Tech Saksham

Case Study Report

Data Analytics with Power BI

"Analysis of Commercial Electricity Consumption in Indian States"

"THIRUVALLUVAR COLLEGE"

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ABSTRACT

This study examines the patterns and determinants of commercial electricity consumption across Indian states. Utilizing data from various sources including government reports, surveys and statistical databases, the analysis employs econometric techniques to identify factors influencing commercial electricity usage. Key variables such as economic growth, industrialization, population density, urbanization, and energy policies are considered in the analysis. The findings contribute to a better understanding of the dynamic of commercial electricity consumption in India, which is essential for policy makers, energy planners, and businesses to develop effective strategies for energy management and sustainable development.

Keywords: Consumption, Analytics, Electricity, Visualizations

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CHAPTER 1

INTRODUCTION

Problem Statement

Currently, electricity is used in every home for various tasks, including watching television, charging smartphones, using an electric light bulb, and other things. Electricity has become an essential part of our daily life. It powers our homes, businesses, and industries, and has enabled us to achieve unprecedented levels of comfort, convenience, and productivity. However, this growing dependence on electricity has led to a significant increase in its consumption, placing enormous pressure on energy resources and the environment. As a result, it has become imperative to analyze and control the supply and demand of electricity, to ensure its sustainable use and reduce the impact of its production on the environment. In recent years, there has been a noticeable rise in electricity consumption, driven by the increasing use of electronic devices, appliances, and industrial machinery. This trend is expected to continue in the coming years, with the growth of emerging markets and the adoption of new technologies, such as electric vehicles and renewable energy systems. To meet the growing electricity demand, utility companies are exploring new ways to optimize energy production and distribution, while minimizing waste and reducing emissions.

Proposed Solution

To achieve this goal, big data analytics 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. 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 analytics.

Feature

- **Gross Domestic Product (GDP):** GDP serves as a proxy for economic activity and can indicate level of commercial and industrial development within a state.
- **Energy Tariffs:** Electricity tariffs set by regulatory authorities influence commercial electricity consumption.
- **Urbanization Rate:** The degree of urbanization reflect the proportion of the population residing in urban areas, where commercial establishments demand is higher compared to rural areas.
- **Industrial Output:** The output of industrial sector, such as manufacturing, construction and services, contributes significantly to commercial electricity consumption, making it an important feature to consider.

Advantages

- **Policy Formulation:** Analysis provides insights into consumption patterns, enabling policy maker to formulate targeted energy policies**.**
- **Cost Reduction**: Identifying opportunities for energy efficiency and conservation help businesses reduce operational cost**.**
- **Risk Management**: Identifying vulnerabilities and potential disruption in electricity supply chains help in developing contingency plans.
- **Competitive Advantage**: Businesses that leverage insight from electricity consumption analysis can gain a competitive advantage by optimizing their energy usage.

Scope

Some studies use a top-down methodology for estimating electricity demand based on its relationship (regression equations or elasticity factors) with macroeconomic variables. However, this approach is limited with regards to addressing the transformational aspects of such relationships over a longer horizon, since electricity requirement is in effect obtained as either a second or third order effect from changes in macroeconomic factors.1 It follows that all-encompassing variables like GDP or sector value additions will fail to account for dynamism in new economic activities, service demands, technologies, policies, and institutional frameworks, that in turn play a more direct role in determining level, composition and growth of demand. Hence, the role of choice and innovation in the technology-policy space needs to be factored in order to translate changes in macroeconomic variables into service demands and finally into electricity demand.

CHAPTER 2

SERVICES AND TOOLS REQUIRED

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 Analytics or AWS Kinesis Data Analytics 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.

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.

