Role of Solar Parks Towards Economic Development in India – An Overview

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Abstract
This study examines the role of solar parks in promoting economic development in India. The study findings highlight the significant economic, environmental, and social benefits of solar parks, including job creation, investment attraction, and reduced dependence on fossil fuels. However, the growth of solar parks is hindered by challenges such as land acquisition, technological barriers, and regulatory frameworks. The study is based on secondary data. The study suggests strategies to overcome these challenges and unlock the full potential of solar parks in India. The results of this study have important implications for policymakers, industry stakeholders, and researchers seeking to promote sustainable development and renewable energy in India.

Key words: India, Solar Park, economic development, Benefits

I. Introduction

One of the most important sources of renewable energy and electricity generation in India is solar power. With the aid of numerous government programs and growing public awareness of the value of sustainable development and renewable energy, India has greatly expanded its solar power since the early 2000s. The Ministry of New and Renewable Energy was established in 1982 to oversee the nation's efforts to further these objectives: reduce carbon dioxide emissions; lessen dependency on fossil fuels (coal currently serves as the country's main source of electricity); increase employment and the economy; and make India energy independent by relying on renewable energy. Together with international cooperation facilitated by the International Solar Alliance (ISA) since 2015, these cooperative initiatives.

Ecosystems face both possibilities and threats as a result of land use and land cover change (LULCC) brought on by the development of renewable energy, while energy policies have not fully taken this into account. Potential hazards include delay deployments and missed opportunities in project development proposals due to the heightened awareness of the ecological disaster. Quick identification of the kind, scope, and spatial distribution of ecosystem impacts, creation of industry standards, and given the need to decarbonize the current energy supply, international initiatives to provide universal access to energy, and the exponential expansion of renewable energy in response to rising global energy consumption per capita, policy is important. Given that photovoltaic (PV) drives the growth of renewable energy, it is imperative to advance scientific knowledge of LULCC for ground-mounted PV solar energy parks **(Li Guoqing.et,).**

There has been a visible impact of solar energy in the Indian energy scenario during the last few years. Solar energy based decentralized and distributed applications have benefited millions of people in Indian villages by meeting their cooking, lighting and other energy needs in an environment friendly manner. The social and economic benefits include reduction in drudgery among rural women and girls engaged in the collection of fuel wood from long distances and cooking in smoky kitchens, minimization of the risks of contracting lung and eye ailments, employment generation at village level, and ultimately, the improvement in the standard of living and creation of opportunity for economic activities at village level. Further, solar energy sector in India has emerged as a significant player in the grid connected power generation capacity over the years. It supports the government agenda of sustainable growth, while, and emerging as an integral part of the solution to meet the nation's energy needs and an essential player for energy security (**Ministry Of New and Renewable Energy).**

Installation of solar energy has increased more than ever before since it is more affordable than alternative energy sources like wind and hydropower. India is now home to some of the biggest solar parks in the world thanks to these resolute efforts. One such park is the Bhadla Solar Park in Rajasthan, which will produce 2,245 MW of solar electricity by 2024, making it the largest in India and the eleventh largest globally. As of November 30, 2024, India had 94.17 GWAC of installed solar power capacity. Achieving 500 GW of renewable energy by 2030, of which at least 250 GW will come from solar power, is another requirement for India to become carbon neutral by 2070. These are the requirements for the country to lower its carbon emissions.

India is home to the headquarters of the International Solar Alliance (ISA), which it proposed as a founding member. In an effort to harness the world's plentiful solar electricity, India has also proposed the "One Sun One World One Grid" and "World Solar Bank" concepts.
The initial 20 GW capacity target set by the Indian government for 2022 was met four years ahead of schedule. The goal was increased in 2015 to 100 GW of solar capacity by 2022, including 40 GW from rooftop solar, with an investment of $100 billion. Poor performance in the rooftop sector caused a 40,000 MW shortfall, which significantly missed the target. 70% of the 2.1 GW of rooftop solar power generated in 2018 came from commercial or industrial uses. India is creating off-grid solar power to meet local energy demands in addition to its extensive grid-connected solar photovoltaic (PV) project. By the end of 2015, just under 10 lakh (1 million) solar lanterns had been sold, demonstrating how solar products have increasingly contributed to address rural needs.

