



सत्यमेव जयते

RENEWABLE ENERGY STATISTICS 2023-24



Government of India
MINISTRY OF NEW AND RENEWABLE ENERGY
www.mnre.gov.in

प्रल्हाद जोशी
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उपभोक्ता मामले, खाद्य और सार्वजनिक वितरण तथा
नवीन और नवीकरणीय ऊर्जा मंत्री
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FOOD & PUBLIC DISTRIBUTION AND
MINISTER OF NEW & RENEWABLE ENERGY
GOVERNMENT OF INDIA



MESSAGE

Under the visionary leadership of Hon'ble Prime Minister Shri Narendra Modi, India has emerged as one of the fastest-growing nations in Renewable Energy sector. The country currently ranks 4th globally in terms of total renewable energy installed capacity. India is steadily advancing towards its goal of 500 GW of non-fossil fuel-based installed capacity by 2030.

Government of India has spearheaded transformative reforms in the Solar, Wind, Bio Power, and Small Hydro Power sectors to meet the target by 2030. Initiatives such as PM KUSUM, National Green Hydrogen Mission, and PM-Surya Ghar: Muft Bijili Yojana exemplify India's commitment and ambition as it strives towards a Net -Zero India by 2070. National Green Hydrogen Mission, in particular, focuses on producing Green Hydrogen, which has the potential to replace imported fossil fuels across various industries, including fertilizer production, petroleum refining, mobility, steel production, and shipping propulsion.

Renewable Energy Statistics 2023-24, first of its kind is a comprehensive document containing the latest and reliable statistics capturing the transformative journey of energy sector from Non-Renewable Energy sources to Renewable Energy sources in terms of installed capacity and energy generation at national, State and international level. This document is expected to be a key resource for a wide range of stakeholders including policymakers, researchers and academicians.

(Pralhad Joshi)



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भारत सरकार



सत्यमेव जयते

SHRIPAD NAIK

Minister of State for

New and Renewable Energy & Power

Government of India



MESSAGE

Energy has been essential to human progress and will remain a key pillar of India's economic growth. As the country continues to develop and prosper, its energy needs will inevitably increase. In addition to addressing climate change, government's priority is to ensure the availability of sustainable and clean energy sources. Renewable Energy sector is a crucial driver in India's shift to clean energy sources. With a vast renewable energy potential of 2,109 GW from solar, wind, hydro, and biomass sources, India is dedicated to making a substantial move towards cleaner alternatives.

Major reforms in the renewable energy sectors of solar, wind, small hydro, biopower, and green hydrogen have significantly boosted investments and are poised to transform India's energy landscape. Recently introduced PM-Surya Ghar: Muft Bijli Yojana aims to expand solar rooftop capacity and enable residential households to generate their own electricity based on clean energy. India now ranks 4th globally in energy generation from solar power.

The publication titled "Renewable Energy Statistics 2023-24 " offers a comprehensive and integrated database on renewable energy installed capacity and energy generation. Statistics are essential for tracking trends and supporting evidence-based policy decisions. Thus, this consolidated data on renewable energy sources is a vital tool for presenting a thorough overview of the evolving renewable energy landscape both nationally and globally. I am confident that this publication will be an invaluable resource for a diverse group of stakeholders.

(Shripad Naik)

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FOREWORD

Renewable energy emerges as a vital solution, offering a cleaner, more sustainable alternative to traditional fossil fuels. As the nodal Ministry, Ministry of New and Renewable Energy (MNRE) plays a pivotal role in developing and deploying new and renewable energy sources to supplement the energy requirements of the country. It is putting in place targets and supportive measures across various Renewable Energy technologies to strengthen the foundation and ecosystem that enables India to meet the ambitious target of 500 GW capacity by 2030. Implementation of the National Green Hydrogen Mission is also one of the critical focus areas for the Ministry.

Ministry's policy initiatives have yielded tangible results, manifesting in a significant expansion of installed capacity of renewable energy sources and a substantial rise in clean energy production. As on 31st March 2024, India's renewable energy power installed capacity was 190.57 GW, constituting about 43% of its total installed capacity, with non-fossil fuel sources contributing around 45%. During last 9 years, growth of RE installed capacity, excluding large hydro power, has grown impressively at 260%. As per Renewable Energy Statistics published by International Renewable Energy Agency (IRENA), India ranks 4th globally in overall renewable energy installed capacity.

The publication titled 'Renewable Energy Statistics 2023-24' is a comprehensive and integrated database on renewable energy offering a definitive guide to India's renewable energy landscape featuring in-depth analysis of installed capacity, generation trends, state-level performance and global renewable energy transition.

I would like to express my deep appreciation to the dedicated officers of Statistics Division for this outstanding work in bringing out this publication for the first time. I am confident that this publication will become an invaluable reference for policy makers, planners, academicians, industry professionals and researchers.

(Bhupinder S. Bhalla)

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MINISTRY OF NEW AND RENEWABLE ENERGY



MESSAGE

A decade ago, Renewable Energy was considered a supplement to conventional sources; however, it now forms an important part of the energy mix, which is a vital component of a sustainable future, offering numerous benefits and vast potential. India's effective policy implementation has translated into noticeable gains, marked by increased renewable energy capacity installations and enhanced green energy generation.

The share of solar power and wind power in India's energy mix has grown phenomenally. As on March 2024, India achieved significant milestones in deploying Renewable Energy, accounting a share of 43.12% of overall installed Capacity in the country. During 2023-24, Renewable Energy capacity installations peaked at 18.56 GW, compared to 7.35 GW of non-renewable energy sectors.

The year 2023 marked a watershed year for the global Renewable Energy sector, with unprecedented achievements of installation of 473.17 GW of renewable energy capacity, compared to 98.83 GW from non-renewable energy sources. Solar power installed capacity surpassed that of hydro power during 2023. India secured 4th rank globally and consistently holding that position for the last 5 years in the overall Renewable Energy installed capacity. This underscores our nation's decisive shift towards cleaner energy solutions.

This statistical publication 'Renewable Energy Statistics-2023-24', presents a comprehensive overview of the renewable energy sector providing its transformative journey at national, state and international level. I extend my appreciation to the dedicated team of Statistics division under the leadership of Smt. Mini Prasannakumar, Deputy Director General. I am confident that it will prove to be an invaluable resource for various stakeholders, policymakers, and professionals in the Renewable Energy sector.

(Sudeep Jain)

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Deputy Director General
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PREFACE

India has led the way in renewable energy growth among major economies, achieving a remarkable increase in installed capacity from 81.22 GW of March 2015 to 190.57 GW by March 2024. Over this period, share of non-fossil fuels based installed capacity has risen significantly, from 31.53% to 44.97%. Furthermore, renewable energy sources like solar, wind, bio-power, and small hydro power have contributed substantially to the energy generation, growing from 5.58% of 2014-15 to 13.02% during 2023-24.

Reliable and precise data is essential for making evidence-based policy decisions and accurately evaluating our progress towards reaching 500 GW of non-fossil fuel energy capacity by 2030 and achieving net-zero emissions by 2070. I am delighted to present the first-ever 'Renewable Energy Statistics 2023-24' from Ministry of New and Renewable Energy, showcasing the transformative journey of the Renewable Energy sector over the past decade at national, state and international levels.

I extend my sincere gratitude to the International Renewable Energy Agency (IRENA) for their invaluable publication, Renewable Energy Statistics - 2024, which served as the primary source for our analysis of the global renewable energy landscape. Additionally, I acknowledge Central Electricity Authority, Ministry of Power for their regular updating of data on installed capacity and energy generation on their website. Various divisions of this Ministry have also played a significant role in shaping this document. Special recognition goes to Ms. Veena Singh, Assistant Director, and Ms. Komal, Stenographer (Grade D) of Statistics Division for their outstanding contributions in preparing this publication. Their efforts are deeply appreciated.

We encourage and appreciate any input or insights that can refine and strengthen future editions of this publication.

(Mini Prasannakumar)

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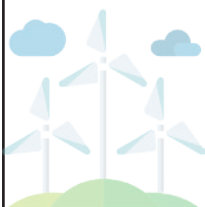
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SCOPE & COVERAGE

Scope: “Renewable Energy Statistics 2023-24” presents comprehensive statistics on various aspects of Renewable Energy sector. This publication offers insights into the installed capacity status of Renewable Energy sector as well as energy generation through Renewable Energy sources, providing an overview of the sector at the national, state, and international level.

Coverage: For national/ state level, analysis is based on utilities whereas non utilities are also being taken into account by International Renewable Energy Agency (IRENA) in their statistics. Pumped Storage has been excluded by IRENA from Hydro Power to treat it as Renewable, i.e. Renewable Hydro.

Source: Data on installed capacity of Non-RE sector and Large Hydro is from the website of National Power Portal of Central Electricity Authority (CEA) and data on Energy generation is from the website of CEA, Ministry of Power. Installed capacity on Solar Power, Wind Power, Bio Power and Small Hydro Power is from Ministry of New and Renewable Energy. International data on installed capacity and energy generation is from the publication ‘Renewable Energy Statistics 2024’ of International Renewable Energy Agency (IRENA). Share of RE (at two-digit level) is used for estimating installed capacity under Non-RE sector at international level. Specific sources for all secondary data are indicated at the bottom of the tables.

Reference Period: National level data on installed capacity and energy generation is presented on a financial year basis (April-March), whereas the international level data is presented on a calendar year basis (January-December).

INTRODUCTION

Energy is the heartbeat of our planet, intricately linked to the climate challenge we face today. The rapid growth of the global population and advances in civilization have resulted in an exponential growth in energy demand. Despite the well-known environmental and health risks posed by fossil fuels, our dependence on them persists.

To address the growing energy demand and mitigate climate change risks, transitioning from fossil fuels to renewable energy is crucial. To accomplish this objective, India's power sector is also undergoing a transformative journey, brimming with enthusiasm for tapping into Renewable Energy from diverse renewable sources.

As per the mandate, Ministry of New & Renewable Energy has taken several initiatives to promote diversified deployment and production of RE technologies which aims to accelerate India's energy transition to renewable sources, reduce dependence on fossil fuels. Some of the important schemes with this objective are Pradhan Mantri Kisan Urja Suraksha Evam Utthaan Mahabhiyan (PM-KUSUM) for decentralised solar aiming to energise the agricultural pumps through Solar power, Roof Top Solar (RTS) Programme, Central Public Sector Undertaking (CPSU) Scheme for Grid-Connected Solar Photovoltaic (PV) Power Projects, Development of Solar Parks and Ultra Mega Solar Power Projects, Performance Linked Initiatives (PLI) Scheme for 'National Programme on High-Efficiency Solar PV Modules', Green Energy Corridor Scheme for construction of intra-state and inter-state transmission lines for power evacuation and grid interaction etc. for development of Solar Power sector. Ministry has also taken various key policy initiatives and schemes to tap the potential of other renewable Energy sources like Wind power, Bio Power and Small Hydro Power.

During 2023-24, Ministry put in place revised targets, and supportive measures across various RE technologies to strengthen the foundation and ecosystem that enables India to meet the ambitious target of 500 GW capacity by 2030. The spotlight was focused firmly on strengthening the groundwork for the implementation of the National Green Hydrogen Mission. Examples of other important announcements included the launch of a bidding trajectory to infuse 50 GW of renewable energy capacity annually till FY 2027-28, viability gap funding for battery storage projects. Focused steps were also taken to ensure progress on offshore wind and PM-KUSUM.

Ministry's effective policy implementation has translated into noticeable gains, marked by increased renewable energy capacity installations and enhanced green energy generation. This publication outlines transformative journey of renewable energy sector at the national, state and international levels.

HIGHLIGHTS

ALL INDIA STATUS

Installed Capacity:

- » As on 31st March 2024, India's total installed power capacity reached 441.97 GW, an increase from 275.90 GW of 2014-15, reflecting a growth of 60.19% over the past nine years. Total installed capacity under Renewable Energy sector, including large Hydro was increased from 81.22 GW of 2014-15 to 190.57 GW by 2023-24 with a growth of 134.63% during the period.
- » Installed capacity under Solar, Wind, Bio Power and Small Hydro Power was 143.64 GW as on 31st March 2024 which was enhanced from 39.95 GW of 2014-15, having a remarkable growth of 259.55%.
- » India witnessed an amazing capacity installation of 18.56 GW in RE sector during 2023-24, significantly higher than that of 7.35 GW in non-RE sector. Annual growth rate for Renewable Energy installations has consistently surpassed 6% whereas growth rate of non-renewable energy has not been more than 3.01% from 2017-18. By the end of 2023-24, Renewable Energy and non-fossil fuel sectors accounted for 43.12% and 44.97% of the total installed capacity, respectively.
- » According to the Renewable Energy Statistics 2024 published by International Renewable Energy Agency (IRENA), India ranks 4th position globally in overall renewable energy installed capacity. Specifically, India holds 4th position in both wind power and Bio power installations and 5th position in both Solar power and Hydro Power installations.

Energy Generation:

- » Renewable energy sources contributed 359.89 BU, representing 20.75% of the total energy generation during 2023-24. Since 2014-15, energy generation from Solar Power, Wind Power, Bio-Power, and Small Hydro Power has surged by 265.89%, highlighting significant progress in India's renewable energy sector.
- » According to the Renewable Energy Statistics 2024 published by the International Renewable Energy Agency (IRENA), India ranks 5th globally in overall renewable energy generation. Specifically, India holds 4th position in Solar power energy generation.

STATE WISE STATUS

RE installed capacity:

- » As on 31st March 2024, Gujarat, Rajasthan, Tamil Nadu, Karnataka, and Maharashtra were the top five states in terms of total renewable energy installed capacity by collectively contributing approximately 61% of the country's total installed renewable energy capacity.
- » In the solar energy sector, Rajasthan, Gujarat, Karnataka, Tamil Nadu, and Maharashtra were the top five states contributing 70.76% of the country's solar power installation.
- » Gujarat, Tamil Nadu, Karnataka, Maharashtra, Rajasthan, and Andhra Pradesh were the leading states in the case of wind power installed capacity, collectively contributing 93.37% of the country's wind power capacity installation.
- » Bioenergy sector had also experienced substantial growth, with Maharashtra, Uttar Pradesh, Karnataka and Tamil Nadu together contributed about 71.49% of the country's total bioenergy sector.
- » Himachal Pradesh, Uttarakhand, Karnataka, Jammu and Kashmir, Maharashtra and Telangana were the top 6 states/UT and collectively contributed 57.15% of the total large hydro installed capacity in the country.

RE Generation during 2023-24:

- » Rajasthan, Gujarat, Karnataka, Himachal Pradesh, and Tamil Nadu emerged as the top five states in renewable energy generation, collectively contributing around 56% of the nation's total renewable energy production.
- » In the solar energy sector, Rajasthan, Karnataka, Gujarat, Tamil Nadu, and Andhra Pradesh lead together accounted for over 75% of the country's solar power energy generation.
- » Gujarat, Tamil Nadu, Karnataka, Andhra Pradesh, Rajasthan, and Maharashtra were the leading states in the case of Wind power generation, contributing approximately 93% of the country's wind energy production.
- » Maharashtra, Uttar Pradesh, Karnataka, West Bengal, and Chhattisgarh together contributed about 74% of the total renewable energy generated from bioenergy sources in the country.
- » In the case of Large Hydro, Himachal Pradesh, Jammu and Kashmir, Uttarakhand, Karnataka and Sikkim contributed 62.47% of the energy generation in the country.

Top 5 states in India in Renewable Energy Installed Capacity

I. GUJARAT

- » As on March 31, 2024, Gujarat was the largest contributor of Renewable Energy installed capacity in the country with cumulative installation of 27.46 GW having a share of 14.41%. Over the past six years, the installed capacity for renewable energy has increased nearly 2.94 times by 2023-24 compared to 1.09 times increase in the case of non-renewable energy sectors since 2017-18. A milestone was achieved by the state during 2023-24 as Renewable Energy installed capacity surpassed Non-Renewable Energy capacity for the first time.
- » Share of renewable energy in installed capacity has risen from 28.45% of 2017-18 to 51.87% by 2023-24 in Gujarat. Out of the Renewable Energy installed capacity, Solar power installed capacity leads in Gujarat, contributing 49.32%, while wind power installed capacity accounts for 42.69%.
- » During 2023-24, Gujarat was the second-largest contributor to renewable energy generation in the country, with a total generation of 43.04 billion units (BU) with 11.96% share. For energy generated from solar, wind, bio power, and small hydro power, Gujarat also ranked second, producing 38.48 BU and contributing 17.04% of the total.
- » Out of the total energy generation in the state during 2023-24, renewable energy sources contributed 31.79%. Out of the total RE generation, wind power is the largest contributor providing 57.61% followed by solar power with 31.29% contribution.

II. RAJASTHAN

- » Rajasthan was the second-largest contributor to renewable energy installed capacity in the country as on 31st March 2024 with an installation of 27.10 GW having a share of 14.22%. Over the past six years, the installed capacity for renewable energy has increased 3.72 times, compared to 1.22 times increase in the installed capacity of non-renewable energy sector. During 2021-22, Renewable Energy installed capacity in the state crossed non-RE installed capacity.
- » Share of Renewable Energy installed capacity within the state has been enhanced from 40.51% of 2017-18 to 67.61% by 2023-24. Within the renewable energy sector, solar power dominated in Rajasthan with a substantial 78.76% share, followed by wind power with a share of 19.17%.
- » Rajasthan was the largest contributor to renewable energy generation in the country during 2023-24, with a total generation of 48.16 billion units (BU) having 13.38% share. For energy generated from solar, wind, bio power, and small hydro power, Rajasthan maintained its top position, producing energy of 47.15 billion unit accounted for 20.88% of the total.
- » During 2023-24, share of renewable energy generation in the overall energy generation in Rajasthan was 41.22%. Out of the total energy generation from renewable sources, solar power contributed 79.65%, while wind power accounted for 17.42%.

III. TAMIL NADU

- » As on 31st March 2024, Tamil Nadu ranked 3rd in the country by contributing 22.16 GW of renewable energy installed capacity having a share of 11.63%. Over the past six years, the state's renewable energy installed capacity has increased by 1.65 times, compared to 1.06 times increase in the non-renewable energy sector.
- » Contribution of installed capacity of RE sector within the state has grown to 55.49% from that of 44.70% of 2017-18. Within the renewable energy sector, wind power was the leading contributor in Tamil Nadu, accounting for 47.85%, followed by solar power contributing 37.05%.
- » During 2023-24, Tamil Nadu ranked 5th in the country for renewable energy generation, contributing 33.17 billion units (BU) and accounting for 9.22% of the total RE generation in the country. Specifically, for energy generated from solar, wind, bio power, and small hydro power, Tamil Nadu secured 4th place, generating 29.60 BU and making up 13.11% of the total.
- » During 2023-24, Tamil Nadu's share of renewable energy generation was 26.90% in the state. Majority of this RE generation was from wind power, contributing 50.98%, while solar power accounted for 35.39%.

IV. KARNATAKA

- » Karnataka held the fourth position in the country for renewable energy installed capacity as on 31st March 2024 with an installation of 21.44 GW having a share of 11.25%. Over the past six years, the installed capacity for renewable energy has increased by 1.32 times by 2023-24, compared to a 0.01 times contraction in the non-renewable energy sector.
- » Renewable Energy installed capacity contribution of 60.71% has grown to 67.37% during last 6 years in Karnataka. Within the renewable energy sector, solar power leads in Karnataka, contributing 39.85%, followed by wind power with 28.07% share.
- » Karnataka ranked 3rd in the country for renewable energy generation during 2023-24, with a total contribution of 39.50 billion units (BU) and a share of 10.98%. For energy generated from solar, wind, bio power, and small hydro power, Karnataka also held the 3rd position, generating 30.53 BU accounted for 13.52% of the total.
- » During 2023-24, renewable energy sector contributed 43.18% to the state's total energy generation. Out of this total renewable energy generation, solar power accounted for 39%, while wind power contributed 27.72%.

V. MAHARASHTRA

- » As on 31st March 2024, Maharashtra ranked 5th in the country for renewable energy installed capacity with 17.53 GW installations having a share of 9.2%. Over the past six years, its renewable energy installed capacity has increased by 1.52 times by 2023-24, against the contraction of 0.04 times in the case of non-renewable energy sector.
- » Renewable Energy installed capacity contribution of 27.80% had grown to 37.99% during last 6 years in Maharashtra. Out of the renewable energy installed capacity, solar power leads in Maharashtra with a contribution of 35.65%, followed by wind power at 29.71%.

- » In 2023-24, Maharashtra ranked 6th in the country for renewable energy generation, with a total contribution of 24.03 billion units (BU) having a share of 6.68%. For energy generated from solar, wind, bio power, and small hydro power, Maharashtra held the 5th position, generating 18.77 BU and accounting for 8.31% of the total.
- » During 2023-24, renewable energy contributed 14.22% to the state's total energy generation. Within this total renewable energy generation, wind power was the largest contributor having 34.24% share followed by solar power contributing 24.20%.

INTERNATIONAL STATUS

Installed capacity:

- » As on 31st December 2023, global installed capacity of renewable energy reached a total of 3,864.52 GW as per Renewable Energy Statistics-2024 published by International Renewable Energy agency (IRENA). The share of renewable energy in worldwide installed capacity has risen from 28.20% of 2014 to 43.00% by 2023.
- » In 2023, global renewable energy sector reached a significant milestone. The year witnessed a record-breaking installation of 473.17 GW of renewable energy capacity, against 98.83 GW installations from non-renewable sources. Notably, solar power's total installed capacity exceeded that of hydro power for the first time.
- » Among renewable energy sources, solar energy experienced the most substantial growth, rising from 179.64 GW of 2015 to 1,418.02 GW by 2024, while wind energy increased from 349.46 GW to 1,017.39 GW during the period.
- » Renewable energy sector has consistently achieved annual growth rates exceeding 7.94%, while non-renewable sector's growth has not been more than 3.21% since 2015.
- » During the past five years, around 80% of annual capacity additions have been driven by the renewable energy sector.
- » Asia had the largest expansion of 1325.94 GW in installed capacity under Renewable energy sources during 2015 to 2023 followed by Europe with an expansion of 345.87 GW .
- » China leads the global renewable energy sector with an installed capacity of 1,453.70 GW followed by United States with 385.21 GW, as on 31st December, 2023. Brazil ranked third with 194.09 GW while India secured fourth position with 175.93 GW of RE installed capacity. Germany was in 5th position with an installation of 166.94 GW. Together, top 5 countries accounted for around 61.48% of the world's total RE installed capacity.
- » Among the top 5 countries in the Renewable Energy installed capacity, China, India and Germany had their largest share of installation from solar power sector in their respective country as on December 2023. In the case of wind power capacity installations, USA held the largest share of 38.43% in the country. Hydro Power installation was dominated in Brazil's RE sector with a contribution of 56.63%.

Renewable Energy Generation:

- » During 2022, total energy generation from renewable energy sources reached 8439.67 TWh, a significant increase from 5039.25 TWh of 2013 with an increase in share from 21.40% of 2013 to 29.10 %.
- » Asia expanded its energy generation from Renewable Energy sector from 1684.40 TWh of 2013 to 3748.55 TWh during 2022, followed by Europe with an expansion from 1094.36 TWh to 1461.75 TWh.



ALL INDIA STATUS



Installed Capacity - RE and Non-RE sector

1.1 Installed Capacity in RE and Non-RE sector: As on 31st March, 2024, India's cumulative installed capacity has reached 441.97 GW, up from 275.90 GW of 2014-15, registering a growth of 60.19% during last 9 years. This growth was 134.63% for Renewable Energy capacity installation including Large Hydro and was around 259.55% growth for capacity installations under Solar, Wind, Bio Power and Small Hydro Power. Renewable Energy installation was on it's peak in 2023-24 by installing 18.56 GW compared to 7.35 GW of Non-RE sector. Annual growth of RE capacity installation has consistently exceeded 6% compared to Non-RE growth of 3.01% since 2017-18. At the end of 2023-24, share of installed capacity under RE and Non-fossil sectors were at 43.12% and 44.97% respectively. Details of the status of capacity installations in the country emphasizing more on RE sector has been elaborated in the following sessions.

Table 1.1 Cumulative Installed Capacity since 2014-15

(in GW)

Year	Mode-wise Breakup (GW)					Grand Total	Growth (%)	Share of RE (%)
	Non-RE		Renewables (RE)					
	Thermal	Nuclear	Hydro	RES*	Total RE			
2014-15	188.90	5.78	41.27	39.95	81.22	275.90	10.62	29.44
2015-16	210.68	5.78	42.78	47.09	89.87	306.33	11.03	29.34
2016-17	218.33	6.78	44.48	58.56	103.04	328.15	7.12	31.40
2017-18	222.91	6.78	45.29	70.65	115.94	345.63	5.33	33.54
2018-19	226.28	6.78	45.40	79.41	124.81	357.87	3.54	34.88
2019-20	230.60	6.78	45.70	88.26	133.96	371.34	3.76	36.07
2020-21	234.73	6.78	46.21	95.80	142.01	383.52	3.28	37.03
2021-22	236.11	6.78	46.72	109.89	156.61	399.5	4.17	39.20
2022-23	237.27	6.78	46.85	125.16	172.01	416.06	4.15	41.34
2023-24	243.22	8.18	46.93	143.64	190.57	441.97	6.23	43.12
Gr (2014-15 to 2023-24)	28.76%	41.52%	13.71%	259.55%	134.63%	60.19%		
CAGR (2014-15 to 2023-24)	2.85%	3.93%	1.44%	15.28%	9.94%	5.38%		

Source : Ministry of New and Renewable Energy(MNRE) and Central Electricity Authority (CEA)

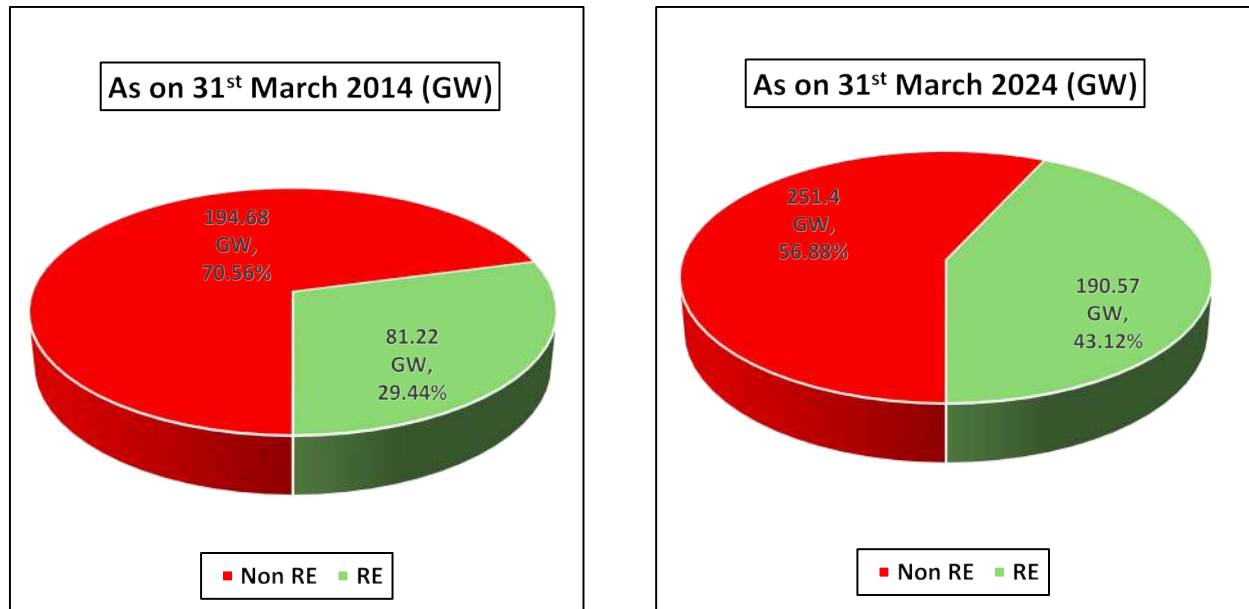
RES*- Comprising of Solar, Wind, Bio-Power and Small Hydro Power

Gr=Growth (%)

CAGR=Compound Annual Growth Rate

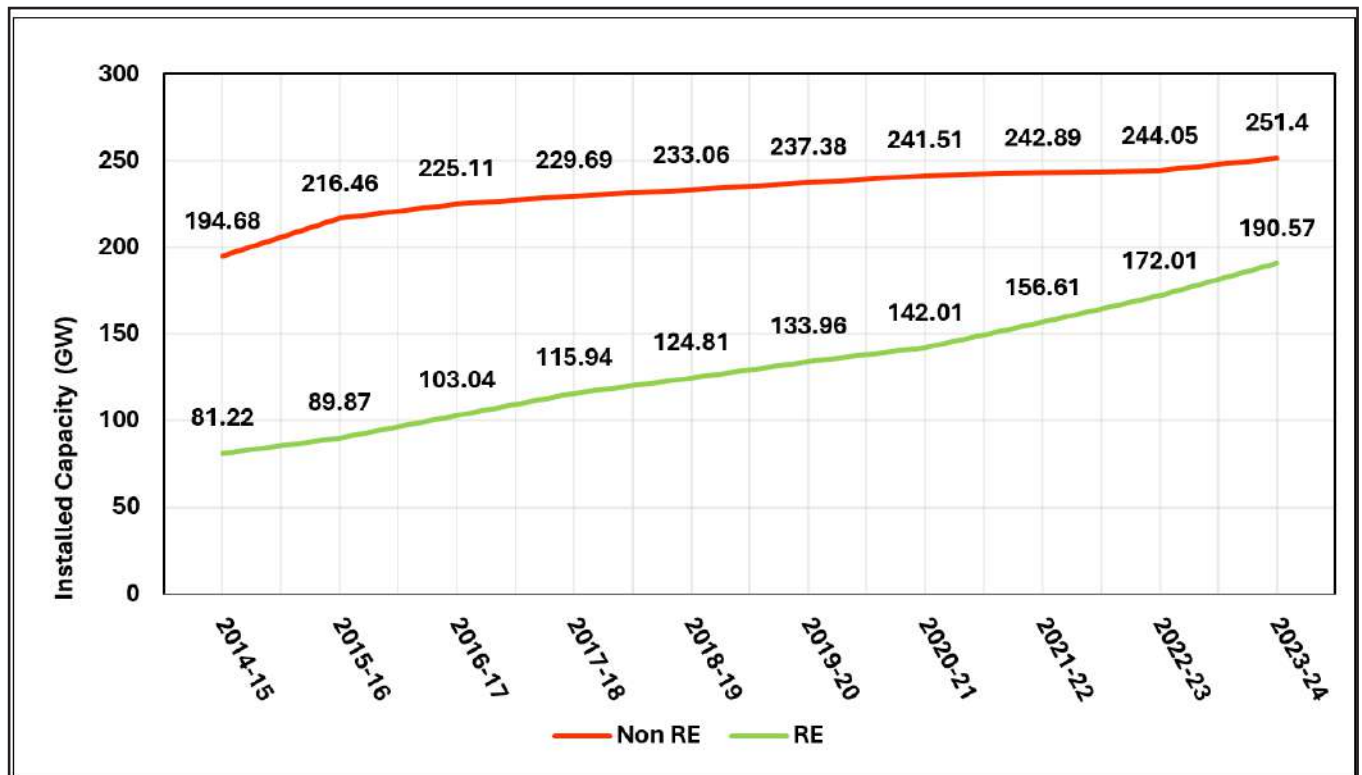
Significantly, the installed capacity of renewable energy (RE) has demonstrated a remarkable growth of 134.63%, surpassing the overall installed capacity growth of 60.19% from 2014-15 to 2023-24. Moreover, installed capacity of Renewable Energy comprising of Solar, Wind, Bio-Power and Small Hydro Power experienced an even more impressive growth of 259.55%, highlighting the substantial advancement in these sectors.

Fig 1.1 Share of Renewable Energy



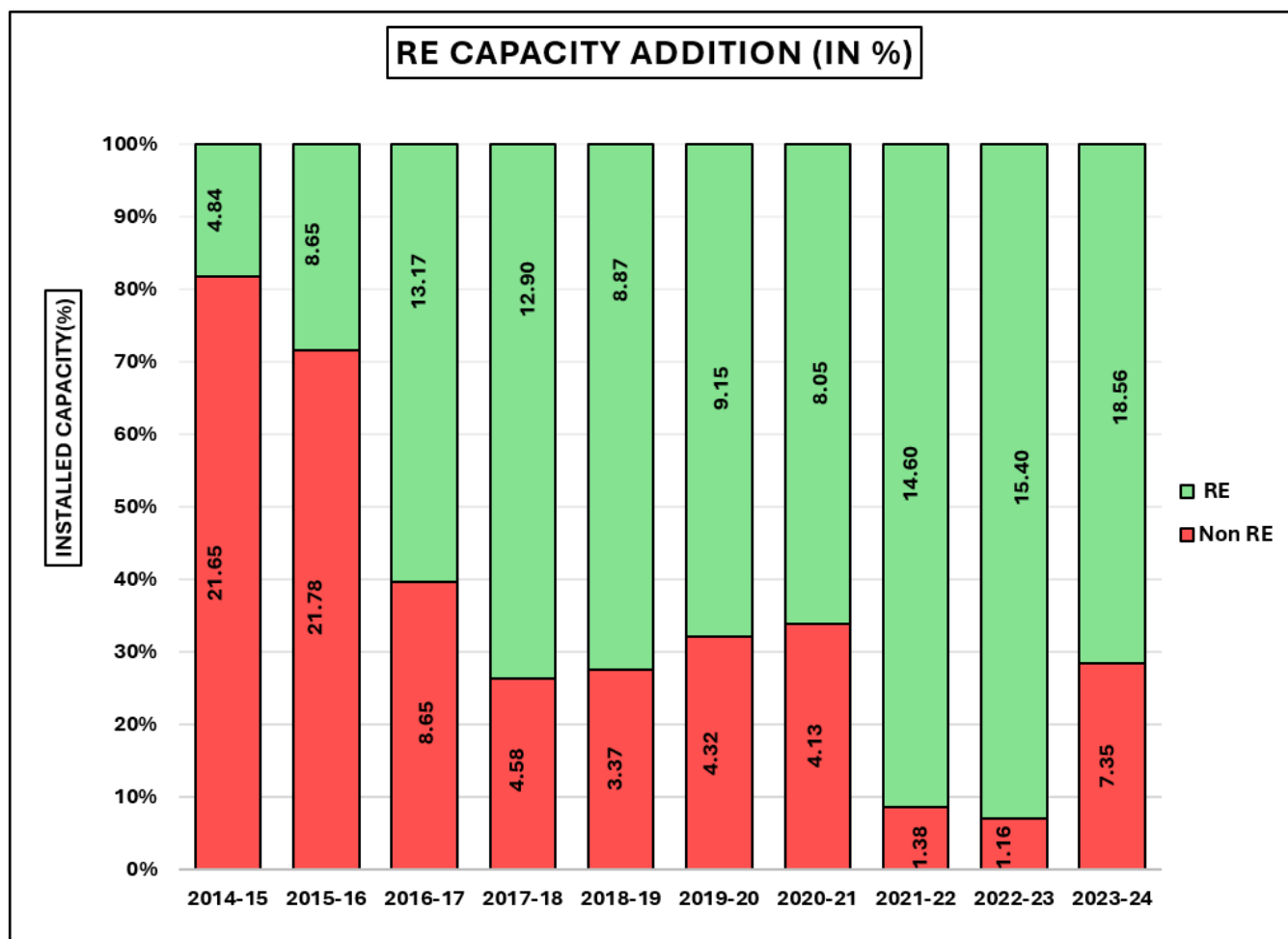
During last 9 years, Renewable Energy sector has a remarkable contribution in the total installed capacity with a significant share of 43.12% in 2023-24 from 29.44% of 2014-15.

Fig 1.2 Trend in Cumulative Capacity installation.



The graph reveals that the trend of year wise capacity installation of renewable energy sector was consistently outpacing that of non-renewable energy sector, narrowing the gap between the two significantly. This reflects the increasing shift towards the utilisation of renewable energy sources, with a compound annual growth rate (CAGR) of 9.94 % from 2014-15 to 2023-24. In comparison, non-renewable energy has grown from 194.68 GW of 2014-15 to 251.4 GW by 2023-24, with a compound annual growth rate (CAGR) of 2.88% during this period.

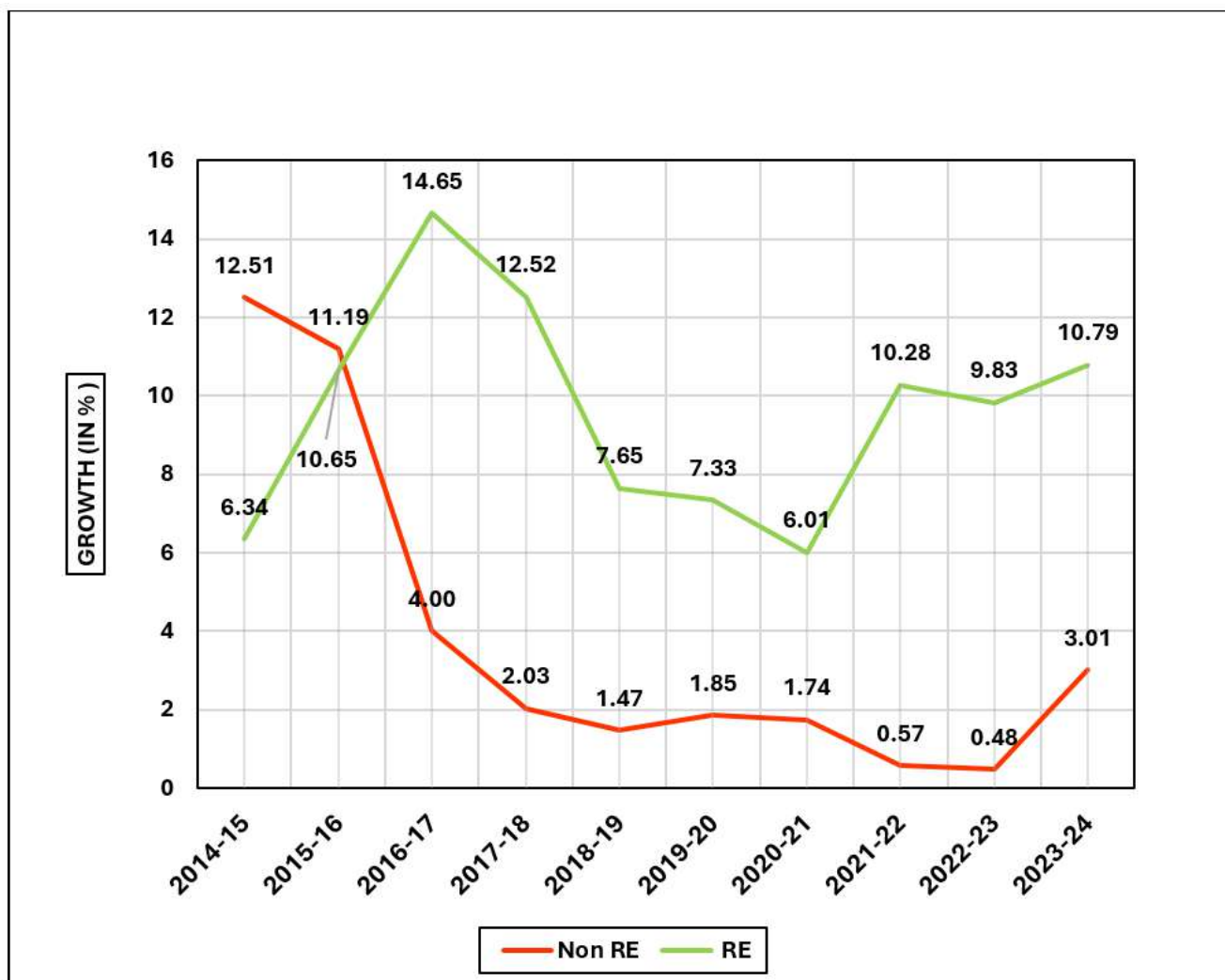
Fig 1.3 Year wise capacity addition (in %).



Data shown inside the bar diagram represents the installed capacity in GW.

In terms of year-on-year capacity addition, RE sector has shown remarkable capacity expansion compared to non-RE sector. This reveals India's dedication towards its utilisation of Renewable Energy potential. India witnessed an amazing capacity installation of 18.56 GW in RE sector during 2023-24, significantly higher than that of 7.35 GW in non-RE sector.

Fig 1.4 Year wise growth (%) in Capacity Installation



In terms of year-on-year growth rates, renewable energy sector has displayed impressive progress compared to non-RE sector, encompassing traditional thermal and nuclear sectors. Graph reveals that the growth of RE has consistently exceeded 6%, whereas non-RE growth has remained below 3.01% after 2016-17.

CHAPTER 2

Installed capacity - Wind, Solar, Small Hydro and Bio Energy (RES) Sector

2.1 Installed Capacity under RES: Ministry of New and Renewable energy (MNRE), as per its mandate is engaged in promotion of various Renewable Energy sources such as Wind, Solar, Bio Energy and Small Hydro Power. Out of the total installed capacity under this sector, capacity installation under Solar Power sector registered the most dramatic increase, from 3.99 GW of 2014-15 to 81.81 GW by 2023-24, with a growth of 1950.38% during the period. 81.88 % of the installation under Solar Power constitutes ground mounted installations. Capacity installation under Wind power recorded growth of 95.78%. Analysis of the installations under Solar, Wind, Bio Power and Small Hydro Power has been elaborated in this chapter.