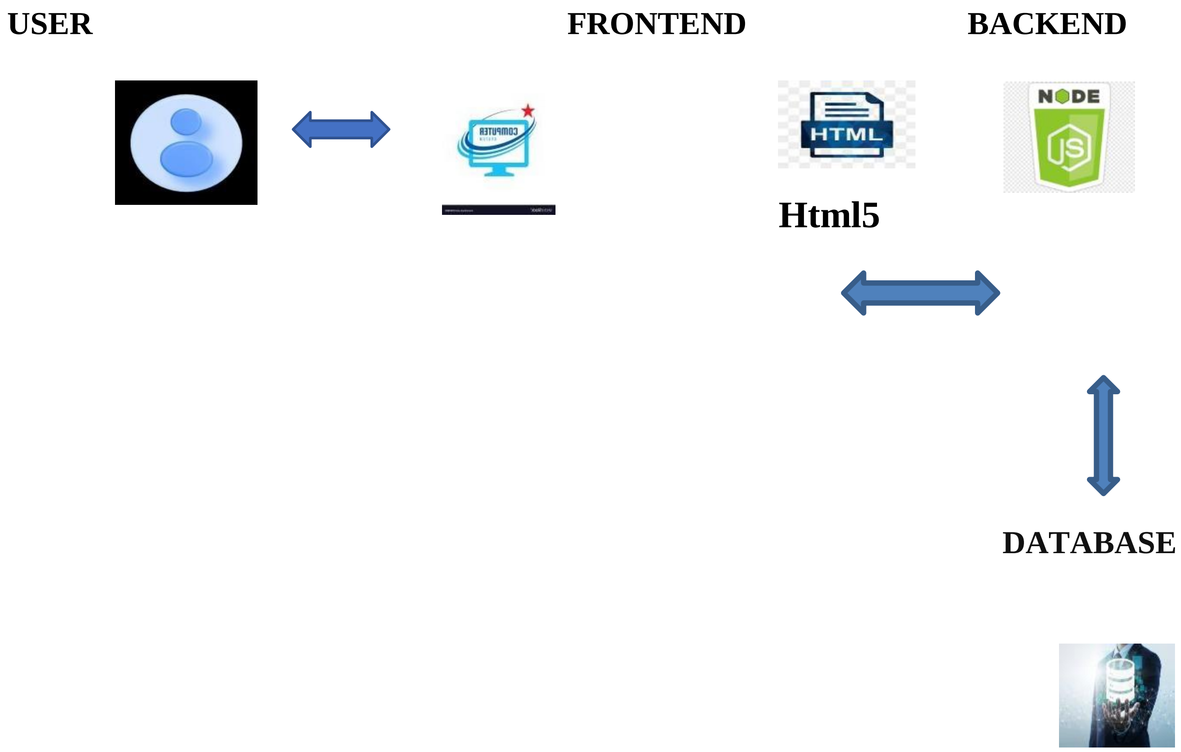
Software Requirements:

- **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

Architecture



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

1. **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 timeframe for analysis.

2. **Data Storage**: The collected data is stored in a database for processing. Azure SQL Database or AWS RDS can be used for this purpose.

3. **Data Processing**: The stored data is processed in real-time using services like Azure Stream Analytics or AWS Kinesis Data Analytics.

4. **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.

5. **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.

6. **Data Access**: The dashboards created in Power BI can be accessed through Power BI Desktop, Power BI Service (online), and Power BI Mobile.

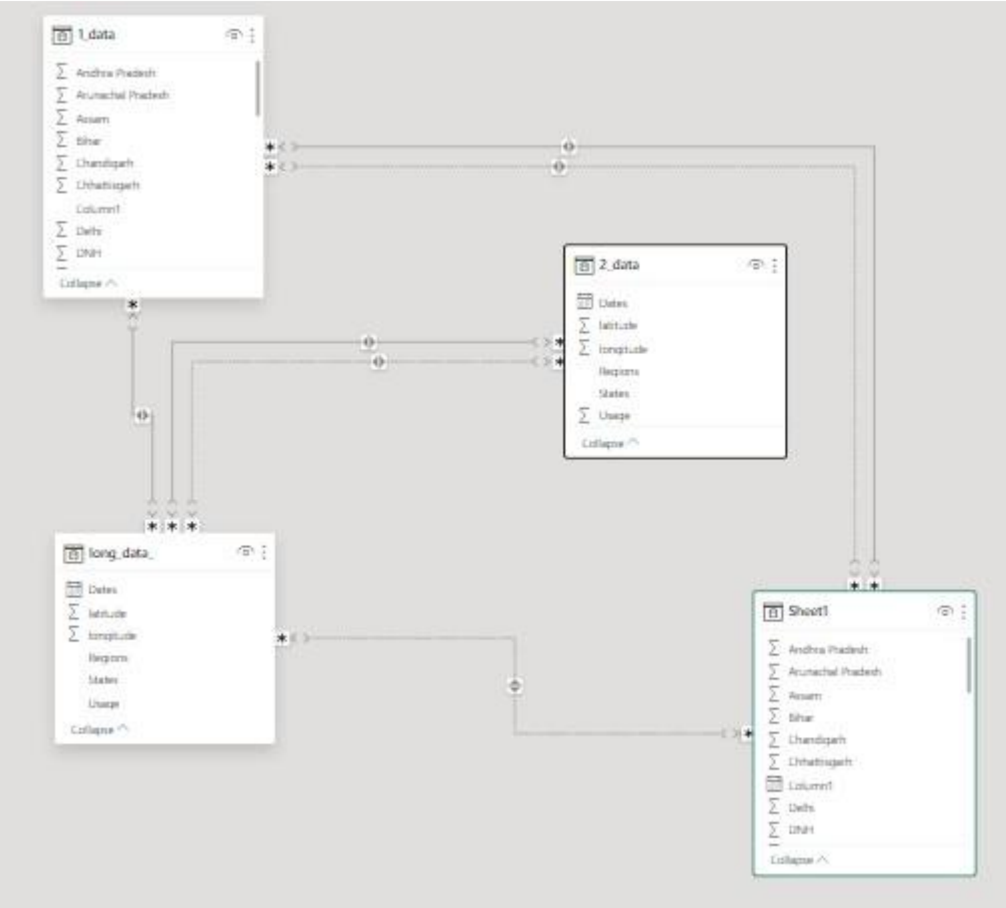
This architecture provides a comprehensive solution for real-time analysis of power consumption. However, it’s important to note that the specific architecture may vary depending on the electricity’s existing infrastructure, specific requirements, and budget. It’s also important to ensure that all tools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

