

Energy Policies and Investments Around Solar and Wind Energy in India: A Review

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Abstract

India is a fast-moving economy and in this race of making our country a world power India is moving aggressively towards attaining its commitment to renewable energy goals. Our country India set an ambitious target of achieving 175 GW of renewable energy volume by 2022 and aim to achieve 500 GW by 2030. Bharat has in mind to move toward the Two Degree Celsius climate change objective under Nationally Determined Contributions in 2015 which has put one's mark on 15% of renewable amalgamation in the foremost energy mix by 2020. Solar and wind energy are the more focused energies on which we are dependent more than any other form of the renewable energy. India like many other developing countries committed towards the net-zero emission and for that government of India form the energy policies for the better implementation of the renewable energy on the grass root level. Bharat's Renewable Energy Programme is unparalleled and the most widespread among the developing nations of the World. The supreme authorities have designed some policies, programs, and an unconventional environment to attract foreign investments to move forward the nation into the renewable market at an increasing pace. This study reflects eloquent policies and investment openings in energy due to the development of renewable production in Bharat. The most important and demanding issue facing Bharat's subsidy framework is the lack of imaginative money involving options that will present larger amounts at less interest rates and for extended and long durations. Overall, sound financing and good policies will give pace to the process of production of energy, ultimately transforming to accelerated renewable growth.

Keywords: Renewable energy, solar energy, wind energy, future potentials, policies in India, investments

INTRODUCTION

According to the Global Trends in Renewable Energy Investment 2020 account, during the timeline 2014-2019, renewable energy agendas and projects in Bharat attracted an investment of USD 64.2 billion (Rs 4.7 lakh crore) [1]. Electricity consumption in Indian buildings increased at 8% annually during 2000–2013, among the highest in major economies. In 2013 buildings accounted for 41% of total final energy use and 38% of electricity demand in India. [2]. Bharat's dream target is to attain 175 GW of renewable energy capacity by 2022 and aspires to gain 500 GW by 2030.

If the country is to achieve 175 GW by 2022, we require a total investment of approximately US \$150-200 billion. [3]. During the timeline from April 2014 to January 2021, the inducted RE capacity of Bharat has grown by two and a half times, and in the same timeline, the installed solar

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energy volume has grown 15 times. Globally, today Bharat stands 4th in RE generation capacity, 4th in Wind generation, and 5th in Solar Power volume [4]. Near about 5,000 trillion kWh per year of power is isolated over the Bharat's landform with maximum areas receiving 4-7 kWh per sq. m per day. From an energy safeguard perspective, the sun is the most trusted and secure of all forms since it is abundantly and largely available [5]. Wind and sun energy have arisen as the most effective and competitive assets for renewable energy. At the end of March 2019, wind power and sun energy volumes in Bharat were 35.6 GW and 28.2 GW respectively (solar and wind together contribute 17.9% of total installed volume). However, their combined generation accounts for only 7.3% of the total energy produced [6].

Bharat's wind energy zone is led by the aboriginal wind power industry and has exhibited consistent progression. The nation currently has the fourth highest wind-installed capacity in the world with a capacity of 39.25 GW installed (as of 31st March 2021) and has brought around 60.149 billion Units during 2020-21 [7]. More than 75% use the plug-and-play model discounted the solar power tariff. Solar power has elevated by 11 times in the last 5 years from 2.6 GW in March 2014 to 30 GW in July 2019. The wind energy was maximum added 5.5 GW in 2016-17. MNRE sets a target of 5.0 GW of offshore wind production by 2022 and 30 GW by 2030 which has been induced to give confidence to the creators in the Indian market [5,7]. To achieve Bharat's renewable energy marks cost-effectively, further debt is required. Foreign loans (e.g., in USD) are appealing to Indian policy administrators, given that affordable (at 5–7%), longer-term (15 years or more), fixed-rate international loans can reduce the cost of administration support by lowering the expense of renewable energy [8].

