Tech Saksham

Case Study Report

Data Analytics with Power BI

“Analysis of Commercial Electricity Consumption in Indian States”

“Ambai Arts College”

NM ID	NAME
E487BCEE290A28E9B8D4B9C2743474A1	M. KRISHNAPRIYA

Trainer Name: R. UMAMAHESWARI

Master Name : R. UMAMAHESWARI

ABSTRACT

This study employs Power BI (Business Intelligence) to analyze commercial electricity consumption patterns in India. The demand for energy has been increasing over the years in India, which may be the result of its rapid economic growth trajectory, urbanization, understanding consumption trends becomes paramount for efficient resource management and policy formulation. The data set used comprises historical electricity consumption data from various commercial establishments across different regions of India. Through interactive visualizations and data analysis tools offered by Power BI, this study aims to identify key factors influencing commercial electricity consumption, such as industry type, geographical location, seasonal variations, and economic indicators. By leveraging Power BI's capabilities, including data modeling, visualization, and predictive analytics, this research provides insights into patterns, trends, and correlations within the commercial electricity consumption landscape. This study demonstrates the value of big data analytics in understanding complex patterns and identifying opportunities for energy savings.

INDEX

CHAPTER 1

INTRODUCTION

1.1 Problem Statement

The consumption of energy plays a vital role to determine the economic growth of a country. Our society is energy based one. Today the demand for energy has been growing rapidly due to increase infrastructure development, rise in per capital income, modernization, rapid population growth, industrialization, urbanization. Further this leads to change in the consumption of energy from traditional aspect to new modern technological aspect in the country. The supply of energy has not been increasing in the same proportion of the demand for energy. The country's economic condition influences the quantity of energy to be consumed by the various sectors from the availability of energy resources in India. Over the years, the capacity to generate electricity has increased, however the actual generation of electricity has not been commensurate with this increased capacity. In the present study, an attempt is made is to understand the changing commercial energy production and consumption pattern in India.

1.2 Proposed Solution

To achieve this goal, big data analytic has emerged as a promising tool for analyzing electricity consumption patterns and identifying opportunities for energy savings. By analyzing large volumes of data generated by smart meters and other monitoring devices, utility companies can gain insights into the behavior of individual consumers, as well as the overall trends in consumption. This information can be used to develop targeted strategies for reducing energy use, promoting energy efficiency, and managing peak demand. In distributed power generation mode may be used depending upon the availability of resources for generation of required electricity. The paper aims to present a study on the electricity consumption patterns of 500 residential consumers in a particular area over 24 months, using big data analytic. The data was obtained from the MSEB and analyzed to identify trends in consumer behavior.

1.3 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 age, income, transaction behavior, 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.

1.4 Advantages

- **Data-Driven Decisions**: Banks can make informed decisions based on real-time data analysis.
- **Improved Customer Engagement**: Understanding customer behavior and trends can help banks engage with their customers more effectively.
- **Increased Revenue**: By identifying opportunities for cross-selling and up-selling, banks can increase their revenue.

1.5 Scope

India is the third largest producer of electricity in the world. During the fiscal year (FY) 2022–23, the total electricity generation in the country was 1,844 TWH of which 1,618 TWA was generated by utilities. The gross electricity consumption per capital in FY2023 was 1,327 kWh. In FY2015, electric energy consumption in agriculture was recorded as being the highest (17.89%) worldwide. The per capital electricity consumption is low compared to most other countries despite India having a low electricity traffic. The Indian national electric grid has an installed capacity of 416.0 GW as of 31 March 2023. Renewable energy plants, which also include large hydroelectric power plants, constitute 40.7% of the total installed capacity. The government has set an ambitious target of achieving 500GW of installed renewable energy capacity by 2030. The scope for renewable energy development in India is enormous.It is expected that non-fossil fuel generation contribution is likely to reach around 44.7% of the total gross electricity generation by 2029–30.

CHAPTER 2

SERVICES AND TOOLS REQUIRED

2.1 Services Used

- **Data Collection and Storage Services**: Electricity consumption of Indian states is collected from various industrial sectors consuming the power and the energy production resources are also collected and stored in cloud.

- **Data Processing Services**: Services like Azure Stream Analytic or AWS Kinesis Data Analytic can be used to process the real-time data.

- **Machine Learning Services**: Azure Machine Learning or AWS Sage-maker can be used to build predictive models based on historical data.

2.2 Tools and Software used

Tools:

- **Power BI**: The main tool for this project is Power BI, 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.

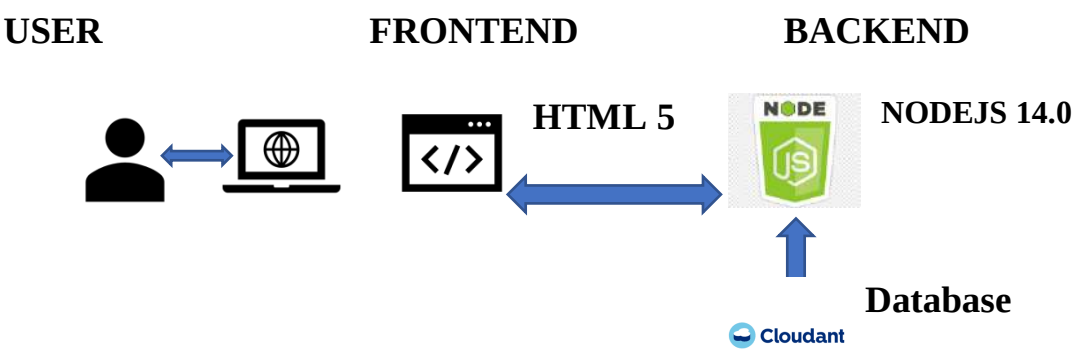
Software Requirements:

