

Mr. Vipin Malik
(Chairman, Infomerics Ratings)

Dr. Manoranjan Sharma
(Chief Economist)

Mr. Rajat Raghav
(Officer - Economic Analysis)

INDUSTRY OUTLOOK

RENEWABLE ENERGY IN INDIA- NEED TO PUSH FULL THROTTLE AHEAD

01 April 2025

1. Overview

The paradigm shift to the renewable energy sector is gaining increasing acceptance the world over. Some of the basic drivers of this strategically important shift include rising environmental awareness, bolder climate ambitions, an accent on energy security, the emergence of climate-centric industrial policy, the rising cost-competitiveness of renewable power and supportive government policies.

The renewable energy sector in India is one of the most diverse and dynamic energy sectors in the world. Renewable Energy (RE) generation sources, such as hydro, solar, and wind, are the primary sources, while biomass, pump storage plants, and waste-to-energy are secondary sources.



A shift in the generation capacity mix towards RE is occurring rapidly. This is due to increasing accountability towards the environment and climate change issues. India's energy generation capacity is also moving towards sustainable development and cleaner environmental goals by significantly adding RE generation capacity.

2. Installed Capacity

India's renewable energy capacity grew manifold over the years. India's total RE installed capacity stood at 212.72 GW while RE* capacity (excluding large hydropower) stood at 165.02 GW as of January 2025. Solar energy leads the way with a contribution of 100.3 GW, followed by wind energy at 48.36 GW.

RE* capacity addition of 21.56 GW occurred in FY 2024-25 (till January 2025). This increase was primarily driven by solar energy of 18.516 GW. Total solar capacity increased by 22.6 per cent while overall renewable energy capacity grew by 15.0 per cent. This trend is expected to continue into 2025 as a large RE capacity addition will be witnessed in the rest of the year, primarily driven by solar energy¹.

3. Renewable Energy Generation

During the last decade, i.e., from 2014 to 2024, the share of non-fossil energy surged from 32 per cent (87 GW) to 45 per cent (198 GW) of India's total installed capacity. The installed capacity of fossil fuel-based electricity, however, also rose from 187 GW to 243 GW during this period.

In India, energy generation stood at 1739.62 billion units (BU) during the April-December 2024 period. Of this generation, RE sources generation stood at 314.91 BU, contributing 18.01 per cent to total energy generation.

RE generation has increased to 314.911 BU in Apr-Dec 2024 compared to 287.24 BU during the corresponding period last year. Implying a growth of 10.96 per cent. RE* generation increased to 189.489 BU compared to 172.488 BU, implying a growth of 9.85 per cent.

Large hydropower formed the major component with 39.8 per cent share in energy generation, solar energy contributed 32.43 per cent, followed by wind at 21.58 per cent. The increase in RE generation has been driven by a 21.13 per cent increase in solar generation and a 9.29 per cent increase in hydro power generation. Wind power generation decreased production by 2.64 per cent due to the withdrawal of monsoon.

Large-scale solar energy generation was possible due to new projects joining the grid, while an increase in hydro generation was possible due to above-normal rainfall in the country.

4. Under Construction Renewable Energy Projects

India's ambitious target of achieving 500 GW of renewable energy capacity by 2030 as part of its commitment under the Paris accord has been partially met, with total RE* capacity of 142.66 GW under construction as of December 2024. The RE* under construction capacity comprises 82.35 GW of solar capacity, 24.53 GW of wind capacity, and 35.78 GW of hybrid (solar +wind). A large portion of these projects are concentrated in the states of Gujarat (46.4 GW), Karnataka (21.9 GW), Maharashtra (10.7 GW), and Madhya Pradesh (9.1 GW).

Projects in Tendering Stage

Month - 2024	Total	Dec	Nov	Oct	Sept	Aug	Jul	Jun	May	Apr	Mar
RE tenders issued (GW)	85.5	9.5	2.71	6.8	11.1	5.927	5.937	8.42	13.2	3.7	18.2
Data Source: JMRK											

RE- Request for Solution (RFS) tenders reached a peak high in March 2024. RFS, which had increased till Sept-2024, slowed in November. In December, an uptick of RE tenders was seen. In terms of composition of RFS, these RFS majorly comprise of Solar or Solar-Wind hybrid projects.

Also, an increase in the Storage and Battery Energy Storage System (BESS) has been seen in RFS. This may have occurred due to the approval of the Validity gap funding scheme in September 2023.

5. India's Renewable Energy Targets

In terms of its August 2022-commitment to the UN Framework Convention on Climate Change, India's targets are to reduce the emissions intensity by 45 per cent by 2030 (compared to 2005 levels), and to achieve 50 per cent of cumulative electric power capacity from non-fossil fuel sources by 2030. This is part of the country's Nationally Determined Contributions (NDCs) for achieving climate goals listed in the Paris Agreement. Furthermore, India has increased its target for installed non-fossil energy capacity to 500 GW by 2030, from 175 GW of renewable energy by 2022.

