OPEN ACCESS
Quick Response Code:
Website: https://wgges.us

Manuscript ID:
IJWGAFES-2025-020202

DOI: 10.5281/zenodo.15023761

DOI Link:
https://doi.org/10.5281/zenodo.15023761

Volume: 2
Issue: 2
Month: February
Year: 2025
E-ISSN: 3066-1552

Submitted: *14 Dec 2024*
Revised: *22 Jan 2024*
Accepted: *22 Feb 2024*
Published: *28 Feb 2025*

Associate Professor, Department of Geography, New Arts, Commerce and Science College, Parner, Dist – Ahilyanagar, Pin- 414 302 (Former Ahmednagar)
Email: dsghungarde@gmail.com

Address for correspondence:
Dr. Dattatray Sheshrao Ghungarde, Associate Professor, Department of Geography, New Arts, Commerce and Science College, Parner, Dist – Ahilyanagar, Pin- 414 302 (Former Ahmednagar)
Email: dsghungarde@gmail.com

How to cite this article:
Ghungarde, D. S. (2025). Renewable Energy Growth and Trends in Maharashtra: An Analysis of Installed Capacity and Energy Generation (2017-2024). International Journal of World Geology, Geography, Agriculture, Forestry and Environment Sciences, 2(2), 5–12. https://doi.org/10.5281/zenodo.15023761

Renewable Energy Growth and Trends in Maharashtra: An Analysis of Installed Capacity and Energy Generation (2017-2024)

Dr. Dattatray Sheshrao Ghungarde

Abstract

The transition to renewable energy is essential for achieving sustainable development, mitigating climate change, and reducing dependency on non-renewable energy sources. This study examines Maharashtra's renewable energy (RE) landscape over the period 2017-18 to 2023-24, with a focus on the installed capacities, energy generation contributions, and the comparative growth of RE and non-RE sectors. Utilizing a secondary data analysis approach, data from authoritative sources such as the Ministry of New and Renewable Energy (MNRE) and Renewable Energy Statistics were analyzed to understand trends and transformations in the state's energy ecosystem.

The findings reveal significant growth in Maharashtra's renewable energy capacity, with solar and wind power dominating the state's energy portfolio. Solar power exhibited exponential growth, surpassing wind power in cumulative installations by 2023-24. While the share of renewable energy in Maharashtra's total energy capacity increased substantially from 27.86% in 2017-18 to 37.99% in 2023-24, non-renewable energy capacity experienced a slight decline. The study highlights the need for diversifying the state's renewable energy portfolio by tapping into underutilized sources such as bio-power and small hydro. By providing insights into Maharashtra's energy transition, this paper contributes to understanding the challenges and opportunities in achieving a balanced and sustainable energy mix.

Key Words: Renewable Energy, Solar Power, Wind Power, Energy Transition, Maharashtra, Energy Sector

Introduction:

The global energy transition towards renewable sources represents a critical response to environmental challenges and the need for sustainable growth. India, as a frontrunner in this transition, ranks fourth globally in bioenergy installed capacity and has demonstrated significant advancements in renewable energy across its states (Chowdhury et al., 2020). Within this national framework, Maharashtra has emerged as a pivotal contributor, leveraging its geographical advantages and policy initiatives to expand its renewable energy portfolio. This study examines Maharashtra's renewable energy journey, highlighting the state's shift from non-renewable to renewable energy over the past decade and its increasing reliance on solar, wind, bioenergy, and small hydro power.

Building on previous studies, such as the challenges and opportunities in optimizing wind energy infrastructure (Smith et al., 2023), this paper contextualizes Maharashtra's progress within broader national and global trends. This research paper aims to analyze Maharashtra's renewable energy landscape over a six-year period, from 2017-18 to 2023-24, by examining installed capacities, the contributions of various renewable energy sources, and the shifting energy mix within the state. A secondary data analysis approach has been employed, relying on data from authoritative sources such as the Ministry of New and Renewable Energy (MNRE) and Renewable Energy Statistics reports. Comparative analysis and graphical interpretations are used to assess the relative growth of renewable and non-renewable energy sectors, with a particular focus on solar and wind power contributions. By critically analyzing these data, the paper provides insights into the trends, challenges, and opportunities that define Maharashtra's journey toward energy sustainability.

