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A Study of India's Renewable Energy Sector: Solar (2015-2025)

Mehak Latwal
Dr. Anuradha Negi
Department of Economics,
Atma Ram Sanatan Dharma College,
Delhi University

Abstract

Renewable energy sources in India are becoming increasingly important nowadays, with regards to the country's growing demand for electricity as well as the concerns around matters related to the energy security, especially when the global geopolitics also revolve according to those who compete for high stakes in this game. Not only the solar energy underpins government's goals of a cleaner and greener lifestyle, it also pushes India's inherent capabilities to achieve the goal of 'Net Zero' by 2070. Also, solar energy is the safest alternative because it remains forever. After the launch of the National Solar Mission in 2010, India continued to move forward with research and development programs in the renewable sector. Fast forward to this day, the installed power capacity of India, in totality, has reached 476 GW as of June 2025, with the non-conventional fuel sources comprising 235.7 GW (49%) of total capacity. Solar energy, as of now, comprise 110.9 GW in India's installed power capacity mix. This paper intends to shed light on the growth of India's solar energy sector, along with the analysis of the relationship between India's CO2 emissions and expenditure on solar energy with India's GDP. Additionally, the paper will also follow along the challenges ahead of India's solar energy pathway, and will suggest some policy measures that India should adopt in order to amplify solar energy's growth in India.

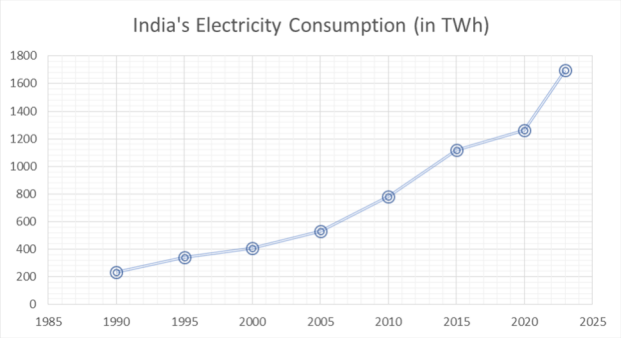
Keywords: Renewable, Solar, Energy, Emissions, Barriers

Introduction

Like food, water, shelter, and clothing, energy too, is essential for sustaining life and an important factor for sustainable development. As per the United Nations Brundtland Commission, sustainability refers to "meeting the needs of the present without comprising the ability of the future generations to meet their own needs." Geopolitical and geoeconomic crises resulted in countries realising the importance of self-sufficiency in basically everything, especially energy. In the wake of the two oil shocks of the 1970s, energy self-sufficiency has been of paramount priority for India (United Nations, 2025). Price hikes, supply chain vulnerabilities, and negative incidence on the country's balance of payments (BOP) position led to creation of the Department of Non-conventional Energy Sources (DNES), which was later renamed as the Ministry of

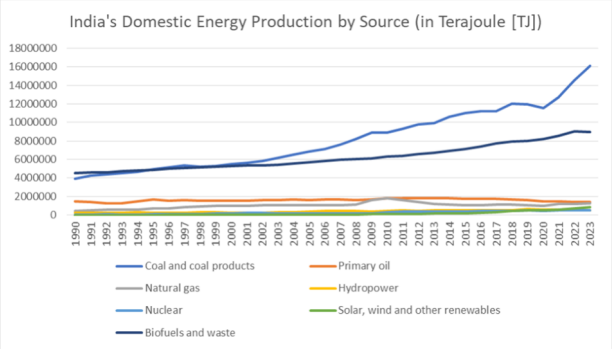
New and Renewable Energy, in 2006. It was responsible for policy formulation and implementation, as well as amplifying research and development in the non-conventional energy sector. As of now, with a skilful growth in renewable energy (RE) sector, India is heading steadily on the path to a sustainable future. What started as a crisis-averting strategy became a national goal along the way. The push for the non-conventional energy sources came from the Paris Agreement of 2015, which diverted countries towards discovery and development of cleaner energy fuels, as global average temperature was on the rise providing alarming signals such as climate change, increasing pollution, glacier melting, permafrost thawing etc. The agreement made the signatories prioritize measures that would be able to keep global average temperature below 2° C. From there, renewable energy sources have been gaining increasing significance from all over the globe (Ministry of New and Renewable Energy, 2025). Renewables like solar, wind, hydro, tidal, geothermal, and bio possess the ability to supplement conventional energy fuels which are based on fossil-fuels.

