

Inspiring Innovation

MCKV Institute of Engineering

Department: Computer Science & Engineering

Subject: Data Analysis & Visualization
Code: PE-CS602C

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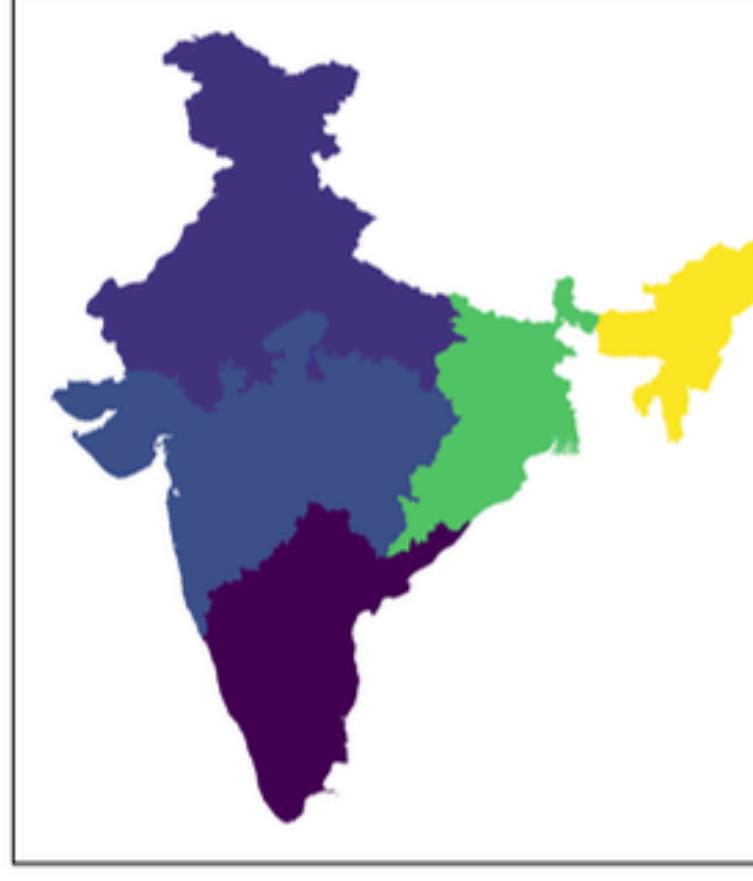
PowerPulse: Analyzing India's Energy Trends (2019 - 2020)

Explores electricity consumption across major states, highlighting seasonal variations, COVID-19 impact, and peak demand trends. The study provides insights into energy usage patterns to support efficient planning and policy decisions.

States



Regions



Demand (TWh)

Demand (TWh)



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Goal of Our Project

	Date	Month	Month_Number	Punjab	Haryana	Rajasthan	Delhi	UP	Uttarakhand	HP	...	Odisha	West Bengal	Sikkim	Arunachal Pradesh	Assam	Manipur	Meghalaya	Mizoram	Nagaland	Tripura
0	2019-02-01	February	2	119.9	130.3	234.1	85.8	313.9	40.7	30.0	...	70.2	108.2	2.0	2.1	21.7	2.7	€	1.9	2.2	3.4
1	2019-03-01	March	3	121.9	133.5	240.2	85.5	311.8	39.3	30.1	...	67.9	110.2	1.9	2.2	23.4	2.4	€	1.8	2.2	3.6
2	2019-04-01	April	4	118.8	128.2	239.8	83.5	320.7	38.1	30.1	...	66.3	106.8	1.7	2.2	21.7	2.4	€	1.7	2.2	3.5
3	2019-05-01	May	5	121.0	127.5	239.1	79.2	299.0	39.2	30.2	...	65.8	107.0	2.0	2.2	22.5	2.7	€	1.8	2.3	3.5
4	2019-06-01	June	6	121.4	132.6	240.4	76.6	286.8	39.2	31.0	...	62.9	106.4	2.0	2.2	21.7	2.7	€	1.9	2.3	3.3
...	
193	2020-01-12	January	1	130.8	126.0	220.4	77.3	322.8	36.5	25.4	...	105.7	172.6	1.4	2.1	20.4	2.1	€	1.8	2.0	2.4
194	2020-02-12	February	2	129.4	127.3	218.4	81.3	331.4	37.0	25.8	...	112.3	174.4	1.5	2.1	23.3	2.4	€	1.6	2.1	3.3
195	2020-03-12	March	3	132.1	129.7	205.6	85.6	336.7	37.8	26.2	...	113.0	169.8	1.4	2.1	21.7	2.3	€	1.5	2.0	3.6
196	2020-04-12	April	4	132.1	128.4	207.0	83.9	334.6	38.2	27.0	...	111.6	145.5	1.2	2.0	24.2	2.5	€	1.6	2.0	3.3
197	2020-05-12	May	5	120.4	111.2	201.4	83.6	287.3	35.2	24.3	...	95.1	110.4	1.2	2.1	20.3	2.5	€	1.6	2.1	3.3

98 rows × 36 columns

Energy consumption is a critical factor in a country's economic growth and development. In India, with its vast geographical diversity and varying industrial and residential energy demands, analyzing state-wise energy consumption patterns is essential for efficient energy planning and management.

This project aims to perform an in-depth data analysis and visualization of the energy consumption trends across all Indian states.

Understand Regional Differences:
Compare high and low energy-consuming states to identify trends and influencing factors.

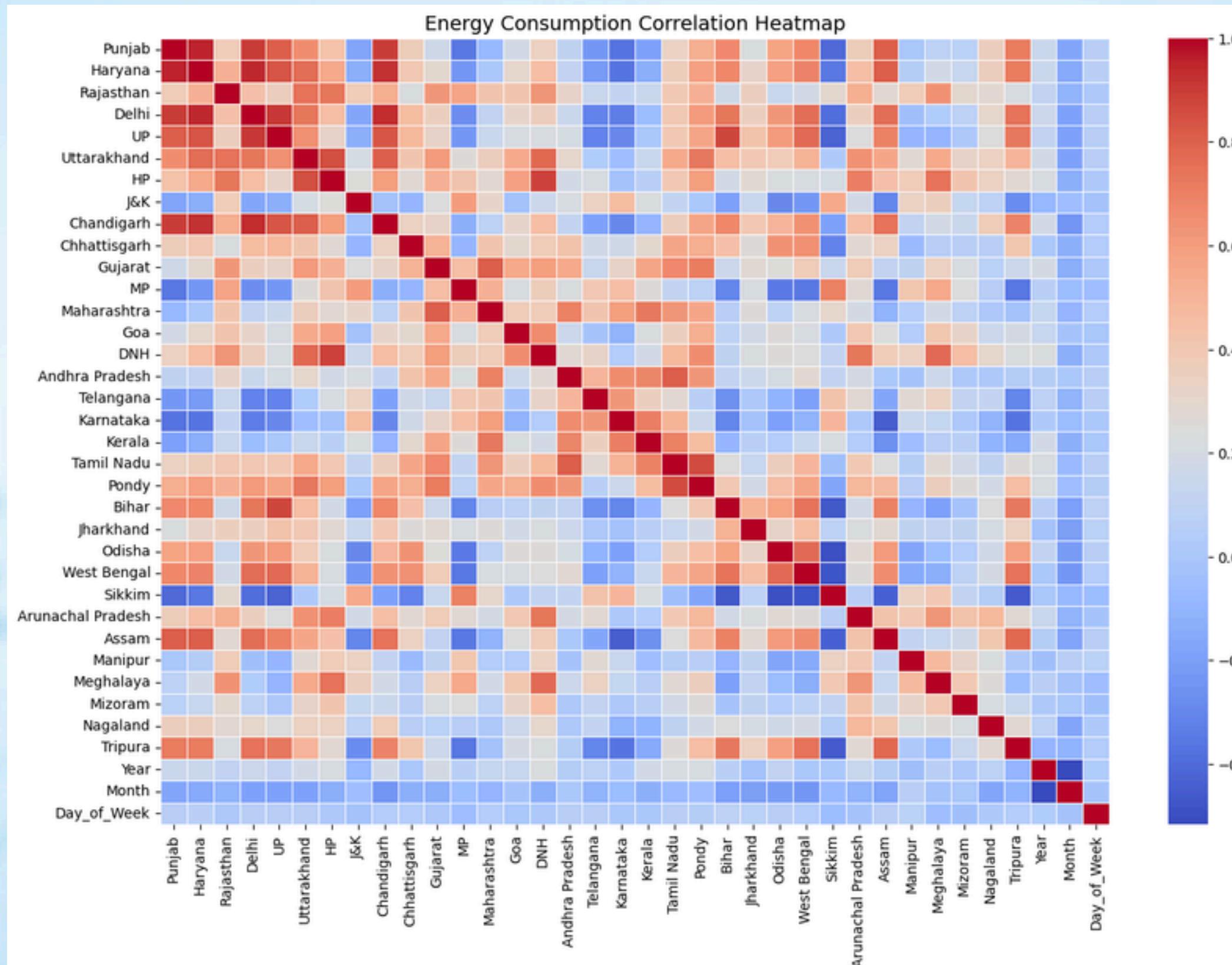
Visualize Energy Trends:
Use various graphical methods like heatmaps, time-series plots, histograms, and correlation matrices to make the data more interpretable.

Identify Consumption Patterns
Analyze how energy consumption varies across different states and months.

Support Decision-Making:
Provide useful insights for policymakers, energy providers, and researchers for efficient resource allocation.



Energy consumption Correlation



1. Strong Positive Correlations (Red Areas):

- States like Punjab, Haryana, Rajasthan, and UP have strong correlations, indicating similar energy consumption patterns.
- This suggests that these states may have similar industrial activities, climate, or energy demand trends.

2. Negative Correlations (Blue Areas):

- Some states show negative correlations, meaning that when energy consumption increases in one, it tends to decrease in another.
- Example: Some Southern and Northeastern states may have opposite consumption trends compared to Northern states.