Objectives:

The present study is based on following objectives;

1. To analyze the growth trends and state-wise distribution of renewable energy potential and installed capacity in Maharashtra from 2017-18 to 2023-24.
2. To evaluate the contribution of solar, wind, bio-power, and small hydro power to Maharashtra's renewable energy portfolio and overall energy generation.
3. To assess the shift in Maharashtra's energy mix, highlighting the decline in non-renewable energy capacity and the rise of renewable energy sources in achieving sustainability goals.

Material & Methods:

This study employs a secondary data analysis approach, utilizing data sourced from reliable and authoritative entities such as the Ministry of New and Renewable Energy (MNRE), the Central Electricity Authority (CEA), and Renewable Energy Statistics reports from 2017-18 to 2023-24. The data encompasses state-wise renewable energy potential, installed capacities, and energy generation figures, with a primary focus on Maharashtra's renewable energy landscape in comparison to national trends. The use of secondary data provides a structured and comprehensive understanding of the developments and transformations in the state's energy ecosystem over the specified period.

The present research further involves a comparative analysis to interpret trends in renewable and non-renewable energy sectors, emphasizing the growth trajectory and shifts in energy contributions. Data tables, figures, and graphical representations derived from secondary sources are critically analyzed to identify key patterns, highlight achievements in renewable energy capacity, and understand the dominance of solar and wind power in Maharashtra's renewable energy portfolio. This approach ensures a systematic examination of the available data to derive meaningful insights into the evolving energy mix and its implications for the state's sustainability goals.

Results & Discussion:

1 State wise Renewable Energy Estimated Potential:

In 2021, the Administrative Staff College of India estimated the country's bio-energy power potential to be 42.27 GW. India currently holds the fourth position globally in terms of bioenergy installed capacity. The renewable energy potential at the state level, including bioenergy, has been systematically detailed in Table 1, which provides an overview of the estimated potential for each state.

2 Status of RE and Non-RE sector in Maharashtra:

Maharashtra has made significant strides in renewable energy (RE) development, securing the fifth position nationally in installed RE capacity as of March 31, 2024, with a total of 17.53 GW, representing 9.20% of India's RE capacity. (Table 1) Over the six-year period from 2017-18 to 2023-24, the state's RE installed capacity increased by 1.52 times, while the non-renewable energy sector experienced a slight decline of 0.04 times in capacity installation during the same period. The share of RE in Maharashtra's total energy capacity grew from 27.86% to 37.99%, with solar power contributing 35.65% and wind power 29.71% of the RE installed capacity.

Table No. 1: State wise Renewable Energy Estimated Potential (in MW)

States/UTs	Wind Power	Small Hydro Power	Bioenergy		Solar Power	Larger Hydro
			Biomass Power	Biogass Cogeneration		
Andhra Pradesh	123336	409.32	1999.49	279.6	38440	2596
Arunachal Pradesh	246	2064.92	18.46	0	8650	50394
Assam	459	201.99	321.89	0	13760	643
Bihar	4023	526.98	964.37	346.6	11200	130.1
Chhattisgarh	2749	1098.2	353.68	0	18270	1311
Goa	14	4.7	32.97	0	880	0
Gujarat	180790	201.97	2637.84	554.7	35770	550
Haryana	593	107.4	1353.35	362.1	4560	0
Himachal Pradesh	239	3460.34	69.71	0	33840	18305
UT of Jammu & Kashmir (including Ladakh)	1 (Ladakh)	1707.45	82.82	0	111050	12971.5
Jharkhand	16	227.96	146.31	0	18180	300
Karnataka	169251	3726.49	1793.88	1762.1	24700	4414.4
Kerala	2621	647.15	778.41	0	6110	2472.75
Madhya Pradesh	55423	820.44	2516.42	0	61660	2819
Maharashtra	173868	786.46	2629.55	3917	64320	3144
Manipur	0	99.95	62.31	0	10630	615
Meghalaya	55	230.05	68.54	0	5860	2026

