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Research

Energizing the Future

Exploring the Legal, Regulatory, and Financial Dimensions of the Renewable Energy Sector

March 2025

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DMS Code: 119829.2

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Acknowledgements

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Glossary

Abbreviation	Particulars
APTEL	Appellate Tribunal
CAGR	Compound Annual Growth Rate
CBG	Compressed Biogas
CEA/Authority	Central Electricity Authority
CERC	Central Electricity Regulatory Commission
ckm	circuit kilometers
CNG	Compressed Natural Gas
CTU	Central Transmission Utility
CTUIL	Central Transmission Utility of India Ltd
DISCOM	State Power Distribution Company
EA 2003	Electricity Act 2003
ESO	Energy Storage Obligation
ESG	Environmental, Social and Governance
FDI	Foreign Direct Investment
FY	Financial Year
GENCO	Generation Company
GW	Gigawatt
IAEA	International Atomic Energy Agency
IPP	Independent Power Producers
IREDA	Indian Renewable Energy Development Agency Limited
IRENA	International Renewable Energy Agency
ISTS	Inter-State Transmission System
kW	Kilowatt
LHPs	Large Hydro Power Plants
LWRs	Light Water Reactors
MNRE	Ministry of New and Renewable Energy
MSME	Micro, Small and Medium Enterprises
MW	Megawatt
MVA	Megavolt Amperes
NDC	Nationally Determined Contribution
NHPC	National Hydroelectric Power Corporation Ltd.
NPCIL	Nuclear Power Corporation of India Limited
NTPC	National Thermal Power Corporation Limited

Glossary

Abbreviation	Particulars
PGCIL	Power Grid Corporation of India Limited
PHWRs	Pressurized Heavy Water Reactors
PPA	Power Purchase Agreement
PSA	Power Sale Agreement
PSP	Pumped Storage Projects
PV	Photovoltaic
RE	Renewable Energy
RPO	Renewable Purchase Obligation
SEBs	State Electricity Boards
SECI	Solar Energy Corporation of India
SERC	State Electricity Regulatory Commissions
SHPs	Small Hydro Projects
STU	State Transmission Utility
TRANSCOs	Transmission Company
VGF	Viability Gap Funding

Introduction

The energy sector plays a pivotal role in fueling India's rapid economic growth, enhancing its social development and supporting the aspirations of its burgeoning population. As one of the world's fastest-growing economies, India has witnessed an ever-increasing demand for energy, specifically for electricity, to meet its development needs.

This puts a burden on the framework of the power sector of the country to meet the ever-increasing demand of the people. In response policymakers have made a slew of regulatory changes and overhauls in order to maximize efficiency at each stage of the generation, transmission, and distribution of electrical power. One of the most significant reforms was the Electricity Act of 2003, which replaced the archaic Electricity Act of 1910 and consolidated the fractured legal framework previously governing this sector. This landmark legislation introduced market-oriented reforms, unbundling of generation, transmission, and distribution, and promoted competition within the sector.

Further, in order to keep up with the demand for sustainability, energy security and climate change mitigation, the evolution of this power sector is also characterized by the growing emphasis on RE sources, modification of the energy sourcing mix and clean energy generation. Additionally, the Indian government has been actively promoting the adoption of RE through launching initiatives and missions, making India a signatory to international treaties and agreements and launching numerous policies such as the RPOs, which mandates that distribution utilities must procure a specific percentage of their energy from renewable sources.

This research paper delves into the multifaceted landscape of India's electricity sector, exploring the evolution of the sector, the challenges faced as well as presenting a holistic assessment of the legal framework and the regulatory aspect surrounding the mechanics of power generation, transmission, and distribution. Moreover, this paper focuses on the critical role of RE as a sustainable solution and explores the potential, utilization, hurdles, investment trends, and the path ahead for this sector.

Evolution of the Framework Governing the Power Sector

Electricity falls under the Concurrent List of the Seventh schedule of the Constitution of India.[1] As such, both the Central and State Government can legislate upon the same (with the central legislation overriding in case of conflict). As it stands, there is one principal central legislation, i.e., the EA 2003 enacted by the Parliament, which governs the activities around buying, selling, trading, etc. of electricity in India.

Prior to the EA 2003, different aspects of the sector were regulated by different statutes and legislations. The very first law related to electricity in India was the Indian Electricity Act, 1887 which was enacted for the protection of person and property from injury and risks. Subsequently, the Indian Electricity Act of 1903 replaced the 1887 act to oversee the electricity sector more comprehensively. However, this new act lacked clarity as it did not acknowledge the bulk sale of electricity and failed to distinctly outline the jurisdictions between the government at the state level vs the federal level.[2] As a consequence of this, various practical, technical, and commercial challenges emerged which the government sought to solve by enacting the Indian Electricity Act of 1910. This was the first act to introduce the concept of licensing for bulk supply and it aimed to establish a structured framework for the transmission and distribution of electricity.

Thereafter, with an increased emphasis on the need for the states to step in and to extend electrification across the country, the Electricity (Supply) Act, 1948 was enacted which nationalized the sector and mandated the creation of SEBs in every state.[3] Subsequently, with an increasing need to regulate the electricity sector, the Electricity Regulatory Commissions Act, 1998 was enacted to set up CERCs and SERCs. The intention of the Electricity Regulatory Commissions Act, 1998 was to bring regulation of tariff under the purview of CERC and the SERCs. EA 2003 replaced all the above acts as one comprehensive legislation.

1 Entry 53, Seventh Schedule, Constitution of India.

2 Indian Electricity Act, 1903, No 3, Acts of Parliament (1903) (India).

3 https://www.oecd.org/development/development-philanthropy/46235043.pdf.

The Electricity Act, 2003

The EA 2003 was enacted with an intent to, inter alia, promote competition, protect consumer's interests, rationalize electricity tariffs, ensure transparent policies regarding subsidies, and provide electricity for all areas.[1] It regulates the 4 (Four) major segments in the power sector, viz. generation, distribution, transmission and trading, and it acted as an important statute as it kick-started the reforms in the debt-ridden distribution segment. It further reformed the electricity sector by providing for the National Electricity Policy, Rural Electrification Policy, Tariff Policy, open access in transmission, phased open access in distribution, delicensed generation, power trading, mandatory metering, establishment of the CEA, Regulatory Commissions, appellate tribunals etc.

I. Regulatory Players

Policy formulation at the national level is carried out by the Ministry of Power and the MNRE, while state-level policies are driven by the power or energy departments of the respective states and union territories.

The CERC and the SERCs play a significant role in shaping the power sector's overall framework in the country. They are a body which has an overlap of all three functions: legislative, judicial and executive. They are responsible for establishing regulations that govern power generators (both government and private), transmission utilities, and distribution companies within their respective jurisdictions, hence play a legislative function. They also play a judicial function as they are responsible for adjudicating disputes between GENCOs, DISCOMs or TRANSCOs and they adjudicate on their own regulations. These commissions also take on operational responsibilities, acting as a comprehensive system operator. It considers the functioning of the entire system, undertaking tasks such as transmission planning, which can be likened to an executive function.[2]

II. Tariff Determination

Tariff refers to a structured set of rates or fees established for the provision of electrical energy to different categories of consumers. The primary goal of tariffs is to fairly distribute the expenses associated with supplying energy among various user classifications. These tariffs are applied to different consumer groups (e.g., agricultural, household, industrial) or serve different purposes (e.g., retail tariff, generation tariff, distribution tariff).

1 Preamble, The Electricity Act 2003

2 https://cprindia.org/know-your-regulator-mr-p-k-pujari-chairperson-central-electricity-regulatory-commission-cerc/.

The main objective of tariffs is to recoup the costs incurred in capital investments for generating, transmitting, and distributing equipment. This includes expenses related to operating, maintaining, and supplying equipment, as well as costs for metering equipment, billing, collection, and other associated services. Additionally, tariffs are designed to ensure a satisfactory return on the overall capital investment.[3]

Section 3(1) of the EA 2003 empowers the Central Government to formulate the tariff policy. Section 3(3) enables the Central Government to review or revise the tariff policy from time to time. The EA 2003 also requires that the CERC and SERCs shall be guided by the tariff policy in discharging their functions including framing the regulations under Section 61 of the Act. Section 61 of the Act provides the guiding principles for determination of tariff applicable to generating companies and transmission licensees.

Cost Plus Determination: Under the EA, 2003, Section 62 provides for the purpose of cost-plus determination of tariff of electricity by the SERCs, i.e., the SERCs are approached (by way of a petition), by the company setting up the project, for the determination of tariff for the specific project on a cost plus basis, wherein the tariff determined under this process recovers all the cost of the distribution licensee/generating company and adds a specific amount as a return as determined by regulations framed by all State Regulatory Commissions under Section 181 of Electricity Act, 2003[4] on the terms and conditions for determination of tariffs. This determination is based on the normative details of the power plant such as, inter alia, the project cost, debt-equity ratio, return on equity, interest on working capital, depreciation, etc. The appropriate commission then determines the tariff for the generating station, transmission utility or the DISCOMs along commercial principles to encourage competition and efficiency while keeping in mind multi-year tariff formulation with gradual elimination of subsidies.

Competitive Bidding: While Section 62 bestows the Commission with wide discretion to determine tariff, Section 63 seeks to curtail this discretion where a bidding process for tariff determination has already been conducted. Section 63 contemplates that in such situations where the tariff has been determined through the bidding process, the Commission cannot by falling back on the discretion provided under Section 62 negate the tariff determined through bidding. The Commission is mandated to adopt such tariff that is determined by the bidding process if the bidding process: (a) is transparent; and (b) complies with the guidelines issued by the Central Government.[5]

The government issued the National Tariff Policy which emphasized the importance of competition and creating conditions for competition in line with EA 2003 and the National Electricity Policy. Towards this end, it specifies that the DISCOMs would procure power (or capacity) competitively for medium and long-term from generators under the procurement guidelines notified on January 19, 2005 through tariff based bids instead of MoU's, except in the case of Public Sector

3 Tariff Setting in the Indian Power Sector-An Overview, J.N. Rai, Rishabh K. Gupta, Rahul Kapoor, Rajesh Garai, IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE), Volume 6, Issue, PP 97-108.

4 States have formulated terms and conditions for determination of tariff regulations.

5 TATA Power Company Limited Transmission v. Maharashtra Electricity Regulatory Commission, 2022 SCC OnLine SC 1615.

projects where tariff of all new generation and transmission projects should be decided on the basis of competitive bidding after a period of five years or when the Regulatory Commission is satisfied that the situation is ripe to introduce such competition.[6]

There has been a shift in the market from the determination of tariffs through the normative approach to more and more power projects preferring the competitive bidding route. Even though competitive bidding is in its nascent stage and the framework is still evolving, this shift indicates a positive evolution as it: (a) facilitates greater transparency in the tariff determination process; (b) increases competition and incentive for private players to participate (c) reduces the burden on the already over-burdened commission and hence increases efficiency in the process; (d) makes this sector more attractive for investors due to the greater degree of certainty in the tariff structure as once it has been decided through the competitive bidding process, there is very limited scope of the commissions changing it, especially at their discretion. Hence, this is a positive step towards balancing the conflicting need to attract adequate investments in the power sector (by providing appropriate return on investment as budgetary resources of the Central and State Governments are incapable of providing the requisite funds) vis a vis ensuring the availability of electricity to different categories of consumers at reasonable rates.[7]

The Government has from time to time, under Section 63 of the EA 2003 released guidelines on the tariff based competitive bidding process. For example, on January 19, 2005, the Government issued Guidelines for Tariff Based Competitive Bidding Process for Procurement of Power by Distribution Licensees.[8] The Government also issued guidelines and standard bidding documents for procurement of inter-state transmission services through the tariff based competitive bidding process.[9]

In the RE Sector, the Ministry of Power released the Guidelines for Tariff Based Competitive Bidding Process for Procurement Power from Grid Connected Wind Power Projects on July 26, 2023, which are applicable for the procurement of electricity from grid-connected Wind Power Projects.[10] These guidelines apply to projects with a bid capacity of 10 (Ten) MW and above for projects connected to the intra-State transmission system, and a bid capacity of 50 (Fifty) MW and above for projects connected to the ISTS. Further, the MNRE also introduced Guidelines for Tariff Based Competitive Bidding Process for Procurement of Power from Grid Connected Solar PV Power Projects on July 28, 2023, to enable procurement of solar power by procurers from grid-connected PV power projects, with or without energy storage, through tariff based competitive bidding.[11]

6 https://cea.nic.in/wp-content/uploads/legal_affairs/2020/09/Tariff%20policy.pdf.

7 https://cea.nic.in/wp-content/uploads/legal_affairs/2020/09/Tariff%20policy.pdf.

8 https://powermin.gov.in/sites/default/files/uploads/Guideline_for_determination_of_tariff_and_SBD_for_case_1.pdf.

9 https://powermin.gov.in/sites/default/files/uploads/Revised_Guidelines_and_Standard_Bidding_Documents_SBDs_for_procurement_ISTS_through_TBCB_process.pdf.

10 https://mnre.gov.in/img/documents/uploads/file_f-1690950828189.pdf.

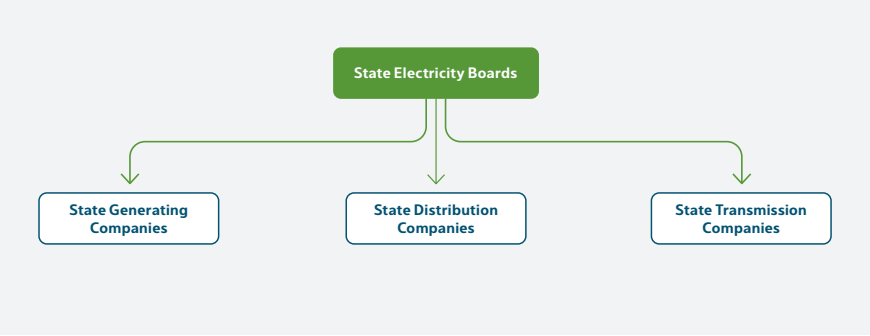
11 https://mnre.gov.in/img/documents/uploads/file_f-1690955137036.pdf.

