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Trends In India's Renewable Energy Capacity: A Sectoral Study (2010–2024)

Author: Dr. Asha Lata, Associate Professor, Department of Geography, G.G.J. Govt. College, Hisar.

Dr. Ashwani Kumar, Assistant Professor, Department of Geography, C.H.L. Government College, Chhara, Jhajjar,

Abstract:

India has become one of the world's fastest-growing renewable energy markets, fueled by ambitious national targets, supportive policy measures, and abundant solar, wind, and bioenergy resources. India's dedication to a low emission future is demonstrated through key initiatives such as the National Solar Mission. However, range of techno-economic, market, and institutional Challenges continue to impede the development and large scale adoption of renewable technologies. Despite their current limited contribution to electricity generation, renewable hold strong potential to adapt to emerging economic, environmental, and sustainability challenges. This paper analyzes the evolution, present status, and future outlook of renewable energy in India. It analyses trends in installed capacity, regional adoption patterns, policy frameworks and sectoral challenges during 2014 to 2024. Through data-driven insights and visualizations, the study highlights India's ongoing transformation toward a more sustainable and resilient energy mix.

Keywords: Renewable Energy, Sustainable Development, Policy Framework.

Introduction

India's growing energy needs, coupled with global climate commitments, have necessitated a significant shift from fossil fuels to renewable energy. As of 2024, India holds the 4th position worldwide in installed renewable energy capacity, with notable strength in solar & wind power. Renewable sources have become imperative amid rising energy demands and environmental concerns. The power sector contributes nearly 40% of total carbon emissions, emphasizing the need to advance alternative energy sources for a sustainable energy–environment balance. Renewable energy offers significant potential under the evolving climate regime, meeting key UNFCCC criteria by reducing greenhouse gas emissions and supporting national priorities through local capacity and infrastructure development. This enhances the relevance of renewable electricity generation. Although India has strong technical expertise in this area, adoption is slowed by technological, economic, market, and institutional barriers. Still, the existing capabilities position the country to meet future economic, environmental, and sustainability goals.

Review of literature: Sahu (2008) links India's rising primary energy use to GDP, population, and per capita growth, offset by declining domestic production and import reliance. Pillai and Banerjee (2009) project diffusion-model growth in wind, small hydro, and solar heating; tidal/geothermal need policy-technology boosts. Kumar et al. (2010) position solar, wind, geothermal, biomass, ocean, and fuel cells as keys to energy security and sustainability. Tripathi et al. (2016) urge coal-to-renewable transition for emission cuts, security, and growth. Charles Rajesh Kumar J. and Majid (2020) examine the status, barriers (including infrastructure/finance), and prospects of renewable through policy, investment, and job creation. The reviewed literature collectively highlights a clear trend of India's growing energy demand, driven by economic and population growth, necessitates a transition from conventional to renewable energy sources. While renewable technologies show promising potential, their widespread adoption depends on robust policy frameworks, financial investment, and innovation.

Aims and Objectives

This paper explores the past development, present status, and future potential of renewable energy in India. It analyses trends in installed capacity, policy frameworks and sectoral challenges during 2014 to 2024. The collected data from secondary sources is processed and analyses in the form of tables and diagrams.