- **Power BI Desktop**: This is a Windows application that you can use to create reports and publish them to Power BI.
- **Power BI Service**: This is an online SaaS (Software as a Service) service that you use to publish reports, create new dashboards, and share insights.
- **Power BI 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:

Data Collection: Gather energy consumption data from various sources, such as smart meters, sensors, or utility bills. Ensure that the data is accurate and covers a suitable time frame for analysis.

1. **Data Storage**: The collected data is stored in a database for processing. Azure SQL Database or AWS RDS can be used for this purpose.
2. **Data Processing**: The stored data is processed in real-time using services like Azure Stream Analytic or AWS Kinesis Data Analytic.
3. **Machine Learning**: Predictive models are built based on processed data using Azure Machine Learning or AWS Sage-Maker. These models can help in predicting customer behavior, detecting fraud, etc.
4. **Data Visualization**: Power BI offers a wide range of interactive visualizations, including charts, graphs, maps, tables, and custom visuals. These visualizations help in presenting data in a visually appealing and meaningful way, making it easier to understand and analyze..
5. **Data Access**: The dashboards created in Power BI can be accessed through Power BI Desktop, Power BI Service (online), and Power BI Mobile.

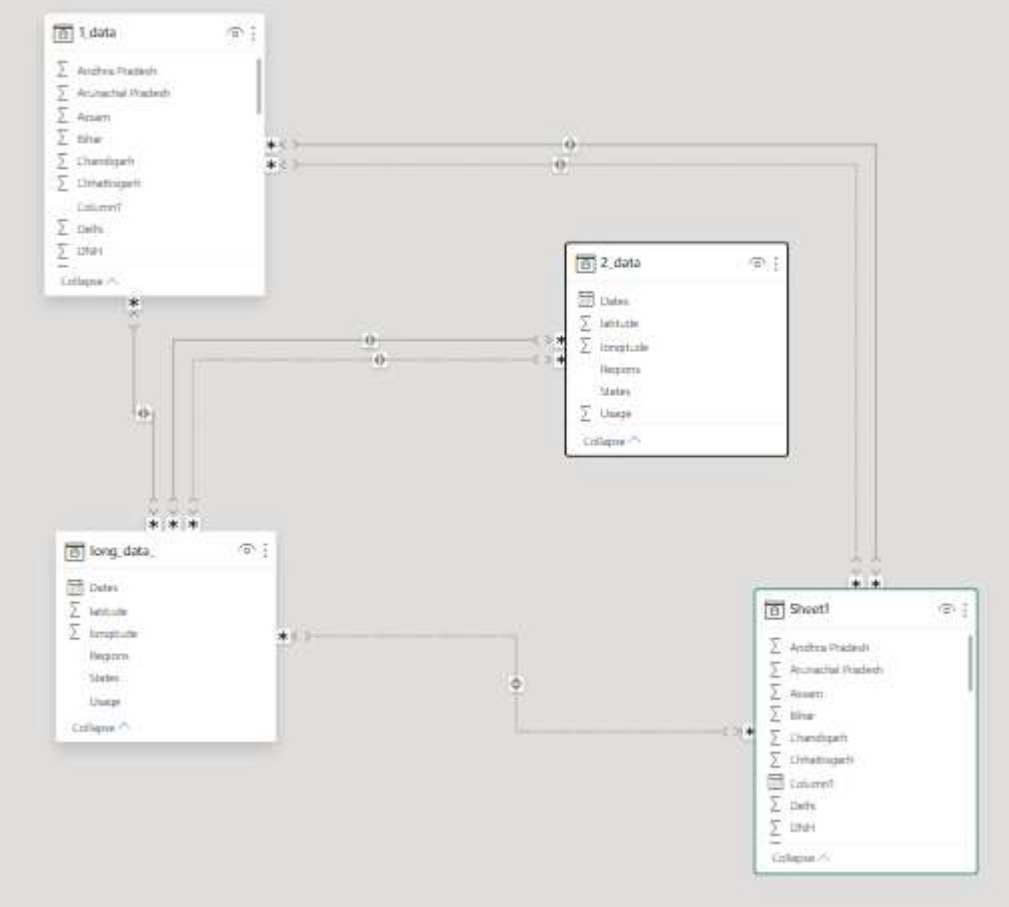
This architecture provides a comprehensive solution for real-time analysis of power consumption. However, it's important to note that the specific architecture may vary depending on the electricity's existing infrastructure, specific requirements, and budget. It's also important to ensure that all tools and services comply with relevant data privacy and security regulations.