III. Unbundling

Starting from the mid-1990s, in response to the increasing financial challenges faced by SEBs, the World Bank suggested the infusion of private capital into the power distribution sector and the implementation of a new regulatory framework. This approach aimed to introduce independent tariff-setting mechanisms to rectify significant price distortions.

Given the strain on the Central government's budgetary provisions, numerous state governments adopted the "reform" agenda proposed by these international organizations, with the key focus being on unbundling. Unbundling was viewed as a necessary step before privatization. Following this trend, Orissa initiated the process of unbundling its SEB in 1996, resulting in the establishment of two generation companies, one transmission enterprise, and four DISCOMs by 1998. Subsequently, several other states such as Haryana, Andhra Pradesh, and Rajasthan followed suit in the late 1990s.[12]

Perhaps one of the most important structural reforms instituted by the EA 2003 was this unbundling of SEBs, which paved the way for greater private sector participation. Under the Electricity Supply Act, 1948, SEBs performed all the functions of generating, transmitting, and distributing electricity within a state. EA 2003 envisaged the vertical unbundling of the power sector, i.e., the three different functions of generation, transmission, and distribution performed by the SEBs were separated into different entities each performing one function, as illustrated below. The aim of unbundling was to end vertically integrated SEBs in order to: (a) reform the structure of power sector to make it efficient and reduce mismanagement and corruption; (b) promote entry of more private players into generation, transmission, trading and distribution and thus encourage competition; (c) help the already bleeding SEBs to recover losses by improving efficiency; (d) decentralization/delegating tasks to independent companies. However, while there might be de jure unbundling, the degree of de facto unbundling might vary[13] as there still exists departmental overlap in many states.



12 https://www.osti.gov/etdeweb/servlets/purl/21115880.

13 https://www.niti.gov.in/sites/default/files/2021-08/Electricity-Distribution-Report_030821.pdf.

Each of these functions and their corresponding legal and regulatory framework under the EA 2003 has been explained in greater detail below.

IV. Generation

Electricity is not freely available in nature, so it must be 'produced', i.e., transforming other forms of energy to electricity. Generation is the process of generating electric power from sources of primary energy, such as fossil fuels (coal, natural gas, crude oil, etc.), renewable (solar, wind, hydro, etc.) and wastes (biomass, municipal waste, etc.), and is governed by Part III of the EA 2003.

The companies which produce electricity, i.e., GENCOs or the IPPs can be both government owned entities (central or state) such as NTPC Ltd., MSEB Holding Co Ltd, NHPC, Indraprastha Power Generation Co. Ltd. (NCT of Delhi), etc. as well as private companies such as Adani Power Ltd, Tata Power Ltd, Reliance Power Ltd, JSW Energy Ltd., Essar Power Ltd., etc.

Generation is a delicensed activity under the EA 2003,[14] i.e., a generator does not require license from the regulatory authorities to set up/ establish their own generating unit (except for hydro and atomic energy plants). This was with the intent of ensuring greater private sector participation in generation, hence increasing the competition and efficiency of this process.

Further, the concept of captive generation was also introduced via Section 9 of the EA 2003, which entails the setting up of a power plant by any person, association or company to generate electricity primarily for its own use.[15] In order to set up a captive generating plant, the 'twin conditions', as stipulated under Rule 3 of the Electricity Rules, 2005, are required to be fulfilled, i.e.: (i) a minimum of 26% (Twenty Six percent) of the ownership, either individual or aggregate, of such captive generating plant should be held by the captive user(s); and (ii) a minimum of 51% (Fifty One percent) of the aggregate electricity generated in such captive generating plant, determined on an annual basis, shall be consumed for the captive use/self-consumption by such owners. Captive power plants on a standalone basis help reduce dependency on the grid and have also led to an increase in the use of renewable sources of energy, for example, more solar panels are being set up on a standalone basis. Further, captive generating plants also have RPO Obligations and are required to procure a fixed percentage of power from RE sources. The imposition of the same was upheld by the Supreme Court in *Hindustan Zinc Ltd. v. RERC*, where the Court held that SERCs has jurisdiction to formulate and impose RPOs and rules incidental thereto, under Section 86(1)(e) read with section 181 of the EA, 2003 in respect of industries running their own captive power plants.[16] Grid connected captive generation plants can be used for exchange of excess generation where surplus electricity can be sold to the grid, thereby reducing costs as well.

14 Section 7, The Electricity Act 2003.

15 Section 2(3), The Electricity Act 2003.

16 Hindustan Zinc Ltd. v. RERC, (2015) 12 SCC 611.

The GENCOs or IPPs can either sell the generated power directly to the end consumer through open access or they can enter into PPAs with DISCOMs for retail distribution of the power produced by them. This power procurement can either be short term, medium term or long term. Short-term power market covers contracts of more than one day and less than one year for electricity transacted through inter-state trading licensees and directly by DISCOMs, power exchanges, and deviation settlement mechanisms. The short-term power market as an integral part of the power sector has been beneficial for meeting the short-term needs of the consumers, suppliers, and the sector as a whole. Short-term power procurement takes place through Over-the-Counter Bilateral Trade Agreements, intraday trading (to be settled in a period of 11 (Eleven) days) and real time trading.[17] CERC has set the regulatory framework for the short-term power markets through Trading License Regulations, Open Access Regulations, Power Market Regulations, and Deviation Settlement Mechanism Regulations. Medium-term and long-term power procurement is covered by contracts of more than one year for electricity transacted by such corresponding agreements for purchase and sale of power, the most prevalent mode of which is through a PPA.

Open access is where the GENCOs use the existing transmission and/or distribution infrastructure (transmission lines, substations, etc.) and supply the power directly to the consumer though a PPA, after paying appropriate charges determined by their respective SERC/CERC. Therefore, for the supply of power through open access, in addition to the PPA tariff, the consumers are required to pay associated open access charges including wheeling charges, transmission charges, cross-subsidy surcharge, additional surcharge, as applicable. The purpose of open access is to enable consumers with more than 1 (One) MW connected load to buy cheap power from the open market directly at competitive rates. The concept is to allow the customers to choose from a number of competitive power companies, rather than being forced to buy power from the local utility monopoly, i.e., the DISCOMs. It can either be Inter-State Open Access (where the purchasing and selling entities belong to different states) and thus falls under the jurisdiction of CERC or Intra-State Open Access (where the purchasing and selling entities belong to the same state) and thus falls under the jurisdiction of SERCs.

PPAs are the key agreements which govern the terms of purchase and sale of electricity between the purchaser/off-taker and the generators, for most of the power projects, whether RE or otherwise. They are usually long-term agreements for around 25 (Twenty-Five) years and some of the major clauses under the PPAs are tariff, under-performance by the GENCOs, term of the PPA, payment mechanism, late payment surcharge in the event of delay in making payments by the DISCOMs, change in law, force majeure, third party sales, termination, dispute resolution, etc. Any disputes arising out of the PPAs are referred to the SERCs or CERCs, depending on the jurisdiction and the location of the generator and distributor. However, there has been an increasing trend to include intermediaries such as SECI in the PPAs as that would give CERCs jurisdiction over the dispute resolution process, which is preferred by GENCO's due to the past practice

17 https://www.iitk.ac.in/ime/anoops/FOR-17/FOR_17_photos/PPTs/IITK_Day_1/IITK_Short_term_market.pdf.

of SERCs, usually siding with the state owned DISCOMs during the dispute resolution process. An appeal from the orders of the SERCs or CERCs can be made to the APTEL,[18] situated in New Delhi and the final stage would be an appeal to the Supreme Court of India.[19] Some PPAs contain an arbitration clause, however, as held in the case of *Gujarat Urja Vikas Nigam Ltd. vs Essar Power Limited*,[20] the EA 2003 being special law would prevail over Section 11 of Arbitration and Conciliation Act, 1996. Therefore, adjudication of all disputes between licensees and generating companies can be done only by State Commissions (or the Central Commission, as the case may be), arbitrator(s) appointed by it or if it has been referred by the appropriate commission for arbitration.[21]

For large scale retail distribution of the power produced by the GENCOs, DISCOMs carry and supply the power to the retail end consumer. However, between this stage the power generated by the GENCOs is transmitted to the DISCOMs by transmission utilities.

V. Transmission

Transmission is the wholesale distribution or transfer of bulk power from the GENCOs to the DISCOMs for further retail distribution, as governed under Part V of the EA 2003. The transmission network carries the electricity over long-distances through conductors and high-tension lines, for which the voltage needs to be stepped up to minimize transmission losses, by step-up transformers to different levels like 132 (One Hundred and Thirty-Two) kV, 220 (Two Hundred and Twenty) kV, 400 (Four Hundred) kV, and 765 (Seven Hundred and Sixty-Five) kV, etc., based on the distance it has to be transmitted. The high-voltage electricity is then transmitted via transmission lines to the sub-station near the consumer end, which contains step-down transformers.[22] Having a robust transmission network helps combat the skewed distribution of resources for power generation within India and connects the surplus region/areas to those which are deficit via intra-state and ISTSs.

As of January 31, 2024, India's transmission network comprises approximately 481,326 (Four Hundred Eighty-One Thousand Three Hundred Twenty-Six) circuit kilometers (ckm) of transmission lines and a transformation capacity of 1,225,260 (One Million Two Hundred Twenty-Five Thousand Two Hundred Sixty) MVA.[23] In fiscal year 2024-25, up to May 2024, an additional 391 (Three Hundred Ninety One) ckm of transmission lines were added, bringing the total inter-regional transmission capacity to 118,740 (One Hundred Eighteen Thousand Seven Hundred

18 Section 111 of The Electricity Act 2003.

19 Section 125 of The Electricity Act 2003.

20 Gujarat Urja Vikas Nigam Ltd. vs Essar Power Limited (2008) 4 SCC 755.

21 Section 86 (1) (f) and Section 79 (1) (f) of The Electricity Act 2003.

22 https://cstep.medium.com/decoding-the-journey-of-electricity-561d4820e2b4.

23 https://powermin.gov.in/en/content/overview.

Forty) MW.[24] To support this expansion, the government has outlined plans to add over 191,000 (One Hundred Ninety-One Thousand) ckm of transmission lines and 1,270 (One Thousand Two Hundred and Seventy) GVA of transformation capacity between 2022-23 and 2031-32.[25]

CTU mainly undertakes transmission of electricity through ISTS whereas STU undertake transmission of electricity through intra-State transmission system. They discharge all functions of planning and co-ordination relating to such transmission system with the Central and State Governments, GENCOs, Regional Power Committees, authorities, licensees, etc. After the unbundling, every state has its own transmission utility, as such, there are STUs and a CTU in the business of transmission. The CTUIL, a 100% (One Hundred percent) subsidiary of PGCIL, is notified as the CTU under EA 2003 and acts as the transmission licensee.[26]

There are centers dispatched at a central level, state level and regional levels known as the National Load Dispatch Centre, the State Load Dispatch Centre and the Regional Load Dispatch Centre respectively. Companies like Power System Operation Corporation along with these National, Regional and State Dispatch Centers work in tandem to ensure grid security and balance. These centers handle real time optimum scheduling for grid control and dispatch of electricity and ensure the integrated operation of the power system in their concerned region in accordance with the Grid Standards[27] and the Grid Code[28] specified by the CEA. They are integral for the stability of grid operations and to ensure scheduling such that the supply meets the demand on a real time basis in accordance with the contracts entered into with the licensees or the generating companies operating in the specific region.[29]

Transmission is a licensed activity governed under Part V of the EA 2003, for which a license[30] from the Appropriate Commission[31] is needed to establish or operate transmission lines.[32] The CTU or the STU shall be deemed to be a transmission licensee under the EA 2003, and any person intending to act as a transmission licensee has the obligation to forward a copy of their application to the CTU or the STU.

24 https://indianinfrastructure.com/2024/06/27/transmission-transformation-building-a-robust-network-to-meet-indias-energy-ambitions.

25 https://globaltransmission.info/transforming-transmission-trends-shaping-the-indian-cables-and-conductors-market.

26 Section 38, The Electricity Act 2003.

27 https://cea.nic.in/wp-content/uploads/2020/02/grid_standards_reg.pdf.

28 https://powermin.gov.in/en/content/indian-electricity-grid-code.

29 Part V, The Electricity Act 2003.

30 Section 14, The Electricity Act 2003.

31 Section 12(a), The Electricity Act 2003.

32 Section 2 (73), The Electricity Act 2003.

In India, CTUIL owns, controls and operates approximately 92-94% (Ninety-Two to Ninety-Four percent) of the country's entire transmission network. Unlike generation and distribution, there very few private players in the transmission sector, such as, Adani Transmission Limited, Powerlinks Transmission Ltd. (a JV between Tata Power and PGCIL), L&T Power Transmission and Distribution (Kolkata), Sterlite Power Transmission Ltd. (Delhi), etc.

VI. Distribution

Distribution (carried out through low voltage lines) is the process of movement of smaller amounts of power/electricity from the substation to the consumer's end over shorter distances and is governed under Part VI of EA 2013. It is a licensed activity under section 2(17) of the EA 2003, which defines 'distribution licensee' as a *"licensee authorised to operate and maintain a distribution system for supplying electricity to the consumers in his area of supply"*.

Unlike generation, distribution is dominated by the unbundled state players. However, privatization has made inroads as the intention is to provide consumers with a "choice of network". The first state to be privatized was Orissa in 1996. Other places where privatization was experimented in 1990s were in Maharashtra (Enron), Andhra Pradesh (GVK Power & Spectrum) and Gujarat (Essar Power), but they were not successful. Thereafter, Delhi was privatized in 2002 when Tata Power Delhi Distribution Limited (TPDDL) and Sterlite Power Transmission Ltd. became distribution licensees in the state followed by BSES Rajdhani Power Ltd. (JV between Reliance and NCT of Delhi).[33] Maharashtra was privatized in 2010 with players like Torrent Power, Tata Power, Reliance Power, Adani Power, etc. coming in. The GENCOs or IPPs enter into a PPAs with the DISCOMs to supply the power produced by them and the DISCOMs in turn carry the power to the retail end consumer.

