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Research Article

Socio-Economic And Environmental Impacts of Solar Energy Adoption in India

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ABSTRACT

In the last ten years, the Indian solar energy market has grown rapidly, with installed capacity shooting up from 2.82 GW in 2014 to 150 GW as of early 2026, making solar energy the largest player in the country's non-fossil fuel energy generation sector. This article reviews the findings on the socio-economic and environmental impacts of solar energy transition. The socio-economic impact encompasses job creation in manufacturing, engineering, procurement, and construction as well as operations and maintenance; savings from electricity consumption for households (including PM Surya Ghar); benefits from rural livelihood initiatives introduced under PM-KUSUM; and the emergence of domestic module manufacturing businesses induced by the establishment of the Production Linked Incentive scheme. Environmental impact includes reduced GHG emissions due to solar energy generation, water savings compared to thermal power generation, and the implications for land use that are being championed through agrivoltaic and floating solar projects. Finally, the research highlights major obstacles to the solar energy transition, including grid integration issues and costs related to financing and disposal of stations that have ceased to operate.

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KEYWORDS: solar energy, India, socio-economic impact, environmental impact, sustainable development, renewable energy policy.

1. INTRODUCTION

India's energy transition has been anchored by an aggressive scale-up of solar photovoltaic (PV) capacity since the launch of the Jawaharlal Nehru National Solar Mission (JNNSM) in 2010. Motivated by energy security concerns, rising electricity demand, and international climate commitments, India set successive capacity targets culminating in a goal of 500 GW of non-fossil-fuel capacity by 2030. Solar power has emerged as the dominant driver of this expansion: cumulative installed solar capacity crossed 150 GW by March 2026, up from just 2.82 GW in 2014, representing more than a fifty-fold increase over roughly twelve years. This growth has been accompanied by wide-ranging socio-economic and environmental consequences that extend well beyond the electricity sector itself, touching employment, rural incomes, manufacturing competitiveness, land use, water resources, and public health. This review examines these impacts holistically, drawing on recent policy, industry, and government data to assess how solar energy adoption is reshaping India's development trajectory.

The Indian transition to renewable energy can be understood through the context of rapid deployment of solar photovoltaics (PVs) following the launch of the Jawaharlal Nehru National Solar Mission (JNNSM) in 2010. Fueled by energy security considerations, electricity consumption, and international climate obligations, India established ambitious capacity targets that culminated in a capacity target of 500 GW of non-fossil fuel capacity by 2030. Solar energy has proven to be the key contributor to the capacity build-up with the cumulative solar capacity installations exceeding 150 GW in March 2026 from just 2.82 GW in 2014, thereby registering an increase of over 50 times in a span of twelve years. The rise in solar capacity has had a range of socio-economic and environmental implications for India that have been felt beyond the electricity generation sector, including labor markets, rural economy, competitiveness, land use, water usage, and public health. This paper looks at these implications in their totality based on current policies, industries, and government data.

2. Policy Framework Driving Solar Adoption

Table 1: Growth of India's Installed Solar Capacity, 2014–2026

Installed Solar Capacity (GW)	Annual Addition (GW)	Source, Year
2.82	—	MNRE, 2014
23.12	~6.0	MNRE/CEA, 2018
73.32	~13.0	MNRE, 2023
136	37.8	JMK Research, 2025
150.3	~14.0 (Q1)	JSW Energy / MNRE, 2026

Note. Compiled from Ministry of New and Renewable Energy (MNRE), Central Electricity Authority (CEA), JMK Research, and JSW Energy reports (2018–2026).

3. Socio-Economic Impacts

3.1 Employment and Industrial Growth

The solar value chain has created significant employment opportunities, both direct and indirect, including those related to the production of polysilicon and wafer manufacturing, modules and cells manufacturing, project engineering and construction, and operation and maintenance. The domestic manufacturing policies have spurred on large companies like Adani, ReNew, NTPC, JSW Energy, and Greenko to invest in their pipeline of solar and hybrid projects.

3.2 Household and Rural Livelihoods

PM Surya Ghar scheme rooftop solar has brought down electricity bills for those who have opted for it, and at the same time, it has provided an opportunity for generating extra power and selling the surplus back to the electricity companies. In rural areas, farmers have been able to save themselves from diesel irrigation pumps with the help of PM-KUSUM, which has not only increased their farm income but also improved energy security.