Growth of Energy in India over last decade

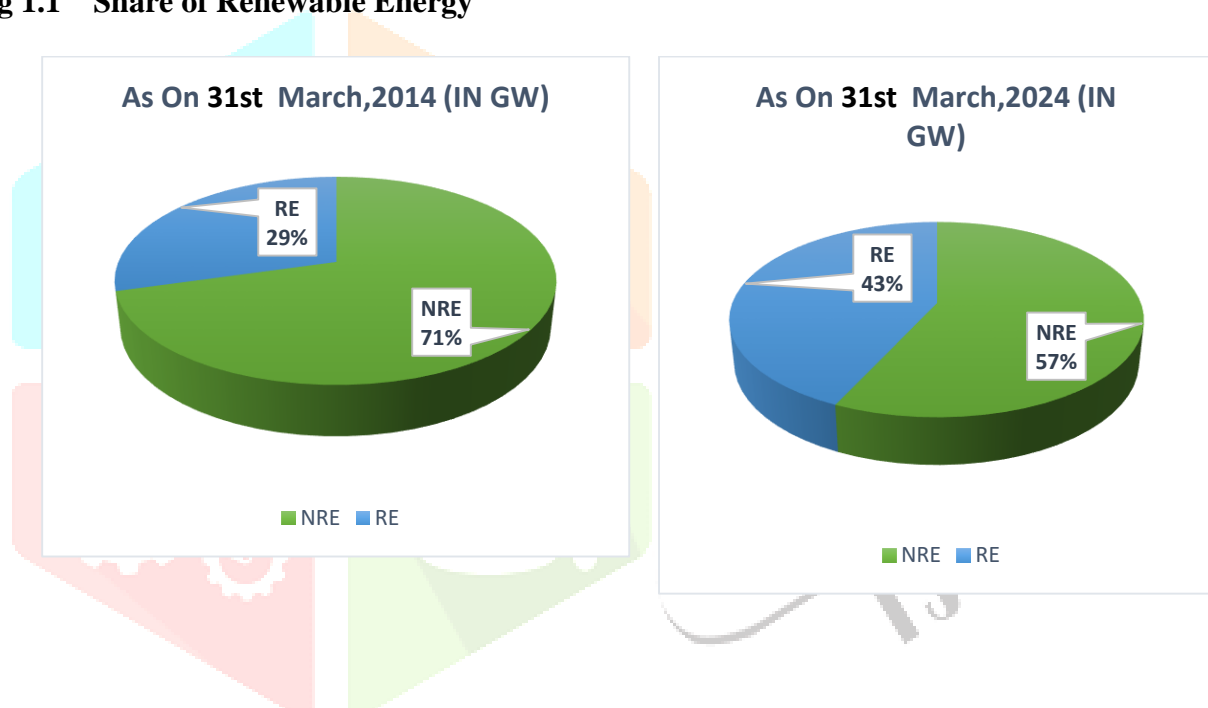
Table 2.1 Cumulative Installed Capacity in RE and Non-RE sector since 2014-15 to 2023-24 (In GW)

Year	Non-RE (GW)		Renewables (RE) (GW)			Grand Total (GW)	Growth (%)	Share of RE (%)
	Thermal	Nuclear	Hydro	REs*	Total RE			
2014-15	188.9	5.78	41.27	39.95	81.22	275.9	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	31.4
2017-18	222.91	6.78	45.29	70.65	115.94	345.63	5.33	33.54
2018-19	226.28	6.78	45.4	79.41	124.81	357.87	3.54	34.88
2019-20	230.6	6.78	45.7	88.26	133.96	371.34	3.76	36.07
2020-21	234.73	6.78	46.21	95.8	142.01	383.52	3.28	37.03
2021-22	236.11	6.78	46.72	109.89	156.61	399.5	4.17	39.2
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

RES*- Comprising of Solar, Wind, Bio-Power and Small Hydro Power**Gr=Growth (%)****CAGR=Compound Annual Growth Rate**

The key highlights of India's energy development over the past decade has been the exceptional growth in renewable energy (RE) capacity. Between 2014-15 and 2023-24, RE installed capacity more than doubled, registering a substantial increase of 134.63%. This significantly outstrips the 60.19% growth in the total installed capacity, demonstrating a clear prioritization of clean energy expansion. Moreover, the core of this RE growth is evident in the phenomenal 259.55% increase in the combined installed capacity of Solar, Wind, Bio-Power, and Small Hydro Power. This remarkable figure underscores the sheer scale of development and deployment achieved within these crucial renewable energy technologies, positioning them as major contributors to India's future energy landscape.

Fig 1.1 Share of Renewable Energy

Over the past decade, the Renewable Energy (RE) sector has significantly contributed to India's total installed capacity. Its share has witnessed a substantial expansion, rising from 29.44% in 2014-15 to a significant 43.12% in 2023-24. This notable increase underscores the rapid integration and growing prominence of renewable sources in the country's energy landscape.