Power distribution is the most vulnerable and loss-making aspect In India's power sector supply chain. Due to the DISCOMs being the last mile supplier, they directly bear the burden of transmission losses, revenue losses, loss from theft from electricity etc. This situation is further exacerbated due to factors such as expensive long-term PPAs, subpar infrastructure, inefficient power procurement practices, poor billing and collection inefficiency, among the other inefficiencies in their operations. As a result of these losses, these utilities are unable to make the necessary investments to enhance power supply quality and adequately prepare for the increased adoption of RE sources. This financial incapacity also poses a risk to power generators and their lenders, triggering a negative chain reaction that impacts the overall economy.

Due to this condition of the DISCOMs, GENCOs generally view entering into PPAs with them as extremely risky. Majority of DISCOMs are behind on their payment to GENCOs, a situation which is made worse because of the weak and often unenforced payment security mechanism

33 https://documents1.worldbank.org/curated/en/855761468041672781/pdf/Private-participation-in-the-Indian-power-sector-lessons-from-two-decades-of-experience.pdf.

in the PPAs.[34] DISCOMs have further spooked investors by cancelling signed 25 (Twenty-Five) year PPAs.[35] Contract risks are exacerbated by the bureaucratic and slow Indian legal system. Hence, there has been an increasing trend of GENCOs bidding for projects and entering into contracts backed by intermediary procurers who take up the payment obligations themselves and provide additional reassurance of the electricity being sold.

VII. Intermediary Procurers or Trading Licensees

As per EA 2003, 'trading' means purchase of electricity for resale thereof.[36] Similar to distribution and transmission, EA 2003 prohibits trading of electricity by an entity without a license[37] from the Appropriate Commission.[38] As such, only trading licensees are permitted to purchase and sell power as intermediary procurers. Intermediary procurers or trading licensees are the third-party procurers which connect the buyers and sellers for the purpose of purchase and sale of electricity. The intermediaries procure electricity from GENCOs and supply the same to the DISCOMs. The trading licensees are allowed to charge a trading margin of not less than 0 (Zero) paise/kWh and up to 7 (Seven) paise/kWh for short-term contracts (of less than 1 (One) year) and to decide the trading margin mutually with the seller for transactions under long-term contracts.[39]

Since these intermediaries both purchase and supply the power, they enter into two different contracts for purchasing and supplying the electricity respectively. The intermediaries enter into a PPA with GENCO for the purchase of power and simultaneously enter into a PSA with the DISCOMs for the supply of such power. Typically, these two agreements are entered on a back-to-back basis,[40] i.e., on identical terms and conditions.

Trading licensees are classified as inter-state and intra-state trading licensees[41] and are provided a license based on certain general, technical and financial qualifications.[42] There are different categories of trading licensees basis their capital adequacy and liquidity requirements.[43] In lieu of the purchasing and supplying power, the intermediaries earn revenue by charging a nominal 'trading margin' from the tariff stipulated under the PPAs and PSAs.

34 https://www.ceew.in/cef/quick-reads/analysis/payment-delays-weakest-link-in-india-energy-transition.

35 https://www.saurenergy.com/solar-energy-news/aperc-approves-cancellation-of-two-wind-ppas-orders-discom-to-pay-compensation.

36 Section 2(17), The Electricity Act 2003.

37 Section 14, The Electricity Act 2003.

38 Section 12(c), The Electricity Act 2003.

39 Regulation 8, CERC (Procedure, Terms and Conditions for grant of trading licence and other related matters) Regulations, 2020.

40 Regulation 2(d), CERC (Procedure, Terms and Conditions for grant of trading licence and other related matters) Regulations, 2020.

41 Regulation 2(2), CERC (Procedure, Terms and Conditions for grant of trading licence and other related matters) Regulations, 2020.

42 Regulation 3, CERC (Procedure, Terms and Conditions for grant of trading licence and other related matters) Regulations, 2020.

43 Regulations 3(3), CERC (Procedure, Terms and Conditions for grant of trading licence and other related matters) Regulations, 2020.

There are various intermediaries (both public and private) in the power sector such as PTC India Ltd. (**"PTC"**), NTPC Vidut Vyapar Nigam Limited (**"NVVN"**), Tata Power Trading Company Limited, Adani Enterprises Limited, etc.[44] While PTC, a PPP company, is the leading provider of power trading solutions in India, SECI and NHPC, etc. are increasingly becoming the intermediaries of choice. SECI and NHPC have been selected by MNRE as the RE implementation agency[45] to select and buy power from RE GENCOs and sell the same to one or more DISCOMs.

44 https://cercind.gov.in/pdf/listoffirm21.pdf.

45 https://www.seci.co.in/about/introduction.

Other Government Initiatives

I. Electricity (Amendment) Bill 2022

While the EA 2003 provided a much-needed push to the regulatory framework of India's power sector, certain challenges continued and needed to be addressed to realize India's power goals. These consisted of, inter alia: (a) sustainability of the power sector; (b) contract enforcement; (c) payment security mechanism; (d) energy transition; (e) the need to provide choice to consumers in order to promote competition, etc.; (f) importance of green energy for our environment in the context of global climate change concerns and our international commitments to increase the share of RE; (g) to strengthen the regulatory mechanism and adjudicatory mechanism; and (h) to bring administrative reforms through improved corporate governance of distribution licensees.[1] Details of these challenges have been captured in the "*Existing Challenges*" portion on page 37 of this paper. These challenges have been sought to be addressed through the proposal of the Electricity (Amendment) Bill 2022 ("**Amendment Bill/Bill**"), the Electricity (Amendment) Rules 2023 ("**Amendment Rules 2023**") and the Electricity Amendment Rules, 2024 ("**Amendment Rules 2024**") (together, "**Proposed Amendments**") which proposes radical changes in the power distribution sector by enabling competition, strengthening payment security and more providing muscles to regulatory commissions.[2]

To enable competition, the Bill proposed a parallel license in electricity distribution using state DISCOMs transmission network and allowed private sector companies to enter the sector and compete with state-owned firms. According to the Electricity Act of 2003, multiple distribution licensees (DISCOMs) are allowed to operate in the same area, and each is responsible for supplying electricity through its own network. However, the proposed Bill seeks to eliminate this obligation. Instead, a DISCOM that owns the network will be mandated to grant open and non-discriminatory access to other DISCOMs on its network. The burden of power and its related expenses from existing PPAs will be distributed among all DISCOMs operating in a specific region. The Bill also provides for minimum tariff ceilings to avoid predatory pricing by power distribution companies as well as a maximum price to protect consumers.

In order to strengthen the payment security mechanism, the Bill proposes to empower the load dispatch centres to stop electricity supply to distribution utilities that do not maintain adequate bank guarantees in favour of power plants with which they are in tie-ups. Section 142 and Section 146 of the EA 2003 are proposed to be amended to enhance the rate of penalty for non-compliance of the provisions of the EA 2003. The functions of the forum of regulators are also proposed to be strengthened.

1 https://loksabhadocs.nic.in/Refinput/New_Reference_Notes/English/08082022_123415_1021205203.pdf.

2 https://www.hindustantimes.com/cities/chandigarh-news/dont-rush-electricity-amendment-bill-urges-pm-modi-101688845704203.html.

The proposed Bill also outlines a framework that enables consumers to have the freedom to choose among various service providers. It introduces the formation of the Electricity Contract Enforcement Authority to handle disputes related to contracts within the electricity sector. To appoint the chairperson and members of the APTEL, CERC, SERCs, and the ECEA, the Bill establishes a selection committee. Additionally, the Bill suggests penalties for licensees who fail to meet their obligations. It mandates all licensees to procure or generate a minimum specified amount of electricity from RE sources as a percentage of their overall electricity consumption.

The Electricity (Amendment) Rules, 2022 provided for the implementation of the Uniform RE Tariff for the Central Pool i.e., a pool of category specific power from Inter State Transmission System connected RE sources being procured by the designated intermediary procurers[3] in Rule 19 of the Electricity Rules, 2005 (**"Rules"**). The Amendment Rules 2023 further amend Rule 19 of the Rules. The methodology for the calculation of tariff for the month has been amended and certain referencing revisions in Schedule II of the Rules has been made which provides for fuel and power purchase adjustment methodology.[4]

The Amendment Rules 2023 also amended the provisions relating to captive generating power plants and stipulates that in the case of a captive generating plant established by an affiliate company, the captive user must possess a minimum ownership share of 51% (Fifty-One percent) in that affiliate company, as opposed to the previous requirement of 26% (Twenty Six percent) for all.

The Amendment Rules 2024 further amend the Rules. It introduced key changes to improve transmission access, cost transparency, and financial sustainability in the power sector. It allowed generating companies, captive plants, energy storage systems, and large consumers to establish dedicated transmission lines without a license, subject to regulatory compliance. It also revised open access charges, limit short term transmission network charges and phasing out additional surcharges for General Network Access users over four years. Additionally, it specified that tariffs should be cost reflective.

Apart from the Proposed Amendments, there are several legal policies that have been initiated by the Government in relation to the power sector to enhance the sector growth in the country's realized potential. The below mentioned policies are a few major policies which contribute to the Government's goal for energy efficiency:

II. National Electricity Policy and Plan

This policy was prepared in accordance with Part II of the EA 2003 by the central government in consultation with state governments and the CEA for development of the power system based on optimal utilization of resources such as coal, natural gas, nuclear substances or materials,

3 https://powermin.gov.in/sites/default/files/Approval_of_Procedure_for_Implementation_of_Uniform_Renewable_Energy.pdf.

4 https://egazette.gov.in/WriteReadData/2023/246925.pdf.

hydro and renewable sources of energy.[5] It also focused on permitting standalone systems for rural areas, rural electrification and bulk purchase of power and management of local distribution in rural areas through Panchayat Institutions, users' associations, cooperative societies, non-Governmental organizations or franchisees.[6] As per the EA 2003, every 5 (Five) years the CEA is obliged to prepare a National Electricity Plan in accordance with the National Electricity Policy. The National Electricity Plan for 2022-2032 was notified on May 31, 2023, and includes the review of the last five years (2017-22), a detailed plan for the next five years (2022-27) and the prospective plan for the next five years after that (2027-32).[7]

III. Ujwal Discom Assurance Yojana ("Uday")

DISCOMs in the country are facing significant financial challenges, with substantial accumulated losses and outstanding debt. These financial constraints prevent DISCOMs from supplying sufficient electricity at affordable rates, which ultimately hinders the overall quality of life and economic growth and development. Achieving goals such as 100% (One Hundred percent) village electrification, round-the-clock power supply, and clean energy becomes unattainable without addressing the issues faced by DISCOMs. Furthermore, power outages have a negative impact on national priorities like "Make in India" and "Digital India". Additionally, the default on bank loans by financially stressed DISCOMs has the potential to severely affect the banking sector and the overall economy.

In order to improve this situation, the Government formulated and launched Uday on November 20, 2015. This scheme aims to provide a financial and operational turnaround for DISCOMs and ensure a sustainable and permanent solution to their problems. The UDAY scheme encompasses reform measures in various sectors, including generation, transmission, distribution, coal, and energy efficiency.

Despite the introduction of this scheme, DISCOMs have experienced significant losses, specifically in terms of aggregate technical and commercial losses. These losses are considerably higher when compared to the targeted percentage in most states. The initial goal was to limit the losses to 15% (Fifteen percent), but in the majority of states, the actual figures are closer to 20% (Twenty percent). In the fiscal year 2019-20, several states experienced significant net losses, with Tamil Nadu recording a loss of INR 119,650,000,000 (Indian Rupees One Hundred and Nineteen Billion Six Hundred and Fifty Million only), Telangana with a loss of INR 60,570,000,000 (Indian Rupees Sixty Billion Five Hundred Seventy Million only), and Uttar Pradesh with a loss of INR

5 Section 3, The Electricity Act 2003.

6 Section 4 and 5, The Electricity Act 2003.

7 https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1928750#:~:text=NEP%20envisages%20that%20the%20share,%25%20as%20on%20April'2023.

37,920,000,000 (Indian Rupees Thirty-Seven Billion Nine Hundred Twenty Million only). Out of the 27 (Twenty-Seven) states that participated in the UDAY initiative, 15 (Fifteen) of them witnessed a decline in net losses from 2014-15 to 2019-20. However, the remaining 12 (Twelve) states saw an increase in net losses during the same period.[8]

A recent study conducted by the Council on Energy, Environment and Water (**"CEEW"**) has revealed that SERCs have implemented different strategies when it comes to the regulatory treatment of UDAY debt takeover. As a result, there has been an uneven distribution of benefits between the DISCOMs and consumers. For example, consumers in Uttar Pradesh received an excessive benefit of approximately INR 380,000,000,000 (Indian Rupees Three Hundred Eighty Billion only), while consumers in Rajasthan were deprived of benefits amounting to INR 260,000,000 (Indian Rupees Two Hundred and Sixty Million only). In response, the DISCOMs of Uttar Pradesh and Madhya Pradesh have sought a review of their SERC's approach by approaching the APTEL.

IV. Rural Electrification Policy, 2006

On August 23, 2006, the Government issued a notification for the Rural Electrification Policy,[9] in accordance with sections 4 and 5 of the Electricity Act, 2003. The objective of this policy is to ensure that all households have access to electricity by the year 2009. Additionally, the policy aimed to provide a reliable and high-quality power supply at affordable rates. The policy sought to establish a minimum lifeline consumption of 1 (One) unit per household per day by 2012, recognizing it as a necessity for the well-being of the population.

V. Integrated Energy Policy, 2006

The Integrated Energy Policy (**"IEP"**) was released in August 2006 and covers various aspects of energy, such as energy security, access, availability, affordability, pricing, efficiency, and the environment. The overarching objective of this energy policy is to ensure the provision of safe and convenient energy at the lowest possible cost, while maintaining technical efficiency, economic viability, and environmental sustainability. This will enable the reliable fulfillment of energy service demand across all sectors, including the energy requirements of vulnerable households throughout the country. In terms of energy efficiency, the IEP sets forth several goals, including a 20% (Twenty percent) reduction in energy intensity and an increase in the average gross efficiency of power generation from 30.5% (Thirty-point Five percent) to 34% (Thirty Four percent).[10]

8 https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1880911.