Mizoram	0	168.9	2.90	0	9090	1926.7
Nagaland	0	182.18	53.90	0	7290	325
Orissa	12129	286.22	298.72	0	25780	2824.5
Punjab	428	578.28	3022.11	414.4	2810	1300.73
Rajasthan	284250	51.67	1299.55	0	142310	411
Sikkim	0	266.64	4.73	0	4940	6051
Tamil Nadu	95107	604.46	1560.08	639.3	17670	1785.2
Telangana	54717	102.25	1678.36	117.4	20410	1302
Tripura	0	46.86	34.35	0	2080	0
Uttar Pradesh	510	460.75	2800.31	4925.7	22830	501.6
Uttarakhand	49	1664.31	93.34	215.1	16800	13481.35
West Bengal	1281	392.06	1741.74	0	6260	809.2
Andaman & Nicobar	1245	7.27	18.13	0	0	0
Chandigarh	0	0	0.15	0	0	0
Dadar & Nagar Haveli & Daman and Diu	17	0	2.16	0	0	0
Delhi	0	0	0.00	0	2050	0
Lakshadweep	31	0	1.39	0	0	0
Puducherry	408	0	5.00	0	0	0
Others	0	0	0.00	284.4	790	0
Total	**1163856**	**21133.62**	**28446.91**	**13818.4**	**748990**	**133410.03**

(Source: MNRE & CEA)

In terms of energy generation, the RE sector accounted for 14.22% of Maharashtra's total energy generation in 2023-24. Wind power led the RE generation with a contribution of 34.24%, followed by solar power at 24.20%. Maharashtra ranked sixth nationally for renewable energy generation in 2023-24, producing 24.03 billion units (BU), which constitutes 6.68% of the country's total. For energy generated from solar, wind, bio power, and small hydro power, the state held the fifth position, generating 18.77 BU and accounting for 8.31% of the national total. These developments underscore Maharashtra's commitment to expanding its renewable energy infrastructure and its significant role in India's renewable energy landscape.

Table No. 2 Installed Capacity in RE and Non-RE sector since 2017-18 (in MW)

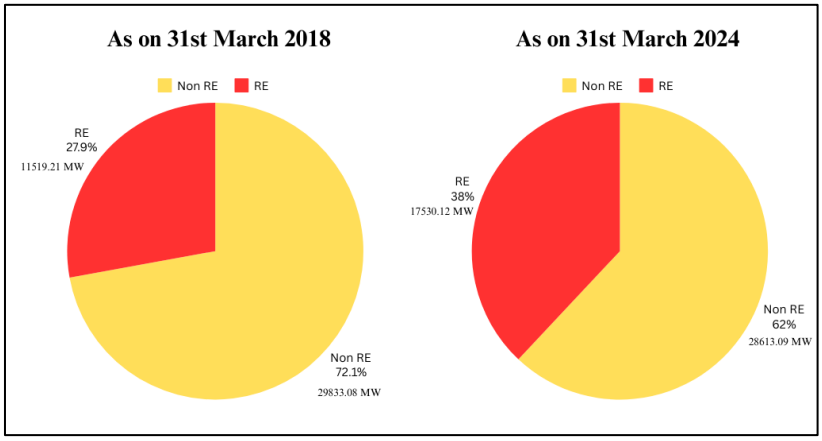
Year	RE	Non-RE	Total	Share (%)		Growth (%)	
				RE	Non-RE	RE	Non-RE
2017-18	11519.21	29833.08	41352.29	27.86	72.14		
2018-19	12421.70	30493.08	42914.77	28.95	71.05	7.83	2.21
2019-20	12822.27	29573.08	42395.35	30.24	69.76	3.22	-3.02
2020-21	13382.85	29573.08	42955.93	31.15	68.85	4.37	0.00
2021-22	13704.08	28463.08	42167.16	32.50	67.50	2.4	-3.75
2022-23	15804.50	28463.08	44267.58	35.70	64.30	15.33	0.00
2023-24	17530.12	28613.09	46143.21	37.99	62.01	10.92	0.53
Gr (2017-18 to 2023-24)	**52.18**	**-4.09**	**11.59**	NA	NA	NA	NA
CAGR (2017-18 to 2023-24)	**7.25**	**-0.69**	**1.84**	NA	NA	NA	NA