Chart 1: India's Electricity Consumption (in TWh)



Source: Energy Statistics Data Browser

Chart 2: India's Domestic Energy Production by Source



Source: Energy Statistics Data Browser

India has vast resources, enormous capacity, and credibility to advance the agenda of sustainability through non-conventional energy sources, especially from solar energy since it is most abundantly available. India is extensively solar energy potent, with about 5000 trillion kWh per year incidence over the country's terrestrial area. This potential has been duly recognised and shows India's willingness to reduce carbon footprint. Harnessing solar photovoltaic power gives the leverage to achieve distribution on a large scale, and it also gives huge scalability all over the country. As a developing nation, India is continuously improvising on its technology and policies for refining the solar energy sector more and producing more output efficiently (Kapoor et al., 2014).

Literature Review

Kapoor, Pandey, Jain, and Nandan (2014) observe the trajectory of solar energy sector of India

from 1950 till now, and highlight some persistent issues as barriers and challenges that are severely impacting the proliferation of solar energy in India. The study underlines several important national plans, policies, and initiatives undertaken by the Government of India, including National Action Plan on Climate Change, National Solar Mission, Semiconductor Policy etc., as well as other state specific policies for scaling the national solar energy ambition. Lastly, along with the sector-specific challenges, plausible policy directives have been suggested to mitigate the issues in the solar energy sector of India. Sharma, Tiwari, and Sood (2012) evaluate the status-quo of the solar power sector of India, with emphasis on grid connected, off-grid, and decentralised power plants. Authors brief about electricity generation from solar thermal power plants and concentrating photovoltaics (CPV), along with describing opportunistic gains of using solar energy. Additionally, the study enlists several schemes and programmes to encourage the deployment of solar power in India, like National Electricity Policy, National Tariff Policy, and National Rural Electrification Policy. Lastly, some contemporary issues in CSP and CPV technologies have been identified and future directions for the solar energy sector have been listed out. Singh and Singh (2016) brief about future scope of solar energy in India, highlighting its potential across sectors and individual states. The study also focuses on grid-connected and off-grid solar installed capacity, current solar projects, along with discussing pros and cons of solar power sector of India. Dawn, Tiwari, Goswami, and Mishra (2016) analyse the recent scenario, strategies, availability, future potential, and policy infrastructure with regards to the solar power sector of India, within the time frame 2004-2014. The study depicts a comparative analysis among the nations across various renewable energy sources. As per this study, Germany emerges as the global solar PV giant, followed by China and Japan in close competition. Authors have also enlisted the institutions associated with development of solar power, including the Solar Energy Corporation of India (SECI), the Indian Renewable Energy Development Agency Ltd. (IREDA), as well as the National Institute of Solar Energy (NISE) etc. Kar, Sharma, and Roy (2016) examine solar energy potential, market developments, capacity additions, trade status, and economics of solar energy in the country. Potential challenges have been identified as rigid policies and regulations, obsolete technology, investment crunch, insufficient infrastructure, and lack of consumer awareness, among others. Directives to mitigate barriers include policy improvisation, sufficient fund allocation, skill development, and making investment market favourable. Yenneti (2016) analyses the political sector's influence on solar power sector of India from a period of 14 years, from 2000 to 2014, commenting that certain policies such as National Solar Mission (NSM) of 2010 has been proven a major breakthrough for the advancement of solar energy across the Indian states. Furthermore, the author briefs that policy, financial, and social challenges surrounding the solar energy sector of India are impeding its growth and hence must be addressed with appropriate actions. Dhara and Desai (2024) evaluate the impact of green bonds on India's carbon emissions and GDP, providing emphasis on their significance in integrating economic and environmental requirements. Using year-wise panel data, authors have further established the relationship between green bonds, CO_2 emissions, and GDP through ordinary least squares (OLS) regression model. Their findings highlight the positive impact of green bond investments on GDP growth and emission reduction. Obani, Izu-Obani, and Akroh (2024) investigate the influence of non-conventional energy sources on GDP, assessing the link between solar energy and GDP of India. The study utilises data from 1990 to 2023, examined through ordinary least squares regression technique. The findings suggest that solar energy positively influence GDP, having an overall insignificant impact. However, CO_2 emissions also positively influence GDP, having an overall significant impact. Bhardwaj and Chauhan (2025) analyse the link between installed renewable energy capacity, GDP, and CO_2 emissions, from a period of 2015 to 2023, in India. The study utilises ARDL bounds testing method, which results in finding that suggests a significant and positively influencing relation between installed renewable energy capacity's expansion and economic growth,