9 https://cercind.gov.in/2018/whatsnew/REP.pdf.

10 https://www.iea.org/policies/1590-integrated-energy-policy.

In addition to the above, in order to tap into the RE potential of the country, the government has initiated policies and initiatives which create avenues for further development and interest of investors in the renewables sector in India. A few of these policies have been mentioned below.

VI. Must-Run Status

The term "must run status" primarily refers to the requirement that power evacuation from solar power plants and wind power plants should not be curtailed unless it is necessary for grid safety or equipment safety reasons. In relation to the must run status, the solar and wind PPAs of SECI/NTPC (the central scheme PPAs) state that dispatch and scheduling should be conducted in accordance with the relevant laws, regulations, and the Grid Code. In actuality, there have been some deviations in practice. The must run status, as a measure, has been issued under Section 176 of the EA 2003 and Electricity (Promotion of Generation of Electricity from Must-Run Power Plant) Rules, 2021. The DISCOMs have chosen to restrict the generation of RE intermittently, without providing any explanation for their actions. The issue of artificial curtailment has been a cause of concern for RE rich states such as Tamil Nadu, Karnataka, Rajasthan, Gujarat, Madhya Pradesh, Telangana and Andhra Pradesh.[11]

VII. Renewable Purchase Obligation (RPO)

RPO is a requirement under the Indian EA, 2003 that mandates all electricity distribution licensees to purchase or produce a specified minimum quantity of their electricity needs from RE Sources. The minimum RPO for each state is determined by the SERCs. For example, in Kerala, the Kerala State Electricity Regulatory Commission established a total RPO of 3% (Three percent) in 2010. Out of this, 2.5% (Two-point Five percent) must be met from non-solar sources, while 0.5% (Zero-point Five percent) must be sourced from solar energy. The RPO is subject to an annual increase of 10% (Ten percent) of the original 3% (Three percent), with a maximum limit of 10% (Ten percent).[12]

With the growth of the energy sector with each passing day, RE sources are also being garnered further and developed to an extent where the country can become self-reliant, particularly with respect to generation of energy. Over the recent years, we have seen a significant growth in the government's goals and initiatives to promote RE as a source. While the above-mentioned framework applies to energy sector as a whole, we will discuss in depth the particular projection of the RE sources which India is witnessing in the present day.

11 https://energy.economictimes.indiatimes.com/energy-speak/the-reality-of-must-run-status-of-renewable-energy-projects-in-india/4160#:~:text='Must%20run%20status'%20mainly%20means,of%20equipment%20or%20personnel%204%20.

12 https://anert.gov.in/node/114.

Types of RE

I. Solar Power

Overview

Among the various RE resources, solar energy potential is the highest in the country. Solar power is energy harnessed from the sun which is then converted to thermal or electrical energy. According to the IREDA, India is endowed with abundant solar energy capable of producing 5,000 (Five Thousand) trillion kW of clean energy.[1]

Capacity in India

In furtherance of the government's aim since years to reach an equilibrium between energy sources, the country achieved grid parity in August 2022,[2] where the generation of electricity from renewables costs more or less the same as conventional sources.

In 2024, India's solar energy sector saw significant expansion, with the cumulative installed solar capacity surpassing 100 (One Hundred) GW. The country added around 24.5 (Twenty- Four point Five) GW of new solar capacity, more than doubling the installations compared to the previous year. The rooftop solar sector also recorded a 53% (Fifty Three percent) increase, contributing approximately 4.59 (Four point Five Nine) GW of new installations, driven by initiatives like the PM Surya Ghar Muft Bijli Yojana.[3]

By the end of 2024, India's total renewable energy installed capacity reached 209.44 (Two Hundred Nine point Four Four) GW, marking a 15.84% (Fifteen point Eight Four percent) increase from the previous year (PIB India). This progress reflects the nation's determination to accelerate its renewable energy transition.[4]

Looking ahead, predictions for 2025 suggest the addition of around 21.2 (Twenty One point Two) GW of new solar capacity, comprising 16.5 (Sixteen point Five) GW of utility-scale projects, 4 (Four) GW of rooftop solar, and 700 (Seven Hundred) MW of off-grid installations.[5] The country's solar manufacturing capabilities are also set to expand, aiming to produce 25 (Twenty Five) GW of solar cells and 60 (Sixty) GW of modules by the end of 2025.

1 https://www.ireda.in/solar-energy.
2 https://www.ibef.org/download/1664768214_renewable-energy-ppt-august-2022.pdf.
3 https://www.enerdata.net/publications/daily-energy-news/india-surpasses-100-gw-solar-capacity.html.
4 https://pib.gov.in/PressReleaseIframePage.aspx?PRID=2092429.
5 https://www.pv-magazine.com/2024/05/27/india-ser-to-install-21-2-gw-of-solar-in-fiscal-2025/.

Government Initiatives

With the government's commitment to increasing the country's solar PV installed capacity, India is poised to become a global leader in RE. There have been several recent trends and initiatives which may be observed as leading to such goals, some of which are as follows:

1. In January 2024, the government announced the Pradhanmantri Suryodaya Yojana to promote installations of rooftop solar panels in 10,000,000 (Ten Million) households. The initiative is aimed at providing up to 300 (Three hundred) units of electricity free of cost to the households, each month. The budget of FY 2025-26 further allocated INR 2,00,00,00,00,000 (Indian Rupees Two Hundred Billion only) to this flagship rooftop solar initiative.[6]
2. The budget of FY 2025-26 also has extended tax holidays for solar power projects by an additional five years. This extension aims to incentivize investments in the solar sector, encouraging the development of renewable energy infrastructure.
3. Several key projects have been implemented to drive the country's renewable power generation mix. One such initiative is the Solar Park Scheme, which aims to establish large-scale solar parks across the nation.
4. The budget for the FY 2024-25, which was INR 3,615,000,000 (Indian Rupees Three Billion Six Hundred and Fifteen Million only) for solar power, which highlights a 30% (Thirty percent) increase from the allocated budget of FY 2023-24.
5. The MNRE's national wind-solar hybrid policy is another significant step towards a sustainable energy future. By promoting grid-connected wind-solar PV hybrid systems, this policy aims to harness the complementarity of wind and solar energy sources. As a result, it reduces the intermittency associated with RE generation and enhances grid stability. Furthermore, the utilization of existing land and transmission infrastructure optimizes resource allocation and minimizes environmental impact.
6. The Delhi government's Solar Policy 2022 plan further reinforces India's commitment to solar energy adoption. With an ambitious target of increasing the installed capacity from 2,000 (Two Thousand) MW to 6,000 (Six Thousand) MW by 2025, Delhi aims to significantly boost its reliance on solar power. This transition is expected to lead to a substantial increase in the share of solar energy in the city's annual electricity demand, promoting a cleaner and greener environment.

Future Goals

India's solar industry has been on a remarkable growth trajectory in recent years. As part of its ambitious target to install 500 (Five hundred) GW of RE by 2030, India is setting its sights on developing 280 (Two hundred and eighty) GW of solar power capacity. According to the

6 https://www.indiabudget.gov.in/.

government-developed India Energy Security Scenarios, India can achieve 479 (Four Hundred Seventy-Nine) GW of solar power by 2047.[7] Additionally, the country is expected to add 15.5 (Fifteen point Five) GW of new utility-scale solar capacity in the FY 2023-24.[8]

II. Hydro Power

Overview

Hydro power projects are classified as large and small hydro projects based on their sizes. SHPs have always been a part of RE resources, however, Ministry of Power, Government of India has also declared LHPs of 25 (Twenty-Five) MW or above capacity as RE source vide its Office Memorandum dated March 08, 2019.[9] LHPs have been declared as RE to promote hydropower and achieve the ambitious target of the ten year vision for hydropower - of adding 30,000 (Thirty Thousand) MW (Including about 7500 (Seven Thousand Five Hundred) MW from PSPs of hydropower by the year 2030. These measures would help to bring down the cost of generation of hydropower and secure PPAs.[10]

Capacity

As of January 2025, India's installed hydropower capacity stands at 466.26 (Four Hundred Sixty-Six point Twenty Six) GW. Looking ahead, the Central Electricity Authority's National Electricity Plan 2023 projects that India's installed hydropower capacity will reach 88 (Eighty-Eight) GW by FY 2031-32, including 26 (Twenty-Six) GW from pumped storage projects (PSP)[11]. By December 2024, India's total renewable energy installed capacity reached 209.44 (Two Hundred Nine point Four Four) GW, marking a 15.84% (Fifteen point Eight Four percent) increase from 180.80 (One Hundred Eighty point Eight Zero) GW in December 2023.[12] Projections for the year 2025 indicate that India's power generation capacity is expected to increase by 30 (Thirty) GW to 32 (Thirty Two) GW, driven predominantly by renewable energy sources.[13]

7 https://indianexpress.com/article/india/india-achieve-energy-independence-by-2047-us-study-8507267/.
8 https://jmkresearch.com/india-added-12-8-gw-solar-capacity-in-fy2023/.
9 https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1567817.
10 https://powermin.gov.in/sites/default/files/uploads/MOP_Annual_Report_Eng_2019-20.pdf.
11 https://www.india-briefing.com/news/indias-power-sector-in-2025-investor-outlook-36367.html.
12 https://pib.gov.in/PressReleaseIframePage.aspx?PRID=2092429.
13 https://www.india-briefing.com/news/indias-power-sector-in-2025-investor-outlook-36367.html.

Government Initiatives

In line with the government's goal to become a global leader in RE, there have been several recent trends and initiatives which may be observed as leading to such goals, some of which are as follows:

1. As of December 2024, about 32% (Thirty Two percent) of India's estimated hydroelectric potential of 145.32 (One Hundred Forty-Five point Thirty Two) GW has been harnessed, with an additional 15 (Fifteen) GW under construction. Furthermore, the country has 8 (Eight) operational PSPs with a combined capacity of 4.75 (Four point Seven Five) GW, while 4 (Four) PSPs with a total capacity of 2.78 (Two point Seven Eight) GW are under construction. [14]

2. Large hydroelectric projects saw a steady increase, with installed capacity growing from 46.88 (Forty-Six point Eight Eight) GW in 2023 to 46.97 (Forty-Six point Nine Seven) GW in 2024. Including projects in the pipeline, the total capacity rose to 67.02 (Sixty-Seven point Zero Two) GW, up from 64.85 (Sixty Four point Eight Five) GW the previous year. [15]

3. The government, in February 2023, approved a USD 3,900,000,000 (United States Dollar Three Billion and Nine Hundred Million only) worth hydropower project near the China border.[16]

4. In January 2023, the Union Cabinet approved investment of INR 26,14,00,00,000 (Indian Rupees Twenty-Six Billion and Fourteen Million only) for SJVN's 382 (Three Hundred and Eighty-Two) MW Sunni Dam Hydro Project.[17]

5. In August 2022, NHPC Limited and the Government of Himachal Pradesh inked an implementation agreement for the 500 (Five Hundred) MW Dugar Hydroelectric Project in the Chamba District of Himachal Pradesh.[18]

6. In August 2022, NHPC signed a MoU with the Investment Board Nepal (IBN) to develop 750 (Seven Hundred and Fifty) MW West Seti and 450 (Four Hundred and Fifty) MW SR-6 Hydroelectric Projects in Nepal.[19]

7. In June 2022, SJVN announced a collaboration with the Assam government for the development of hydro and RE projects in the state.[20]

Future Goals

With the growing expansion in projects, India is projected to have an installed hydropower generation capacity of 70,000 (Seventy Thousand) MW by 2030.[21]

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14 https://pib.gov.in/PressReleaseIframePage.aspx?PRID=2083317.

15 https://pib.gov.in/PressReleaseIframePage.aspx?PRID=2083317.

16 https://economictimes.indiatimes.com/industry/energy/power/india-approves-3-9-billion-hydropower-project-near-china-border/articleshow/98299318.cms.

17 https://pib.gov.in/PressReleasePage.aspx?PRID=1888538.

18 https://economictimes.indiatimes.com/industry/renewables/nhpc-inks-pact-with-himachal-pradesh-for-500-mw-dugar-hydro-project/articleshow/93824525.cms?from=mdr.

19 https://economictimes.indiatimes.com/industry/renewables/nhpc-inks-pact-to-develop-two-hydro-projects-in-nepal/articleshow/93660631.cms?from=mdr.

20 https://solarquarter.com/2022/06/10/assam-govt-to-collaborate-with-sjvn-for-development-of-renewable-energy-projects/.

21 https://cea.nic.in/wp-content/uploads/irp/2022/09/DRAFT_NATIONAL_ELECTRICITY_PLAN_9_SEP_2022_2-1.pdf.

III. Wind Power

Overview

The wind power sector in India is experiencing a surge in attention and interest, primarily driven by the growing fascination with wind-solar hybrid projects and round-the-clock renewable power plants. These innovative initiatives aim to provide a consistent and reliable power supply to utilities, as well as cater to the energy needs of large commercial and industrial customers.

The concept of wind-solar hybrids combines the strengths of both wind and solar energy generation. By integrating wind turbines and solar panels within the same project, the hybrid approach maximizes the utilization of renewable resources and optimizes power output. This integration ensures a more consistent power supply by harnessing wind energy during the day and the solar energy accumulated during the day to be used during the night or periods of low wind activity. The combined output of wind and solar sources enhances the stability and reliability of the electricity grid, providing a steady and uninterrupted power supply.

Furthermore, the interest in developing round-the-clock renewable power plants has gained traction in recent years. These plants utilize a mix of RE sources, such as wind, solar, and other clean energy technologies, along with advanced energy storage systems. By combining different renewable sources and incorporating energy storage capabilities, round-the-clock renewable power plants can generate a continuous supply of electricity, even during non-peak hours or periods of low renewable resource availability. This ensures a reliable and uninterrupted power flow, meeting the energy demands of utilities and large-scale commercial and industrial consumers throughout the day.