II. Review of Literature

- **Radhey shyam Meena.et. (2019): Development of solar parks in India and the way forward:** This study analysed **solar** park development in India. The study found that India aims to generate 40% of its power from renewables by 2030, as per the Paris Climate Accord. To achieve this, India targets 175 GW of renewable energy capacity by 2022. With 82 GW already installed, India is on track to become one of the largest green energy producers globally. Solar and wind power costs have declined significantly, making them cheaper than thermal power. By 2030, India will require 500 GW of solar and wind power capacity. This paper discusses the current status and role of solar parks in India's renewable energy growth, initiatives, and challenges faced by solar project developers.
- **Amirullah (2021): Public Private Partner in Solar Energy Development of India.** The study found that India's growing economy and increasing energy demand have led to a reliance on conventional energy sources, straining financial resources and threatening the climate. However, India's tropical location offers immense solar energy potential. To harness this potential, the Indian government launched the Jawaharlal Nehru National Solar Mission (JNNSM) in 2009, and aiming to deploy 100,000 MW of solar power by 2022.Public-Private Partnerships (PPPs) can help achieve this target by bringing in technology, expertise, and capital. Several states have initiated solar projects, and the government plans to set up solar cities, parks, and ultra-mega solar projects through PPPs, positioning India as a renewable energy superpower.
- **Brijesh Kumar Vyas.et, (2022): Planning and developing large solar power plants: A case study of 750 MW Rewa Solar Park in India.** The study focused on solar park planning and how it's developing. The National Solar Mission was introduced in India in 2009 with an initial target of achieving 20 GW of solar installations by 2022. However, in 2014, the target was revised to 100 GW, and a solar park scheme was launched to promote large solar power projects. The Rewa Ultra Mega Solar Park is a notable example of a large solar power project in India. Planning for the project began in 2014, and full commercial generation started in 2020. The park has achieved a levelized tariff of Rs 3.30 (~USD 0.04) per unit for 25 years, making it one of the cheapest solar power producing plants in the world. This paper provides an in-depth look at the planning and development of the Rewa Ultra Mega Solar Park, reviews common risks associated with large renewable projects, and analyses ways in which the park has mitigated those risks. The insights gained from this study are useful for designing policies and planning for large solar projects in India and elsewhere.
- **Sanju John Thomas.et, (2023): Solar parks: A review on impacts, mitigation mechanism through agrivoltaics and techno-economic analysis.** Solar parks require large land areas, potentially impacting local livelihoods and the environment. This study reviews the effects of solar parks on livelihoods and explores agrivoltaics (combining agriculture and solar power) as a mitigation mechanism. The study found that agrivoltaics can increase income through medicinal plants, poultry, and beekeeping. Economic analysis showed that agrivoltaic plants can break even in 3-4 years, while conventional solar plants break even in 2-4 years. The study highlights the importance of considering social impact mitigation costs and environmental impact mitigation costs when calculating the levelized cost of energy (LCOE). With subsidies and incentives, the LCOE for agrivoltaic plants can be reduced to 0.041 $/kWh, making them a viable option.
- **Stuti Haldar.et, (2024): Reimagining energy infrastructure for justice: Power, politics, and institutional work in India's 2.05 GW Pavagada solar park.** India aims to transition its energy sector to renewable sources, with ambitious targets and policies. The country has made significant progress, achieving 40% of its installed renewable electricity generation capacity by 2023. To meet its revised target of 500 GW by 2030, India is deploying large-scale renewable energy projects, including solar parks. This study focuses on the Pavagada Solar Park (PSP), a 2050 MW project in Karnataka, India. The research examines the institutional work and power dynamics involved in the project's planning and realization, highlighting the impact on local communities and socially just outcomes.