whereas CO_2 emissions have a negative relationship with GDP. The authors also enlist some policy recommendations inspired by some countries to help India align its green transition measures effectively. Lankala and Reddy (2025) assess the influence of non-conventional energy consumption on India's GDP and CO_2 emissions, by analysing data like consumption of non -conventional energy, India's economic growth, CO_2 emissions, FDI inflow, and population from 1980 to 2021, to find short and long-term correlation among the variables. Findings of the study reveal past renewable energy consumption has favourable influence on GDP whereas carbon emissions negatively affect GDP. Acharyya (2009) examines GDP growth and environmental degradation, which are two most important benefits and costs of FDI (Foreign Direct Investment) in the Indian scenario. The findings of the study reveal long-term positive influence of FDI spread on India's economic growth from 1980 to 2003, whereas its long-term growth influence on carbon emissions is abruptly higher. Tiwari (2011) examines the relation amongst RE consumption, GDP, and carbon emissions, using the structural VAR approach. The results suggest that positive influence on the consumption of non-conventional energy sources advance economic growth, leading to a decline in carbon emissions. However, positive influence on GDP creates a further positive influence on carbon emissions. This scenario shows that a positive influence towards renewable energy sources might lead to an increase in carbon emissions. As a result, the administration must induct policies that support and advance the usage of non-conventional energy sources, so that demand of the clean electricity so generated, will increase and will help in compensating the environmental loss incurred due to the usage of fossil fuels.

Research Methodology

India's solar energy potential is much talked about globally. As the co-founder of the International Solar Alliance, in liaison with the French government, India has taken major steps to transform its power sector to accommodate renewables, especially solar power, as an initiative towards a sustainable future. With a continued increase in population, which currently stands at 1.4 billion, India energy consumption is estimated to almost double by 2040. Per capita electricity consumption has risen to 1.3 MWh in 2023-24 from 0.9 MWh in 2013-14. Given this scenario, the solar power sector of India is surrounded by various challenges that are hampering its growth.

The aim of this study is to shed light on the growth of India's solar energy sector, along with the analysis of the relationship between India's CO_2 emissions and expenditure on solar energy with India's GDP, along with enlisting various challenges that are rampant in the solar power sector of India.

Based on the findings from reports and papers reviewed, the present study will focus on the following objectives:

1. To examine the growth of India's solar energy sector
2. To assess the relation between India's environmental investment, CO_2 emissions, and GDP
   To explore challenges and barriers impeding the growth of solar energy sector

To achieve the objectives of the study, secondary data will be used along with quantitative research methods. The secondary data has been gathered from ministries' websites and annual reports, government reports, and research papers. The techniques for analysis that have been used are statistical and econometric such as Ordinary Least Squares (OLS) regression, Annual Growth Rate (AGR), and Compound Annual Growth Rate (CAGR).

Secondary sources of data such as Energy Statistics Data Browser, Press Information Bureau, Ministry of Statistics and Program Implementation (MOSPI), and Ministry of New and Renewable Energy (MNRE), among others have been used to analyse first and second objectives. The data has been collected from reports, websites, and repositories from the period 2014-2025.

The research objectives of the study have been chosen after carefully analysing the existing and prevailing literature, which aims to evaluate India's achievements in the solar energy sector, examining the effects of environmental investment and CO_2 emissions on India's economic growth, and enlisting the barriers impeding the growth of India's solar sector, amplifying the scope thoroughly.