3.3 Manufacturing and Economic Value Addition

The swift development of indigenous capacity in cell and module manufacturing has decreased dependency on imports and has started the process of value addition inside the solar energy industry chain. These developments have further implications for forex savings, Atmanirbhar Bharat objectives and competitive advantage of indigenous solar equipment in international markets. Table 2 highlights some of the socio-economic and environmental parameters of India's solar energy transition.

Table 2: Key Socio-Economic and Environmental Indicators of Solar Adoption in India

Dimension	Indicator / Impact	Approx. Value / Trend
Employment	Jobs in solar value chain (manufacturing, EPC, O&M)	Rising with domestic manufacturing (PLI scheme)
Household Savings	Electricity bill reduction under PM Surya Ghar	>26 lakh households covered; ~₹14,771 crore disbursed
Rural Development	Farmer income via PM-KUSUM solar pumps/feeders	Reduced diesel dependence; irrigation reliability
Manufacturing	Domestic module manufacturing capacity	Grew from 2.3 GW (2014) to ~172 GW (Mar 2026)
Emissions Avoided	CO2 mitigation from solar generation	Substantial and growing with capacity additions
Land Use	Land requirement for utility-scale plants	~4–5 acres per MW; agrivoltaics mitigates trade-off
Water Savings	Water use vs. thermal power generation	Significantly lower water intensity than coal plants

Note: Compiled from MNRE, PM Surya Ghar dashboard, and industry reports (2024–2026).

4. Environmental Impacts

4.1 Emissions Reduction

Replacing coal power with solar energy leads to lower levels of greenhouse gases as well as particulate matter, sulfur dioxide, and nitrogen oxide. With more use of solar energy in the power production, there is increased level of cumulative emission avoidance in line with India’s Nationally Determined Contributions (NDCs).

4.2 Water Conservation

Solar PV energy production uses minimal water compared to thermal power stations that use huge quantities of water for cooling purposes. The saving of water is crucial in states like Rajasthan and Gujarat where there is a scarcity of water. Utility-scale solar PV plants have been installed in these states in large numbers.

4.3 Land Use and Biodiversity Considerations

Large utility-scale solar plants demand a lot of land space, with each megawatt needing between four and five acres of land space. This raises concerns regarding land use conflicts and effects on the ecosystems of the areas. Some innovations in the industry include agrivoltaics that combine food production and solar energy production, and floating solar power plants on reservoirs.

4.4 End-of-Life Waste Management

With India's first solar energy projects nearing the end of their useful life span, the issue of module waste management becomes increasingly pressing for the environment. Recycling facilities and extended producer responsibility systems must be put in place to ensure that there is no e-waste generated by obsolete panels.

5. Challenges and Constraints

While there has been robust growth, certain issues hamper the development of solar adoption. Grid integration becomes an issue in light of the variability of solar power generation and the need to develop battery energy storage systems, transmission networks, and flexibility of generation sources. The purchase of land for large utility projects may raise concerns among communities. Moreover, while financing is becoming less expensive, it is still one of the issues for smaller developers and rooftop owners living in low-income families. Lastly, there is the concentration of utility-scale solar capacity in a few states such as Rajasthan, Gujarat, and Tamil Nadu.

6. Solar Energy and the Sustainable Development Goals

Utilisation of solar power in India has direct relevance to several Sustainable Development Goals. This supports the achievement of Goal 7 (Affordable and Clean Energy) through provision of increased access to energy and lowering costs; Goal 8 (Decent Work and Economic Growth) through job creation; Goal 9 (Industry, Innovation and Infrastructure) through increased local manufacture; and Goal 13 (Climate Action) through prevention of emissions. Continued synergy between solar policy and development goals will play an important role in making sure benefits are shared.

7. CONCLUSION

The Indian solar industry has seen impressive growth on account of a well-coordinated policy regime covering missions at the national level, production policies, and subsidies to households. Such growth has brought with it socio-economic advantages, including jobs, rural livelihoods development, and value creation in industry, as well as environmental advantages of emission reduction and savings in water consumption. Simultaneously, issues surrounding land use, grid connections, and future waste from solar modules demand continued policy focus. With a goal of achieving 500 GW non-fossil fuel capacity by 2030, storage technologies, recycling, and regional development will become crucial elements of solar policy in India.

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