Table 2.1: Cumulative Installed Capacity under RES since 2014-15

(in GW)

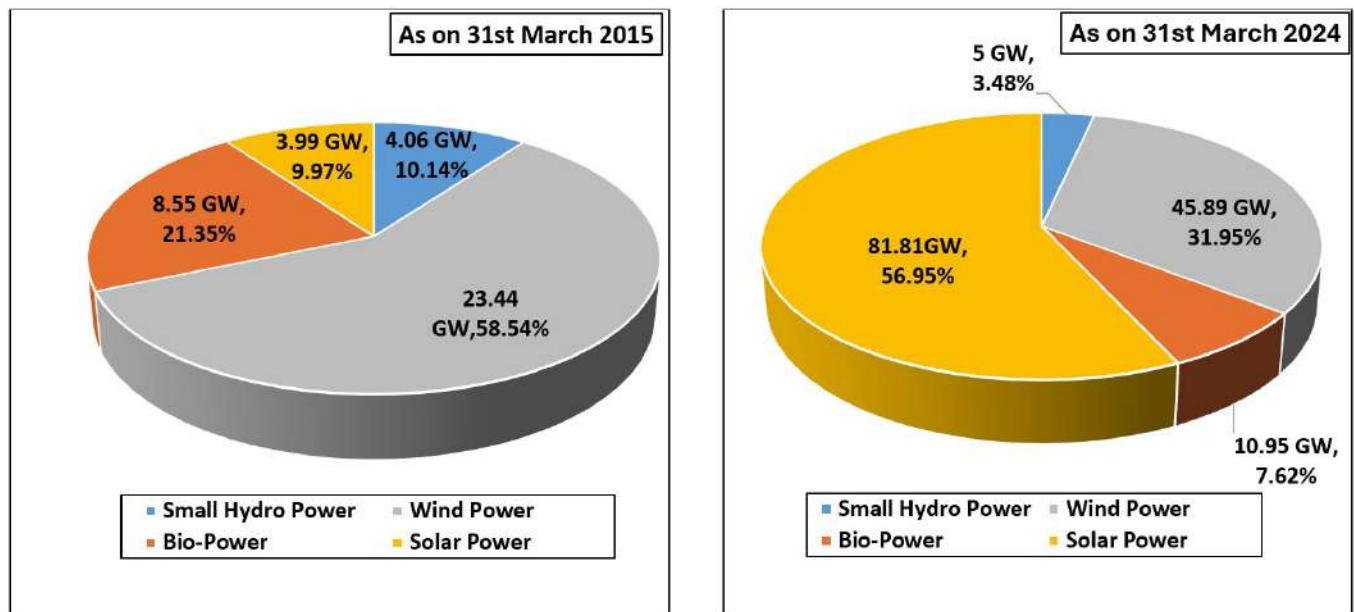
Year	Small Hydro Power	Wind Power	Bio-Power		Solar Power	Total RES Capacity
			BM Power/ Cogeneration	Waste to Energy		
2014-15	4.06	23.44	8.31	0.24	3.99	40.04
2015-16	4.27	26.78	8.67	0.25	7.12	47.09
2016-17	4.38	32.28	8.84	0.28	12.78	58.56
2017-18	4.49	34.15	9.36	0.31	22.35	70.65
2018-19	4.59	35.63	9.78	0.32	29.10	79.41
2019-20	4.68	37.74	9.88	0.35	35.60	88.26
2020-21	4.79	39.25	10.15	0.39	41.24	95.80
2021-22	4.85	40.36	10.21	0.48	54.00	109.89
2022-23	4.94	42.63	10.25	0.55	66.78	125.16
2023-24	5.00	45.89	10.36	0.59	81.81	143.64
Gr (2014-15 to 2023-24)	23.15%	95.78%	24.67%	145.83%	1950.38%	258.74%
CAGR (2014-15 to 2023-24)	2.34%	7.75%	2.48%	10.51%	39.88%	15.25%

Gr=Growth (%)

CAGR=Compound Annual Growth Rate

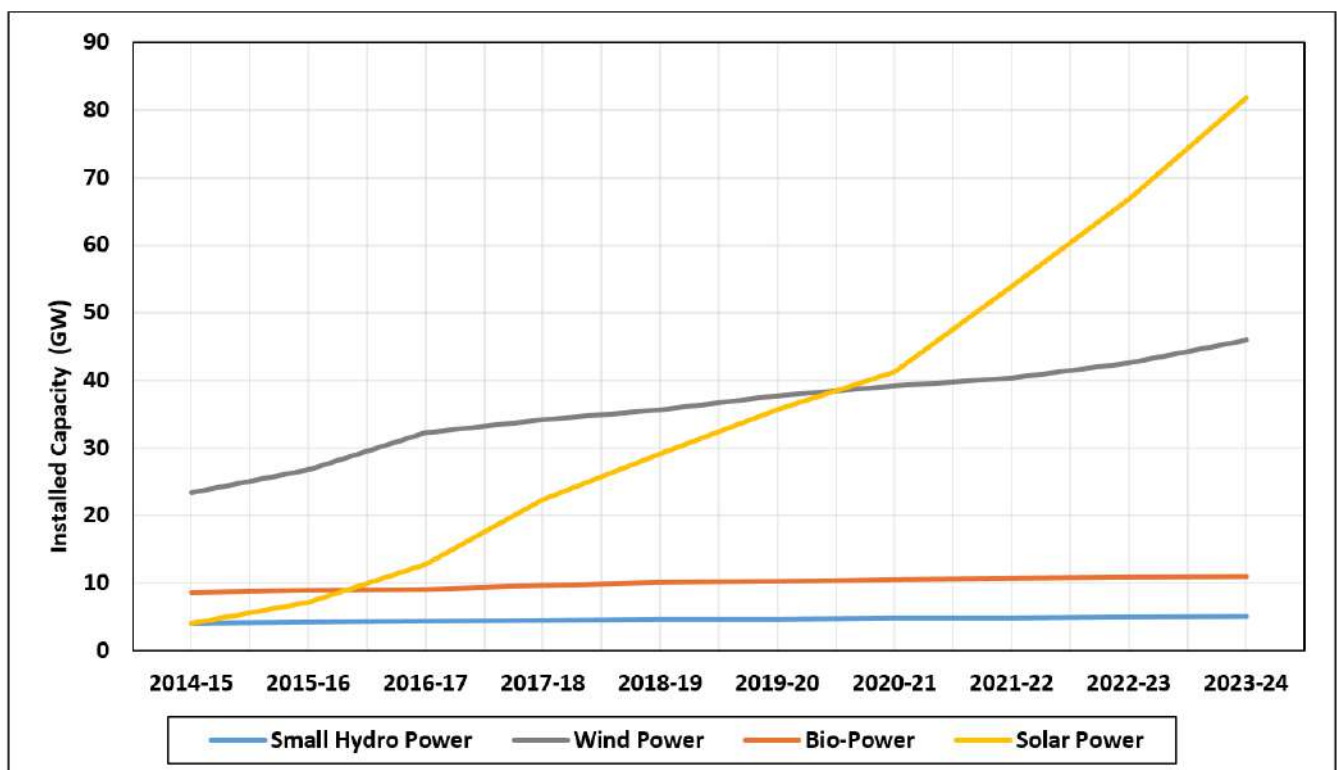
As on 31st March 2024, cumulative installed capacity of renewable energy from Solar, wind, Biopower and Small Hydro Power was 143.64 GW significantly higher than that of 40.04 GW as on 31st March 2015. A substantial growth in renewable energy capacity, with solar power emerging as a dominant force is seen in recent years.

Fig 2.1 Share of various sources in RES Cumulative Installed capacity



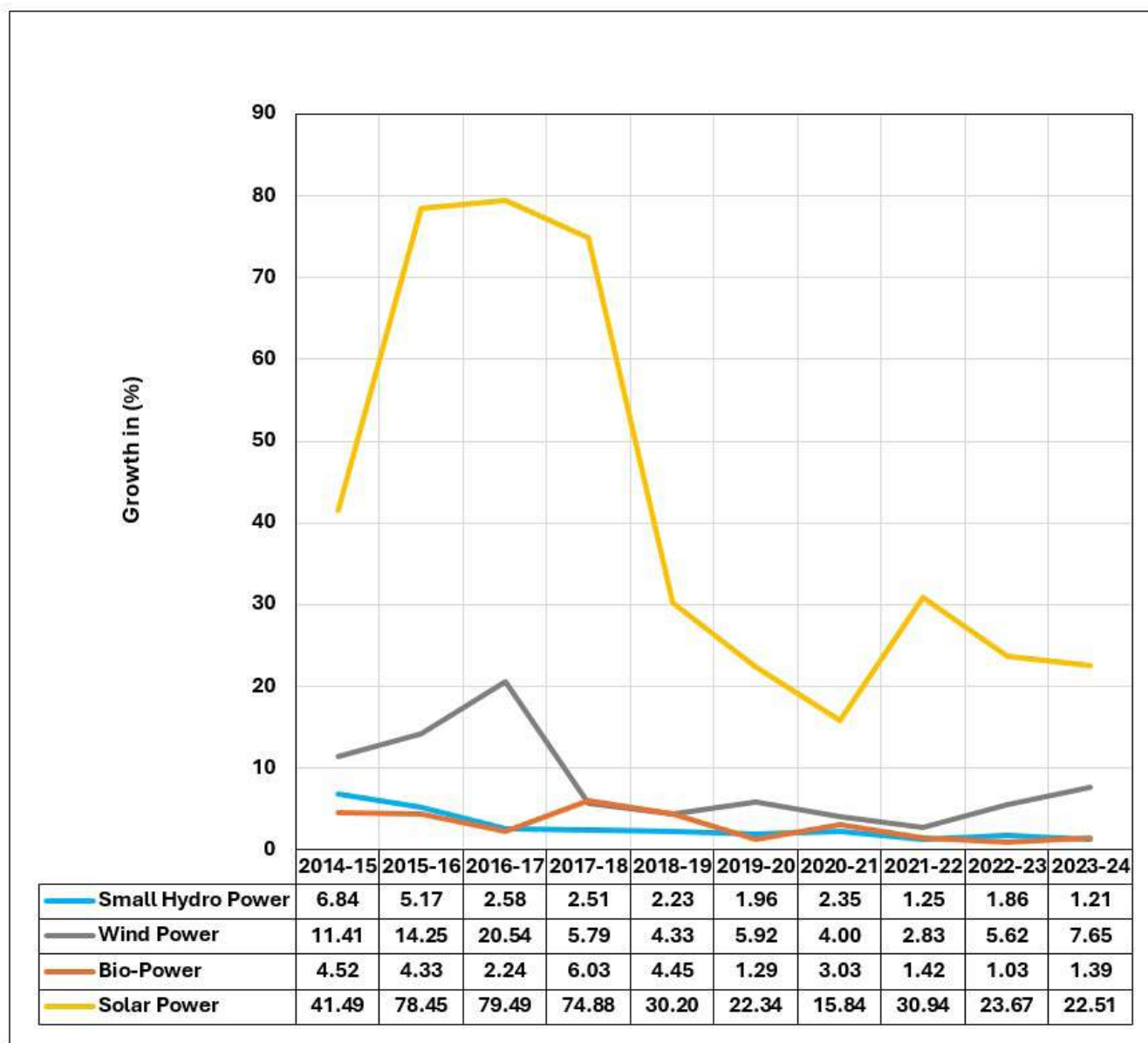
As on 31st March, 2024, out of the cumulative installed capacity of renewable energy from Solar, Wind, Bio-Power, and Small Hydro Power, solar power had a share of 56.95% with capacity installation of 81.81 GW, followed by wind power having a share of 31.95% with an installation of 45.89 GW. Bio-power contributed 7.62% with installation of 10.95 GW, and Small Hydropower accounted for 3.48% with installed capacity of 5 GW. This progress in capacity installation marks a significant shift from 2014-15 when the total installed renewable energy capacity was 40.04 GW. Back then, wind power dominated with a share of 58.54% having 23.44 GW installation, followed by Bio-Power installation of 8.55 GW with a share of 21.35%. Small Hydropower had a 10.14% share having installation of 4.06 GW and solar Power had the least share of 9.97% with a cumulative installation of 3.99 GW.

Fig 2.2 Trend in RES cumulative Installed Capacity



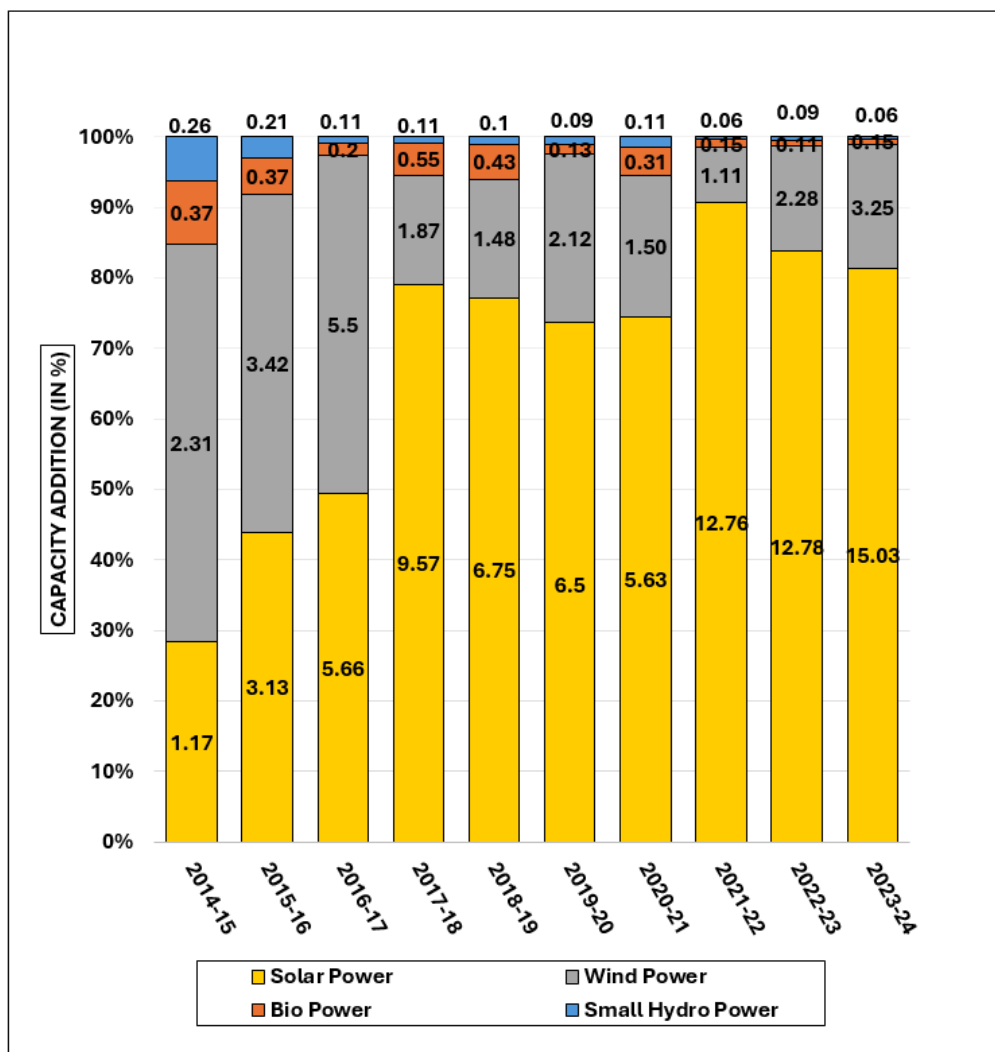
Installed capacities of different renewable energy sources have shown varying trends over the years. Trend expresses dynamic growth patterns across various renewable energy sources, with Solar Power followed by Wind Power leading the charge in substantial capacity expansions. Bio power is having steady growth, while Small hydro power shows a slight increase in installed capacity over the years. Solar power capacity installation registered the most dramatic increase, from 3.99 GW to 81.81 GW, registering a CAGR of 39.88% during last 9 years. Wind power's capacity enhanced from 23.44 GW to 45.89 GW, recording a CAGR of 7.75%.

Fig 2.3 Year wise growth (%) in installed capacity



From 2014-15 to 2023-24, in the renewable energy sector, solar power exhibited exceptional growth over the years. It achieved a high CAGR of 78.97% from 2014-15 to 2016-17, then faced a slow-down with a CAGR of 34.03% from 2016-17 to 2020-21, and 25.65% from 2020-21 to 2023-24, highlighting its resilience and potential despite short-term fluctuations. Wind energy also grew significantly, with a CAGR of 17.55% from 2014-15 to 2016-17, and 5.15% from 2016-17 to 2023-24.

Fig 2.4 Year wise installed capacity addition (in%)

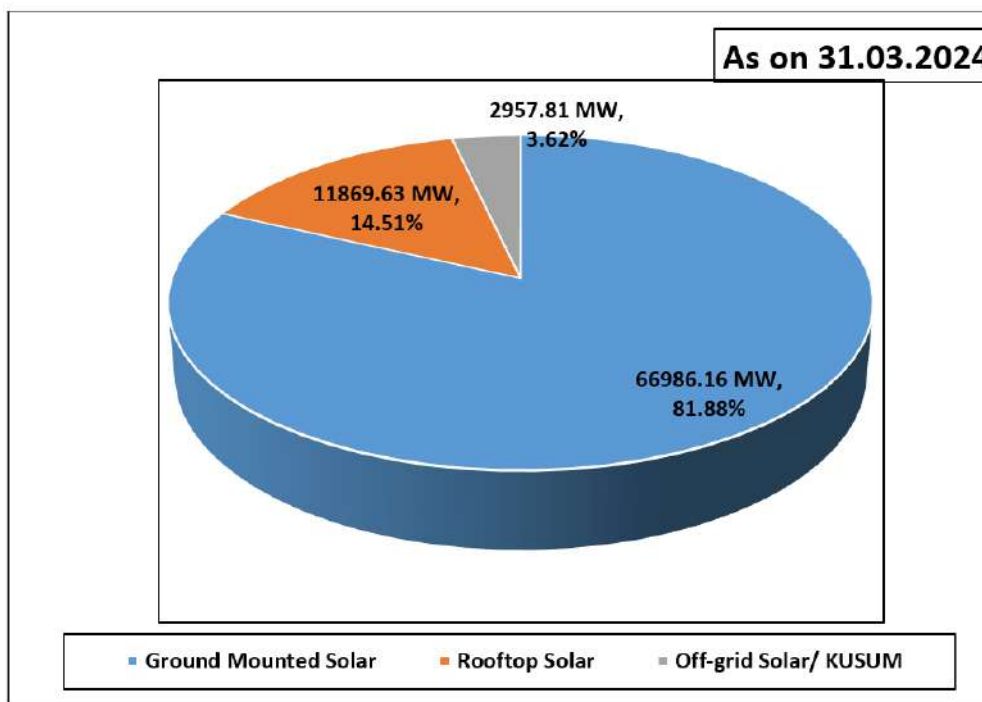


Data shown inside the bar diagram represents the installed capacity in GW.

From 2014-15 to 2023-24, Solar sector exhibited remarkable year-on-year capacity expansion. Installation of wind power exhibited fluctuation in installations over the years. Small Hydro Power (SHP) and Bio Power, while holding smaller shares, generally experienced fluctuations in capacity installations.

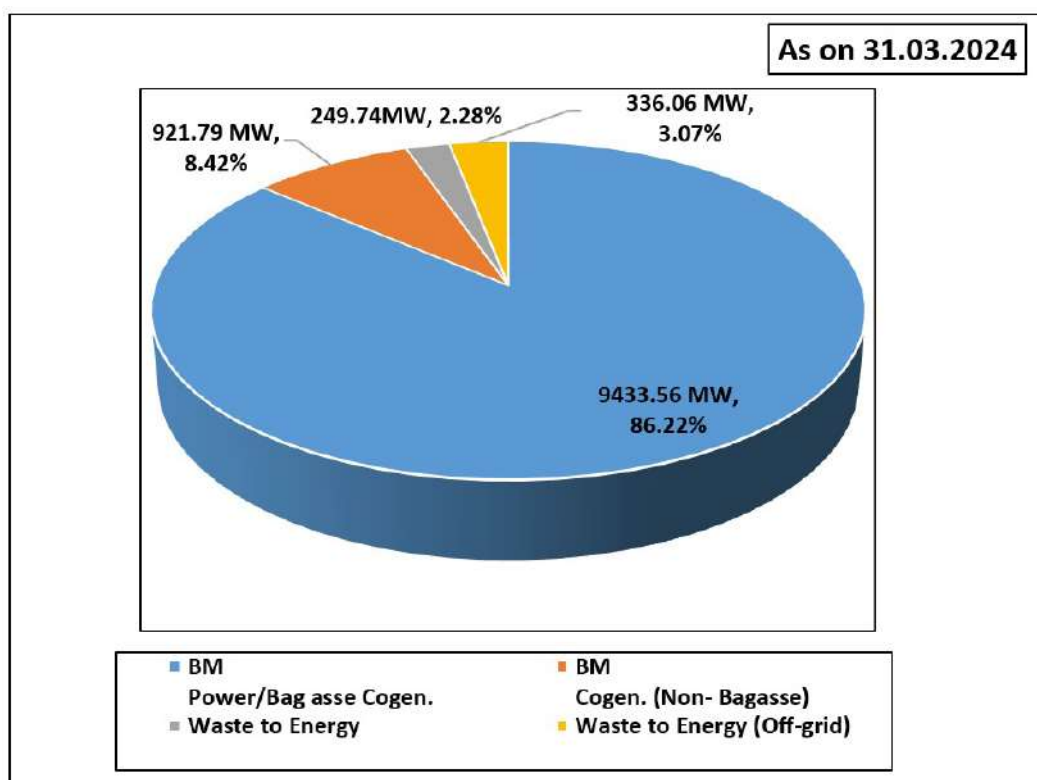
Various categories of Solar Power installations: Solar Power emerged at standout performer in the capacity installation out of which ground-mounted solar installations dominate with a substantial 81.88% share, amounting to 66.99 GW. Rooftop solar installations constitute 14.51% of the installed capacity, accounting for 11.87 GW while off-grid solar / KUSUM installations contribute 3.62% to the overall installed capacity of solar power, totalling 2.96 GW. (Refer Fig. 2.5).

Fig. 2.5 Various categories of Solar Power installations



Various categories of Bio Power installations: Biomass Power / Bagasse Cogeneration dominate the Bio Power sector with a substantial share of 86.22%, totalling 9.43 GW. Non-Bagasse sources constitute 8.42% of the installed capacity, accounting for 0.92 GW, while Waste to Energy contributes 2.28% to the overall installed capacity, amounting to 0.25 GW. Additionally, Waste to Energy (Off Grid) holds a share of 3.07% with an installed capacity of 0.34 GW.

Fig 2.6 Various categories of Bio Power installations



CHAPTER 3

Energy Generation - RE and Non-RE sector

3.1 Energy generation from RE and Non-RE sector: India's total energy generation was approximately 1,734.12 billion units (BU), during 2023-24, a significant increase from 1,105.38 BU of 2014-15, reflecting a growth of 56.88% during this period. Energy generation from renewable energy sources, contributed 359.89 BU, accounting for 20.75% of the total generation, registering a growth of 88.46% from that of 2014-15. Renewable Energy generation from Solar Power, Wind Power, Bio-Power and Small Hydro Power has shown an impressive growth of 265.89%, underscoring substantial advancements in India's renewable energy sector. Year wise India's total energy generation from 2014-15 to 2023-24 in Renewable Energy sector and Non-Renewable Energy sector and its analysis have been done in this chapter.

Table 3.1 Year-wise All India Energy Generation since 2014-15

(in BU)

Year	Non-RE		RE			Grand Total	Share (%)	
	Thermal	Nuclear	Large Hydro	RES*	Total		RE	RES*
2014-15	878.32	36.10	129.24	61.72	190.96	1105.38	17.28	5.58
2015-16	943.79	37.41	121.38	65.78	187.16	1168.37	16.02	5.63
2016-17	994.22	37.92	122.38	81.55	203.93	1236.08	16.50	6.60
2017-18	1037.10	38.30	126.10	101.84	227.94	1303.34	17.49	7.81
2018-19	1072.22	37.81	134.89	126.76	261.65	1371.68	19.08	9.24
2019-20	1042.75	46.47	155.77	138.34	294.11	1383.33	21.26	10.00
2020-21	1032.51	43.03	150.30	147.25	297.55	1373.09	21.67	10.72
2021-22	1114.71	47.11	151.63	170.91	322.54	1484.36	21.73	11.51
2022-23	1206.15	45.83	162.10	203.55	365.66	1617.58	22.61	12.58
2023-24	1326.29	47.94	134.05	225.84	359.89	1734.12	20.75	13.02
Gr (2014-15 to 2023-24)	51.00%	32.80%	3.72%	265.89%	88.46%	56.88%		
CAGR (2014-15 to 2023-24)	4.69%	3.20%	0.41%	15.50%	7.29%	5.13%		

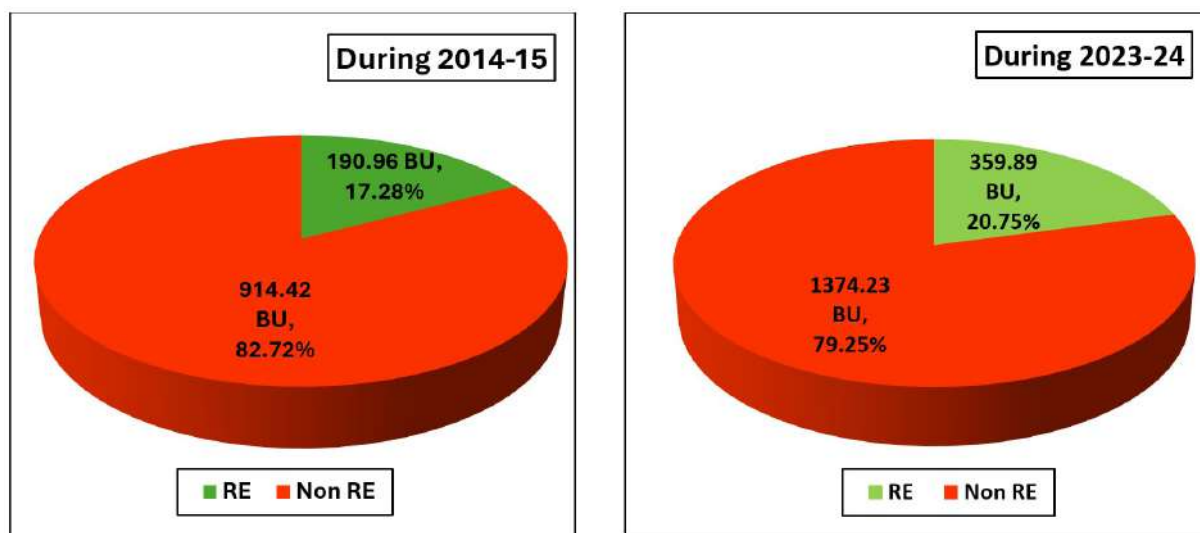
Source: CEA, Ministry of Power (MoP)

*RES constitutes Solar, Wind, Bio-Power & Small Hydro Power

Gr=Growth (%)

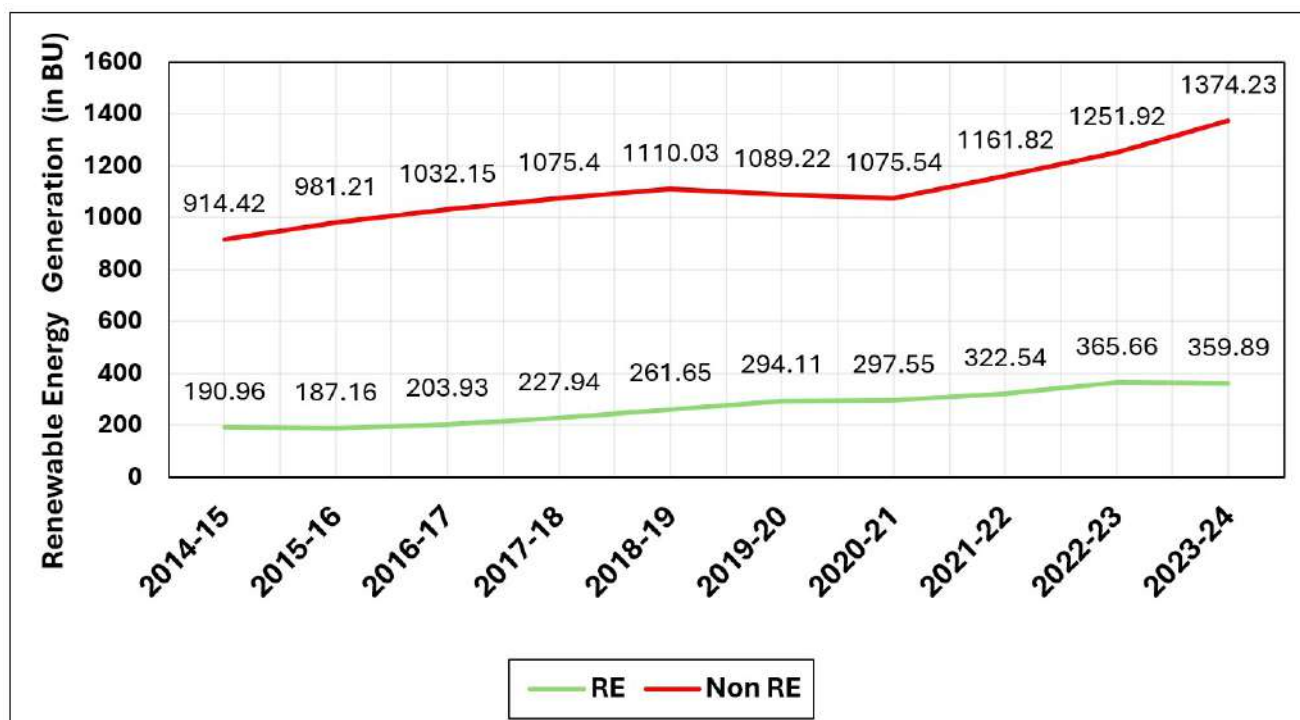
CAGR=Compound Annual Growth Rate

Fig 3.1 Share of Renewable Energy



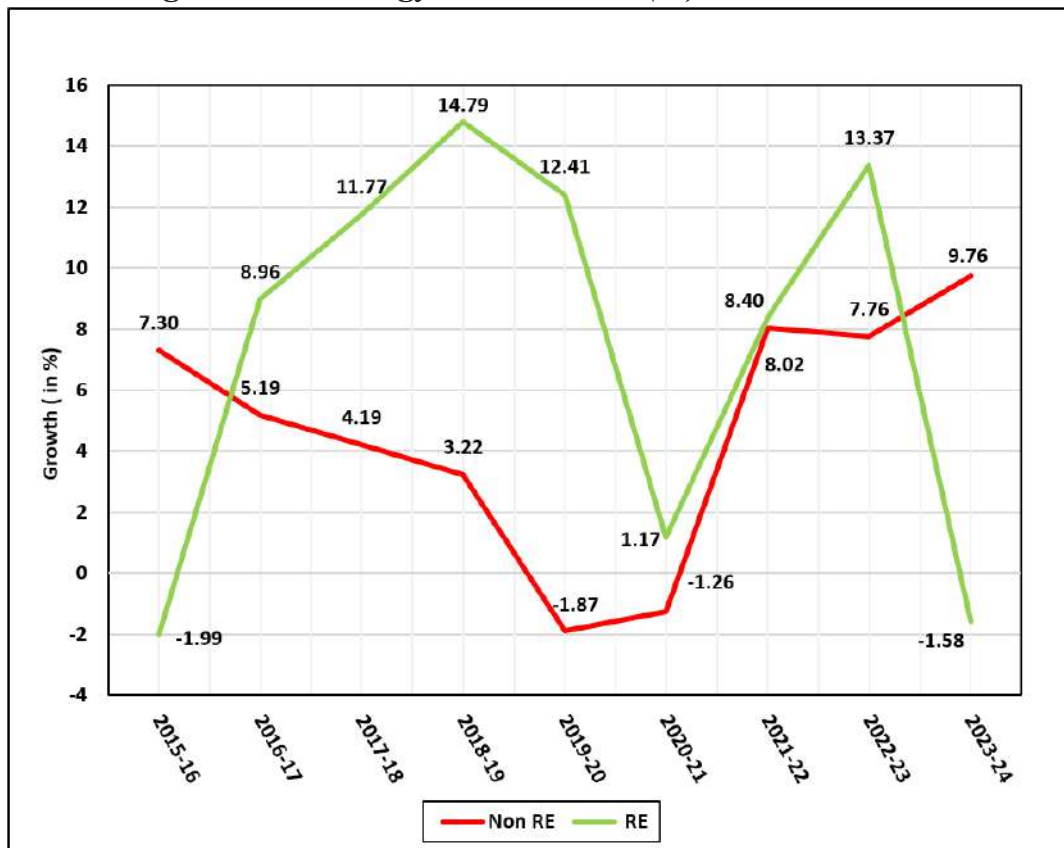
During last 9 years, contribution of Renewable Energy sector to total Energy generation increased from 17.28% of 2014-15 to 20.75% by 2023-24.

Fig 3.2 Trend in Energy Generation



During 2023-24, energy generation from renewable sources reached to 359.89 billion units (BU), up from 190.96 BU during 2014-15, marking 88.46% increase in renewable energy generation from that of during 2014-15 with a compound annual growth rate (CAGR) of 7.29%. Non-renewable energy generation enhanced from 914.42 BU to 1,374.23 BU, achieving a 50.28% increase with a CAGR of 4.63% from 2014-15.

Fig 3.3 Year wise growth in Energy Generation (%)



In terms of year-on-year energy generation growth rates, renewable energy sector has consistently outpaced Non-RE since 2016-17, except in 2023-24. The decline in 2023-24 is attributed to decline in energy generation from Large Hydro Power. However, year-on-year growth in energy generation from Solar Power, Wind Power, Small Hydro power and Bio-Power remains consistently higher than that of Non-RE since 2016-17.

CHAPTER 4

Energy Generation - Wind, Solar, Small Hydro & Bio Energy (RES) Sector

4.1 Energy generation from RES sector: During 2023-24, Renewable Energy generation through wind, solar, small hydro and Bio energy was 225.83 BU significantly higher than that of 61.72 BU energy generation during 2014-15. Data reveals a substantial growth in renewable energy generation, with solar power emerging as a dominant force in recent years. Energy generation from solar power increased at a CAGR of 43.13% since 2014-15. Energy generation for RES sector grew with a CAGR of 15.50% during last 9 years. Detailed analysis of energy generation through RES sources is described in this chapter.

Table 4.1 Year-wise Energy Generation under RES since 2014-15

(in BU)

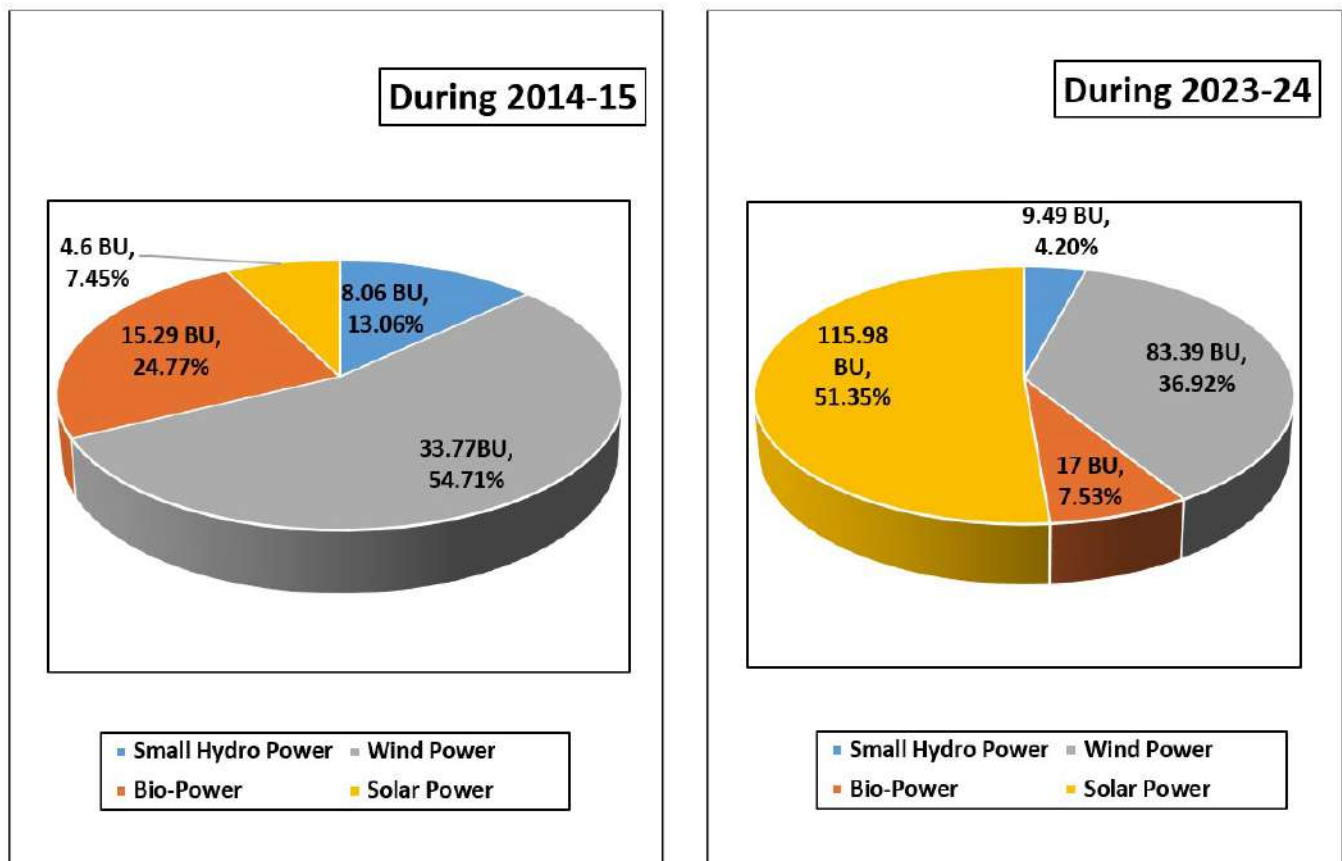
Year	Wind	Solar	Bio-Power				Small Hydro	Grand Total	Growth (%)
			Biomass	Bagasse	Waste to Energy	Total			
2014-15	33.77	4.60	3.16	11.78	0.35	15.29	8.06	61.72	...
2015-16	33.03	7.45	3.73	12.95	0.27	16.95	8.35	65.78	6.58
2016-17	46.00	13.50	4.20	9.96	0.21	14.37	7.67	81.55	23.97
2017-18	52.70	25.80	3.41	11.87	0.36	15.64	7.70	101.84	24.88
2018-19	62.04	39.27	2.76	13.56	0.43	16.75	8.70	126.76	24.47
2019-20	64.65	50.13	2.94	10.80	0.37	14.11	9.45	138.34	9.14
2020-21	60.15	60.40	3.51	11.30	1.62	16.43	10.26	147.25	6.44
2021-22	68.64	73.48	3.48	12.57	2.27	18.32	10.46	170.91	16.07
2022-23	71.81	102.01	3.16	12.86	2.53	18.55	11.17	203.55	19.10
2023-24	83.39	115.98	3.42	10.83	2.75	17.00	9.49	225.83	10.95
Gr % (2014-15 to 2023-24)	146.94%	2421.30%	8.23%	-8.06%	685.71%	11.18%	17.74%	265.89%	
CAGR (2014-15 to 2023-24)	10.57%	43.13%	0.88%	-0.93%	25.74%	1.18	1.83%	15.50%	

Source : CEA, MoP

Gr=Growth (%)

CAGR=Compound Annual Growth Rate

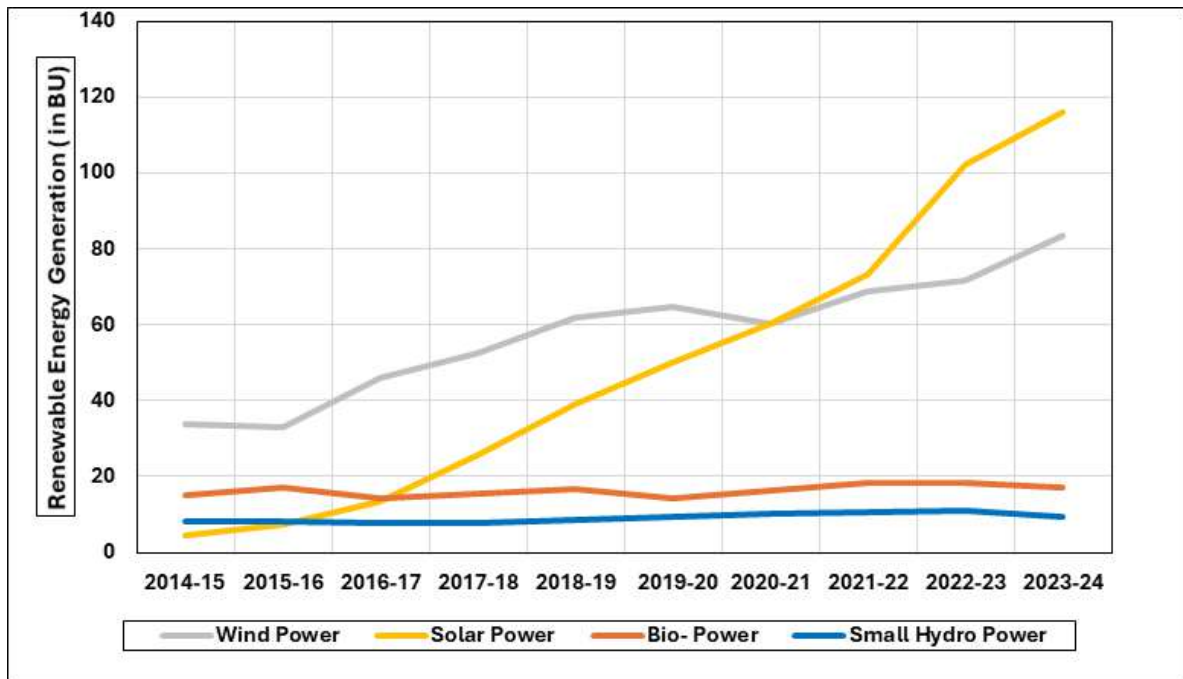
Fig 4.1 Share of various RE sources in energy Generation



As stipulated in above diagram, during 2014-15, energy generation through Solar, Wind, Bio-Power, and Small Hydro Power was 61.72 BU. Wind power constituted majority share of 54.71% with energy generation of 33.77 BU, followed by bio power having share of 24.77% with energy generation of 15.29 BU. Small Hydro Power accounted for 13.06% share with energy generation of 8.06 BU while Solar power contributed only 7.45% share with energy generation of 4.6 BU. This distribution sharply changed during 2023-24. By then, energy generation through renewable energy sources had significantly increased to 225.83 BU. Solar power became the dominant source, contributing 51.35% with 115.98 BU energy generation, followed by wind power having 36.92% with 83.39 BU energy generation. Bio power contributed 7.53% with energy generation of 17 BU, while small hydro power accounted for 4.20% with 9.49 BU.

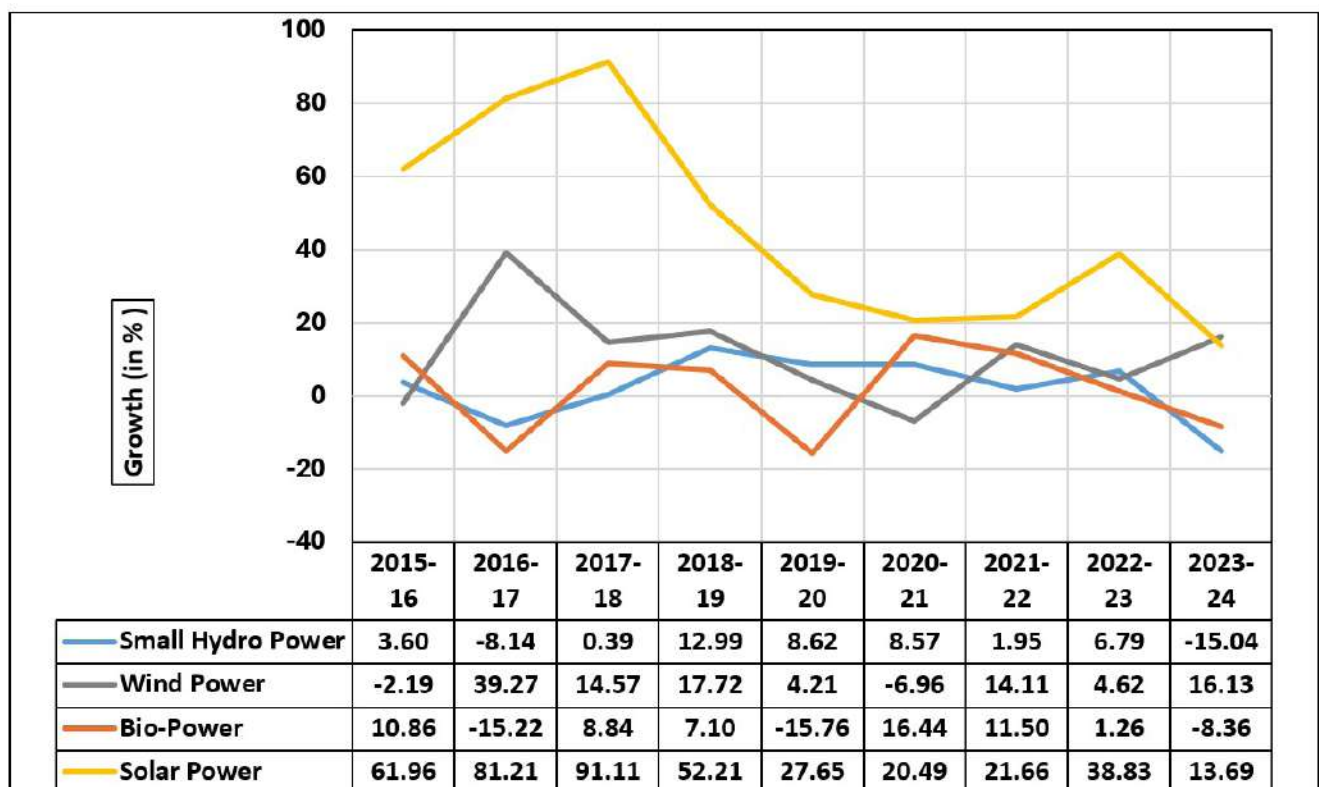
4.2 Trend in year wise energy Generation: Energy generation through renewable energy sources has shown varying trends over the years. Solar power registered the most dramatic increase, increased from 4.6 BU to 115.98 BU, registering a growth of 2421.30% having a CAGR of 43.13%. Energy generation from wind sector has been raised from 33.77 BU to 83.39 BU, achieving a growth of 146.94% with a CAGR of 10.57%. Small hydro power grew steadily from 8.06 BU to 9.49 BU, with a growth of 17.74% and a CAGR of 1.83%. Bio power experienced a slight increase from 15.29 BU to 17 BU, reflecting a growth of 11.18% having CAGR of 1.18%. (Refer Fig 4.2)

Fig 4.2 Trend in year wise energy Generation



4.3 Yearwise growth(%) in Energy Generation : From 2015-16 to 2023-24, solar power showed exceptional growth rate, despite year-on-year variations. Its growth rate consistently surpassed all other renewable energy sources except during 2023-24 where growth rate of wind power exceeded that of Solar Power. (Refer Fig 4.3)

Fig 4.3 Yearwise growth(%) in Energy Generation



STATE WISE STATUS



Estimated RE potential and Installed Capacity in RE and Non-RE sector

5.1 Estimated Renewable Energy Potential: India has significant renewable energy potential across various sources, including solar, wind, hydro, and bioenergy. Government of India regularly undertakes initiatives to assess the potential of these resources. According to the most recent estimates, the nationwide potential for Solar Power, Wind Power, Hydro Power, and Bio Power are as follows:

Solar Power:

National Institute of Solar Energy (NISE), in 2014 estimated country's solar power potential as 749 GW. India is in the process of tapping this potential and secured 5th position globally in installed solar capacity and 4th position in energy generation from solar power.