Results

To Examine the Growth of India's Solar Energy Sector

The first objective of this study is to examine the growth of the solar energy sector of India, or specifically the large-scale solar installations. India has a ranking of 3rd globally in solar power installed capacity, which indicated India's efforts and contributions in its renewable energy industry. Not only the solar energy underpins government's goals of a cleaner and greener lifestyle, it also pushes India's inherent capabilities to accomplish the target of net zero by 2070. Also, solar energy is the safest alternative because it remains forever.

The National Solar Mission (NSM), which was launched in 2010, is a landmark initiative by the Government of India (GOI) to promote sustainable growth in India while addressing India's energy security challenges. Consistent infrastructure distribution efforts such as Rooftop solar, solar pumps, etc. have generated employment along with providing benefits to the Indian population in a sustainable way. In a first, Dharnai village of Bihar's Jehanabad district became the first village in India to run entirely on solar energy (Champions of Change, 2023).

The Indian government has taken a lot of measures to launch various programmes in order to proliferate solar energy in India, related to infrastructure, financing, and production of solar related equipment. The CPSU, which is essentially a government producer scheme, will be helpful in installing grid-connected energy projects using indigenously built cells and modules. The VGF scheme, on the other hand, will be useful in securing grants for energy projects that are facing a financial crunch, through PPP (Public-Private-Partnership). Additionally, the government has also undertaken diverse initiatives to promote the grid connected solar power plants (Press Information Bureau, 2025).

India's solar energy installed capacity includes various solar projects such as rooftop solar and off-grid solar. The oldest programme related to solar energy is the off-grid solar, wherein, photovoltaic powered equipment and tools are set up in areas where electricity is not available or often not found. It includes street-lighting projects, solar irrigation tools, among other infrastructure (Ministry of New and Renewable Energy, 2022).

Table 1: State-wise Estimated Potential of Solar Power in India (as on 31.03.2024)

Sl. No.	States/ UTs	Solar Power (in MW)
1	Andhra Pradesh	38440
2	Arunachal Pradesh	8650
3	Assam	13760
4	Bihar	11200
5	Chhattisgarh	18270
6	Goa	880
7	Gujarat	35770
8	Haryana	4560
9	Himachal Pradesh	33840
10	J& K (including Ladakh)	111050

Source: MOSPI

11	Jharkhand	18180
12	Karnataka	24700
13	Kerala	6110
14	Madhya Pradesh	61660
15	Maharashtra	64320
16	Manipur	10630
17	Meghalaya	5860
18	Mizoram	9090
19	Nagaland	7290
20	Odisha	25780
21	Punjab	2810
22	Rajasthan	142310
23	Sikkim	4940
24	Tamil Nadu	17670
25	Telangana	20410
26	Tripura	2080
27	Uttar Pradesh	22830
28	Uttarakhand	16800
29	West Bengal	6260
30	Andaman & Nicobar	0
31	Chandigarh	0
32	Dadar & Nagar Haveli, Daman & Diu	0
33	Delhi	2050
34	Lakshadweep	0
35	Puducherry	0
36	Others$	790
All India Total		**7,48,990**

India is also encouraging the advancement of solar energy industry through bilateral and multilateral treaties with countries around the world. India co-founded the International Solar Alliance (ISA) in partnership with France. It is a collaborative partnership which aims to combine mitigation efforts against the fight with climate change vulnerabilities. The ISA also helps LDCs and SIDS in integrating their infrastructure, financing, climate advocacy, and development requirements (International Solar Alliance, 2022).
Additionally, there are several schemes by the Government of India (GOI) to promote the development of the solar energy sector in India. These include:

PM-KUSUM Scheme: The Pradhan Mantri Kisan Urja Suraksha evam Uthhan Mahaabhiyaan was initiated in 2019. This scheme helps in financially aiding farmers through subsidised equipment and installation costs for the solar powered equipment.

