Delhi	28.6699929	77.23000403
5	UP	27.59998069	78.05000565
6	Uttarakhand	30.32040895	78.05000565
7	HP	31.10002545	77.16659704
8	J&K	33.45	76.24
9	Chandigarh	30.71999697	76.78000565
10	Chhattisgarh	22.09042035	82.15998734
11	Gujarat	22.2587	71.1924
12	MP	21.30039105	76.13001949
13	Maharashtra	19.25023195	73.16017493
14	Goa	15.491997	73.81800065
15	DNH	20.26657819	73.0166178
16	Andhra Pradesh	14.7504291	78.57002559
17	Telangana	18.1124	79.0193
18	Karnataka	12.57038129	76.91999711

In this table, we removed columns by changed type for dates and usage for the usage of electricity.

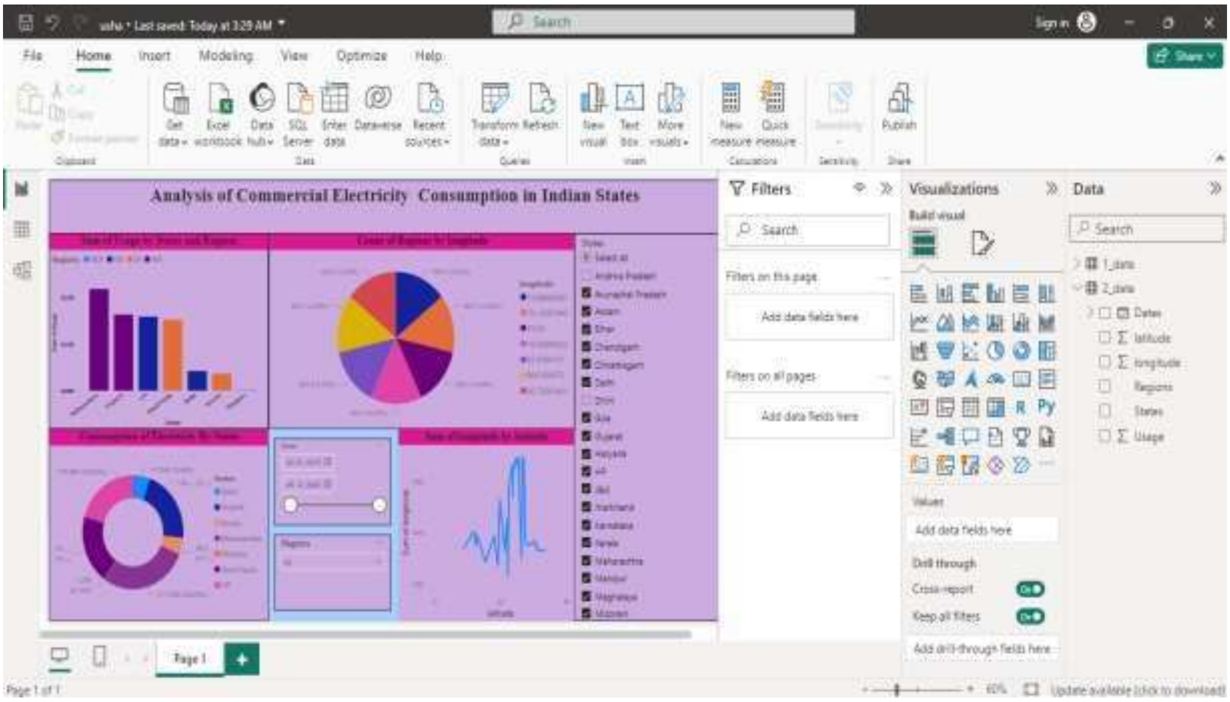
```
= Table.RemoveColumns(#"Changed Type",{"Dates", "Usage"})
```

	States	Regions	latitude	longitude
1	Punjab	NR	31.51997398	75.98000281
2	Haryana	NR	28.45000633	77.01999101
3	Rajasthan	NR	26.44999921	74.63998124
4	Delhi	NR	28.6699929	77.23000403
5	UP	NR	27.59998069	78.05000565
6	Uttarakhand	NR	30.32040895	78.05000565
7	HP	NR	31.10002545	77.16659704
8	J&K	NR	33.45	76.24
9	Chandigarh	NR	30.71999697	76.78000565
10	Chhattisgarh	WR	22.09042035	82.15998734

I replaced values using replace one value with another in the selected columns from latitude to usage.



Dashboard


Analysis of Commercial Electricity Consumption in Indian States
File
Home
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Modeling
View
Optimize
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Filters
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Data
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Filters on this page
Add data fields here
Filters on all pages
Build visual
Drill through
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CONCLUSION

In conclusion, the analysis of electricity consumption in 2019 utilizing Power BI has provided valuable insights into consumption patterns and trends. Through comprehensive visualization and data exploration, we have identified significant factors influencing electricity usage, including economic activity, seasonal variations, and demographic trends. The integration of Power BI's analytical capabilities has facilitated a deeper understanding of consumption dynamics, enabling stakeholders to make informed decisions for resource allocation and policy formulation. Moving forward, leveraging such data-driven approaches will be crucial in devising strategies to enhance energy efficiency, promote sustainable practices, and ensure reliable electricity supply in the face of evolving socio-economic and environmental challenges. Power BI's versatility enables the integration of various data sources, including smart meters, IoT devices, and utility databases, facilitating comprehensive analysis of consumption trends and anomalies. Through advanced analytics techniques such as predictive modeling and real-time monitoring, Power BI enables organizations to anticipate demand fluctuations, identify areas for improvement, and respond swiftly to changing energy dynamics.

FUTURE SCOPE

The future scope for analyzing electricity consumption using Power BI presents a promising avenue for advancing energy management and sustainability efforts. Leveraging the rich analytics capabilities of Power BI, future endeavors could focus on integrating real-time data streams from smart meters and IoT devices to provide up-to-date insights into electricity usage patterns. Additionally, predictive modeling techniques within Power BI can forecast future consumption trends, enabling proactive decision-making and resource allocation. Enhanced visualization features can facilitate stakeholder engagement and communication, empowering businesses, policymakers, and utility providers to collaborate effectively towards energy efficiency goals. Power BI may integrate with sophisticated energy optimization algorithms, enabling organizations to dynamically adjust electricity consumption in response to changing market conditions, renewable energy availability, and demand-response signals. This could result in significant cost savings and environmental benefits by maximizing the use of clean energy sources and minimizing reliance on fossil fuels.

REFERENCES

https://journals.sagepub.com/doi/abs/10.1177/0143624419891554?journalCode=bsea

LINKS