(Source: MNRE & Renewable Energy Statistics 2023-24)

Gr = Growth (%)
CAGR = Compound Annual Growth Rate

Share of RE in Maharashtra's total energy capacity has seen a steady increase. In 2017-18, RE accounted for 27.86 % of the total capacity. By 2023-24, this share had increased to 37.99%. Maximum year wise growth of 15.33% has been registered in the state during 2022-23 with an installation of 2100.42 MW.

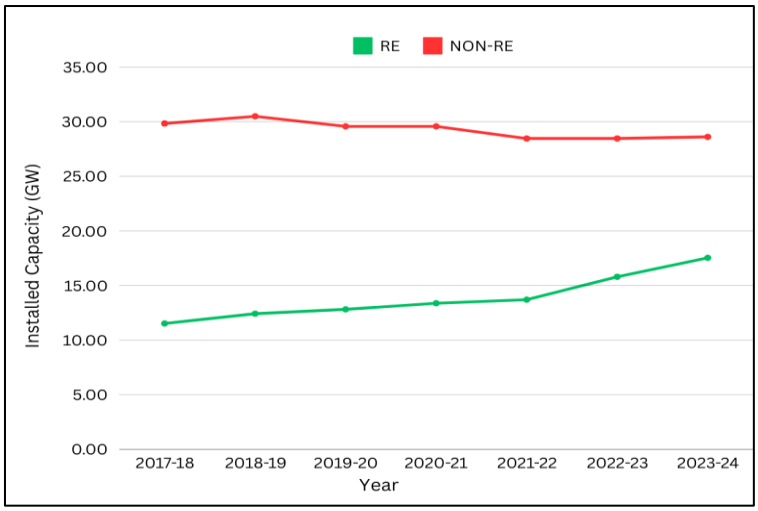
Figure No. 1: RE Installed Capacity (in MW) and its share (%)



(Source: MNRE & Renewable Energy Statistics 2023-24)

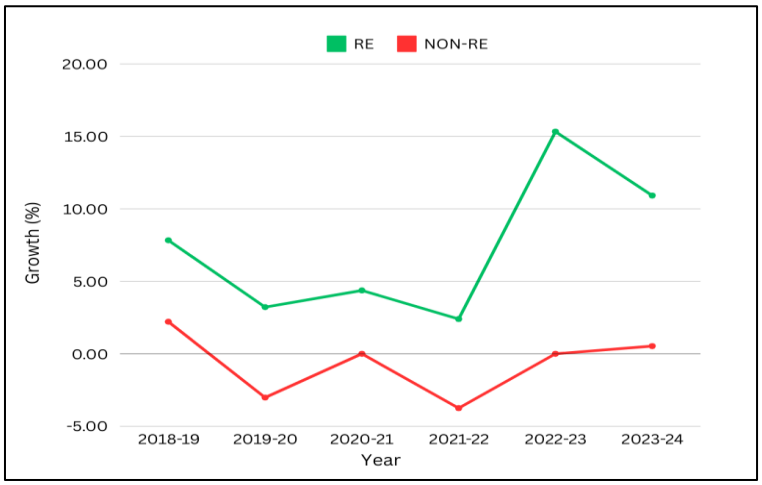
As of March 2018, Maharashtra ranked fifth in India in terms of renewable energy installed capacity, following Gujarat, Rajasthan, Karnataka, and Tamil Nadu. From 2017 to 2024, the state witnessed a significant increase in its renewable energy share, growing from 27.86% to 37.99%. Over this period, Maharashtra's renewable energy capacity expanded by 52.18%, from 11.52 GW to 17.53 GW, outperforming the national overall capacity growth rate of 11.59%. In contrast, the capacity installation in the non-renewable energy sector experienced a decline of 4.09%, highlighting a shift towards cleaner energy sources within the state.