Wind Power:

National Institute of Wind Energy (NIWE) in 2023, India's wind power potential has been estimated at 1163.86 GW at 150 meters above ground level. India ranks 4th in the world for wind installed capacity, reflecting significant progress in harnessing its wind energy potential.

Hydro Power: India secured 5th in Hydro Power installed capacity in the world.

- **Large Hydro Power:** India possesses substantial hydro power potential due to its numerous rivers and dams. According to Exploitable capacity identified by Central Electricity Authority, Ministry of Power, Large Hydro Power has the estimated potential of 133.41 GW in the country.
- **Small Hydro Power:** As per the assessment done by IIT Roorkee in 2016, India's estimated potential for small hydro power (up to 25 MW) is 21.13 GW.

Biomass Power:

Administrative Staff College of India, in 2021 estimated country's bio-energy power potential as 42.27 GW. India ranks 4th globally in bioenergy installed capacity. State wise Renewable Energy estimated potential has been described in **Table 5.1**.



Table 5.1 Estimated potential in RE Sector
(in MW)

STATES / UTs	Wind Power	Small Hydro Power	Bio-energy		Solar Power	Large Hydro
			Biomass Power	Bagasse 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

5.2 State wise Installed Capacity under RE and Non -RE sector:

India's

reliance on renewable energy has increased significantly from 33.55% of 2017-18 to an impressive 43.12% by 2023-24 marking around 10% surge in its share within the overall installed capacity. Gujarat, Rajasthan, Tamil Nadu, Karnataka, and Maharashtra not only lead in total renewable energy capacity as on March, 2024 but also dominate in terms of the most significant increases in RE installed capacity from March 2018 to March, 2024.

Rajasthan tops in the country in installation of Renewable Energy by installing around 19,814.53 MW during last 6 years achieving a growth of 271.83% followed by Gujarat of 18,122.27 MW capacity installation registering a growth of 194.04%. Tamil Nadu and Maharashtra have also shown commendable progress, each added 8,709.91 MW and 6,010.91 MW with corresponding increase of 64.75% and 52.18% respectively. Karnataka has also demonstrated significant improvement as well, increasing its capacity by more than 5,200.35 MW with a growth of about 32.02% during 2018-19 to 2023-24.

Rajasthan, specifically has witnessed a substantial surge in installed capacity of renewable energy, showcasing an impressive Compound Annual Growth Rate (CAGR) of over 24.47% from 2017-2018 to 2023-24. Similarly, Gujarat, Tamil Nadu, Maharashtra, and Karnataka have all experienced significant CAGR of 19.69%, 8.68%, 7.25%, and 4.74%, respectively, over the same period, indicating sustained and robust growth in their renewable energy sectors. Details of installed capacity in various states and UTs as on March 2018 and March 2024 are described in **Table 5.2** below:

Table 5.2 State wise Non-RE and RE Cumulative Installed Capacity up to March 2018 and up to March 2024

(in MW)

Sr. No.	Year	Up to March, 2018		Up to March, 2024	
	States/UTs	Non-RE	RE	Non-RE	RE
1	Andhra Pradesh	16507.20	8060.58	18125.34	11029.33
2	Arunachal Pradesh	0.00	517.00	0.00	1259.90
3	Assam	1103.95	378.39	1347.36	542.29
4	Bihar	5480.00	346.18	9060.00	450.15
5	Chhattisgarh	22968.00	785.42	23688.00	1683.39
6	Goa	48.00	1.08	48.00	45.47
7	Gujarat	23483.41	9339.45	25483.41	27461.72
8	Haryana	5971.59	510.49	5761.59	1832.92
9	Himachal Pradesh	0.00	10514.30	0.00	11356.16
10	Jammu & Kashmir	175.00	3650.22	175.00	3595.37
11	Jharkhand	4590.00	320.14	5570.00	395.55
12	Karnataka	10513.12	16241.59	10385.20	21441.94
13	Kerala	693.54	2282.06	693.54	3229.46
14	Ladakh	0.00	0	0.00	139.79
15	Madhya Pradesh	17065.00	6445.13	22000.00	9333.37
16	Maharashtra	29833.08	11519.21	28613.09	17530.12
17	Manipur	36.00	115.28	36.00	123.49
18	Meghalaya	0.00	418.85	0.00	395.07
19	Mizoram	0.00	100.16	0.00	135.78
20	Nagaland	0.00	108.51	0.00	110.84

Table 5.2 contd.

Sr. No.	Year	Up to March,2018		Up to March,2024	
	States/UTs	Non-RE	RE	Non-RE	RE
21	Odisha	7680.00	2364.94	9540.00	2825.03
22	Punjab	6540.00	2626.98	5680.00	3163.92
23	Rajasthan	10703.10	7289.36	12982.83	27103.89
24	Sikkim	0.00	2222.98	0.00	2344.15
25	Tamil Nadu	16638.90	13451.7	17777.88	22161.62
26	Telangana	6682.50	6507.48	9442.50	7604.40
27	Tripura	1132.10	24.53	1067.60	34.47
28	Uttar Pradesh	23776.10	3447.25	27328.14	5697.17
29	Uttarakhand	450.00	4379.83	664.00	4971.94
30	West Bengal	14495.00	1747.46	13567.00	1982.13
31	Andaman & Nicobar	40.05	12.05	92.71	35.16
32	Chandigarh	0.00	26.01	0.00	65.52
33	Dadar & Nagar Haveli/Daman & Diu	0.00	16.07	0.00	46.47
34	Delhi	3048.40	123.03	2208.40	340.51
35	Lakshadweep	0.00	3.14	26.83	4.97
36	Pondicherry	32.50	0.34	32.50	49.91
	Others		47.66		49.31
	Total	229687.00	115945.00	251396.92	190572.68

Source: National Power Portal (NPP), MoP & MNRE

CHAPTER 6

Installed capacity in RE sector

6.1 Region wise /state wise installed capacity in RE sector: Region wise data analysis for the years 2017-18 to 2023-24 reveals that western region recorded the highest growth of 99.60% with a compound annual growth rate (CAGR) of 12.21%, followed by Northern states with a growth of 78.91% and a CAGR of 10.18% in RE installed capacity. Despite topographical constraints, North Eastern states have also showed consistent growth, achieving a growth of 56.48% and a CAGR of 7.75%. Southern states reported a growth of 40.73 % and a CAGR of 5.86%, while Eastern states registered a growth of 14.52% with a CAGR of 2.29%. Additionally, Union Territories made significant contributions to RE capacity installation, collectively achieving a growth of 11.66% and a CAGR of 1.86%. For details of State wise /Region wise RE installed capacity from 2017-18 to 2023-24. (Refer table 6.1)

Table 6.1 Region wise / State wise RE Cumulative Installed Capacity from 2017-18 to 2023-24

(in MW)

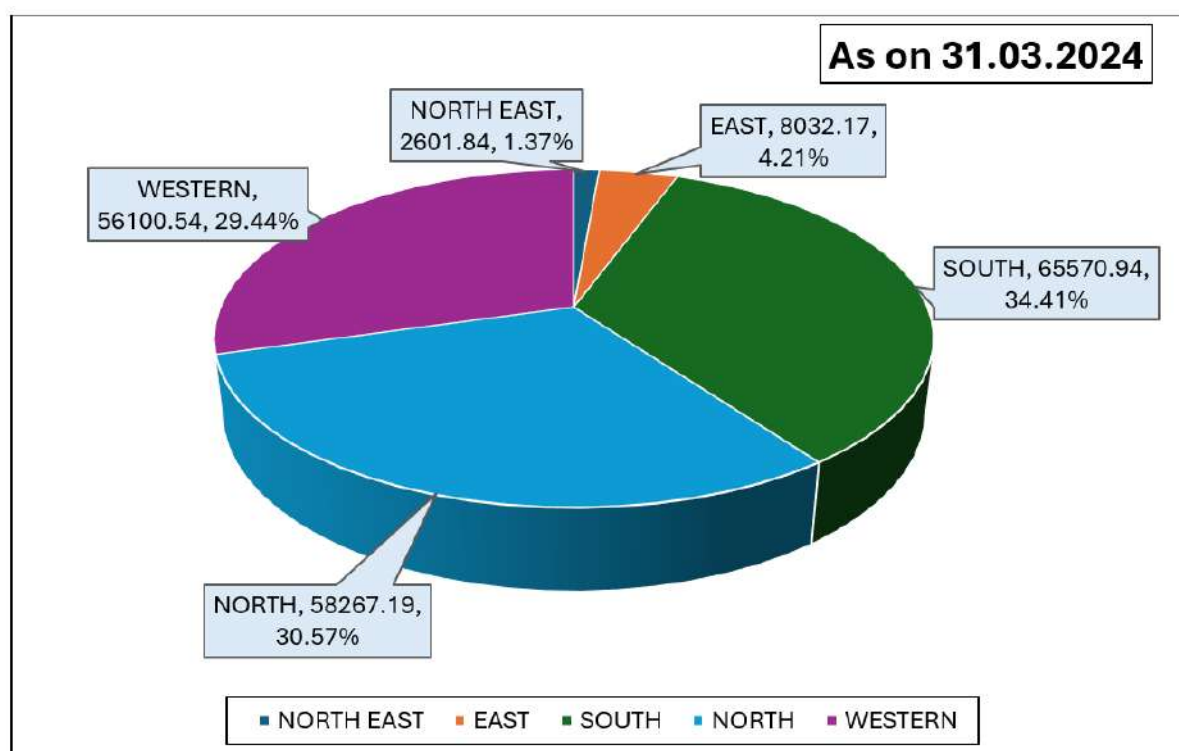
STATES / UTs	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24
NORTHERN REGION							
Haryana	510.49	519.11	547.19	762.51	1242.13	1362.09	1832.92
Himachal Pradesh	10514.30	10707.75	10768.91	10916.61	11303.49	11330.42	11356.16
Jammu & Kashmir	3650.22	3664.10	3581.11	3588.11	3551.61	3556.12	3595.37
Ladakh	0.00	0.00	89.00	89.00	136.44	137.79	139.79
Punjab	2626.98	2522.38	2566.86	2743.80	2864.12	2961.93	3163.92
Rajasthan	7289.36	8223.73	10134.97	10812.35	17451.62	22809.05	27103.89
Uttar Pradesh	3447.25	3739.46	3900.97	4563.07	4985.12	5282.65	5697.17
Uttarakhand	4379.83	4426.88	4437.96	4589.24	4787.15	4909.14	4971.94
Chandigarh	26.01	35.52	41.36	45.97	55.17	58.69	65.52
Delhi	123.03	180.35	218.62	246.43	270.12	302.26	340.51
NORTH-EASTERN REGION							
Arunachal Pradesh	517.00	655.69	955.98	1256.27	1257.34	1259.75	1259.90
Assam	378.39	414.58	433.86	437.67	504.05	534.04	542.29
Manipur	115.28	118.66	120.43	121.84	122.70	122.73	123.49
Meghalaya	418.85	372.18	372.18	372.18	372.48	372.48	395.07
Mizoram	100.16	101.20	102.52	103.45	104.37	133.49	135.78
Nagaland	108.51	108.51	108.51	108.58	108.71	110.71	110.84
Tripura	24.53	24.53	28.91	29.57	30.9	33.61	34.47
WESTERN REGION							
Chhattisgarh	785.42	850.77	864.89	886.52	989.08	1419.82	1683.39
Goa	1.08	4.09	5.29	7.95	20.34	26.88	45.47
Gujarat	9339.45	10697.72	12683.77	15204.25	18577.90	21425.85	27461.72
Madhya Pradesh	6445.13	6864.87	7285.75	7526.97	7703.88	8140.08	9333.37
Maharashtra	11519.21	12421.69	12822.27	13382.85	13704.08	15804.50	17530.12
Dadar & Nagar Haveli/Daman & Diu	16.07	19.93	25.32	46.01	46.18	46.47	46.47

Table 6.1 Contd.

STATES / UT's	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24
EASTERN REGION							
Bihar	346.18	352.23	365.09	376.63	387.35	389.60	450.15
Jharkhand	320.14	267.87	273.80	288.21	307.14	324.19	395.55
Odisha	2364.94	2681.68	2686.38	2715.63	2771.64	2782.57	2825.03
Sikkim	2222.98	2222.99	2223.05	2223.05	2338.79	2341.80	2344.15
West Bengal	1747.46	1849.29	1888.03	1923.44	1928.15	1962.77	1982.13
Andaman & Nicobar	12.05	17.22	17.68	34.71	34.74	35.16	35.16
SOUTHERN REGION							
Andhra Pradesh	8060.58	9560.02	10091.43	10696.14	10821.56	10970.18	11029.33
Karnataka	16241.60	17524.40	18918.13	19149.33	19593.79	20408.43	21441.94
Kerala	2282.06	2290.71	2304.35	2428.92	2527.2	2957.10	3229.46
Tamil Nadu	13451.72	14909.39	16588.84	17476.69	18277.5	20098.60	22161.62
Telangana	6507.48	6405.96	6442.85	6796.59	7364.79	7510.97	7604.40
Lakshadweep	3.14	3.14	3.27	3.27	3.27	3.27	4.97
Puducherry	0.34	3.32	5.69	9.51	13.69	35.53	49.91
Others	47.66	49.31	49.31	49.31	49.31	49.31	49.31
Total	115944.87	124811.22	133954.52	142012.61	156607.90	172009.98	190572.68

Source: MNRE & NPP, MoP

6.2 Share of various regions in the installed capacity as on 31.03.2024: Installed capacity under renewable energy across different regions as on 31st March, 2024, indicates significant variations. Southern Region leads with the highest share of 34.41%, followed closely by North with a share of 30.57%. Details may be seen at Fig 6.1

Fig 6.1 Region wise RE Installed Capacity**(in MW)**

6.3 RE Installed Capacity as on 31.03.2024:

As on 31st March, 2024, Gujarat, Rajasthan, Tamil Nadu, Karnataka and Maharashtra were the top five states in total renewable energy installed capacity. These top five states contributed significantly to the renewable energy sector, representing around 61% of total installed capacity of the country.

In solar energy sector, Rajasthan, Gujarat, Karnataka, Tamil Nadu, and Maharashtra were the top five states contributing 70.76% of the country's solar power installation. For wind power, Gujarat, Tamil Nadu, Karnataka, Maharashtra, Rajasthan, and Andhra Pradesh, were the leading states, contributing approximately 93.37% of the country's wind energy installation. Bioenergy sector had also experienced substantial growth, with Maharashtra, Uttar Pradesh, Karnataka and Tamil Nadu together contributes about 71.49% of the total renewable energy installed capacity. In the case of large hydro, Himachal Pradesh, Uttarakhand, Karnataka, Jammu and Kashmir, Maharashtra and Telangana contributed 57.15% of the total installed capacity in the country. (Refer Table 6.2)

6.4 State wise Installation of Various categories of Solar and Bio Power as on 31.03.2024:

In Solar Power installed capacity, most of the installations were from Ground-Mounted Solar systems, followed by Rooftop Solar & KUSUM projects. In Bio Power installation, the largest share was from Biomass Power and Bagasse Cogeneration. (Refer Table 6.3)

6.5 Installation of Off-grid / Decentralized Renewable Energy Systems / Devices as on 31.03.2024:

Decentralized, small-scale, and off-grid solutions are often better suited for meeting the energy needs of rural communities than large-scale projects. These solutions can be more cost-effective in areas with low population density, low energy demand, and limited infrastructure, using various renewable power sources such as solar home lighting, street lighting, power plants, pumps, lanterns and off-grid biogas plants. Details of off-grid / decentralized renewable energy system installation under schemes of MNRE is presented in table 6.4.

6.6 Renewable energy share in the total installed capacity within the state :

Share of Renewable Energy in installed capacity is 100% in the case of states/UTs, Arunachal Pradesh, Himachal Pradesh, Meghalaya, Mizoram, Nagaland, Sikkim, Ladakh, Chandigarh, Dadar & Nagar Haveli and Daman & Diu. This share is in between 60 % and 100% in the states/ UTs of Uttarakhand, Kerala, Manipur, Rajasthan, Karnataka, Jammu & Kashmir and Puducherry. (Refer Table 6.5)



Table 6.2 RE cumulative installed capacity as on 31.03.2024**(in MW)**

States /UTs	Small Hydro Power	Wind Power	Bio Power	Solar Power	Large Hydro	Total Capacity
Andhra Pradesh	163.31	4096.65	574.39	4584.98	1610.00	11029.33
Arunachal Pradesh	133.11		0.00	11.79	1115.00	1259.90
Assam	34.11		2.00	156.18	350.00	542.29
Bihar	70.70		140.22	239.23		450.15
Chhattisgarh	76.00		275.00	1212.39	120.00	1683.39
Goa	0.05		1.94	43.48		45.47
Gujarat	91.64	11722.72	112.48	13544.88	1990.00	27461.72
Haryana	73.50		283.70	1475.72		1832.92
Himachal Pradesh	969.71		10.20	95.23	10281.02	11356.16
Jammu & Kashmir	169.93		0.00	65.44	3360.00	3595.37
Jharkhand	4.05		19.10	162.40	210.00	395.55
Karnataka	1280.73	6019.61	1907.72	8544.68	3689.20	21441.94
Kerala	276.52	63.50	2.50	1022.79	1864.15	3229.46
Ladakh	42.99		0.00	7.80	89.00	139.79
Madhya Pradesh	123.71	2844.29	134.94	3995.43	2235.00	9333.37
Maharashtra	382.28	5207.98	2643.19	6249.67	3047.00	17530.12
Manipur	5.45		0.00	13.04	105.00	123.49
Meghalaya	55.03		13.80	4.24	322.00	395.07
Mizoram	45.47		0.00	30.31	60.00	135.78
Nagaland	32.67		0.00	3.17	75.00	110.84
Odisha	115.63		59.22	495.63	2154.55	2825.03
Punjab	176.10		567.25	1324.27	1096.30	3163.92
Rajasthan	23.85	5195.82	125.64	21347.58	411.00	27103.89
Sikkim	55.11		0.00	7.04	2282.00	2344.15
Tamil Nadu	123.05	10603.54	1045.45	8211.38	2178.20	22161.62
Telangana	90.87	128.10	221.67	4758.16	2405.60	7604.40
Tripura	16.01		0.00	18.46		34.47
Uttar Pradesh	49.10		2226.14	2920.33	501.60	5697.17
Uttarakhand	218.82		142.24	575.53	4035.35	4971.94
West Bengal	98.50		348.36	194.07	1341.20	1982.13
Andaman & Nicobar	5.25		0.00	29.91		35.16
Chandigarh			0.00	65.52		65.52
Dadar & Nagar Haveli/ Daman & Diu			0.00	46.47		46.47
Delhi			84.00	256.51		340.51
Lakshadweep			0.00	4.97		4.97
Puducherry			0.00	49.91		49.91
Others		4.30	0.00	45.01		49.31
Total	5003.25	45886.51	10941.15	81813.60	46928.17	190572.68

Table 6.3 Cumulative installed capacity of bio-power and solar power as on 31.03.2024.

(in MW)

States/UT's	Bio-Power				Solar Power		
	BM Power/ Bagasse Cogen.	BM Cogen. (Non-Bagasse)	Waste to Energy	Waste to Energy (Off-grid)	Ground Mounted Solar	Rooftop Solar	Off-grid Solar/ KUSUM
Andhra Pradesh	378.10	113.57	53.16	29.56	4298.52	198.12	88.34
Arunachal Pradesh					1.27	4.34	6.18
Assam		2.00			105	41.74	9.44
Bihar	112.50	26.40		1.32	146.06	71.89	21.28
Chhattisgarh	272.09	2.50		0.41	747.96	75.70	386.73
Goa			1.94		0.95	41.41	0.12
Gujarat	65.30	12.00	7.50	27.68	10028.37	3455.90	60.61
Haryana	151.40	111.26	11.20	9.84	265.8	590.67	617
Himachal Pradesh		9.20		1.00	41.85	19.31	11.165
Jammu & Kashmir					2.49	37.66	25.29
Jharkhand		19.10			21	91.87	49.53
Karnataka	1867.10	20.20	1.00	19.42	7920.47	593.90	30.31
Kerala		2.27		0.23	322.79	675.25	20.46
Ladakh					6	1.80	0.00
Madhya Pradesh	92.50	14.85	15.40	12.19	3550.33	346.07	81.90
Maharashtra	2568.00	16.40	12.59	46.20	3848.47	2071.55	319.15
Manipur					0.6	6.36	6.08
Meghalaya		13.80			0	0.21	4.03
Mizoram					22	1.96	6.35
Nagaland					0	1.00	2.17
Odisha	50.40	8.82			419.16	48.22	28.25
Punjab	299.50	231.79	10.75	25.21	886.27	356.65	81.36
Rajasthan	119.25	2.00		4.39	19534.08	1154.25	527.71
Sikkim					0	5.12	1.92
Tamil Nadu	969.10	43.55	6.40	26.40	7546.37	599.16	65.85
Telangana	158.10	3.30	45.80	14.47	4360.49	388.96	8.71
Tripura					5	4.78	8.58
Uttar Pradesh	1957.50	165.26		103.38	2435.46	265.10	219.77
Uttarakhand	72.72	60.00		9.52	298.4	262.71	14.42
West Bengal	300.00	43.52		4.84	113.8	67.13	12.99
Andaman & Nicobar					25.05	4.59	0.27
Chandigarh					6.34	58.37	0.81
Dadar & Nagar Haveli/ Daman & Diu					12.64	33.82	0.00
Delhi			84.00		9.84	245.21	1.46
Lakshadweep					2.45	0.00	2.52
Puducherry					0.88	48.85	0.18
Others					0	0.00	45.01
Total	9433.56	921.79	249.74	336.06	66986.16	11869.63	2765.96

Table 6.4 Installation of Off-grid / Decentralized Renewable Energy Systems / Devices as on 31.03.2024

State/UT	Biogas Plants (Nos)	SPV Pumps (Nos.)	Solar Photovoltaic (SPV) Systems			
			SLS	HLS	SL	PP
			(Nos.)	(Nos.)	(Nos.)	(KWP)
Andhra Pradesh	268628	34045	16460	22972	77803	3815.69
Arunachal Pradesh	3686	221	25,008	35065	218551	963.20
Assam	139435	45	29538	46879	647761	1605.00
Bihar	130091	2813	54147	12303	1735227	6905.00
Chhattisgarh	60717	119282	4538	42232	3311	31372.90
Goa	4245	45	707	393	1093	32.72
Gujarat	438320	14920	5004	9253	31603	13576.60
Haryana	64092	88937	34625	56727	93853	2321.25
Himachal Pradesh	47718	644	98800	22592	33909	1905.50
Jammu & Kashmir	3201	877	39076	144316	51224	8129.85
Jharkhand	7890	17655	14344	9450	790515	3769.90
Karnataka	516091	7734	5694	52638	7781	7854.01
Kerala	154879	826	1735	41912	54367	16268.39
Ladakh	0	0	-	-	-	-
Madhya Pradesh	383347	25138	16808	7920	529101	3654.00
Maharashtra	939275	91408	10420	3497	239297	3857.70
Manipur	2128	118	32767	24583	69722	1580.50
Meghalaya	11156	101	5800	14874	97360	2004.00
Mizoram	5857	37	20325	12060	155,217	3894.60
Nagaland	7954	68	16045.00	1045.00	30766.00	1506.00
Odisha	271932	10962	19,109.00	5274.00	99843.00	2321.51
Punjab	189148	17534	43,758	8,626	17495	2066.00
Rajasthan	73145	118784	8934.00	187968.00	225851.00	30449.00
Sikkim	9044	0	504	15059	45200	850.00
Tamil Nadu	224148	8695	41419	298641	16818	13052.60
Telangana	316870	424	2458	-	142000	7450.00
Tripura	4132	2268	15,517	32723	364012	867.00
Uttar Pradesh	441447	60862	302532	235909	2351205	10638.31
Uttarakhand	366083	344	43803	91595	165071	4059.53
West Bengal	1216	653	18203	145332	17662	1730.00
Andaman & Nicobar	97	5	1490	468	6296	167.00
Chandigarh	169	12	901	275	1675	730.00
Dadar & Nagar Haveli	681		-	-	-	-
Daman & Diu	0		-	-	-	-
Delhi	587	90	301	-	4,807	1269.00
Lakshadweep	0		4465	600	5289	2190.00
Puducherry	17541	21	417	25	1637	121.00
Others	--	4621	9150	140273	125797	23885.00
Total	5104950	630189	944802	1723479	8459119	216862.67

SLS =Street Lightening System, HLS=Home Lightening System, SL=Solar Lantern, PP= Power Plants, SPV=Solar Photo Voltaic

Table 6.5 Share of RE in Cumulative Installed Capacity as on 31.03.2024**(in MW)**

STATES / Uts	Non-RE	RE			Grand Total	Share (%)	
		RES	Hydro	Total		RES	RE
Andhra Pradesh	18125.34	9419.33	1610.00	11029.33	29154.67	32.31	37.83
Arunachal Pradesh	0.00	144.90	1115.00	1259.90	1259.90	11.50	100.00
Assam	1347.36	192.29	350.00	542.29	1889.64	10.18	28.70
Bihar	9060.00	450.15	0.00	450.15	9510.15	4.73	4.73
Chhatisgarh	23688.00	1563.39	120.00	1683.39	25371.39	6.16	6.63
Goa	48.00	45.47	0.00	45.47	93.47	48.65	48.65
Gujarat	25483.41	25471.72	1990.00	27461.72	52945.13	48.11	51.87
Haryana	5761.59	1832.92	0.00	1832.92	7594.51	24.13	24.13
Himachal Pradesh	0.00	1075.14	10281.02	11356.16	11356.16	9.47	100.00
Jammu & Kashmir	175.00	235.37	3360.00	3595.37	3770.37	6.24	95.36
Jharkhand	5570.00	185.55	210.00	395.55	5965.55	3.11	6.63
Karnataka	10385.20	17752.74	3689.20	21441.94	31827.15	55.78	67.37
Kerala	693.54	1365.31	1864.15	3229.46	3923.00	34.80	82.32
Ladakh	0.00	50.79	89.00	139.79	139.79	36.33	100.00
Madhya Pradesh	22000.00	7098.37	2235.00	9333.37	31333.37	22.65	29.79
Maharashtra	28613.09	14483.12	3047.00	17530.12	46143.21	31.39	37.99
Manipur	36.00	18.49	105.00	123.49	159.49	11.59	77.43
Meghalaya	0.00	73.07	322.00	395.07	395.07	18.50	100.00
Mizoram	0.00	75.78	60.00	135.78	135.78	55.81	100.00
Nagaland	0.00	35.84	75.00	110.84	110.84	32.33	100.00
Odisha	9540.00	670.48	2154.55	2825.03	12365.03	5.42	22.85
Punjab	5680.00	2067.62	1096.30	3163.92	8843.92	23.38	35.78
Rajasthan	12982.83	26692.89	411.00	27103.89	40086.72	66.59	67.61
Sikkim	0.00	62.15	2282.00	2344.15	2344.15	2.65	100.00
Tamil Nadu	17777.88	19983.42	2178.20	22161.62	39939.50	50.03	55.49
Telangana	9442.50	5198.80	2405.60	7604.40	17046.90	30.50	44.61
Tripura	1067.60	34.47	0.00	34.47	1102.07	3.13	3.13
Uttar Pradesh	27328.14	5195.57	501.60	5697.17	33025.31	15.73	17.25
Uttarakhand	664.00	936.59	4035.35	4971.94	5635.94	16.62	88.22
West Bengal	13567.00	640.93	1341.20	1982.13	15549.13	4.12	12.75
Andaman & Nicobar	92.71	35.16	0.00	35.16	127.87	27.50	27.50
Chandigarh	0.00	65.52	0.00	65.52	65.52	100.00	100.00
Dadar & Nagar Haveli/Daman & Diu	0.00	46.47	0.00	46.47	46.47	100.00	100.00
Delhi	2208.40	340.51	0.00	340.51	2548.91	13.36	13.36
Lakshadweep	26.83	4.97	0.00	4.97	31.80	15.63	15.63
Pondicherry	32.50	49.91	0.00	49.91	82.41	60.56	60.56
Others		49.31		49.31			
Total	251396.92	143644.51	46928.17	190572.68	441969.6	32.50	43.12

Energy generation - RE and Non-RE Sector

7.1 Share of Renewable Energy in total energy generation during 2023-24:

Rajasthan, Gujarat, Karnataka, Himachal Pradesh, and Tamil Nadu were the top five states during 2023-24, in energy generation through Renewable Energy sources, including large Hydro, collectively contributing approximately 56% of the country's total Energy generation through Renewable Energy. (Refer table 7.1)

7.2 Generation of energy from various Renewable Energy Sources:

During 2023-24, around 73% of the total energy generation in the country through the sources of Solar, Wind, Bio Power and Small Hydro Power were in the states of Rajasthan, Gujarat, Karnataka, Tamil Nadu, and Maharashtra. In solar energy sector, Rajasthan, Karnataka, Gujarat, Tamil Nadu, and Andhra Pradesh were the top five states, accounting for more than 75% of the country's solar power generation. Wind power generation was prominent in Gujarat, Tamil Nadu, Karnataka, Andhra Pradesh, Rajasthan and Maharashtra and they constitute about 93% wind power generation of the country. Bioenergy sector had also seen significant growth, with Maharashtra, Uttar Pradesh, Karnataka, West Bengal, and Chhattisgarh contributing about 74% of the total Renewable Energy generation from bioenergy sources.

Large hydro power energy generation was concentrated in Himachal Pradesh, Jammu & Kashmir, Uttarakhand, Karnataka, and Sikkim, which collectively generated about 62% of the Renewable Energy from large hydro sources. Small hydro power generation was led by Himachal Pradesh, Karnataka, Maharashtra, Kerala, and Punjab, with these states contributing 65% of the total small hydro Power generation. (Refer Table 7.2)

Table 7.1 Share (%) of RE generation in Total Energy Generation during 2023-24**(in MU)**

S.No.	STATES / UTs	Non-RE	RE			Grand Total	Share(%)	
			RES	Hydro	Total		RES	RE
1	Andhra Pradesh	71243.65	17464.48	1373.19	18837.67	90081.32	19.39	20.91
2	Arunachal Pradesh	0.00	2.55	4278.18	4280.73	4280.73	0.06	100.00
3	Assam	8433.38	381.26	614.70	995.96	9429.34	4.04	10.56
4	Bihar	58361.80	342.08	0.00	342.08	58703.88	0.58	0.58
5	Chhatisgarh	162388.63	2477.44	321.76	2799.20	165187.83	1.50	1.69
6	Goa	0.00	67.95	0.00	67.95	67.95	100.00	100.00
7	Gujarat	92359.35	38483.22	4556.33	43039.55	135398.90	28.42	31.79
8	Haryana	28197.43	1651.50	0.00	1651.50	29848.93	5.53	5.53
9	Himachal Pradesh	0.00	2586.52	36365.85	38952.37	38952.37	6.64	100.00
10	Jammu & Kashmir	0.00	408.69	15874.24	16282.93	16282.93	2.51	100.00
11	Jharkhand	35764.81	20.38	196.80	217.18	35981.99	0.06	0.60
12	Karnataka	51969.23	30526.55	8973.17	39499.72	91468.95	33.37	43.18
13	Kerala	0.00	2204.24	5155.72	7359.96	7359.96	29.95	100.00
14	Ladakh	0.00	0.00	388.48	388.48	388.48	0.00	100.00
15	Madhya Pradesh	148680.03	9655.02	6444.78	16099.80	164779.83	5.86	9.77
16	Maharashtra	145008.01	18765.41	5264.49	24029.90	169037.91	11.10	14.22
17	Manipur	0.00	8.96	298.18	307.14	307.14	2.92	100.00
18	Meghalaya	0.00	66.55	808.58	875.13	875.13	7.60	100.00
19	Mizoram	0.00	99.11	118.63	217.74	217.74	45.52	100.00
20	Nagaland	0.00	81.14	165.47	246.61	246.61	32.90	100.00
21	Odisha	65756.82	1261.72	6162.20	7423.92	73180.74	1.72	10.14
22	Punjab	32462.85	4122.40	4676.42	8798.82	41261.67	9.99	21.32
23	Rajasthan	68682.37	47150.89	1013.97	48164.86	116847.23	40.35	41.22
24	Sikkim	0.00	12.36	8609.85	8622.21	8622.21	0.14	100.00
25	Tamil Nadu	90145.04	29603.31	3563.28	33166.59	123311.63	24.01	26.90
26	Telangana	56913.73	7509.10	1243.29	8752.39	65666.12	11.44	13.33
27	Tripura	6353.31	5.09	0.00	5.09	6358.40	0.08	0.08
28	Uttar Pradesh	156999.35	7201.59	850.64	8052.23	165051.58	4.36	4.88
29	Uttarakhand	609.78	933.72	13919.23	14852.95	15462.73	6.04	96.06
30	West Bengal	89513.96	1920.39	2816.49	4736.88	94250.84	2.04	5.03
31	Andaman & Nicobar	335.79	39.50	0.00	39.50	375.29	10.53	10.53
32	Chandigarh	0.00	11.70	0.00	11.70	11.70	100.00	100.00
33	Dadar & Nagar Haveli/Daman & Diu	0.00	28.86	0.00	28.86	28.86	100.00	100.00
34	Delhi	3755.14	728.81	0.00	728.81	4483.95	16.25	16.25
35	Lakshadweep	64.79	0.09	0.00	0.09	64.88	0.14	0.14
36	Puducherry	224.10	12.24	0.00	12.24	236.34	5.18	5.18
	Total	1374223	225834.8	134053.9	359888.7	1734112	13.02	20.75

Source: CEA, MoP

Table 7.2 State-wise Renewable Energy generation during 2023-24.**(in MU)**

States /UTs	Small Hydro Power	Wind Power	Bio Power	Solar Power	Large Hydro	Total
Andhra Pradesh	127.10	8644.00	393.35	8300.03	1373.19	18837.67
Arunachal Pradesh	0.66		0.00	1.89	4278.18	4280.73
Assam	64.20		0.75	316.31	614.70	995.96
Bihar	5.92		140.98	195.19	0.00	342.08
Chhattisgarh	145.54		1388.15	943.75	321.76	2799.20
Goa			7.96	59.99		67.95
Gujarat	217.68	24794.50	2.13	13468.91	4556.33	43039.55
Haryana	222.05		436.54	992.91		1651.50
Himachal Pradesh	2526.98			59.54	36365.85	38952.37
Jammu & Kashmir	408.69				15874.24	16282.93
Ladakh					388.48	388.48
Jharkhand	2.74			17.64	196.80	217.18
Karnataka	1370.76	10950.20	2801.51	15404.09	8973.17	39499.72
Kerala	716.31	214.53	78.12	1195.28	5155.72	7359.96
Madhya Pradesh	469.6	4949.78	210.46	4025.19	6444.78	16099.80
Maharashtra	888.48	8228.97	3833.83	5814.13	5264.49	24029.90
Manipur			1.23	7.73	298.18	307.14
Meghalaya	66.55				808.58	875.13
Mizoram	95.93			3.19	118.63	217.74
Nagaland	81.14				165.47	246.61
Odisha	407.97		96.07	757.69	6162.20	7423.92
Punjab	636.97		811.43	2673.99	4676.42	8798.82
Rajasthan	7.45	8390.67	387.55	38365.21	1013.97	48164.86
Sikkim	12.35				8609.86	8622.21
Tamil Nadu	206	16908.08	751.75	11737.48	3563.28	33166.59
Telangana	58.87	304.63	260.94	6884.68	1243.29	8752.39
Tripura	0.00		0.00	5.09	0.00	5.09
Uttar Pradesh	175.24		3055.05	3971.31	850.64	8052.23
Uttarakhand	353.40		248.52	331.8	13919.23	14852.95
West Bengal	204.46		1547.62	168.32	2816.49	4736.88
Andaman & Nicobar	12.00		0.00	27.5		39.50
Chandigarh			0.00	11.7		11.70
Dadar & Nagar Haveli/ Daman & Diu			13.12	15.74		28.86
Delhi			522.28	206.53		728.81
Lakshadweep				0.09		0.09
Puducherry				12.24		12.24
Others	-					
Total	9485.04	83385.35	16989.33	115975.11	134053.93	359888.74

Source: CEA, MoP

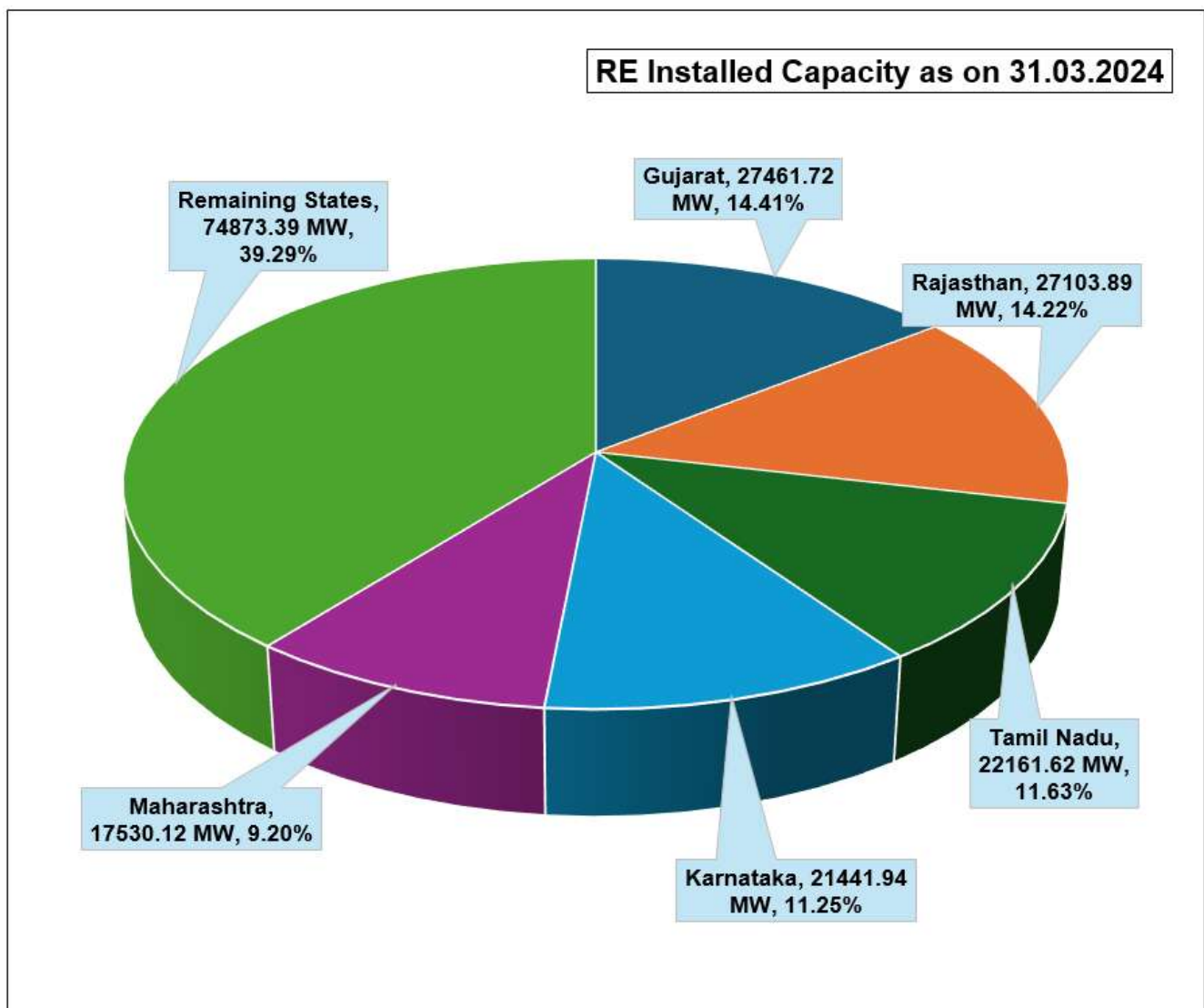
CHAPTER 8

Top 5 states in Renewable Energy Installed Capacity

8.1 Top 5 states in RE installed capacity and their contribution in the country's cumulative RE Installed Capacity: Gujarat, Rajasthan, Karnataka, Tamil Nadu and Maharashtra were the top 5 states in terms of their installed capacity in Renewable energy sector in the country. Total share of renewable energy in installed capacity as on 31.03.2024 shows that Gujarat emerges as the frontrunner with the largest share, standing at approximately 14.41%, followed closely by Rajasthan with 14.22% share. States of Tamil Nadu, Karnataka and Maharashtra contributes with shares of 11.63%, 11.25% and 9.20% respectively. Remarkably, these five states collectively command a significant portion, accounting for around 61% of India's total installed capacity in renewable energy. (Refer Fig 8.1)

Fig 8.1 Top 5 states in RE installed capacity and its share (%)

(in MW)

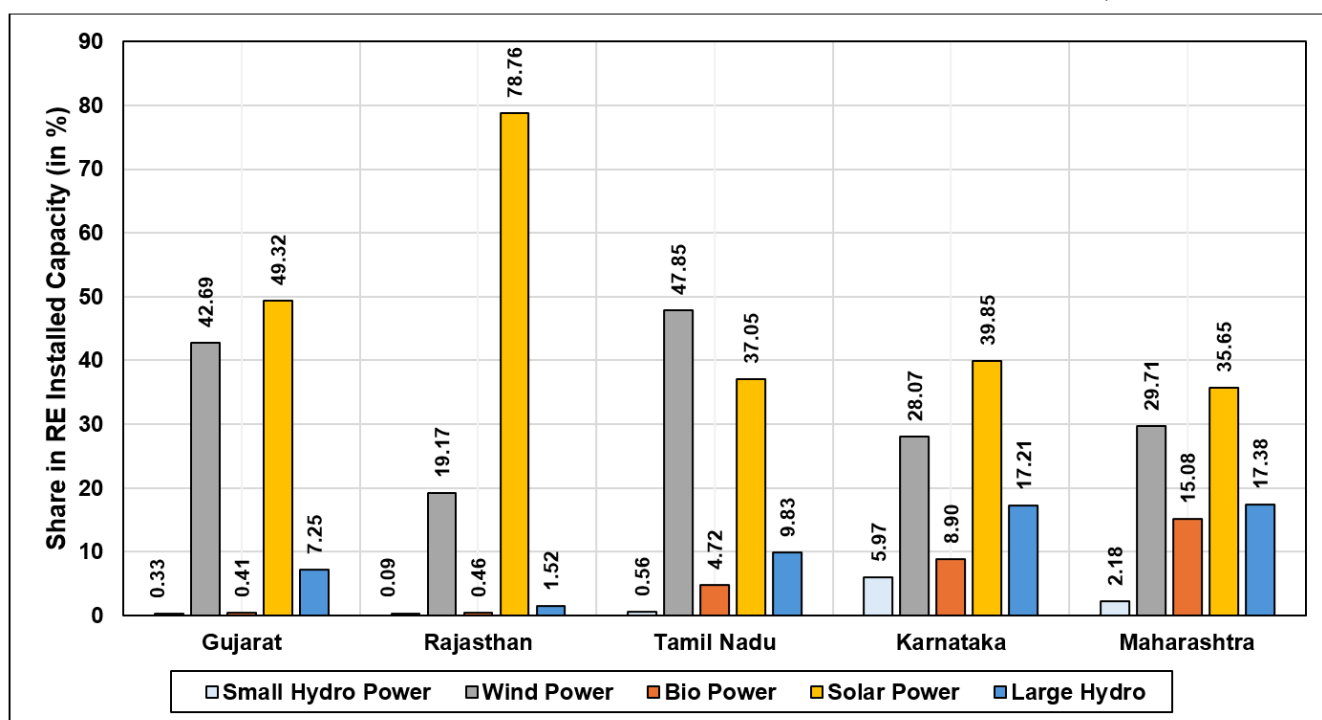


8.2 Contribution of various RE sources of top 5 RE installed capacity states within the respective state's RE installed Capacity:

Analysis of the contribution of various renewable energy sources of the top 5 states within their respective RE installed capacity as on 31st March 2024, revealed that solar power had the largest share in all the states except Tamil Nadu. Rajasthan led with a 78.76% contribution from Solar installed capacity. In the case of wind power, Tamil Nadu held the largest share having 47.85% in the state. With respect to large hydro sector, among top five states in RE installed capacity, Maharashtra had the highest share of 17.38%. For biopower, Maharashtra led with a 15.08% share. Regarding small hydro power, Karnataka had the highest share at 5.97% among the top five states. (Refer Fig 8.2).