Capacity

India has the 4th (Fourth) largest installed wind power capacity in the world.[22] The development of wind power in India began in the 1990s in Tamil Nadu and has significantly increased in the last decade. Between fiscal years 2021 and 2025, India added around 9.38 (Nine point Three Eight) GW of wind capacity, falling short of the projected 20.2 (Twenty point Two) GW anticipated by GWEC and MEC Intelligence (MEC+). In the FY ending March 2025, India expects to add about 5 (Five) GW of new wind capacity, indicating a renewed focus on accelerating wind energy installations.[23] However, the pace of installations has accelerated recently, with 3.4 (Three point Four) GW added in 2024 alone, a 21% (Twenty One percent) increase compared to 2023.[24]

22 https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1555373.

23 https://www.reuters.com/business/energy/india-gets-386-bln-financial-commitment-expand-renewable-capacity-2024-09-16.

24 https://economictimes.indiatimes.com/industry/renewables/india-added-24-5-gw-solar-and-3-4-gw-wind-capacity-in-2024-sets-new-records/articleshow/117085849.cms.

The largest wind power generating state is Tamil Nadu accounting for nearly 23% (Twenty Three percent) of installed capacity, followed in decreasing order by Gujarat, Maharashtra, Rajasthan and Karnataka.[25] The wind power tariff of around INR 2.7/kWh (Indian Rupees Two point Seven) is cheapest of all power generation sources in India.[26]

As of February 28, 2025, India's installed wind power capacity reached 48.59 (Forty-Eight point Five Nine) GW.[27] This falls short of the initial target of 60 (Sixty) GW set for 2022. However, the country is actively working to accelerate wind energy installations. Projections indicate that India's annual wind capacity addition is expected to more than double, averaging 7.1 (Seven point One) GW over the next two financial years, potentially bringing the total installed capacity to around 63 (Sixty-Three) GW by 2026-27.[28]

Government Initiatives

With the growing capacity and potential of the country's wind power, the government has taken several steps and initiatives to identify loopholes and add on to enhance the generated wind power:

1. The budget 2024-25 allocation for the wind energy sector is INR 9,300,000,000 (Indian Rupees Nine Billion and Three Hundred Million only), showcasing a 1.5% (One point Five percent) increase from the previous year budget allocation for this sector.
2. The surge in installations is primarily due to the introduction of the RPO and ESO trajectory until 2029-2030 by the government, which specified that wind RPO will be met only by energy produced from wind power projects commissioned after March 31, 2022.[29]
3. The waiver on charges for the ISTS pertaining to electricity generated from solar and wind sources has been extended by the Ministry of Power. This extension applies to projects that are expected to be finalized by June 30, 2025.[30] It promotes the advancement of solar, wind, PSPs, and battery energy storage systems, as well as the trading of RE in power exchanges. Additionally, it emphasizes the smooth transmission of RE power across different states.
4. Rajasthan was felicitated for achieving the highest wind capacity addition, Gujarat for achieving the highest wind capacity addition through open access and Tamil Nadu for initiating the repowering of wind turbines.[31]

25 https://energy.economictimes.indiatimes.com/news/renewable/indias-top-9-states-by-installed-wind-power-capacity/68782064.

26 https://energy.economictimes.indiatimes.com/news/renewable/tariff-of-rs-2-69-to-rs-2-70-per-unit-discovered-in-secis-latest-wind-power-generation-bid/88053811#:~:text=New%20Delhi%3A%20The%20tariff%20discovered,is%2039.99%20gigawatt%20(GW).

27 https://mnre.gov.in/en/physical-progress/.

28 https://www.evwind.es/2025/02/24/indias-wind-power-capacity-poised-to-surge-to-63-gw-by-2026-27/104580.

29 https://powermin.gov.in/sites/default/files/webform/notices/Renewable_Purchase_Obligation_and_Energy_Storage_Obligation_Trajectory_till_2029_30.pdf.

30 https://www.pib.gov.in/PressReleasePage.aspx?PRID=1880517.

31 https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1932715.

5. While the overall wind capacity of India has reached 43.7 (Forty-Three point Seven) GW, this is limited to land-based wind projects. However, in the budget allocation for the FY 2024-25, the government has announced VGF which shall provide economic support to infrastructure projects, with a priority to the wind energy installation projects which shall hopefully provide incentive to bypass this limitation. [32]

Future Goals

As part of its ambitious target to install 500 (Five Hundred) GW of RE by 2030, India is setting its sights on developing 140 (One Hundred and Forty) GW of wind power capacity. This substantial wind capacity expansion has the potential to provide electricity to approximately 100 (One Hundred) million households. By pursuing this goal, India aims to significantly increase its RE capacity and make substantial progress towards a cleaner and more sustainable energy future.

IV. Biomass Power

Overview

Biomass power plays a significant role in India's RE sector. Biomass refers to organic materials derived from plants, agricultural residues, and animal waste, which can be used to generate electricity and heat. In this system biomass, bagasse, forestry, domestic organic wastes, industrial organic wastes, organic residue from biogas plants and agro-residue & agricultural wastes are used as fuel to produce electricity. [33]

Capacity

As of February 28, 2025, India's cumulative installed capacity for biomass power, including bagasse and non-bagasse cogeneration, reached 10,752.66 (Ten Thousand Seven Hundred Fifty Two point Six Six) MW. [34] This reflects a modest increase from 10,205.61 (Ten Thousand Two Hundred Five point Six One) MW in the FY 2022-23, indicating a continued, albeit slower, growth in the biomass sector. In terms of state-wise distribution, Maharashtra and Uttar Pradesh collectively account for nearly 45% (Forty Five percent) of the total installed biomass capacity. [35]

Within the biomass sector, the biomass bagasse (dry pulpy fibrous material that remains after crushing sugarcane or sorghum stalks which is used as biofuel to produce heat, energy and electricity) segment holds the 3rd (Third) position in terms of generating RE. As of October 31, 2024, India's installed biomass power capacity reached 10,728.21 (Ten Thousand Seven Hundred Twenty-Eight point Two One) MW. This includes 9,806.42 (Nine Thousand Eight Hundred Six

32 https://www.indiabudget.gov.in/.

33 https://energy.economictimes.indiatimes.com/news/power/ntpc-to-use-biomass-to-co-fire-coal-based-power-plants-cut-emissions/66302484.

34 https://mnre.gov.in/en/physical-progress/.

35 https://pib.gov.in/PressReleasePage.aspx?PRID=1911482.

point Four Two) MW from bagasse-based cogeneration and 921.79 (Nine Hundred Twenty One point Seven Nine) MW from non-bagasse cogeneration, maintaining a similar distribution to previous years.[36]

Government Initiatives

MNRE has realized the potential and role of biomass energy in the Indian context and hence has initiated a number of programmes or promotion of efficient technologies for its use in various sectors of the economy to ensure derivation of maximum benefits.

1. As part of a biofuels policy aimed at promoting the blending of ethanol in vehicle fuel, an agreement was signed between The Ministry of Petroleum and Natural Gas and various businesses or institutions. This agreement sets the stage for the establishment of 5,000 (Five Thousand) CBG Plant facilities by FY 2024, with a combined capacity of 15 (Fifteen) million metric tons of CBG production per year. The goal of this initiative is to encourage the use of renewable and eco-friendly fuel sources in the transportation sector.[37]

2. A particular focus was also laid down on the National Green Hydrogen Mission. The Union Budget for 2025-26 has allocated INR 6,000,000,000 (Indian Rupees Six Thousand Million only) to the National Green Hydrogen Mission, doubling the previous year's allocation of INR 3,000,000,000 (Indian Rupees Three Thousand Million only) as stated in the budget for FY 2024-25.[38] The government had announced a target to reach an annual production of 5 (Five) million metric tonnes of green hydrogen by 2030, in the budget for FY 2023-24. With this, India aims to achieve decarbonization and growth in sustainable energy sector, thus creating more green jobs.

3. Seperately, the government has proposed for central financial aid till FY 2029-30 to promote the usage of green hydrogen in the steel industry sector particularly.[39]

4. The 'GOBARdhan Scheme' to support the rural areas in the management of cattle, agricultural and organic waste was announced in the budget for FY 2023-24, with an allocation of INR 100,000,000,000 (Indian Rupees One Hundred Billion only).The program is set to include 500 (Five Hundred) 'waste to wealth' plants, with 200 (Two Hundred) CBG projects, which includes 75 (Seventy-Five) plants in urban areas and 300 (Three Hundred) cluster-based projects.

36 https://cdnbbsr.s3waas.gov.in/s3716e1b8c6cd17b771da77391355749f3/uploads/2025/01/2025010917753748 33.pdf.

37 https://www.researchandmarkets.com/reports/5734595/biomass-market-in-india?utm_source=CI&utm_medium=PressRelease&utm_code=ch3kr8&utm_campaign=1828369+-+India+Biomass+Market+Report+2023%3a+Biomass+Bagasse+Segment+Holds+92.44%25+Share+by+Capacity+Installed+FY+2022+-+Forecasts+to+2027&utm_exec=chdo54prd.

38 https://energy.economictimes.indiatimes.com/news/renewable/budget-2025-green-hydrogen-allocation-rises-100-per-cent-to-rs-600-cr/117828075.

39 https://energy.economictimes.indiatimes.com/news/renewable/govt-allocates-rs-455-crore-for-green-hydrogen-usage-in-steel-sector/107429314?utm_source=most_read&utm_medium=newsDetail.

5. As opposed to the allocation of INR 3,818,400,000 (Indian Rupees Three Billion Eight Hundred and Eighteen Million and Four Hundred Thousand only) to National Bioenergy Programme in the budget for FY 2023-24, the budget for FY 2024-25 has announced an increased allocation of INR 6,000,000,000 (Indian Rupees Six Billion only).
6. The budget for the FY 2024-25 has announced for financial assistance to be provided to help the collection centres for the procurement of biomass aggregation machinery.[40]
7. The government has announced a mandate on mandatory blending of CBG in the CNG which is used for vehicles as well as domestic purposes, thus increasing energy security, substituting the imports for CNG and promoting the usage of CBG in India. [41]
8. For promoting green growth, a new scheme of bio-manufacturing and bio-foundry will be launched. This will provide environment friendly alternatives such as biodegradable polymers, bioplastics, biopharmaceuticals and bio-agri-inputs. This scheme is also intended to help in transforming the current approach to manufacturing, which is based on consumption of resources, to an approach that follows regenerative principles instead.[42]

Future Goals

By the year 2030, the thermal power sector has the potential to significantly reduce pollution by substituting 50-100 (Fifty- Hundred) million tons of coal with biomass. This substitution could result in a remarkable decrease of 90-180 (Ninety- One hundred and eighty) million tons of pollutants in the sector.[43] This shift towards biomass as an alternative fuel source holds promise for mitigating the environmental impact of thermal power generation and promoting a cleaner and more sustainable energy future.

V. Geothermal Power

Overview

Thermal power generation involves the use of steam power, which is generated by burning fuels such as oil, liquid natural gas (**"LNG"**), coal, and other substances. Steam power drives generators to produce electricity. Thermal power plants utilize different types of fuels based on their reliability, cost-effectiveness, and environmental impact, ensuring a balance between these factors. The selection of fuels for thermal power generation takes into consideration the plant's ability to procure them consistently, economically, and in an environmentally responsible manner.

The Geographical Survey of India (**"GSI"**) has carried out exploration of geothermal energy in various recognized geothermal fields which includes collection of data on temperature,

40 https://www.indiabudget.gov.in/.

41 Ibid.

42 Ibid.

43 https://pib.gov.in/Pressreleaseshare.aspx?PRID=1808263.

discharge, and quality/chemistry of water in different geothermal fields.[44] The GSI has also studied 381 (Three Hundred Eighty-One) thermally anomalous areas across India has shortlisted about 350 (Three Hundred Fifty) high potential sites across India for geothermal energy projects. A potential of about 10,600 (Ten Thousand Six Hundred) MW of geothermal power has been estimated in the country [45]

Certain zones identified[46] for geothermal energy projects in India include the Himalayan region, Western Ghats or the Western Coastal region, Son-Narmada-Tapi basin, Godavari basin, North-Eastern region and Andaman and Nicobar Islands.

Capacity

As of February 2025, India's installed thermal power capacity reached 236.11 (Two Hundred Thirty-Six point One One) GW, reflecting a compound annual growth rate (CAGR) of approximately 1.45% (One point Four Five percent) from FY 2018-19 to FY 2022-23.[47] In the fiscal year ending March 2025, India added 4 (Four) GW of new coal-fired power generation capacity, consistent with the previous year's additions. Regarding geothermal energy, the Indian market was valued at USD 1,220,000,000 (United States Dollar One Thousand Two Hundred Two Billion only) in 2022 and is projected to reach USD 2,240,000,000 (United States Dollar Two Billion Two Hundred Forty Million only) by 2032, exhibiting a CAGR of 6.30% (Six point Three Zero percent) during the forecast period of 2023 to 2032.[48]

Government Initiatives and Projects

With a growth in the adoption of RE at large, the government has taken initiatives with respect to geothermal energy production, and other players are also showing interest in this space. Some projects/initiatives are as follows:

1. In February 2023, the Geothermal Core of Texas, USA signed a letter of intent with the Government to invest INR 8,200,000,000 (Indian Rupees Eight Billion Two Hundred Million only) in producing geothermal energy in Uttar Pradesh.[49]
2. Singareni Collieries Company Limited (**"SCCL"**) has commissioned a 20 (Twenty) kW pilot geothermal power plant in Manuguru area of Bhadradri Kothagudem district in Telangana.[50] This power plant has been funded by the Ministry of Coal and has been set on an experimental basis.

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44 https://pib.gov.in/PressReleaseIframePage.aspx?PRID=2039089.