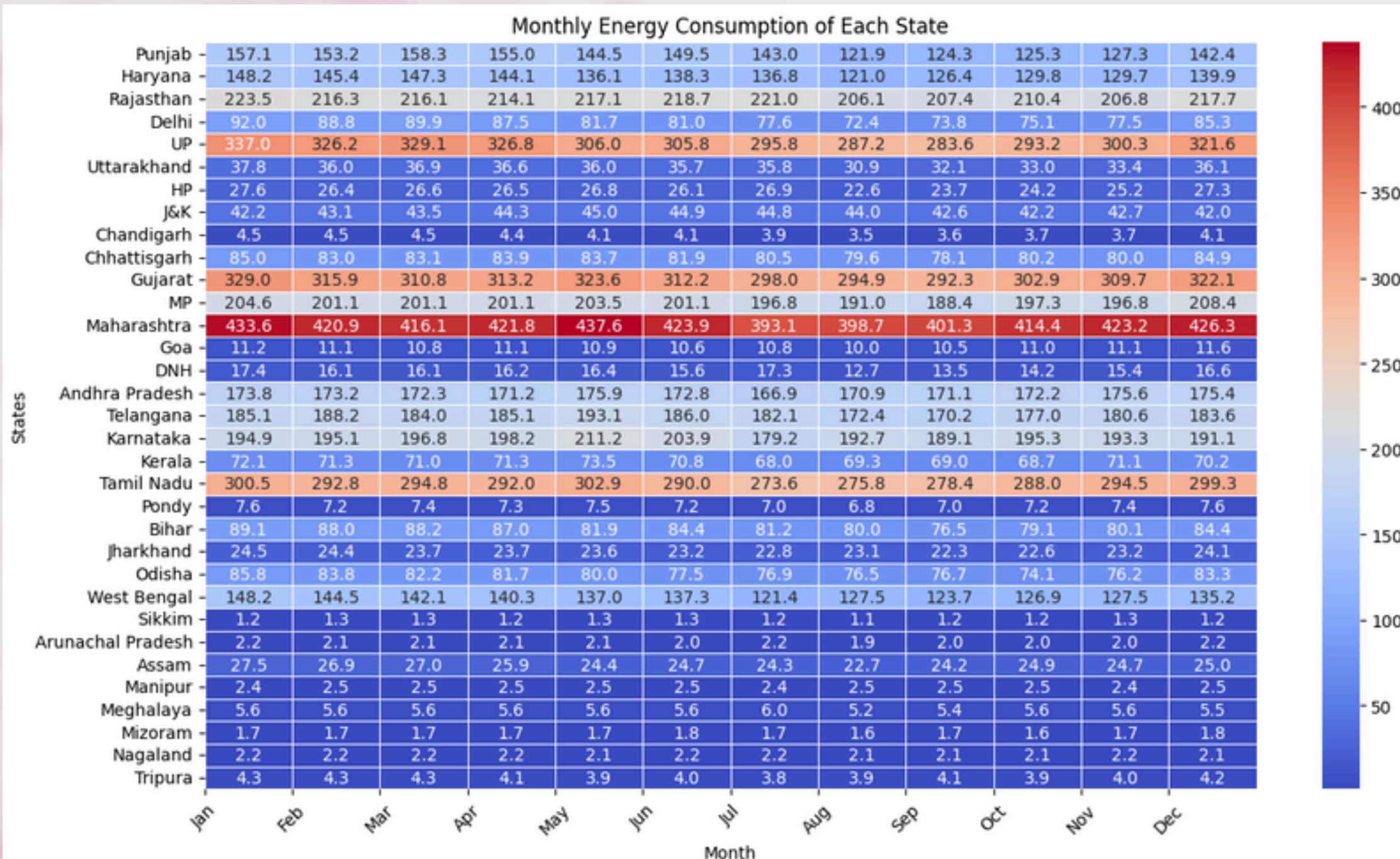
3. Time-Based Factors (Year, Month, Day_of_Week):

- "Month" and "Day_of_Week" correlations indicate seasonal or weekly variations in energy consumption.
- If a state has a strong correlation with "Month," its energy usage is likely affected by seasonal changes.

- Red (close to 1.0) means a strong positive correlation.
- Blue (close to -1.0) means a strong negative correlation.
- White (close to 0.0) means little or no correlation.



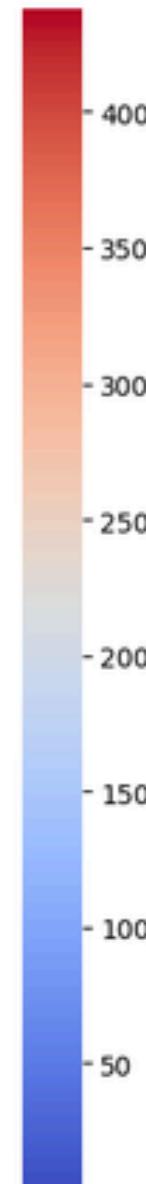
Monthly Energy Consumption of Each State



Color Representation:

Dark Red (Higher values) → Indicates states with high energy consumption.

Blue (Lower values) → Indicates states with low energy consumption.



Key Observations:

- Maharashtra, Gujarat, and Uttar Pradesh have the highest energy consumption across all months.
- Sikkim, Arunachal Pradesh, Mizoram, and Nagaland have the lowest energy consumption.
- Some states show fluctuations across months, indicating seasonal energy demands.

State-Wise Insights:

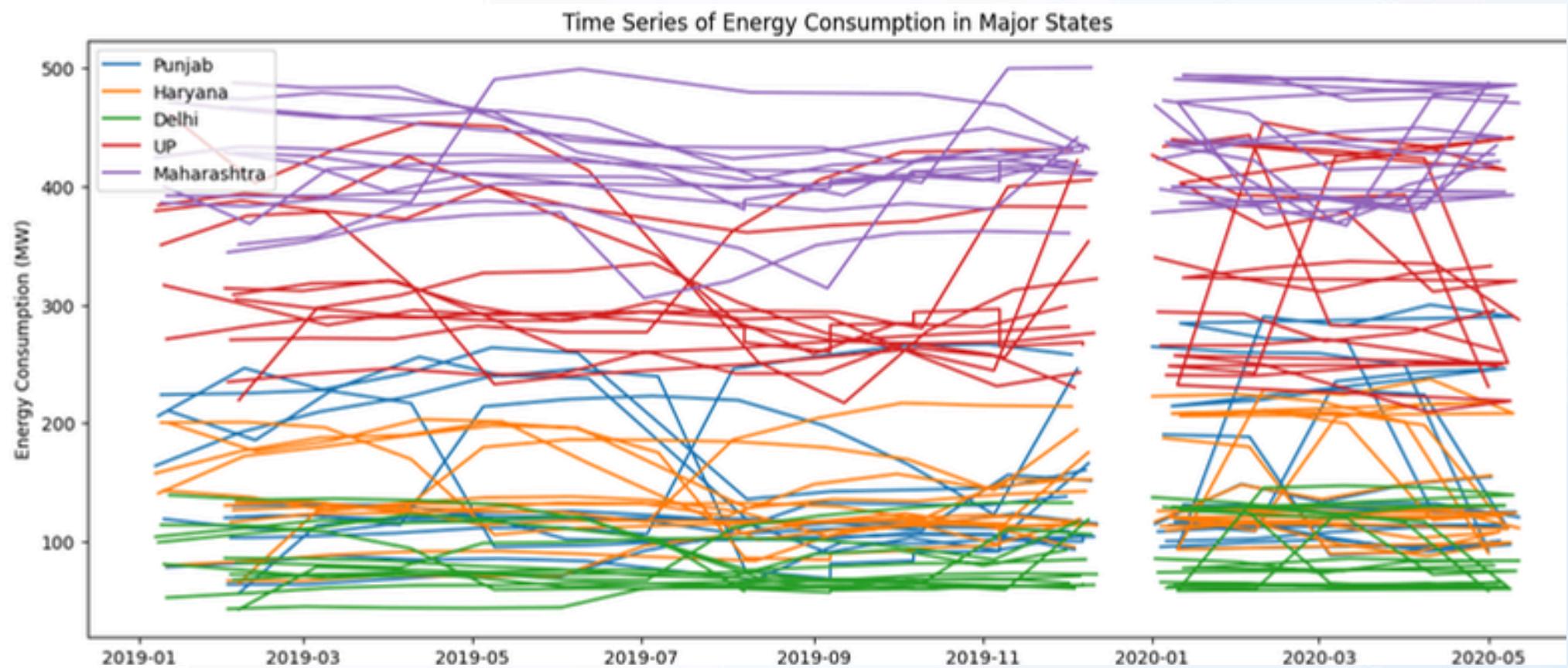
- **Maharashtra (Highest Consumption): Peaks in January, May, and December.**
- **Delhi:** Shows relatively lower consumption compared to larger states.
- **Tamil Nadu & Karnataka:** Consistently moderate consumption.
- **Smaller Northeastern states:** Maintain consistently low consumption.

Practical Implications:

- Helps identify states with higher energy demands, which can aid in energy distribution planning.
- Seasonal variations might indicate peak demand periods, useful for electricity providers.