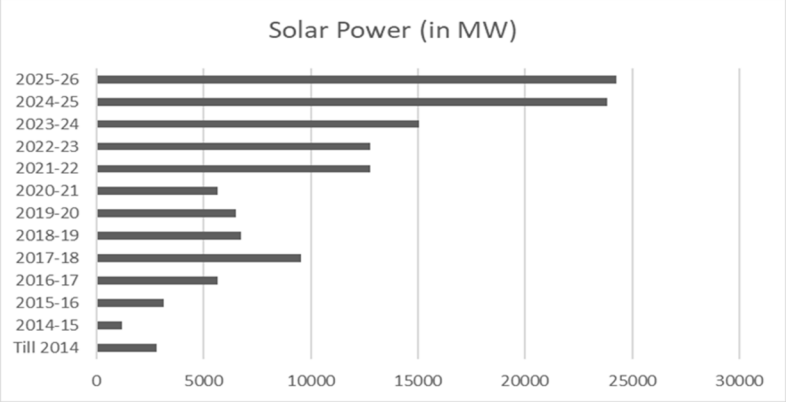
PM Surya Ghar Muft Bijli Yojana: Initiated in 2024, this scheme was deployed to proliferate and advance the agenda of solar energy usage in residential areas. It has now become a flagship scheme promoting the domestic usage of rooftop solar panels.
To quantify the growth, we will be using Annual Growth Rate (AGR) and Compound Annual Growth Rate (CAGR).

Table 2: Annual Growth Rate (AGR) of India's Solar Power Sector

Year	Solar Power (in MW)	Annual Growth Rate (AGR)
2014-15	1171.62	-
2015-16	3130.36	167.15
2016-17	5658.63	80.76
2017-18	9563.69	69.01
2018-19	6750.97	-29.41
2019-20	6510.06	-3.56
2020-21	5628.8	-13.53
2021-22	12760.5	126.7
2022-23	12783.8	0.18
2023-24	15033.24	17.59
2024-25	23832.87	58.53
Compound Annual Growth Rate (CAGR)		**33.5%**

Source: Author's calculation

Chart 3: Year-wise achievements in Solar Power



Source: Ministry of New and Renewable Energy

To Assess the Relation between India's Environmental Investment, CO_2 Emissions, and GDP

The second objective of this study is to assess the relationship between India's environmental investment, CO_2 emissions, and India's GDP. For analysing this relation, we will be using Ordinary Least Squares, with a multiple regression model.

Dependent variable: GDP

Independent variable(s): CO_2 Emissions, Environmental Investment*

*The year-wise budgetary allocation in solar energy sector has been chosen to be denoted as environmental investment for this study.

Hypothesis:

(Null) H0: Environmental investment and CO_2 emissions do not cause significant variability in GDP growth.

(Alternate) H1: Environmental investment and CO_2 emissions cause significant variability in GDP growth.

Multiple linear regression model to be used:

$Y = \beta0 + \beta1X1 + \beta2X2 + ...+\beta nXn + \epsilon$ - *Table 3: Author's Compilation*

YEAR/ ENERGY	India's CO_2 Emissions (in MtCO2)	Environmental Investment (in Rs. Crores)	INDIA'S GDP (in Rs. Crores)
2014-15	2021.83	1824.93	₹ 1,24,67,959
2015-16	2049.11	3153.46	₹ 1,37,71,874
2016-17	2072.22	2742.80	₹ 1,53,91,669
2017-18	2189.83	1893.78	₹ 1,70,90,042
2018-19	2279.81	2972.45	₹ 1,88,99,668
2019-20	2274.64	3009.90	₹ 2,01,03,593
2020-21	2112.2	1474.27	₹ 1,98,54,096
2021-22	2312.2	3500.07	₹ 2,35,97,399
2022-23	2527.9	5205.89	₹ 2,68,90,473
2023-24	2763.34	6268.01	₹ 3,01,22,956
2024-25	3000	15061.35	₹ 3,30,68,145
2025-26	3220	24224.36	₹ 7,14,27,772

Source: India Budget, Energy Statistics Data Browser, and MOSPI

Regression Statistics	
Multiple R	0.946678078
R Square	0.896199383
Adjusted R Square	0.87313258
Standard Error	5659857.96
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	2.48919E+15	1.2446E+15	38.85234364	3.74024E-05
Residual	9	2.88306E+14	3.2034E+13		
Total	11	2.7775E+15			

SUMMARY OUTPUT

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	965107.4923	22359259.97	-0.04316366	0.966513539
India's CO_2 Emissions (in $MtCO_2$)	6286.427508	10660.1478	0.589712978	0.569889451
Environmental Investment	1865.559567	617.2673065	3.022287989	0.014425748

To Explore the Challenges and Barriers Impeding the Growth of Solar Energy Sector

Despite India's tremendous progress in the solar energy sector, there are several challenges that are persistent and acting as an obstacle to its further scalability. These challenges encompass financial, policy, political, geotechnical, economic, geopolitical, regulatory, and environmental aspects. Adequate measures must be undertaken to minimise the damage these challenges create for the solar energy sector's growth in India. Addressing these challenges is vital to develop a long-term solar power sustainability for the country.

