1. Introduction

1.1 Overview

Electricity consumption patterns in the future are expected to undergo significant changes due to a variety of factors, including technological advancements, changes in consumer behavior, and global efforts to reduce greenhouse gas emissions.

One of the key drivers of change is the increasing adoption of renewable energy sources such as solar and wind power. As these sources become more affordable and accessible, they are likely to play a larger role in meeting global electricity demand. This could lead to a more decentralized energy system, where households and businesses generate their own electricity and sell any excess back to the grid.

Another important factor is the rise of electric vehicles (EVs) and the electrification of other forms of transportation. This is expected to increase overall electricity demand, but also presents opportunities for smart charging and energy management systems that can help balance the grid.

Smart homes and the Internet of Things (IoT) are also expected to play a significant role in shaping future electricity consumption patterns. Connected devices and appliances can be programmed to use energy more efficiently, and homes can be designed to optimize energy use based on the time of day and the occupants' behavior.

Overall, the future of electricity consumption will likely be more sustainable, decentralized, and intelligent, with a greater emphasis on renewable energy sources and energy efficiency.

1.2 Purpose

The purpose of exploring electricity consumption patterns is to gain a deeper understanding of how electricity is being used, identify opportunities to reduce overall consumption, increase the use of renewable energy sources, and improve energy efficiency. By analyzing historical, current, and future trends, we can identify patterns and drivers of change and develop evidence-based

recommendations for individuals, businesses, and policymakers to improve electricity consumption patterns. The ultimate goal is to create a more sustainable, efficient, and reliable energy system that meets the needs of society while m inimizing environmental impacts.