45 Ibid.

46 https://www.fortuneindia.com/macro/india-to-tap-10-gigawatt-geothermal-energy-mnre-forms-task-force/118396; https://www.livemint.com/economy/govt-eyes-finalizing-geothermal-policy-plans-demonstration-projects-of-up-to-25-mw-11713783289513.html.

47 https://cea.nic.in/installed-capacity-report/.

48 https://www.powermag.com/india-adds-4-gw-of-new-coal-fired-capacity-for-second-straight-year.

49 https://timesofindia.indiatimes.com/blogs/the-write-wing/geothermal-energy-heats-up-in-india-with-rs-820-crore-investment-proposed-in-up/.

50 https://pib.gov.in/PressReleaseIframePage.aspx?PRID=2039089

3. SCCL has signed a MoU with ONGC and the Telangana Renewable Energy Development Corporation Ltd. for the exploration and development of the Manuguru Geothermal Field in Pranahita Godavari basin in Telangana.[51]
4. Geothermal Core has signed a letter of intent to invest INR 8,200,000,000 (Indian Rupees Eight Billion Two Hundred Million only) in a geothermal project in Uttar Pradesh.[52]

Future Goals

The government introduced a draft Geothermal Energy Development Policy in 2016 ("**Draft Policy 2016**"), which has not yet been finalised. The initial plan was to finalise the Draft Policy 2016 based on the success of few pilot projects in India. However, there has only been one project in motion in Ladakh (carried out by ONGC) had stalled due to the drilling process. The government has recalibrated its approach and may finalise a new policy even as demonstration/pilot projects are being set up. With respect the new policy, the following is being speculated:[53]

1. Barren Island in Andaman and Nicobar is being considered as a key site for the development of geothermal energy projects.
2. The support given to private entities may largely be non-fiscal.
3. The new policy is likely to be in line with the Draft Policy 2016, retaining provisions for (i) awarding of land for the development of the project, (ii) maintenance of production wells, and (iii) provision of soft loans.

However, noting that the budget announcements in the last 2 (Two) years do not give a specific allocation to geothermal energy, and that government's initiatives in the geothermal sector have been limited/delayed, it can be noted that the actual potential or capacity of the country to produce geothermal energy is still untapped.

VI. Tidal Power

Overview

Tidal power, also called tidal energy, is a form of hydropower that converts the energy obtained from tides into useful forms of power, mainly electricity. The potential of tidal wave energy becomes higher in certain regions by local effects such as shelving, funneling, reflection and resonance. India is surrounded by sea on three sides, hence its potential to harness tidal energy is significant. Energy can be extracted from tides in several ways. In one method, a reservoir

51 https://www.thehindu.com/news/national/telangana/sccl-inks-tripartite-mou-for-godavari-geothermal-energy-project/article68478826.ece#:~:text=The%20SCCL%20has%20already%20set,in%20Hyderabad%20on%20Friday%20evening.

52 https://www.hindustantimes.com/cities/lucknow-news/us-company-signs-loi-to-invest-rs-820-cr-to-produce-geothermal-power-in-up-101675191278883.html.

53 Ibid.

is created behind a barrage and then tidal waters pass through turbines in the barrage to generate electricity. This method requires mean tidal differences greater than 4 (Four) meters and also favourable topographical conditions to keep installation costs low.

A report from the Ocean Engineering Centre, Indian Institute of Technology, Madras estimates the annual wave energy potential along the Indian coast is between 5 (Five) MW to 15 (Fifteen) MW per meter, suggesting a theoretical maximum potential for electricity harvesting from India's 7500 (Seven Thousand Five Hundred) kilometer coastline may be about 40 (Forty) GW. However, the realistic economical potential, the report claims, is likely to be considerably less.[54]

Capacity

India possesses significant potential for tidal energy generation, due to its expansive 7,500 (Seven Thousand Five Hundred) km coastline, which is estimated to have the capacity to generate around 12,455 (Twelve Thousand Four Hundred and Fifty-Five) MW of power. However, the country is still in the early stages of tidal energy development, with only 0.5 (Zero point Five) MW of installed capacity. This slow progress can be attributed to several challenges that need to be overcome.[55]

One of the primary hurdles is the high cost associated with installing tidal energy infrastructure and the specialized technology required to harness tidal power effectively. These factors present financial and technical challenges that need to be addressed for the widespread adoption of tidal energy.

Furthermore, mitigating the potential impact on marine ecosystems is another crucial aspect that needs careful consideration. It is vital to ensure that tidal energy projects are designed and implemented in a manner that minimizes harm to marine ecosystems and marine life.

Government Initiatives

Even though India is surrounded by sea on three sides and its potential to harness tidal energy is significant, it seems to be underutilized and overlooked. It has been about 40 (Forty) years since India started efforts to assess and harness tidal power, but it is yet to achieve any solid breakthrough in its development even as the country made rapid strides in boosting other sources of renewable power. One of the reasons, according to the MNRE, for not pursuing tidal power is "exorbitant costs".[56]

54 http://www.eai.in/ref/ae/oce/oce.html.

55 https://www.centralchronicle.in/the-potential-and-challenges-of-tidal-energy-in-india/.

56 https://india.mongabay.com/2021/08/indias-tidal-power-potential-hampered-by-high-costs-and-environmental-risks/.

Future Goals

India has set ambitious targets for its installed capacity of RE. By 2030, the country aims to expand the capacity to 500 (Five hundred) GW. While tidal power is not specifically included in the 500 (Five hundred) GW target, the MNRE has stated that all sources of RE, including tidal energy, will be considered in the deployment targets for 2030. Therefore, there is hope that tidal energy will be taken into account in the future as India progresses towards achieving its long-term RE goals.[57]

VII. Nuclear Power

Overview

Nuclear power plays a significant role in India's energy mix, contributing to the country's electricity generation and energy security. The FY 2025-26 budget highlights the government's intent to leverage this source by shifting focus toward this sector and bringing it to the forefront—marking a departure from previous budgets, where traditional sectors like solar energy dominated the spotlight.

Capacity

As of January 30, 2025, India's nuclear power capacity has increased to 8,180 (Eight Thousand One Hundred Eighty) MW, up from 6,780 (Six Thousand Seven Hundred Eighty) MW in January 2022.[58] This growth includes the recent grid connection of Unit 7 at the Rajasthan Atomic Power Project, a 700 (Seven Hundred) MW pressurized heavy water reactor (PHWR), on March 17, 2025.[59]

The current fleet comprises 23 (Twenty-Three) operational reactors across seven power plants, totaling 8,180 (Eight Thousand One Hundred Eighty) MW. This includes 19 (Nineteen) PHWRs and 4 (Four) light water reactors (LWRs). The government has set an ambitious target to achieve 100 (One Hundred) GW of nuclear energy capacity by 2047, necessitating significant expansion in the coming decades.[60] To facilitate this growth, legislative changes are being proposed to attract private and foreign investments into the nuclear sector. State-run companies like NTPC Ltd are planning substantial investments, with NTPC aiming to build 30 (Thirty) GW of nuclear capacity over the next two decades, involving an estimated expenditure of USD 62,000,000,000 (United States Dollar Sixty Two Billion only).[61]

57 https://india.mongabay.com/2021/08/indias-tidal-power-potential-hampered-by-high-costs-and-environmental-risks/#:~:text=India%20has%20a%20target%20of,the%20deployment%20targets%20for%202030.%E2%80%9D.

58 https://pib.gov.in/PressReleasePage.aspx?PRID=2099244.

59 https://www.world-nuclear-news.org/articles/india-welcomes-newest-rajasthan-unit-to-the-grid.

60 https://pib.gov.in/PressReleasePage.aspx?PRID=2099244.

61 https://www.reuters.com/world/india/indias-ntpc-plans-spend-62-billion-30-gw-nuclear-power-sources-say-2025-02-17.

Notably, in January 2021, the Kakrapar Atomic Power Project (KAPP-3) reactor was successfully connected to the grid. KAPP-3 is a significant milestone for India, as it represents the country's first 700 (Seven Hundred) MW unit and the largest indigenously developed variant of the PHWR.

The presence of these reactors and the successful connection of KAPP-3 demonstrate India's commitment to advancing its nuclear power capabilities, enhancing energy security, and reducing reliance on conventional energy sources. The combination of PHWRs and LWRs in the nuclear power fleet allows for diversity in technology and fuels, enabling India to leverage its domestic resources while adhering to stringent safety and regulatory standards.[62]

Government Initiatives

The Government plans on augmenting production of clean energy by setting up nuclear power plants and several other initiatives as have been mentioned below, which will enable further boost in the country's overall capacity dependent on nuclear power generation and usage:

1. The government launched a Nuclear Energy Mission with an allocation of INR 200,000,000,000 (Indian Rupees Two Hundred Billion). While the budget for FY 2024-25 mainly funded research in nuclear energy, the budget for FY 2025-26 is pushing for real-world deployment, especially through SMRs.

2. In the FY 2024-25, several public sector companies operating under the Department of Atomic Energy received funding allocations. Indian Rare Earths Ltd has been allocated INR 1,203,000,000 (Indian Rupees One Billion Two Hundred and Three Million only), Uranium Corporation of India Ltd. has been allocated INR 598,200,000 (Indian Rupees Five Hundred Ninety-Eight Million Two Hundred Thousand only), and Electronics Corporation of India Ltd has been allocated INR 150,000,000 (Indian Rupees One Hundred and Fifty Million only). These funds will support the operations and initiatives of these companies during the specified fiscal year.[63]

3. Furthermore, the Fuel Recycle Projects under the Nuclear Regulatory Board have been allocated INR 8,052,100,000 (Indian Rupees Eight Billion Fifty-Two Million One Hundred Thousand only), an increase from the revised estimates of INR 7,035,000,000 (Indian Rupees Seven Billion and Thirty-Five Million only) in FY 2022-23. This funding is specifically aimed at the construction of the Integrated Nuclear Recycle Project, which is designed to improve the supply of fuel to the second stage of the nuclear power program. The increased allocation underscores the importance of advancing nuclear fuel recycling efforts to enhance the sustainability and efficiency of India's nuclear power generation.[64]

4. The Government has approved installation of 10 (Ten) new nuclear reactors in four states i.e., Karnataka, Haryana, Madhya Pradesh and Rajasthan.[65]

62 https://www.statista.com/statistics/1352855/nuclear-power-capacity-india/

63 Ibid.

64 Supra note 33.

65 https://www.indiatoday.in/science/story/india-approves-installation-of-10-new-nuclear-reactors-in-five-states-2356115-2023-04-05.

Future Goals

Having thorium reserves that might be termed as one of the largest, it can be deduced that India has great potential when it comes to nuclear energy. It is estimated that the total installed capacity will grow by 3.30 (Three Point Three Zero) GW. There are plans to build up to 5 (Five) energy parks having a capacity of about 10,000 (Ten Thousand) MW by NPCIL,[66] and the government aims to develop and deploy 5 (Five) operational SMRs by 2033, contributing an additional 1-2 (One-Two) GW of clean energy to the grid.

India's current fuel situation, marked by a shortage of fossil fuels, is leading to increased investment in nuclear power for electricity generation. As a response to this fuel scarcity, India aims to achieve a 25% (Twenty-Five percent) contribution from nuclear power by 2050. This ambitious goal aligns with the country's projected requirement of 1,094 (One Thousand and Ninety-Four) GW of base-load capacity by 2050. By expanding nuclear power capacity, India aims to meet its growing electricity demands while reducing its dependence on fossil fuels.[67]

India currently has an installed nuclear power capacity of 8,180 (Eight Thousand One Hundred Eighty) MW.[68] Looking ahead, the country has ambitious plans to expand its nuclear power generation capabilities, with a target of 100 (One Hundred) GW nuclear power capacity by 2047.

To facilitate private sector participation in nuclear projects, the Government also plans to amend the Atomic Energy Act and the Civil Liability for Nuclear Damage Act. These amendments are expected to encourage private sector investments in nuclear power projects.8 However, given that foreign investment is not permitted in the sector, the avenues for expansion may be limited.

66 https://www.orfonline.org/research/the-future-of-nuclear-energy-in-india/.

67 https://www.world-nuclear.org/information-library/country-profiles/countries-g-n/india.aspx.

68 https://pib.gov.in/PressReleasePage.aspx?PRID=2099244.

Other RE Initiatives

1. The government in the budget for the FY 2025-26, the Government of India has announced significant allocations to promote research and development in emerging sectors. An INR 200,000,000,000 (Indian Rupees Two Hundred Billion only) Deep Tech Fund has been introduced to foster private sector-driven innovation, while the Atal Innovation Mission (AIM) received an INR 4,000,000,000 (Indian Rupees Four Billion only) allocation to expand Atal Tinkering Labs in schools. Additionally, the Prime Minister's Research Fellowship will offer 10,000 fellowships to support advanced research at premier institutions. To enhance agricultural biodiversity, the government will establish a second Gene Bank with 1,000,000 (One Million) germplasm lines.[1]

2. The government announced its vision for 'LiFE' i.e., 'Lifestyle for Environment' with intention to lower India's estimated overall carbon emissions by approximately 1 (One) billion tonnes to reduce the carbon intensity in the economy by less than 45% (Forty-Five percent) by 2030 and to attain net zero carbon emissions, 'Panchamrit', by the year 2070. The proposals and initiatives under the Budget are focused on 'green growth' and 'green industrial and economic transition' of the Indian economy.[2]

3. The budget for FY 2023-24 has been hailed as a leap forward for green mobility, given its emphasis on boosting electric vehicles. To initiate the same, a change in the basic custom duty levied on electrically operated vehicles in completely built unit (CBU) form, other than the cost, insurance and freight value of more than INR 302,000,000 (Indian Rupees Three Hundred and Two Million only) has been increased from 60% (Sixty percent) to 70% (Seventy percent). Additionally, to facilitate the adoption of green mobility, an exemption of customs duty on import of several capital goods and machinery required for manufacturing of lithium-ion cells for batteries primarily used in electric vehicles has been introduced. It has also announced an exemption of CNG from excise duty to the extent of such excise amount being equal to the GST levied on biogas/CBG in blended CNG.[3]

4. Energy transition has been a long-standing goal for the Indian economy. In line with the same, the 'Green Energy Transition' of the economy was identified as a pillar among the seven primary pillars for the budget for FY 2023-24 and in line with this, the Budget proposed 'priority capital investment' of INR 3,50,000,000,000 (Indian Rupees Three Billion Fifty Million only) for Green Energy Transition, security of energy and net zero initiatives. While it is appreciated that huge sums of monies are dedicated to energy transition, the Budget fails to mention the specific areas of allocation.[4]

5. A Production Linked Incentive scheme for solar PV manufacturers has been implemented, with an allocation of INR 240,000,000 (Indian Rupees Two Hundred Forty Million only) which will help boost domestic manufacturing capabilities in the RE sector.[5]

1 https://www.india.gov.in/spotlight/union-budget-2025-2026.