International Solar Alliance

ISA demonstrated under the Paris Agreement states that the nations share the collective aspiration to undertake innovative, creative, and concerted attempts to lower the price of finance and technology for the stationing of solar generation assets [9]. The aim is to pave the path for near future solar production, storage, and technologies for Member nation's needs by summoning over USD 1000 billion by 2030. Achievement of ISA's intentions will also fortify the climate action in member countries, aiding them to fulfill the allegiance expressed in their Nationally Determined Contributions (NDCs).

Launch of Green Grids Initiative - One Sun, One World and One Grid

“India's leadership of the International Solar Alliance now gets a further boost with the GGI-OOWOG. Linking up the grids across countries, if successful, can greatly boost energy interdependence, energy security and help emerging markets leapfrog to a clean energy future [10].

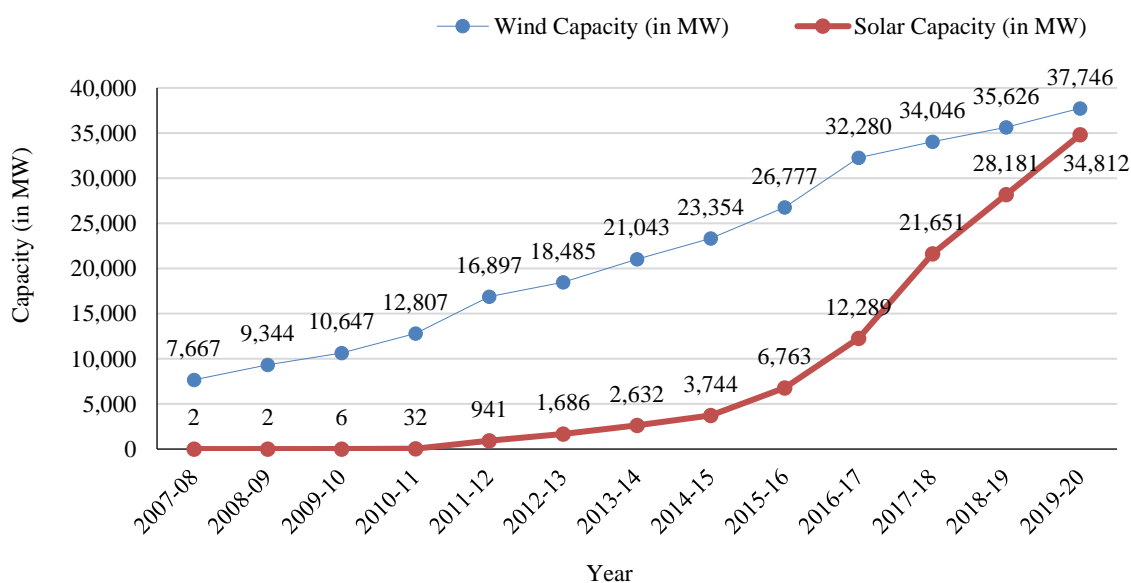


Figure 1. Growth of solar and wind capacity in India up to 2020

Source: IEA (International Energy Agency) (2020), *Renewable Market Update: Outlook for 2020 and 2021*.