Fig 8.2 Share of various RE sources of top 5 RE installed capacity states within the state's RE installed capacity

(As on 31.03.2024)

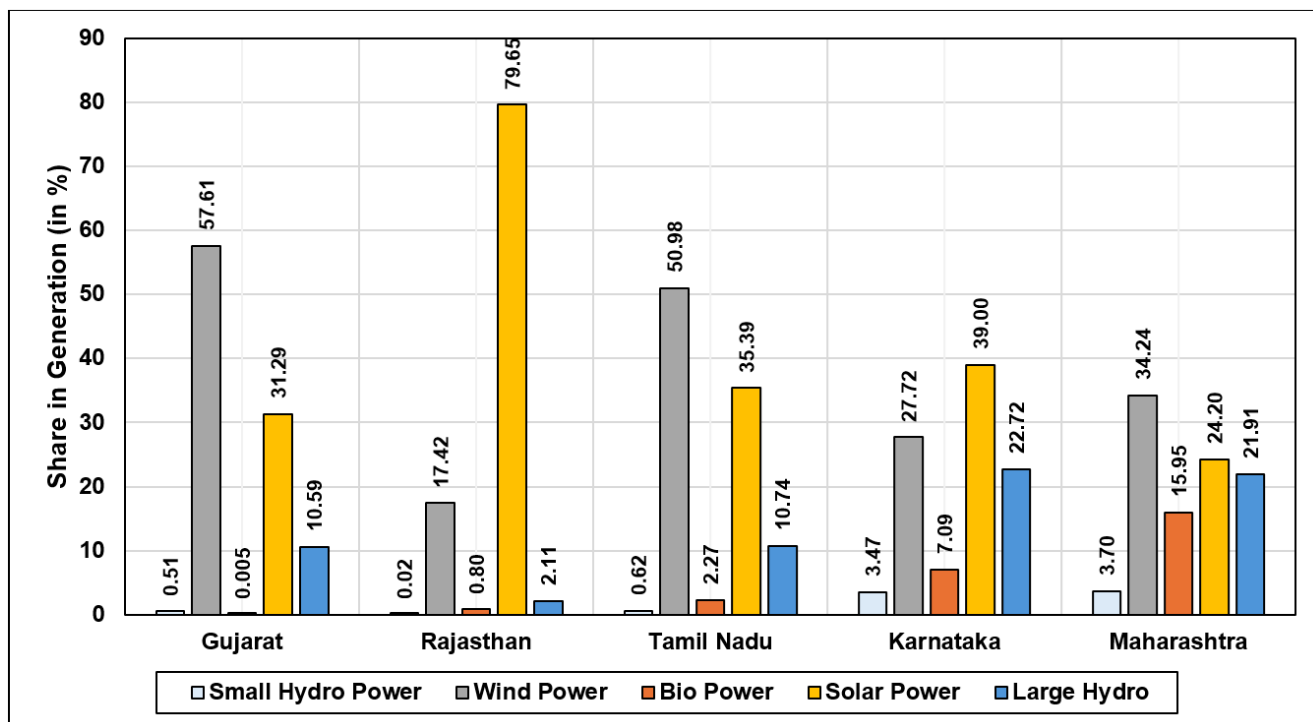


8.3 Contribution of various RE sources of top 5 RE installed capacity states in RE generation within the respective states:

Among the top 5 RE installed capacity states, Solar power had the largest share in Rajasthan and Karnataka in RE generation contributing 79.65% and 39.00% respectively within their states. Wind power had the largest contribution in Gujarat, Tamil Nadu and Maharashtra having share of 57.61%, 50.98 % and 34.24% respectively. Hydro power contribution was highest in Karnataka followed by Maharashtra having share of 22.72% and 21.91% respectively. Bio power generation was highest in Maharashtra having 15.95% share in the RE generation of the state. In the case of small hydro power generation, Maharashtra had the largest share of 3.70 % among the top five states. (Refer Fig. 8.3)

Fig 8.3 Share of the various RE sources of top 5 RE installed capacity states within their respective total RE generation

(During 2023-24)



CHAPTER 9

Gujarat

9.1 Status of RE and Non-RE sector in Gujarat: Gujarat was the largest contributor of renewable energy installed capacity in the country as on 31st March 2024 having an installation of 27.46 GW with a share of 14.41%. Over six-year period, installed capacity under renewable energy has been increased 2.94 times by 2023-24 from the installed capacity of 2017-18, against 1.09 times increase of capacity installation under Non-RE sector during the period. Annual growth of RE installed capacity has been robust, with the highest annual growth of 28.17% recorded in 2023-24. RE installed capacity contribution of 28.45% had grown to 51.87% during last 6 years in Gujarat indicating a substantial shift towards cleaner energy sources by the state. Installation of solar power is dominated with a contribution of 49.32% followed by wind power with 42.69% whereas maximum energy generation under RE sector was from wind power with contribution of 57.61% followed by solar power generation with a share of 31.29% during 2023-24. Out of the total energy generation in the state during 2023-24, 31.79% was from RE sector. During 2023-24, Gujarat was the second-largest contributor to renewable energy generation in the country, with a total generation of 43.04 billion units (BU) with 11.96% share. For energy generated from solar, wind, bio power, and small hydro power, Gujarat also ranked second by producing energy of 38.48 BU and contributing 17.04% of the total RE generation of the country. Subsequent sections provide an in-depth examination of Gujarat's energy sector, with particular focus on the Renewable Energy sector.

INSTALLED CAPACITY

Table 9.1.1 Installed Capacity under 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	9339.39	23483.41	32822.80	28.45	71.55		
2018-19	10697.66	23483.41	34181.07	31.30	68.70	14.54	0.00
2019-20	12683.77	24223.41	36907.18	34.37	65.63	18.57	3.15
2020-21	15204.25	24083.41	39287.66	38.70	61.30	19.87	-0.58
2021-22	18577.90	24083.41	42661.31	43.55	56.45	22.19	0.00
2022-23	21425.85	24083.41	45509.26	47.08	52.92	15.33	0.00
2023-24	27461.72	25483.41	52945.13	51.87	48.13	28.17	5.81
Gr (2017-18 to 2023-24)	194.04	8.52	61.31				
CAGR (2017-18 to 2023-24)	19.69	1.37	8.29				

Source :NPP, MoP & MNRE

Gr=Growth (%)

CAGR=Compound Annual Growth Rate

Fig. 9.1.1 Share of RE Installed Capacity

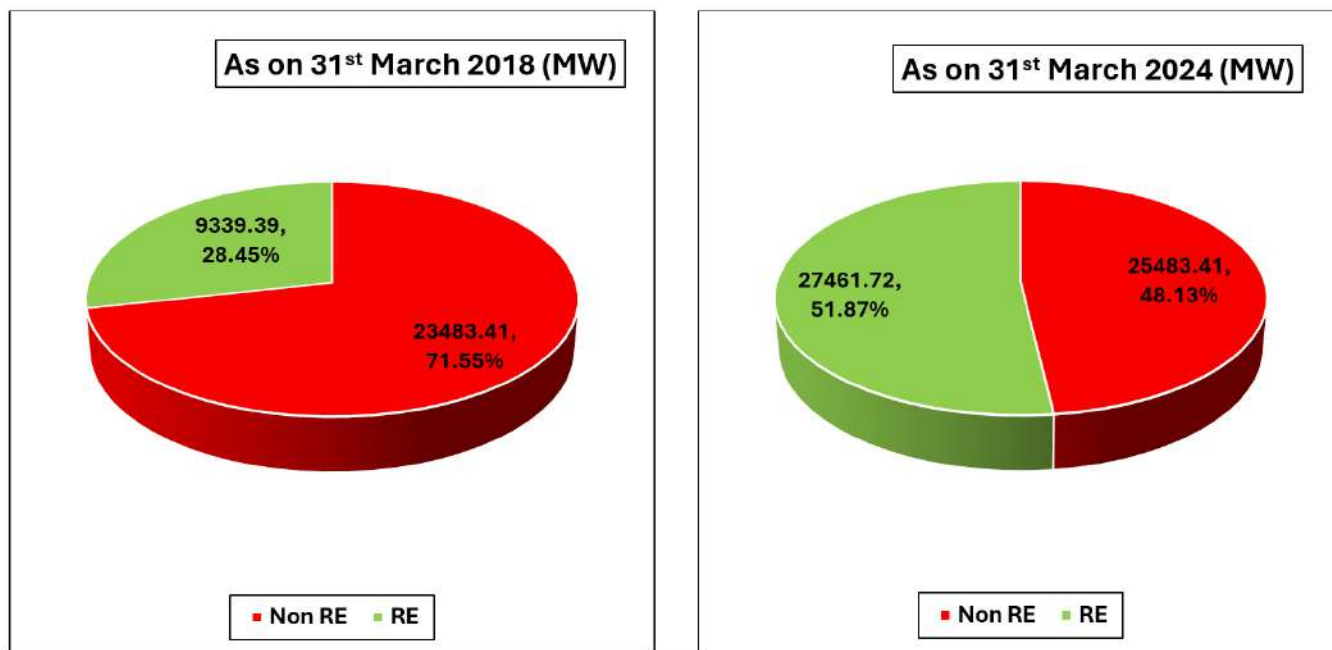
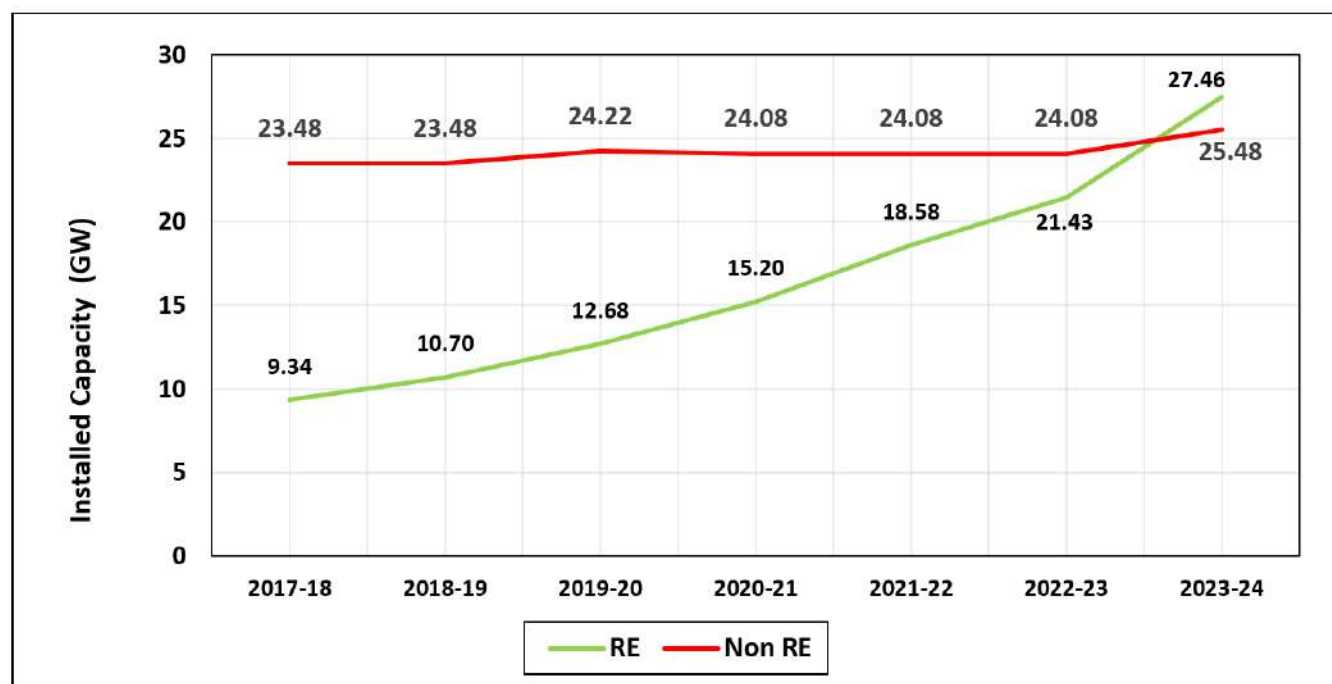
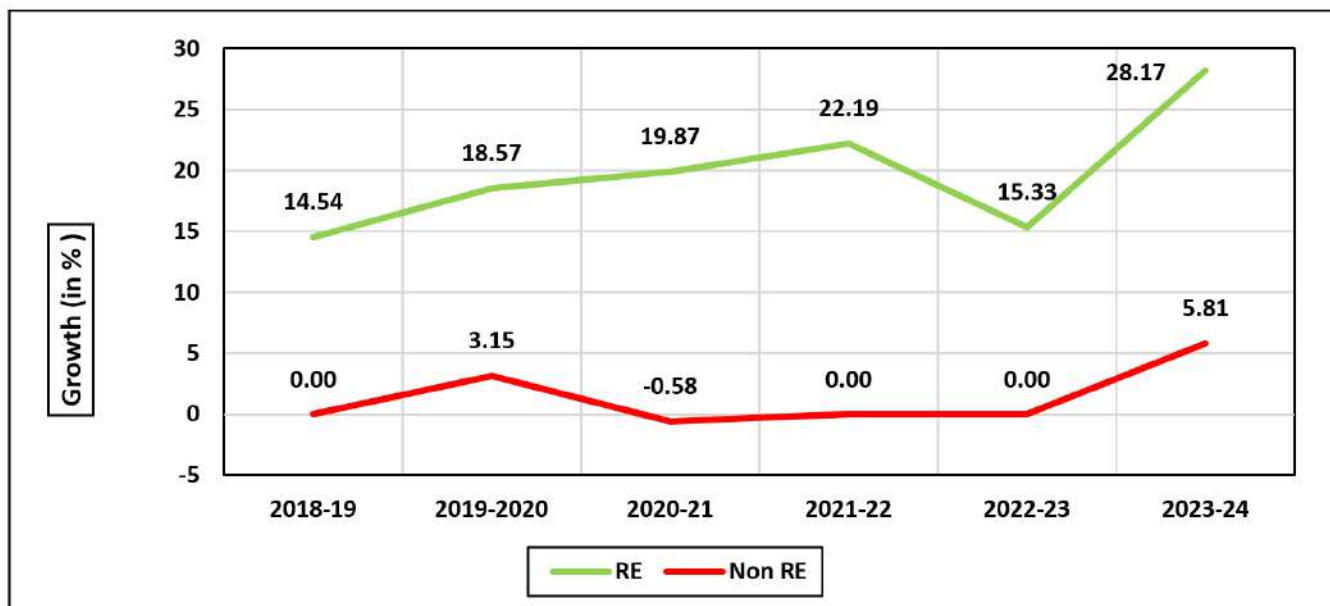


Fig 9.1.2 Trend in Capacity installation



Renewable Energy (RE) capacity has surged significantly during 2018-19 to 2023-24 from 9339.39 MW to 27461.72 MW in Gujarat registering a growth of 194.04%. Installed capacity of Non-Renewable Energy (Non-RE) has remained relatively stable, with a slight increase from 23,483.41 MW of 2017-18 to 25,483.41 MW by 2023-24, reflecting an overall growth of just 8.52%. A milestone was achieved in 2023-24 as Renewable Energy installed capacity surpassed Non-Renewable Energy capacity for the first time in the state's history.

Fig 9.1.3 Year wise Growth (%) in Capacity Installation



Above graph reveals that RE growth has consistently been surpassed 14.53% annually. Conversely, non-RE growth has stagnated, showing no growth for three years, decline in one year, and only positive growth in two years during 2019-20 and 2023-24, during last 6 years.

9.2 Installed capacity under Solar, Wind, Bio Power and Small Hydro Power (RES):

The state's renewable energy landscape has transformed significantly over the past decade, with solar power leading the growth with a total increase of 1238.84 % during a 9 year period. Installation of Solar power capacity has registered a Compound Annual growth rate of 33.41% and that of wind power was 14.17%. For the first time in 2023-24, Solar power installations crossed the capacity installation of Wind power in the state of Gujarat. Details of installed capacity under RES is given in the **Table 9.2.1**.

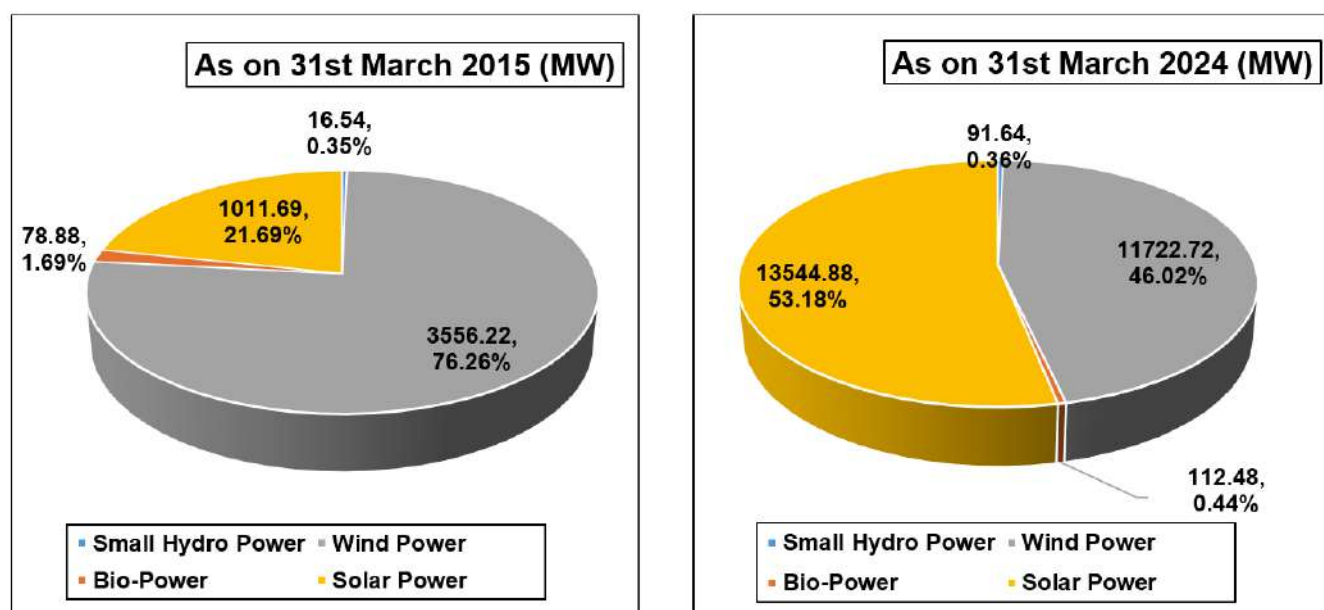
Table 9.2.1: Installed Capacity under solar, wind, bio power and small hydro power (RES) since 2014-15 (in MW)

Year	Small Hydro Power	Wind Power	Bio-Power	Solar Power	Total	Growth(%)
2014-15	16.60	3556.22	78.88	1011.69	4663.39	6.55
2015-16	16.60	3948.62	78.92	1137.82	5181.96	11.12
2016-17	16.60	5340.62	79.99	1278.19	6715.40	29.59
2017-18	28.60	5613.42	81.24	1626.19	7349.45	9.44
2018-19	61.30	6073.07	95.03	2478.32	8707.72	18.48
2019-20	68.95	7541.52	96.53	2986.77	10693.77	22.81
2020-21	82.69	8561.82	99.87	4469.87	13214.25	23.57
2021-22	89.39	9209.22	109.26	7180.03	16587.90	25.53
2022-23	91.64	9978.92	110.73	9254.56	19435.85	17.17
2023-24	91.64	11722.72	112.48	13544.88	25471.72	31.06
Gr (2014-15 to 2023-24)	452.05	229.64	42.60	1238.84	446.21	
CAGR (2014-15 to 2023-24)	20.90	14.17	4.02	33.41	20.76	

Gr=Growth (%)

CAGR=Compound Annual Growth Rate

Fig 9.2.1 Share of various sources in RES Cumulative Installed capacity



As on March 2015, wind power dominated with a share of 76.26% having 3556.22 MW installation, followed by Solar-Power installation of 1011.69 MW with a share of 21.69%. Bio-power had a 1.69% share having installation of 78.88 MW and Small Hydro Power had the least share of 0.35% with a cumulative installation of 16.54 MW. However, as on 31st March, 2024, solar power had a share of 53.18% with capacity installation of 13544.88 MW, followed by wind power having share of 46.02% with an installation of 11722.72 MW. Biopower contributed 0.44% with installation of 112.48 MW, and Small Hydropower accounted for 0.36 % with installed capacity of 91.64 MW.

Fig 9.2.2 Trend in cumulative Installed Capacity

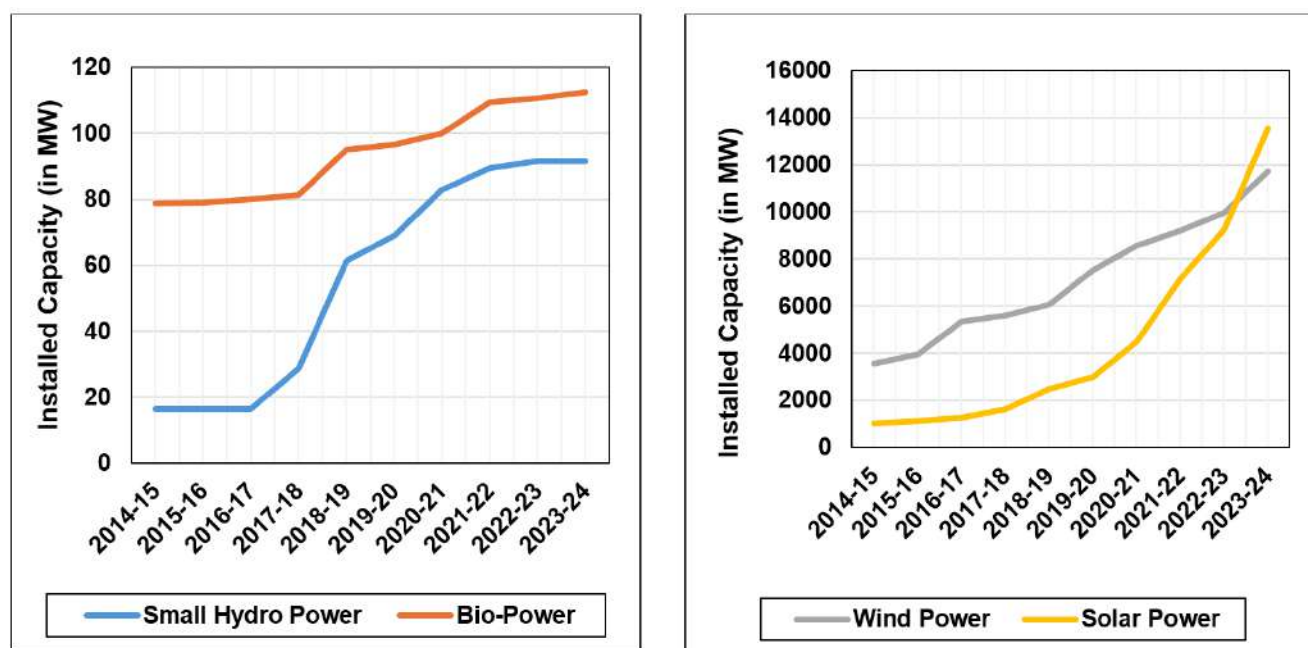
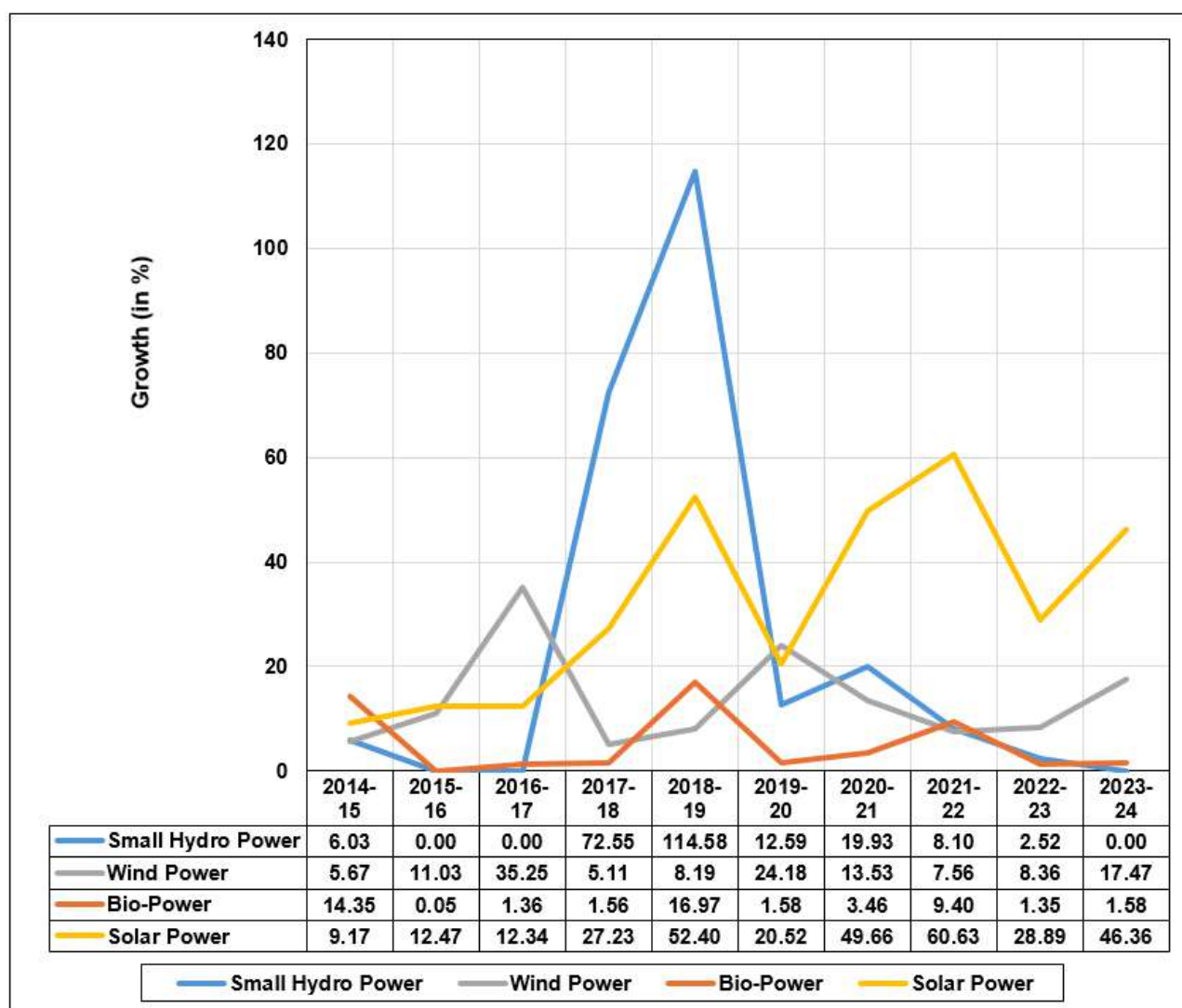


Fig 9.2.3 Year wise growth (%) in installed capacity



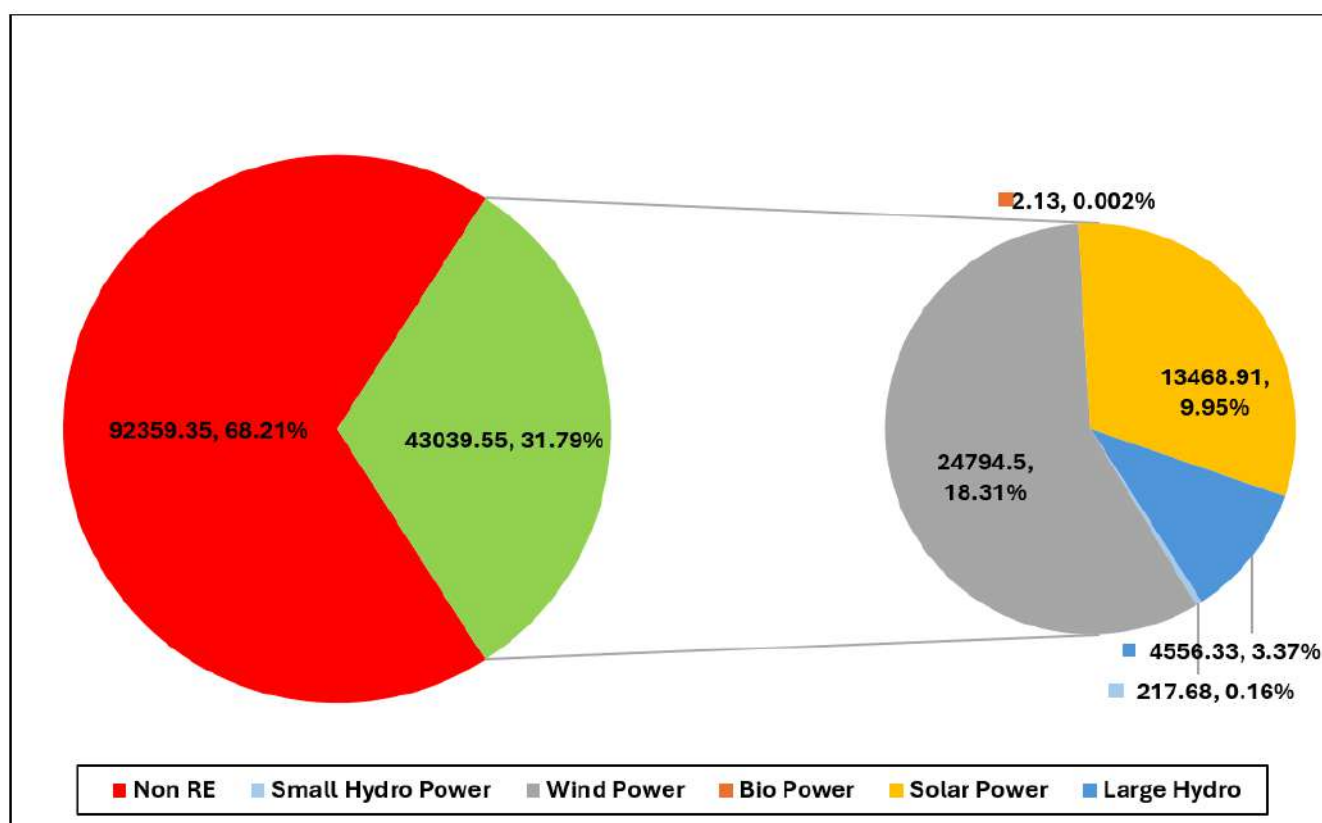
Graphs on trend of capacity installations and year wise growth indicate significant increase in renewable energy sources capacity installations in Gujarat, predominantly driven by solar power. Over the past decade, solar power capacity surged from 1011.69 MW to 13,544.88 MW with a significant year on year growth rate and Wind power capacity enhanced from 3556.22MW to 11,722.72 MW registering high year on year growth rate.

ENERGY GENERATION

9.3 Energy Generation during 2023-24: Total energy generation in Gujarat during 2023-24 was 135.40BU with a share of 31.79% from Renewable energy sources. Out of the total energy generation from Renewable Energy sources, maximum energy was generated from Wind Power followed by Solar Power. During 2023-24, Gujarat was the second-largest contributor to renewable energy generation in the country, with a total generation of 43.04 billion units (BU) with 11.96% share. For energy generated from solar, wind, bio power, and small hydro power, Gujarat also was in second position, producing 38.48 BU and contributing 17.04% of the total of the country. Fig 9.3 depicts the detailed share of RE and Non-RE generation in the total energy generation in the state of Gujarat.

Fig 9.3 RE share in total energy generation during 2023-24

(in MU)



CHAPTER 10

Rajasthan

10.1 Status of RE and Non-RE Sector in Rajasthan: Rajasthan was the second-largest contributor to renewable energy installed capacity in the country as on 31st March 2024 with an installation of 27.10 GW having a share of 14.22%. Renewable energy capacity has surged 3.72 times during last six years, significantly outpacing the 1.22 times growth in non-renewable energy capacity installations during the same period. Growth rates for RE installed capacity have been impressive, with the highest annual growth of 61.40% recorded in 2021-22. Share of RE sector in installed capacity has surged from 40.51% of 2017-18 to 67.61% by 2023-24, propelling Rajasthan's transition to clean energy. Under RE sector, installation of solar power is dominated in Rajasthan with the highest contribution of 78.76% followed by wind power with 19.17%. Rajasthan had a renewable energy generation share of 41.22% during 2023-24 within the state. Maximum energy generation under RE sector was from solar power itself with contribution of 79.65% followed by wind power generation with a share of 17.42% during 2023-24. Rajasthan was the largest contributor to renewable energy generation in the country during 2023-24, with a total generation of 48.16 billion units (BU) with 13.38% share. For energy generated from solar, wind, bio power, and small hydro power, Rajasthan maintained its top position, producing 47.15 BU and accounting for 20.88% of the total of the country. Following sections offer a granular analysis of Rajasthan's energy ecosystem, zeroing in on the Renewable Energy sector's achievements.

INSTALLED CAPACITY

Table 10.1.1 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	7289.36	10703.13	17992.49	40.51	59.49		
2018-19	8223.73	11363.13	19586.86	41.99	58.01	12.82	6.17
2019-20	10134.97	12023.13	22158.10	45.74	54.26	23.24	5.81
2020-21	10812.35	12023.13	22835.48	47.35	52.65	6.68	0.00
2021-22	17451.62	12683.13	30134.75	57.91	42.09	61.40	5.49
2022-23	22809.05	12682.83	35491.88	64.27	35.73	30.70	0.00
2023-24	27103.89	12982.83	40086.72	67.61	32.39	18.83	2.37
Gr (2017-18 to 2023-24)	271.83	21.30	122.80				
CAGR (2017-18 to 2023-24)	24.47	3.27	14.28				

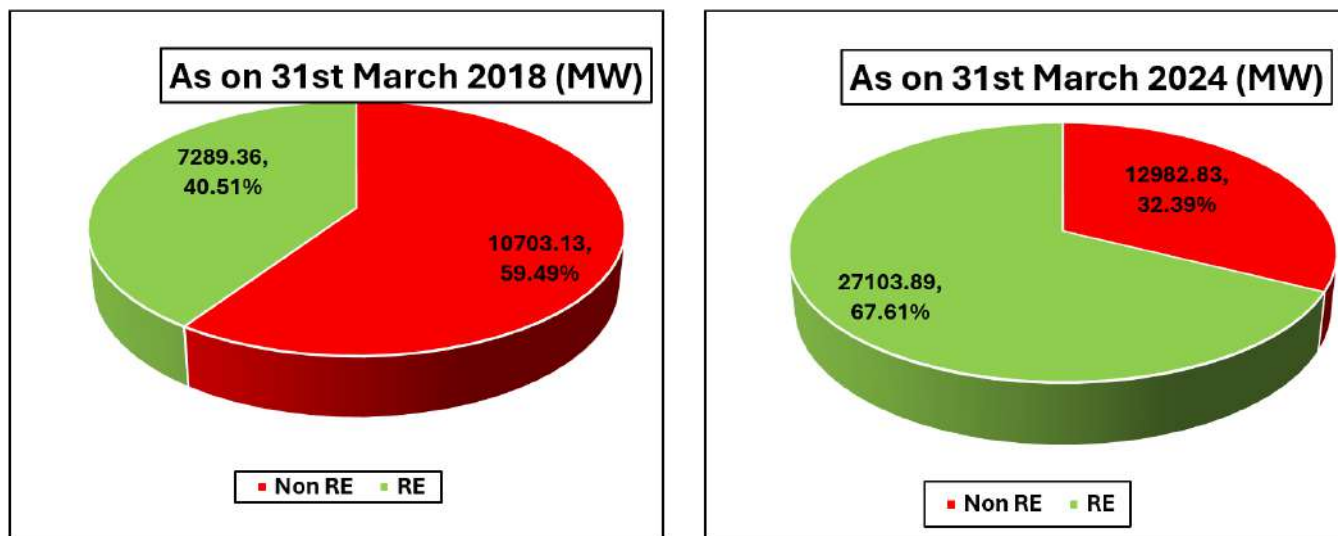
Source: NPP, MoP & MNRE

Gr=Growth (%)

CAGR=Compound Annual Growth Rate

Fig. 10.1.1 Share of RE in Installed Capacity

(in MW)



As on 31st March 2024, Rajasthan was the second-largest contributor to renewable energy installed capacity, with its share rising from 40.51% in March 2018 to 67.61% by March 2024. State's renewable energy capacity surged by 271.83%, from 7.29 GW to 27.10 GW, surpassing overall capacity growth of 122.80% and non-RE growth of 21.30% during these 6 years.

Fig 10.1.2 Trend in Capacity installation

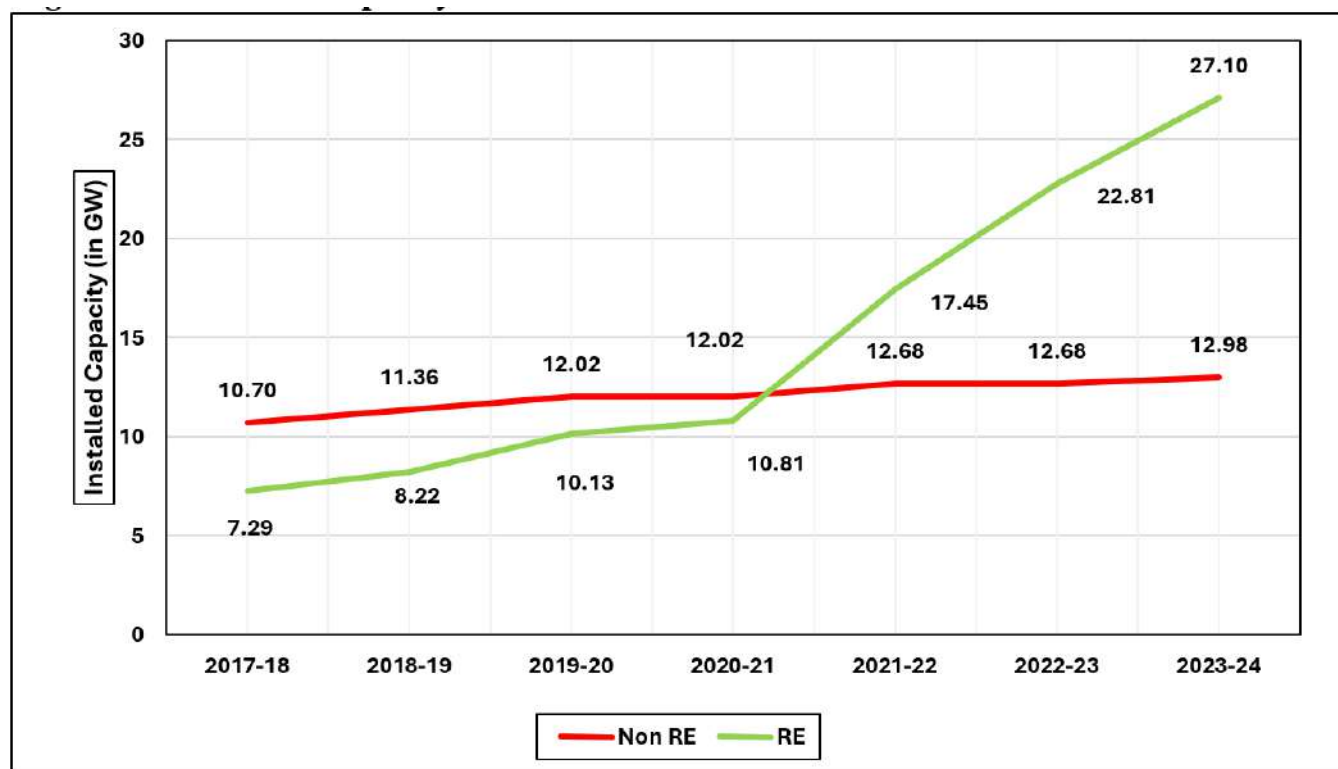
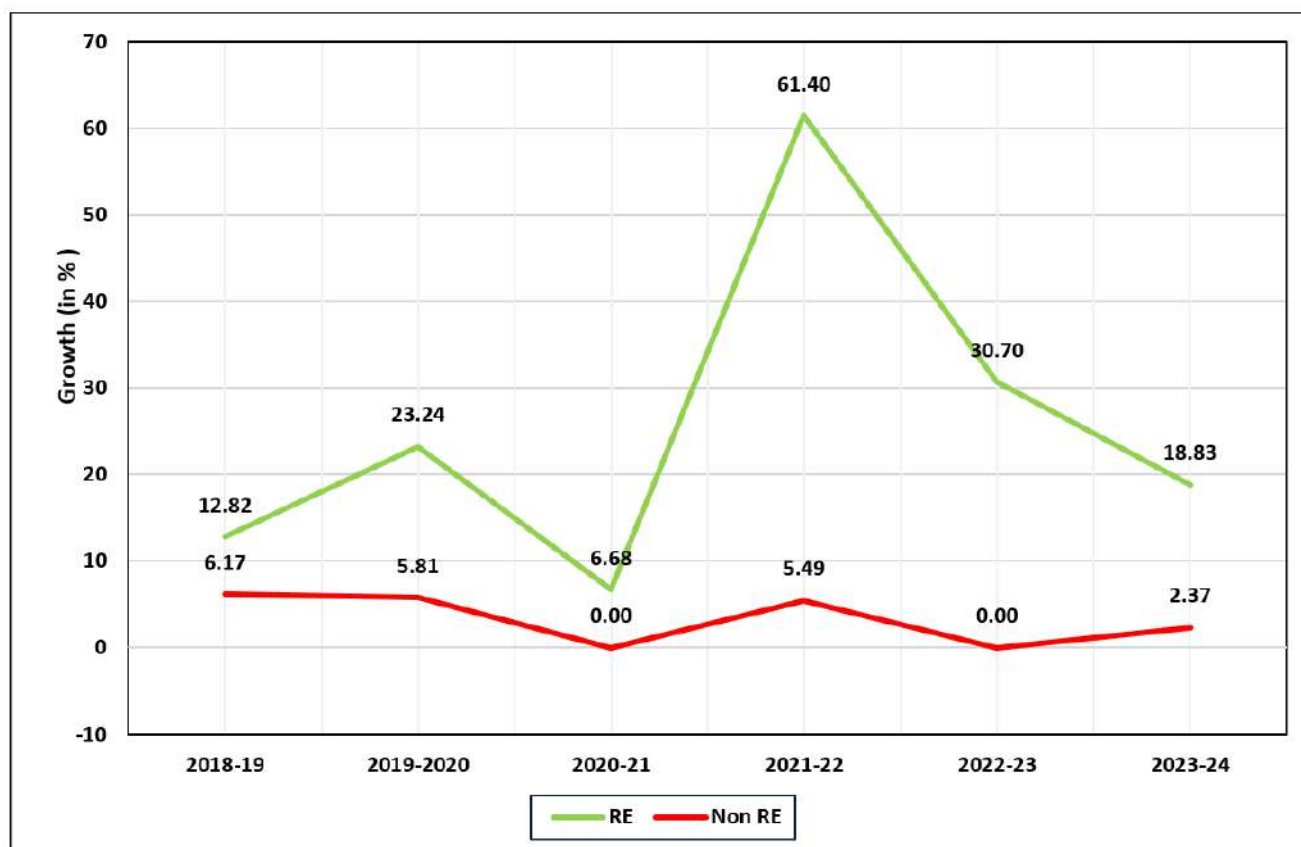


Fig 10.1.3 Growth (%) in Capacity Installation



Renewable Energy capacity has experienced a significant surge, increasing from 7,289.36 MW of 2017-18 to 27,103.89 MW by 2023-24. This remarkable growth of 271.83% underscores a strong shift towards renewable energy sources in Rajasthan. During 2021-22 itself Renewable Energy installed Capacity in the state crossed Non-RE installations registering a highest annual growth of 61.40% of Renewable Energy installed capacity. In contrast, the installed capacity of Non-Renewable Energy (Non-RE) has shown modest growth, rising from 10,703.13 MW in 2017-18 to 12,982.83 MW by 2023-24, representing a growth of 21.30% during the period. Year on year growth rate of RE sector in the state have been impressive which has consistently exceeded 12.82%, except for 2020-21, which saw a growth of 6.68%.