CHAPTER 4

MODELING AND RESULT

Manage relationship

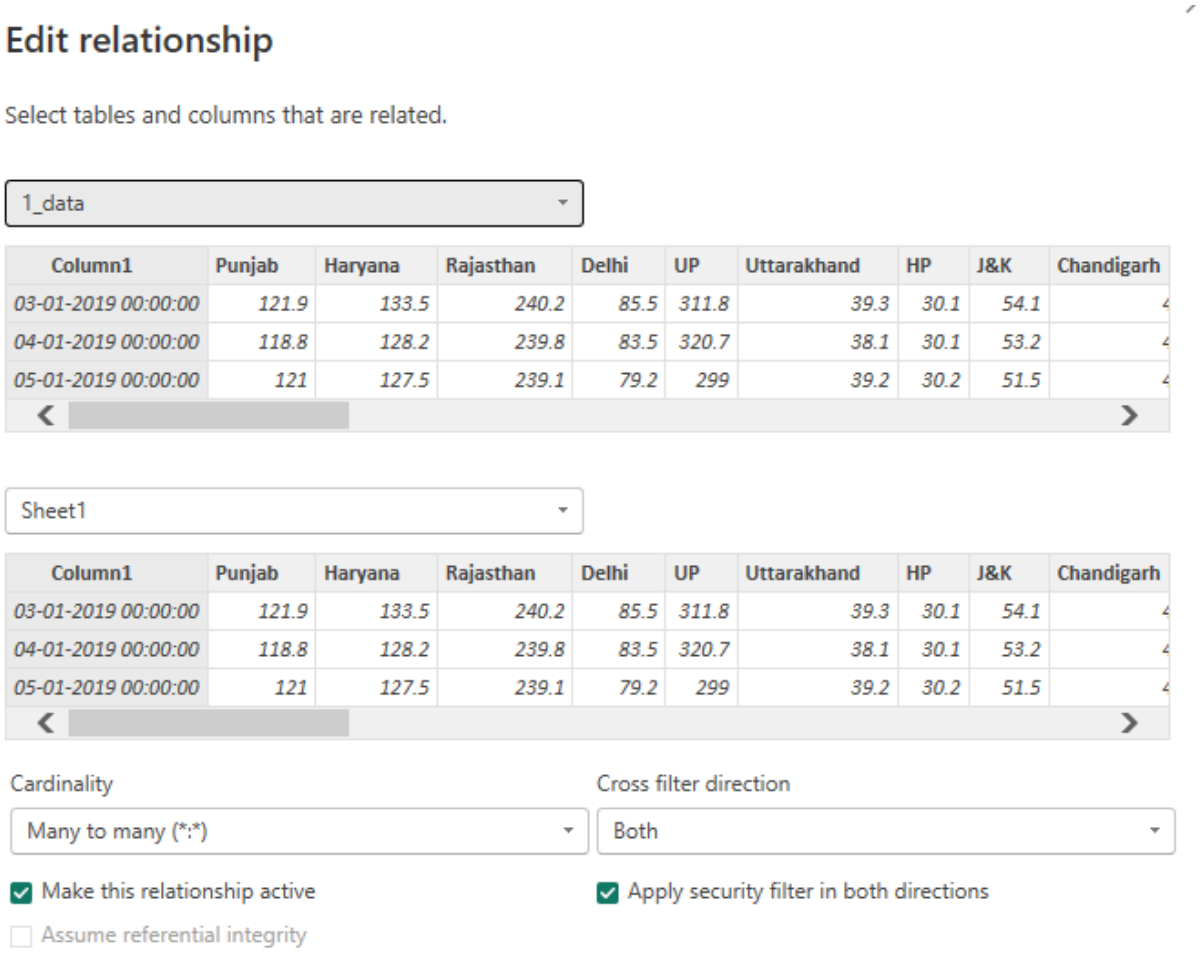
The “1_data” file will be used as the main connector as it contains most key identifier (account id, client id and dips id) which can be use to relates the 8 data files together. The “district” file is use to link the client profile geographically with “district id”



Manage relationships

Active	From: Table (Column)	To: Table (Column)
☑	1_data (Column1)	Sheet1 (Column1)
☐	1_data (Punjab)	Sheet1 (Punjab)
☑	1_data (Tripura)	long_data_ (Usage)
☐	2_data (latitude)	long_data_ (latitude)
☑	2_data (States)	long_data_ (States)
☐	long_data_ (longitude)	Sheet1 (Delhi)

New... Autodetect... Edit... Delete



Modelling for Gender and Age data

Notice that the Gender and age of the client are missing from the data. These can be formulated from the birth number YYMMDD where at months (the 3rd and 4th digits) greater than 50 means that client is a Female. We can create a column for Gender.


```
1  Gender =
2  VAR stringDate = FORMAT(client[birth_number],"General Number")
3  VAR month = VALUE(MID(stringDate,3,2))
4  RETURN IF(month > 50,"F","M")
5
```

client_id	birth_number	district_id	Gender	Birthday	age
3428	875927	42	F	27/09/1987	13
4354	860813	28	M	13/08/1986	14
3417	855318	35	F	18/03/1985	15
10201	851019	13	M	19/10/1985	15