LITERATURE SURVEY

Vikas Khare, Savita Nema, Prashant Baredar [11] present an overview of the solar and wind energy status in India and make an understanding about the challenges faces in the Indian power sector, challenges faced it the manufacturing of solar. They try to make a better understanding of the government supports toward the solar and wind energy in India. Edmund Ntom Udemba, and Andrew Adewale Alola [12] study the encounter of potential shocks related to Australia's 'Direct Action' plans in renewable power, fossil fuel energy, and foreign direct investment (FDI). This is true when there are both positive and negative shocks to economic development, but only a positive shock to FDI has an environmental impact. Evidence suggests that an energy transition policy is critical to achieving Australia's 2030 climate objective. Rajvikram Madurai Elavarasan, G. M. Shafiullah, Nallapaneni [13] In this study, a case study clarifying a full evaluation of the Gujarat state in India is being considered. The activities and policies taken by the Gujarat government to overcome potential impediments to non-conventional and renewable energy production are examined in this paper. Vinish Kathuria, Pradeep Ray, Rekha Bhangaonkar [14] in the research investigates the influence of state-level institutional disparities in attracting FDI (for-eign direct investment) in India's wind energy sector. A.A. Amrutha, P. Balachandra, M. Mathirajan [15] discusses the encounters of Feed-in Tariff (FIT), Renewable Purchase Obligation (RPO) and Renewable Energy Certificate (REC) needed policies in accelerating the part of renewable electricity generation in the case of Karnataka State Electricity System. Arun Singh [16] studies the impact of laws that carry forward renewable power, the model represents renewable electricity in brief. The influence of money and scale factors are also taken into consideration in the expansion of renewables. Paul J. Burke, and Jinnie Widnyana [17] paper reviews barriers such as substantial obstacles, regulatory obstacles to market access, and frail abilities of electricity utilities to handle intermittent renewables and discusses plans to overcome them. A. Singh, N. Winchester and V.J. Karplus [18] apply a numerical economy-wide model of Bharat with power sector data to analyze the impact of Bharat's allegiance to the Paris Climate Agreement and equate the average cost per unit of emissions reduced under a CO2 pricing regime to the no-policy scenario in 2030. Gireesh Shrimali, Sandhya Srinivasan, and Shobhit Goel [19] use financial money models to equate existing laws federal; for wind and solar technologies generation-based subsidiaries, viability gap support, and accelerated derogation – with a new class of debt-related government policies, the key result is that debt-related steps have the greatest strength for long-term cost-effectiveness; they also do well on other variables. Gireesh Shrimali, David Nelso [20] do financial money modeling of actual renewable power projects in Bharat and conclude that Indian officials should prioritize the stipulation of low-cost, long-term finance and look concisely at China and Brazil's successful efforts.

POLICIES TO PROMOTE SOLAR AND WIND ENERGY IN INDIA

The government's strategic plans, acts, and planning are all necessary for the energy situation to continue to flourish. The development of a solar policy is critical for assessing the state's solar potential and identifying strategies for improving the present energy infrastructure [21]. The objectives of such policies are to: (a) increase the use of renewable energy sources in day-to-day life; (b) lower the costs/pricing of renewable sources; (c) promotion of innovative ideas and invention of renewable technologies; and (d) facilitate trade in products and services and investment in renewable energy sources [22].

Electricity Act-2003

The act aims to promote and streamline electricity policies and tariffs across the country. The state electricity boards are required to set tariff rates for the promotion of renewable energy resources under Section 61 of the Act. Rural electrification, national pricing policy, power theft prevention, and consumer protection are all mandated under the legislation. The policy's section 86 assures that renewable energy is generated and purchased at a minimum with grid access [23].

National Electricity Policy 2005

In 2005, the National Electricity Policy was modified to provide quality and reliable power to all Indian households at lower prices and with improved efficiency. The policy's section 5.12.1 attempts to reduce capital costs by encouraging competition among generation businesses. Aside from determining tariff rates, the program requires state electrical boards to set production and installation targets for renewable energy [24].

National Tariff Policy 2006

In 2006, the Indian government implemented a national pricing policy to boost the financial viability of the electrical sector by attracting new investors. The policy's goal is to offer electricity to all customers at a fair and reasonable unit price through increasing competition, efficiency, and operational quality. The Policy shows the State Electricity Regulatory Commission (SERC) to target a minimum percentage of energy taken from renewable sources, considering the availability of such pockets in the region and their impact on retail tariffs [25].

National Action Plan on Climatic Change (NAPCC)

In 2008, the NAPCC was established to address the effects of climate change and related environmental issues, as well as to achieve sustainable growth in India, which meets both financial and environmental objectives [26]. The NAPCC has eight missions, the most important of which is the implementation and execution of the Jawaharlal Nehru National Solar Mission (JNNSM). There are two such missions i.e. The National Mission for Enhanced Energy Efficiency and the National Mission for Green Bharat [27].