III.Research Objectives

- To Analyse the Role of Solar Parks in India's Economic development.
- To Identify the Benefits of Solar Parks in India.

IV. Research Methodology

The present study is based on secondary data. The data is collected from various sources like books, Academic journals and Articles, Research papers, government websites or department websites, Media Reports, internet sources, government reports and Publications, statistical data.

V. The role of solar parks towards Economic development in India

A. Economic benefits

- **Job creation:** Manufacturing, installation, and maintenance jobs are created by solar parks. Employments have been produced in India by the solar industry, according to the International Renewable Energy Agency (IRENA).
- **Investment attraction:** By drawing capital from both domestic and foreign businesses, solar parks promote economic expansion. With more than $10 billion invested in 2020 alone, India has drawn substantial investments in the renewable energy sector.
- **Revenue generation:** Through taxes, royalties, and lease payments, solar parks bring in money for the government. The selling of solar power has brought in a substantial amount of money for the Indian government; in 2020, the Solar Energy Corporation of India (SECI) brought in over ₹10,000 crores, or almost $1.4 billion.
- **Less reliance on fossil fuels**: By lowering India's reliance on imported fossil fuels, solar parks help the country save money. Over 80% of India's oil needs are imported; lowering this reliance can aid in stabilizing the trade balance of the nation.

B. Infrastructure Development

- **Grid expansion:** Solar parks require grid expansion and strengthening, improving the overall power infrastructure. The Indian government has invested heavily in grid expansion, with over ₹2.5 lakh crores (approximately $35 billion) invested in the past five years.
- **Road and transportation infrastructure:** Solar parks necessitate the development of roads and transportation infrastructure, benefiting local communities. The Indian government has invested in road development, with over ₹1.5 lakh crores (approximately $21 billion) invested in the past five years.
- **Water and sanitation infrastructure:** Solar parks may require water and sanitation infrastructure development, improving local living standards. The Indian government has invested in water and sanitation infrastructure, with over ₹1 lakh crore (approximately $14 billion) invested in the past five years.

- **Telecommunication Infrastructure**

Solar parks require telecommunication infrastructure development, enhancing communication networks and promoting digital connectivity. The Indian government has invested in telecommunication infrastructure, with over ₹50,000 crores (approximately $7 billion) invested in the past five years.

C. Social Benefits

- **Rural development:** Solar parks can contribute to rural development by providing employment and income opportunities. Solar parks can also provide energy access to rural communities, improving their quality of life.
- **Energy access:** Solar parks help increase energy access for rural and remote communities, improving their quality of life. India has made significant progress in increasing energy access, with over 99% of households having access to electricity.
- **Reduced greenhouse gas emissions:** Solar parks contribute to India's climate change mitigation efforts, reducing greenhouse gas emissions. India has set ambitious targets to reduce its greenhouse gas emissions, with a goal of reducing emissions intensity by 33-35% by 2030.

D. Other Benefits

- **Eco-Friendly**

  The low environmental impact of solar power plants is one of their biggest benefits. Solar energy helps lower pollution and greenhouse gas emissions because it doesn't emit any damaging substances like conventional fossil fuels do. Solar power is an important component of sustainable energy solutions and development because of its environmentally friendly character, which is essential in the battle against climate change. Sustainable energy source. The sun continuously replenishes solar electricity, making it a renewable energy source. The endless nature of solar energy ensures a long-term, sustainable energy solution, unlike finite fossil fuels. This advantage is especially significant since the world's energy needs are only going to increase, requiring dependable and sustainable energy sources.