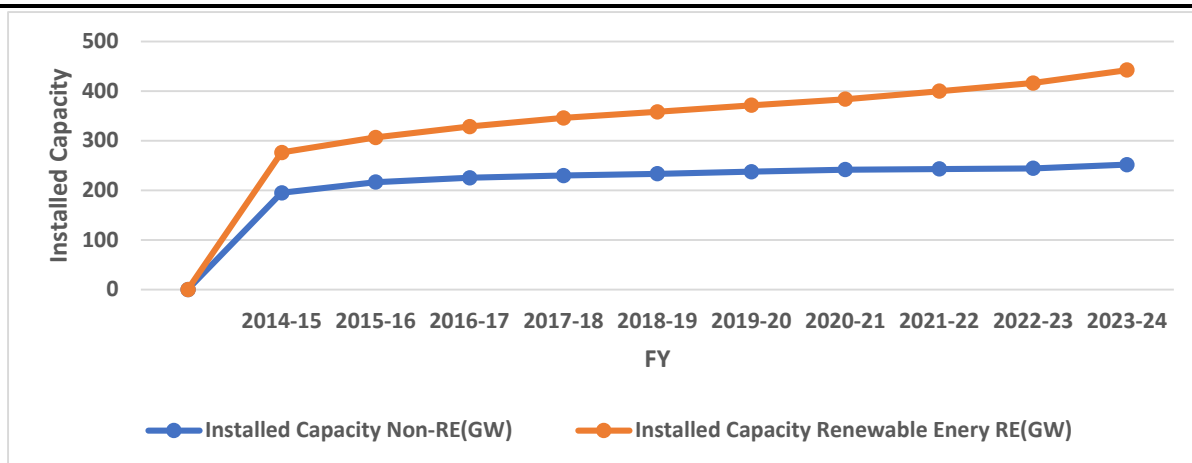
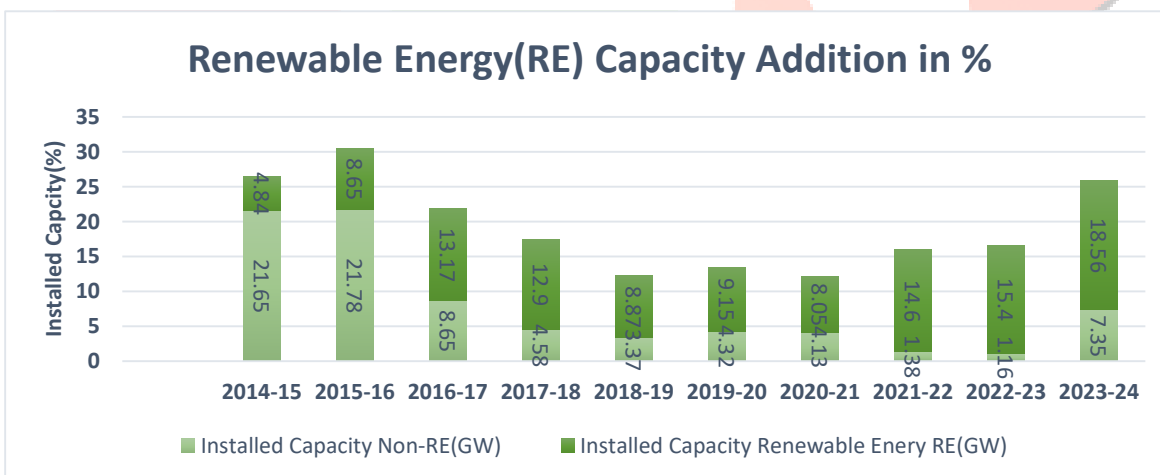


Fig. 1.2 Trend in Cumulative Capacity installation

Over the period from fiscal year 2014-15 to 2023-24, the renewable energy sector demonstrated a robust compound annual growth rate (CAGR) of 9.94%, consistently exceeding the growth observed in the non-renewable energy sector. In contrast, the non-renewable sector exhibited a considerably lower CAGR of 2.88% during the same time-frame, growing from 194.68 GW in 2014-15 to 251.4 GW in 2023-24. This disparity in growth rates indicates a substantial narrowing of the capacity gap between renewable and non-renewable energy sources, highlighting an increasing momentum towards renewable energy deployment.