For birthday, we need to reduce the birth month of the female by 50 and then change the date format to DD/MM/YYYY adding 1900 to the year.

```
1  Birthday =
2  VAR stringDate = FORMAT(client[birth_number],"General Number")
3  VAR stringMonth = VALUE(MID(stringDate,3,2))
4  VAR mth = IF(stringMonth > 50, stringMonth - 50,stringMonth)
5  VAR year = VALUE(MID(stringDate,1,2))
6  VAR day = VALUE(MID(stringDate,5,2))
7  RETURN FORMAT(DATE(year+1900,mth,day),"DD/MM/YYYY")
```

client_id	birth_number	district_id	Gender	Birthday	age
3428	875927	42	F	27/09/1987	13
4354	860813	28	M	13/08/1986	14
3417	855318	35	F	18/03/1985	15
10201	851019	13	M	19/10/1985	15

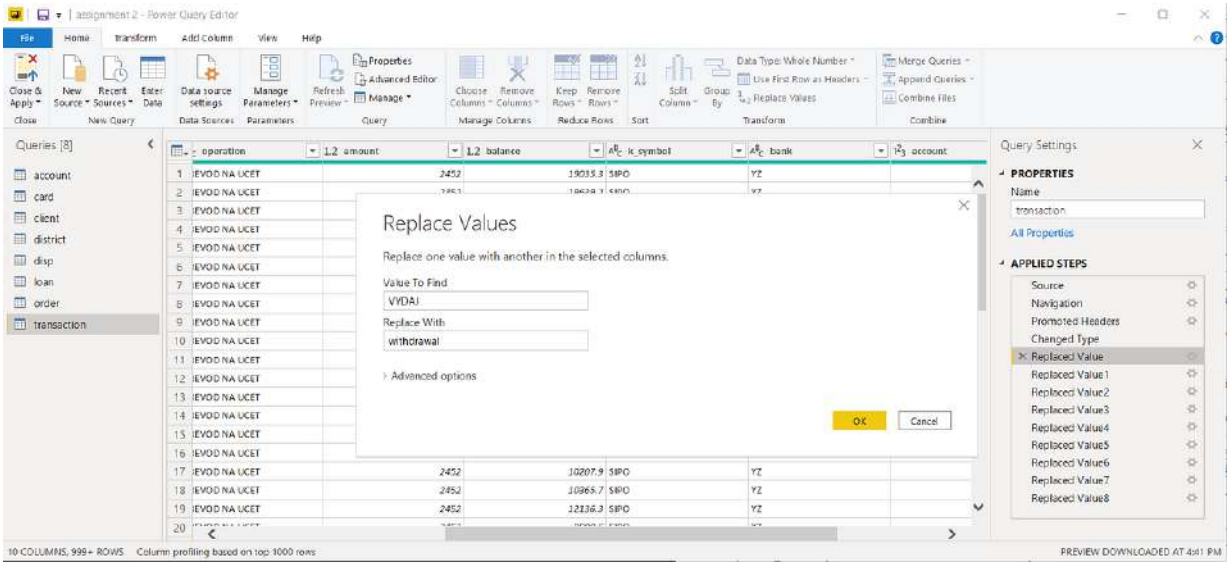
For Age, we shall assume it is year 1999 as explain previously and use it to minus from the birth year.

```
1  age = 1999 -RIGHT(client[Birthday],4)
```

client_id	birth_number	district_id	Gender	Birthday	age	age (groups)
2	450204	1	M	04/02/1945	54	36 -54 Baby Boomers

Replacing values

Set some fields to English for easy understanding, we replace values to English with the Power Query Editor.