2.Problem Definition & Design Thinking
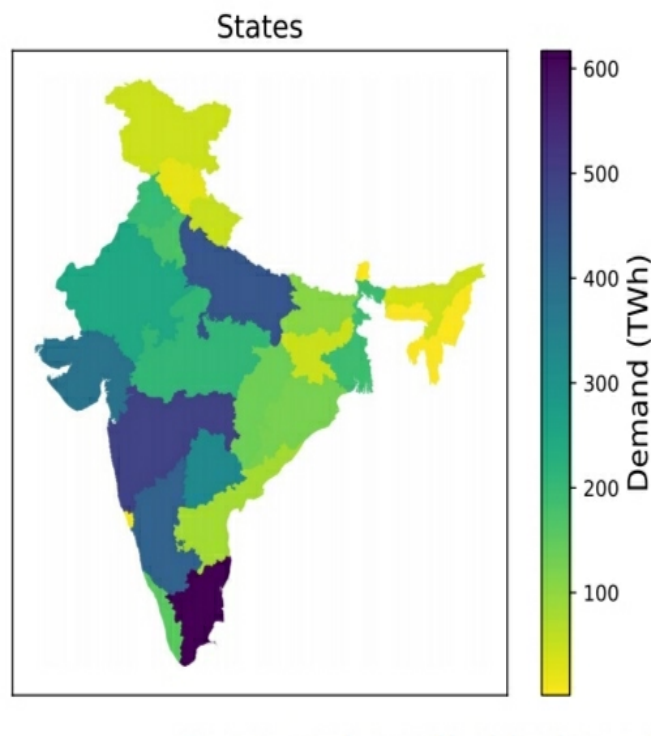## 2.1 Empathy map
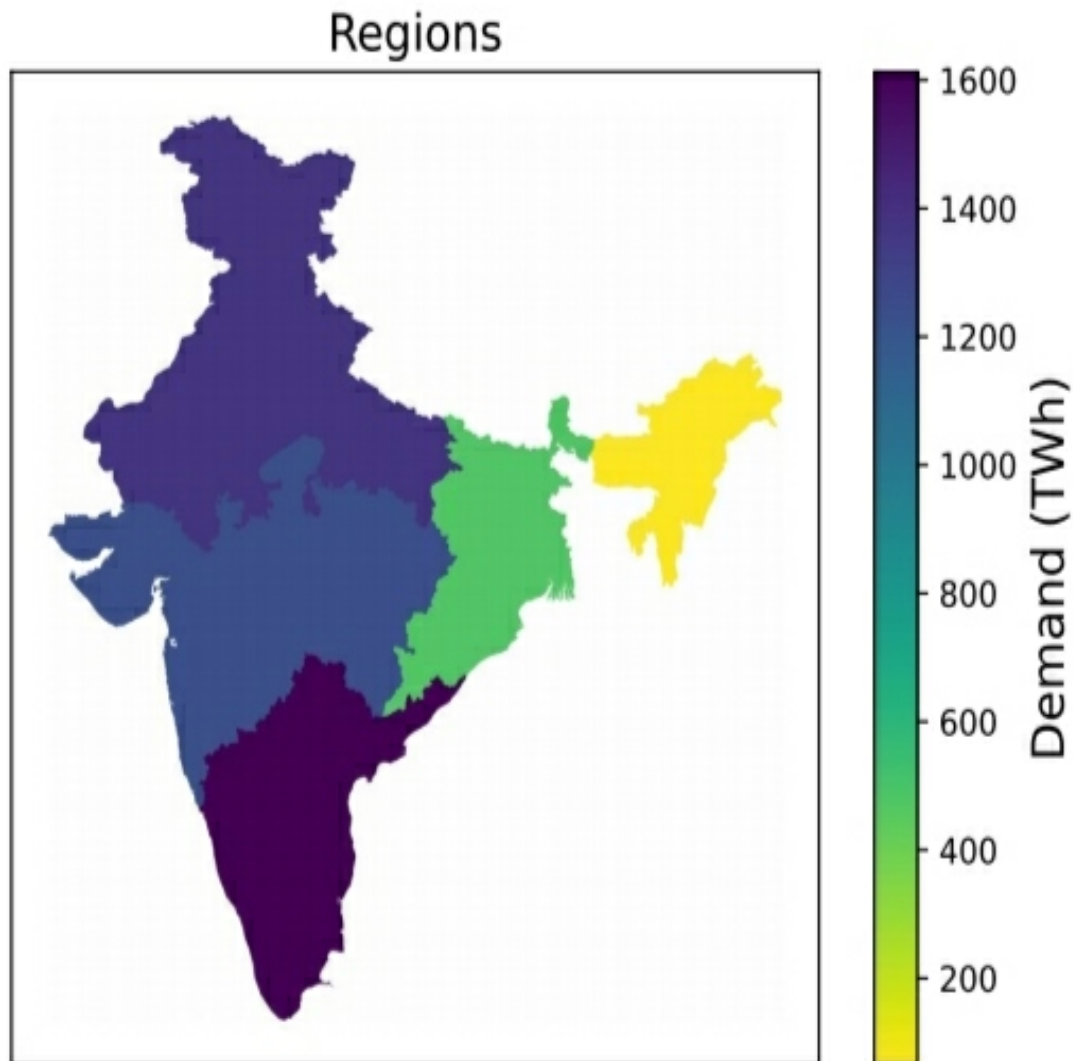
Fig.1 State and regional level distribution of annual electricity 2050 for stable GDP growth, baseline cooling, and home electric vehicle (EV) charging scenario.
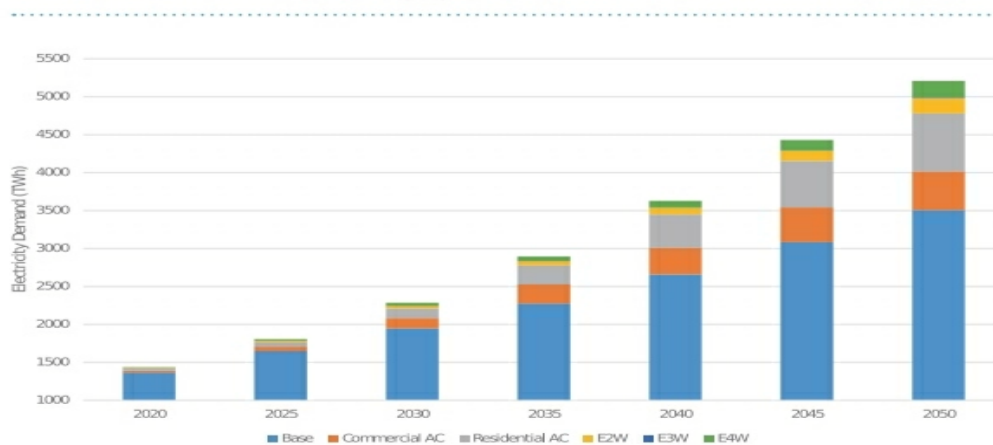