Financial Challenges

- The high initial costs for the solar power installation are progressively high. Solar panels, solar cells, inverters, batteries, and other mounting infrastructure demands massive investment which often discourage small investors, residential users, and farmers to transition to this unconventional energy source.
- Investors remain sceptical of their returns on their investment in solar power projects, as the equipment only lasts a few years during which expenditure incurred is usually not paid off, which further deters investors' interest in the solar power sector and hence finance crunch always remains.
- Many times, developers face delayed payments from distribution companies (DISCOMS), which adds to their financial crunch and discourages them from taking up any project in future.

b. Geopolitical Challenges

- India is dependent on foreign imports for energy infrastructure. The infrastructure required for setting up a solar power project has high initial costs, often due to unavailability of certain expensive materials used in the equipment (semiconductor chips) which shoot up the price of tools in the international market, hence hurting the country's reserves for imports.
- Apart from the regular energy infrastructure imports, some countries like China with abundant resources at their disposal, produce cheaper equipment to achieve economies of scale and then dump these cheap materials to other countries to eliminate competition. India also faces a similar situation, wherein, either the cost of installation is too high due to generally expensive imports or there are cheap and unreliable alternatives that endanger sustainability.

c. Environmental Challenges

- Solar panels generally have a lifespan of 20-25 years, after which they need to be dismantled and disposed of properly. In this scenario, India lacks a proper dumping and disposal process for solar panels' equipment and infrastructure, which knowingly threatens the environment and triggers pollution.
- Large chunks of arable lands often fall within the purview of allocation for power projects. This raises the issue of land wastage of a perfectly harvesting field where agriculture might have given some better pay off, especially in rural areas.

d. Infrastructural Challenges

- Large scale solar projects require large chunks of land, which are generally difficult to acquire either due to limited availability in that specific region, high market prices, politicisation among other factors.

Although there are projects being set up in some regions, the distribution of power still remains a grave concern as grid infrastructure is not pervasive. Lack of a modern electricity grid to support large-scale solar power transmission, especially in rural areas, is an obstacle in solar power adoption.

e. Policy and Regulatory Challenges

- Major differences in state-level policies, net-metering rules, and incentive's structure cause chaos and confusion amidst companies and investors. Additionally, lack of appropriate quality standards, subsidies, credit norms, and other incentives disrupt the growth of the solar power sector.

Individualistic state-level tender policies, delay in project approvals, and inherent politicisation hurt investor sentiment in the long-term. Also, there are no proper rules for rehabilitation of Project Affected Persons (PAP). Displacement of local communities and land-use conflicts also cause significant trouble for power projects.

f. Technical and Institutional Challenges

- Solar energy is largely weather dependent – which effectively means that without energy storage systems, the grid connected to the power station may not be able to supply power consistently, especially during night and cloudy days.

Lack of vocational training institutions and specialised training centres for people working in the renewable energy sector is a potential barrier that could harm its growth in the long term. Also, there are hardly any research institutions that provide R&D facilities and invest in new technologies in India.

Discussion

As per the data shown and analysed, India's **solar power capacity grew 33.5% over the last decade,** with some major and minor declines in a few years. The data shows us that India had an installed capacity of 1171.62 MW in 2014-15 which grew almost 1.5 or 2-fold for the next 3 years. However, in 2018-19, the capacity shrank and dropped to 6750.97 MW. Here, our data depicts each year's individual additive capacities, rather than a cumulative figure. After 3 years of constant decline, the solar capacity of India bounced back, starting from a constant growth and then almost doubling over the next two years. The analysis frames both annual growth rates and the compound annual growth rate which helps the reader visualise the complex growth of the solar power sector of India. Jammu and Kashmir as well as Rajasthan tops the list of Indian states with the highest establishments of solar power, i.e., 111050 MW and 142310 MW respectively, as of 31 March, 2024.