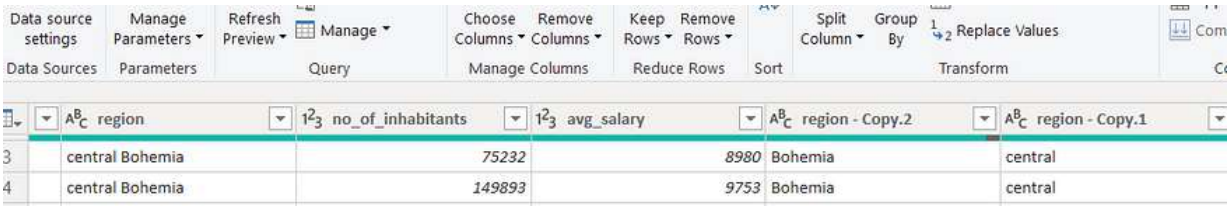


type	+/- transaction	"PRIJEM" stands for credit "VYDAJ" stands for withdrawal

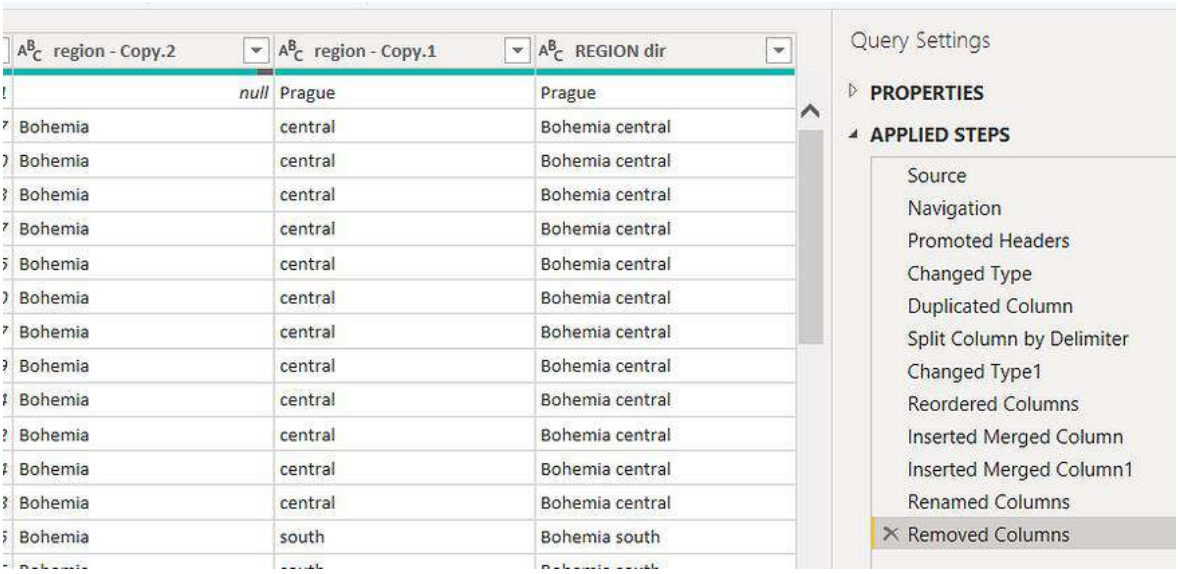
k_symbol	characterization of the transaction	"POJISTNE" stands for insurance payment "SLUZBY" stands for payment for statement "UROK" stands for interest credited "SANKC. UROK" sanction interest if negative balance "SIPO" stands for household "DUCHOD" stands for old-age pension "UVER" stands for loan payment

Changing the order of region name at Power Query

Duplicate the “district /region” then split column using space as delimiter.



Then merge column by region and direction. Refer to applied steps for details.



region - Copy.2	region - Copy.1	REGION dir
null	Prague	Prague
Bohemia	central	Bohemia central
Bohemia	central	Bohemia central
Bohemia	central	Bohemia central
Bohemia	central	Bohemia central
Bohemia	central	Bohemia central
Bohemia	central	Bohemia central
Bohemia	central	Bohemia central
Bohemia	central	Bohemia central
Bohemia	central	Bohemia central
Bohemia	central	Bohemia central
Bohemia	central	Bohemia central
Bohemia	central	Bohemia central
Bohemia	south	Bohemia south

Grouping of age by ranges

As the customers' age ranges from 12 to 88, we shall group them into different generation age range for easier profiling, we will group the ages into 5 groups.

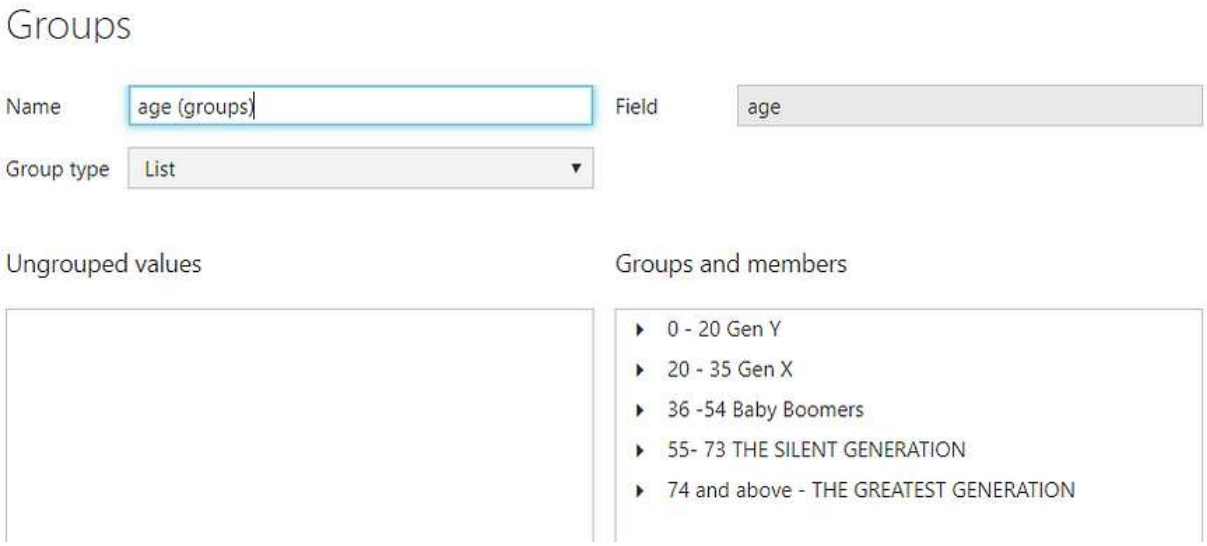
The Gen Y are youths,

Gen X are young working adults, some starting their families

Baby Boomer are working adults with families.

The silent Generations some are working and retired, living on pensions.