According to the Union Ministry of Power, this translates into the 50 per cent non-fossil energy target pledged under the NDC. This target was recommended under the *Panchmrit Goals* at CoP 26. These renewable energy targets can be subdivided into:

	Capacity (GW)	Solar	Wind	Bio energy	Small Hydro	Large Hydro	Nuclear
Target (2031-32)		365	122	16	5	62	20
Target (2030)	500	270	117	15	5	72	21
Achievement	220.17	100.33	48.36	11.3	5.1	46.9	8.18
Data Sources: Target (2032) according to NEP 2023 while Target (2030) according to MNRE.							

India achieved 220.17 GW installation of non-fossil fuel-based capacity till Jan 2025. To meet the net target, an annual installation rate of around 50 GW is required. In the current year, India achieved an 18.8 GW addition (till Dec 2024), primarily driven by solar capacity addition. The shortfall of 28.5 GW will be met mainly through upcoming solar plants. This steady growth is driven by expanding policy support, growing energy security concerns, and improving competitiveness against fossil fuel alternatives. These factors are high interest rates, higher investment costs, and persistent supply chain challenges.

6. Renewable Purchase Obligations

Renewable Purchase Obligations (RPO) denote the purchase of a certain percentage of RE-generated electricity by obligatory entities such as Distribution Companies (DISCOM). These entities are obliged to purchase electricity under the provisions of Electricity Act-2003 and National Tariff Policy-2006.

Year	24-25	25-26	26-27	27-28	28-29	29-30
Wind RE	0.67	1.45	1.97	2.45	2.95	3.48
Hydro RE	0.38	1.22	1.34	1.42	1.42	1.33
Distributed RE	1.50	2.10	2.70	3.30	3.90	4.50
Other RE	27.35	28.24	29.94	31.64	33.1	34.02
Total RE	29.91	33.01	35.95	38.81	41.36	43.33
% of total electricity purchased. Data Source: Ministry of Power Note: Wind and Hydro RE should be met through projects commissioned after 31st March 2024; Distributed RE shall be met through projects less than 10 MW, Other RE (Excludes Wind, Hydro, Other commissioned before 1st April 2024).						

RPO obligations are expected to increase from 29.9 per cent in FY 2024-25 to 33.01 per cent in FY 2025-26. The increase in RE RPO is expected because of higher other, wind and hydro RPO.

7. Government Initiatives

With India's commitment to achieving 500 GW of installed electricity capacity from non-fossil fuel sources by 2030, there has been a sharp focus on renewable energy capacity projects (including large hydro), solar, and wind power projects. This has enhanced the power generation capacity from non-fossil-based energy sources in absolute and relative terms.

At the present pace of installing power generation projects, India is way behind its 2030 commitments and necessitates a doubling or possibly even trebling of investment. Accordingly, there is a need to substantially increase the expenditure to enhance the capabilities of entities operating in the clean energy sector, thereby driving growth and sustainability.

With India's concerted efforts to achieve a steady growth of 7 to 8 per cent, there would be a concomitant rise in energy consumption. Hence, there must be a sharper focus on clean and sustainable sources of energy by creating funds, removing tax, incentivizing lending, promoting clean technologies in the field of energy, transport, etc., and a conducive ecosystem of supporting net-zero emissions and phasing out fossil fuels.

The Government's recent efforts to reduce the limit on the minimum contracted demand or sanctioned load to access green energy through the open access process will significantly transform the green energy segment. Under the Green Open Access Rules 2022, the earlier limit of 1MW has now been reduced to 100 kW. Because of the limit of 1MW, many potential consumers in the MSME sector were kept out of the purview of accessing renewable energy. This move will provide greater access to many such potential consumers to procure renewable energy through the open access route.

The way ahead requires fiscal instruments for climate friendly industrial development, exploring opportunities in renewable and solar purchase obligations, an accent on the Perform, Achieve, Trade (PAT) scheme established by National Mission for Enhanced Energy Efficiency, financing of clean tech projects in industries, energy efficiency financing and examining financing opportunities in renewable energy projects.

Among other nation-wide initiatives to boost the renewable sector, the Government of India (GoI) has implemented a financial assistance scheme for setting up of 50 Solar Parks of aggregate capacity of 40,000 MW in the country. These parks are meant to provide developed infrastructure to facilitate the installation of solar power projects. Also, for promoting solar energy in the residential sector, the Ministry of New and Renewable Energy is implementing the Rooftop Solar Programme Phase-II, which is a Central Financial Assistance (CFA) programme with a target of adding 4000 MW rooftop solar (RTS) capacity.

Under this scheme, 40 per cent of the benchmark cost is to be given in the form of Central Financial Assistance to RTS project up to 3 kW capacity and up to 20 per cent for the RTS system capacity beyond 3 kW and up to 10 kW for individual households. In case of Group Housing Societies/Residential Welfare Associations (GHS/RWA), CFA is limited to 20 per cent for RTS plants for the supply of power to common facilities maximum 500 kW capacity.