- **Decreases Dependency on Fossil Fuels**

By using solar energy, we reduce our reliance on fossil fuels and preserve these priceless resources for use in the future. The benefits of solar power plants in this shift not only help in preserving natural resources but also reduce the geopolitical and economic vulnerabilities associated with fossil fuel dependence. This transition underscores the importance of harnessing clean and sustainable energy sources to ensure a more resilient and environmentally friendly future. Low Maintenance Solar power plants or solar open access require minimal maintenance, making them an

economically viable option. Once installed, they need only occasional cleaning and routine checks, leading to significant savings in operational costs over the years.

- **Long Lifespan**

The main component of solar power plants, solar panels, is made using a high-quality method and usually last 25 to 30 years. Because of its extended lifespan, solar power's advantages—like lower electricity costs and a less negative environmental impact—can be reaped for many years.

- **Boosts the Value of Real Estate**

The value of properties with solar power systems frequently rises. An additional advantage of solar plants is that they are a wise investment for property owners, as solar panels are seen as a valuable asset that not only helps with energy savings but also attracts environmentally concerned buyers.

- **Energy Portfolio Diversification**

Adding solar energy to a nation's energy mix improves energy security and lessens dependency on foreign fuels. In order to ensure a steady and dependable energy supply, this diversification is crucial for national energy strategy.

- **Qualified for Government Rebates**

Numerous countries worldwide offer tax credits, rebates, and feed-in tariffs as incentives for the installation of solar power. By lowering costs and increasing accessibility, these incentives promote the broad use of solar energy.

- **Promotes the Local Economy**

Manufacturing, installation, and maintenance jobs are all generated by the expanding solar industry. Local economies are strengthened and overall economic growth is aided by investments in solar power facilities.

- **Lowers Emissions of Greenhouse Gases**

Since solar power plants don't emit greenhouse gases while they're operating, they're a crucial component of the fight against climate change. Solar energy helps create a more sustainable future and a healthier planet by lowering emissions. energy, reducing greenhouse gas emissions and mitigating climate change. India has set ambitious targets to reduce its greenhouse gas emissions, with a goal of reducing emissions intensity by 33-35% by 2030.

- **Air Pollution Reduction**

Solar parks help reduce air pollution by decreasing the reliance on fossil fuels. The Indian government has estimated that the transition to renewable energy can prevent over 1 million premature deaths annually.

- **Water Conservation**

Solar parks require very little water to operate, conserving this precious resource. India is facing significant water scarcity challenges, and solar parks can help alleviate this pressure.

- **Telecommunication Infrastructure**

Solar parks require telecommunication infrastructure development, enhancing communication networks and promoting digital connectivity. The Indian government has invested in telecommunication infrastructure, with over ₹50,000 crores (approximately $7 billion) invested in the past five years.

E. Technological Benefits

- **Technological Innovation**

Solar parks promote technological innovation and improvement in manufacturing capabilities, driving research and development in the renewable energy sector. The Indian government has implemented policies to promote innovation, including the Make in India initiative.

- **Increased Energy Efficiency**

Solar parks can incorporate energy-efficient technologies, reducing energy losses and improving overall energy efficiency.

- **Smart Grid Integration**

Solar parks can be integrated with smart grid systems, enhancing energy management and distribution. The Indian government has invested in smart grid development.

The Union Minister for New & Renewable Energy and Power has informed that India’s total solar energy potential has been estimated to be 748 GWp (Giga Watt peak), as estimated by National Institute of Solar Energy (NISE), on the basis of the data from Waste Land Atlas of India 2010. State-wise details are given below.