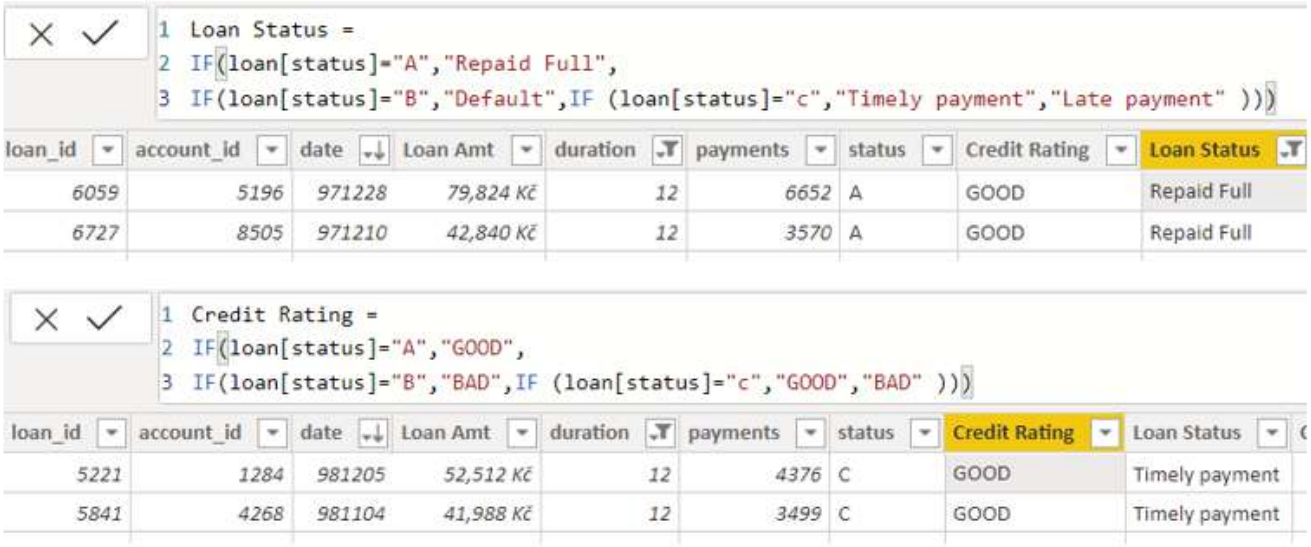
The greatest Generation, retired elderly living on pensions.



Credit Rating and Loan Status

As the Loan status uses A, B, C, D which are not reader friendly. We can add a column to represent what it stands for, we also simplify the classification of those with late or default on payment as bad credit, refer to the table below for details on the new columns added.

Status in "loan" data	New column "loan status"	New column "credit rating"
'A' stands for contract finished no problems	Fully Repaid	Good
'B' stands for contract finished loan not payed	Default	Bad
'C' stands for running contract OK so far	Timely Payment	Good
'D' stands for running contract client in debt	Late payment	Bad



```
1 Loan Status =
2 IF(loan[status]="A","Repaid Full",
3 IF(loan[status]="B","Default",IF (loan[status]="c","Timely payment","Late payment" )))
```

loan_id	account_id	date	Loan Amt	duration	payments	status	Credit Rating	Loan Status
6059	5196	971228	79,824 Kč	12	6652	A	GOOD	Repaid Full
6727	8505	971210	42,840 Kč	12	3570	A	GOOD	Repaid Full

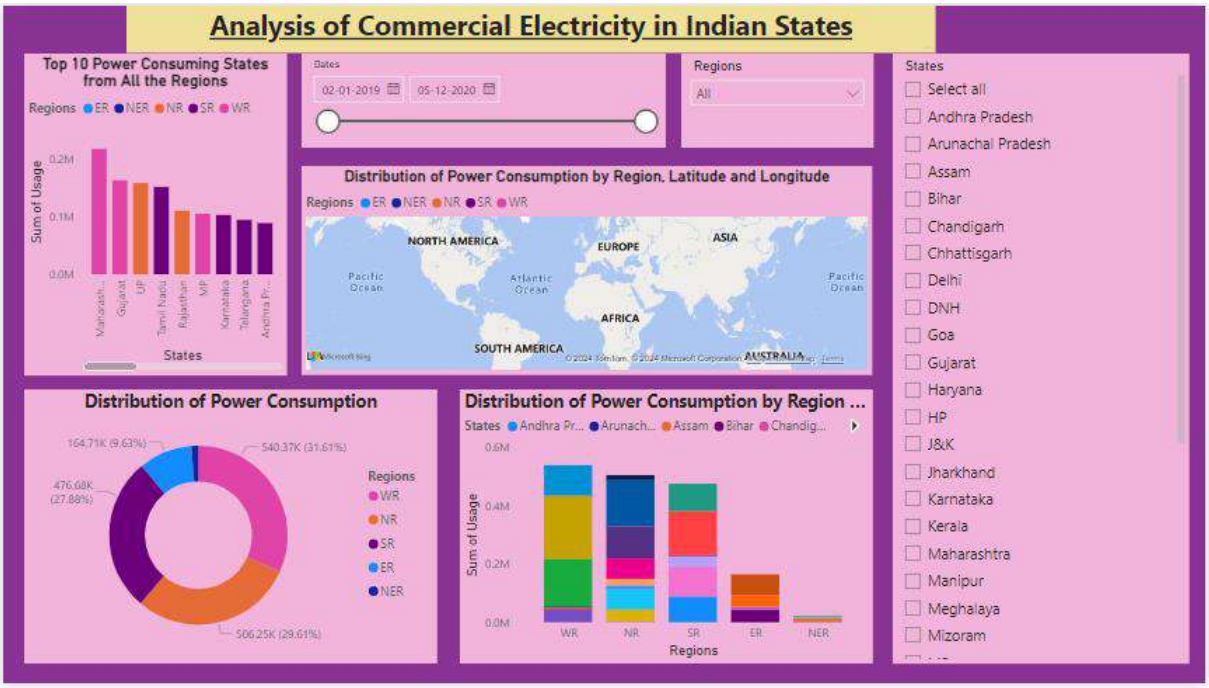

```
1 Credit Rating =
2 IF(loan[status]="A","GOOD",
3 IF(loan[status]="B","BAD",IF (loan[status]="c","GOOD","BAD" )))
```