The regression analysis supports the alternative hypothesis that environmental investment and CO_2 emissions cause significant variability in GDP growth. At 95% confidence level and 5% significance level, the p-value (Significance F) when simplified, comes down to 0.00003740 which is essentially less than 0.05; which means

p-value (Significance F) < 0.05 = **Reject null hypothesis**

Additionally, if we observe the model's value of Adjusted R Square, which is 0.87313258, meaning that approximately 87% of the variation caused in GDP can be explained by CO_2 emissions and environmental investment. Thus, by rejecting the null hypothesis, we can say that environmental investment and CO2 emissions cause significant variability in the GDP growth. We can also conclude that this model is statistically significant.

However, if we see the individual p-values of the explanatory variables, i.e., environmental investment and CO_2 emissions, we happen to find that only environmental investment is a strong predictor for variations in GDP because its p-value (0.01) < 0.05, making it statistically significant. On the other hand, p-value of CO2 emissions' (0.56) > 0.05, making it statistically insignificant.

Lastly, we have discussed various barriers for the solar power sector of India, and have further categorised them under financial, geopolitical, environmental, infrastructural, policy and regulatory, as well as technical and institutional challenges. While some challenges are structural

(policy and regulatory, infrastructural, and institutional challenges) which could be solved with adequate measures, others are fairly external (geopolitical and environmental challenges) that might take a long while to settle down, even if adequate measures are taken.

6.1 Limitations

This study has a few limitations that should be considered. The study explores the solar power sector of India with its three distinctive objectives. In the first objective, we are only exploring and quantifying large scale solar installations, which obviously excludes small-scale solar installations such as data on rooftop solar panels, solar lamps, etc. The secondary data used in first and second objectives doesn't explicitly differentiate between the large-scale and small-scale installed capacities. There could be certain flaws in terms of data quality and accuracy.

6.2 Future Research

Future research can be done by analysing the third objective using primary data, rather than secondary data. Also, the examination of growth of the solar sector could be done more efficiently by analysing data of both large-scale and small-scale solar installations along with the related government schemes. Analysis scope for the second objective can be broadened by adding in more variables such as Indian green bonds data, renewable energy consumption data, conventional energy prices etc. to the regression equation, so as to get a clear picture of the relationship of all the factors/variables.

Conclusion

India's solar power sector has grown significantly in the last few years, making the country rank 4th globally in renewable installed capacity, and 3rd in solar power capacity, as per the International Renewable Energy Agency (IRENA) Renewable Energy Statistics 2025. Solar power has a considerable impact on the economic growth of India, it is also impacting the employment market of India, providing employment opportunities to skilled youth, and encouraging budding entrepreneurs to contribute in its growth chapter. The government has played a big role in this transformation through initiatives like National Solar Mission, PM-KUSUM Scheme, and PM Surya Ghar Muft Bijli Yojana among others.

However, despite this rapid growth, the solar power sector still faces major challenges. Many power projects struggle with funding shortages, especially in the early stages, making them exceptionally hard to initiate and survive in the long-run. Complicated regulations and tax policies add to these projects' difficulties, slowing down their development further. Another big issue is low investment in research and development (R&D). This limits innovation and lowers the success rate of projects compared to the global average.

The solar power sector also faces tough competition from various countries in equipment and infrastructure imports. There are also consumer trust issues due to the solar power sector being an unconventional source of power, which deters from it being the pivotal catalyst of transition. Many power projects fail due to lack of innovation, weak market demand, or operational challenges. To overcome these obstacles and build a stronger startup ecosystem, following measures must be taken:

- Invest more in research and development to encourage innovation and boost startup success rates in renewable energy sector
- Make funding and credit more accessible, especially for early-stage renewable startups, so as to provide Renewable Energy Projects (REPs) adequate funds.
- Simplify regulations regarding net-metering rules, energy supply, and incentive structure to make it easier to get project approvals.
- Build reliable institutions to provide better training to workers in the renewable energy industry.

- Establish rules for DISCOMS and vendors regarding project delivery, completion, and payment.
- Exchange knowledge from various countries regarding adequate disposal of obsolete equipment so it doesn't harm the environment in the long-term.