Table: 01 STATE/UT-WISE DETAILS OF SOLAR POTENTIAL

Sl. No.	Name of State/UT	Solar Potential (MW_P)
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	Jammu & Kashmir	111050
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	Orissa	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	Delhi	2050
31	Others (UTs)	790
	Total	**748990.00= 748 GW_P**

(Source: Ministry of New and Renewable Energy)

Table: 02 - The Details of Fund Released In Last Financial Year

Sl. No	State	2022 - 23
1	Andhra Pradesh	68.96
2	Arunachal Pradesh	9.30
3	Assam	14.02
4	Chandigarh	0.73
5	Chhattisgarh	13.54
6	Delhi	10.07
7	Gujarat	1114.65
8	Haryana	118.18
9	Himachal Pradesh	15.73
10	Jammu & Kashmir	27.98
11	Jharkhand	40.64
12	Karnataka	90.98
13	Kerala	89.71
14	Ladakh	125.00
15	Madhya Pradesh	170.14
16	Maharashtra	304.58
17	Mizoram	1.29
18	Nagaland	6.37
19	Odisha	26.70
20	Punjab	55.93
21	Rajasthan	258.84

22	Tamil Nadu	10.98
23	Telangana	42.81
24	Tripura	0.12
25	Uttarakhand	8.33
26	Uttar Pradesh	74.32
27	West Bengal	4.71
28	Others (CEL, REL, NABARD, Regional Rural Banks, NGOs, etc.) and other Channel Partners	17.71
Total		**2722.32**

(Source: Ministry of New and Renewable Energy)

Table: 03 - Details of Solar Parks sanctioned and projects commissioned State-wise - 2023)

Sl.No	State	Number of Parks	Sanctioned Capacity (MW)	Projects commissioned (in MW)
1	Andhra Pradesh	5	4200	3050
2	Chhattisgarh	1	100	28
3	Gujarat	7	12150	900
4	Jharkhand	3	1089	0
5	Karnataka	2	2500	2000
6	Kerala	2	155	100
7	Madhya Pradesh	8	4180	1000
8	Maharashtra	3	1000	0
9	Mizoram	1	20	20
10	Odisha	3	340	0
11	Rajasthan	9	8276	3065
12	Uttar Pradesh	7	3730	341
Total		51	37740	10504

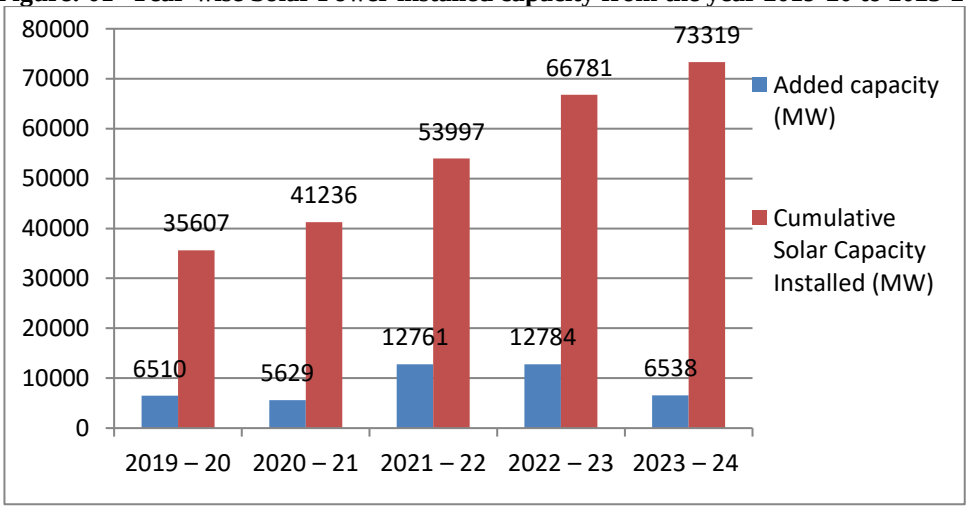
(Source: Ministry of New and Renewable Energy)

Table: 04- Year-wise Solar Power installed capacity from the year 2019-20 to 2023-24 (up to December 2023)

Sl. No	Year	Added capacity (MW)	Cumulative Solar Capacity Installed (MW)
1	2019 – 20	6510	35607
2	2020 – 21	5629	41236
3	2021 – 22	12761	53997
4	2022 – 23	12784	66781
5	2023 – 24	6538	73319

(Source: Ministry of New and Renewable Energy)

Figure: 01- Year-wise Solar Power installed capacity from the year 2019-20 to 2023-24



The Government has set a target of achieving 500 GW of installed capacity from non-fossil fuel sources by 2030, in line with the Prime Minister's announcement at COP-26, held in Glasgow. State-wise targets for this goal have not been set. This information has been given by the Union Minister for New & Renewable Energy and Power Shri R. K. Singh, in written replies to two separate questions, in Rajya Sabha on February 6, 2023.