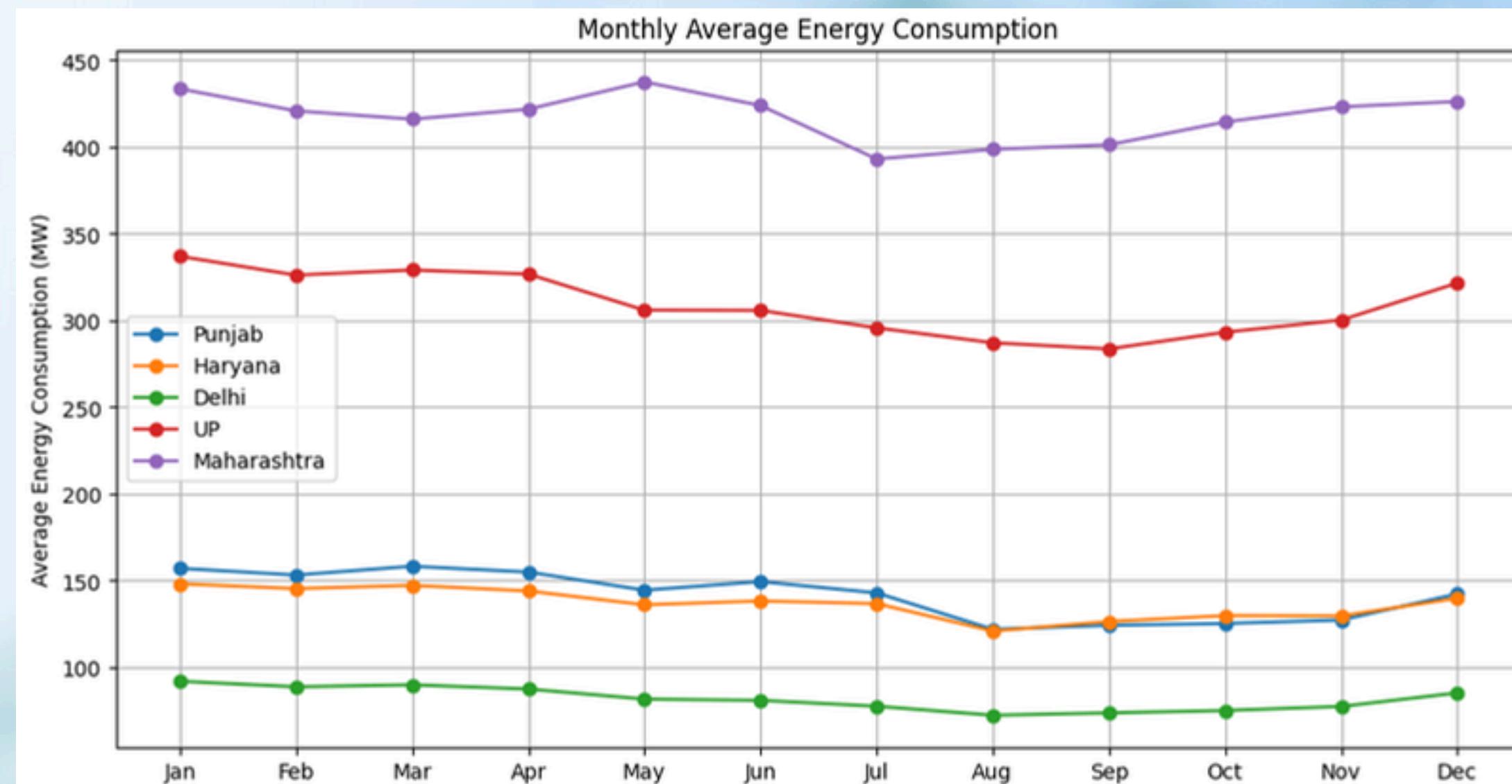


Comparison between 5 Major State



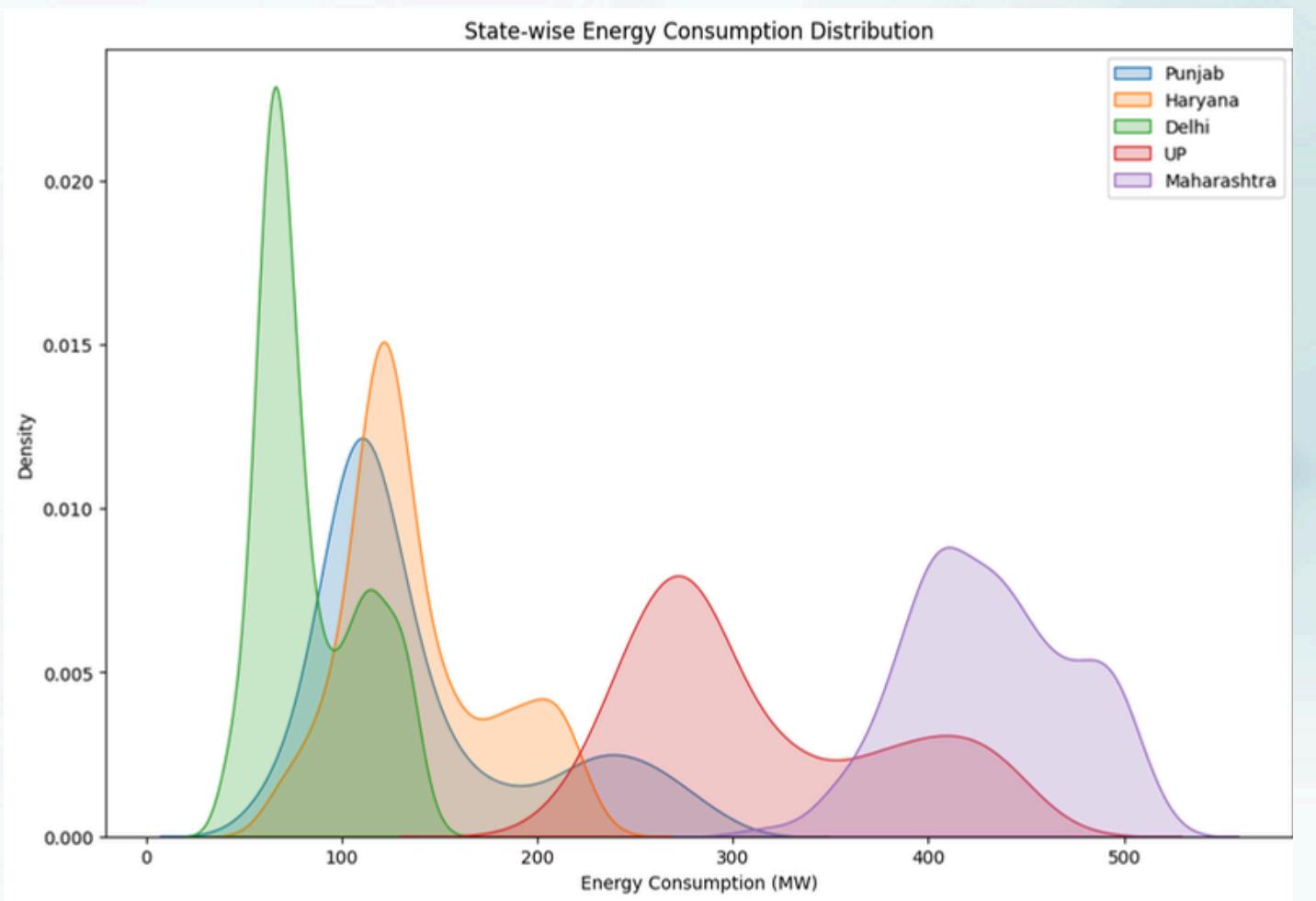
- Punjab (blue), Haryana (orange), Delhi (purple), UP (red), and Maharashtra (green) are highlighted in the legend.
- There is a clear drop in energy consumption around early 2020, which likely corresponds to the COVID-19 lockdown period.
- Maharashtra and Delhi appear to have the highest energy consumption levels.
- Haryana and Punjab show relatively moderate usage, while other states have varying trends.

- Maharashtra has the highest energy consumption throughout the year, staying above 400 MW.
- UP (Uttar Pradesh) follows next, with energy consumption fluctuating around 300-350 MW.
- Punjab and Haryana have similar trends, with their values being relatively lower, between 125-175 MW.
- Delhi has the lowest energy consumption, staying below 100 MW throughout the year.