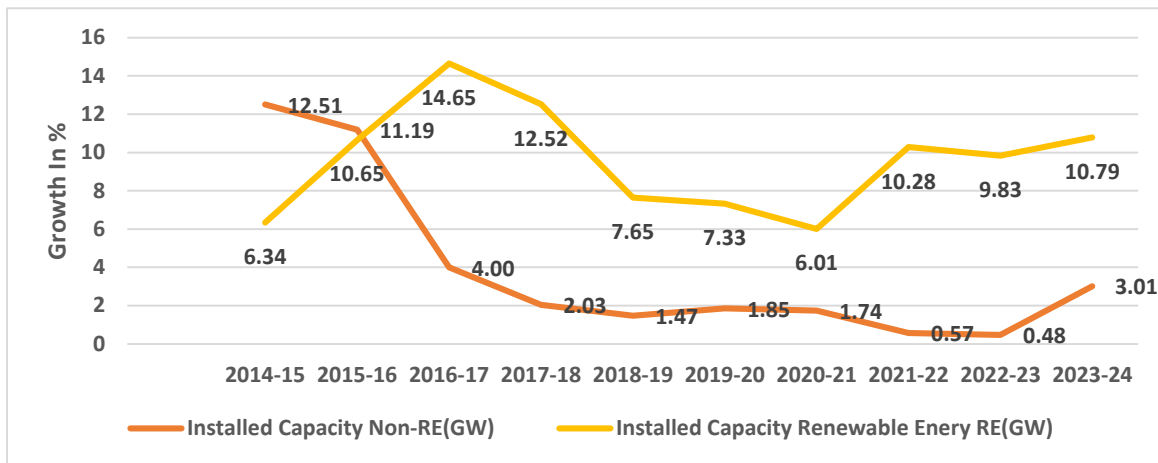
Fig 1.3 Year wise capacity addition (in %).



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

Bar diagram data denote installed capacity (GW). Year-wise trends reveal renewable energy (RE) sector dominance over non-renewable (non-RE), with RE's 9.94% CAGR (2014–15 to 2023–24) far exceeding non-RE's 2.88% (194.68 GW to 251.4 GW). RE added 18.56 GW in 2023–24 versus non-RE's 7.35 GW, driving capacity convergence and signaling policy-driven shifts toward sustainability.

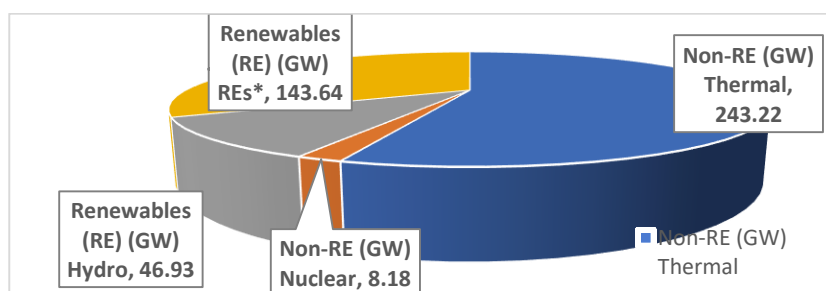
Fig 1.4 Year wise growth (%) in Capacity Installation



Analysis of the year-on-year growth rates in capacity installation reveals a significant and sustained disparity between the renewable energy (RE) and non-renewable energy (non-RE) sectors. As depicted in Fig 1.4, the RE sector has consistently demonstrated robust annual growth, maintaining a rate exceeding 6% post-fiscal year 2016-17. In contrast, the non-RE sector, encompassing traditional thermal and nuclear power generation, has exhibited considerably lower annual growth, remaining below 3.01% for the period following 2016-17. This divergence in growth trajectories underscores the accelerating momentum of renewable energy deployment relative to conventional power sources.

1. Energy Mix and Capacity (2023-24)

As of late 2024, India's energy sector remained dominated by coal-based thermal power. However, renewable energy sources, especially solar, wind, and hydro, recorded rapid growth and a rising share in installed capacity. Nuclear power retained strategic importance despite its smaller contribution. To meet climate and development goals, India has set ambitious targets to expand non-fossil fuel capacity and advance a cleaner energy transition by 2030 and beyond.