The Union Minister for New & Renewable Energy and Power has informed that the Government has sanctioned a total of 50 Solar Parks with aggregate capacity of 37,490 MW in 12 States across the country, under Solar Parks Scheme since 2014. In these parks, solar projects of aggregate capacity of 10,237 MW have been established. The State-wise, year-wise details of solar projects established in Solar Parks with their capacity since 2018-19, are given below.

Table: 5 - State-wise, year-wise details of solar projects established in Solar Parks with their capacity since 2018-19 to 2023 - 24

Sl. No	State	Name of Park	Year – wise Capacity Established					
			2018-19	2019 - 20	2020-21	2021 - 22	2022 - 23	2023 - 24
1	Andhra Pradesh	Ananthapuramu-I Solar Park (1400)	400	250	402	98	0	00
2		Kadapa Solar Park (1000)	0	250	0	0	0	0
3		Ananthapuramu-II Solar Park (500)	400	0	0	0	0	100
4	Gujarat	Radhnesada Solar Park (700)	0	0	0	485	15	0
5		Dholera Solar Park (1000)	0	0	0	300	0	0
6	Karnataka	Pavagada Solar Park(2000)	800	600	0	0	0	0
7	Kerala	Kasargod Solar Park(105)	0	0	50	0	0	0
8	Madhya Pradesh	Rewa Solar Park(750)	490	260	0	0	0	0
9	Mizoram	Vankal Solar Park(20)	0	0	0	0	20	0
10	Rajasthan	Bhadla-III Solar Park(1000)	500	500	0	0	0	0
11		Bhadla-IV Solar Park(500)	250	250	0	0	0	0
12		Phalodi-Pokaran Solar Park(750)	0	0	0	300	0	0
13		Fatehgarh Phase-1B Solar Park(421)	0	0	0	421	0	0
14	Uttar Pradesh	Solar Park in UP(365)	40	0	0	0	75	0
15		Kalpi Solar Park(65)	0	0	0	0	26	0
Total			2880	2110	452	1604	136	100

(Source: Press Information Bureau Government of India)

VI. Findings of the study

- Solar parks have created employment opportunities in India.
- Solar parks have attracted significant domestic and international investments.
- Solar parks reduce India's dependence on imported fossil fuels.
- Solar parks promote the use of renewable energy in India.
- Solar parks reduce air pollution by decreasing reliance on fossil fuels.
- Solar parks conserve water by requiring very little for operation.
- Solar parks increase energy access for rural and remote communities.
- Solar parks improve public health by reducing air pollution.

VII. Suggestions

- The government should simplify land acquisition processes for solar park development.
- Investing in technological innovation can enhance the competitiveness of India's solar industry.
- A strengthened policy and regulatory framework is necessary to support the growth of solar parks.
- Increasing investment in solar parks can accelerate India's transition to renewable energy.
- Developing a skilled workforce is crucial for the growth and sustainability of India's solar industry

VIII. Conclusion

The development of solar parks in India has emerged as a crucial strategy for promoting economic growth, reducing dependence on fossil fuels, and mitigating climate change. The findings of this study highlight the significant economic, environmental, and social benefits of solar parks in India. To overcome the challenges faced by solar parks, this study suggests simplifying land acquisition processes, promoting technological innovation, strengthening policy and regulatory frameworks, increasing investment in solar parks, and developing a skilled workforce. By implementing these strategies, India can accelerate its transition to renewable energy, promote sustainable development, and achieve its climate change mitigation goals.

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