Despite the persistent challenges, India's solar power sector is full of potential. With a young, tech-savvy population and growing digital economy, the country is well-positioned to lead the global solar-power revolution. By investing in innovation, improving regulatory policies, and fostering entrepreneurship, India can turn its solar power sector boom into long-term economic strength.

References

1. United Nations. (2025). Sustainability. *United Nations*. https://www.un.org/en/academic-impact/sustainability
2. Kapoor, K., Pandey, K. K., Jain, A. K., & Nandan, A. (2014). Evolution of solar energy in India: A review. *Renewable and Sustainable Energy Reviews*, *40*, 475-487.
3. Data, S. (2025). *Energy Statistics Data Browser – Data Tools - IEA*. IEA. https://www.iea.org/data-and-statistics/data-tools/energy-statistics-data-browser?country=INDIA&fuel=Energy%20supply&indicator=DomesticProduction
4. Sharma, N. K., Tiwari, P. K., & Sood, Y. R. (2012). Solar energy in India: Strategies, policies, perspectives and future potential. *Renewable and sustainable energy reviews*, *16*(1), 933-941.
5. Singh, B. R., & Singh, O. (2016). Future scope of solar energy in India. *SAMRIDDHI: A Journal of Physical Sciences, Engineering and Technology*, *8*(01), 20-25.
6. Dawn, S., Tiwari, P. K., Goswami, A. K., & Mishra, M. K. (2016). Recent developments of solar energy in India: perspectives, strategies and future goals. *Renewable and Sustainable Energy Reviews*, *62*, 215-235.
7. Kar, S. K., Sharma, A., & Roy, B. (2016). Solar energy market developments in India. *Renewable and sustainable energy reviews*, *62*, 121-133.
8. Yenneti, K. (2016). The grid-connected solar energy in India: Structures and challenges. *Energy Strategy Reviews*, *11*, 41-51.
9. Abhani, D. K., & Desai, J. (2024). *Impact of green bonds on carbon emissions and GDP growth: A case study of the Indian economy*. ResearchGate.
10. Obani, I., Izu-Obani, Z., & Akroh, T. (2024). Renewable Energy and Economic Growth: An Empirical Analysis of the Relationship between Solar Power and GDP. *International Journal of Humanities Social Science and Management (IJHSSM)*, *4*(6), 3048–6874.
11. Bhardwaj, N., & Chauhan, N. (2025). Green Growth in India: Nexus Between Renewable Energy Deployment and Economic Sustainability. *International Journal of Innovative Research in Engineering & Multidisciplinary Physical Sciences*, *13*(3).
12. Goverdhan, R., Lankala, & Reddy, B. (2025). *Indiana Journal of Economics and Business Management the Impact of Renewable Energy Consumption on GDP and Carbon dioxide emissions in India Article History Citation of the Creative Commons Attribution 4.0 International License (CC BY-NC 4.0)*.
13. Acharyya, J. (2009). FDI, GROWTH AND THE ENVIRONMENT: EVIDENCE FROM INDIA ON CO 2 EMISSION DURING THE LAST TWO DECADES. *JOURNAL of ECONOMIC DEVELOPMENT*, *43*(1).
14. Tiwari, A. (2011). *A Structural VAR Analysis of Renewable Energy Consumption, Real GDP and CO2 Emissions: Evidence from India*. ResearchGate.
15. PIB (2025). *India's Energy Landscape Powering Growth with Sustainable Energy*. Pib.gov.in
16. Ministry of Finance (2024). *Union Budget*. Indiabudget.gov.in
17. *Explore Best Practices | ABP*. (2023). Championsofchange.gov.in.
18. Ministry of New and Renewable Energy. (2022). *Solar Overview | MINISTRY OF NEW AND RENEWABLE ENERGY | India*. Mnre.gov.in.
19. *Ministry of Statistics and Program Implementation | Government of India*. (2025). Mospi.gov.in.
20. ISA. (2022). *International Solar Alliance*. Isa.int.
21. Chahal, M. (n.d.). *Solar Energy Challenges and Future Role in India: A Review*. Retrieved March 5, 2026.
22. Indian Renewable Energy Federation (IREF). (2022). *Addressing barriers to scaling-up renewable energy through industry involvement*. Shakti Sustainable Energy Foundation.