Fig 3.1 India's Installed Power Capacity as on 31st March 2024

1. Advancing India's Renewable Energy Landscape: Strategic Interventions and Sectoral Transformation by Govt. Of India:

At the apex of India's renewable energy strategy lies a multi-layered policy architecture, anchored by several key national frameworks as:

- *National Renewable Energy Act (NREA) (Proposed)*: This aims to streamline regulatory oversight and provide a coherent impetus for sectoral expansion.
- *National Action Plan on Climate Change (NAPCC)* incorporates dedicated missions and played a pivotal role in the mainstreaming and proliferation of key RE technologies.
- *Structured Annual Bidding Trajectory* has been instituted, targeting the addition of 50 GW of renewable energy capacity annually throughout the fiscal years 2027–28.

1.1. Sector-Specific Schemes and Strategic Initiatives:

A. Solar Energy:

- To promote the decentralized deployment of solar energy technologies within the agricultural sector *Pradhan Mantri Kisan Urja Suraksha Evam Utthaan Mahabhiyan (PM-KUSUM) Scheme* was initiated.
- Targeting the solarization of one crore households *Rooftop Solar (RTS) Programme, PM Surya Ghar: Muft Bijli Yojana* (2024) recently launched.
- To facilitate the development and deployment of grid-connected solar photovoltaic power projects by *Central Public Sector Undertaking (CPSU) Scheme* was started.
- *Develop of Solar Parks and Ultra Mega Solar Power Projects.*
- Production Linked Incentives (PLI) Scheme for High-Efficiency Solar PV Modules have been started.

B. Wind Energy:

- To provide direct financial incentives contingent upon the actual electricity generated by commissioned wind energy projects *Generation-Based Incentive (GBI)* was initiated.
- To enhance project financial viability and improve investor returns *Accelerated Depreciation (AD) Benefits* have been provided.
- To harness the significant offshore wind energy potential along India's extensive western and southern coastlines *Offshore Wind Development Programme*: Strategic governmental initiatives are actively underway

C. Bioenergy:

- To promote the use of bio-fuels in the transportation sector and reducing dependence on imported crude oil *Ethanol Blending Programme* has been started.
- *National Policy on Biofuels* framed to provide strategic direction and support mechanisms for the enhanced production and consumption of diverse biofuels across various sectors of the Indian economy.
- *GOBARdhan Scheme* framed to convert agricultural residues and other organic waste streams into valuable bio-products, including biogas and bio-CNG.
- In remote and topographically challenging regions where grid access may be limited *Small Hydro Power (SHP) deployed*

- **E. Green Hydrogen:**

- To encompasses support for pilot-scale projects, incentives for electrolyzer manufacturing, and proactive measures to stimulate demand creation across key industrial sectors *National Green Hydrogen Mission launched.*

1.2. Infrastructure Development and Grid Integration Initiatives:

- To focuses on the strategic development of both intra-state and inter-state transmission infrastructure *Green Energy Corridor Scheme* initiated.
- To enhance the financial viability of renewable energy projects *Inter-State Transmission System (ISTS) Charge Waivers* was started.
- *A Comprehensive Transmission Infrastructure Plan for 500 GW RE* formulated to proactively ensure the timely creation of the necessary grid infrastructure by the year 2030.
- To manage the energy storage system *Viability Gap Funding (VGF) for Battery Storage Projects* has been started.

1.3. Regulatory and Financial Support Mechanisms:

- To obligate power distribution companies (DISCOMs) and other designated large energy consumers to procure a specified proportion of their total electricity consumption from renewable energy sources *Renewable Purchase Obligations (RPOs) scheme* was implemented.
- To provide project financing and actively promoting investments in diverse clean energy ventures across the country *Financial Support via the Indian Renewable Energy Development Agency (IREDA)* was constituted.
- To attract foreign capital and expertise into the renewable energy sector, the government permits up to *100% Foreign Direct Investment (FDI) through the Automatic Route* has been started.
- To directly procure renewable energy through open access mechanisms *Green Open Access Rules, 2022* fostering greater adoption of green power.
- *"Must-Run" Status for Renewable Energy Power Plants.* Renewable energy generating facilities in many jurisdictions are accorded must-run status, ensuring priority grid dispatch.