CHAPTER 4

MODELING AND RESULT

Manage relationship

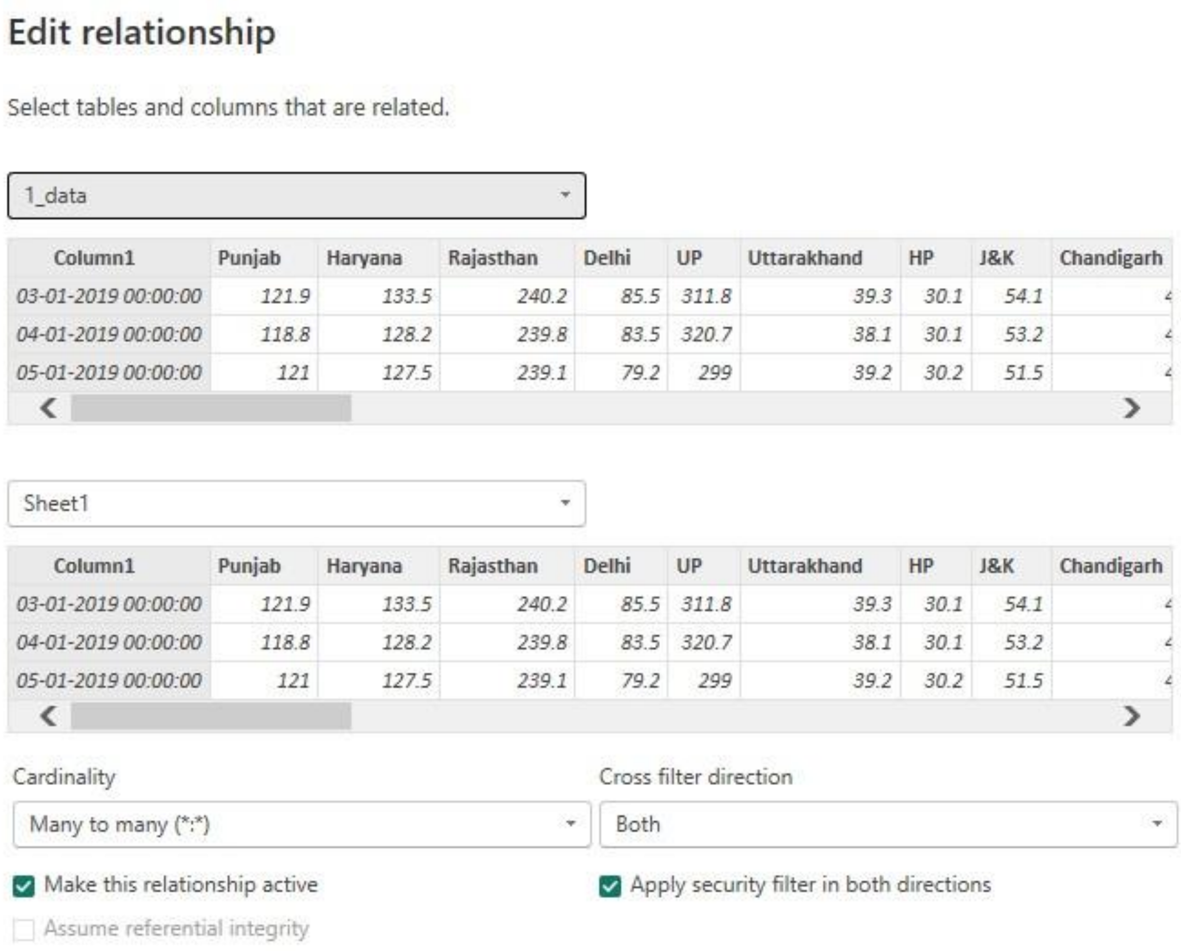
The “1_data” file will be used as the main connector as it contains most key identifier (Column 1) which can be use to relates the 4 data files together. The “long_data” file is use to link the client profile geographically with “Dates”.



