Renewable Energy Usage

INSIGHTS FROM DATA ON

RENEWABLE ENERGY GENERATIONS

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Introduction

- Renewable energy plays a key role in India's energy future.
- The analysis covers state-wise energy generation, yearly trends, and contributions from various renewable energy sources (solar, wind, hydro).
- The data used is focused on **Renewable Energy** across India, examining electricity generation in **TWh**.

DataSet Source:

- **Kaggle** :
- **Link of DataSet:**

https://www.kaggle.com/datasets/zsinghrahulk/indian-engery-potential-generation-capacity?resource=download

Code:

```
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
```

```
df = pd.read_csv("../data/Energy_dataset.csv")
```

```
df.head(5)
```

Filtering out RENEWABLE Energy sources

```
df_renewable = df[df['Nature of Energy Sources'] == 'RENEWABLE']
df_renewable.head(5)
```

Feature selection and replacing missing value

```
print(df_renewable.isnull().sum())
```

```
srcStateName                                                0
srcYear                                                     0
Region-wise installation of electricity                  2395
Energy Value Type ( Potential, Capacity, Generation )       0
Types of Energy Sources                                     0
Nature of Energy Sources                                    0
Values for renewable electricity                            0
Types of Usage (Utility ,Captive)                         692
Type of Energy Sector                                     692
YearCode                                                    0
Year                                                        0
dtype: int64
```

```
df_cleaned = df_renewable.drop(columns=[
    'Region-wise installation of electricity',
    'Types of Usage (Utility ,Captive)',
    'Type of Energy Sector'
])
df_cleaned = df_cleaned.fillna({
    'Values for renewable electricity': 0,
    'Types of Energy Sources': 'Unknown'
})
print(df_cleaned.isnull().sum())
```

```
srcStateName                                              0
srcYear                                                   0
Energy Value Type ( Potential, Capacity, Generation )     0
Types of Energy Sources                                   0
Nature of Energy Sources                                  0
Values for renewable electricity                          0
YearCode                                                  0
Year                                                      0
dtype: int64
```

State-wise Renewable Energy => Bar graph

```
plt.figure(figsize=(10, 30))
sns.barplot(data=df_renewable, y='srcStateName', x='Values for renewable electricity', hue='Types of Energy Sources', errorbar=None)
plt.title('State-wise Renewable Energy Generation in India (by Type)')
plt.xlabel('State')
plt.ylabel('Renewable Energy Generation (in TWh)')
plt.xticks(rotation=45)
plt.tight_layout()
plt.show()
```