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

Renewable energy landscape of Rajasthan has transformed significantly over the past decade, with solar power leading the growth. Installation of Solar power capacity has registered a Compound Annual growth rate of 40.51% and that of wind power was 5.14%. Details of installed capacity under RES is given in the **Table 10.2.1**.

Table 10.2.1 : Installed Capacity under Solar, wind, Bio Power and Small Hydro Power (RES) since 2014-15

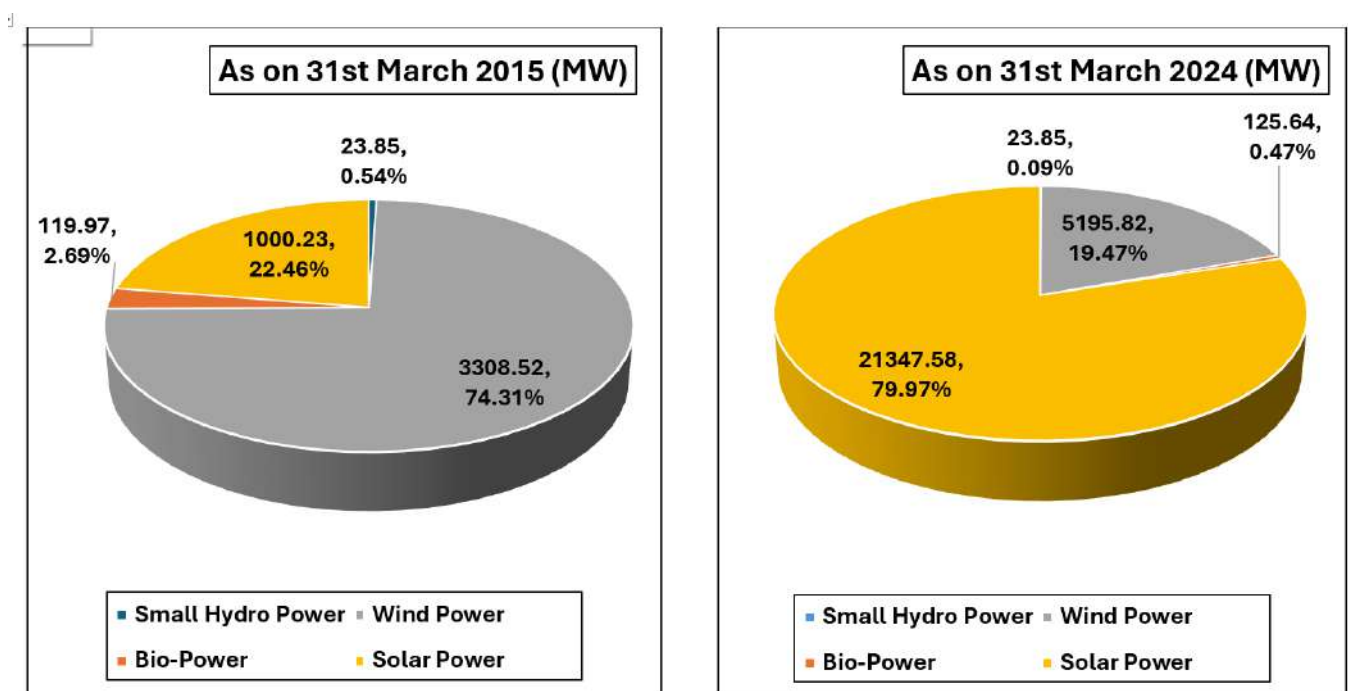
(in MW)

Year	Small Hydro Power	Wind Power	Bio-Power	Solar Power	Total	Growth (%)
2014-15	23.85	3308.52	119.97	1000.23	4452.57	20.83
2015-16	23.85	3994.02	119.97	1346.09	5483.93	23.16
2016-17	23.85	4281.72	125.13	1907.99	6338.69	15.59
2017-18	23.85	4297.72	125.13	2431.66	6878.36	8.51
2018-19	23.85	4299.72	125.13	3364.03	7812.73	13.58
2019-20	23.85	4299.72	125.13	5275.27	9723.97	24.46
2020-21	23.85	4326.82	125.08	5925.6	10401.35	6.97
2021-22	23.85	4326.82	125.08	12564.87	17040.62	63.83
2022-23	23.85	5193.42	125.08	17055.7	22398.05	31.44
2023-24	23.85	5195.82	125.64	21347.58	26692.89	19.18
Gr (2014-15 to 2023-24)	0.00	57.04	4.73	2034.27	499.49	
CAGR (2014-15 to 2023-24)	0.00	5.14	0.51	40.51	22.02	

Gr=Growth (%)

CAGR=Compound Annual Growth Rate

Fig 10.2.1 Share (%) in Cumulative Installed capacity



As on 31st March 2015, wind power dominated with a share of 74.31% having 3308.52 MW installation, followed by Solar-Power installation of 1000.23 MW with a share of 22.46%. Bio-power had a 2.69% share having installation of 119.97 MW and Small Hydro Power had the least share of 0.54% with a cumulative installation of 23.85 MW whereas as on 31st March, 2024, out of the cumulative installed capacity of renewable energy from Solar, Wind, Bio-Power, and Small Hydro Power, solar power leads with a share of 79.97% with capacity installation of 21347.58 MW, followed by wind power having share of 19.47% with an installation of 5195.82 MW. Biopower contributed 0.47% with installation of 125.64 MW, and Small Hydropower accounted for 0.09 % with installed capacity of 23.85 MW.

Fig 10.2.2 Trend in cumulative Installed Capacity

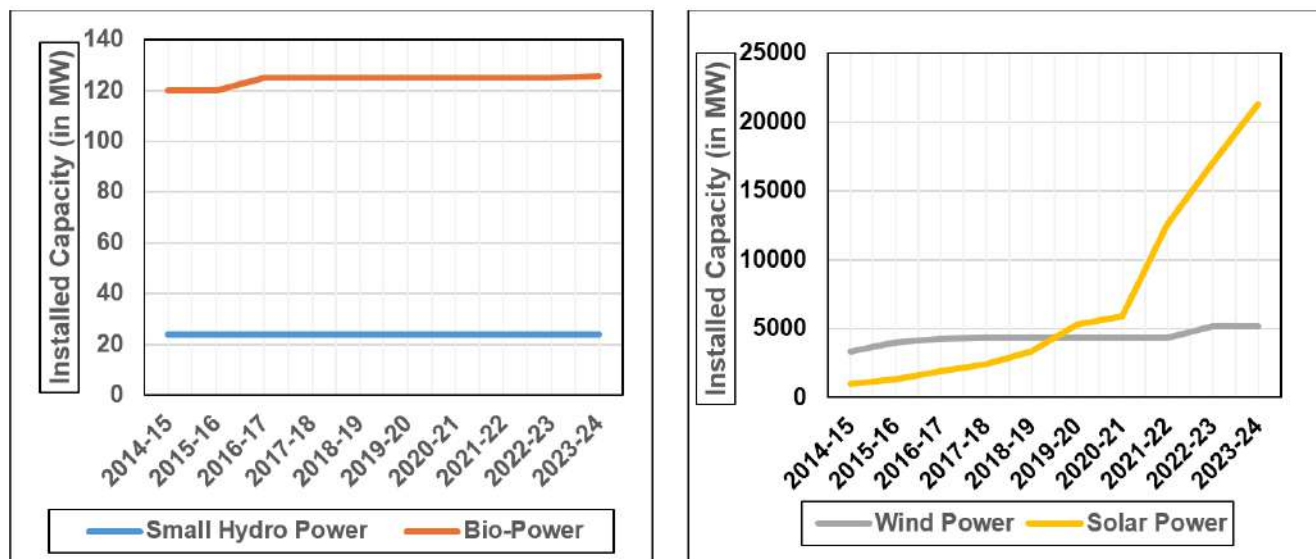
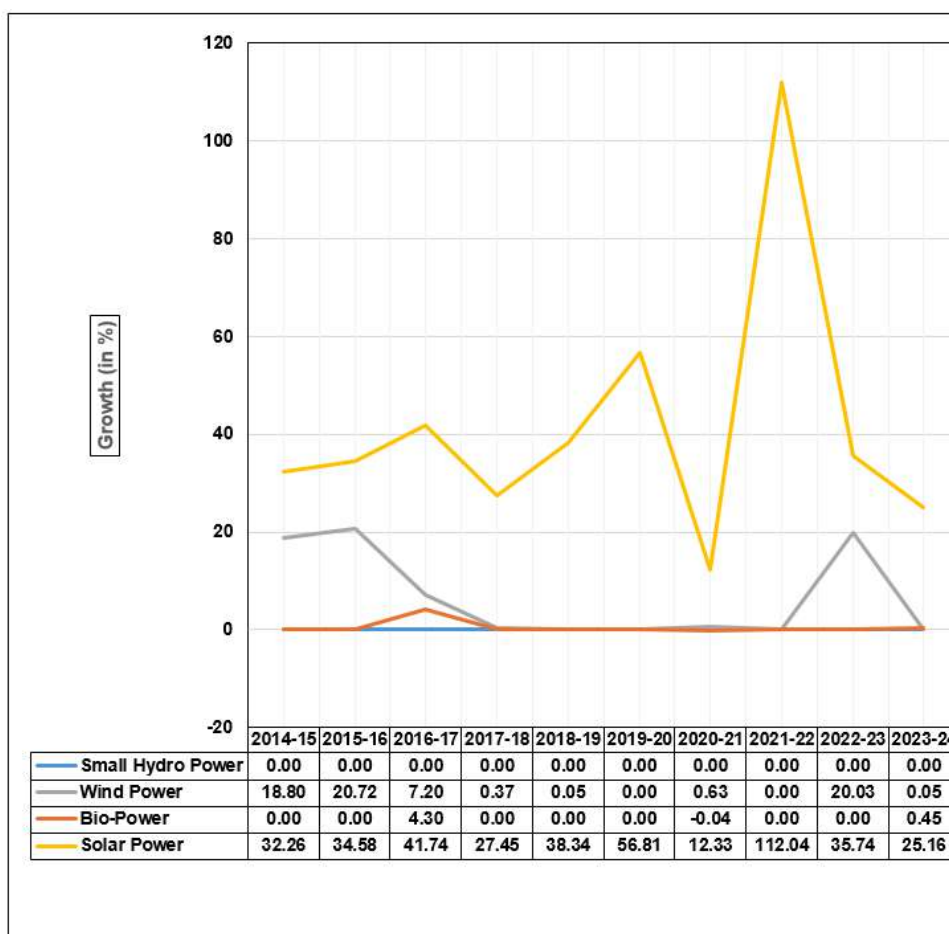


Fig 10.2.3 Year wise growth (%) in capacity installation



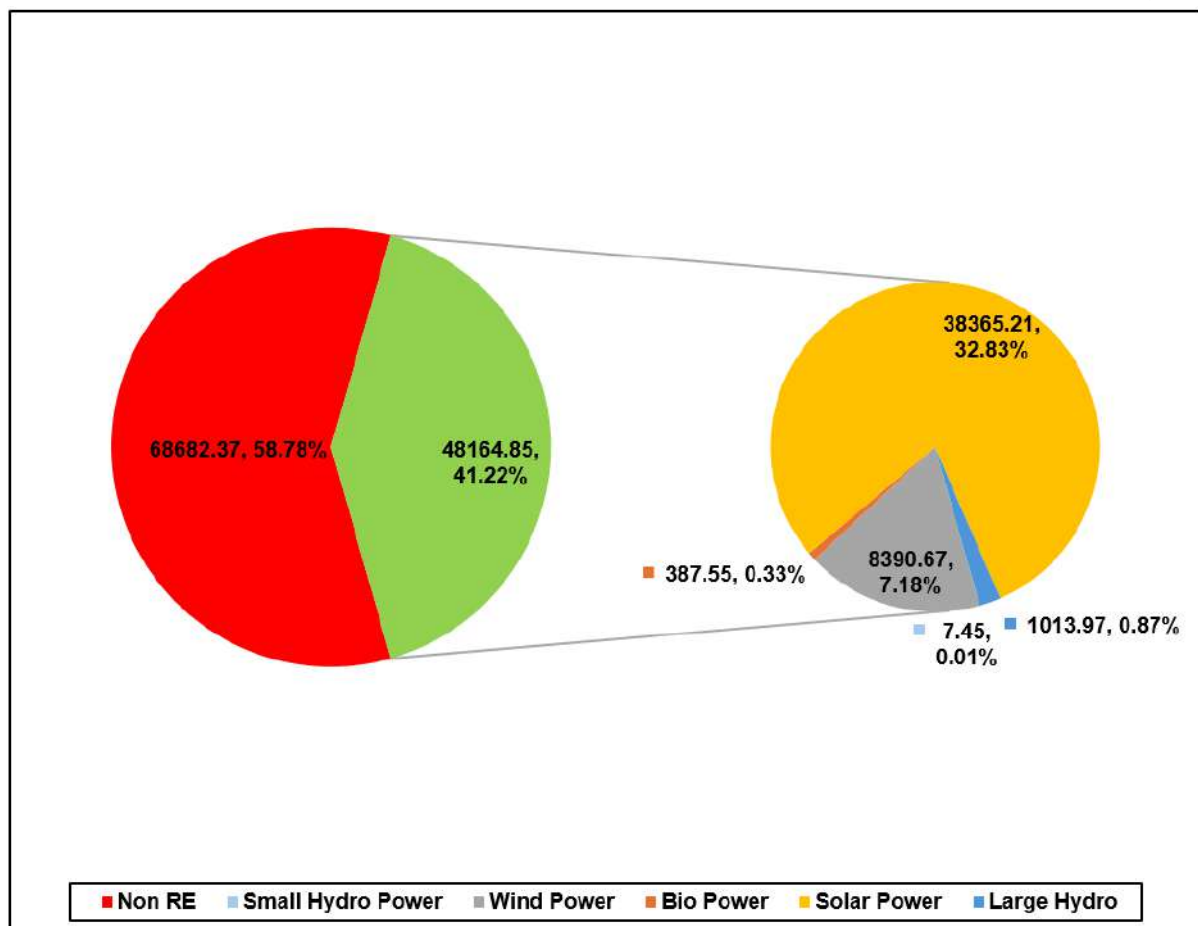
The trends highlight significant growth in renewable energy sources, primarily driven by solar power, followed by wind power. Over the past decade, solar power capacity enhanced from 1000.23 MW to 21,347.58 MW, demonstrating an impressive 2,034.27% growth with a Compound Annual Growth Rate (CAGR) of 40.51%. Wind power capacity increased from 3308.52 MW to 5,195.82 MW, marking a 57.04% growth at a 5.14% CAGR, while bio power grew from 119.97 MW to 125.64 MW, showing a modest 4.73% growth with a CAGR of 0.51%. No installation was done in the state in respect of Small Hydro power during the period. High year on year growth rate was registered in respect of Solar power installations compared to other source's installations.

ENERGY GENERATION

10.3 Energy generation during 2023-24: Total energy generation in Rajasthan during 2023-24 was 116.85 BU with a share of 41.22% from Renewable energy sources. In the total Energy generation from RE sources, maximum energy was generated from Solar Power followed by wind power. During 2023-24, Rajasthan was the largest contributor to renewable energy generation in the country, with a total generation of 48.16 billion units (BU) with 13.38% share. For energy generated from solar, wind, bio power, and small hydro power, Rajasthan maintained its top position, producing 47.15 BU and accounting for 20.88% of the total. Fig 10.3 depicts the detailed share of RE and non-RE generation in the total energy generation in the state of Rajasthan.

Fig 10.3 RE share in total energy generation during 2023-24

(in MU)



CHAPTER 11

Tamil Nadu

11.1 Status of RE and Non-RE sector in Tamil Nadu: Tamil Nadu obtained third rank in contributing renewable energy installed capacity of the country as on 31st March 2024 by installing 22.16 GW with 11.63% share. Renewable Energy sector has witnessed 1.65-fold increase in installed capacity during last six years against 1.06-fold growth in non-renewable energy capacity. During 2020-21 itself, installation under RE sector crossed the installations under Non-RE sector in Tamil Nadu. Contribution of installed capacity of RE sector had grown to 55.49% by 2023-24 from that of 44.7% of 2017-18. Under RE sector, installation of wind power is dominated in Tamil Nadu contributing to 47.85% followed by Solar Power with 37.05%. Tamil Nadu has a renewable energy generation share of 26.90% during 2023-24. Maximum energy generation under RE sector was from wind power itself with contribution of 50.98% followed by solar power generation with a share of 35.39%. During 2023-24, Tamil Nadu ranked 5th in the country for renewable energy generation, contributing 33.17 billion units (BU) , accounting for 9.22% of the total. Specifically, for energy generated from solar, wind, bio power, and small hydro power, Tamil Nadu secured 4th place, generating 29.60 BU and making up 13.11% of the total. The next sections present an in-depth review of Tamil Nadu's energy profile, emphasizing the growth of Renewable Energy sector.

INSTALLED CAPACITY

Table 11.1.1 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	13451.72	16638.88	30090.60	44.70	55.30		
2018-19	14909.39	16338.88	31248.27	47.71	52.29	10.84	-1.80
2019-20	16588.84	16688.88	33277.72	49.85	50.15	11.26	2.14
2020-21	17476.67	16838.88	34315.55	50.93	49.07	5.35	0.90
2021-22	18277.50	17363.88	35641.38	51.28	48.72	4.58	3.12
2022-23	20098.55	17363.88	37462.43	53.65	46.35	9.96	0.00
2023-24	22161.62	17777.88	39939.5	55.49	44.51	10.26	2.38
Gr (2017-18 to 2023-24)	64.75	6.85	32.73				
CAGR (2017-18 to 2023-24)	8.68	1.11	4.83				

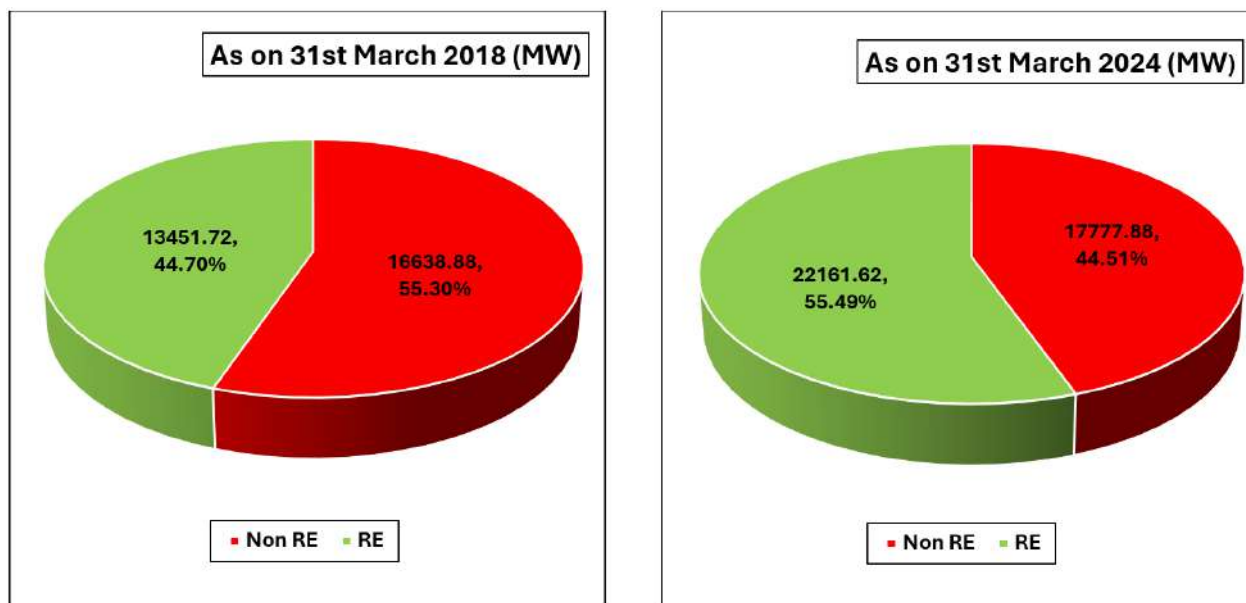
Source : NPP, MoP and MNRE

Gr=Growth (%)

CAGR=Compound Annual Growth Rate

Fig. 11.1.1 Share in RE Installed Capacity

(in MW)



As of March 2024, Tamil Nadu ranks third in the renewable energy sector after Gujarat and Rajasthan. Its share of renewable energy (RE) increased from 44.70% in March 2018 to 55.49% in March 2024. The state's renewable energy capacity grew by 64.75%, from 13.45 GW to 22.16 GW, surpassing overall capacity growth of 32.73% and Non-RE growth of 6.85% during last six years.

Fig 11.1.2 Trend in Capacity installation

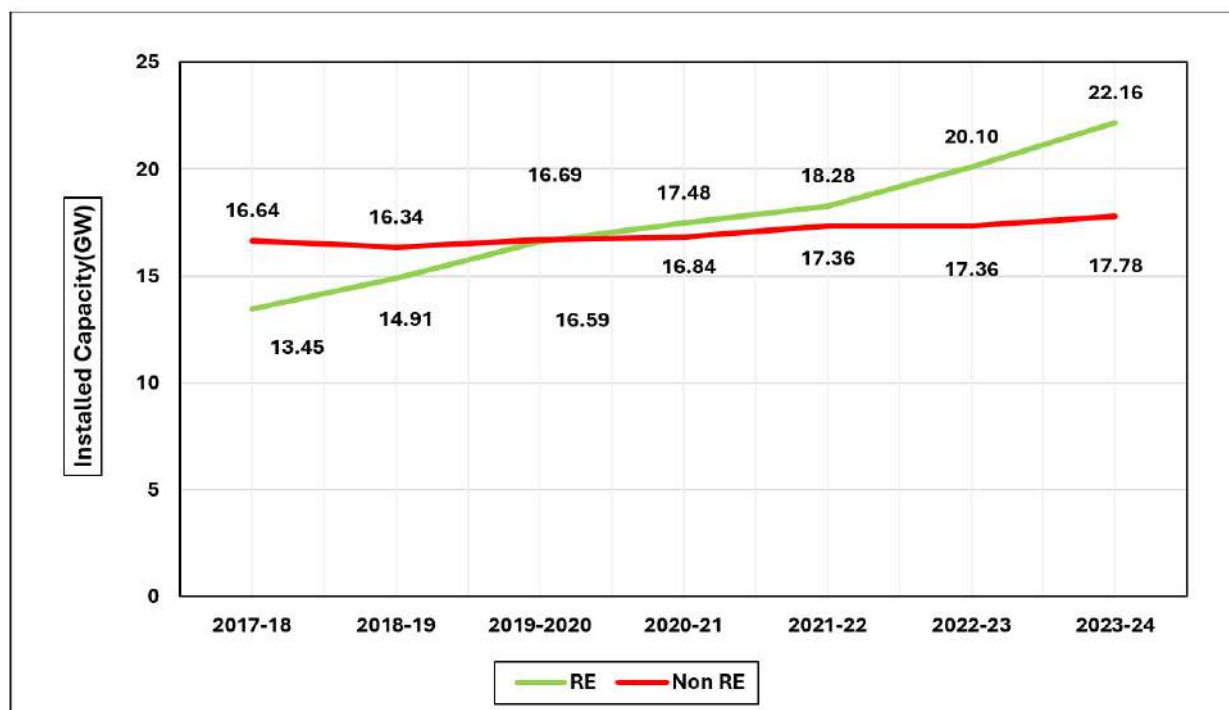
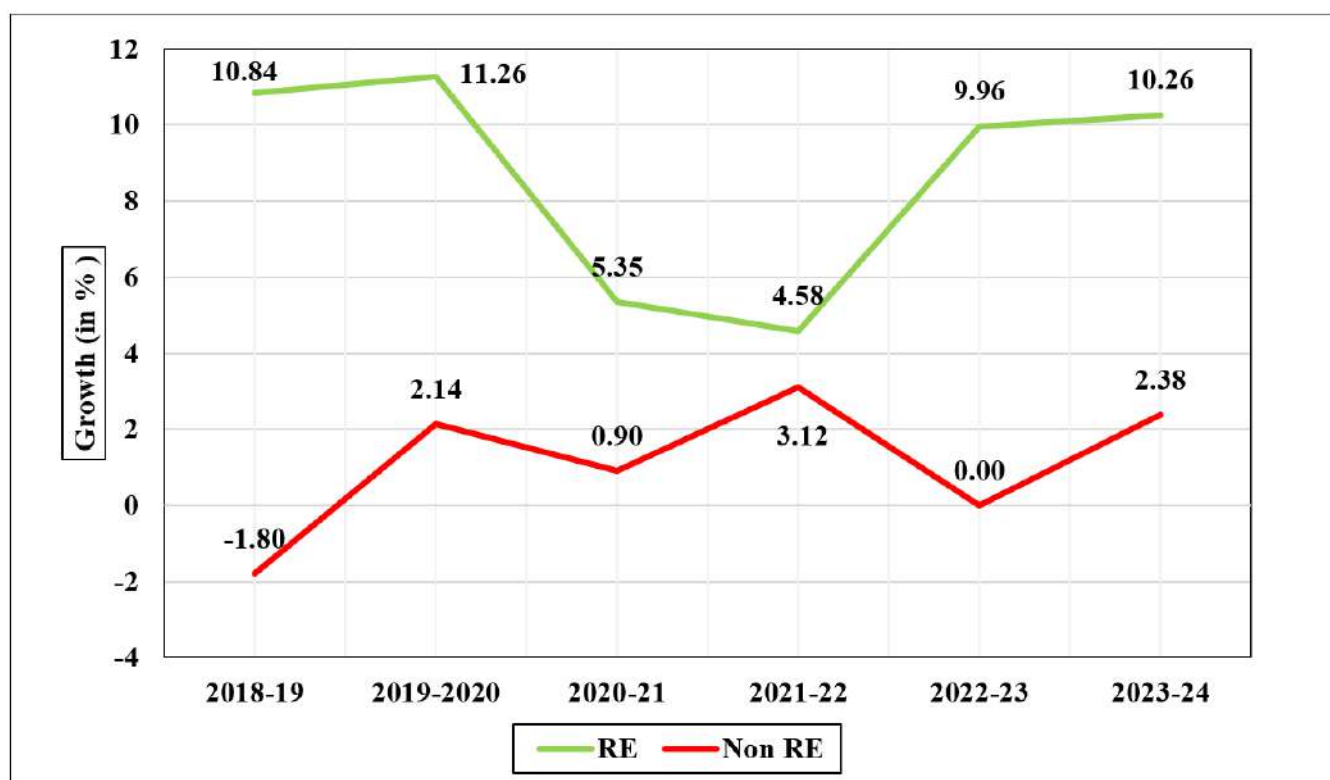


Fig 11.1.3 Year wise growth (%) in Capacity Installation



The trend shows that the installations under RE installed capacity has surpassed during 2020-21 itself and growing fast compared to Non-RE sector. Notably, year wise growth of RE sector has remained strong, with peaks of 11.26% in 2019-20. Conversely, Non-RE growth has remained minimal, with stagnation observed in 2022-23 and a decline in 2018-19.

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

State's renewable energy landscape has transformed significantly over the past decade, with solar power leading the growth. Installation of Solar power enhanced from 156.83 MW to 8211.38 MW, demonstrating an exponential expansion with 5135.85% growth with a Compound Annual Growth Rate (CAGR) of 55.24%. Wind power capacity increased from 7455.09 MW to 10603.54 MW, marking steady expansion with a 42.23% growth at a 3.99% CAGR, while bio power increased from 926.06 MW to 1045.45 MW, showing a modest 12.89% growth with a CAGR of 1.36%. No installations have been done in the case of Small hydro power in the state during the period. Installed capacity under RES sector from 2014-15 is stipulated in **Table 11.2.1**.

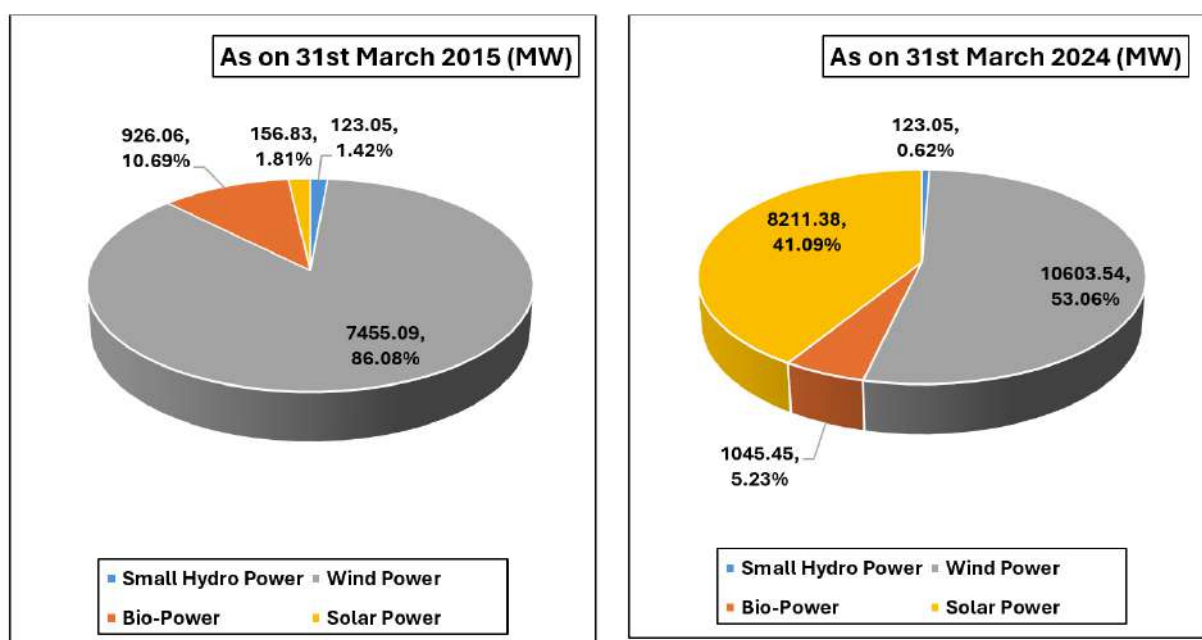
Table 11.2.1: Installed Capacity under Solar, wind, Bio Power and Small Hydro Power (RES) since 2014-15 (in MW)

Year	Small Hydro Power	Wind Power	Bio-Power	Solar Power	Total	Growth (%)
2014-15	123.05	7455.09	926.06	156.83	8661.03	3.10
2015-16	123.05	7613.89	926.06	1090.57	9753.57	12.61
2016-17	123.05	7861.46	926.67	1728.52	10639.7	9.09
2017-18	123.05	8197.09	977.52	1950.86	11248.52	5.72
2018-19	123.05	8968.91	1020.52	2618.71	12731.19	13.18
2019-20	123.05	9304.34	1021.69	3961.56	14410.64	13.19
2020-21	123.05	9608.04	1039.91	4527.47	15298.47	6.16
2021-22	123.05	9866.37	1042.70	5067.18	16099.3	5.23
2022-23	123.05	10017.17	1043.70	6736.43	17920.35	11.31
2023-24	123.05	10603.54	1045.45	8211.38	19983.42	11.51
Gr(2014-15 to 2023-24)	0.00	42.23	12.89	5135.85	130.73	
CAGR(2014-15 to 2023-24)	0.00	3.99	1.36	55.24	9.73	

Gr=Growth (%)

CAGR=Compound Annual Growth Rate

Fig 11.2.1 Share (%) in Cumulative Installed capacity



As on March 2015, wind power dominated with a share of 86.08% having 7455.09 MW installation, followed by Bio-Power installation of 926.06 MW with a share of 10.69%. Solar power had a 1.81% share having installation of 156.83 MW and Small Hydro Power had the least share of 1.42% with a cumulative installation of 123.05 MW. However, as on 31st March, 2024, out of the cumulative installed capacity of renewable energy from Solar, Wind, Bio-Power, and Small Hydro Power, wind power lead with a share of 53.06 % with capacity installation of 10603.54 MW, followed by solar power having share of 41.09 % with an installation of 8211.38 MW. Biopower contributed 5.23 % with installation of 1045.45 MW, and Small Hydropower accounted for 0.62 % with installed capacity of 123.05 MW.

Fig 11.2.2 Trend in cumulative Installed Capacity

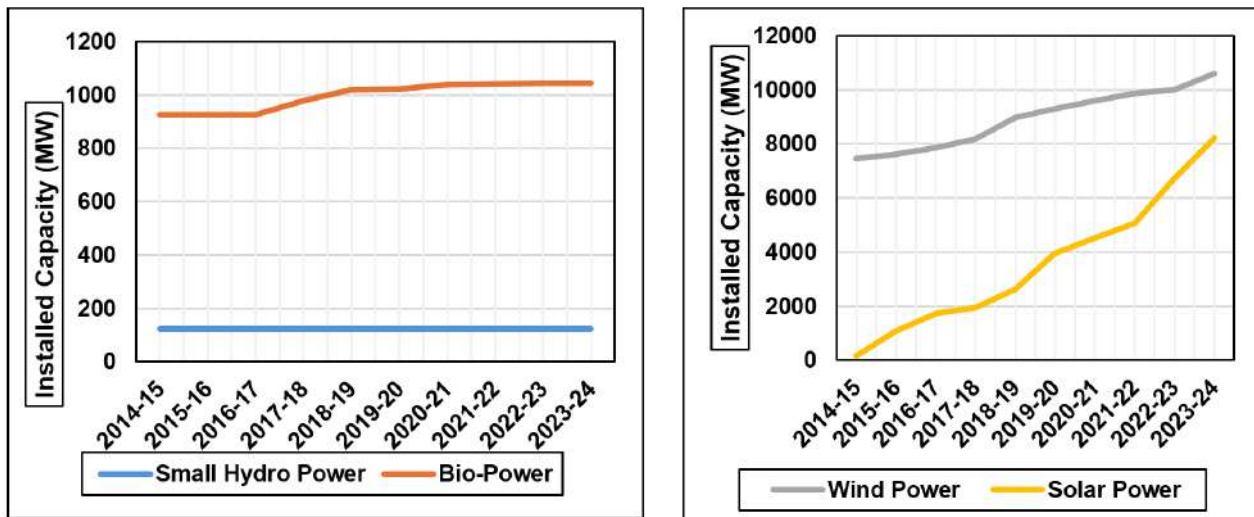
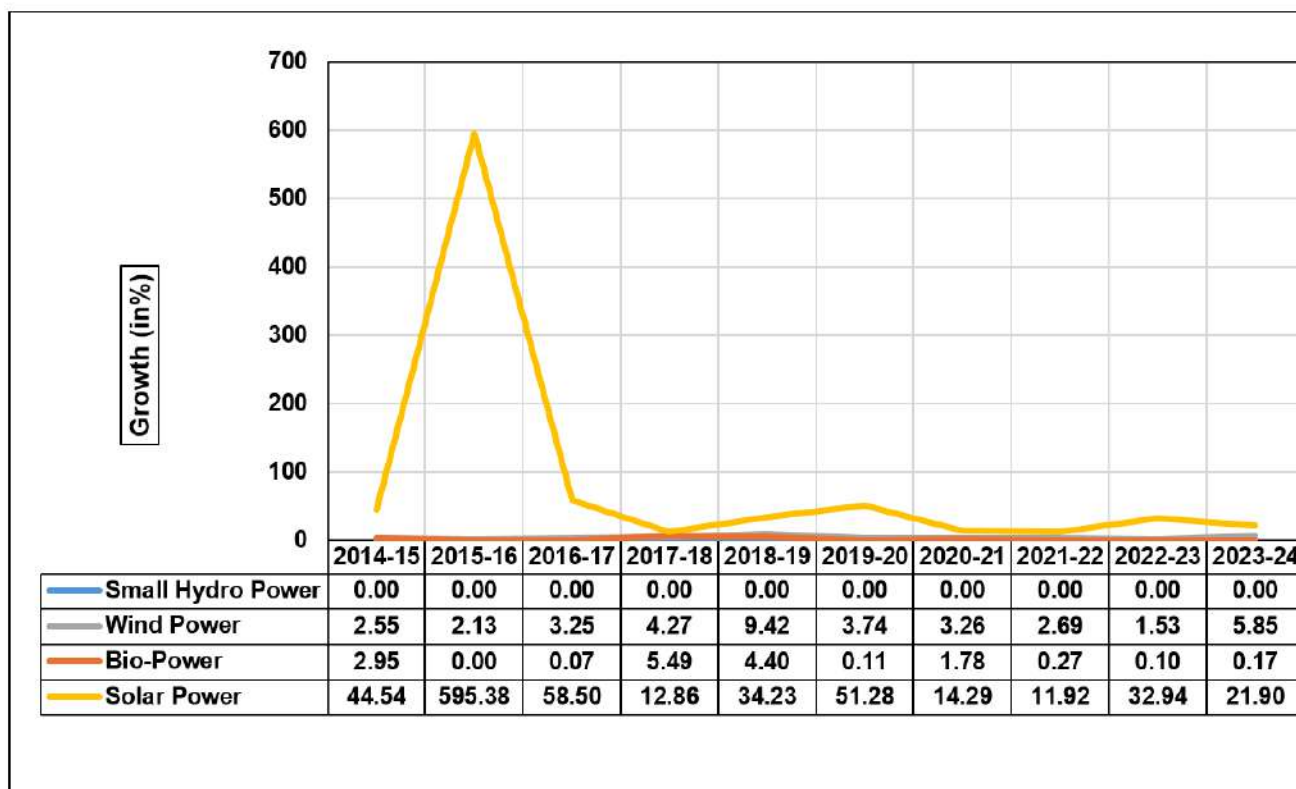


Fig 11.2.3 Year wise growth (%) in installed capacity



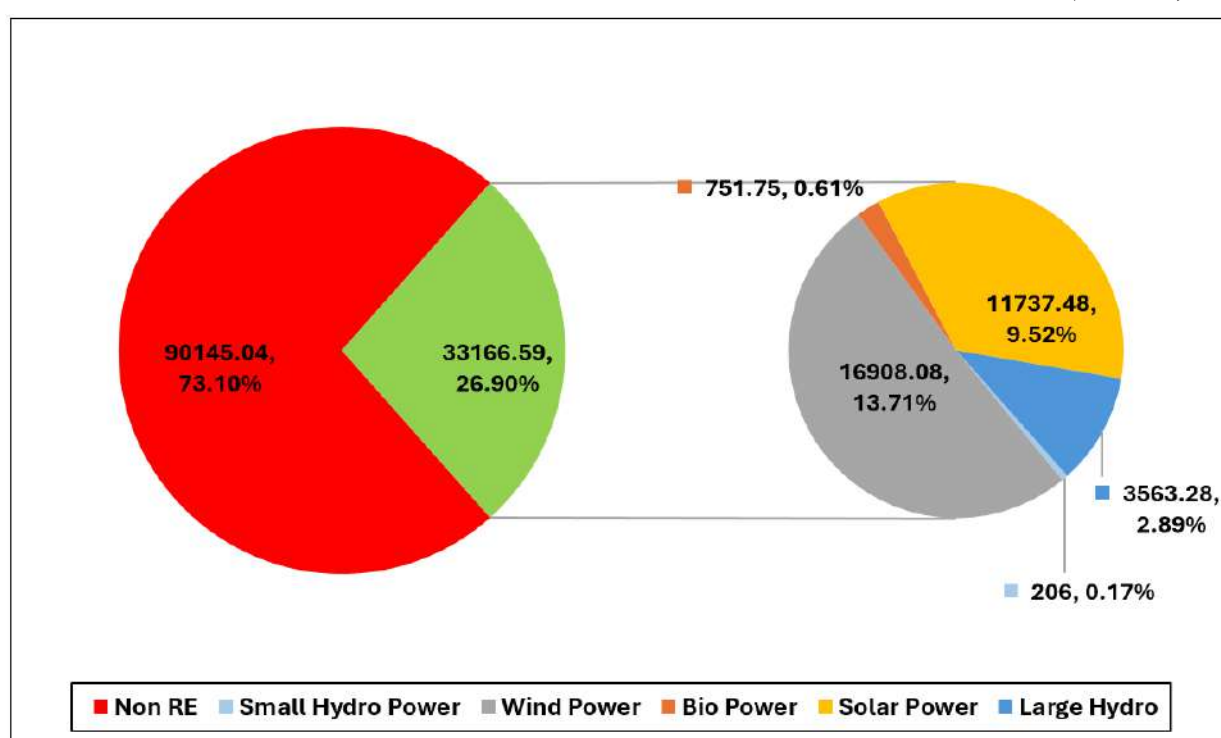
The trends highlight significant growth in renewable energy sources, primarily driven by solar power. Year wise growth rate was highest in the case of Solar Power registering a highest growth during 2015-16. Installations of wind power has registered a modest growth during this period.

ENERGY GENERATION

11.3 Energy Generation during 2023-24: Total energy generation in Tamil Nadu during 2023-24 was 123.31BU with a share of 26.90% from Renewable energy sources. In the total Energy generation from RE sources, maximum energy was generated from Wind Power followed by Solar Power. During 2023-24, Tamil Nadu ranked 5th in the country for renewable energy generation, contributing 33.17 billion units (BU) and accounting for 9.22% of the total. Specifically, for energy generated from solar, wind, bio power, and small hydro power, Tamil Nadu secured 4th place, generating 29.60 BU and making up 13.11% of the total. Fig 11.3 depicts the detailed share of RE and Non-RE generation in the total energy generation in the state of Tamil Nadu.

Fig 11.3 RE share in total energy generation during 2023-24

(in MU)



CHAPTER 12

Karnataka

12.1 Status of RE and Non-RE sector in Karnataka: Karnataka was in 4th position in contributing Renewable Energy installed capacity in the country as on 31st March 2024 with an installed capacity of 21.44 GW having a share of 11.25%. Between 2018-19 and 2023-24, Renewable Energy installed capacity surged by 1.32 times, while Non-Renewable Energy capacity declined marginally by 0.01 times, marking a significant shift towards sustainable energy. RE installed capacity contribution of 60.71% of 2014-15 had grown to 67.37% by 2023-24 in Karnataka and installation of solar power is dominated in Karnataka with a contribution of 39.85% followed by wind power with 28.07 % share. In overall energy generation of the state, contribution of RE sector was 43.18% during 2023-24. Out of total RE generation, maximum energy generation was from Solar power contributing 39% followed by wind power generation with a share of 27.72%. During 2023-24, Karnataka ranked 3rd in the country for renewable energy generation, with a total contribution of 39.50 billion units (BU) having a share of 10.98% of the total. For energy generated from solar, wind, bio power, and small hydro power, Karnataka also held the 3rd position, generating 30.53 BU and accounting for 13.52% of the total. Upcoming sections provide a meticulous examination of Karnataka's energy landscape, focusing on Renewable Energy sector's advancements.