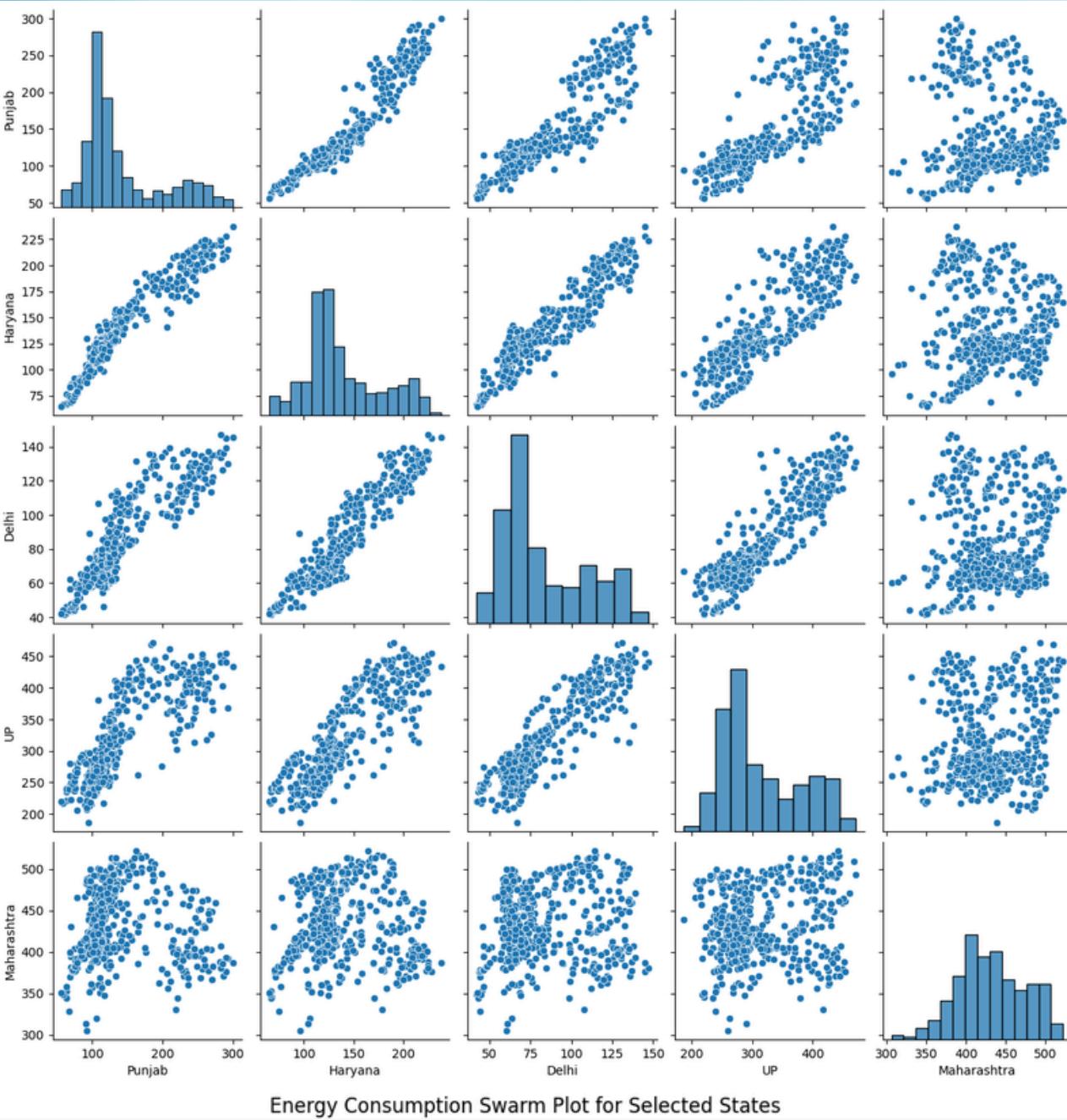




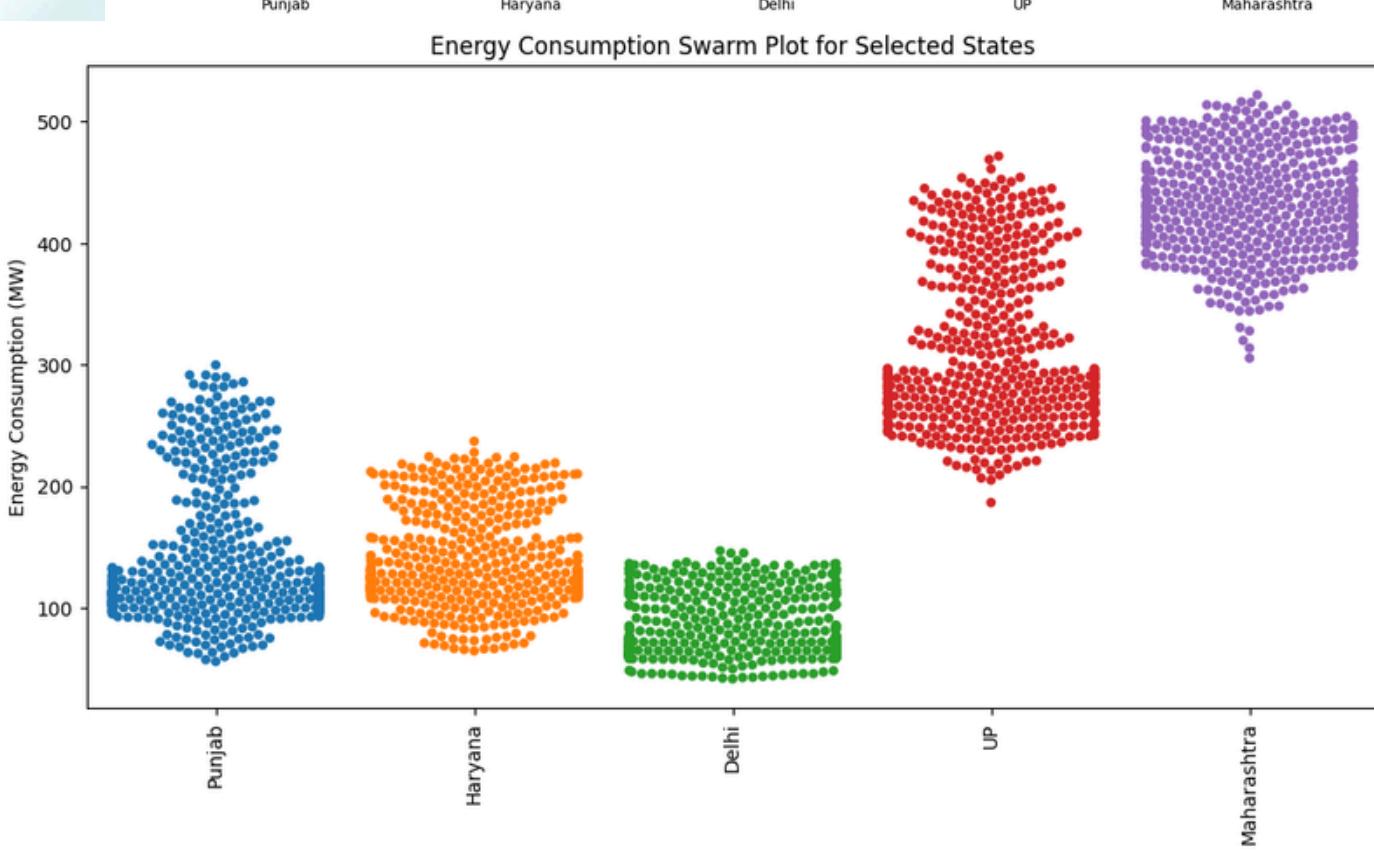
Comparison between 5 Major State



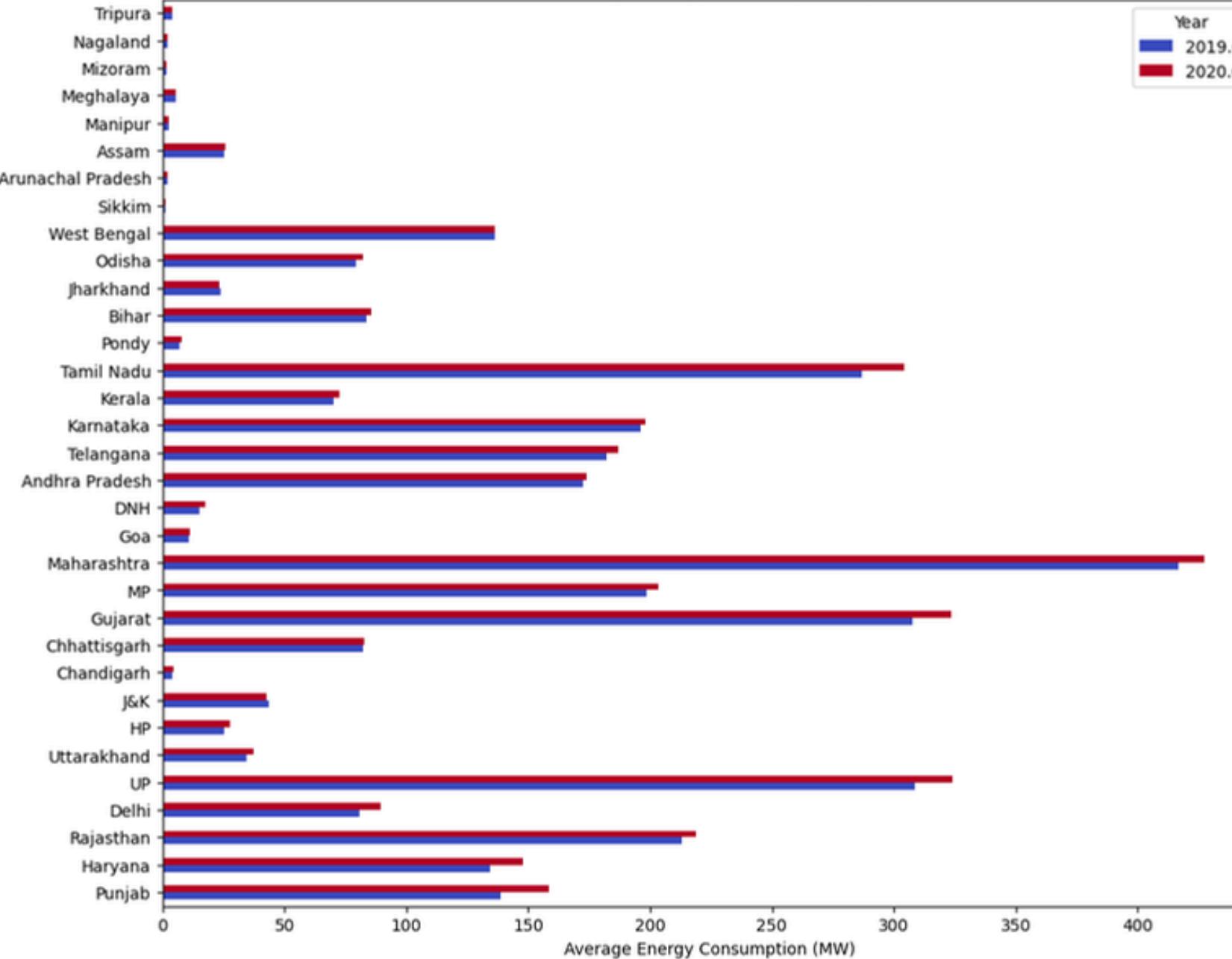
- The graph shows state-wise energy consumption distribution in India. Punjab has a sharp peak, indicating concentrated consumption, while Maharashtra and UP have broader distributions, suggesting varied usage. Delhi and Haryana show moderate variation, indicating balanced energy consumption.