1.4 Challenges Impeding the Accelerated Deployment of Renewable Energy in India Despite

India's robust policy framework and significant progress in expanding renewable energy (RE) capacity, the sector continues to face persistent challenges that hinder its accelerated deployment are as:

- *Land Acquisition Bottlenecks:* Bureaucratic delays in land conversion, clearances, and ownership disputes hinder progress, increasing cost etc are the major hindrances.
- *Financial Constraints and Investment Risks:* The weak financial position of many state distribution companies (DISCOMs), reflected in payment delays, low tariff recovery, and hesitation to sign power purchase agreements, increases investor risk.
- *Grid Integration and Infrastructure Gaps:* India's existing grid infrastructure is inadequately equipped to absorb the increasing influx of variable renewable power
- *Regulatory and Policy Fragmentation:* Inconsistencies in RE policies across states—particularly in land access, open access, and net metering—create a fragmented regulatory environment.

- *Technological and Supply Chain Vulnerabilities:* Current limitations in energy storage technologies and India's reliance on imported solar and wind components expose the sector to cost fluctuations and supply chain disruptions.
- *Socio-Environmental and Human Resource Constraints:* Environmental concerns and potential socio-economic displacement, highlighting the need for transparent stakeholder engagement and rigorous impact assessments.

2. Future Roadmap and Targets of India for capacity building for renewable energy

India has articulated an ambitious renewable energy trajectory, underscored by its commitments at the 26th Conference of the Parties (COP26) to the United Nations Framework Convention on Climate Change (UNFCCC). The key pledges include:

- Achieving 500 GW of non-fossil fuel-based installed power capacity by 2030.
- Meeting 50% of total electricity requirements from renewable energy sources by 2030.
- Reaching net-zero carbon emissions by 2070.

3. Conclusion

India stands at a crucial juncture in its energy transformation. With the right blend of policy support, private investments, and innovation, the country can achieve its ambitious renewable energy goals, making it a global leader in clean energy transition. Over the past decade, India's power sector has undergone a significant transformation, marked by a robust expansion in overall installed capacity, which surged by 60.19% from 275.90 GW in 2014-15 to 441.97 GW by March 2024. Notably, the Renewable Energy (RE) sector has been a primary driver of this growth, exhibiting a remarkable 134.63% increase in installed capacity (including large hydro) during the same period, rising from 81.22 GW to 190.57 GW. Within the RE landscape, Solar, Wind, Bio Power, and Small Hydro Power segments have demonstrated an even more impressive growth of 259.55%, reaching 143.64 GW in 2024 from a mere 39.95 GW in 2015. The above analysis clearly indicates a strong and accelerating shift towards renewable energy sources in India's power generation mix, signifying a commitment to sustainable energy development. Ensuring equitable growth across regions and addressing infrastructural and financial challenges will be key to success.

References:

1. Kumar, A., Kumar, K., Kaushik, N., Sharma, S., & Mishra, S. (2010). Renewable energy in India: Current status and future potentials. *Renewable and Sustainable Energy Reviews*, 14(8), 2434–2442. <https://doi.org/10.1016/j.rser.2010.04.003>.
2. Pillai, I. R., & Banerjee, R. (2009). Renewable energy in India: Status and potential. *Energy*, 34(8), 970–980. <https://doi.org/10.1016/j.energy.2008.10.017>.
3. Tripathi, L., Mishra, A. K., Dubey, A. K., Tripathi, C. B., & Baredar, P. (2016). Renewable energy: An overview on its contribution in current energy scenario of India. *Renewable and Sustainable Energy Reviews*, 60, 226–233. <https://doi.org/10.1016/j.rser.2016.01.047>.
4. Kumar, C. R. J., & Majid, M. A. (2020). Renewable energy for sustainable development in India: Current status, future prospects, challenges, employment, and investment opportunities. *Energy, Sustainability and Society*, 10(2). <https://doi.org/10.1186/s13705-019-0232-1>.

- *MNRE Annual Reports – <https://mnre.gov.in>*
- *Central Electricity Authority (CEA) Reports*
- *International Energy Agency (IEA)*
- *Bridge to India Solar Report*
- *India's National Electricity Plan (NEP) 2023*
- *COP26 India National Statement – UNFCCC*