2 https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1847812.

3 https://www.hindustantimes.com/car-bike/budget-2023-imported-cars-including-evs-become-costlier-101675243551732.html.

4 https://economictimes.indiatimes.com/industry/renewables/budget-2023-will-promote-green-growth-says-renewable-industry/articleshow/97534169.cms?from=mdr.

5 https://pib.gov.in/PressReleseDetailm.aspx?PRID=1909958.

6. Additionally, the budget for FY 2023-24 has provided much needed support to the battery storage sector by providing VGF for battery-energy storage systems with a capacity of 4,000 (Four thousand) MWh. VGF will provide capital support storage projects which otherwise would not have been financially viable. Similar to the solar sector, which thrived after VGF support, this could mark an advent of the battery storage era of the green energy sector for both.[6]

7. Construction of an ISTS from Ladakh for the evacuation of power and grid integration of 13 (Thirteen) GW of RE. An investment of INR 207,000,000 (Indian Rupees Two Hundred and Seven Billion only) has been announced for the construction, along with support from the central government of INR 83,000,000,000 (Indian Rupees Eighty-Three Billion only).[7]

8. Revamping of the credit-guarantee program for MSMEs with effect from credit of INR 2,000,000,000,000 (Indian Rupees Two billion only). This may lead to a boost in the production of April 1, 2023, with an infusion of INR 900,000,000,000 (Indian Rupees Nine Hundred Million only), enabling additional collateral free guaranteed products/goods related to the power sector by the benefitting MSMEs, leading to an independence of manufacturing energy products in the country.[8]

9. In addition to the NTPC's successful solar project in Hazira, Surat, other major players are also making significant investments in the sector. Reliance Industries has inked a pact with the Gujarat Government to establish 100 (One hundred) GW of RE power plants, including solar power plants. This ambitious venture, coupled with their investments in manufacturing facilities for solar PV modules, electrolyzers, batteries, and fuel cells, demonstrates RIL's commitment to driving the RE revolution in India.[9]

10. ISTS charges for the inter-state sale of solar and wind power will be waived for projects that will be commissioned by June 30, 2025.[10]

11. A trajectory for RPO has been declared, extending up to the year 2029-30.[11]

12. Ultra Mega RE Parks will be established to provide land and transmission facilities to RE developers on a plug and play basis.[12]

13. Various schemes, such as the Pradhan Mantri Kisan Urja Suraksha Evam Utthaan Mahabhiyan (PM-KUSUM), Solar Rooftop Phase II, 12,000 (Twelve Thousand) MW CPSU Scheme Phase II, etc. have been implemented.[13]

14. New transmission lines will be laid, and new sub-station capacity will be created under the Green Energy Corridor Scheme to facilitate the evacuation of renewable power.[14]

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6 https://pib.gov.in/PressReleseDetailm.aspx?PRID=1907698.

7 https://pib.gov.in/PressReleseDetailm.aspx?PRID=1909590.

8 https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1912500.

9 https://economictimes.indiatimes.com/industry/renewables/reliance-to-invest-80-billion-in-green-energy-projects-in-gujarat/articleshow/88877199.cms?from=mdr.

10 https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1928128.

11 https://powermin.gov.in/sites/default/files/Renewable_Purchase_Obligation_and_Energy_Storage_Obligation_Trajectory_till_2029_30.pdf.

12 https://pib.gov.in/PressReleasePage.aspx?PRID=1885147.

13 https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1944696.

14 Ibid.

15. A Project Development Cell will be set up to attract and facilitate investments in the RE sector.[15]

16. Standard Bidding Guidelines have been established for tariff-based competitive bidding processes for the procurement of power from grid-connected solar PV and wind projects to promote competitive procurement of electricity from solar PV power plants, by distribution licensees.[16]

17. The government has issued orders mandating that power shall be dispatched against letters of credit ("**LoCs**") or advance payment to ensure timely payment by distribution licensees to RE generators.[17] However, it is usually seen that even though the PPAs account for these LoCs, in practice they are rarely enforced because of the weak payment settlement mechanism contained in these agreements and in the regulatory framework.

18. Basic customs duty will be imposed on cells and modules to encourage domestic manufacturing. The National Bioenergy Energy Program has been notified, with an allocation of INR 8,580,000,000 (Indian Rupees Eight Billion Five Hundred and Eighty Million only) under Phase I, to promote waste-to-energy, biomass, and biogas programs.[18]

19. Sovereign Wealth Funds ("**SWFs**") and Pension Funds ("**PFs**"), established by foreign governments, have emerged as crucial financiers of infrastructure and RE projects. Acknowledging their significant role, the Indian government introduced tax incentives in the FY 2020-21 Budget to encourage their sustained capital inflow. This initiative, outlined in Section 10(23FE) of the Income Tax Act, 1961, grants tax exemptions on various income streams earned by PFs and SWFs, encompassing interest, dividends, and capital gains. By incentivizing these investments, the government aims to bolster infrastructure financing, ensuring a consistent influx of long-term capital into key development projects. This strategy aligns with broader efforts to attract foreign investment and stimulate economic growth in India. The tax incentives have been extended in the budget for FY 2024-25, with a sunset clause of March 31, 2025.[19]

20. The Green Open Access Rules have been promulgated to enable the commercial and industrial sector to generate or procure energy for their own consumption.[20]

15 Supra note 57.

16 https://mnre.gov.in/Solar/policy-and-guidelines.

17 https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1843538.

18 https://www.business-standard.com/article/economy-policy/solar-projects-awarded-before-customs-duty-change-allowed-cost-pass-through-122092800505_1.html.

19 https://economictimes.indiatimes.com/news/economy/policy/budget-2024-continuity-of-swfs/-pf-tax-benefits-by-extending-sunset-clause-to-31-march-2025-augurs-well-for-infrastructure-sector/articleshow/107401364.cms?from=mdr.

20 https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1842737.

International Treaties and Agreements

In addition to the various government initiatives and policies, the country has also entered into several arrangements with governments of other countries to promote international relations, RE related import-export as well as to ensure India's position in the sector being recognized based on the assistance received from other countries under these agreements. A list of the recent/landmark key agreements has been mentioned below:

1. **Kyoto Protocol**[1]

   The Kyoto Protocol, adopted in Kyoto, Japan in December 1997, was an international treaty which extended the 1992 United Nations Framework Convention on Climate Change that commits state parties to reduce greenhouse gas emissions. India ratified the same in 2002 and the Protocol came into force in 2005.

2. **Agenda 21**[2]

   The United Nations Conference on Environment & Development, held in Rio-de-Janerio, in June 1992 was implemented as a comprehensive plan of action to be taken globally, nationally and locally by the UN organisations and the countries together. The objective was to encourage environmentally sound and sustainable use of renewable natural resources.

3. **Paris Agreement**[3]

   The Paris Agreement is a legally binding international treaty on climate change, adopted by196 (One Hundred Ninety-Six) parties at COP21 in Paris, on December 12, 2015, and entered into force on November 04, 2016. Its goal is to limit global warming to below 2 (Two) degrees Celsius,however, the working goal is set at preferably 1.5 (One point five) degrees Celsius, compared to pre-industrial levels.

   The Paris Agreement (Article 4, paragraph 2) requires each signatory party to prepare, communicate and maintain successive NDCs, every 5 (Five) years, that it intends to achieve towards their post-2020 climate actions. India has achieved its NDC target with total non-fossil based installed energy capacity of 157.32 (One Hundred and Fifty-Seven point three two) GW which is 40.1% (Forty-point One percent) of the total installed electricity capacity.

1 https://unfccc.int/resource/docs/convkp/kpeng.pdf.
2 https://sustainabledevelopment.un.org/outcomedocuments/agenda21.
3 https://unfccc.int/process-and-meetings/the-paris-agreement.

4. COP-28[4]

The United Arab Emirates (UAE) was selected as the host country for the 28th (Twenty-Eighth) Conference of the Parties to the United Nations Framework Convention on Climate Change (COP 28). This significant event took place in November 2023 at Expo City Dubai. The primary objective of COP28 was to bring together nations from around the world to reach a consensus on bold, practical, and ambitious solutions to address the most urgent global challenge of our era - climate change.

COP28 holds particular importance as it signifies the culmination of the first Global Stock take, a comprehensive evaluation of the progress made in achieving the objectives outlined in the Paris Agreement. Recognizing that the world is not currently on track to meet these goals, the designated President of COP28, has expressed his commitment to keeping the 1.5 (One point Five) degrees Celsius target alive. He aims to ensure that the international community responds to the stock take with a clear and actionable plan, including the implementation of measures necessary to bridge the existing gaps in progress.

5. Memorandum of Understanding (MOUs) with Other Countries[5]

India has entered into several MOUs with other countries in order to safeguard the environment and establishing RE as the dominant form of energy used. Some of the MOUs recognized by the MNRE have been listed below:

Sr. No.	Particulars	Date of MOU
1.	Memorandum of Understanding (MoU) between India and France to establish a partnership on advanced and small modular nuclear reactors	February 12, 2025
2.	Memorandum of Understanding (MoU) between India and the United States to strengthen cooperation on supply chains for critical minerals essential for electric vehicles and clean energy, such as lithium and cobalt.	October 03, 2024
3.	Memorandum of Understanding (MoU) between the MNRE of the Government of the Republic of India and the Ministry of Energy and Water Resources of the Government of the Republic of Tajikistan	October 08, 2023
4.	Memorandum of Understanding (MoU) between The Government of Republic of India and The Government of the Kingdom of Saudi Arabia on Cooperation in the Field of Energy	September 10, 2023

4 https://unfccc.int/cop28.

5 https://mnre.gov.in/en/international-relations-memorandums-documents/.

Sr. No.	Particulars	Date of MOU
5.	MNRE of the Republic of India and the Ministry of Electricity and Water Authority of the Kingdom of Bahrain	July 07, 2023
6.	MNRE and the Ministry of Energy and Mining of the Republic of Peru	May 05, 2023
7.	Joint Declaration of Intent between the MNRE and the Federal Ministry for Economic Cooperation and Development of the Federal Republic of Germany on Indo-German Development Cooperation regarding Renewable Energy Partnership	May 02, 2022
8.	Joint Declaration of Intent between the MNRE and the Ministry for Economic Affairs and Climate Action (BMWK) of the Federal Republic of Germany on Indo-German Green Hydrogen Task force	May 02, 2022
9.	Letter of Intent between MNRE and Ministry of Industry, Energy and Emissions Reduction Govt. of Australia on New and Renewable Energy Technology	February 15, 2022
10.	Memorandum of Agreement between National Institute of Solar Energy and Commissariat al'Energie Atomique et aux Energies Alternatives on solar energy	August 22, 2019
11.	Strategic Partnership Agreement between the MNRE, Government of India and IRENA on green energy transitions based on RE	January 14, 2022
12.	MoA between the National Institute of Wind Energy (NIWE) under the MNRE and the University of Massachusetts, (UMA), Amherst, Massachusetts, USA for academic and research collaboration	September 22, 2021
13.	MoU between MNRE and the Ministry of Economic Affairs and Employment of the Republic of Finland on co-operation in the field of RE	April 29, 2022
14.	MoU between MNRE-ISA- World Bank on the implementation of 'One Sun One World One Grid' Initiative	September 08, 2020
15.	MoU between India- Uzbekistan (NISE, MNRE and ISEI) on projects in solar energy	December 10, 2020
16.	MoU between MNRE and Ministry of Energy of the Kingdom of Saudi Arabia on Cooperation in the field of RE	October 29, 2019
17.	MoU between MNRE and Guinea on cooperation in the field of RE	August 02, 2019
18.	MoU between MNRE and the Ministry for the Ecological Transition of the French Republic on RE co-operation	January 28, 2021
19.	MoU between the MNRE and Denmark Technical University on collaboration in the field of wind energy and wind- solar hybrid system	December 17, 2018
20.	MoU between the MNRE and the Ministry of Energy and Water Resources of the Government of Republic of Tajikistan on cooperation in the field of RE	October 08, 2018
21.	MoU between the MNRE and the Ministry of Electricity and Water Authority of the Kingdom of Bahrain on cooperation with the aim of developing new and renewable energy technologies	July 15, 2018

Sr. No.	Particulars	Date of MOU
22.	MoU between MNRE and the Ministry of Energy and Mining of the Republic of Peru on cooperation in new and renewable energy	May 11, 2018
23.	MoU between MNRE and Ministry of Energy, Mines and Sustainable Development of the Kingdom of Morocco to promote bilateral technical cooperation on new and renewable energy, especially in the field of Capacity Building, Solar Energy, Biomass/Bioenergy and Small Hydro Energy	April 10, 2018
24.	MoU between MNRE and USA to establish a fund to support the Promoting Energy Access Through Clean Energy track of the US India partnership to advance clean energy	June 30, 2015
25.	MoU between MNRE and the Government of Uruguay on cooperation in new and renewable energy	February 25, 2011
26.	MoU between Government of India and Government of United Kingdom of Great Britain and Northern Ireland to establish a framework for strategic cooperation covering technical, policy, research and commercial aspects of development of energy sector	November 11, 2015

Existing Challenges

Over the years, with the growth of the RE sector, there have been several challenges that have cropped up. A few that have remained relevant through the evolution of this sector are as follows:

1. **Infrastructure and Grid Integration:** One of the main challenges is the integration of RE sources into the existing power grid. India has one national grid for the entire supply of electricity. There is inclusion of renewable sources of energy while producing such electricity, however, due to the unpredictable nature of the availability of a renewable source such as wind or solar energy, it becomes difficult to schedule the same in a consistent manner. Due to this infirm nature, there is inconsistency which leads to fluctuations at a large scale causing national grid overload. As the share of renewables increases, ensuring a stable and reliable grid connection has become crucial. India needs to invest in grid infrastructure and storage technology to handle the variability and intermittency of renewable sources like solar and wind.