- The graph is a swarm plot representing energy consumption (in MW) for selected Indian states: Punjab, Haryana, Delhi, UP, and Maharashtra. Here are some key observations:
 - Maharashtra has the highest energy consumption
 - UP has high variability in energy consumption
 - Delhi has the lowest energy consumption
 - Punjab and Haryana have similar distributions
 - Overall, Maharashtra and UP are the biggest energy consumers, while Delhi consumes the least among the selected states.



Comparison of Average Energy Consumption by State (Yearly)

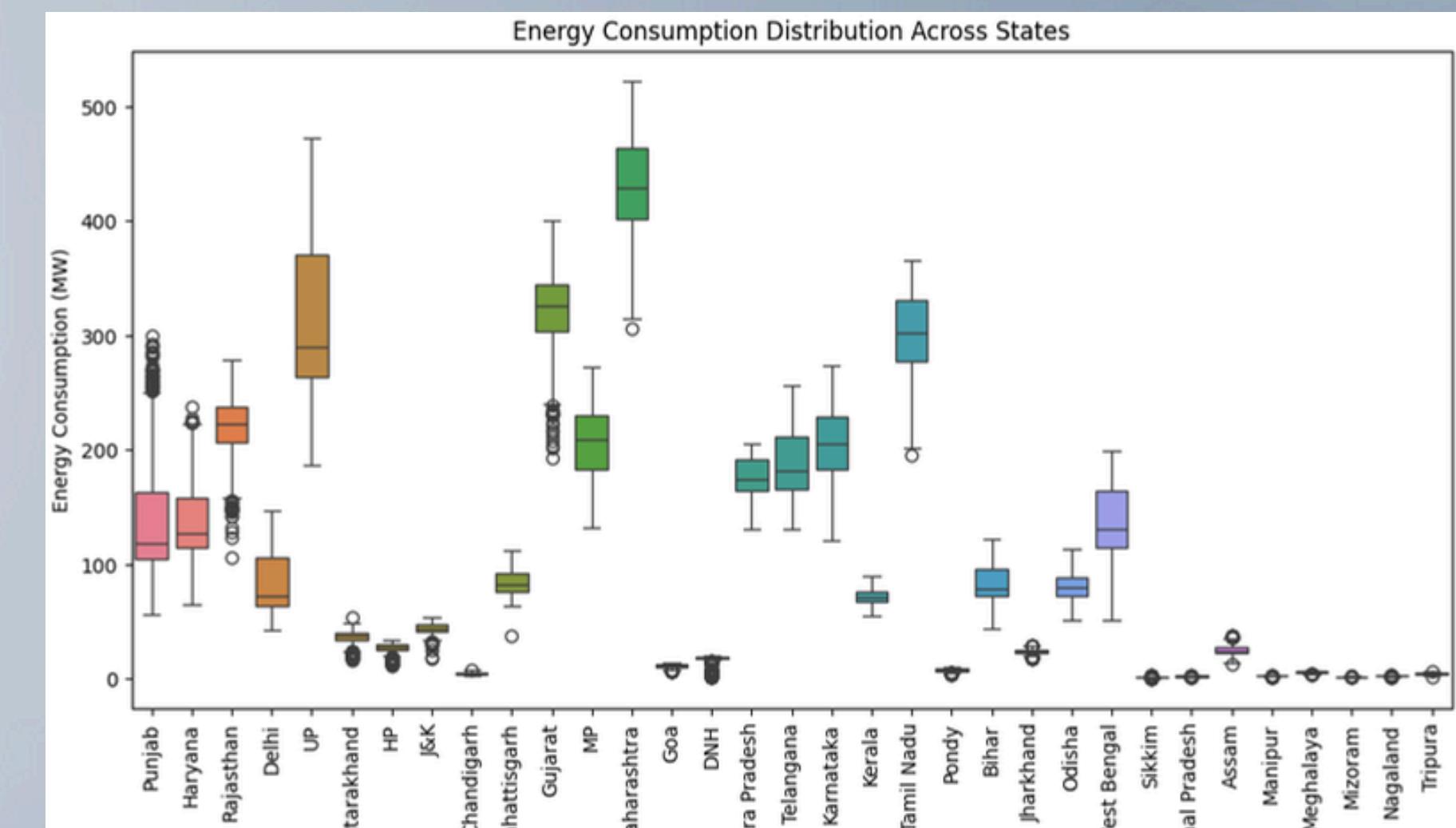


- Maharashtra, Tamil Nadu, and Gujarat have the highest energy consumption in both 2019 and 2020.
- Most states show a slight increase in energy consumption from 2019 to 2020, indicating overall growth.
- Smaller states like Mizoram, Nagaland, and Tripura have the lowest energy consumption levels.



State wise Energy Consumption

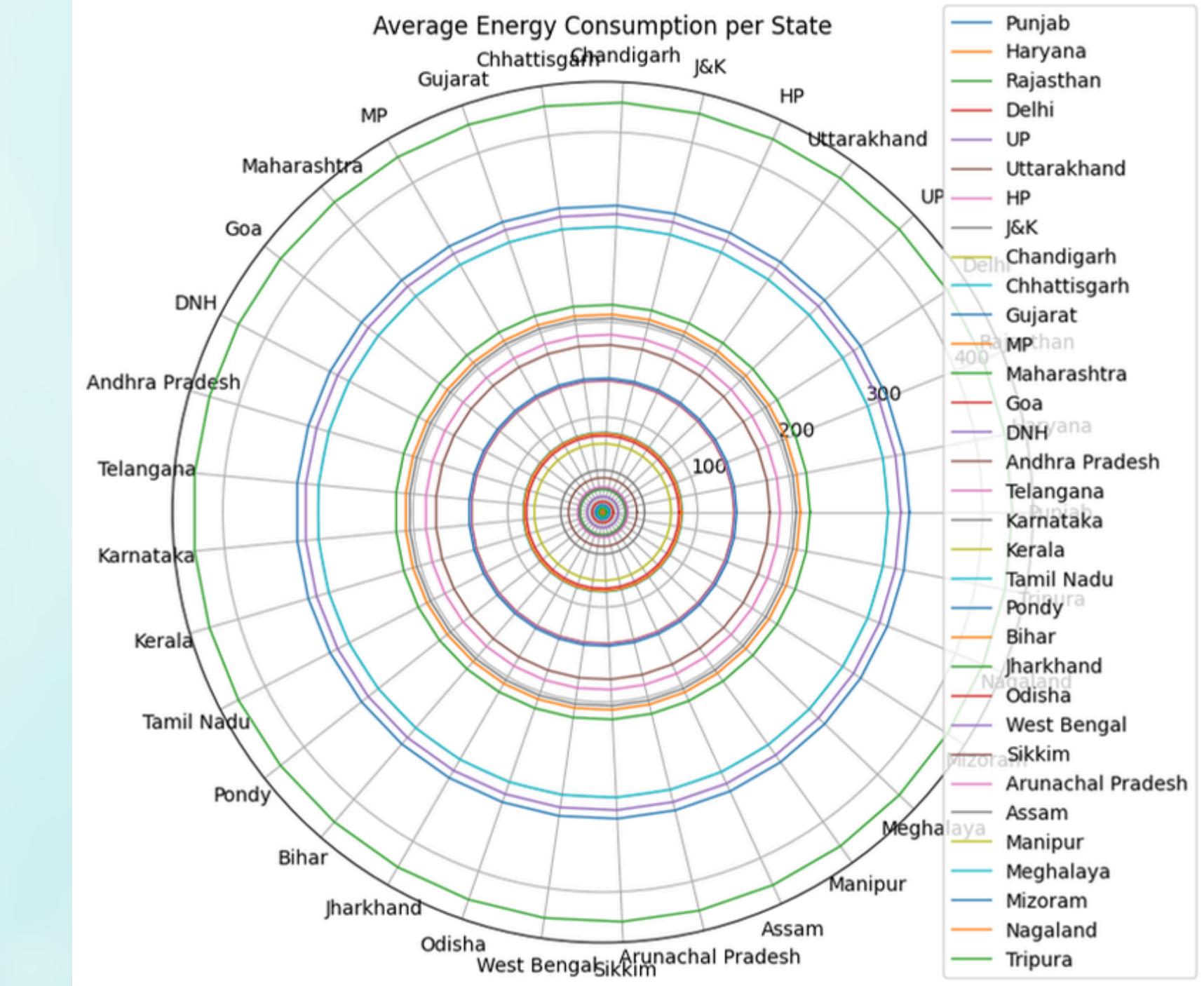
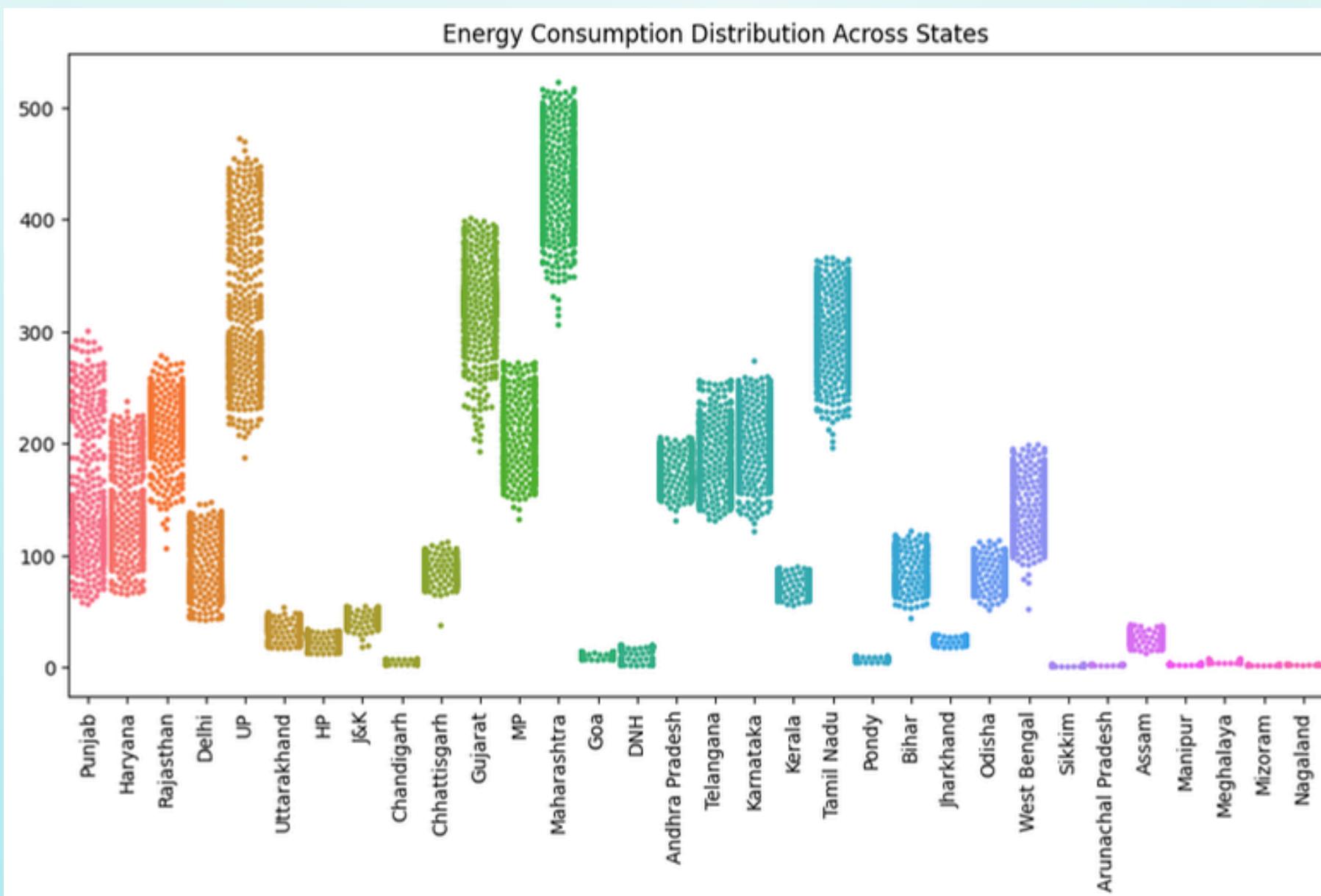
- Maharashtra, Gujarat, and Tamil Nadu show the highest energy consumption, with a wide range of values
- Smaller states like Mizoram, Nagaland, and Tripura have the lowest energy consumption.
- States like Delhi and Rajasthan exhibit high variability, indicating fluctuations in energy demand.
- Clusters of data points suggest consistent energy usage patterns in some states, while others show large variations.
- Certain states, like Punjab and Haryana, have moderate but consistent energy consumption trends.