Fig.2 Summary results of India's electricity demand forecasting at national level with stable GDP growth, baseline cooling, and home electricity vehicle (EV) charging.
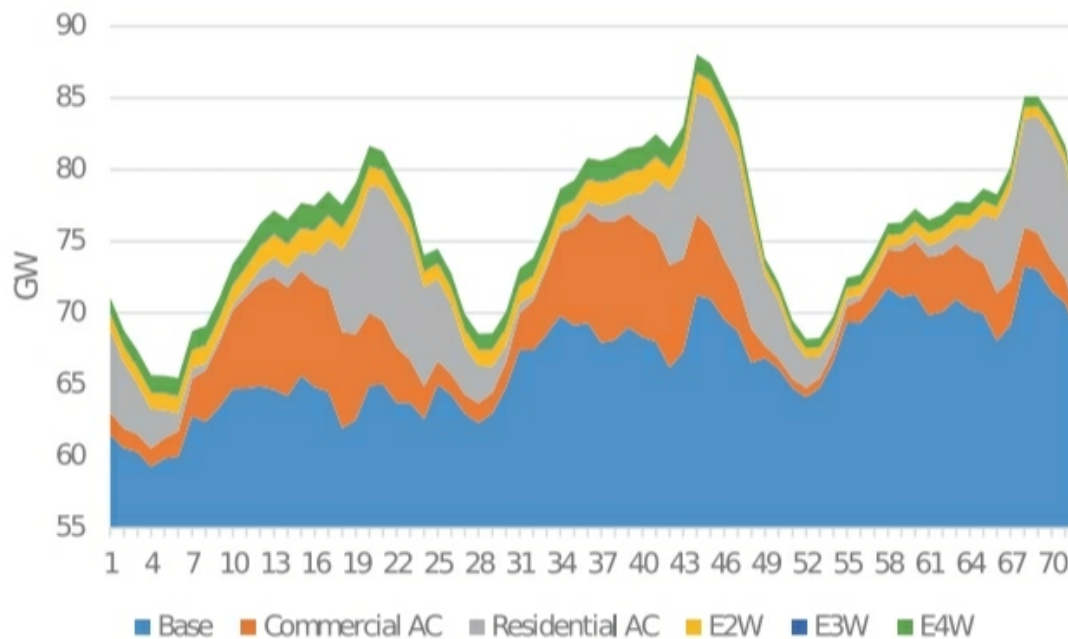
Fig.3 2030 Load profile for southern Region across three days in summer. Scenario: stable GDP growth, baseline cooling, home electric vehicle (EV)charging.
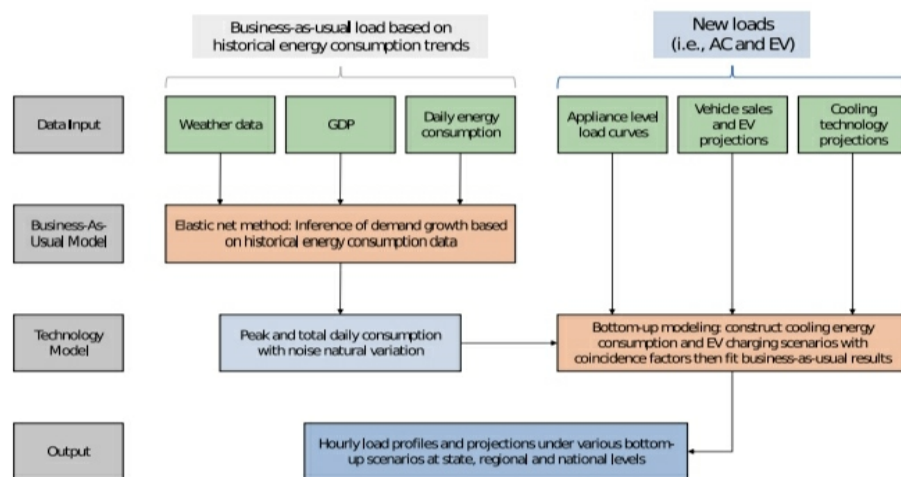