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



Edit relationship

Select tables and columns that are related.

1_data

Column1	Punjab	Haryana	Rajasthan	Delhi	UP	Uttarakhand	HP	J&K	Chandigarh
03-01-2019 00:00:00	121.9	133.5	240.2	85.5	311.8	39.3	30.1	54.1	4
04-01-2019 00:00:00	118.8	128.2	239.8	83.5	320.7	38.1	30.1	53.2	4
05-01-2019 00:00:00	121	127.5	239.1	79.2	299	39.2	30.2	51.5	4

Sheet1

Column1	Punjab	Haryana	Rajasthan	Delhi	UP	Uttarakhand	HP	J&K	Chandigarh
03-01-2019 00:00:00	121.9	133.5	240.2	85.5	311.8	39.3	30.1	54.1	4
04-01-2019 00:00:00	118.8	128.2	239.8	83.5	320.7	38.1	30.1	53.2	4
05-01-2019 00:00:00	121	127.5	239.1	79.2	299	39.2	30.2	51.5	4

Cardinality

Many to many (*:*)

Cross filter direction

Both

Make this relationship active

Apply security filter in both directions

Assume referential integrity

Modeling for Date and consumption data:

Notice that the Dates and usage of the consumption of electricity are there in the datasets by not sorted, so by using the ascending command, it is been sorted in ascending order.


```
= Table.Sort(#"Changed Type",{{"Regions", Order.Descending}})
```

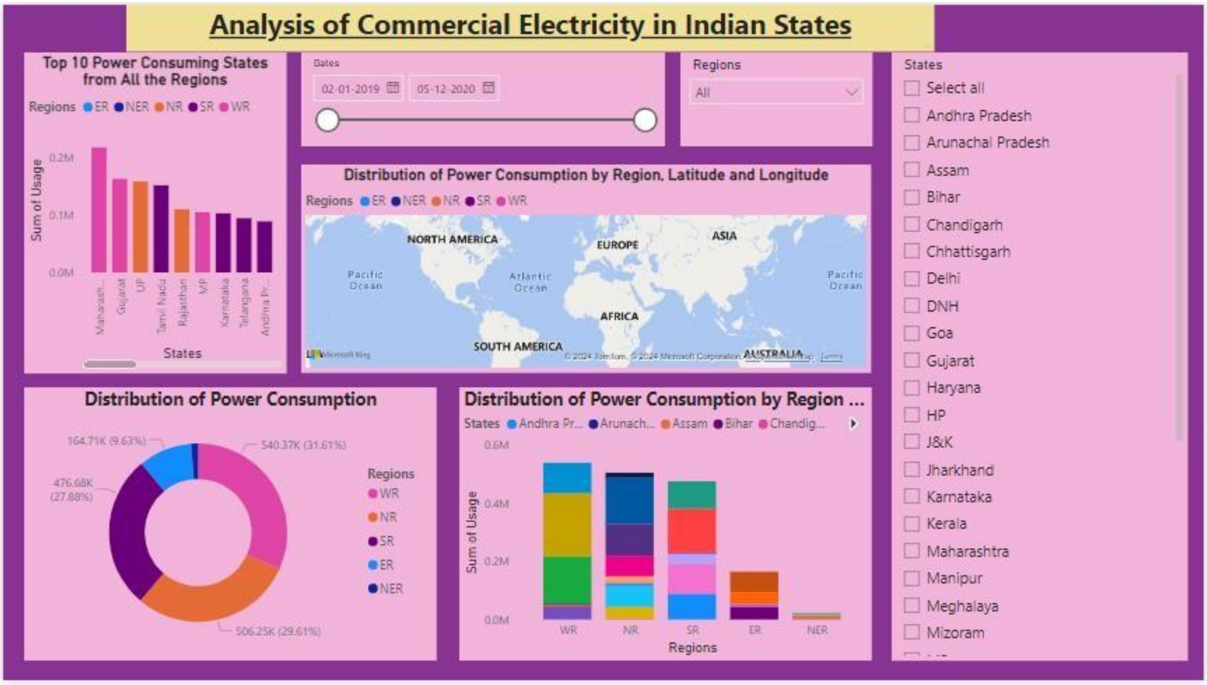
	States	Regions	latitude	longitude	Dates
1	Goa	WR	15.491997	73.81800065	04-12-2020 00:00:00
2	Goa	WR	15.491997	73.81800065	04-01-2019 00:00:00
3	Chhattisgarh	WR	22.09042035	82.15998734	11-03-2019 00:00:00
4	Maharashtra	WR	19.25023195	73.16017493	04-12-2020 00:00:00
5	DNH	WR	20.26657819	73.0166178	19-01-2019 00:00:00
6	Maharashtra	WR	19.25023195	73.16017493	21-01-2019 00:00:00
7	Gujarat	WR	22.2587	71.1924	07-01-2019 00:00:00
8	Gujarat	WR	22.2587	71.1924	13-03-2019 00:00:00
9	Chhattisgarh	WR	22.09042035	82.15998734	08-01-2019 00:00:00
10	Maharashtra	WR	19.25023195	73.16017493	20-03-2019 00:00:00
11	MP	WR	21.30039105	76.13001949	04-12-2020 00:00:00
12	MP	WR	21.30039105	76.13001949	22-02-2019 00:00:00
13	Maharashtra	WR	19.25023195	73.16017493	24-02-2019 00:00:00
14	Chhattisgarh	WR	22.09042035	82.15998734	04-01-2019 00:00:00
15	MP	WR	21.30039105	76.13001949	11-02-2019 00:00:00
16	MP	WR	21.30039105	76.13001949	22-01-2019 00:00:00
17	Gujarat	WR	22.2587	71.1924	23-01-2019 00:00:00
18	Maharashtra	WR	19.25023195	73.16017493	03-01-2019 00:00:00