Jawaharlal Nehru National Solar Mission (JNNSM) 2010

The Jawaharlal Nehru National Solar Mission (JNNSM) was launched by the Indian government in 2010 to promote the economic growth of solar power to address India's energy challenges, such as a lack of electrical power, clean energy, sustainable growth, human resource development, R&D, and domestic production of critical raw materials, components, and products [28].

National Solar Mission (NSM)

This has been an aim of installation of 20,000 MW of grid-connected solar generation by the end of 2022. It was readdressed in June 2015 to 1,00,000 MW by 2022. To increase programs for off-grid workthings, reaching 1000 MW by 2017 and 2000 MW by 2022. The total amount for upgradation to 100 GW solar power volume would be \$94 Billion. Three parts of the National Solar Mission (NSM):

- *Part I:* It includes the 11th Plan and the 1st year of the 12th Plan (up to 2012-13) with an aim of 1.4 GW.
- *Part II:* It attains the pending 4 years of the 12th Plan (2013-17) with an aim of 11-15 GW.
- *Part III:* It includes the 13th Plan (2017-22) with a target of 22 GW.

Green Energy Corridors

This scheme attempts to synchronize electricity obtained from renewable sources such as sun and wind with the grid's conventional power stations. The overall project cost was initially Rs. 11014 crores but has now risen to Rs. 34141 crores. The money and finance pathway includes a 40% grant from the GoI (totaling Rs. 4056.67 crores), 20% state equity, and a 40% loan from KfW, Germany (500 million EUR).

FEED IN TARIFF (FIT), RENEWABLE PORTFOLIO OBLIGATION, AND FISCAL INCENTIVES

The Central Electricity Regulatory Commission (CERC) is empowered under the 2003 Electricity Act and National Tariff Policy to set technology-specific feed-in tariffs (wind, biomass, small hydro, solar thermal, solar PV) for grid-connected power from various renewable sources. The FIT assures a return with complete cost recovery during the loan payback period for the entire useful life of the power generation station, making it comparable to a levelized tariff.

Most states follow the same cost recovery principle as CERC, but they are allowed to deviate if they want to give renewable energy a higher return on equity. Installation subsidies in the form of accelerated depreciation and a generation-based incentive in the form of a subsidy payout for power produced were two of the most crucial fiscal subsidies introduced. However, abrupt changes in the terms of fiscal incentives (for example, accelerated depreciation and generation-based incentives) caused policy uncertainty and confusion. Furthermore, while allowing states to choose varying levels of FIT and RPO was intended to accommodate variances in renewable resource endowment for a big federal country like India, it ultimately resulted in a lack of policy coherence [29].

INVESTMENT ON RENEWABLE SECTOR (SOLAR AND WIND)

Bloomberg New Energy Finance, published the following statement according to which money involvement in renewable in Bharat rose by 22% in the first half of 2018 compared to 2017, while investments in China decreased by 15% over the same period of time (BNEF). Between April 2000 and March 2021, Bharat's renewable power sector attracted \$10.08 billion in foreign direct investment. Since 2014, India's renewable energy sector has received over \$42 billion in investment [30]. India stands 3rd on the EY Renewable Energy Country Attractive Index 2020. By 2028, India will be able to see investment worth US \$500 billion in the sector of renewable energy.