INSTALLED CAPACITY

Table 12.1.1 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	16241.59	10513.12	26754.71	60.71	39.29		
2018-19	17524.40	10513.12	28037.52	62.50	37.50	7.90	0.00
2019-20	18918.13	10385.20	29303.33	64.56	35.44	7.95	-1.22
2020-21	19149.33	10385.20	29534.53	64.84	35.16	1.22	0.00
2021-22	19593.79	10385.20	29978.99	65.36	34.64	2.32	0.00
2022-23	20408.43	10385.20	30793.63	66.27	33.73	4.16	0.00
2023-24	21441.94	10385.20	31827.14	67.37	32.63	5.06	0.00
Gr (2017-18 to 2023-24)	32.02	-1.22	18.96				
CAGR (2017-18 to 2023-24)	4.74	-0.20	2.94				

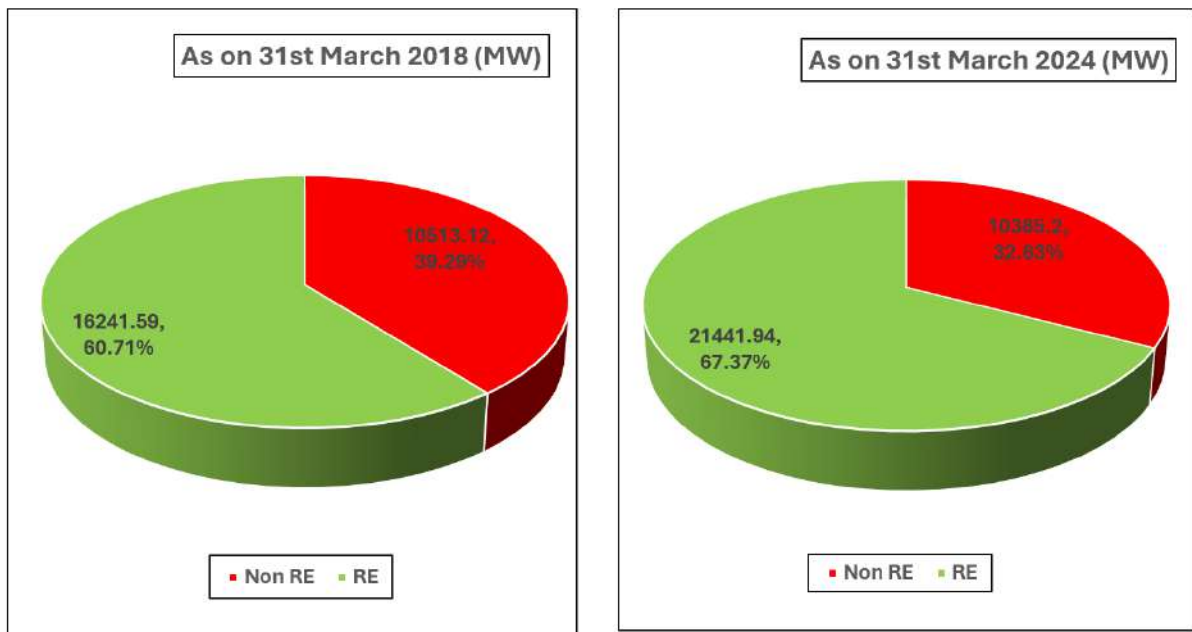
Source: NPP, MoP and MNRE

Gr=Growth (%)

CAGR=Compound Annual Growth Rate

Karnataka made significant strides in enhancing its renewable energy capacities, reflected in the substantial and increasing share of RE in the state's total installed capacity. The share of RE in Karnataka's total energy capacity has seen a steady increase. In 2017-18, RE accounted for 60.71% of the total capacity. By 2023-24, this share had increased to 67.37%. Growth of RE capacity demonstrate a consistent upward trend, with notable increases of 7.90% in 2018-19 and 7.95% in 2019-20. Although the growth slowed to 1.22% in 2020-21, it picked up again in subsequent years, reaching 5.06% in 2023-24.

Fig. 12.1.1 Share of RE in Installed Capacity

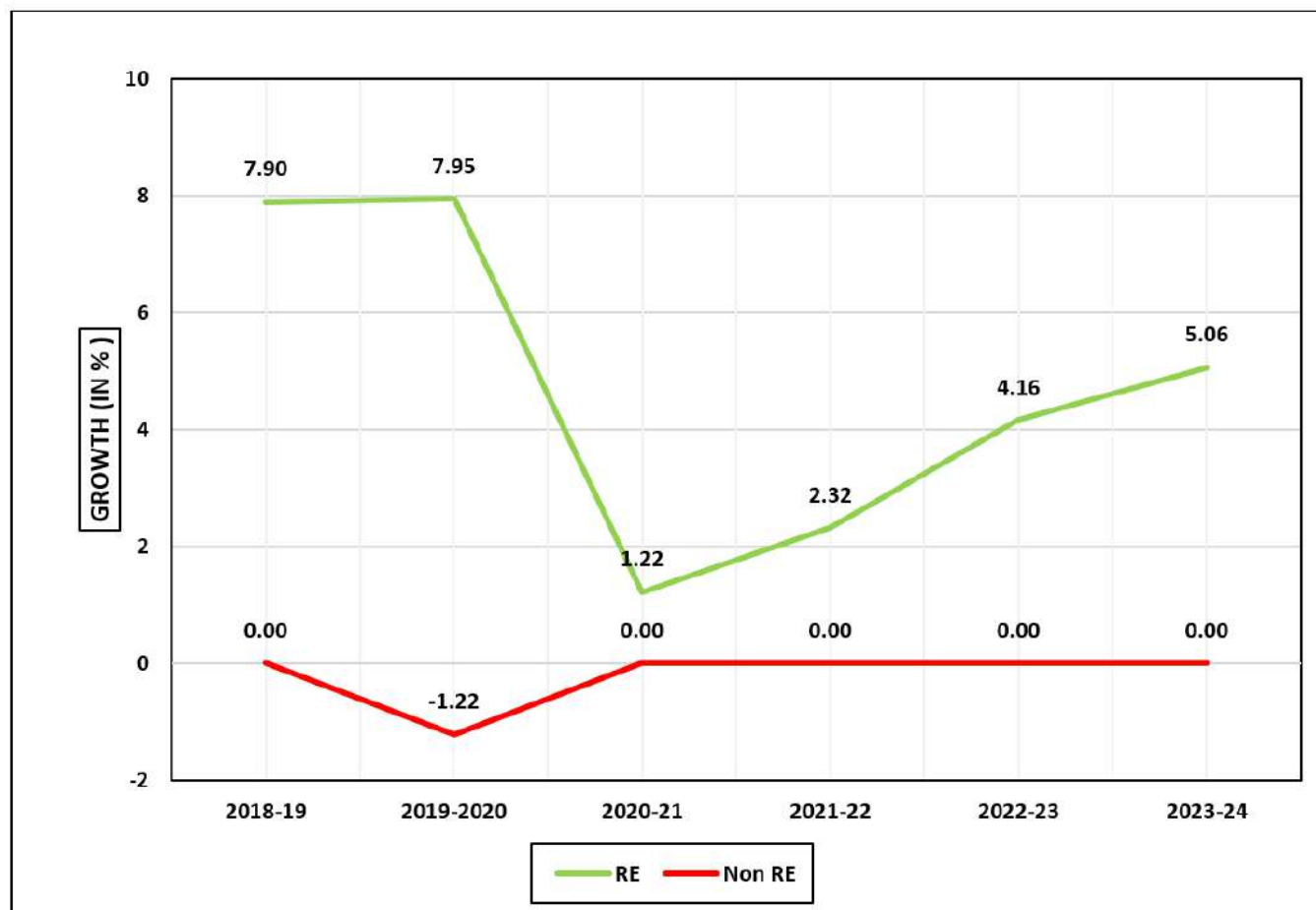


As on 31st March 2024, Karnataka had fourth position in the renewable energy sector after Gujarat, Rajasthan and Tamil Nadu. Its share of renewable energy (RE) increased from 60.71% in March 2018 to 67.37% in March 2024. The state's renewable energy capacity increased by a growth of 32.02%, from 16.24 GW to 21.44 GW, surpassing overall capacity growth of 18.96% during the period. Notably, non-RE declined by 1.22%.

Fig 12.1.2 Trend in Capacity Installation



Fig 12.1.3 Growth (%) in Capacity Installation



Trend in capacity installation shows that Renewable Energy installations enhanced from 16.24 GW of 2017-18 to 21.44 GW by 2023-24 while that of Non-RE sector, cumulative installation has been declined from 10.51GW of 2017-18 to 10.39 GW by 2023-24. In the case of year-on-year growth rates, growth rates for renewable energy have shown a positive trend, though with some fluctuations. In 2018-19, renewable energy sector grew by 7.90%, increasing its share from 60.71% to 62.50% and then in the following year growth increased at the rate of 7.95% raising the RE share to 64.56%. Growth rate experienced a decline to 1.22% in 2020-21 but rebounded in subsequent years.

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

The state's renewable energy landscape has transformed significantly over the past decade, with solar power leading the growth. Since 2015-16, a capacity of 8460.73 MW has been installed registering a Compound Annual growth rate of 67.14%. In the case of Wind power, 3381.41 MW has been installed during this period registering a CAGR of 9.60%. Details of installed capacity under RES is given in the Table 12.2.1.

Table 12.2.1: Installed Capacity under Solar, wind, Bio Power and Small Hydro Power (RES) since 2014-15:

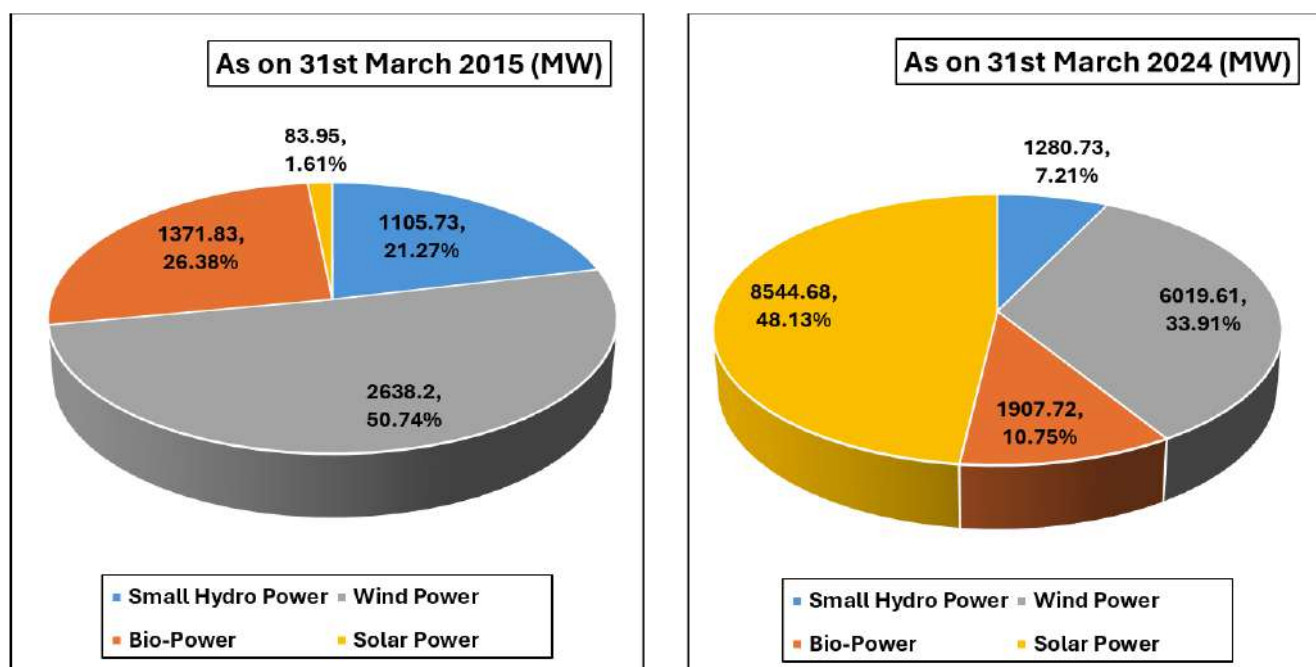
(in MW)

Year	Small Hydro Power	Wind Power	Bio-Power	Solar Power	Total	Growth (%)
2014-15	1105.73	2638.20	1371.83	83.95	5199.71	10.10
2015-16	1217.73	2869.10	1427.83	158.41	5673.07	9.10
2016-17	1225.73	3751.40	1477.83	1045.30	7500.26	32.21
2017-18	1230.73	4608.40	1779.81	4965.25	12584.19	67.78
2018-19	1254.73	4694.90	1809.81	6120.76	13880.20	10.30
2019-20	1280.73	4790.60	1896.42	7306.18	15273.93	10.04
2020-21	1280.73	4938.60	1901.92	7383.88	15505.13	1.51
2021-22	1280.73	5130.90	1902.15	7590.81	15904.59	2.58
2022-23	1280.73	5294.95	1902.15	8241.40	16719.23	5.12
2023-24	1280.73	6019.61	1907.72	8544.68	17752.74	6.18
Gr (2014-15 to 2023-24)	15.83	128.17	39.06	10078.30	241.42	
CAGR(2014-15 to 2023-24)	1.65	9.60	3.73	67.14	14.62	

Gr=Growth (%)

CAGR=Compound Annual Growth Rate

Fig 12.2.1 Share in Cumulative Installed capacity



As on 31st March, 2024, out of the cumulative installed capacity of renewable energy from Solar, Wind, Bio-Power, and Small Hydro Power, solar power lead with a share of 48.13 % with capacity installation of 8544.68 MW, followed by wind power having share of 33.91 % with an installation of 6019.61 MW. Biopower contributed 10.75 % with installation of 1907.72 MW, and small Hydropower accounted for 7.21 % with installed capacity of 1280.73 MW.

This progress in installed capacity marks a significant shift from 2014-15. Back then, wind power dominated with a share of 50.74% having 2638.2 MW installation, followed by Bio-Power installation of 1371.83 MW with a share of 26.38%. Small Hydro power had a 21.27 % share having installation of 1105.73 MW and Solar Power had the least share of 1.61% with a cumulative installation of 83.95 MW.

Fig 12.2.2 Trend in cumulative Installed Capacity

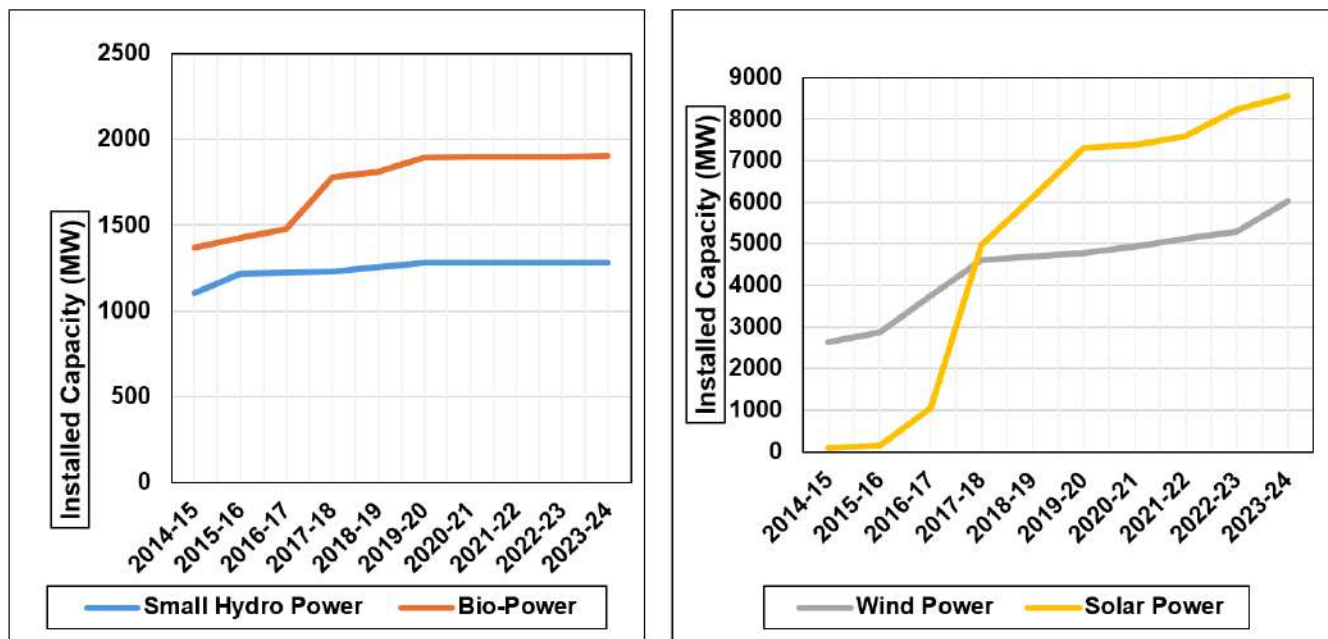
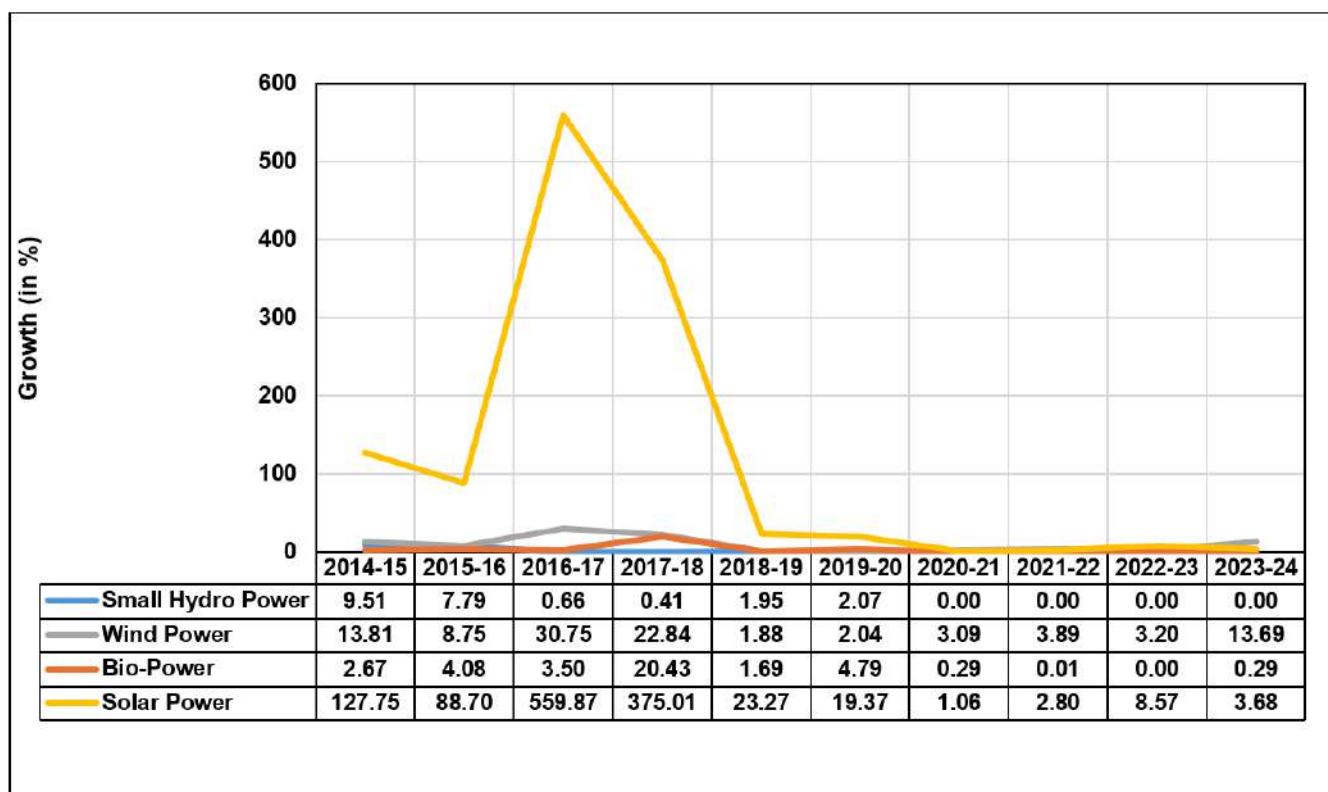


Fig 12.2.3 Year wise growth (%) in installed capacity



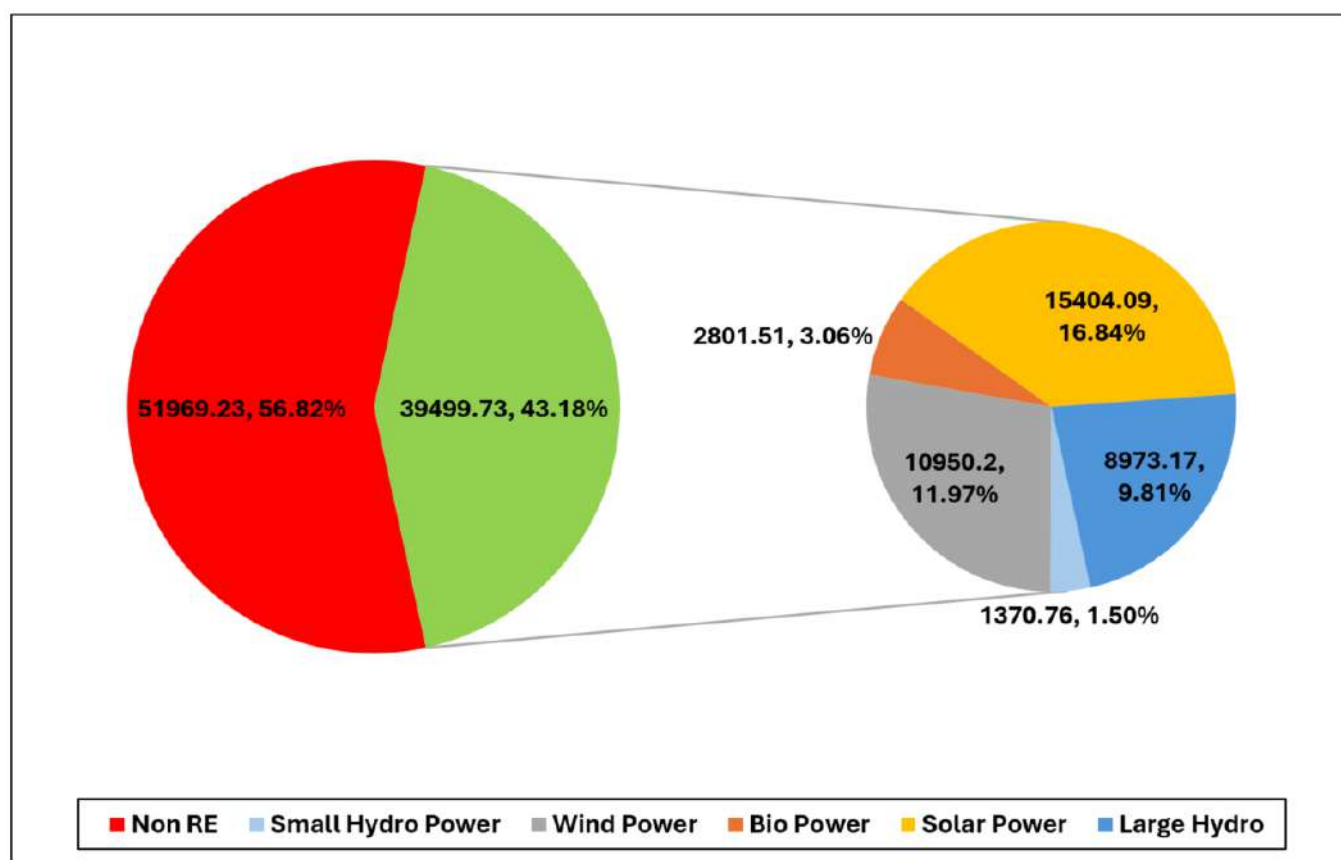
The trends highlight significant growth in renewable energy sources, primarily driven by solar power, followed by wind power. Over the past decade, solar power capacity enhanced from 83.95 MW to 8544.68 MW, Wind power capacity increased from 2638.2 MW to 6019.61 MW, while bio power increased from 1371.83 MW to 1907.72 MW. In the case of year wise growth, both solar power and wind power has registered impressive growth since 2014-15.

ENERGY GENERATION

12.3 Energy generation during 2023-24: Total energy generation in Karnataka during 2023-24 was 91.47BU with a share of 43.18% from Renewable energy sources. In the total Energy generation from RE sources, maximum energy was generated from Solar Power followed by Wind Power. In 2023-24, Karnataka ranked 3rd in the country for renewable energy generation, with a total contribution of 39.50 billion units (BU) and a share of 10.98%. For energy generated from solar, wind, bio power, and small hydro power, Karnataka also held the 3rd position, generating 30.53 BU and accounting for 13.52% of the total. Fig 12.3 depicts the detailed share of RE and non-RE generation in the total energy generation in the state of Karnataka.

Fig 12.3 RE share in total energy generation during 2023-24

(in MU)



CHAPTER 13

Maharashtra

13.1 Status of RE and Non-RE sector: Maharashtra secured 5th position in contributing the Renewable Energy installed capacity in the country as on 31st March 2024 by installing 17.53 GW having a share of 9.20%. State's renewable energy sector has witnessed remarkable growth, with installed capacity increasing by 1.52 times from 2017-18 to 2023-24 while non-renewable energy sector declined by 0.04 times in capacity installation during the same period. RE installed capacity contribution of 27.86% had grown to 37.99% during last 6 years in Maharashtra and out of the RE installed capacity, installation of solar power is dominated with a contribution of 35.65% followed by wind power with 29.71%. In overall energy generation of the state, contribution of RE sector was 14.22% during 2023-24. Out of RE generation, maximum energy generation was from wind power with contribution of 34.24% followed by solar power generation with a share of 24.20%. In 2023-24, Maharashtra ranked 6th in the country for renewable energy generation, with a total contribution of 24.03 billion units (BU) having a share of 6.68%. For energy generated from solar, wind, bio power, and small hydro power, Maharashtra held 5th position, generating 18.77 BU and accounting for 8.31% of the total. Following sections offer a granular analysis of Maharashtra's energy ecosystem, zeroing in on Renewable Energy sector's achievements.

INSTALLED CAPACITY

Table 13.1.1 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				
CAGR (2017-18 to 2023-24)	7.25	-0.69	1.84				

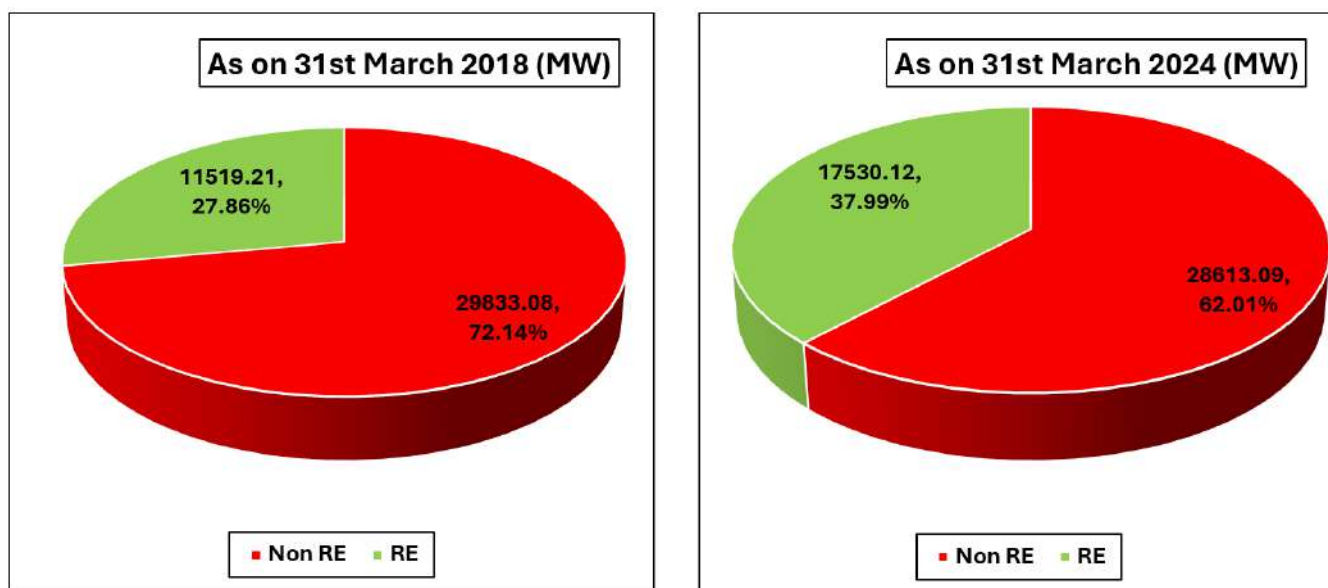
Source: NPP, MoP and MNRE

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.

Fig. 13.1.1 RE Installed Capacity (in MW) and its share (%)



As on March 2018, Maharashtra ranked fifth in the renewable energy sector installed capacity after Gujarat, Rajasthan, Karnataka, and Tamil Nadu. Its share of renewable energy increased from 27.86% to 37.99% by March 2024. The state's renewable energy capacity grew by 52.18%, from 11.52 GW to 17.53 GW, surpassing overall capacity growth of 11.59%. Capacity installation under Non-RE sector was declined by 4.09%.

Fig 13.1.2 Trend in Capacity installation

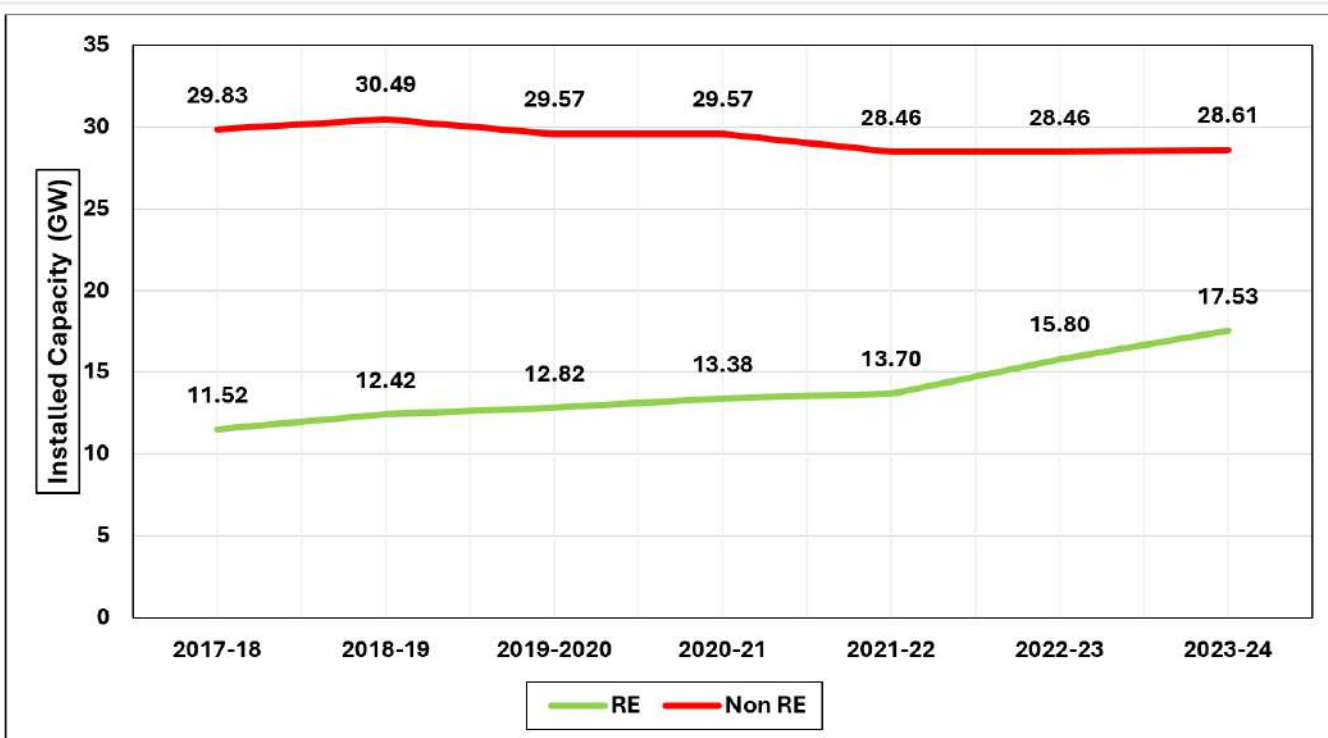
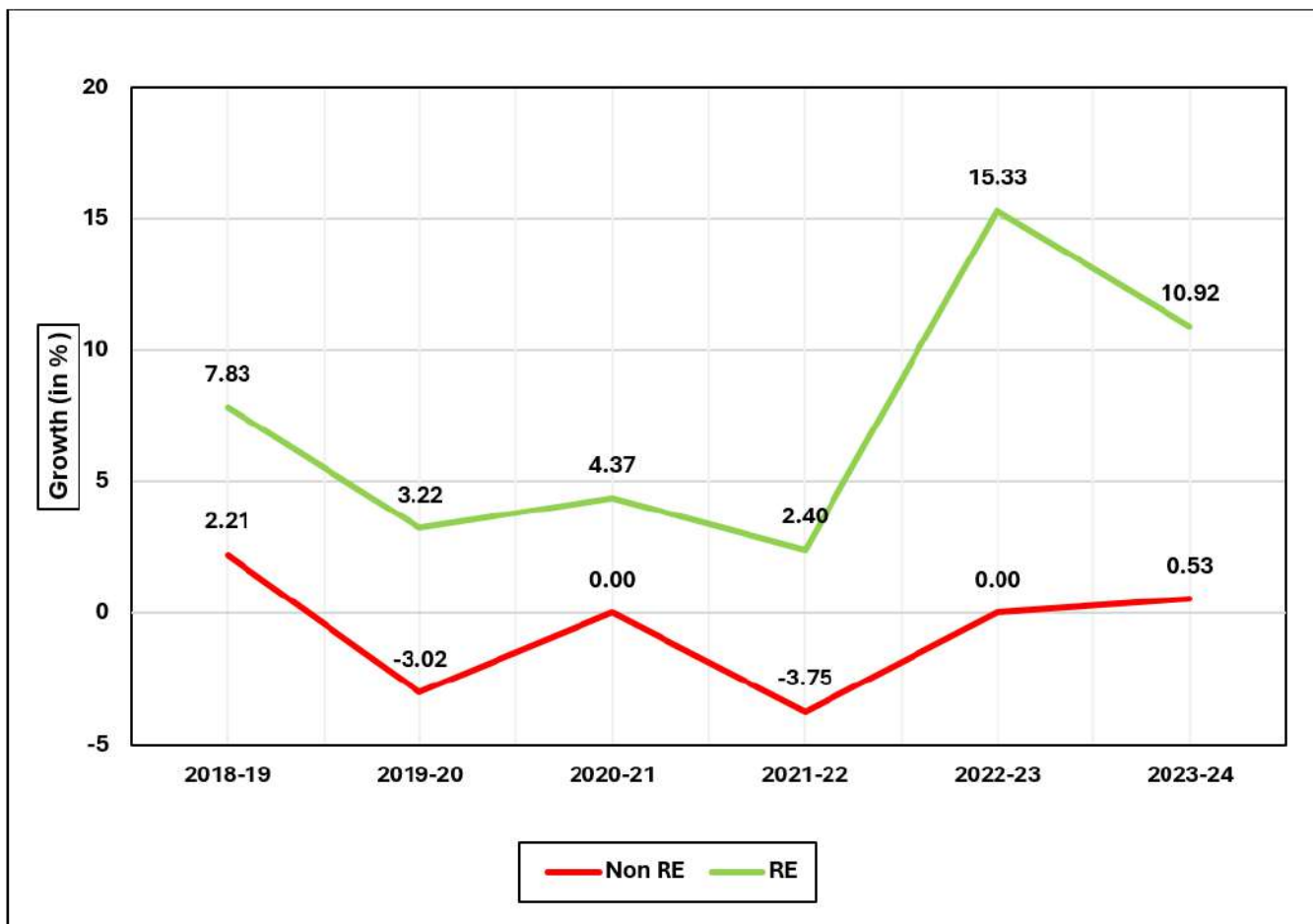


Fig 13.1.3 Year wise growth (%) in Capacity Installation



Renewable energy capacity has grown significantly, from 11,519.21 MW to 17,530.12 MW, during 2018-19 to 2023-24 highlighting a robust expansion in the sector. Trend shows the gap between RE sector and Non-RE sector is gradually shrinking over the years. Growth of RE capacity has fluctuated over the years. It saw a notable increase of 15.33% in 2022-23 and 10.92% in 2023-24.

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

Maharashtra's renewable energy sector has undergone a remarkable transformation over the past decade, driven by solar power leading the charge, accounting for a significant share of the growth. Installation of Solar power capacity has registered a Compound Annual growth rate of 37.16% and that of wind power was 1.77%. Details of installed capacity under RES is given in the **Table 13.2.1**.

Table 13.2.1: Installed Capacity under Solar, wind, Bio Power and Small Hydro Power (RES) since 2014-15

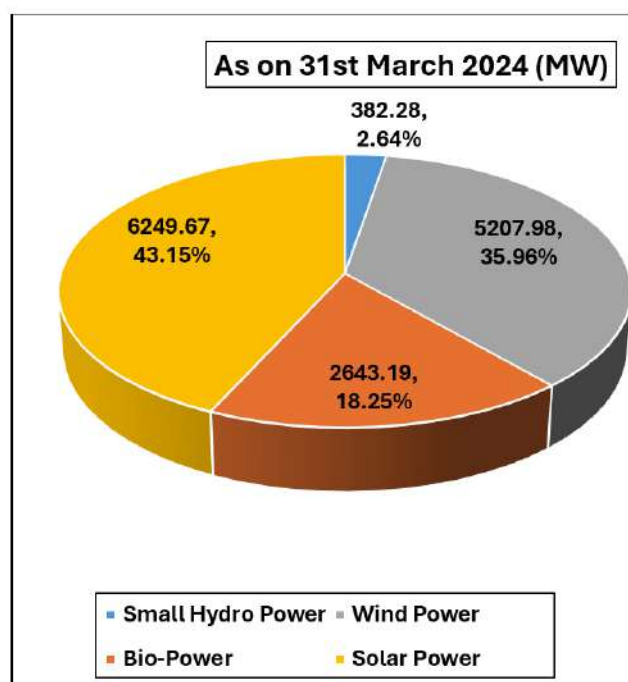
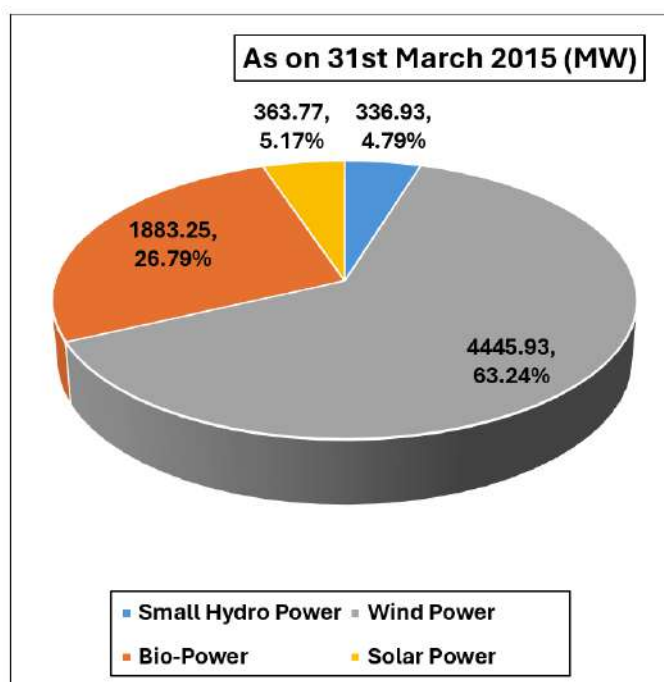
(in MW)

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(2014-15 to 2023-24)	13.46	17.14	40.35	1618.03	106.02	
CAGR(2014-15 to 2023-24)	1.41	1.77	3.84	37.16	8.36	

Gr=Growth (%)

CAGR=Compound Annual Growth Rate

Fig 13.2.1 Share (%) in Cumulative Installed capacity



As on 31st March, 2024, out of the cumulative installed capacity of renewable energy from Solar, Wind, Bio-Power, and Small Hydro Power, Solar power lead with a share of 43.15 % with capacity installation of 6249.67 MW, followed by wind power having share of 35.96 % with an installation 5207.98 MW. Biopower contributed 18.25% with installation of 2643.19 MW, and Small Hydropower accounted for 2.64 % with installed capacity of 382.28 MW. As on 31st March, 2015, wind power dominated with a share of 63.24% having 4445.93 MW installation, followed by Bio-Power installation of 1883.25 MW with a share of 26.79%. Solar power had a 5.17% share having installation of 363.77 MW and Small Hydro Power had the least share of 4.79% with a cumulative installation of 336.93MW.