Figure No. 2: Trend in Capacity installation



(Source: MNRE & Renewable Energy Statistics 2023-24)

Figure No. 3: Year wise growth (%) in Capacity Installation



(Source: MNRE & Renewable Energy Statistics 2023-24)

3 Installed Capacity under Wind, Solar, Small Hydro & Bio Energy (RES):

Maharashtra's renewable energy sector has experienced a significant transformation over the past decade, with solar power playing a central role in driving this change. The state's solar power capacity has achieved an impressive Compound Annual Growth Rate (CAGR) of 37.16%, making it the dominant contributor to the growth of renewable energy installations. In comparison, wind power installations have seen a more modest growth rate of 1.77%. A detailed breakdown of the installed capacity across various renewable energy sources is provided in Table 3, offering a clearer perspective on the state's evolving energy mix.

Table No. 3: Installed Capacity under Solar, wind, Bio Power and Small Hydro Power (RES) since 2014-15

Year	Small Hydro Power	Wind Power	Bio-Power	Solar Power	Total	Growth (%)
2014-15	336.93	4445.93	1883.25	363.77	7029.88	10.83
2015-16	339.88	4653.78	2020.08	390.88	7404.61	5.33
2016-17	346.18	4771.33	2118.83	460.69	7697.03	3.95
2017-18	373.18	4783.93	2223.7	1251.4	8632.21	12.15
2018-19	375.58	4794.13	2556.53	1648.46	9374.70	8.60
2019-20	379.58	5000.33	2559.74	1835.62	9775.27	4.27
2020-21	379.58	5000.33	2632.15	2323.79	10335.85	5.73
2021-22	381.08	5012.83	2632.15	2631.02	10657.08	3.11
2022-23	381.08	5012.83	2640.69	4722.9	12757.5	19.71
2023-24	382.28	5207.98	2643.19	6249.67	14483.12	13.53
Gr (2017-18 to 2023-24)	13.46	17.14	40.35	1618.03	106.02	NA
CAGR (2017-18 to 2023-24)	1.41	1.77	3.84	37.16	8.36	NA

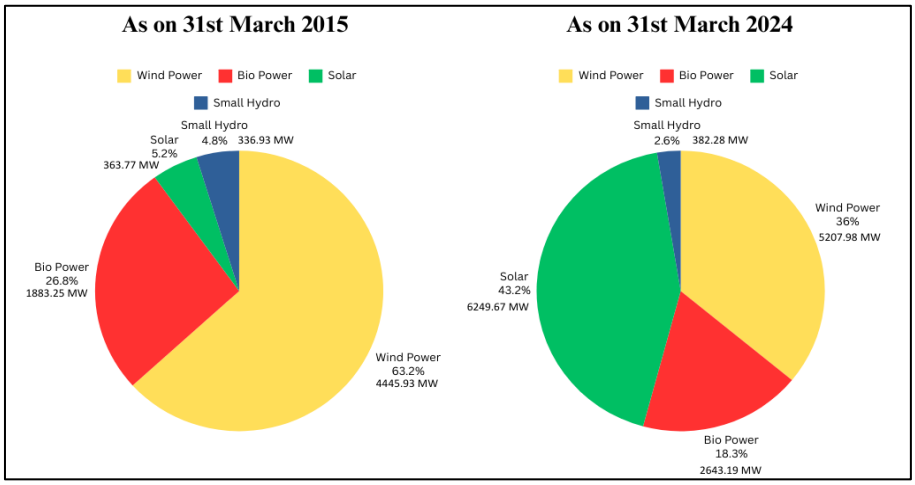
(Source: MNRE & Renewable Energy Statistics 2023-24)

Gr = Growth (%)