Fig.4 Simplified schematic of methods; inputs in green, models in reds, outputs in blue.
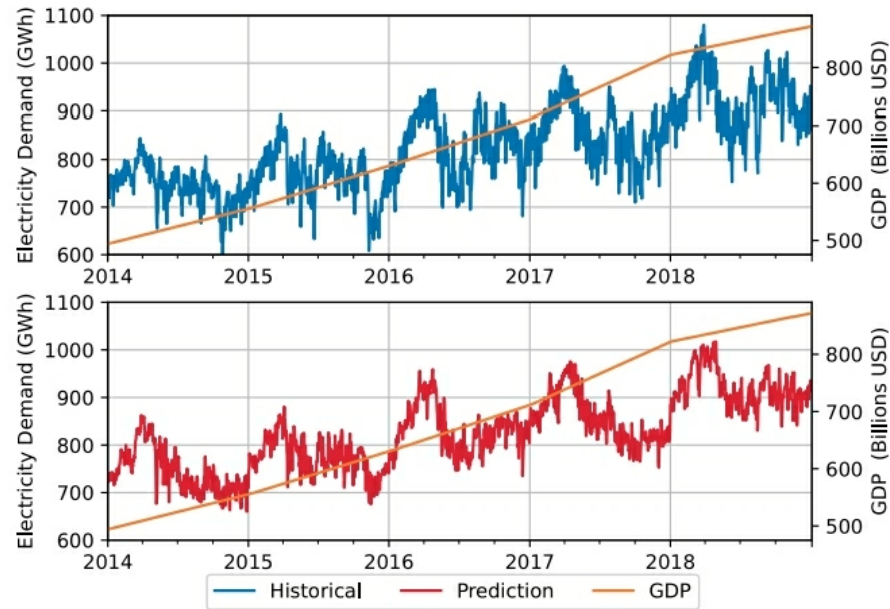
2.2 Ideation & Brainstroming Map

Fig.5 Southern region back test annual demand growth given GDP projection.
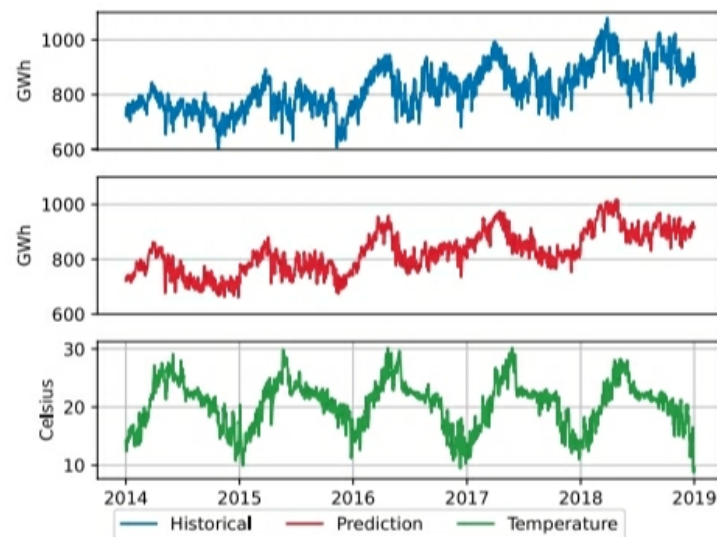
Fig.6 Southern region back test seasonal demand variation given weather data.

3. Result

Based on the research and analysis of historical, current, and future trends in electricity consumption, we can expect to see a transition towards a more sustainable and reliable energy system that prioritizes renewable energy sources, energy efficiency, and smart grid technology. This will require collaboration between individuals, businesses, and policymakers to overcome challenges related to cost, reliability, and complexity, but the potential benefits in terms of reduced carbon emissions, improved energy security, and cost savings are significant. Continued research and analysis of electricity consumption patterns will be critical to inform energy planning and policy decisions at the local, national, and international levels, and to promote the development and adoption of innovative solutions to address energy challenges.