Fig 13.2.2 Trend in cumulative Installed Capacity

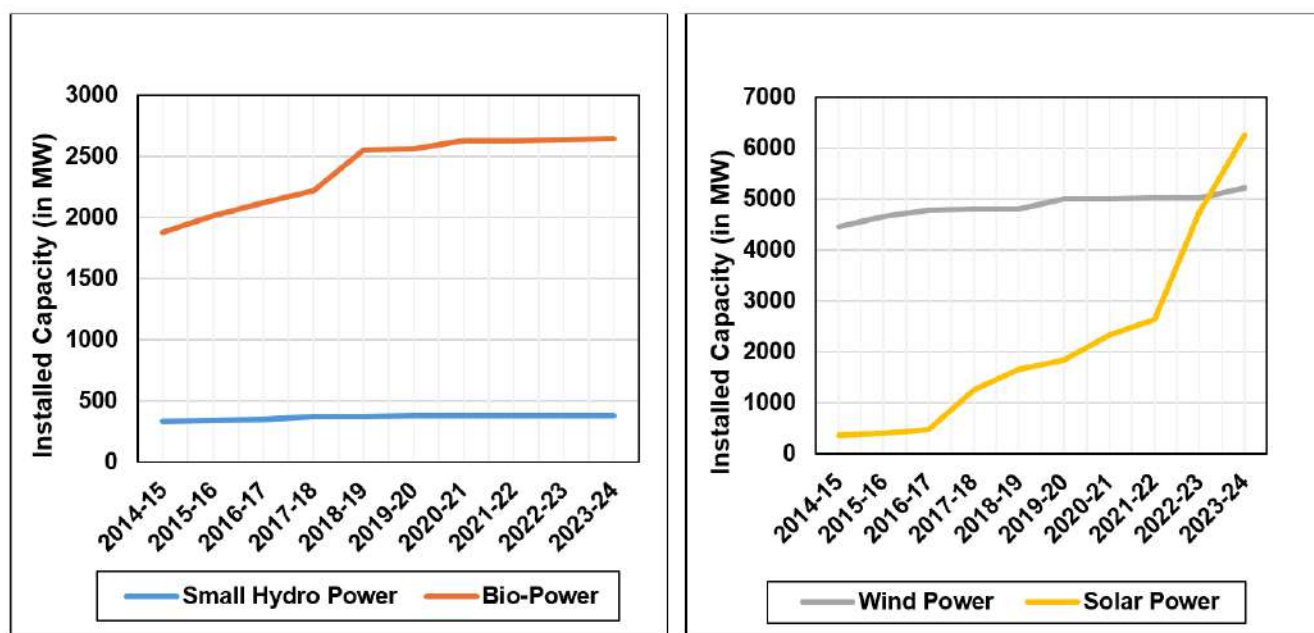
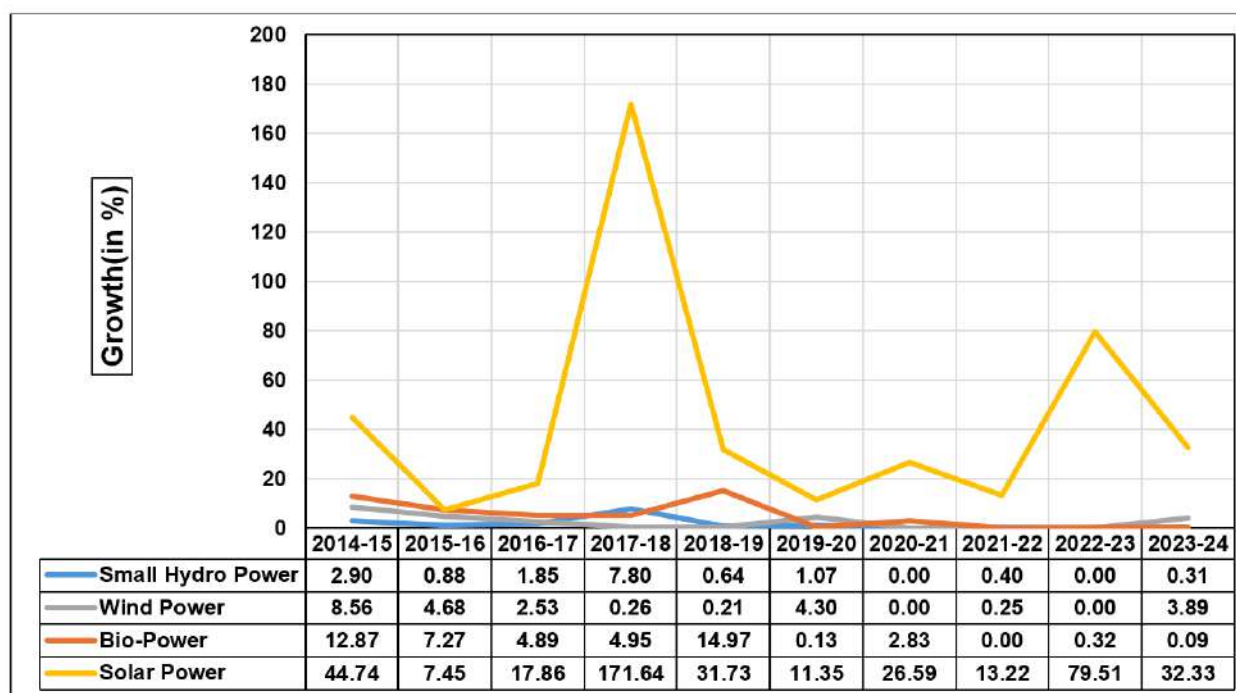


Fig 13.2.3 Year wise growth (%) in installed capacity



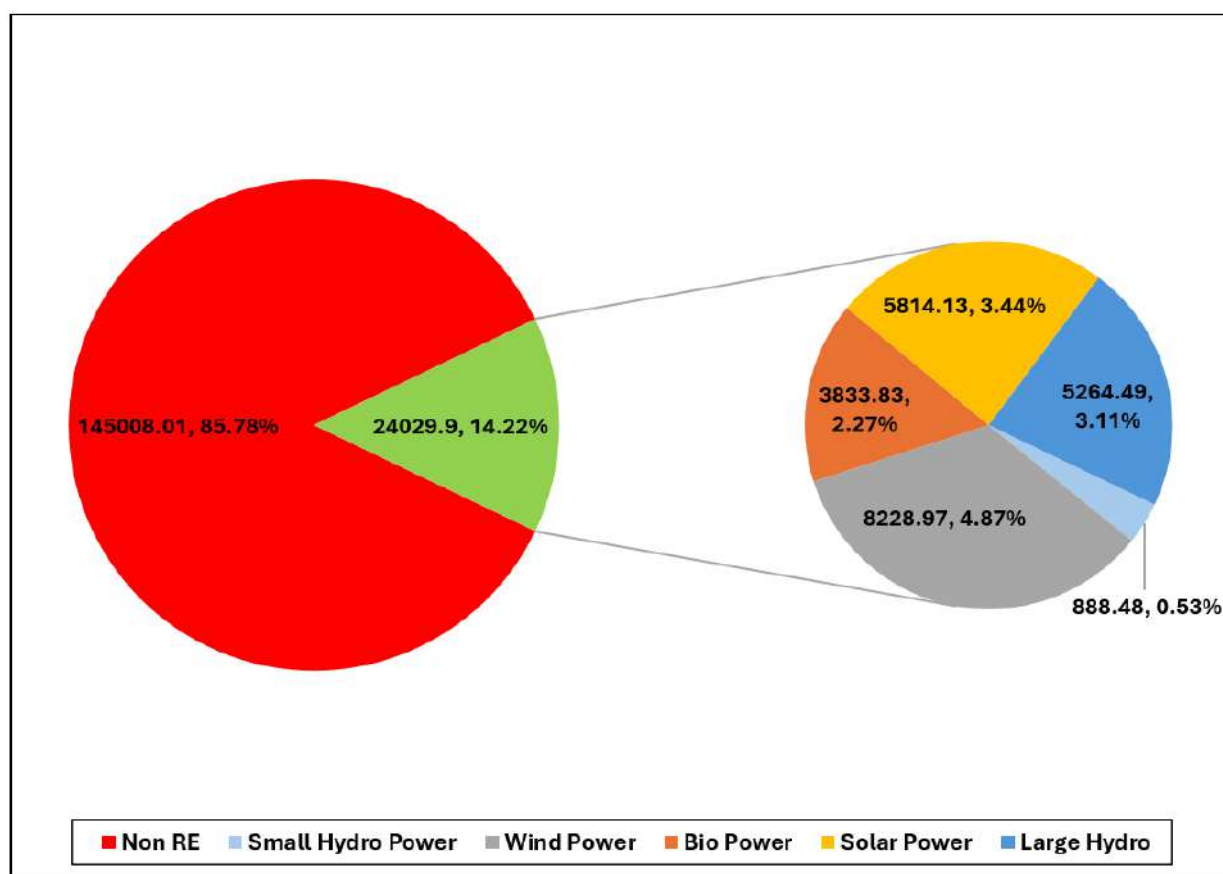
Solar Power has increased dramatically, enhanced from 363.77 MW of 2014-15 to 6,249.67 MW by 2023-24. Cumulative installation of Solar Power crossed the cumulative installation of Wind power by installing 2091.88 MW during 2022-23. Wind Power has grown from 4,445.93 MW to 5,207.98 MW.

ENERGY GENERATION

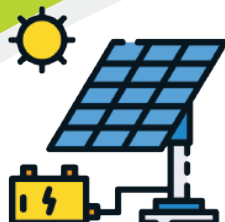
13.3 Energy Generation during 2023-24: Total energy generation in Maharashtra during 2023-24 was 169.04 BU with a share of 14.22% from Renewable energy sources. Out of the energy generation from RE sources, maximum energy was generated from Wind Power followed by Solar Power. In 2023-24, Maharashtra ranked 6th in the country for renewable energy generation, with a total contribution of 24.03 billion units (BU) having a share of 6.68%. For energy generated from solar, wind, bio power, and small hydro power, Maharashtra held the 5th position, generating 18.77 BU and accounting for 8.31% of the total. Fig 13.3 depicts the detailed share of RE and Non-RE generation in the total energy generation in the state of Maharashtra.

Fig 13.3 RE share in total energy generation during 2023-24

(in MU)



INTERNATIONAL STATUS



Installed Capacity

14.1 Installed Capacity- in RE & Non-RE sector: As on 31st December, 2023, overall installed capacity under RE and Non-RE sector was 8987.26 GW internationally, out of which a total of 3864.52 GW was installed under Renewable Energy sector. RE installed capacity was enhanced from 1698.30 GW of 2014, marking a growth of 127.55% with a CAGR of 9.57%, significantly outpacing non-RE growth of 18.47% having CAGR of 1.90% during the period. Share of Renewable Energy sources in worldwide installed capacity has been increased from 28.20% of 2014 to 43.00% by 2023. An unprecedented capacity installation of 473.17 GW from RE sources was added against 98.83 GW installation of Non-RE sources in 2023. Out of the total year wise installed capacity, RE sources contributed an astounding share of 80% during each of the last 5 years. RE sector has consistently achieved annual growth rates above 7.94%, while non-RE sector's growth has not been more than 3.21% during 2015 to 2023. Detailed analysis of capacity installations under RE and Non-RE sector has been elaborated in this chapter.

Table 14.1.1 Total RE & Non-RE installed capacity from 2014 to 2023

(in GW)

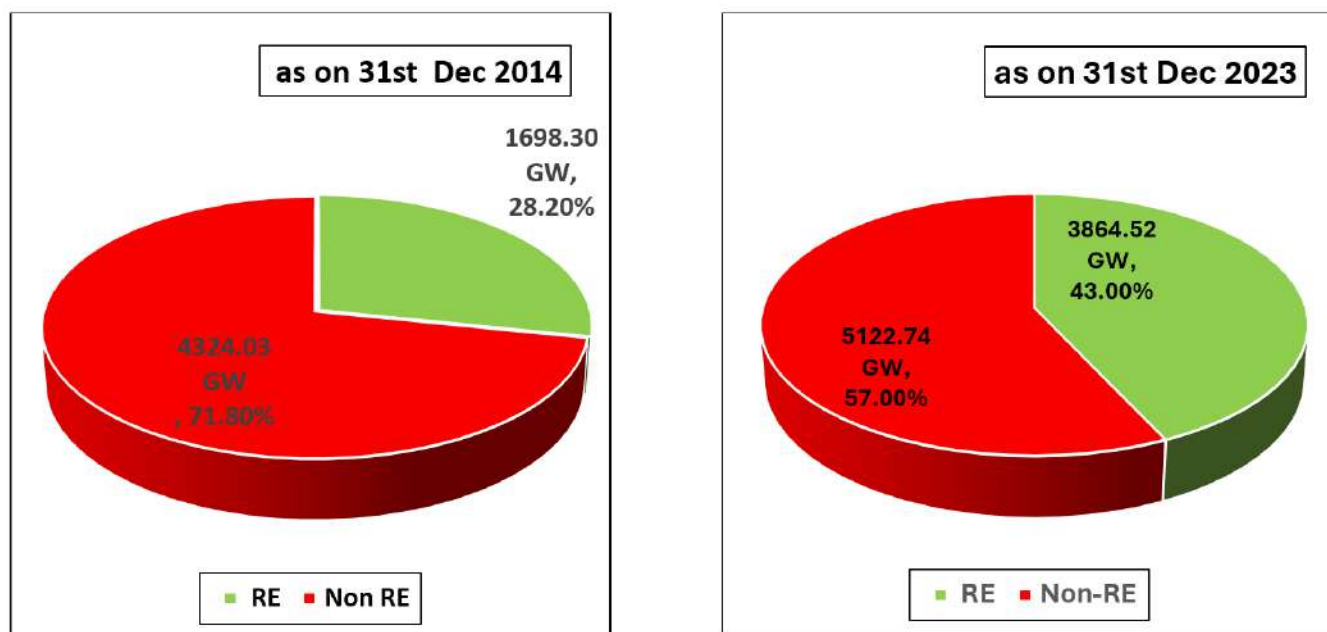
Year	RE	Non-RE	Total	Share (%)		Growth (%)	
				RE	Non-RE	RE	Non-RE
2014	1698.30	4324.03	6022.33	28.20	71.80		
2015	1852.50	4427.15	6279.65	29.50	70.50	9.08	2.38
2016	2015.00	4527.21	6542.21	30.80	69.20	8.77	2.26
2017	2185.71	4623.36	6809.07	32.10	67.90	8.47	2.12
2018	2360.96	4771.84	7132.80	33.10	66.90	8.02	3.21
2019	2548.69	4817.46	7366.15	34.60	65.40	7.95	0.96
2020	2819.25	4883.61	7702.86	36.60	63.40	10.62	1.37
2021	3083.43	4946.34	8029.77	38.40	61.60	9.37	1.28
2022	3391.35	5023.91	8415.26	40.30	59.70	9.99	1.57
2023	3864.52	5122.74	8987.26	43.00	57.00	13.95	1.97
Gr (2014 to 2023)	127.55%	18.47%	49.23%				
CAGR (2014 to 2023)	9.57%	1.90%	4.55%				

Source: IRENA –Renewable Energy Statistics 2024

Gr=Growth Rate

CAGR=Compound Annual Growth Rate

Fig 14.1.1 RE share(%) in Cumulative installed capacity



Global renewable energy sector has achieved phenomenal growth, expanding its share of total installed capacity from 28.20% of 2014 to 43% by 2023, representing a remarkable 127.55% increase over the past nine years.

Fig 14.1.2 Trend in Capacity installation



Global installed capacity of renewable energy has seen a remarkable surge, enhanced from 1698.30 GW of 2014 to 3864.52 GW by 2023 with 127.55% increase having CAGR of 9.57%. This growth is significantly outpacing that of non-renewable energy, which grew from 4,324.03 GW to 5,122.74 GW, with a modest 18.47% increase with a CAGR of 1.90% during the period. The graph clearly shows that the gap between the capacity installation of RE and Non-RE is shrinking over the years.

Fig 14.1.3 Capacity addition (in %)

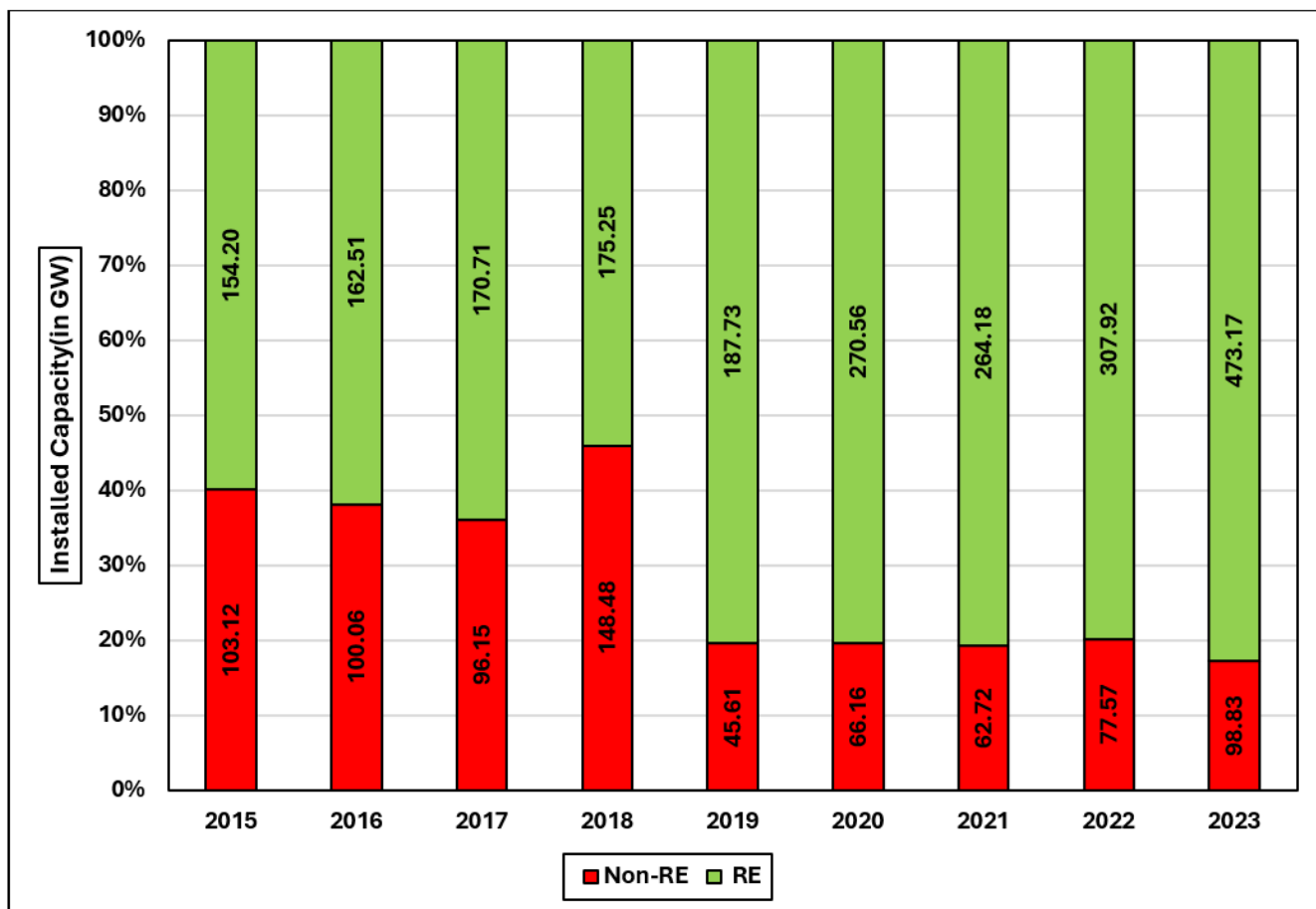
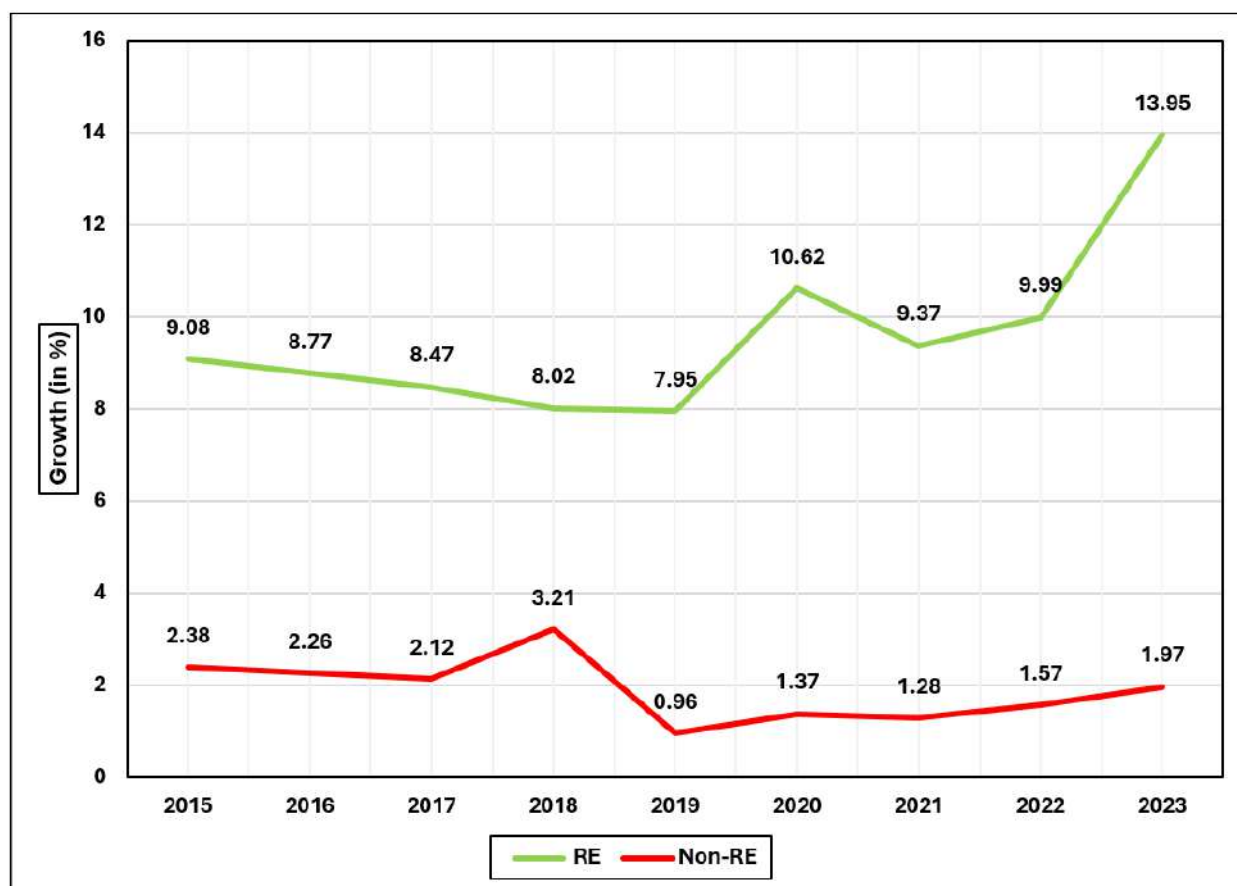


Figure inside the bar shows the installed capacity in GW

In terms of year-on-year global capacity addition, renewable energy (RE) sector has demonstrated remarkable expansion compared to non-RE sector. Worldwide, an impressive installation of 473.17 GW has been done under RE sector during 2023, significantly higher than the installation of 98.83 GW added in the non-RE sector. It is observed that out of the total installed capacity addition during last 5 years, around 80% of the yearly addition was from renewable Energy sector.

Fig 14.1.4 Growth (%) in Capacity Installation



Renewable energy sector has shown impressive year-on-year growth rates in installation compared to the traditional thermal and nuclear sectors. From 2015 to 2023, growth rate of installed capacity under renewable energy sector has consistently outpaced that of non-renewable energy sector. Notably, since 2019, this growth has been accelerating. The graph indicates that the RE sector has consistently achieved growth rates above 7.94%, while non-RE sector's growth has not been more than 3.21%.

14.2 Capacity installation under various RE Sector:

Out of the Renewable energy sources, Solar energy installed capacity registered the largest increase, growing from 179.64 GW to 1,418.02 GW, a 685.37% growth with a CAGR of 25.80% compared to other sources during last 9 years. Wind energy expanded from 349.46 GW to 1,017.39 GW, registering a growth of 191.13% with a CAGR of 12.61%. Renewable hydro energy capacity increased from 1,067.33 GW to 1,264.74 GW, registering 18.50% growth with a CAGR of 1.90%. Bioenergy capacity raised from 90.10 GW to 148.84 GW, a 65.19% rise with a CAGR of 5.74%. Solar power exhibited a higher year-on-year growth rates, followed by wind, bioenergy, and renewable hydro. Details of installed capacity under important Renewable Energy sources are described below:

Table 14.2.1 Installed Capacity under solar, wind, renewable hydro and bioenergy from 2014 to 2023

(in GW)

Year	Solar	Wind	Renewable Hydro	Bioenergy	Total RE	Growth (%)
2014	179.64	349.46	1067.33	90.10	1698.30	
2015	228.08	416.44	1099.51	96.11	1852.50	9.08
2016	300.15	467.24	1130.05	104.87	2015.00	8.77
2017	395.85	514.93	1151.06	110.59	2185.71	8.47
2018	491.99	563.68	1173.78	117.82	2360.96	8.02
2019	595.03	622.73	1192.48	124.10	2548.69	7.95
2020	726.23	733.47	1212.87	132.02	2819.25	10.62
2021	870.64	824.32	1235.19	138.34	3083.43	9.37
2022	1070.85	902.88	1258.17	144.29	3391.35	9.99
2023	1418.02	1017.39	1264.74	148.84	3864.52	13.95
Gr (2014-2023)	689.37%	191.13%	18.50%	65.19%	127.55%	
CAGR (2014-2023)	25.80%	12.61%	1.90%	5.74%	9.57%	

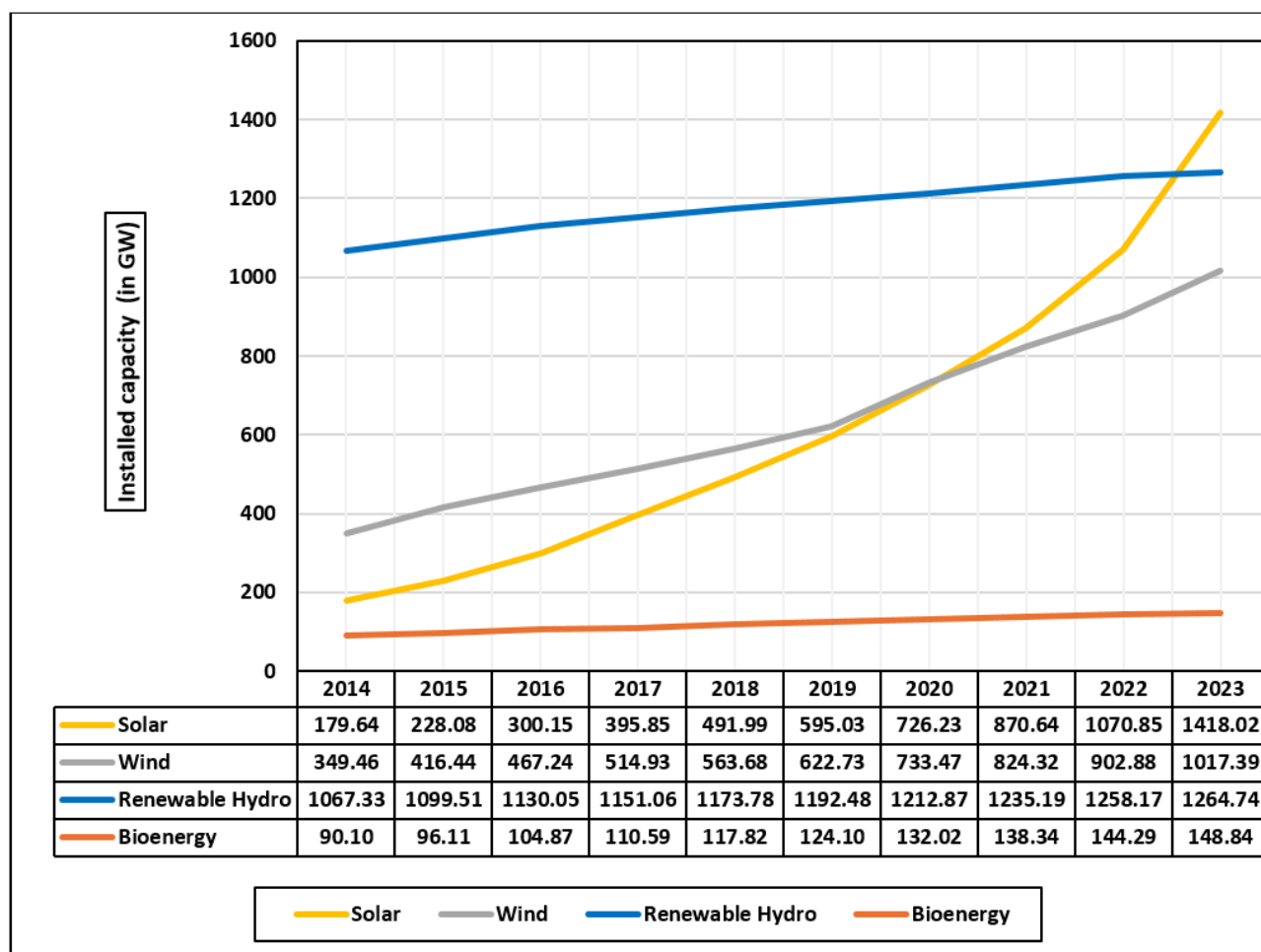
Source: IRENA – Renewable Energy Statistics 2024

Gr=Growth (%)

CAGR=Compound Annual Growth Rate

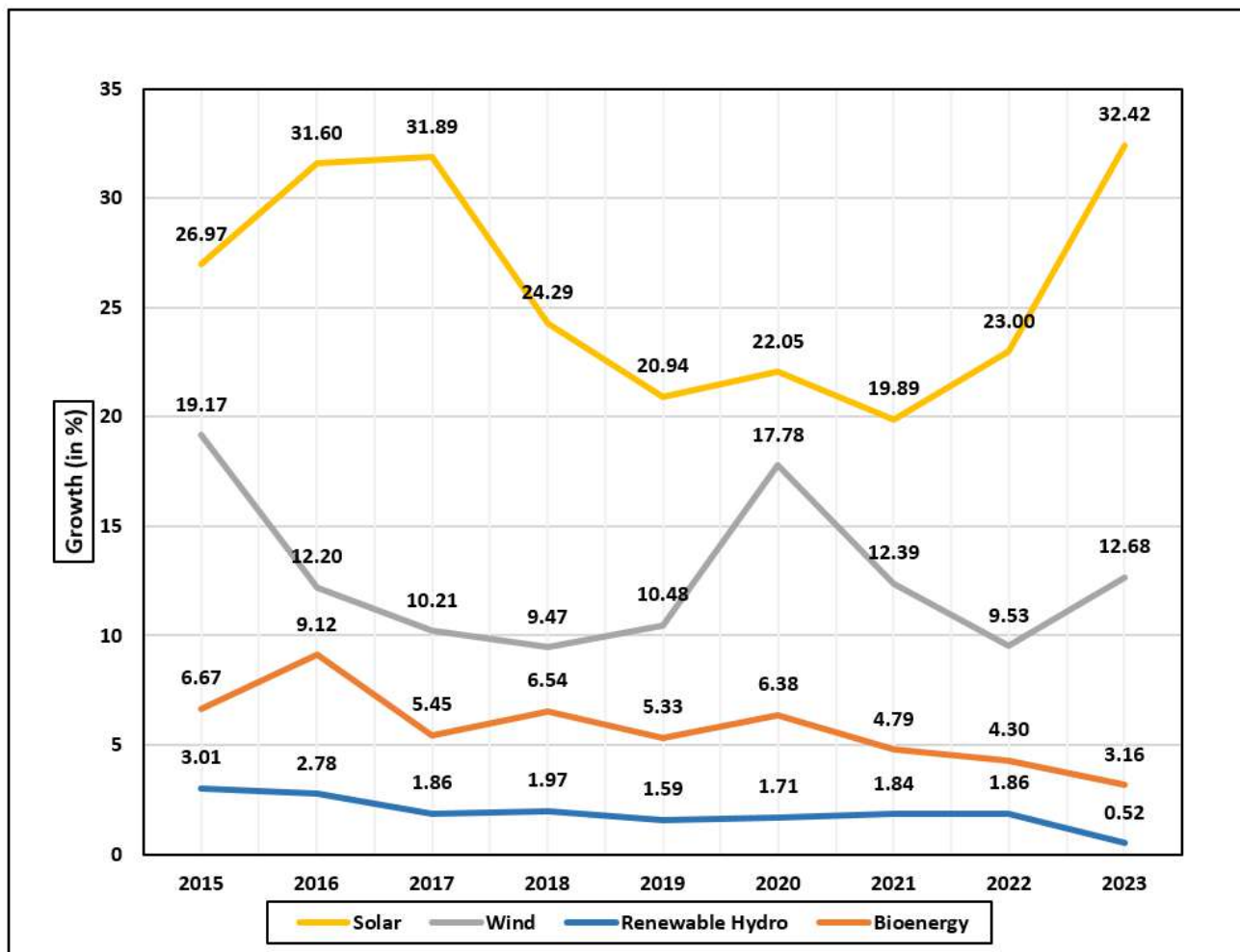
Fig 14.2.1 Trend in Capacity installation

(in GW)



Trend of cumulative capacity installation from 2014 to 2023 highlights dynamic growth across various renewable energy sources. For the first time, in 2023 cumulative installed capacity of Solar Power crossed that of renewable Hydro. Solar power leads the way in capacity expansions, followed closely by wind power, while renewable hydro power drives stable capacity expansions. Concurrently, bioenergy maintains a steady trend.

Fig 14.2.2 Growth (%) in Capacity installation



Year wise growth reveals that solar power has the highest growth rate among renewable energy sources, followed by wind power surpassing the growth rate of bioenergy and renewable hydro. Maximum growth rate of 32.42 % has been registered during 2023 in respect of Solar power installations since 2015.

CHAPTER 15

Energy Generation

15.1 Energy generation in RE & Non-RE sector:

In 2022, total energy generation from renewable energy sources reached 8439.67 TWh, a significant increase from 5039.25 TWh of 2013 with a growth of 67.48% with a compound annual growth rate (CAGR) of 5.90%. During this period, contribution of global energy generation from renewable energy sources in the total energy generation increased to 29.10 % in 2022 from 21.40% of 2013. Renewable energy sector worldwide has shown an impressive year-on-year growth rates in energy generation compared to that of Non-RE sector.

Table 15.1.1 Energy generation in RE and Non RE sector from 2013 to 2022

(in TWh)

Year	RE	Non-RE	Total	Share (%)		Growth (%)	
				RE	Non RE	RE	Non RE
2013	5039.25	18508.6	23547.9	21.40	78.60		
2014	5304.34	18589.1	23893.4	22.20	77.80	5.26	0.43
2015	5512.47	18771.5	24284.0	22.70	77.30	3.92	0.98
2016	5869.29	19106.4	24975.7	23.50	76.50	6.47	1.78
2017	6237.09	19429.9	25667.0	24.30	75.70	6.27	1.69
2018	6633.77	20007.9	26641.6	24.90	75.10	6.36	2.97
2019	6994.09	20010.1	27004.2	25.90	74.10	5.43	0.01
2020	7458.04	19563.9	27021.9	27.60	72.40	6.63	-2.23
2021	7872.66	20548.5	28421.2	27.70	72.30	5.56	5.03
2022	8439.67	20562.6	29002.3	29.10	70.90	7.20	0.07
Gr (2013-2022)	67.48%	11.10%	23.16%				
CAGR(2013-2022)	5.90%	1.18%	2.34%				

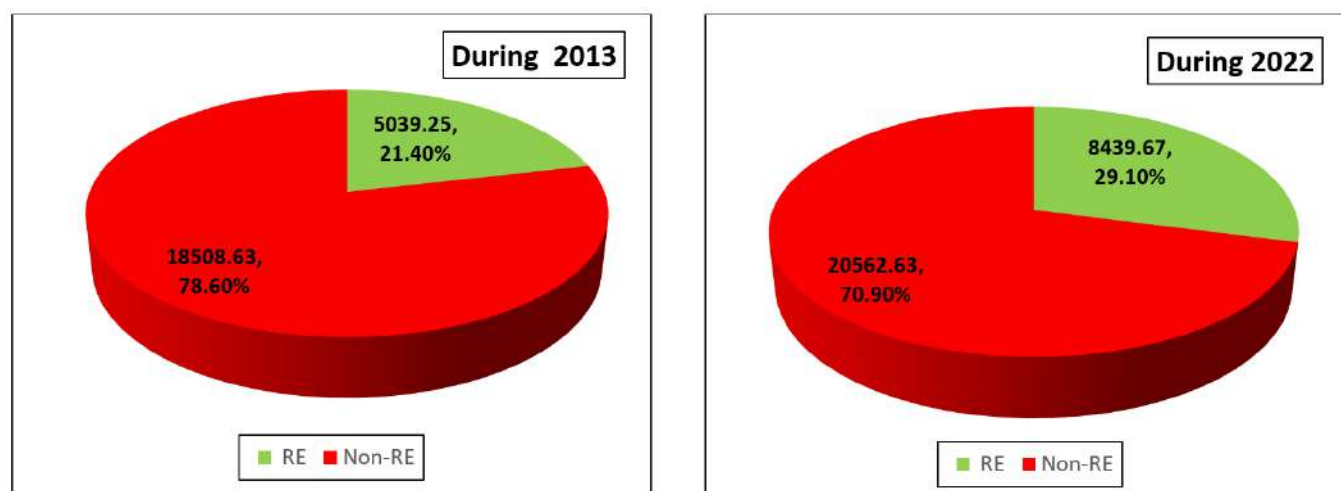
Source: IRENA – Renewable Energy Statistics- 2024

Gr=Growth (%)

CAGR=Compound Annual Growth Rate

Fig 15.1.1 Share of RE and Non RE in total Energy Generation

(in TWh)



In 2022, total energy generation from renewable energy sources reached 8439.67 TWh, a significant increase from 5039.25 TWh of 2013. This reflects a growth of 67.48% with a compound annual growth rate (CAGR) of 5.90%. In comparison, non-renewable energy sources experienced a growth of 11.10% with a CAGR of 1.18% during the period.

Fig 15.1.2 Trend in Energy Generation

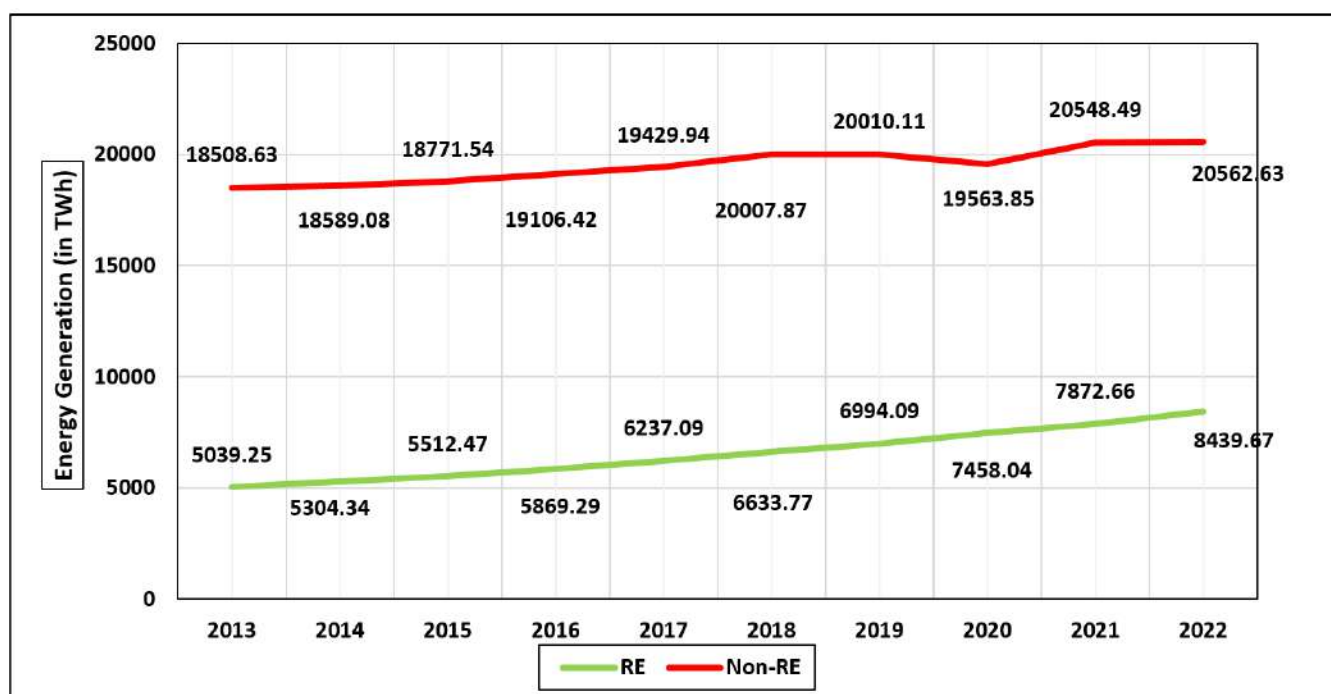
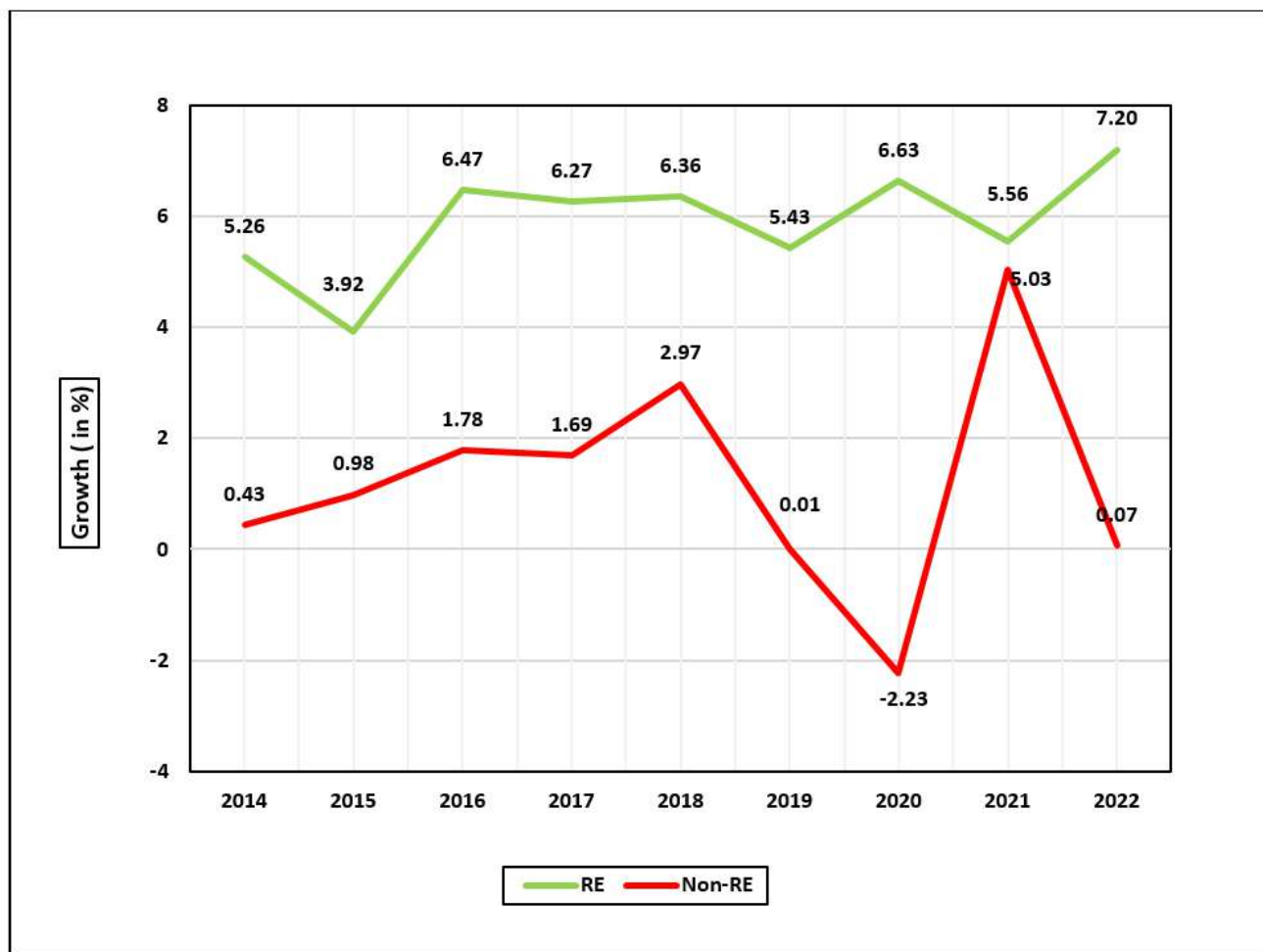


Fig 15.1.3 Year wise Growth (%) in Energy Generation



Renewable energy sector worldwide has shown an impressive year-on-year growth rates compared to Non-RE sector. Maximum growth rate of Renewable Energy generation was registered in the year of 2022. It is to be seen that growth registered from 2014 to 2022 in the energy generation through renewable energy sources has consistently outpaced that of the growth of energy generation through Non-RE sources.

15.2 Energy generation in various RE sources:

During 2022, energy generation from renewable energy sources has reached 8439.67 TWh, a significant increase from 5039.25 TWh of 2013. This comparison highlights substantial growth in renewable energy generation over the nine-year period, with solar power emerging as a dominant force followed by Wind power. Annual growth trends reveal that energy generation from solar power has the highest growth rate followed by Wind Power, Bio Power and Hydro Power.