CAGR = Compound Annual Growth Rate

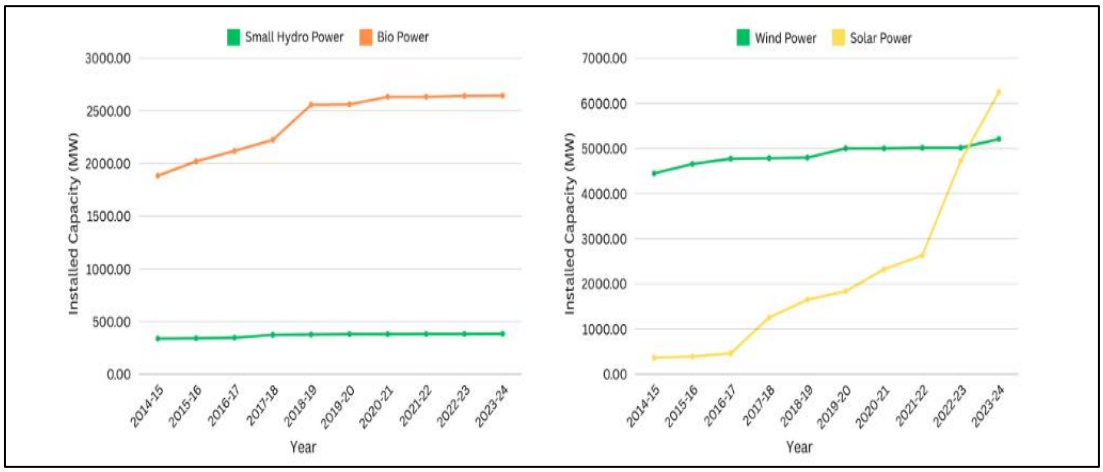
As of March 31, 2024, solar power led Maharashtra's cumulative installed capacity of renewable energy, accounting for 43.15% with a total installation of 6249.67 MW. Wind power followed closely, contributing 35.96% to the state's renewable energy capacity, with a total installation of 5207.98 MW. These figures underscore the dominant role of solar and wind power in the state's renewable energy landscape.

Figure No. 4: Share (%) in Cumulative Installed capacity



(Source: MNRE & Renewable Energy Statistics 2023-24)

Figure No. 5: Trend in cumulative Installed Capacity

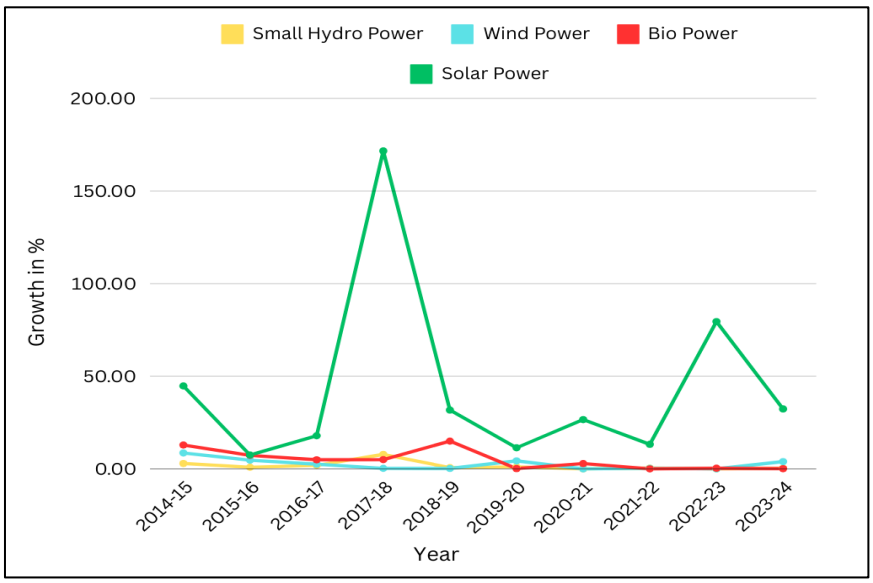


(Source: MNRE & Renewable Energy Statistics 2023-24)

As of March 31, 2024, biopower contributed 18.25% to Maharashtra's total renewable energy capacity, with an installation of 2643.19 MW, while small hydropower accounted for 2.64%, with a capacity of 382.28 MW.