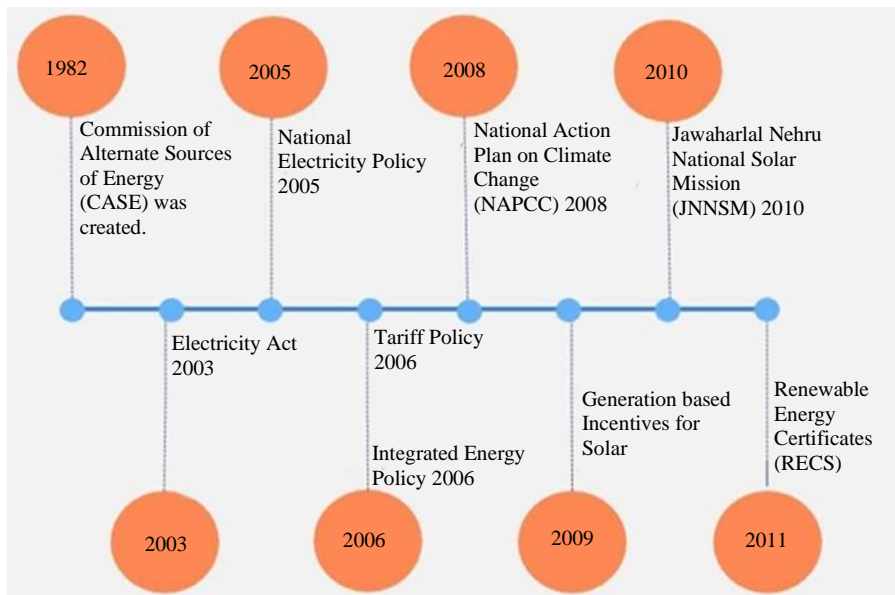


Figure 2. Timeline of the energy policies in India

Source: Solarify, <https://solarify.in/blog/policies-regulations-solar-energy-india/>

Table 1. Evolution of renewable energy policies over the period.

Technology	2006-2010	2010-2015	2015-till now
Solar Wind	Promotion of RE, competitive bidding, and RPO in National Tariff Policy, 2006	GBI for grid interactive wind power projects, 2009 and 2013	National Tariff Policy, 2016
	National Action Plan on Climate Change, 2008	NSM Phase I Batch II (Bundling scheme), 2011	NSM Phase II Batch IV (State specific VGF scheme), 2016
	National Solar Mission, 2010	NSM Phase II Batch I, 2013 (VGF Scheme)	Commencement of competitive bidding in wind, 2016
	Introduction of renewable energy certificates (REC), 2010	Green Energy Corridor project, 2013	MoP's order on waiver of interstate transmission charges and losses, 2016
	Must-run status in Grid Code, 2010	Scheme for solar park development, 2014	MNRE's policy for re-powering wind projects, 2016

		NSM Phase II BatchIII, 2015	Competitive bidding guidelines for solar and wind, 2017
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Source: Ministry of New and Renewable Energy Annual Report 2020-21

Table 2. Investments in different renewable sector in India.

Sector	2017-18 - Total Investment made during 2017-18 (in crore)	2018-19 - Total Investment made during 2018-19 (in crore)	2019-20 (Up-to Dec) - Total Investment made during 2019-20 (in crore)
Solar Power	37450.56	26116.8	22199.52
Wind Power	13056.61	10366.79	13154.47
Small Hydro	1059.5	1073.5	784
Bio- Power	3869.74	2902.9	591.5
Total	55436.41	40459.99	36729.49

Source: <https://data.gov.in/resources/source-wise-estimated-investment-re-sector-2017-18-2019-20-ministry-new-and-renewable>

Foreign direct investment (FDI) in the renewable sector of Bharat between April 2000 and June 2018 was estimated at USD 6.84 billion according to the research of the Department for the Promotion of Industry and Internal Trade (DPIIT) formerly known as the Department of Industrial Policy and Promotion (DIPP) which works under the GoI. Bharat reached US\$ 7.4 billion in fundraising in the middle of 2018. Between April 2015 and June 2018, Bharat gets USD 3.2 billion in FDI in the renewable. Funding has increased year over year, rising from USD 776 million in 2015–2016 to USD 783 million in 2016–2017 and in 2017–2018 it raised to USD 1204 million. FDI worth INR 452 crore (4520 million INR, 63.3389 million USD) was added between January and March 2018 [31].

Sources of Investment

Green Bonds

Under the Climate Bond Initiative (CBI), the green bond market has moved up drastically in previous years, with issuances rising from USD 36.6 billion in 2014 to USD 167.6 billion in 2018. India has issued \$8.6 billion in bonds as of August 2019, with 80% of the proceeds going to renewable energy projects in the country [32].

Banking vs. Non-banking Institutions

In 2017 itself, 60 renewable energy projects gained more than US\$2.5 billion in funding from these sources, roughly 60% of which came from non-banking financial (NBF) organizations, with IDFC alone accounting for almost a fifth of the total investment [33].