**Table 15.2.1 Energy Generation under Solar, Wind, Renewable Hydro and Bioenergy
RE sources from 2013 to 2022**

(in TWh)

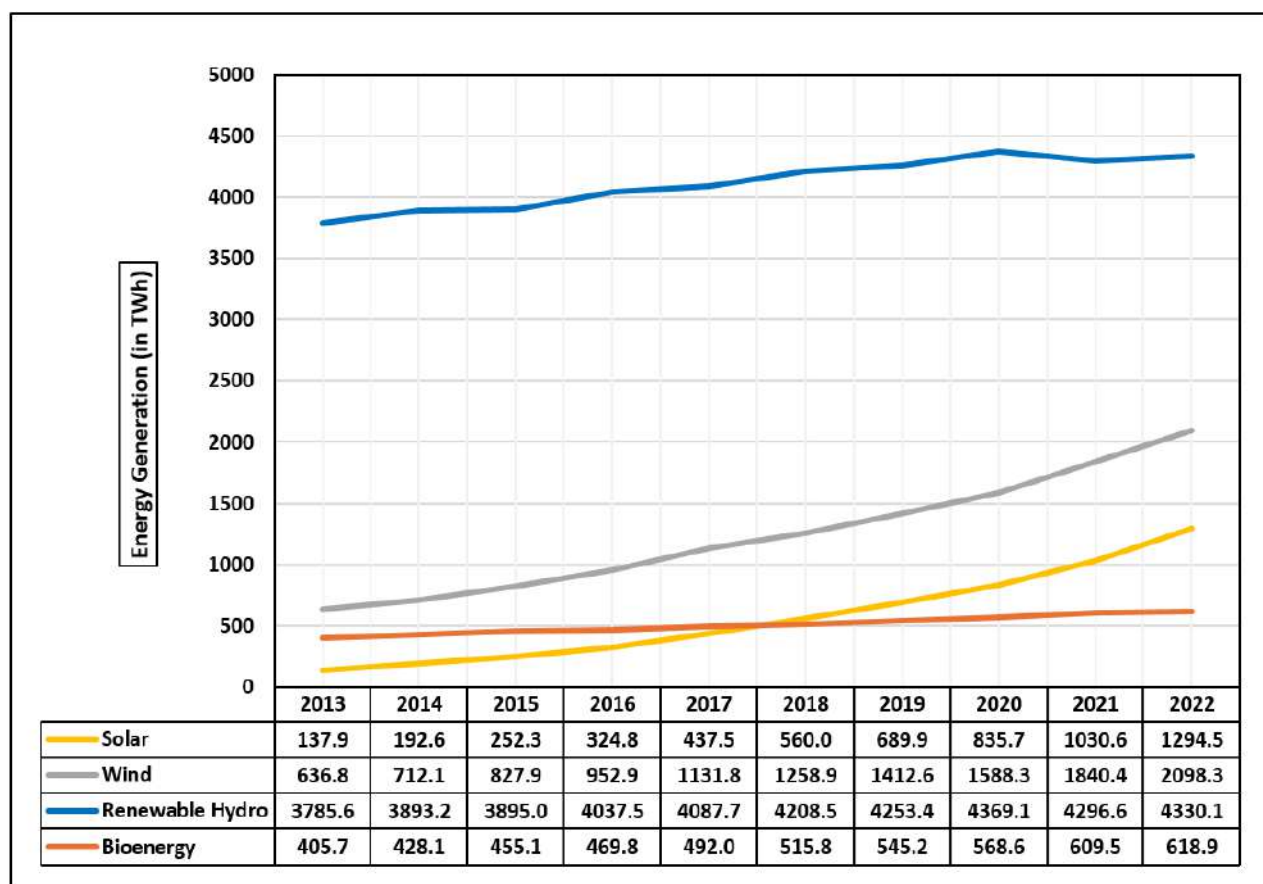
Year	Solar	Wind	Renewable Hydro	Bioenergy	Total RE	Growth (%)
2013	137.89	636.79	3785.58	405.65	5039.25	
2014	192.60	712.13	3893.17	428.10	5304.34	5.26
2015	252.27	827.89	3894.99	455.09	5512.47	3.92
2016	324.80	952.94	4037.46	469.81	5869.29	6.47
2017	437.52	1131.76	4087.70	492.01	6237.09	6.27
2018	560.04	1258.93	4208.48	515.84	6633.77	6.36
2019	689.90	1412.64	4253.38	545.17	6994.09	5.43
2020	835.69	1588.32	4369.06	568.55	7458.04	6.63
2021	1030.57	1840.36	4296.55	609.55	7872.66	5.56
2022	1294.48	2098.33	4330.11	618.92	8439.67	7.20
Gr (2022-2013)	838.78%	229.52%	14.38%	52.57%	67.48%	
CAGR(2022-2013)	28.25%	14.17%	1.50%	4.81%	5.90%	

Source : IRENA – Renewable Energy Statistics 2024

Gr=Growth (%)

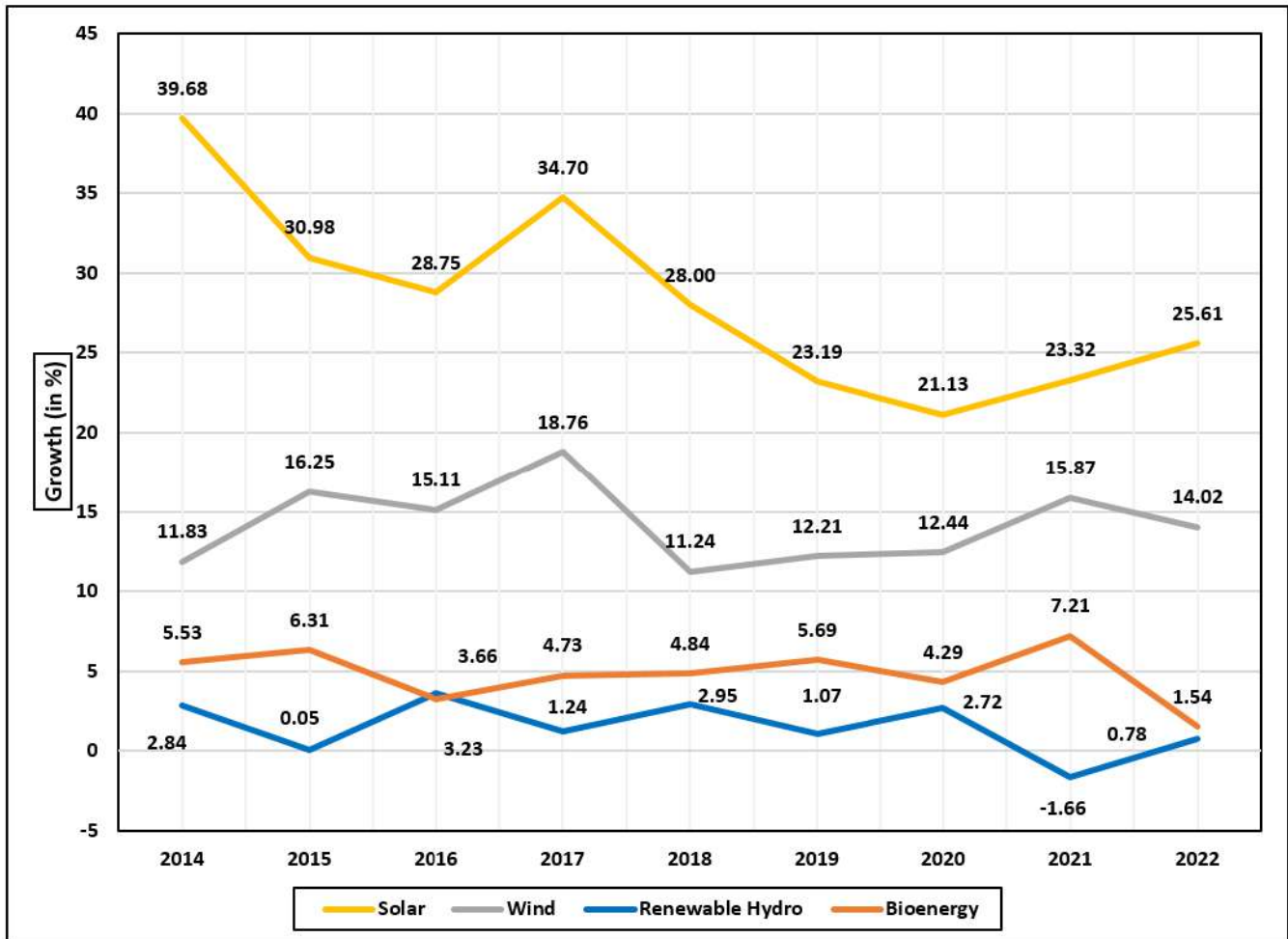
CAGR=Compound Annual Growth Rate

Fig 15.2.1 Trend in Energy Generation



Energy generation through renewable energy sources has shown varying trends over the years. Solar power registered the most dramatic increase from 137.89 TWh to 1294.48 TWh, with a growth of 838.78% having CAGR of 28.25% during 9 years starting from 2013. Wind power's generation raised from 636.79 TWh to 2098.33 TWh, achieving a growth of 229.52% with a CAGR of 14.17%. Bio Energy generation enhanced steadily from 405.65 TWh to 618.92 TWh, with a growth of 52.57% and a CAGR of 4.81%. Renewable Hydro experienced an increase from 3785.58 TWh to 4330.11 TWh, reflecting a growth of 14.38% and a CAGR of 1.50%.

Fig 15.2.2 Year wise Growth (%) in Energy Generation.



Annual growth rates reveal that energy generation from solar power has the highest growth rate followed by Wind Power, Bio Power and Renewable Hydro Power. All sources have registered fluctuations in growth rates over the years.

Installed capacity and generation

16.1 Installed Capacity in RE and Non-RE sector:

Asia region leads with the largest expansion of 1325.94 GW in installed capacity under Renewable energy sources during 2015 to 2023. Asia enhanced its installed capacity under RE from 633.14 GW of 2014 to 1,959.08 GW by 2023, registered a remarkable growth of 209.42% with a CAGR of 13.37%, followed by Europe with an expansion of 345.87 GW during the period registering growth of 78.62% and a CAGR of 6.66%. North America raised its installed capacity of 287.52 GW of 2014 to 526.97 GW by 2023 with a growth of 83.28% having 6.96% CAGR. Other regions have also registered positive growth in RE installation during this period. Europe and North America registered a decline in capacity installation under Non-RE sector. Detailed analysis based on various regions installed capacity are described in this chapter.

Table16.1.1 Total RE & Non-RE Installed capacity from 2014 to 2023

(in GW)

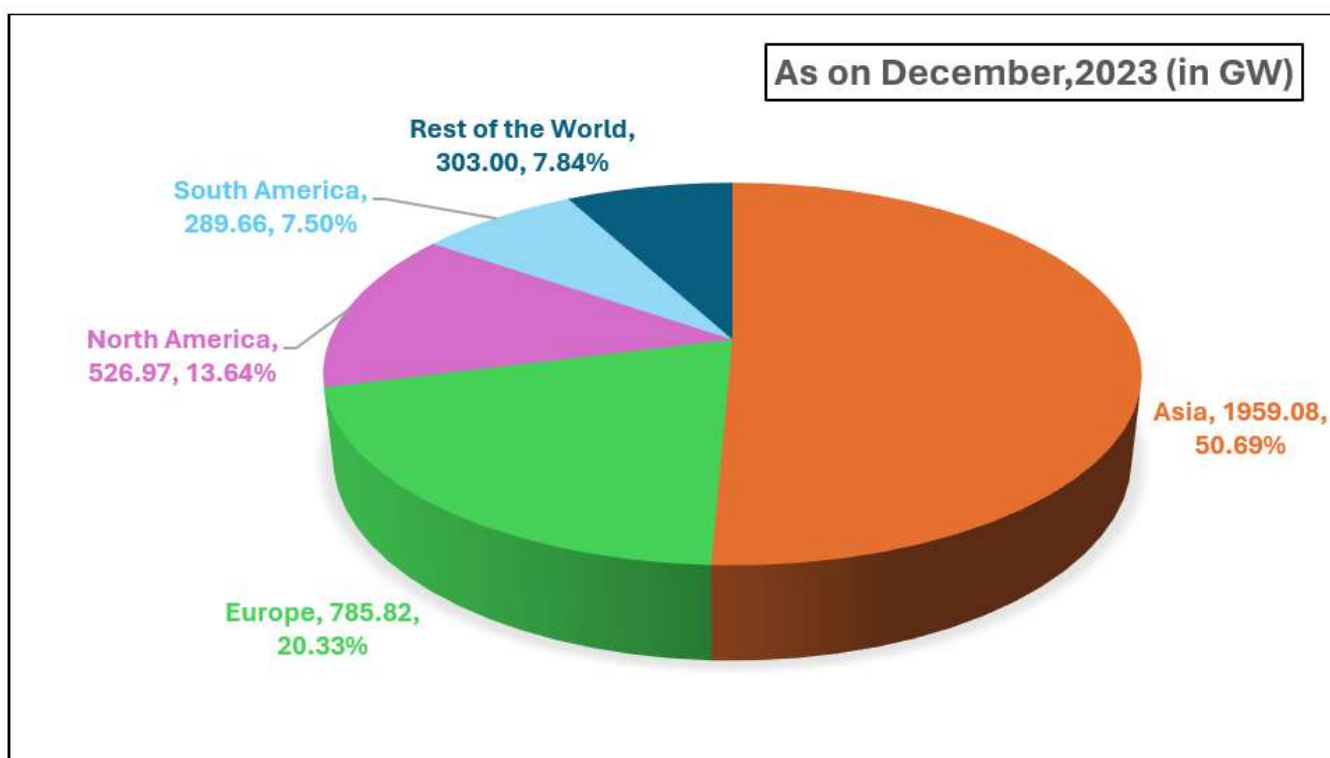
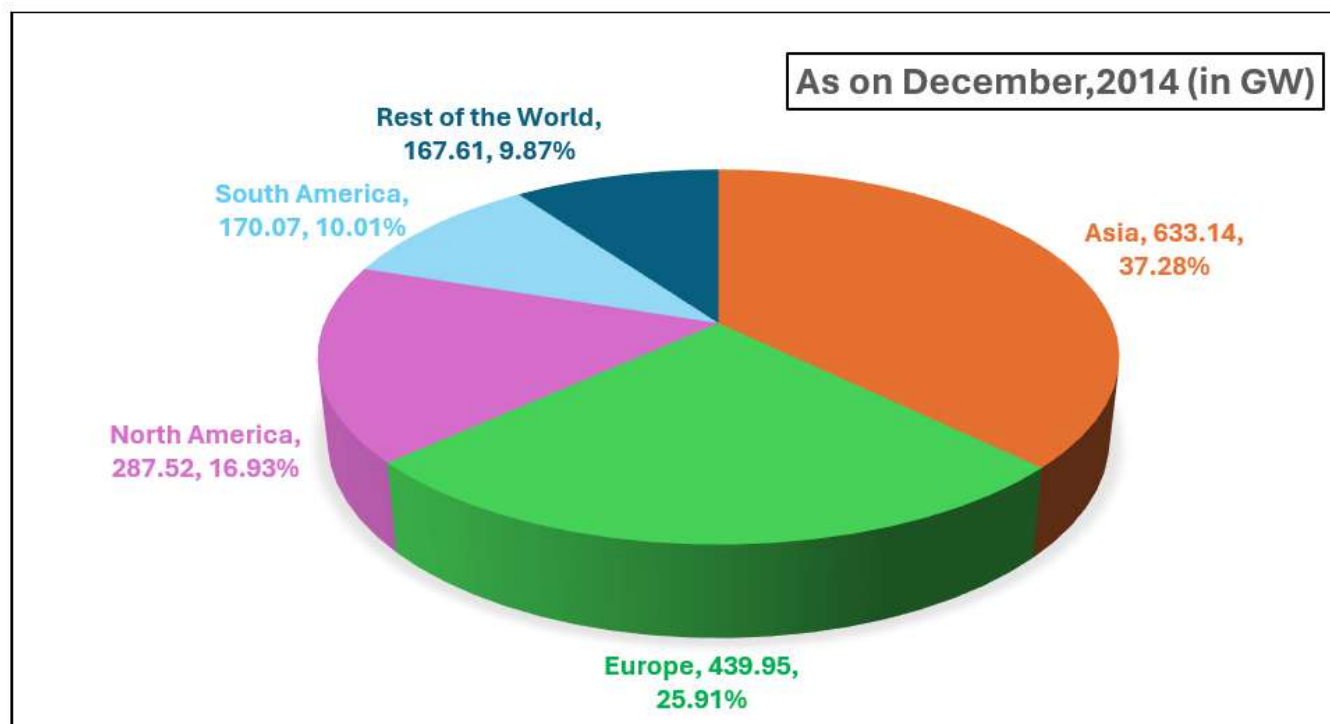
Year	Asia		Europe		North America		South America		Rest of the World	
	RE	Non-RE	RE	Non-RE	RE	Non-RE	RE	Non-RE	RE	Non-RE
2014	633.14	1830.44	439.95	679.52	287.52	990.34	170.07	99.46	167.61	724.27
2015	722.38	1933.44	465.13	661.09	309.49	974.69	178.65	99.19	176.85	758.75
2016	813.32	2030.45	488.68	650.43	333.15	973.32	193.52	103.74	186.34	769.27
2017	920.59	2117.66	513.00	639.81	349.64	974.75	202.73	106.31	199.75	784.82
2018	1025.15	2208.77	537.51	643.84	367.83	984.48	213.54	108.54	216.93	826.22
2019	1125.14	2274.07	574.88	625.29	392.95	976.21	223.58	109.13	232.14	832.76
2020	1301.28	2343.76	609.13	614.03	424.73	963.28	232.87	112.12	251.24	850.43
2021	1455.90	2405.91	651.44	603.75	462.21	968.78	247.17	114.72	266.71	853.18
2022	1630.94	2477.23	715.65	599.88	492.47	968.87	266.93	114.94	285.36	862.99
2023	1959.08	2554.92	785.82	595.24	526.97	970.10	289.66	116.03	303.00	886.45
Gr (2014 to 2023)	209.42%	39.58%	78.62%	-12.40%	83.28%	-2.04%	70.32%	16.66%	80.77%	22.39%
CAGR (2014 to 2023)	13.37%	3.77%	6.66%	-1.46%	6.96%	-0.23%	6.10%	1.73%	6.80%	2.27%

Source: IRENA – Renewable Energy Statistics 2024

Gr=Growth (%)

CAGR=Compound Annual Growth Rate

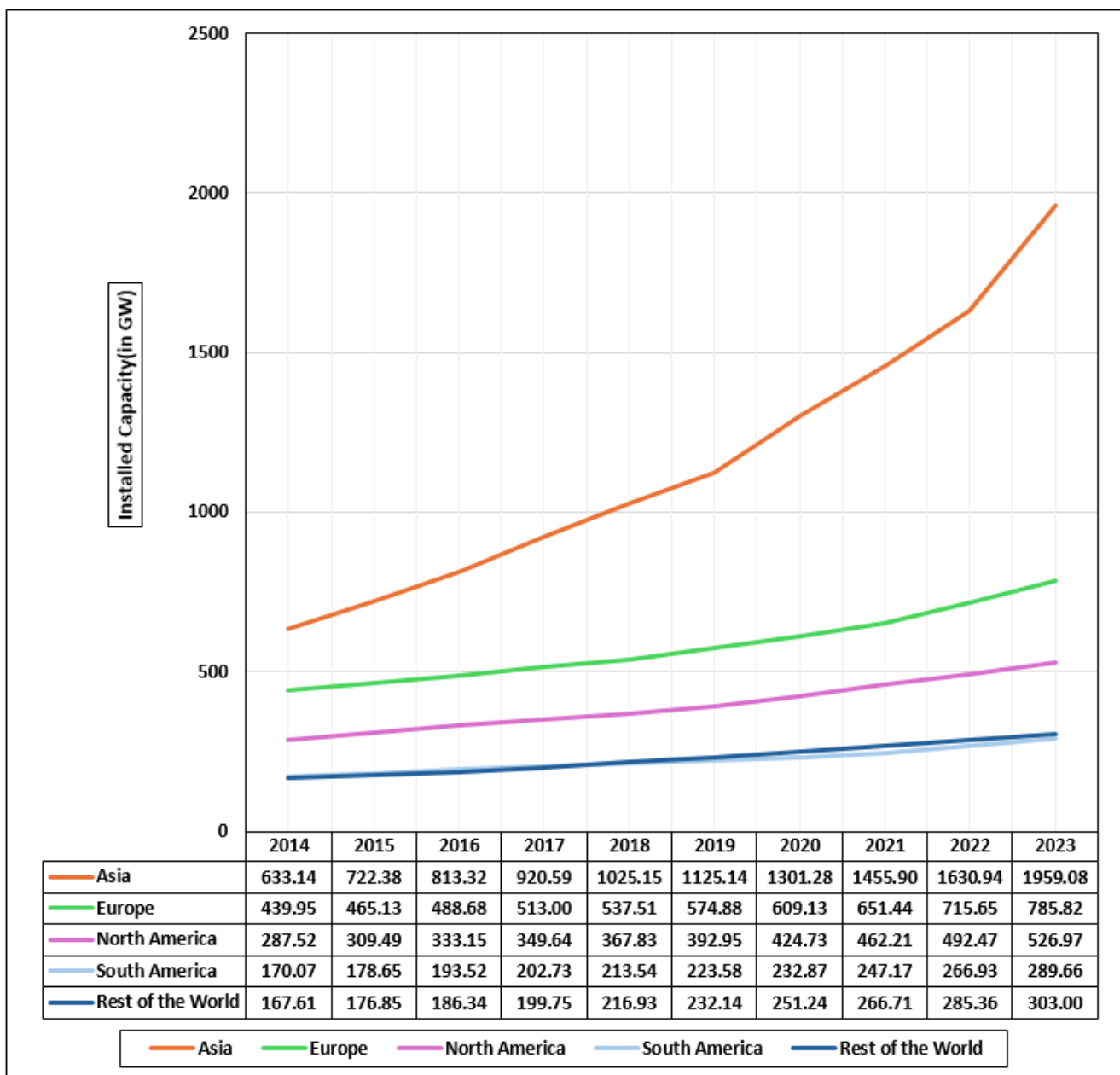
Fig 16.1.1 Region wise share in RE installed Capacity



Asia was leading with largest share of 37.28% in regional distribution of installed renewable energy capacity in 2014 followed by Europe having 25.91% share. North America had the share of 16.93% followed by South America with 10.01%, and rest of the world having 9.87% share. By 2023, Asia's share of RE increased to 50.69%, while Europe, North America, South America, and other regions of the world accounted for 20.33%, 13.64%, 7.50%, and 7.84%, respectively in the installed capacity under Renewable Energy sources.

Fig 16.1.2 Region wise trend in RE installed Capacity

(in GW)



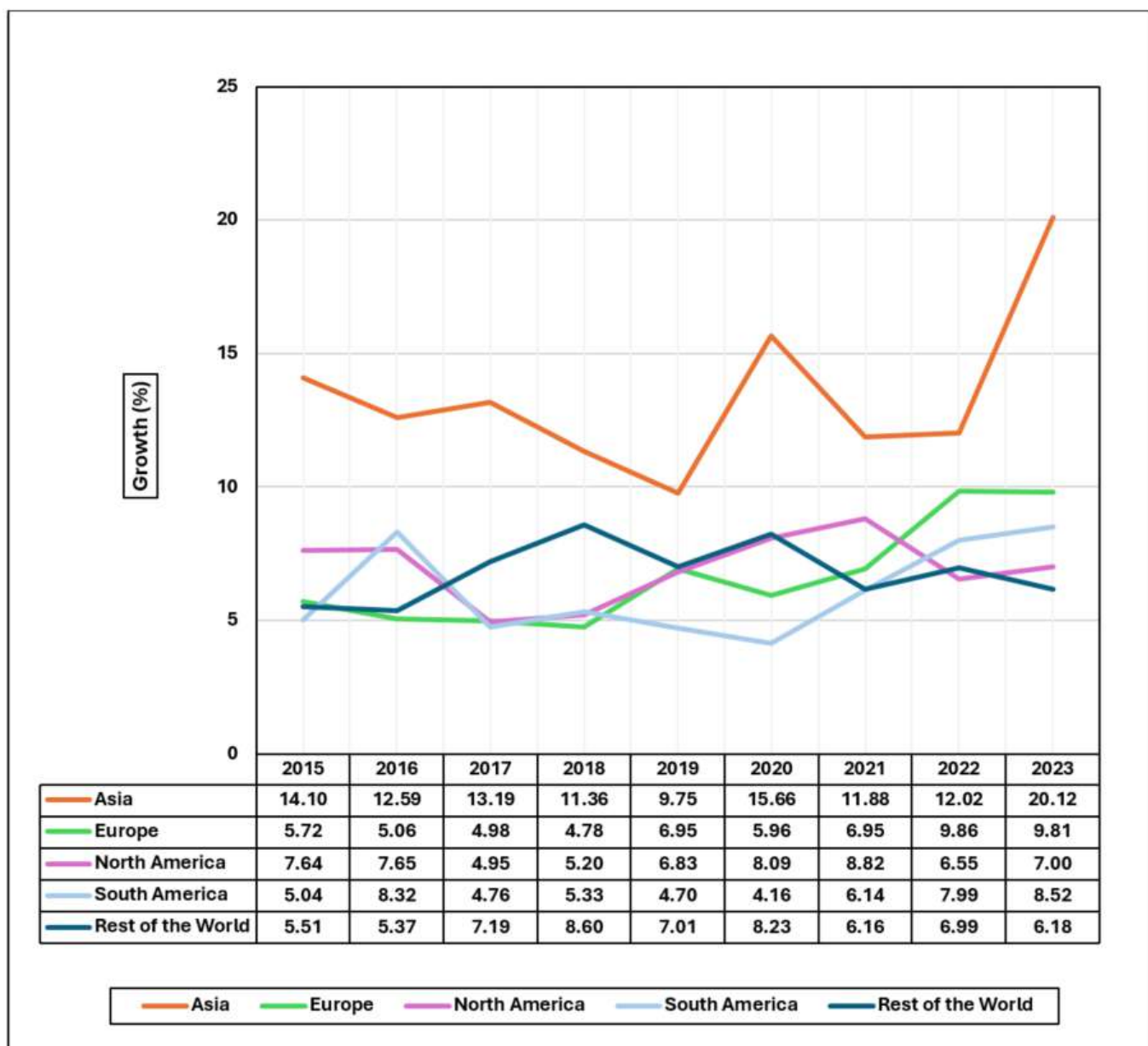
During last 10 years from 2014 to 2023 Asia stands out with an exceptional exponential trend in RE installed capacity, displaying a remarkable growth of 209.42%, whereas remaining sectors exhibited a steady growth during the period.

16.2 Region wise growth (%) in RE installed Capacity:

During 2023, Asia experienced the highest growth rate of 20.12% in renewable energy installed capacity, followed by Europe, South America, and North America. Although almost all regions showed fluctuations in their year-on-year growth rates, Asia consistently led in growth rate from 2015 to 2023, surpassing other regions in terms of total installed capacity in the renewable energy sector.

Fig 16.2.1 Region wise growth (%) in RE installed Capacity

(in GW)



16.3 Region wise RE and Non-RE Generation:

Asia led the Renewable Energy generation expanding from 1684.40 TWh of 2013 to 3748.55 TWh during 2022, with an impressive growth of 122.55% having CAGR of 9.30%. North America followed Asia with a growth of 48.77% and a CAGR of 4.51% in the renewable energy generation. Europe enhanced its generation of RE from 1094.36 TWh to 1461.75 TWh, with a growth of 33.57% and a CAGR of 3.27%. Europe, North America and South America registered negative growth and negative CAGR during this period in the case of energy generation through Non-RE sectors.

Table 16.3.1 RE & Non-RE Generation from 2013 to 2022.

(in TWh)

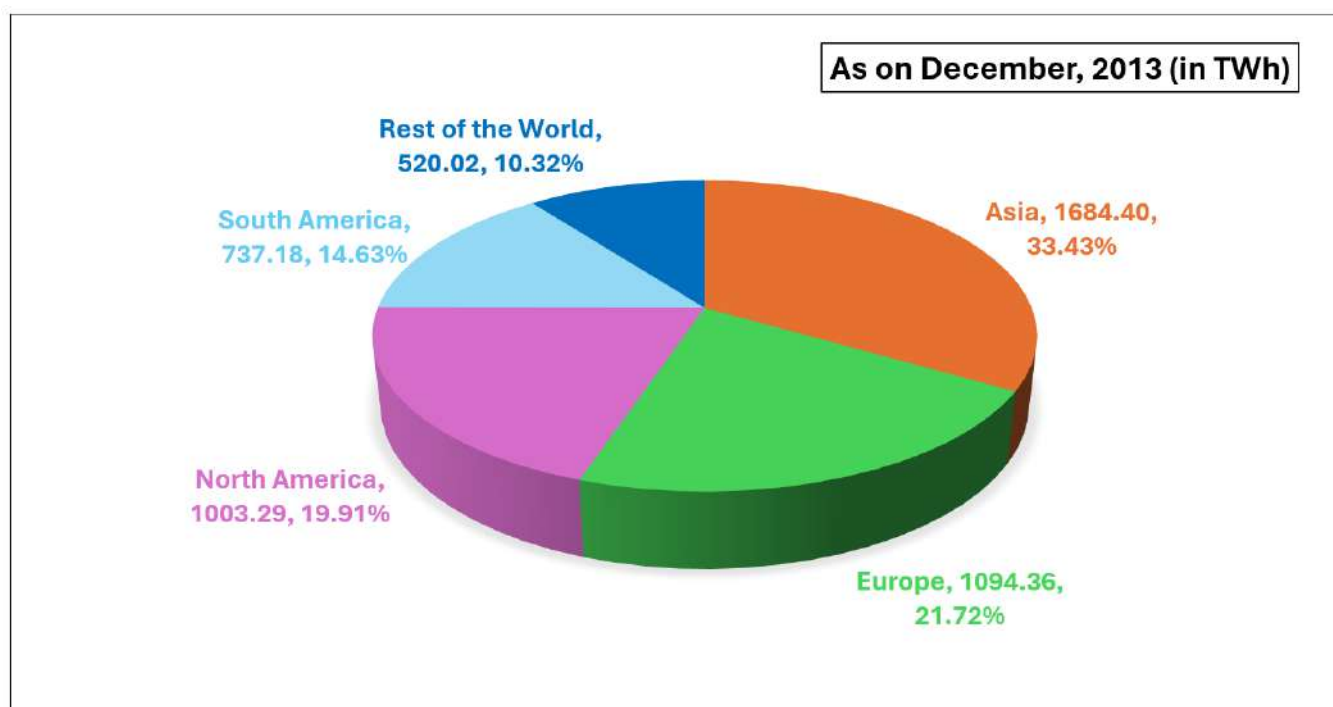
Year	Asia		Europe		North America		South America		Rest of the World	
	RE	Non-RE	RE	Non-RE	RE	Non-RE	RE	Non-RE	RE	Non-RE
2013	1684.40	8052.02	1094.36	2718.74	1003.29	4249.52	737.18	402.20	520.02	3086.15
2014	1900.54	8155.24	1135.68	2587.86	1029.76	4278.29	731.81	426.12	506.55	3141.58
2015	2034.47	8292.80	1173.95	2576.68	1037.46	4255.71	732.69	435.88	533.90	3210.48
2016	2220.18	8663.04	1195.66	2588.08	1117.87	4180.08	763.94	405.95	571.65	3269.26
2017	2431.99	9039.66	1210.69	2584.57	1211.88	4057.15	797.05	382.02	585.49	3366.54
2018	2651.92	9568.90	1297.81	2496.96	1231.85	4243.05	826.96	354.41	625.23	3344.56
2019	2868.68	9824.61	1330.91	2407.61	1251.71	4143.60	838.10	347.33	704.68	3286.97
2020	3101.87	9822.58	1451.26	2167.83	1327.20	3898.00	841.26	333.69	736.45	3341.75
2021	3429.26	10454.40	1470.36	2271.02	1374.58	4015.93	840.78	386.64	757.67	3420.51
2022	3748.55	10558.90	1461.75	2147.51	1492.55	4035.40	940.48	313.49	796.35	3507.34
Gr (2013-2022)	122.55%	31.13%	33.57%	-21.01%	48.77%	-5.04%	27.58%	-22.06%	53.14%	13.65%
CAGR (2013-2022)	9.30%	3.06%	3.27%	-2.59%	4.51%	-0.57%	2.74%	-2.73%	4.85%	1.43%

Source: IRENA – Renewable Energy Statistics- 2024

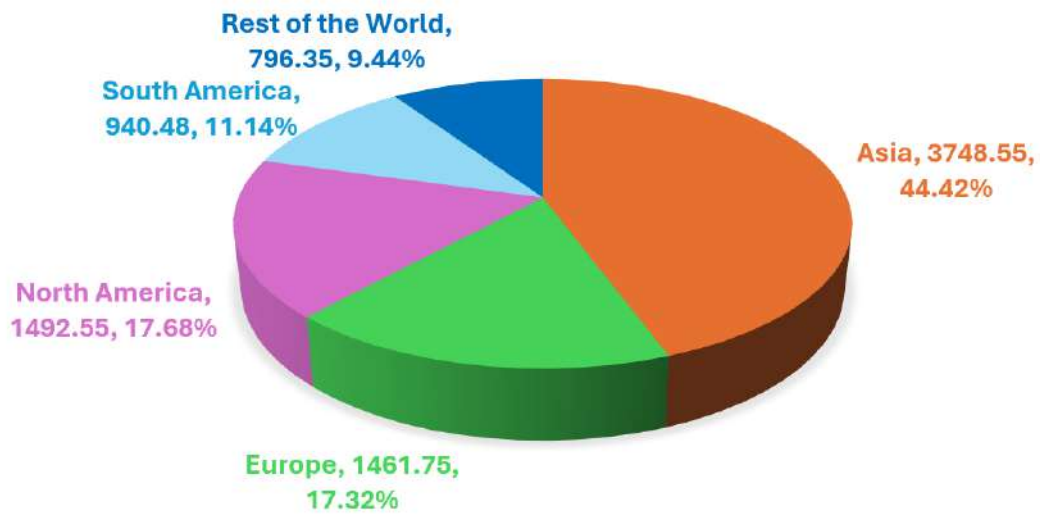
Gr=Growth (%)

CAGR=Compound Annual Growth Rate

Fig 16.3.1 Region wise share in RE Generation

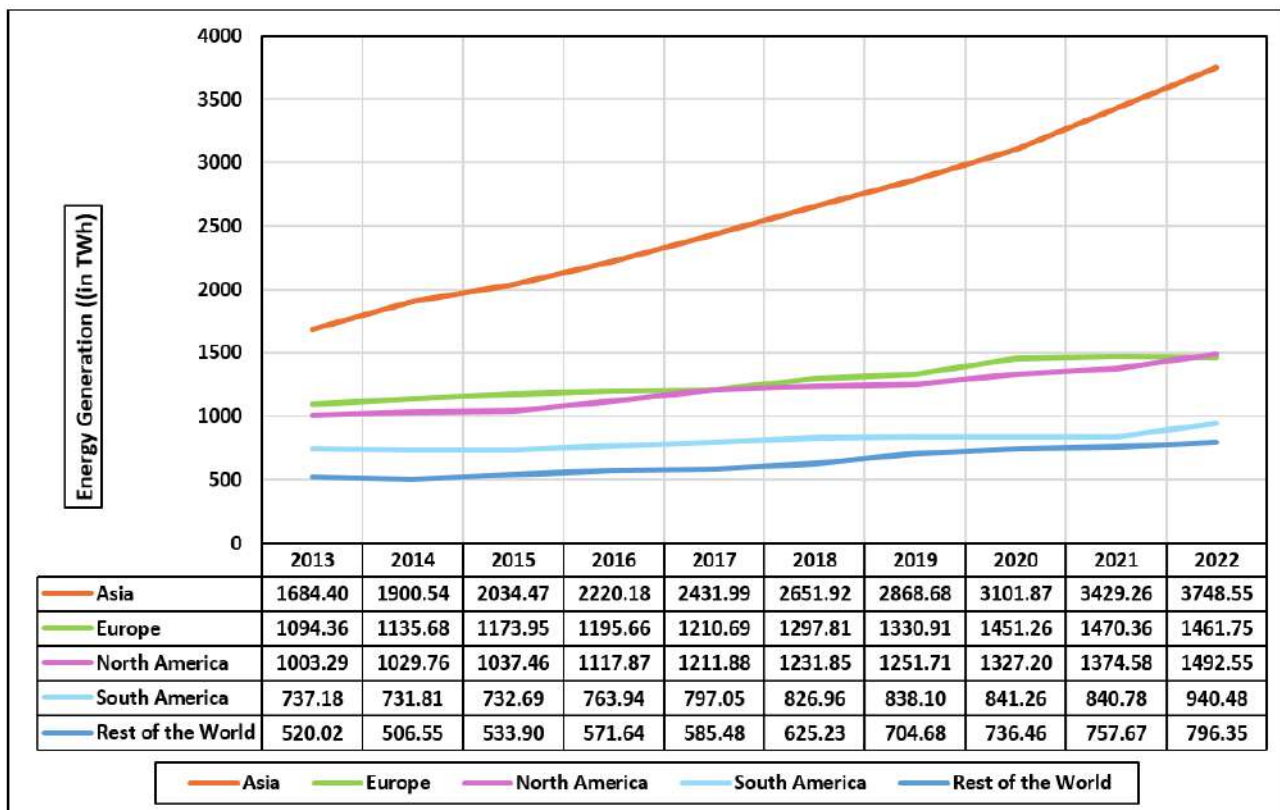


As on December, 2022 (in TWh)



In 2013, renewable energy generation was led by Asia region with a 33.43% share, followed by Europe with 21.72% and North America by 19.91%, share. By 2022, Asia's share had risen significantly to 44.42%, followed by Europe and North America.

Fig 16.3.2 Region wise Trend in Renewable Energy Generation



Graphs clearly exhibits that Asia registered a sharp increase in the energy generation through Renewable Energy sources over the years while other regions have moderate increase over the years.

Installed Capacity and Energy Generation

17.1 Installed Capacity

17.1.1 Top 10 countries in RE Installed Capacity: As on 31st December, 2023, China leads the global renewable energy sector with an installed capacity of 1,453.70 GW, holding 37.62% share of the world installed capacity followed by United States with 385.21 GW with a share of 9.97%. Brazil ranked third with 194.09 GW having 5.02% share, while India was in fourth position having 4.55% share with installation 175.93 GW of RE installed capacity. Together, top 10 countries accounted for around 73.14% of the world's total RE installed capacity (Refer Table 17.1.1)

Table 17.1.1 Cumulative RE installed capacity of top 10 (in RE Installed Capacity) countries up to 31st December, 2023

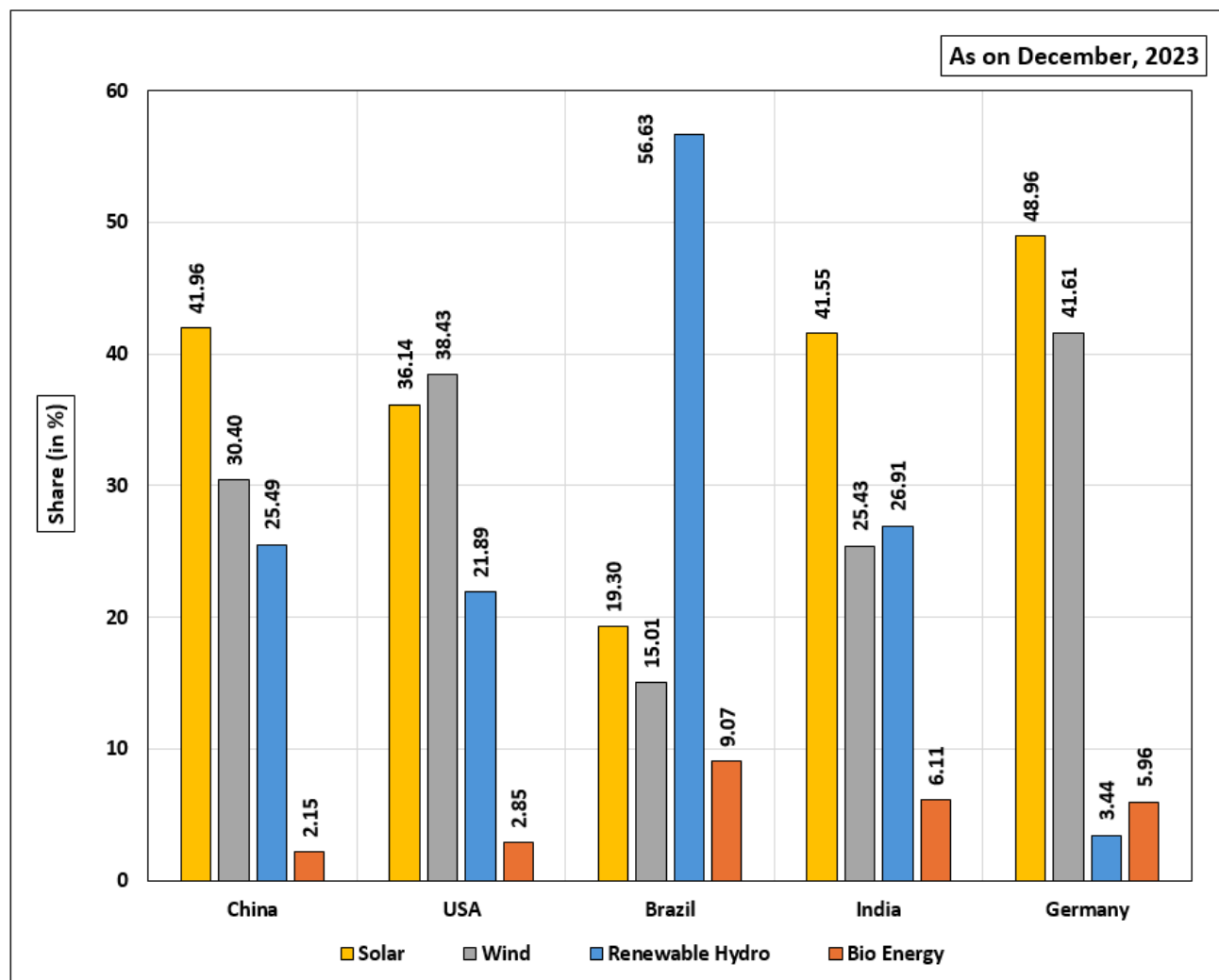
Country	RE Installed Capacity (GW)	Contribution in Total RE installed capacity of the World (in %)
China	1453.70	37.62
USA	385.21	9.97
Brazil	194.09	5.02
India	175.93	4.55
Germany	166.94	4.32
Japan	128.78	3.33
Canada	108.72	2.81
Spain	80.14	2.07
France	67.92	1.76
Italy	65.16	1.69
World	3864.52	

Source: IRENA – Renewable Energy Statistics 2024

17.1.2 Share of various RE installed capacity of top 5 (in RE Installed Capacity) countries within the country:

China, USA, Brazil, India and Germany ranked as the top five countries in total renewable energy installed capacity as on December, 2023. Among them, China, India and Germany have their largest share from solar power sector within their RE installations. In the case of wind power capacity installations, USA holds the largest share amounting to 38.43%. Hydro Power installation is dominated in Brazil's RE sector with 56.63%. In these top 5 countries, Bioenergy holds the smallest share of total RE capacity except Germany. Germany has the smallest share of Hydro power among the top five countries in their respective RE installed capacity. (Refer Fig 17.1.3)

Fig 17.1.3 Share of various RE installed capacity of top 5 (in RE Installed Capacity) countries within the respective country



17.2 Renewable Energy Generation

17.2.1 China leads the global renewable energy (RE) sector with generation of 2625.26 TWh, holding a 31.11% share of RE generation in the world during 2022 followed by United States with 959.23 TWh having a share of 11.37%. Brazil and Canada ranked third and fourth position with 594.03 TWh having 7.04% share and 449.27 TWh having 5.32% share respectively. India secured fifth position having 4.01 % share with 338.19 TWh generation of Renewable Energy. Together, top 10 countries accounted for about 70.04% of the world's total generation from Renewable Energy sources. **(Refer Table 17.2.1)**

Table 17.2.1 RE generation of top 10 (in RE generation) countries during 2022

(in TWh)

Country	RE Generation (TWh)	Contribution in the total RE generation of the World (in %)
China	2625.26	31.11
USA	959.23	11.37
Brazil	594.03	7.04
Canada	449.27	5.32
India	338.19	4.01
Germany	251.09	2.98
Russia	208.61	2.47
Japan	218.83	2.59
Norway	143.46	1.70
Spain	122.96	1.46
World	8439.67	

17.2.2 Share of various RE sources in the total RE generation of top 5 (in RE generation) countries within the respective country: In 2022, China, USA, Brazil, Canada and India ranked as the top five countries in total renewable energy (RE) generation. China, Brazil, Canada and India had the largest share of Renewable Hydro within their Renewable Energy Generation. In USA, wind power held the largest share in RE generation. In top five RE generating countries, bioenergy held the smallest share of total RE generation except Canada. Canada had the smallest share of Solar Power among the top five RE generating countries in their RE generation. Detailed contribution of various RE sectors in the respective country's Renewable energy generation is mentioned in **Fig 17.2.1**.

Fig 17.2.1 Share of various RE sources in the total RE generation of top 5 (in RE generation) countries within the respective country