In comparison, the renewable energy landscape in Maharashtra in 2015 was primarily dominated by wind power, which held a significant share of 63.24% with 4445.93 MW installed. Bio-power followed with a share of 26.79% and an installation of 1883.25 MW. Solar power contributed a modest 5.17% of the total capacity with 363.77 MW, and small hydro power had the smallest share of 4.79%, with a cumulative installation of 336.93 MW. This shift in the energy mix over the years highlights the growing prominence of solar energy in the state's renewable energy sector.

Figure No. 6: Year wise growth (%) in installed capacity



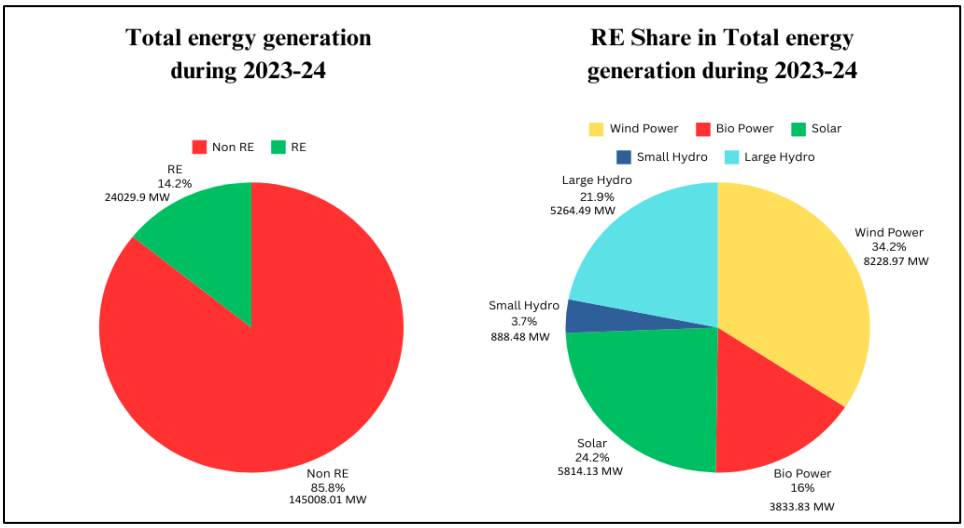
(Source: MNRE & Renewable Energy Statistics 2023-24)

Solar power in Maharashtra has increased significantly, rising from 363.77 MW in 2014-15 to 6249.67 MW by 2023-24. In 2022-23, solar power installation surpassed wind power, adding 2091.88 MW. Wind power, on the other hand, grew from 4445.93 MW to 5207.98 MW during the same period.

4 Energy Generation during 2023-24:

In 2023-24, Maharashtra's total energy generation reached 169.04 BU, with 14.22% derived from renewable energy sources. Among the renewable energy generation, wind power contributed the most, followed by solar power.

Figure No. 7: RE share in total energy generation during 2023-24 (in MU)



(Source: MNRE & Renewable Energy Statistics 2023-24)

Maharashtra ranked 6th in the nation for renewable energy generation, with a total contribution of 24.03 billion units (BU), accounting for 6.68% of the national total. In terms of generation from solar, wind, bio power, and small hydro power, Maharashtra secured the 5th position, producing 18.77 BU, which made up 8.31% of the overall national generation. Figure 7 presents a detailed breakdown of the share of renewable and non-renewable energy in the state's total energy generation.

Conclusion:

The analysis highlights Maharashtra's remarkable progress in the renewable energy (RE) sector, underscored by a significant increase in installed capacity and its growing share in the state's overall energy ecosystem. Between 2017-18 and 2023-24, the state's RE installed capacity grew by an impressive 52.18%, rising from 11.52 GW to 17.53 GW, with solar power leading the charge at a compound annual growth rate (CAGR) of 37.16%. Solar and wind power together constituted over 79% of the state's cumulative RE capacity by 2023-24, showcasing their pivotal role in driving Maharashtra's transition towards sustainable energy. The sector's growth is further validated by its increased contribution to Maharashtra's total energy generation, with renewable sources accounting for 14.22% of total generation in 2023-24. Solar power, which witnessed a dramatic leap from 363.77 MW in 2014-15 to 6,249.67 MW in 2023-24, now surpasses wind power in cumulative installations, marking a paradigm shift in the state's energy landscape.

