Solar Power in India:

A Case Study of the Bhadla Solar Power Park

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Raktim Majumder

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Author: **Raktim Majumder**
Cover & Layout: **Haripriya Harshan**

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Contents

List of Abbreviations

ADB- Asian Development Bank
AIIB- Asian Infrastructure Investment Bank
CDM- Clean Development Mechanism
CIF- Climate Investment Fund
CTF- Clean Technology Fund
DMCs- Developing Member Countries
ESSP- Environmental and Social Policy Procedures
GoI- Government of India
IFC- International Financial Corporation
IREDA- Indian Renewable Energy Development Agency
JNNSM – Jawaharlal Nehru National Solar Mission
JVC- Joint Venture Company
MNRE -Ministry of New and Renewable Energy
NBFC - Non-Banking Financial Company
NDCs- Nationally Determined Contributions
NTPC- National Thermal Plant Corporation
NTPCREL- National Thermal Plant Corporation Renewable Energy Limited
PV -photovoltaic
RE- Renewable Energy
RoW- Right of Way
RREC- Rajasthan Renewable Energy Corporation
RRVPNL- Rajasthan Rajya Vidyut Prasaran Nigam Limited
RSDCL- Rajasthan Solar Park Development Company Limited
SECI- Solar Energy Corporation of India
Solar Project Developers - Solar Project Developers
SPDs- Solar Park Developers
SPPDs- Solar Power Park Developers
SPV- Special Purpose Vehicles

Introduction

The Bhadla Solar Power Park, boasting a capacity to generate 2245 MWs of solar power, stands as the world's largest solar power park. Spanning across a vast expanse of 5700 hectares, a size almost equivalent to that of San Marino[1]. Bhadla has been touted as a striking exemplar of how a fusion of innovation, cutting-edge technology, and a blend of public and private financial support can propel the cause of green energy.

However, the Bhadla case also shines a light on a pressing issue: the emerging conflicts over land resources[2] in the realm of solar infrastructure development. Many of the locations chosen for solar power projects are government-owned lands traditionally used by local communities for their livelihoods. In this context, it is noteworthy that the 2013 Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation, and Resettlement Act, which safeguards the rights of landholders during acquisition processes, does not apply to government-held lands. Consequently, when these government lands are repurposed for solar power generation, the Act's protective provisions fail to address the displacement and economic disruption experienced by local communities who relied on these lands for their sustenance. The absence of a clear legal framework in such cases often leads to ongoing disputes and grievances.

This preliminary report delves into the specific case of Bhadla, offering valuable insights into the prevailing issue of what can be termed "green grabbing"[3]. It sheds light on the approach adopted by the Indian government in establishing solar parks, particularly in the context of achieving its broader objectives of transitioning to a renewable energy-powered economy. The report thus also delves into the financial architecture behind the development of Bhadla Solar Power Park.

Currently, India accommodates several ultra-mega solar parks boasting capacities exceeding 1GW, two of which stand as the world's largest commissioned parks to date. These solar parks in India consistently draw global investments and interest from esteemed domestic and international renewable energy developers[4]. These investments are claimed to have transformed erstwhile wastelands into highly efficient solar energy facilities.

However, it is crucial to recognize that such approaches to renewable energy transition may fall short of achieving a fair and just transition. Land enclosures for utility-scale solar energy generation not only dispossess local communities of their livelihoods but also do not necessarily translate into the electrification of households located in close proximity to these solar parks, further exacerbating the social and economic disparities caused by these projects. A comprehensive and equitable approach to renewable energy transition should encompass the interests and well-being of both local communities and the broader energy goals.

[1] Verma. (2023, March 17). How PM Narendra Modi is Leading the Way for Green Growth in India. *News18*. Retrieved October 9, 2023, from https://www.news18.com/opinion/opinion-how-pm-narendra-modi-is-leading-the-way-for-green-growth-in-india-7316845.html
[2] Chari. (2020, September 20). How solar farm fuels lad conflicts. *Mint*. Retrieved October 9, 2023, from https://www.livemint.com/news/india/how-solar-farms-fuel-land-conflicts-11600612526037.html
[3] Fairhead, J., Leach, M., & Scoones, I. (2012, April). Green Grabbing: a new appropriation of nature? *Journal of Peasant Studies*, *39*(2), 237–261. https://doi.org/10.1080/03066150.2012.671770
[4] Shah. (2020, May). *India's Utility-Scale Solar Parks a Global Success Story: India Is Home to the World's Largest Utility-Scale Solar Installations*. Institute for Energy Economics and Financial Analysis. https://ieefa.org/wp-content/uploads/2020/05/Indias-Utility-Scale-Solar-Parks-Success-Story_May-2020.pdf

Chapter One: Unravelling India's Renewable and Solar Energy Infrastructure

Given the pressing nature of the climate crisis, there is a significant shift in energy infrastructure happening, moving away from fossil fuels to harnessing energy from renewable and non-carbon sources. In this case, techno-managerial solutions to the climate crisis through the establishment of large scale Renewable Energy (RE) infrastructures has become the sine qua non. India, too, has been making rapid strides in this journey of transitioning its energy sources.