The government has attempted to enable energy transition through provision for boosting domestic manufacturing of solar power equipment and batteries, in line with India's large global commitment to tackling climate change. The renewable expansion in the country on the projected scale requires the creation of an investor-friendly ecosystem with timely reform measures by the government. In the wake of this development, the GoI allowed Foreign Direct Investment (FDI) up to 100 per cent under the automatic route to attract more investments and an essential source of non-debt finance for economic expansion in the solar power sector. The solar sector has been a focus area of the government in providing a renewed thrust on renewable energy.

8. Solar Renewable Energy

Solar Energy Potential and Capacity

India's solar energy potential is estimated at 748.98 GW. Large potential has been estimated in states of Rajasthan (142.3 GW), Jammu & Kashmir (111 GW), Maharashtra (64.3 GW), and Madhya Pradesh (61.6 GW).

A total of 100.39 GW of solar capacity addition took place. Rajasthan (27.37 GW), Gujarat (17.58 GW), and Tamil Nadu (9.52 GW) are the states with the highest installed capacity. Solar capacity addition rose from 81.8 GW at the end of FY24 to 100.39 GW (till Jan 25). This marked an increase of 18.51 GW in the FY25².

State	Potential (GW)	Installed capacity (GW) (as on 31 Dec 2024)	Exploitation of potential
Rajasthan	142.3	27.37	19.23
Jammu & Kashmir	111.05	0.074	0.07
Maharashtra	64.3	9.337	14.52
Madhya Pradesh	61.66	4.99	8.09
Andhra Pradesh	38.44	4.73	12.30
Himachal Pradesh	33.84	0.162	0.48
Gujarat	35.77	17.58	49.15
Odisha	25.78	0.621	2.41
Karnataka	24.7	9.282	37.58
Telangana	20.41	4.84	23.71
Total	748.98	100.39	13.40

DataSource: MNRE
Note: GWp estimated assuming solar PV modules cover 3% of the waste land area

The solar potential exploitation has increased from 10.9 per cent to 13.40 per cent. While this solar potential exploitation was led by Gujarat, Karnataka, and Telangana, States with large solar potential, such as Rajasthan, Maharashtra, and Madhya Pradesh, had less than 20 per cent exploitation.

Capacity Additions

Indian solar capacity addition grew by 18.51 GW (till Jan 2025 for FY 25). The solar capacity addition was driven by utility-scale solar, followed by the rooftop solar programme. Off-grid solar contributed a minor share of overall solar capacity.

Month - 2024	Total	Dec	Nov	Oct	Sept	Aug	Jul	Jun	May	Apr	Mar
Solar RE Installed capacity (GW)	22.19	3.69	2.04	1.357	1.33	2.224	1.734	1.19	1.64	0.824	6.238

Data Source: JMKR Monthly RE Update.

Utility-scale solar capacity addition was mostly concentrated in the state of Rajasthan, Maharashtra, Gujarat, and Tamil Nadu. Fast capacity addition of utility-scale solar plants was led by private players and supported by various government schemes such as the Development of Solar Parks and ultra-mega solar Power Projects.

Demand Drivers

The solar sector grew rapidly in the past and will continue to witness large growth in the coming years due to:

- Significant untapped solar potential, as currently only 13.4 per cent of solar potential has been exploited. Also, states with the highest solar potential have the lowest exploitation rate.
- The government's focus has remained on the implementation and adoption of Renewable Energy. India revised its target set of non-fossil fuel RE from 300 GW to 500 GW by 2030. This will translate to a solar capacity addition of 270 GW.
- Solar RE adoption cost is the lowest amongst all RE and non-RE sources. This is supported by low capital requirements, shorter duration of implementation, and low solar tariffs winning bids.
- An increase in solar panel efficiency was witnessed in the past years. Currently solar PV panels used in utility-scale solar plants have an efficiency of up to 20 per cent, current technologies permit solar efficiency to be increased up to 40 per cent.

Govt Schemes

Solar sector has been supported by a large number of schemes. These include JNNSM, ISA, PM-KUSUM, UMREPP, Solar City, CPSU Solar scheme, Grid Solar PV, Rooftop Solar Programme (RTS), New Solar Power scheme for PVTG under PM-JANAM.