2. **Financing and Investment:** The RE sector is capital intensive and requires substantial investments for technology development, project implementation, and expansion. Attracting both domestic and foreign investment is essential to accelerate the growth of RE projects across the country.

3. **Policy and Regulatory Framework:** A stable and supportive policy and regulatory environment is crucial for the success of the RE sector. However, due to electricity being a subject of the concurrent list, the policies formulated at the state level are not aligned with those imposed by the center. For example, the micro level policies governing the fuel cost pass-through, mega power policy, competitive bidding guidelines are not in consonance with the macro framework like the EA, 2003 and the National Electricity Policy. These uncertainties or changes in government policies affect investor confidence and project viability.

4. **Land Acquisition and Permitting:** Setting up RE projects often requires large tracts of land, which leads to challenges in land acquisition and permitting processes, especially in a bureaucratic set up like that of India. Streamlining these procedures is necessary to avoid delays and project cancellations.

5. **Storage and Grid Balancing:** As India aims to increase the share of RE in its overall energy mix, the need for energy storage technologies is becoming more pronounced due to the intermittent generational capacity of RE. Efficient storage solutions, which India lacks, are essential to store excess energy during peak generation periods and release it during low generation periods.

6. **Reliance on Imports:** India has been one of the few largest importers of various forms of generating equipments and technology for the improvement of its RE sector. However, this has posed a challenge in the growth to the extent that it has led to increased dependency and in some cases, debt surmounting on the country.[1]

1 https://www.trade.gov/country-commercial-guides/india-renewable-energy.

7. **Skills and Manpower:** Developing a skilled workforce to design, install, operate, and maintain RE systems is a challenge. Training programs and educational initiatives are necessary to create a pool of skilled workers in the sector.
8. **Public Awareness and Perception:** Public awareness about the benefits of RE and its role in combating climate change is crucial. Educating the public and promoting RE adoption could help in garnering more support for the sector. This hurdle in the sector is based on a majority of the country's population being uneducated, which becomes a big impediment in their understanding of how to use sources of RE efficiently.
9. **Political Goals:** Although we have seen several initiatives been taken at the central level by the Government to promote RE, it is often noticed that the policies and working of the state governments are not particularly aligned with the same. Short term progress is given a lot of importance due to politics and providing incentive to the population in order to achieve re-election. Therefore, short term capital gains are prioritized by the state and the long-term benefits of promoting and building the infrastructure for RE is put on the back burner.
10. **Competing with Fossil Fuels:** While RE is gaining traction, fossil fuels still dominate the energy landscape in India. Competition with conventional energy sources, which often benefit from subsidies and established infrastructure and hence may be relatively cheaper and more efficient, is a challenge.
11. **Environmental Concerns:** Although RE sources have lower environmental impacts compared to fossil fuels, they are not entirely without their environmental consequences. Issues such as the impact on biodiversity, habitat loss, and water usage need to be considered and addressed.
12. **Abandonment of Projects:** A major challenge faced by the RE sector at large is the initiation of a project by the players and then abandoning the same, due to varied reasons such as unviability due to costs, volatility of resources etc. This leads to several projects being abandoned, which in turn becomes a hurdle for investors to have investing faith in the sector.

Challenges Faced by GENCOs:

In addition to the above-mentioned challenges faced in the RE sector, we note that GENCOs play an important role in the supply chain of such energy. The below-mentioned challenges are specific to GENCOs:

1. **Outstanding dues:** There are non-payment and delay in payment of dues by DISCOMs, i.e., the main off-takers of power to GENCOs, and the payments are either delayed on average for a period of up to 8 (Eight) to 10 (Ten) months or no payments are made at all, thereby creating severe cash-flow issues for the RE GENCOs. The total outstanding dues of DISCOMs to GENCOs is INR 91,610,000,000 (Indian Rupees Ninety-One Billion Six Hundred Ten Million only) as of March 2023.[2]

2 https://economictimes.indiatimes.com/industry/energy/power/discoms-outstanding-dues-to-gencos-decline-to-rs-91061-cr-minister-rk-singh/articleshow/99301580.cms?from=mdr.

2. **Non-performing assets (NPAs):** As a matter of practice, the power projects are funded in a 70:30 (Seventy: Thirty) debt-equity ratio. Due to the cash crunch, the RE GENCOs are not able to meet their debt service obligations, which leads to lower credit ratings and charging higher rates of interest including penal interest on the GENCOs. Further, such inability to repay their debts often lead the RE GENCOs to be declared as NPAs.

3. **Open Access for DISCOMs:** Due to the availability and access of open exchanges, there are instances where DISCOMs violate their PPAs and avail of electricity generation through open exchanges and trading mechanisms as these may be a cheaper option than the price fixed under their PPAs. Due to such a transfer of power, the PPAs are frequently violated and there is no penalization mechanism prevalent on the defaulting DISCOMs. State utilities can be barred from trading on electricity exchanges under the payment security mechanism.

4. **Curtailment of power:** Despite there being a law to prioritise scheduling/buying of RE power over other sources, there has been unreasonable curtailment or non-scheduling of power from RE plants which leads to an inconsistent supply of electricity. It is because there is reluctance to buy RE power since thermal power is much cheaper than RE sources, and if the power is not scheduled, then the DISCOMs/off-takes will not be required to make payment for the same, thereby causing financial distress to the GENCOs.

Challenges Faced by DISCOMs:

There are several challenges faced by DISCOMs, who are argued to be the most vulnerable in India's power sector due to accumulated losses and various other reasons. The below mentioned challenges form a major reason for such a condition:

1. **Unbundling rendered inefficient:** Prior to unbundling, SEBs incurred huge losses due to poor management. However, since the majority of DISCOMs are still under state control, either directly through the SEBs or their unbundled successors, they carry the legacy issues and are financially distressed. Further, sometimes unbundling is a concept that is not undertaken in practice, which further adds to the inefficiencies of the sector.

2. **Financial distress:** Most of the DISCOMs are financially strained due to the gap between the cost of supply of power, low tariff structure, delay in tariff revisions, technical & commercial losses, and poor revenue collection.

3. **Subsidies for agricultural consumers:** The subsidized power provided to the agricultural consumers is neither recovered from collection nor from the state funds thereby aggravating cash-flow concerns for DISCOMs. Time and again a direct transfer benefit scheme has been proposed, but the same has not been implemented yet.

4. **High power procurement cost/RPOs:** Power purchase costs account for 60-70% (Sixty to Seventy percent) of the total cost for the utilities. Whereas RE power is already more expensive than thermal or hydro sources, DISCOMs have oversubscribed to many long-term RE and thermal PPAs based on incorrect estimates of power demand. This has led to a high cost of power, insufficient investment in infrastructure, and payment delays to generators. The Forum of Regulators has calculated in a study of 12 (Twelve) states that they are paying approx. INR 174,420,000 (Indian Rupees One Hundred Seventy-Four Million Four Hundred Twenty Thousand only) annually as the fixed cost alone for surplus energy.

5. **Delay in tariff revisions:** Most of the State distribution utilities have failed to file annual tariff revision petitions in time. Therefore, in a number of States, tariff revision has not taken place for years and State Commissions constituted all over India have also failed to make periodical tariff revisions suo-moto, resulting in the poor financial health of the State distribution utilities. This contributes to the difference between revenue realized by the DISCOMs and their costs. Even when tariff is revised, the increase is not commensurate with the legitimate costs.

It is important to note that while there are challenges, India's RE sector is poised for growth and presents numerous opportunities as well. Experts and policymakers are actively working towards addressing these challenges and realizing the country's RE goals.[3]

3 https://m.economictimes.com/industry/renewables/experts-to-discuss-opportunities-challenges-and-implementation-of-clean-energy-projects-at-reconindia-2023/articleshow/97697986.cms.

Capital Trends in the RE Sector

The transition to green energy is well underway and is the new global phenomenon. Activists are increasing the social pressure and have even taken to disrupting annual general meetings of European banks and energy firms, as part of a call to end extraction of fossil fuels for generating energy.[1] Slowly but surely, the supply chain of these fossil fuels is coming under pressure. Take the example of coal. Over 200 (Two hundred) of the largest global financial institutions, including 87 (Eighty-Seven) banks, have declared policies that limit investments in coal mining or coal-fired power generation.[2] Financial institutions accounting for 40% (Forty percent) of the world's banking assets have joined the Net Zero Banking Alliance, committing to align their portfolios with net-zero emissions by 2050.[3] During the COP26 summit, the United Nations forecasted that this initiative could relegate coal to the past.[4] At this turning point (which doubles as a significant economic opportunity), India is well-positioned to showcase its commitment to achieving net-zero carbon emissions, providing cost-effective clean energy sources and to emerge as a global leader in renewable batteries and green hydrogen. According to the 2020 Climate Transparency Report, India is the only G20 nation on track to meet its climate targets per the Paris Agreement.[5] As of June 2024, according to the 63rd (Sixty Third) edition of the Renewable Energy Country Attractiveness Index (RECAI) published by Ernst & Young (EY), India has maintained its position as the 3rd most attractive country for renewable energy investments.[6] Developed countries are taking note of India's potential in the RE sector as well as of its progress, making it an ideal investment destination at a time where a major shift is underway in global energy markets.

As of the third quarter of FY 2023, India's renewable energy sector attracted approximately INR 20,500,000,000 (Indian Rupees Twenty Billion Five Hundred Million only) in FDI, with major contributions from Singapore, Mauritius, the Netherlands, and Japan. In September 2024, TotalEnergies announced a USD 444,000,000 (United States Dollar Four Hundred Forty-Four Million only) joint venture with Adani Green Energy Ltd, further boosting investments in the sector. Despite this, a report by Ember indicated that while over USD 13,000,000,000 (United States Dollar Thirteen Billion only) was invested in 2024, an annual investment of USD 68,000,000,000 ((United States Dollar Sixty Eight Billion only) is required to meet the goal of 500 (Five Hundred) GW of renewable energy capacity by 2030.[7]

1 https://www.economist.com/finance-and-economics/2023/06/04/who-is-keeping-coal-alive.

2 https://ieefa.org/resources/200-and-counting-global-financial-institutions-are-exiting-coal.

3 https://www.unepfi.org/net-zero-banking/.

4 https://www.un.org/en/climatechange/cop26.

5 https://www.dw.com/en/india-only-g20-nation-doing-its-fair-share-to-meet-2-degree-goal-report/a-55657420

6 https://www.ey.com/content/dam/ey-unified-site/ey-com/en-gl/insights/energy-resources/documents/ey-gl-recai-63-top-40-ranking-06-2024.pdf.

7 https://www.ft.com/content/dabfeb72-f3ed-4207-b498-1c1d5c103ef2.

To meet this, India has the option to further tap into foreign funds as environmental performance is becoming a key metric in their measure of performance. India can also tap into funds which aim to invest to combat climate change and contribute to India's climate action goals.[8] Further, there are international public finance institutions which have mandates to provide assistance and funds to finance clean energy transitions in the developing world.[9] This confluence of factors will ensure this sector grows even during "funding winters". However, sustained investment, especially the amounts required to meet India's ambitious targets, depends on a predictable regulatory framework, simplified land acquisition, and financial incentives that de-risk long-term capital commitments.

8 https://eversourcecapital.com/wp-content/uploads/2023/06/EverSource-SR_2022_2-page-view_compressed-1.pdf.

9 https://www.irena.org/Energy-Transition/Partnerships/ETAF.

Conclusion

As seen by the evaluation of capital trends above, capital is available both within India and overseas to facilitate the transition to green energy. With an inflow of capital investment India can hopefully invest in grid infrastructure, technology development (especially for energy storage technologies), project implementation, and upskilling the workforce. Further, some of this funding could be used to overhaul the loss-making distribution utilities and infrastructure.

India may not be able to achieve a high-growth, low-carbon economy unless the distribution sector achieves profitability. Addressing this issue will involve the implementation of smart meters[1] and smart grids, but the most crucial solutions may be found in institutional intelligence. The Electricity (Amendment) Bill 2022 aims to achieve this by promoting private involvement in distribution and encouraging efficiency and competition in the flagging sector. Competition is further promoted through encouraging open access, power trading and captive power generation. The Amendment Bill further aims to limit the negative externalities in the economy caused by the bleeding distribution utilities by strengthening the payment system mechanism. The increase of backing by intermediary procurers such as SECI and NHPC also acts like a buffer and increases confidence in projects. Hence, we can see that proposals are in the works to overhaul the regulatory framework in such a way that the use of RE will be boosted.

At a time where the issue of climate change and global warming has become so urgent, social factors are aligning to facilitate this transition. Mounting public awareness and thus pressure is being put on governments worldwide to mitigate the risks. Awareness within India is also spreading, especially since India gained presidency of the G20.

However, it may be argued that there should be more incentivizing legislature to facilitate the transition to green energy. Further, there is a discrepancy where India is not leveraging our natural advantage in geographic features and mineral resources, such as harnessing tidal energy, which has not been explored so far when compared to other forms, or utilizing our thorium reserves. There is also a lack of focus on promoting technology which diversify the infirmity risk of renewable resources. This approach may also limit the negative environmental impact which comes from exploiting RE, for example, using different resources such as tidal may curtail the overexploitation of land used to build the turbines to generate wind energy. Policies and politics should also be aligned at the central and state level and there should be co-ordination and dovetailing between all the government departments in order to ensure a smooth transition.

1 https://www.nishithdesai.com/fileadmin/user_upload/pdfs/Research_Papers/Smart_Meters.pdf.

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