Yearly rise/fall in renewable energy usage in India

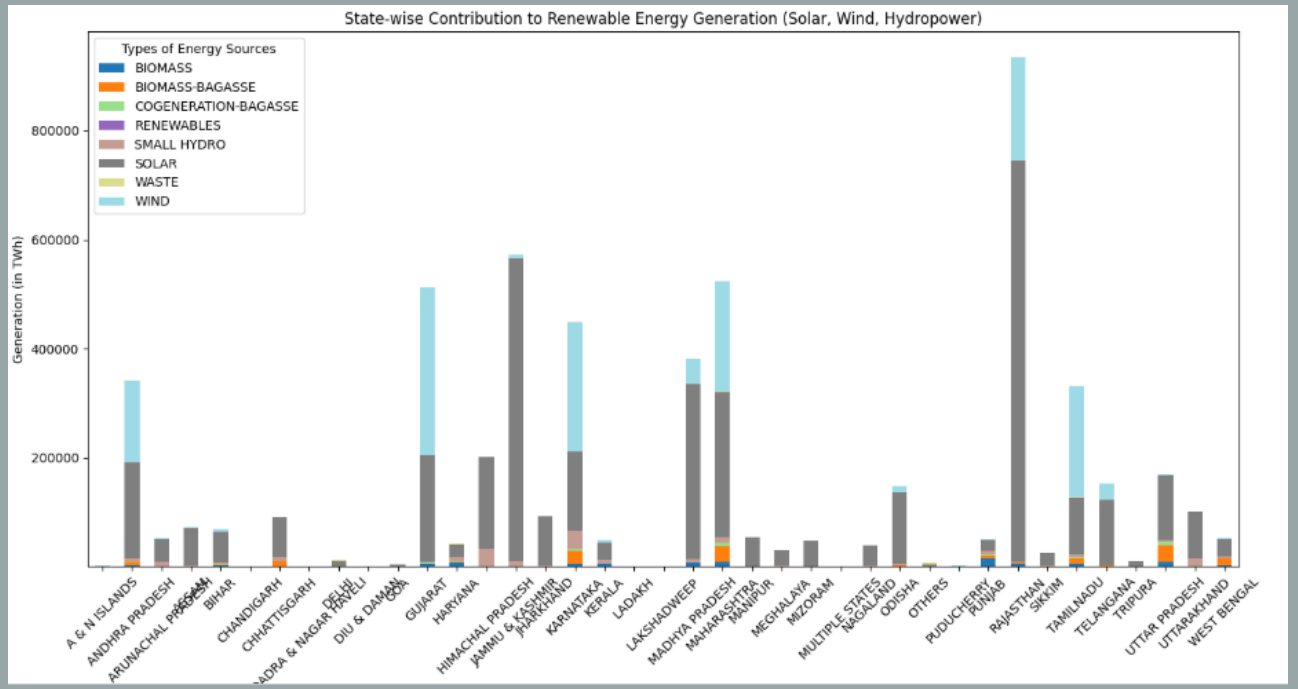
```
df_yearly = df_renewable.groupby(['srcYear', 'Types of Energy Sources']).agg(
    total_generation=('Values for renewable electricity', 'sum')
).reset_index()
plt.figure(figsize=(12, 6))
sns.lineplot(data=df_yearly, x='srcYear', y='total_generation', hue='Types of Energy Sources', marker='o')
plt.title('Yearly Growth of Renewable Energy Generation in India')
plt.xlabel('Year')
plt.ylabel('Generation (in TWh)')
plt.xticks(rotation=45)
plt.tight_layout()
plt.show()
```

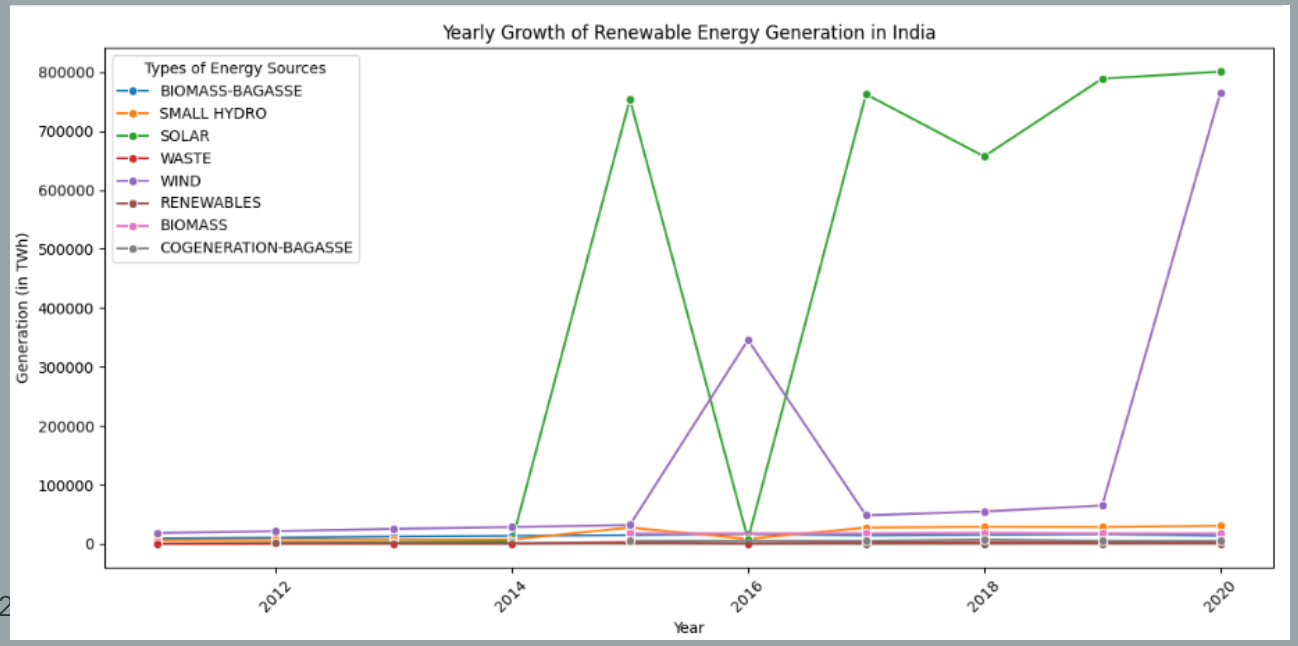
State Contribution to Renewable Energy Generation

```
df_state_contribution = df_renewable.groupby(['srcStateName', 'Types of Energy Sources']).agg(
    total_generation=('Values for renewable electricity', 'sum')
).unstack().fillna(0)

df_state_contribution.columns = df_state_contribution.columns.droplevel()
df_state_contribution.plot(kind='bar', stacked=True, figsize=(14, 8), colormap='tab20')
plt.title('State-wise Contribution to Renewable Energy Generation (Solar, Wind, Hydropower)')
plt.xlabel('State')
plt.ylabel('Generation (in TWh)')
plt.xticks(rotation=45)
plt.tight_layout()
plt.show()
```