Sr No.	Scheme	Overview	Outlay/ Capacity
1.	CPSU Scheme-Phase II	For setting up grid-connected Solar Photovoltaic (PV) Power Projects by Central and State PSUs, Government Organisations either directly or through Distribution Companies (DISCOMs)	Outlay: 8,580 crore of Validity Gap Spending (VGF) support Capacity: 12 GW
2.	Grid Connected Rooftop Solar Programme	To achieve a cumulative installed capacity of 40,000 MW from Grid Connected Rooftop Solar (RTS) projects	Capacity: 40 GW
3.	Development of Solar Parks and Ultra Mega Solar Power Projects	Scheme was rolled out with an objective to facilitate solar project developers to set up projects expeditiously.	Outlay: Central Financial Assistance (CFA) of up to Rs. 25 lakh per solar park for (DPR) preparation. CFA of up to Rs. 20.00 lakh per MW or 30% of

			the project cost, including Grid-connectivity cost. Capacity: 40GW
4.	PM KUSUM	The scheme aims to add solar capacity of 30.8 GW.	Outlay: 34,422 crores Capacity 30.8 GW
5.	New Solar Power Scheme (for PVTG Habitations) under PM JANMAN	Scheme covers implementation of New Solar Power Scheme (for Particularly Vulnerable Tribal Groups (PVTG) Habitations/Villages)	Outlay: 515 crores. Households: 1 lakh un-electrified households (HHs) in PVTG areas
6.	Off Grid and Decentralised Solar PV Application	Central financial Assistance (CFA) for deployment of solar streetlight, lamps, home lighting, and solar power packs	Installed: 0.216 GW

The Government of India launched the PM Surya Ghar: Muft Bijli Yojana (PMSGMBY) to increase focus on solar adoption at a household level. Under this scheme households will be provided with a subsidy to install solar panels on their roofs. The subsidy will cover up to 40% of the cost of the solar panels. PMSGMBY installation crossed 6.3 lakh installations with an average of 70,000 installations per month. Installations are expected to surpass 10 lakhs by end of FY 2024-25, with a target of 1 crore installations by 2027.

In FY25, Rajasthan and Andhra Pradesh have unveiled an Integrated clean energy policy which will be valid till 2030. The policy intends state-specific solar targets of 90 GW and 78.5 GW, respectively.

Government Initiatives

- Notification of trajectory for RE power bids of 50 GW/annum to be issued by Renewable Energy Implementation Agencies (REIAs: SECI, NTPC, NHPC, SJVN) from FY 2023-24 to FY 2027-28.
- Foreign Direct Investment (FDI) permitted up to 100 per cent under the automatic route.
- Waiver of Inter State Transmission System (ISTS) charges for inter-state sale of solar for projects to be commissioned by 30th June 2025.
- To boost RE consumption, the Renewable Purchase Obligation (RPO) trajectory has been announced till 2029-30, including a separate RPO for Decentralized Renewable Energy.

- Standard Bidding Guidelines for tariff-based competitive bidding process for procurement of Power from Grid Connected Solar, Wind, and Wind-Solar Projects have been issued.
- Laying of new transmission lines and creating new substation capacity under the Green Energy Corridor Scheme for evacuation of renewable power.
- Electricity (Rights of Consumers) Rules, 2020 have been issued for net-metering up to five hundred kilowatts or up to the electrical sanctioned load, whichever is lower.
- Standard & Labelling (S&L) programs for Solar Photovoltaic modules and Grid-connected Solar Inverters have been launched.
- Notification of Promoting Renewable Energy through Green Energy Open Access Rules 2022 issued.
- Notification of “The Electricity (Late Payment Surcharge and related matters) Rules (LPS rules) issued.
- Launched Green Term Ahead Market (GTAM) to facilitate sale of Renewable Energy Power through exchanges³.

Manufacturing of Solar Panels.

To promote the domestic manufacturing of solar panels, MNRE has implemented PLI scheme for high-efficiency PV modules. The scheme has a total outlay of 24,000 crores.

Under the PLI Scheme, Letters of Award have been issued for setting up 48.34 GW of fully/ partially integrated solar PV module manufacturing units. Solar manufacturers have set up manufacturing units under the Scheme with an investment of around Rs. 35,000 crore, which will provide direct employment for more than 10,000 persons⁴.

To promote domestic manufacturing, the Approved List of Models and Manufacturers (ALMM) of Solar PV-2019 was notified. Only ALMM-approved manufacturers are eligible for use in Government Projects/Government-assisted Projects/ Projects under Government Schemes & Programmes/ Open Access / Net-Metering Projects, installed in the country, including Projects set up for sale of electricity to the Government⁵.

9. Wind

Overview

India's wind energy potential is estimated at 695 GW at 120-meter Above Ground Level (AGL) and 1163.85 GW at 150-meter AGL. Large potential has been estimated in states of Gujarat (142.56 GW), Rajasthan (127.75 GW), Karnataka (124.15 GW), Maharashtra (98.21 GW), and Tamil Nadu (68.75 GW) at 120-meter AGL.

A total of 48.36 GW of wind capacity has been installed. Tamil Nadu (11.44 GW), Gujarat (12.509 GW), and Karnataka (6.85 GW) are the leading states with highest installed capacity. Wind capacity increased from 45.88 GW at the end of FY24 to 48.36 GW (till Jan 25). This marked an increase of 2.48 GW in the current year.