The states are sorted in ascending order to find the highest consumption state and the usage of it.


```
= Table.Sort(#"Filtered Rows",{{"States", Order.Ascending}})
```

	States	Usage	Regions	latitude	longitude
1	Andhra Pradesh	174.6	SR	14.7504291	78.57002559
2	Andhra Pradesh	162.2	SR	14.7504291	78.57002559
3	Andhra Pradesh	166	SR	14.7504291	78.57002559
4	Andhra Pradesh	190.1	SR	14.7504291	78.57002559
5	Andhra Pradesh	155.2	SR	14.7504291	78.57002559
6	Andhra Pradesh	164.6	SR	14.7504291	78.57002559
7	Andhra Pradesh	167.6	SR	14.7504291	78.57002559
8	Andhra Pradesh	173.2	SR	14.7504291	78.57002559
9	Andhra Pradesh	181	SR	14.7504291	78.57002559
10	Andhra Pradesh	155.9	SR	14.7504291	78.57002559
11	Andhra Pradesh	196.9	SR	14.7504291	78.57002559
12	Andhra Pradesh	151.6	SR	14.7504291	78.57002559
13	Andhra Pradesh	156	SR	14.7504291	78.57002559
14	Andhra Pradesh	159.1	SR	14.7504291	78.57002559
15	Andhra Pradesh	181.9	SR	14.7504291	78.57002559
16	Andhra Pradesh	164.7	SR	14.7504291	78.57002559

Dashboard


Analysis of Commercial Electricity in Indian States
Top 10 Power Consuming States from All the Regions
Regions ER NER NR SR WR
Sum of Usage
0.2M
0.1M
0.0M
Maharash...
Gujarat
UP
Tamil Nadu
Rajasthan
MP
Karnataka
Telangana
Andhra Pr...
States
Dates
02-01-2019
05-12-2020
Regions
All
Distribution of Power Consumption by Region, Latitude and Longitude
Regions ER NER NR SR WR
NORTH AMERICA
EUROPE
ASIA
Pacific Ocean
Atlantic Ocean
AFRICA
SOUTH AMERICA
AUSTRALIA
States
Select all
Andhra Pradesh
Arunachal Pradesh
Assam
Bihar
Chandigarh
Chhattisgarh
Delhi
DNH
Goa
Gujarat
Haryana
HP
J&K
Jharkhand
Karnataka
Kerala
Maharashtra
Manipur
Meghalaya
Mizoram
Distribution of Power Consumption
164.71K (9.63%)
540.37K (31.61%)
476.68K (27.88%)
506.25K (29.61%)
Regions
WR
NR
SR
ER
NER
Distribution of Power Consumption by Region ...
States Andhra Pr... Arunach... Assam Bihar Chandig...
Sum of Usage
0.6M
0.4M
0.2M
0.0M
WR
NR
SR
ER
NER
Regions

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. 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 strategize policies and optimize energy usage in homes. Although the current model has been developed using a limited dataset, 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

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