4. Advantages

- Reduced carbon emissions: The adoption of renewable energy sources and energy efficiency measures can help to reduce carbon emissions and mitigate the impacts of climate change.
- Improved energy security: Diversifying the energy mix to include more renewable energy sources can reduce reliance on fossil fuels and increase energy security.
- Cost savings: Energy efficiency measures can reduce energy consumption and lower electricity bills for consumers.
- Job creation: The transition to a more sustainable energy system can create new job opportunities in the renewable energy sector.
- Innovation: The development and adoption of new technologies and solutions to address energy challenges can drive innovation and create new business

opportunities.

Disadvantages

- Reliability challenges: Renewable energy sources can be intermittent and may require backup power sources to ensure a reliable energy supply.
- Complexity: The transition to a more sustainable energy system can be complex and require significant changes to infrastructure, regulations, and consumer behavior.
- Limited availability: In some areas, renewable energy sources may not be readily available or feasible due to geographic, technical, or regulatory constraints.
- Resistance to change: Some individuals or organizations may resist the transition to a more sustainable energy system due to concerns about costs, reliability, or other factors.

5.Application

- **Energy planning**: Analyzing historical, current, and future trends in electricity consumption can inform energy planning and policy decisions at the local, national, and international levels.
- **Energy efficiency programs**: Understanding patterns of electricity consumption can inform the development of energy efficiency programs that target high-consumption areas or behaviors to reduce overall energy use.
- **Renewable energy deployment**: Analyzing patterns of electricity consumption can inform the deployment of renewable energy sources to match demand and reduce reliance on fossil fuels.
- **Demand response programs:** Understanding patterns of electricity consumption can inform the development of demand response programs that incentivize consumers to shift their electricity use to times of day when renewable energy sources are more abundant.
- **Grid modernization:** Understanding patterns of electricity consumption can inform the development of smart grid technologies and energy storage solutions that improve grid reliability, flexibility, and efficiency.

- **Consumer education**: Understanding patterns of electricity consumption can inform consumer education programs that promote energy conservation and help consumers understand the impacts of their electricity use.

Overall, the applications of electricity consumption patterns in the future are critical to achieving a more sustainable and reliable energy system. By analyzing patterns and drivers of change in electricity consumption, we can develop evidence-based solutions and policies that promote energy efficiency, renewable energy deployment, and grid modernization.

6. Conclusion

In conclusion, exploring electricity consumption patterns in the future is critical to achieving a more sustainable and reliable energy system. By analyzing historical, current, and future trends, we can identify patterns and drivers of change and develop evidence-based recommendations for individuals, businesses, and policymakers to improve electricity consumption patterns. It is clear that renewable energy sources and energy efficiency will play a vital role in the future of electricity consumption patterns, along with smart grid technology, energy storage, and demand response programs. The transition to a more sustainable energy system requires a collaborative effort between individuals, businesses, and policymakers to achieve the goals of reducing carbon emissions, improving energy efficiency, and ensuring a reliable energy supply for future generations.

7. Future scope

The future scope of electricity consumption patterns is vast and exciting, as advancements in technology, changes in policy, and shifts in consumer behavior continue to shape the energy landscape. Some of the potential future developments in this area include:

- Decarbonization: A continued push to decarbonize the energy system through the adoption of renewable energy sources, electrification of transportation, and the deployment of carbon capture and storage technologies.
- Smart grid technology: The widespread adoption of smart grid technology and advanced metering infrastructure to improve grid reliability, flexibility, and efficiency.
- Energy storage: The development and deployment of advanced energy storage solutions to address the intermittency of renewable energy sources and improve grid resiliency.
- Electric vehicles: The growth of the electric vehicle market and the integration of vehicle-to-grid technologies to help balance the grid and increase renewable energy penetration.
- Energy efficiency: The continued development and deployment of energy efficiency technologies and programs to reduce overall energy consumption.

- Consumer engagement: The increasing importance of consumer engagement and education in promoting energy conservation and the adoption of sustainable energy practices.

Overall, the future scope of electricity consumption patterns is characterized by an increasing emphasis on sustainability, innovation, and collaboration between individuals, businesses, and policymakers. As we continue to face the challenges of climate change and energy security, understanding and managing electricity consumption patterns will be critical to achieving a more sustainable and reliable energy system for future generations.

8.Appendix

Source code

The code used in the generation of the data sets is open-sourced on Github repository