Energy Consumption Per State:

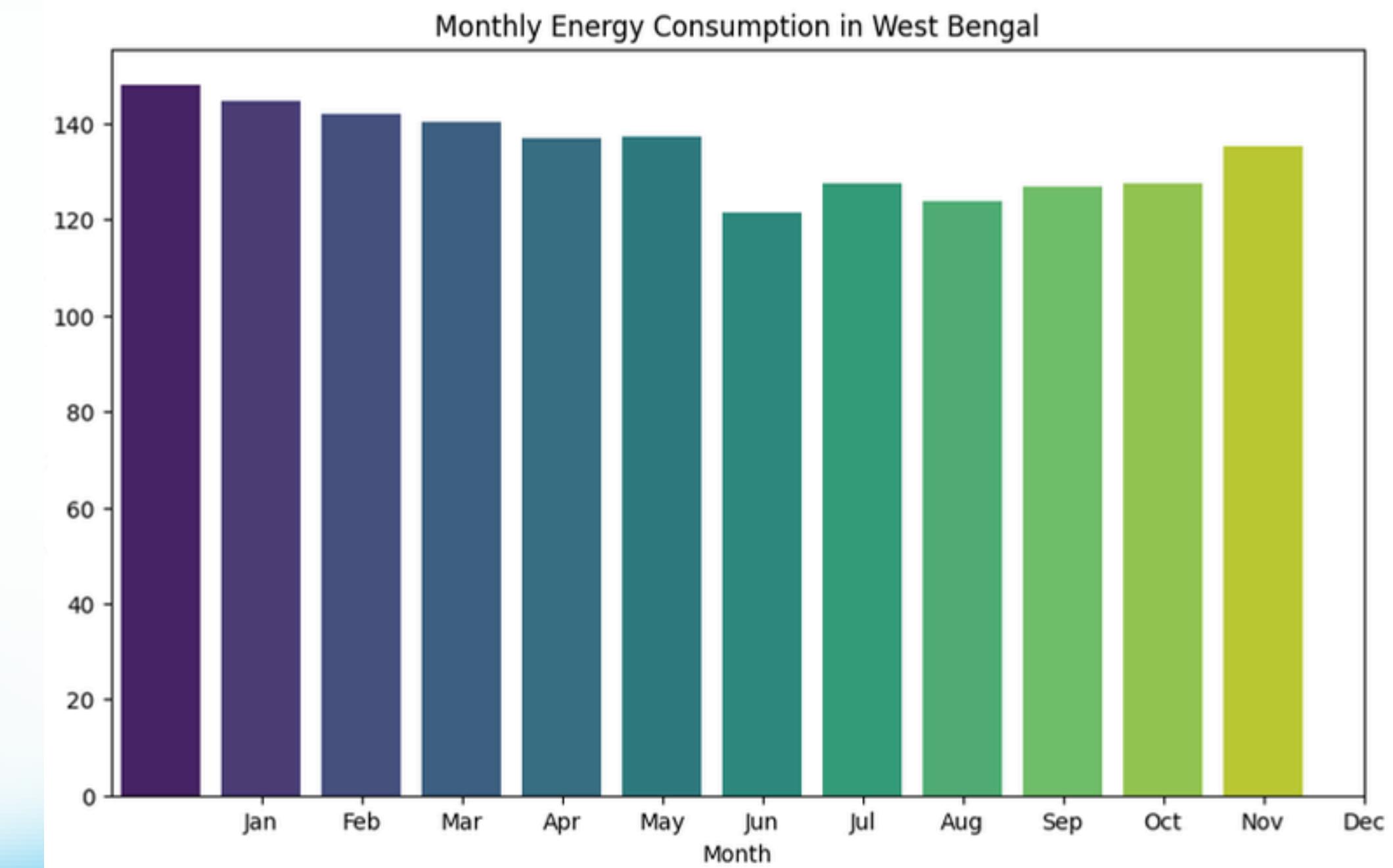
- Maharashtra, Gujarat, and Tamil Nadu show the highest median energy consumption.
- States like Mizoram, Nagaland, and Tripura have the lowest energy consumption.
- There is high variability in states like Rajasthan, Maharashtra, and Gujarat, indicated by a wide range of values.
- Outliers are present in several states, showing occasional spikes in energy usage.



- Maharashtra, UP, and Gujarat have the highest energy consumption among all states.
- Northeastern states like Mizoram, Nagaland, and Tripura consume the least energy.
- The distribution of energy consumption varies significantly across states, with some having a steep increase compared to others.

✓ Monthly Energy Consumption In West Bengal:

- **Highest Energy Consumption:** The month of January shows the highest average energy consumption, exceeding 140 MW.
- **Winter Peak:** November and December also demonstrate high energy usage, indicating potential seasonal demand during the winter months.
- **Lower Energy Consumption:** The lowest energy consumption is observed around June or July, possibly due to reduced demand during summer or monsoon months.
- **Steady Mid-Year Trend:** From March to October, the energy consumption seems relatively steady, with minor fluctuations between months.





Daily Energy Consumption Heatmap (West Bengal):

High Consumption Days

- Days with dark red tiles represent the highest energy consumption, concentrated around mid-August and specific weekends in other months.
- These peaks might indicate special events, holidays, or industrial surges.

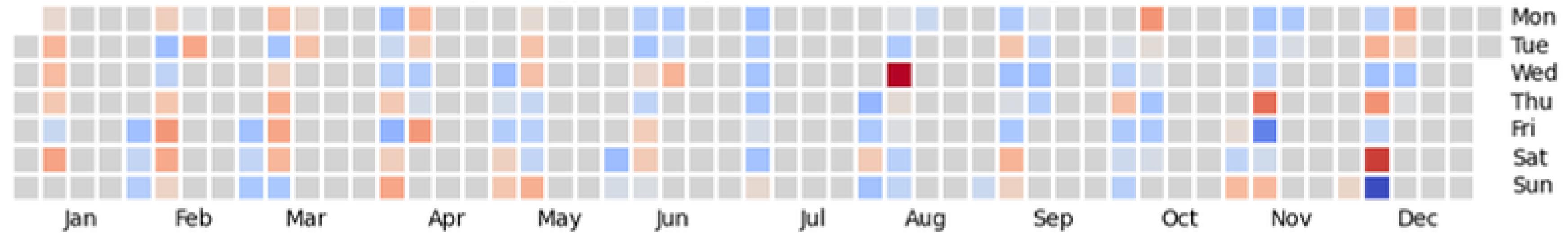
Low Consumption Days

- Dark blue tiles indicate significantly lower energy usage, mainly observed sporadically across the year, often coinciding with Sundays.

Seasonal Fluctuations:

- In summer and monsoon (May to August) it is slightly more variability with frequent high and low extremes.
- In winter (November to February) it is relatively balanced but with fewer high-consumption days compared to summer.