Major States	Potential (GW)	Installed capacity (GW) (as on 31 Dec 2024)	Exploitation of potential
Gujarat	142.56	12.509	8.77
Rajasthan	127.75	5.195	4.07
Karnataka	124.15	6.85	5.52
Maharashtra	98.21	5.226	5.32
Andhra Pradesh	74.9	4.09	5.46
Tamil Nadu	68.75	11.444	16.65
Telangana	24.83	0.128	0.52
Madhya Pradesh	15.4	2.844	18.47
Total	695.5	48.36	6.95

DataSource: MNRE
Note: GWp estimated at 120 meter above ground level.

In the current year, the exploitation of wind potential rose from 6.59 per cent to 6.95 per cent. The potential exploitation was led by Gujarat, Tamil Nadu, and Karnataka. However, states with large solar potential, such as Rajasthan, Karnataka, Maharashtra, and Telangana have exploited only 5 per cent of their potential.

Capacity Additions

Month - 2024	Total	Dec	Nov	Oct	Sept	Aug	Jul	Jun	May	Apr	Mar
Wind RE capacity (GW)	2.80	0.204	0.24	0.35	0.171	0.117	0.419	0.234	0.261	0.275	0.733

Data Source: JMKR Monthly RE Update.

Indian wind capacity grew by 2.478 GW (till Jan 2025 for FY25). Wind capacity addition was mostly concentrated in the states of Gujarat, Tamil Nadu and Karnataka. The fast capacity addition was led by private players and has been supported by various government schemes, such as the VGF Scheme for Offshore Wind Energy Projects and Guidelines for Development of Onshore Wind Power Projects and amendments.

Demand Drivers

Wind energy grew rapidly in the past and will continue to witness large growth in the coming years.

- Significant untapped wind potential exists as currently only around 6.95 per cent of the wind potential has been exploited. Also, states with the highest wind potential have low exploitation rates.
- The focus of the government has remained on the implementation and adoption of Renewable Energy. India revised the target set of non-fossil fuel RE from 300 GW to 500 GW by 2030. This implies a wind capacity addition of 100 GW by 2030, of which 70 GW will come from Onshore wind energy and 30 GW from Offshore wind energy.
- Wind RE adoption costs are among the lowest of RE sources, second only to Solar Energy. This is further attested by low capital required, shorter duration of implementation and Government VGF funding.
- An increase in wind turbine efficiency was witnessed in the past years. While current wind turbines have an efficiency of up to 20 to 40 per cent, current technologies permit turbine efficiency to reach 40 per cent.

Govt Schemes

The wind sector has been supported by a large number of schemes since its inception.

These include permitting 100 per cent FDI under the automatic route, setting up Ultra mega renewable energy parks (UMREPP) to provide land and transmission to RE developers on plug and play basis, among others.

Sr No.	Scheme	Overview	Year/Outlay/ Capacity
1.	VGF for Offshore wind energy projects	Scheme guideline for implementation of Validity gap funding for Offshore wind energy projects	Year: 2023 Outlay: 6853 crore Capacity: 1 GW of offshore wind capacity
2.	Guidelines for development of Onshore wind power		2016
3.	Guidelines for installation of prototype Wind turbines models		2016

Government Initiatives

Some important initiatives in the wind renewable energy sector include:

- Notification of trajectory for RE power bids of 50 GW/annum to be issued by Renewable Energy Implementation Agencies (REIAs: SECI, NTPC, NHPC, SJVN) from FY 2023-24 to FY 2027-28.
- Foreign Direct Investment (FDI) permitted up to 100 per cent under the automatic route.
- Waiver of Inter State Transmission System (ISTS) charges for transmission of electricity of wind projects to be commissioned up to 30th June 2025.
- Exemption of payment of ISTS charges for a period of 25 years.
- To boost RE consumption, the Renewable Purchase Obligation (RPO) trajectory has been announced till 2029-30, including a separate RPO for Decentralized Renewable Energy.
- Standard Bidding Guidelines for tariff-based competitive bidding process for procurement of Power from Grid Connected Wind, and Wind-Solar Projects have been issued.
- Laying of new transmission lines and creating new substation capacity under the Green Energy Corridor Scheme for evacuation of renewable power.
- Notification of Promoting Renewable Energy through Green Energy Open Access Rules 2022 issued.
- Launched Green Term Ahead Market (GTAM) to facilitate sale of Renewable Energy Power through exchanges.
- Generation-based incentives provided to projects commissioned before 31st March 2017.
- Concessional duty exemption on certain components required for the manufacturing of wind electric generators.

- Technical support for wind resource assessment and identification of potential sites through the National Institute of Wind Energy.

Trajectory of Wind Auctions

A trajectory of wind auctions has been indicated for offshore wind energy development in India. A total of 37 GW of offshore wind energy projects have been recommended till 2030.