Government Investment Flows

Indian Government's foremost efforts were concentrated on building loads of funds (monetary fund)—the National Clean Energy Fund, now called the National Clean Energy & Environment Fund (NCEEF) [34]. A part of the NCEEF is used by the organization owned by government, the Indian Renewable Energy Development Agency (IREDA) to lend to banks at a 2% interest rate. According to budgeted projections for 2017-18, the fund has allocated about INR 53,410 million to the Ministry of New and Renewable Energy (MNRE) to promote renewable energy development initiatives across the country [35].

DISCUSSION AND RECOMMENDATIONS BASED ON THE RESEARCH

Policy and Regulation Advancements

- MNRE should include a thorough action plan for the promotion of the renewable sector in its regulatory framework.
- The central and state governments must work on a "Must run status" in their new policies and laws and ensure that sources of different energy are used.
- Strong initiatives should be taken from the municipality for the approval and installation of renewable energy-based projects.

- A well-established REC legislation could help to make projects in renewable energy more financially viable. The government must look into ways to develop and promote the REC ecosystem.
- The government and policymakers of the nation must look at building the REC market.
- The FITs and tariff orders must be consistent and not limited to a few years.

Financing the Renewable Sector

- The government must allocate funds sufficiently to the sector of renewable. China invests almost 128 times that of India's investment. China spent USD 126.6 billion (INR 9 lakh crore) in 2017, whereas India spent USD 10.9 billion (INR 75500 crore).
- In 2017, INR 445 crore budget was allocated, down from an INR 272.85 crore budget in 2016. The focus on R&D should be increased by the government. The initial funding for 2017–2018 was INR 144 crore, which decreased to INR 81 crore in the new forecasts.
- The implementation of the Goods and Service Tax (GST) in 2017 impacts the industry's performance in a negative way, causing increases in the cost and jeopardizing the profitability of ongoing projects, ultimately impacting in achievement of the target. GST difficulties must be resolved as quickly as possible.
- Priority must be given to the renewable energy sector which in turn enhance financing availability and promote commercial banks to participate more actively.

CONCLUSION

Good planning, governance, and strategy have a direct and indirect impact on the overall level of innovation and productivity of the particular country. Governments should encourage trade and investment in renewable energy products, services, and technologies which in turn make more people aware of the sources of energy in the market. They should decrease import tariffs and non-tariff barriers (NTBs), promote the use of tradable renewable energy certificates (RECs), and make improvements in the FDI climate in renewables. FDI in the renewable energy sector is one option to address these issues because it has the ability to generate both direct and indirect advantages, such as economic growth without environmental damage and technology acquisition. Renewable technology can't be borrowed because of a shortage of comprehensive and wide-understanding policy and regulatory frameworks. To trap the investor's attention, the renewable energy market needs explicit rules & plans and legal procedures.

The government should take steps to entice private investors. The report made recommendations for more precisely improving present solar regulations. Making investments financially feasible through smart legislation and tax incentives will have social benefits in addition to economic rewards. To meet the high 2022 targets, India's renewable energy funding framework requires significant restructuring. More new investment vehicles are needed, with government-backed financial institutions leading the way. India must continue to focus on developing an optimal ecosystem through policy intervention, a stable regulatory framework, improved stakeholder coordination, and healthy demand growth, all supported by a strong financial system, to fulfill its energy transition goals.

Authors Contribution

Gaurav Kumar [1] has done the overall research and the findings of the data of the paper. The analysis has been thoroughly done and make the study as simple as possible. Shaifali [2] merges all the content and does all the formatting of the paper. She all added value to the paper as she provided different approaches to the findings of the paper. Anoop Kumar [3] reviews the paper after its completion and finds the gaps in the formation which are completed before the final submission.

Declaration of Competing Interest

The authors of the paper declare that there has been no relation or personal vendetta that could have appeared to alter the examination of the study of this review paper. The authors declare that there is no

financial inclusion of any kind or from any institution in the making of this paper. The study is purely based on the interest of the authors and has no sign of conflict or personal relationship with any of the related studies of this paper.

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