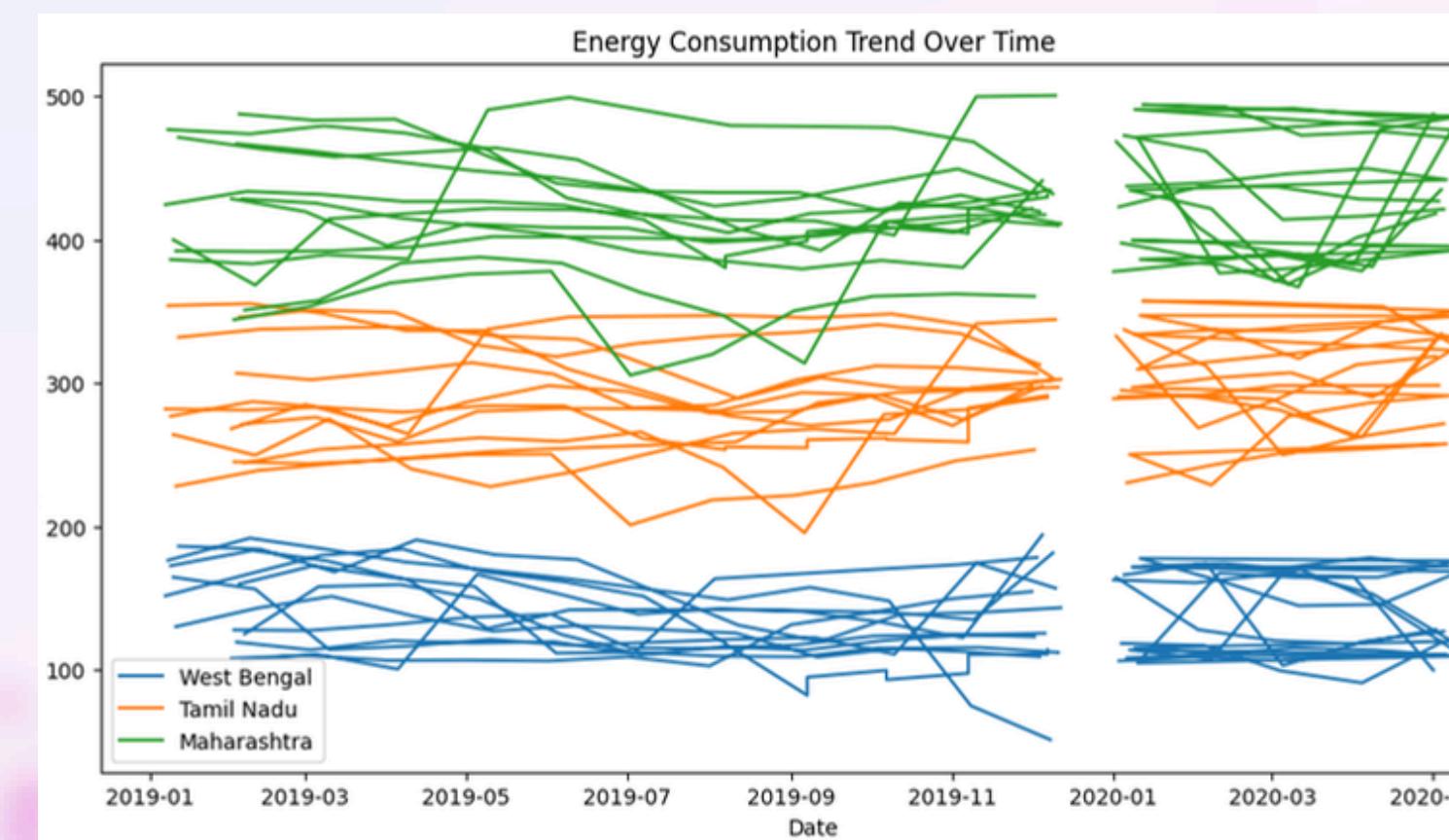
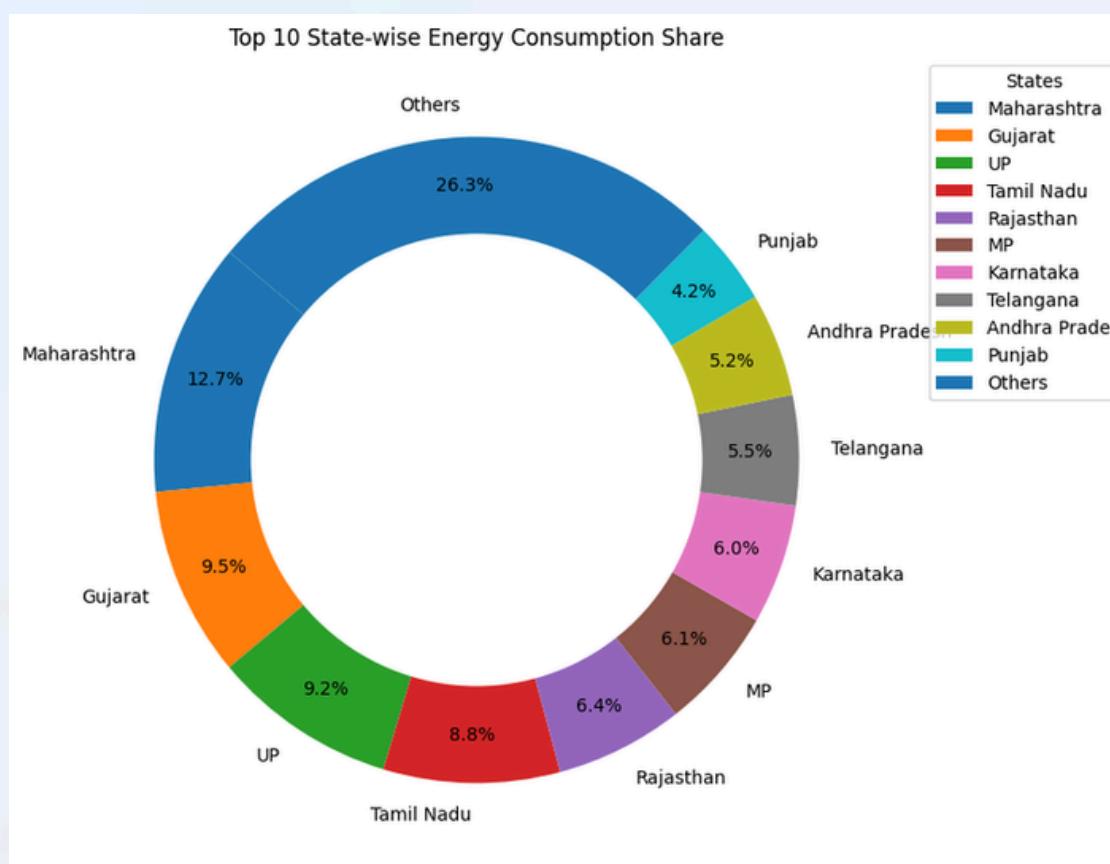
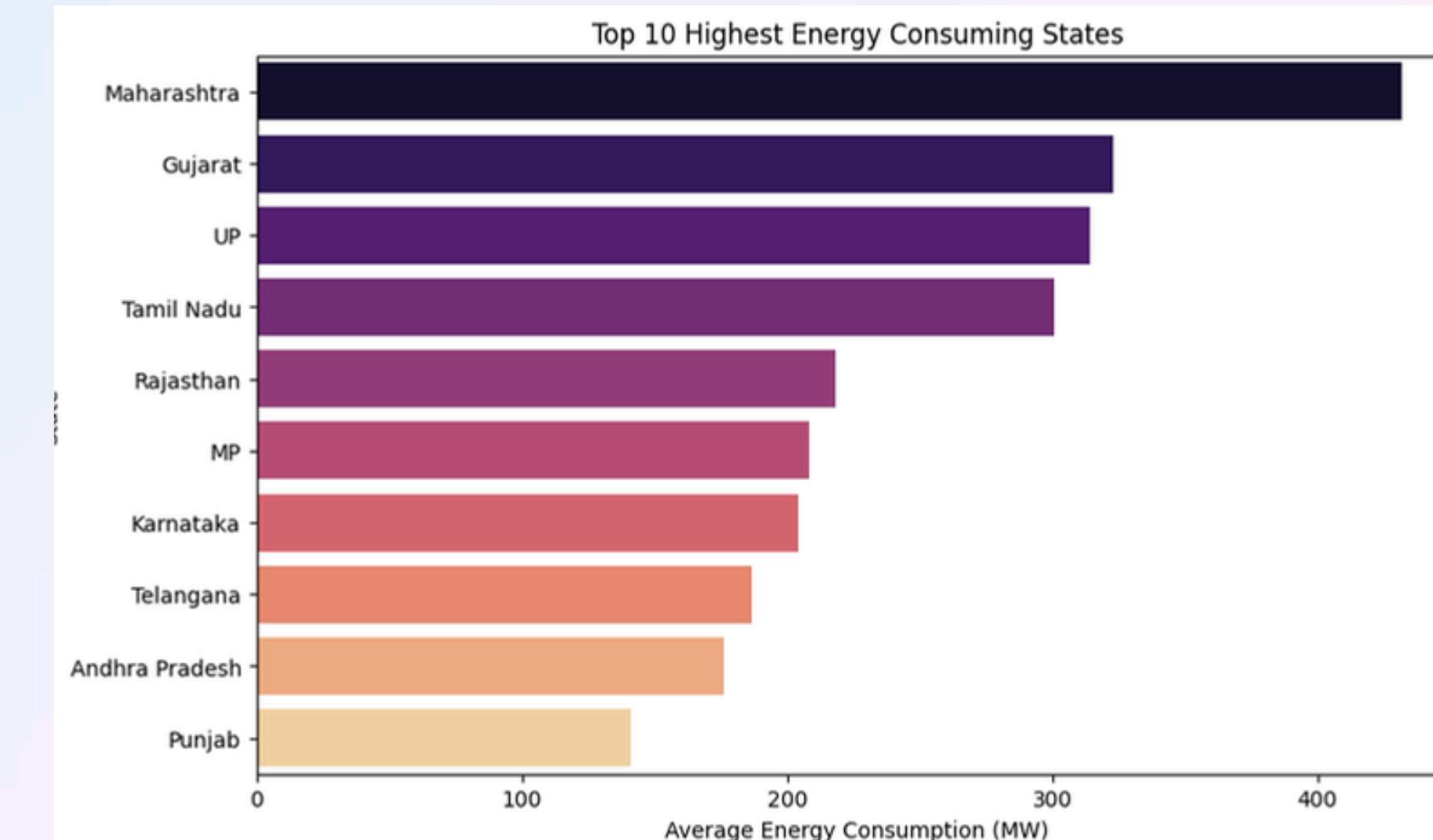
Daily Energy Consumption Heatmap (West Bengal)