Year	Total	23-24	24-25	25-26	26-27	27-28	28-29	29-30
GW	37	4.5	3.5	7	7	5	5	5
*Data source: Strategy for establishment of offshore wind energy projects								

In the current FY, 2.48 GW has been established (till Jan 2025), compared to a target of 3.5 GW. 1 GW of projects is expected to come up. SECI has invited bids for development of 4 GW offshore wind energy off the Tamil Nadu coast, divided into four blocks of 1 GW each.

10. Hydro

Overview

India's hydro potential stands 133.4 GW for conventional hydro power storage and 176.28 GW for pumped storage projects. Large potential exists in the country in the North-Eastern and Northern parts of the country for conventional hydro.

Total large hydro energy capacity stands at 46.9 GW, contributing 22.8 per cent of the RES capacity (including Hydro) in the country. Currently only 35.15 per cent of the total renewable energy has been exploited till date. Installed capacity is highest in the states of Uttarakhand and Himachal Pradesh, where the majority of India's perennial rivers originate.

Region	Conventional	Pumped Storage
Northern	46.97	34.08
Western	7.82	68.19
Southern	12.57	60.47
Eastern	10.11	12.05
Northeastern	55.93	6.53
Total	133.4	181.3
*Data Source: Ministry of Power, Value in GW		

Large potential for pump storage plants also exists across India. The highest potential for PSP exists in the Western and Southern regions of the country. High potential for

PSP exists in the Western region due to the combination of topographical variation and river flow. Maharashtra, Andhra Pradesh, and Tamil Nadu are states with the highest PSP potential, having 43.4 GW, 26.4 and 16.5 GW respectively.

Capacity Additions

Indian hydro capacity grew by 40 MW (till Nov 2024 for FY25). Hydropower addition occurred in Kerala and was carried out by the State Government.

Govt Schemes and Incentives

The hydro sector has been supported by a large number of schemes. These include:

- Declaring large hydropower projects (capacity above 25 MW) as renewable energy sources.
- Hydro Renewable Energy Consumption Obligation by Designated Consumers and a separate Hydro power purchase obligation.
- Tariff rationalization measures for bringing down the hydropower tariff.
- Budgetary support for Flood Moderation/Storage hydroelectric projects.
- Guidelines to promote the development of Pumped Storage Projects (PSPs) were issued on 10th April 2023.
- Waiver of Interstate Transmission System (ISTS) charges for hydroelectric projects and PSPs.
- Central Financial Assistance (CFA) to the State Governments of Northeastern Region (NER) towards their equity participation for development of Hydro Electric Projects in the NER.
- Reduction of timeline by Central Electricity Authority (CEA) for concurrence of Detailed Project Reports (DPR) of hydroelectric projects and PSPs
- Budgetary support towards the cost of enabling infrastructure for Hydro Electric Projects (HEP) with a total outlay of Rs.12461 crore. The scheme would be implemented from FY 2024-25 to FY 2031-32 for cumulative generation capacity of about 31.35 GW.

Trajectory of Hydro Auctions

A growth of hydro capacity addition has been indicated in the Annual report of the Ministry of Power. A total of 16.7 GW of hydro energy projects are expected to be commissioned by 2030.

Year	Total	24-25	25-26	26-27	27-28	28-29	31-32
GW	16.737	3.32	2.719	5.41	1.08	1.32	2.88

*Data source: Ministry of Power

In December 2024, the Government revised the Hydro power targets to 31.3 GW to be achieved by 2030. To support these hydropower targets, budgetary support of Rs. 12461 crore towards enabling infrastructure for Hydro Electric Projects (HEP) is to be provided.

11. Small Hydro Power

Overview

Small hydro power (SHP) projects harness energy from flowing or falling water from rivers, rivulets, artificially created storage dams, or canal drops for the generation of electricity. The capacity of SHP is up to 25 MW. These projects have the potential to meet the power requirement of remote and isolated areas in decentralised manner. The estimated potential for SHP is 21.13 GW of which 5.01 GW has been realised.

Capacity Addition

A total of 5.1 GW SHP capacity has been installed (till Jan 2025). SHP capacity has increased by 81 MW in the current year. Capacity increase in the current year is higher than the past year's installed capacity of 58.95 MW.

12. Biomass Energy

Overview

Around 228 MMT of agricultural residue is generated in India. The potential for agricultural residue is estimated at 28.46 GW. But with modernization of sugar mills, the surplus power generation is estimated to be 13.86 GW. Taking the total estimated potential for biomass power to be 42.31 GW.

Capacity Addition

A total of 10.743 GW biomass capacity was installed (till Jan 2025). Biomass capacity consists of 9.821 GW of bagasse-based Cogeneration units and 0.921 GW of non-bagasse-based cogeneration units. The bagasse-based cogeneration capacity has increased by 387 MW in the current year. Circular economy, large agricultural residue, and promotion of its use are driving Biomass energy adoption.