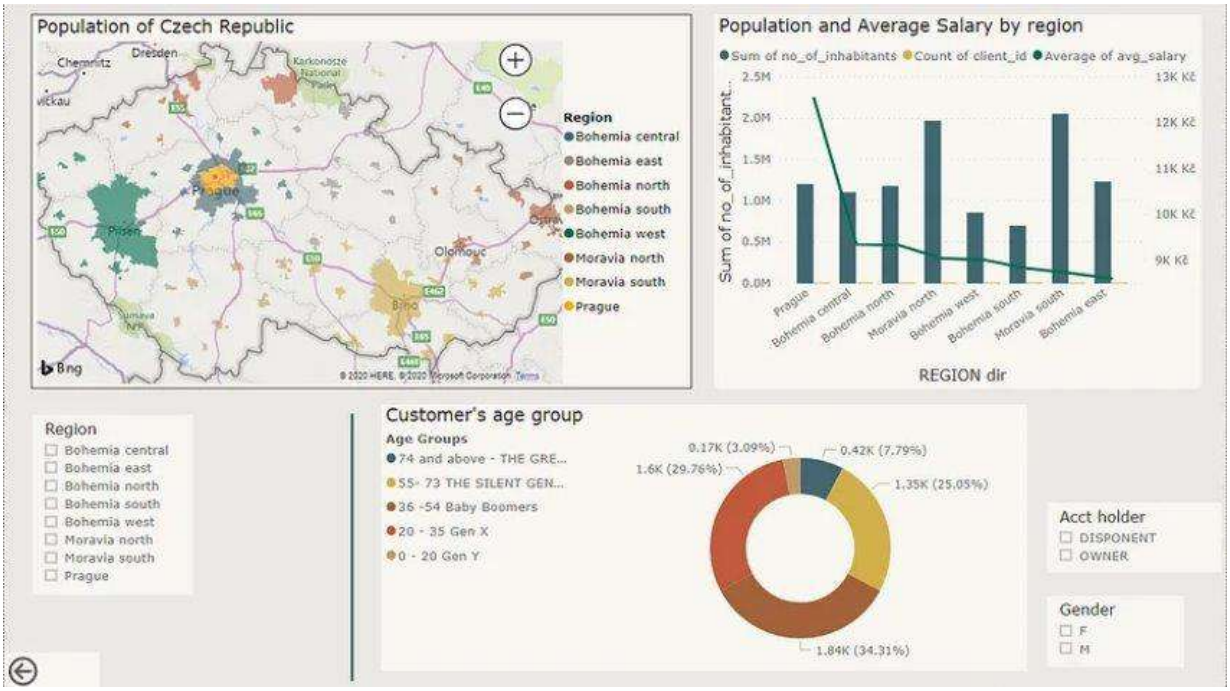
loan_id	account_id	date	Loan Amt	duration	payments	status	Credit Rating	Loan Status
5221	1284	981205	52,512 Kč	12	4376	C	GOOD	Timely payment
5841	4268	981104	41,988 Kč	12	3499	C	GOOD	Timely payment

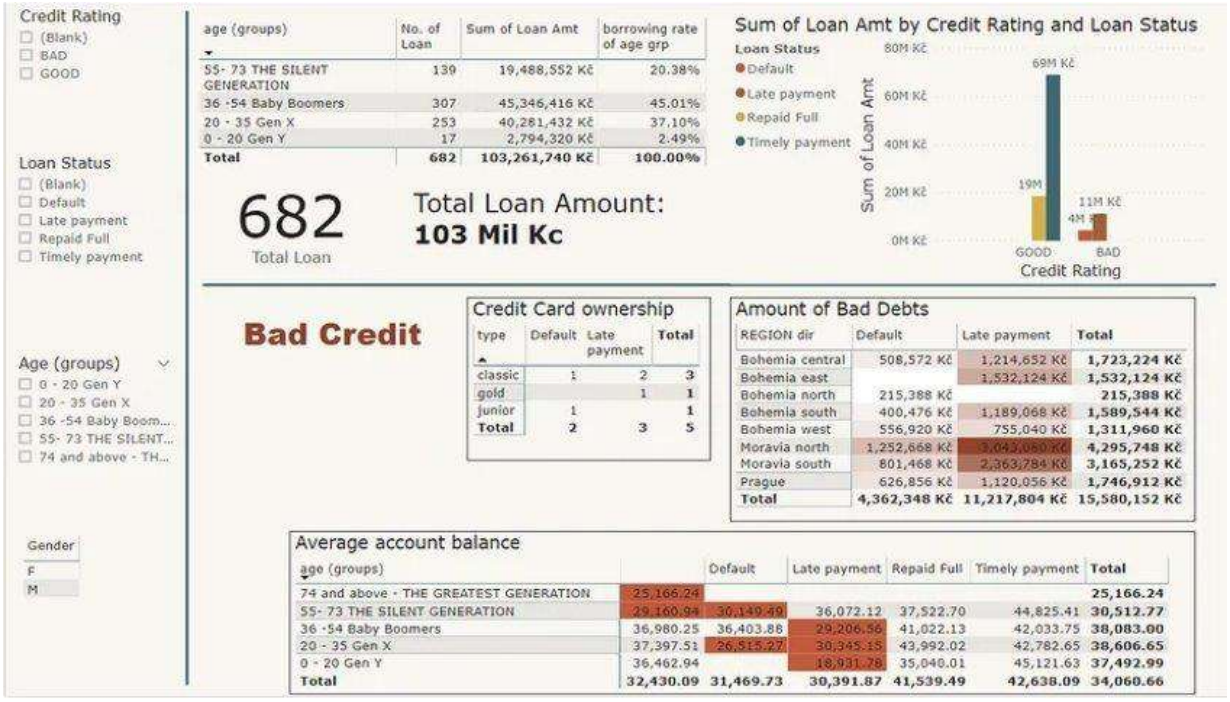
Values of such as "account Id" have also been set as Text.