Highest Energy Consumption:

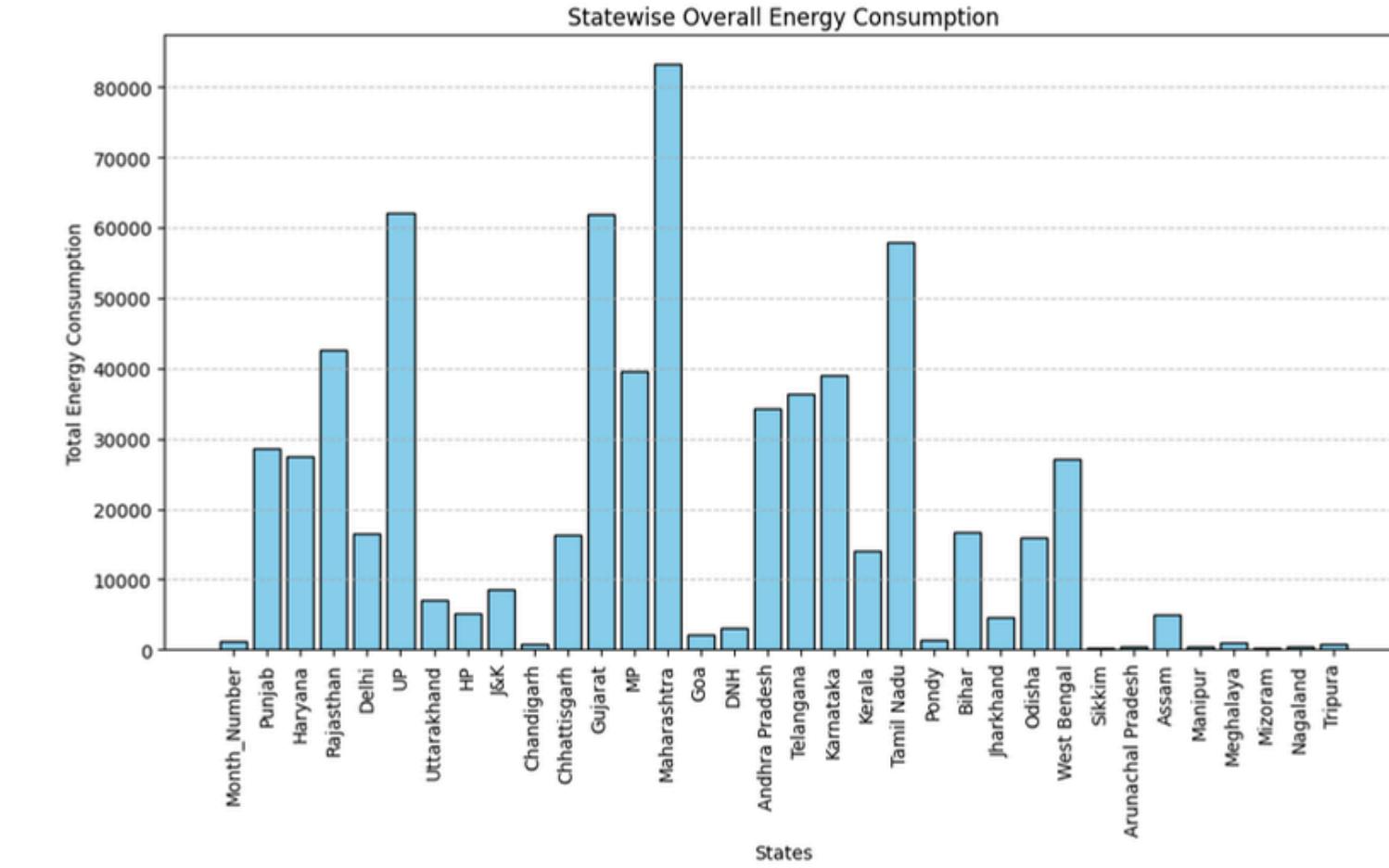
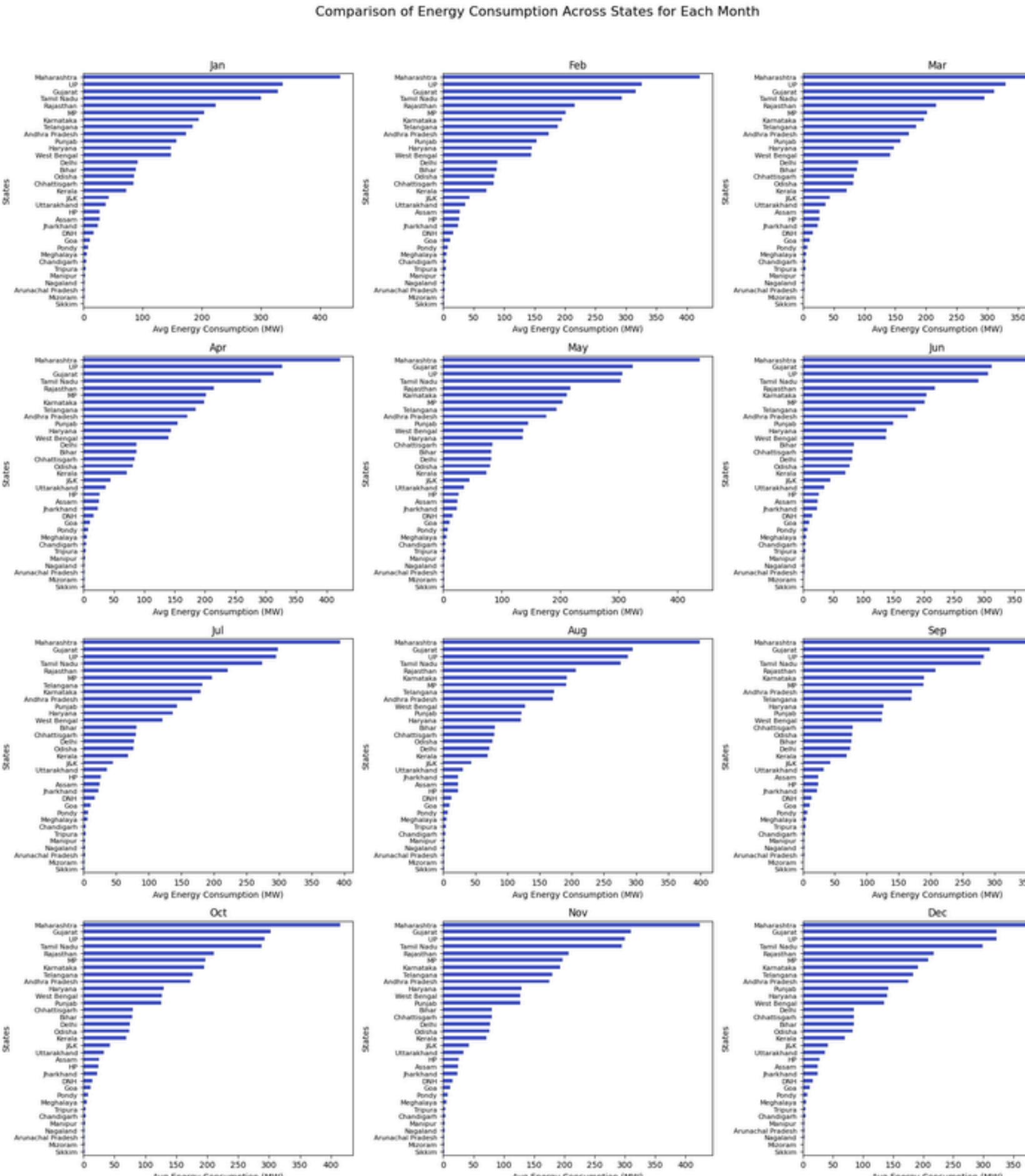
- Maharashtra (Green Lines):** Noticeable variations occur across months, with occasional dips, potentially reflecting industrial activity, seasonal changes, or policies.
- Tamil Nadu (Orange Lines):** Compared to Maharashtra, Tamil Nadu exhibits fewer fluctuations, suggesting more consistent energy demand across sectors.
- West Bengal (Blue Lines):** The trend shows stability, implying a steady energy usage pattern, possibly due to lesser industrial load compared to the other two states.



- Maharashtra** tops the list with the highest average energy consumption, exceeding 400 MW, reflecting its industrial and economic significance.
- Gujarat and UP** follow as the second and third highest energy-consuming states, showcasing their significant industrial and population-driven energy needs.
- Punjab** ranks tenth, showcasing substantial energy use, possibly tied to its agricultural and industrial sectors.



Conclusion:



- Maharashtra consistently has the highest energy consumption across all months.
- Gujarat, Tamil Nadu, and Uttar Pradesh also show high energy demand throughout the year.
- States like Arunachal Pradesh, Mizoram, and Nagaland have significantly lower energy consumption.
- Maharashtra consistently has the highest energy consumption across all months.
- Gujarat, Tamil Nadu, and Uttar Pradesh also show high energy demand throughout the year.
- States like Arunachal Pradesh, Mizoram, and Nagaland have significantly lower energy consumption.
- Our state is in 11th position according to the Overall Energy Consumption



Resources & Technologies Used



Thank You !