Government Scheme and Initiatives

The Ministry notified the Biomass Programme on 2nd November 2022 with a budget outlay of 158 crores. The programme was notified under umbrella of National Bioenergy Programme (Phase I) for the duration of FY21- 22 to FY25- 26 to harness the available biomass potential in the country.

13. Waste-to-Energy

Overview

The government has implemented the scheme “Programme on energy from urban, Industrial and Agricultural waste/residues” (waste to energy aimed at generation of biogas, Bio-CNG and power from different wastes, such as vegetable and other market wastes, agricultural residue and industrial wastes and effluents.

Capacity Addition

A total of 663.46 MW of installed capacity of waste-to-energy exists. This consists of 383.9 MW of off-grid waste-to-energy project. A capacity addition of 29.82 MW of off grid projects occurred in the current year.

Government Scheme and Initiatives

For implementation of the above-mentioned scheme, the government has notified guidelines under phase-I of Umbrella programme of National Bioenergy programme. The scheme will be implemented for the period of FY 21-22 up to FY 25-26 and has an allotment of Rs 600 crores.

The Central financial assistance pattern for waste-to-energy is as follows:

- Biogas generation: At 0.25 crore per 12000 cubic mtr/day (up to a maximum CFA of 5 crore/project)
- Bio-CNG/CBG: Up to a maximum CFA of 10 crore/project.
- Power generation-based Biogas: Up to a maximum CFA of 5 crore/project.

14. Green Hydrogen

Overview

Green Hydrogen is produced by the process of electrolysis, when water is split into hydrogen and oxygen using electricity generated from renewable sources like solar, wind, or hydropower. This process results in a clean and emission-free fuel with immense potential to replace fossil fuels and reduce carbon emissions. Another method of producing Green Hydrogen is from biomass, which involves the gasification of biomass to produce hydrogen. Both these production methods are clean and sustainable, making Green Hydrogen an attractive option.

The need for Green Hydrogen is rapidly increasing due to its potential to decarbonize several sectors, including transportation, shipping, and steel among others. Green hydrogen can replace traditional fossil fuels in transportation, which contributes significantly to greenhouse gas emissions. To promote adoption of green hydrogen, the National Green Hydrogen Mission (NGHM) was launched in January 2023.

Government Scheme and Initiatives

To promote Green Hydrogen, Rs.19744 crore has been allocated under the NGHM. This consists of an outlay of Rs.17490 crore under Strategic Intervention for Green Hydrogen Transition (SIGHT) for manufacturing of electrolyzers and production of green hydrogen.

Rs. 1466 crore for pilot projects in low-carbon steel, mobility projects, and shipping pilot projects, Rs. 400 crore for R&D programmes, and Rs 388 crore towards Outreach, Skilling, and other components of NGHM.

Capacity Addition

Under the NGHM, tender have been awarded for hydrogen production, electrolyser manufacturing and green ammonia production.

- Tenders awarded to companies for 4.12 lakh TPA green hydrogen production.
- Selection of manufacturers for 1,500 MW electrolyser capacity
- Government Increases Green Ammonia Allocation for the Fertilizer Sector from 5.5 lakh tonnes to 7.5 lakh tonnes per annum.
- Guidelines issued for pilot projects in the transport sector with ₹496 crore outlay.
- Request For Selection (RfS) issued for selection of Green Ammonia producers for 5.39 lakh MT/year capacity.
- New initiatives launched for the shipping sector with ₹115 crore budget.
- Guidelines Issued for Green Hydrogen Testing and Infrastructure Support by MNRE for funding testing facilities, infrastructure, and institutional support, with a budget of Rs. 200 crores until 2025-26, focusing on establishing a robust quality and testing ecosystem in the GH2.

15. Budget Analysis

There has been a steady increase in budgetary allocation over the years. Despite low budget utilization in FY 2023-24 there has been a large increase in allocation in both FY 2024-25 and FY 2025-26.

Table 13: Budgetary Allocation for 2024-25					
	2023-24 (B)	2023-24(A)	2024-25(B)	2024-25(R)	2025-26(B)
Head	10222.0	7928.89	19100	17298.4	26549.38
Solar Energy	7327.96	6268.01	16394.75	15061.35	24224.36
<i>Solar Power (Off-Grid)</i>	361.50	34.42	24.01	12.00	0.01
<i>Solar Power (Grid)</i>	4970.00	5009.17	8500.35	1300.0	1500.0
<i>KUSUM</i>	1996.46	1100.00	1496.0	2525.0	2600.0
<i>PM Surya Ghar Muft Bijli Yojana</i>	-	-	6250.0	11100.0	20000.0

Wind and Other RE	1245.0	929.75	851.0	846.00	551.00
Bioenergy	381.85	70.51	300.0	185	325
Support Programme	-	33.33	107.01	71.01	99.01
* Value in Rupees Crore Data Source: Budget Documents					

The large increase has occurred due to higher budgetary allocation for solar energy which has been facilitated by launch of a new scheme, PM-SGMBY, and due to a higher allocation under Solar Grid Projects. Wind and other RE projects have seen a decrease in budgetary allocation of 46 per cent. The budgetary allocation of bioenergy decreased, driven by lower budgetary utilization of less than 25 per cent. This represents a dichotomy, where despite increases in overall budgetary allocation across the renewable energy sector there has been a decreasing focus of the government on non-solar sources, particularly wind energy.