Despite this remarkable progress, challenges persist in scaling other RE sources, such as bio-power and small hydro, which together represent less than 21% of the state's RE capacity. Maharashtra's focus on solar and wind energy aligns with national trends, but the comparatively lower growth rates in bio-power and small hydro installations point to untapped potential in diversifying the state's RE portfolio. The decline in non-renewable energy capacity further underscores the growing significance of renewable energy in meeting the state's energy demands sustainably. Moving forward, Maharashtra's renewable energy trajectory will hinge on continued investment, policy innovation, and leveraging emerging technologies to maintain its leadership position in India's clean energy transition while achieving a balanced energy mix that supports long-term sustainability goals.

Acknowledgement:

I am Dr. Dattatray Sheshrao Ghungarde thankful to Dr. L.S, Matkar Principal and Dr. R. E Najan HOD, post graduate Department of Geography, New Arts, Commerce and Science College Parner for granting permission to carry out the work.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References:

Journal/periodical articles:

1. **Chowdhury, S., Das, R., & Verma, K. (2020):** A Holistic Review of the Present and Future Drivers of the Maharashtra State Energy Landscape in India*. MDPI Sustainability, Vol. 12, Issue 16, p. 6596. DOI: [10.3390/su12166596] (https://www.mdpi.com/2071-1050/12/16/6596)

2. **Johnson, L., Rao, M., & Singh, P. (2018):** Greening the Grid: Impact of Renewable Energy Growth on Maharashtra's Power Sector*. National Renewable Energy Laboratory (NREL). NREL Technical Report No. 70951. Available at: [nrel.gov] (https://www.nrel.gov/docs/fy18osti/70951.pdf)
3. **Kumar, A., Iyer, S., & Mehta, D. (2013):** Renewable Energy for Rural Communities in Maharashtra, India*. International Journal of Renewable Energy Studies, Vol. 2, Issue 1, pp. 45-59. Available at: [researchgate.net] (https://www.researchgate.net/publication/257126613_Renewable_energy_for_rural_communities_in_Maharashtra_India)
4. **Reddy, V., Sharma, T., & Nair, P. (2023):** Green Commitment: Maharashtra Pushes the Pedal on Growing Its Renewables Capacity. Renewable Watch Journal, September Issue. Available at: [renewablewatch.in] (https://renewablewatch.in/2023/09/30/green-commitment-maharashtra-pushes-the-pedal-on-growing-its-renewables-capacity/)
5. **Shah, R., Banerjee, A., & Roy, S. (2023):** Renewable Energy Sector in India: Current Trends and Challenges*. Energy Policy and Management, Vol. 10, Issue 4, pp. 231-245. Available at: [researchgate.net] (https://www.researchgate.net/publication/384687234_Renewable_Energy_Sector_in_India)
6. **Smith, J., Patel, R., & Gupta, A. (2023):** Redirecting Wind Energy in India: Challenges and Opportunities. Ember Energy Insights. Available at: [ember-energy.org] (https://ember-energy.org/latest-insights/redirecting-wind-in-india/)

Online Documents:

7. **Administrative Staff College of India (ASCI)**. (2021). Bio-Energy Power Potential Assessment in India. Hyderabad: ASCI Publications.
8. **Central Electricity Authority (CEA)**. (2024). Annual Report 2023-24. Government of India, Ministry of Power.
9. **Ministry of New and Renewable Energy (MNRE) & Central Electricity Authority (CEA).** (2024). State-wise Renewable Energy Estimated Potential Report. Retrieved from MNRE official website.
10. **Ministry of New and Renewable Energy (MNRE)**. (2023-24). Renewable Energy Statistics 2023-24. Retrieved from MNRE official website.
11. **Renewable Energy Statistics India.** (2024). State-wise Growth and Trends in Renewable Energy Installation 2017-2024. Published by MNRE.