Output's:


State-wise Contribution to Renewable Energy Generation (Solar, Wind, Hydropower)
Types of Energy Sources
BIOMASS
BIOMASS-BAGASSE
COGENERATION-BAGASSE
RENEWABLES
SMALL HYDRO
SOLAR
WASTE
WIND
Generation (in TWh)
800000
600000
400000
200000
A & N ISLANDS
ANDHRA PRADESH
BIHAR
CHANDIGARH
CHHATTISGARH
DIU & DAMAN
GUJARAT
HARYANA
HIMACHAL PRADESH
JAMMU & KASHMIR
JHARKHAND
KARNATAKA
KERALA
LADAKH
LAKSHADWEEP
MADHYA PRADESH
MAHARASHTRA
MANIPUR
MEGHALAYA
MIZORAM
MULTIPLE STATES
NAGALAND
ODISHA
OTHERS
PUDUCHERRY
PUNJAB
RAJASTHAN
SIKKIM
TAMILNADU
TELANGANA
TRIPURA
UTTAR PRADESH
UTTARAKHAND
WEST BENGAL


Yearly Growth of Renewable Energy Generation in India
Types of Energy Sources
BIOMASS-BAGASSE
SMALL HYDRO
SOLAR
WASTE
WIND
RENEWABLES
BIOMASS
COGENERATION-BAGASSE
Generation (in TWh)
800000
700000
600000
500000
400000
300000
200000
100000
0
2012
2014
2016
2018
2020
Year

State-wise Renewable Energy Generation

- A **Bar Chart** illustrates renewable energy generation by state.
- States like **Tamil Nadu**, **Gujarat**, and **Rajasthan** are major contributors to renewable energy in India.
- The chart visualizes the total renewable electricity generation across states in terms of **TWh** and by type (Solar, Wind, Hydropower).

Yearly Trends in Renewable Energy Generation

- **Line Chart** shows the **yearly growth** or **fall** in renewable energy usage in India.
- Significant increase in renewable energy generation over the years, particularly in **Solar** energy.
- The data highlights the rising adoption and investments in renewable energy sources.

State Contribution to Renewable Energy Generation

- The **stacked bar chart** reveals the **contribution of each state** to renewable energy generation, broken down by energy type (solar, wind, hydropower).
- **Tamil Nadu**, **Gujarat**, and **Rajasthan** contribute significantly to solar and wind energy generation.
- States with lower contributions need to focus on strengthening renewable energy infrastructure and policies.

Insights and Key Takeaways

- **Solar Energy** is the fastest-growing renewable energy sector, driven by **policy support** and **technological advancements**.
- **Wind Energy** is growing but at a slower pace compared to solar, with high potential in coastal regions like Tamil Nadu and Gujarat.
- **Top States**: Tamil Nadu, Gujarat, and Rajasthan are leading the way in renewable energy adoption.
- **Growth Potential**: States like **Maharashtra** and **Uttar Pradesh** can further boost their renewable energy contributions with focused investments and supportive policies.

Conclusion

- Renewable energy usage in India is rising steadily, with solar energy being the key driver.
- **Solar** and **Wind** energies are expected to play a crucial role in India's energy transition towards a more sustainable future.
- **State-Level Focus**: States with strong renewable energy infrastructure are seeing higher energy generation, while others have room for improvement.
- India is on the path to achieving its renewable energy targets with further growth in solar and wind power.