Company	2022-23 (A)	2023-24 (R)	2023-24 (A)	2024-25 (B)	2024-25 (R)	2025-26 (B)
IREDA	18065.32	20496.59	35777.35	30130.06	31132.58	34974.99
SECI	183.43	858.63	2050.80	585.00	568.88	485.00
Total	18248.7	21355.22	37828.15	30715.06	31701.46	35459.99
*Value in Rupees Crore Data Source: Budget Document 2024-25						

In the current Union Budget, there was an increase in budgetary allocation towards state public enterprises engaged in renewable energy. This increase was due to overutilization of the previous year's Budget. In the current Budget, the increased targets for renewable energy adoption drive higher budgetary allocation.

16. Conclusion

In the past decade, India's power sector has undergone a transformative journey, with focus on delivering reliable, affordable, and sustainable energy. Significant achievements in the sector include a substantial increase in power generation capacity, widespread electricity access, and a strong commitment to renewable energy. India has emerged as a global leader, ranking fourth in Renewable Energy Installed Capacity, with remarkable growth in solar and wind energy. India's progress aligns with its commitment to the Paris Agreement, setting ambitious targets, including 500 GW by 2030 and achieving net-zero by 2070.

The achievement of the goal of ‘net zero’ commitment by 2070 requires, *inter alia*, a multidimensional approach and a changed energy mix. Given the magnitude of the problem, energy-intensive sectors, industries, transport, aviation, and shipping need to increasingly shift towards non-fossil-based energy sources. Facilitating climate-friendly industrial development through policy interventions, implementing appropriate fiscal instruments, low-carbon technologies and financial options for implementation requires an enabling ecosystem together with supportive government policies, greater participation from the key industry players, and lower cost of finance for industry stakeholders.

Challenges, however, persist. Legacy infrastructure costs, transmission losses, coal-related issues, and the evolving grid's reliability pose hurdles in the pursuit of the avowed objectives of development. The government's efforts to address financial distress in the DISCOM are acknowledged, but a more comprehensive approach is needed to meet renewable energy targets. The success of India's energy transition hinges on consistent policy support, institutional strengthening, depoliticizing tariff setting, and supporting vulnerable communities through direct benefit transfers.

Given the enormity of the challenge, budgetary capex is required for augmenting transmission infrastructure for smart grids to manage intermittent supply and enhancing the capabilities of entities operating in the clean energy sector. Emerging areas like green hydrogen and offshore wind need further policy support to achieve commercial viability.

The synchronized efforts of the government, private sector, research institutions, and civil society as partners in development are crucial to overcoming challenges, such as, land acquisition, grid integration, and affordability. As India stands at the forefront of the renewable energy revolution, achieving its goals requires streamlined processes, enhanced infrastructure, innovation in energy storage, and a diversified renewable energy mix. While the outlook is promising, focused actions in these areas will not only secure India's energy independence but also position India as a global leader in sustainable and clean energy. With ongoing technological advancements, increased investments, and growing public awareness, India's renewable energy landscape is promising.

The renewable energy sector has made large strides in the past year. The total installed renewable energy capacity has crossed 212.17 GW, with 21.5 GW installations occurring. RE growth has been fueled by large fund allocation and higher fund

realization. The increase in RE capacity was driven by solar energy, which increased by 18.52 GW, and the highest support for solar energy projects.

While wind and other renewable energy, though witnessing higher capacity addition, have seen lower budgetary allocation. In the current year, increased budgetary allocation with increased capacity addition targets for hydropower have also been seen. At the same time, the Bio-energy programme has seen both increased capacity addition and higher budgetary allocation. The Renewable energy sector is expected to increase multifold in the coming years due to policy and budgetary support.

References

¹ Monthly Renewable Energy Generation Report– Ministry of Power

² Ministry of New and Renewable Energy - Annual Report

³ Target for Generation of Electric Power Using Non-Fossil Fuel Based Energy Resources” - RAJYA SABHA UNSTARRED QUESTION NO. 1735 answered on 10/12/2024

⁴ “PLI Scheme for Solar PV Module”- LOK SABHA UNSTARRED QUESTION NO. 1418 answered on 04/12/2024

⁵ MNRE Announces Significant Amendment to ALMM Order 2019 to Advance Solar Manufacturing – PIB Press Release dated 10 December 2024 – Ministry of New and Renewable Energy (Press Release Id: 2082901)