And District name have been categorized as place to be use for the map to show the sum of the inhabitants in each region.

Dashboard







age (groups)	No. of Loan	Sum of Loan Amt	borrowing rate of age grp
55- 73 THE SILENT GENERATION	139	19,488,552 Kč	20.38%
36 -54 Baby Boomers	307	45,346,416 Kč	45.01%
20 - 35 Gen X	253	40,281,432 Kč	37.10%
0 - 20 Gen Y	17	2,794,320 Kč	2.49%
Total	**682**	**103,261,740 Kč**	**100.00%**

type	Default	Late payment	Total
classic	1	2	3
gold		1	1
junior	1		1
Total	**2**	**3**	**5**

REGION dir	Default	Late payment	Total
Bohemia central	508,572 Kč	1,214,652 Kč	**1,723,224 Kč**
Bohemia east		1,532,124 Kč	**1,532,124 Kč**
Bohemia north	215,388 Kč		**215,388 Kč**
Bohemia south	400,476 Kč	1,189,068 Kč	**1,589,544 Kč**
Bohemia west	556,920 Kč	755,040 Kč	**1,311,960 Kč**
Moravia north	1,252,668 Kč	3,043,080 Kč	**4,295,748 Kč**
Moravia south	801,468 Kč	2,363,784 Kč	**3,165,252 Kč**
Prague	626,856 Kč	1,120,056 Kč	**1,746,912 Kč**
Total	**4,362,348 Kč**	**11,217,804 Kč**	**15,580,152 Kč**

age (groups)		Default	Late payment	Repaid Full	Timely payment	Total
74 and above - THE GREATEST GENERATION	25,166.24					**25,166.24**
55- 73 THE SILENT GENERATION	29,160.94	30,149.49	36,072.12	37,522.70	44,825.41	**30,512.77**
36 -54 Baby Boomers	36,980.25	36,403.88	29,206.56	41,022.13	42,033.75	**38,083.00**
20 - 35 Gen X	37,397.51	26,515.27	30,345.15	43,992.02	42,782.65	**38,606.65**
0 - 20 Gen Y	36,462.94		18,931.78	35,040.01	45,121.63	**37,492.99**
Total	**32,430.09**	**31,469.73**	**30,391.87**	**41,539.49**	**42,638.09**	**34,060.66**

CONCLUSION

In conclusion, our research paper has successfully developed a consumption and prediction model that can be utilized to forecast electricity consumption for the next few months. Electricity is an essential part of modern life and important to the U.S. economy. The model, developed using the Prophet algorithm, has shown reasonable forecasting accuracy, which can be used to draw inferences about the demand-side increase and to help bolster the supply side of the equation. We have also developed a dashboard using the Power BI tool that can provide insights into the electricity consumption patterns, such as the top 10 consumers, the top 5 values and counts of months by year and users, and the average values by user. These insights can be leveraged to strategics policies and optimize energy usage in homes. Although the current model has been developed using a limited data set, we have shown that it can perform even better with more data. Overall, our research provides a strong foundation for future studies on electricity consumption prediction and optimization.

FUTURE SCOPE

Future scenarios of sectoral value-added and overall and per capita GDP, are used to determine service demands in certain sectors, that in turn determine the employment of various appliances and equipment to convert electricity into end-use services (such as water pumped, steel produced, lighting and air conditioning, etc.). The government over successive years has prioritised the manufacturing sector to draw surplus labor from primary activities and enhance growth, productivity and meaningful employment. This has reflected in the National Manufacturing Policy (NMP) as well as the more recently launched Make in India (MII) campaign. Among key priorities has been increasing the share of manufacturing from 16-17 percent at present to 25 percent of GDP (Bhattacharjee, 2015). If this is achieved by 2030, then industry will need to grow at 1.5 percentage points higher than overall GDP, assuming services retains its current 60 percent share.

REFERENCES

https://ijarsct.co.in/Paper9099.pdf

https://wecindia.in/indias-yearly-energy-consumption-analysis/

LINK