On the 12th of August, 2021, the Indian economy crossed the mark of 100 Gigawatts in installed renewable power generation capacity[5]. As of February 2023, the country's renewable energy capacity, excluding large hydro and nuclear plants, has reached 122 GW. This represents a nearly 15% growth compared to the figures from February 2022. However, it's important to note that this growth still falls short of the central government's target of 175 Gigawatts by the end of 2022, with a deficit of 30%.[6] In the year 2022, the government decided to revise its renewable energy goals. The initial target of reaching 500 GigaWatts of renewable energy capacity was adjusted, and instead, a more flexible plan was adopted, aiming for 50% of electricity generation to come from non-fossil fuel sources.

In terms of the institutionalization of the renewable energy infrastructure, India has achieved significant progress in the global forum. With time, in the renewable energy sector, the Indian economy has nurtured a market space, which has set it as one of the fastest growing, and sought after destinations for foreign investments, and green energy pacts[7]. Consequently, foreign countries are continually seeking opportunities to engage with India's renewable energy sector. Officials and stakeholders closely monitoring this institutional shift in energy transition have projected that the renewable energy sector in India will attract investment opportunities amounting to Rs 1 lakh crore annually over the next decade[8].

While India has emerged as a key hub for forging green energy agreements, it currently lacks a framework to enable a "just transition" to renewable energy[9]. This oversight neglects the legitimate concerns of people during this shift to renewable energy and fails to address them adequately. The methods for evaluating the effectiveness of renewable energy projects tend to primarily focus on estimations, numerical data, and statistics. Numbers have mostly dominated the speculations around financial investments, and employment generation in case of RE transition in India. However, this approach has resulted in the neglect of significant challenges and their real-life impacts on people. As observed by Shukla, and Sharma (2021), those responsible for overseeing the transformative process have failed to tackle critical questions. These questions pertain to the collective and shared consequences of the transition, as well as the necessary institutional and procedural mechanisms required to ensure a seamless transition and mitigate its unintended repercussions.

Despite the enthusiastic celebration of the infrastructure for transitioning to renewable energy, current energy transition policies in India have largely disregarded significant critical feedbacks coming from various stakeholders concerning the shape and direction of the national energy transition. Environmental activists, civil society organizations, and energy experts have rightly voiced their respective concerns against policies that blindly chase higher and higher renewable energy targets. Similarly, the potential involvement, in the renewable energy sector, of workers in

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[5] Live Mint Staff. (2021, 12 Aug). India's installed renewable energy capacity crosses 100 GW. Mint. https://www.livemint.com/industry/energy/indias-installed-renewable-energy-capacity-crosses-100-gw-11628781563745.html

[6] Paul, Manjul. (2023, 30 March). India's renewable energy capacity at 122 GW in February. Mint. https://www.livemint.com/news/india/indias-renewable-energy-capacity-at-122-gw-in-february-11680179203975.html

[7] Live Mint Staff. (2023, 6 February). India most suitable destination for renewable energy investments: PM Modi. Mint. https://www.livemint.com/news/india/india-most-suitable-destination-for-renewable-energy-investments-pm-modi-11675681344286.html

[8] Mohanty Shashwant.(2020, Nov 26). India sought after for green energy pacts, says Renewables Secretary Indu Shekhar Chaturvedi. The Economics Times. https://energy.economictimes.indiatimes.com/news/renewable/india-sought-after-for-green-energy-pacts-says-renewables-secretary-indu-shekhar-chaturvedi/79421948

[9] Shukla, & Sharma. (2021, September 17). A 'just transition': Is India's green transition inclusive? *Observers Research Foundation*. Retrieved September 4, 2023, from https://www.orfonline.org/expert-speak/a-just-transition-is-indias-green-transition-inclusive/

India's coal and other carbon-rich sectors has been completely overlooked. As highlighted by Roy, Kuruvilla, and Bhardwaj in 2019, due to the presence of worker's unions in India's hydrocarbon sector, the engagement of trade unions in ensuring a just transition process holds paramount importance[10]. Furthermore, stakeholders in the existing coal-based energy sector have expressed their grievances against the oversimplified mindset of "coal is bad, green is great"[11].

Furthermore, the tendency of renewable energy experts to exclusively focus on quantitative metrics often leads to a narrow perspective when considering their implications for people's overall quality of life. While there is speculation that advancements in green energy will result in the creation of numerous green jobs[12], critical questions remain unaddressed. These questions include whether and to what extent former coal workers will transition into these new green jobs and the sustainability of employment within the renewable energy sector. Consequently, it becomes imperative for advocates of sustainable finance to closely monitor the quality of jobs emerging in the green economy. Merely working in the renewable energy sector should not automatically imply that a job is well-paying, non-exploitative, offers opportunities for skill development and income growth, encourages collective efforts, and provides a robust social safety net.

Finally, these numerical assessments, which promote the swift implementation of green energy initiatives, often overlook a crucial aspect: the complete lack of transparency, accountability, and community involvement in the decision-making procedures concerning the transition to clean energy and the reduction of the current coal-based energy infrastructure. The rapid deployment of renewable energy infrastructures across, and generation of low tariffs have spurred a lot of land related conflicts across the world. Renewable energy projects across has necessitated large swathes of land. It is in case of acquiring these large tracts of land that the racial and caste based attitude of the state apparatus comes to the fore[13]. The grabbing of such vast tracts of common land to this end, used by communities for their livelihood purposes and other necessities are legitimized by identifying those lands as 'wastelands'[14].

As stated by Jacobson et al. in 2017[15], the global effort to power all nations with renewable energy requires an estimated land footprint of approximately 119,651,632 square kilometers. This utilitarian necessity to address the climate crisis through renewable sources has triggered a worldwide rush for land, as noted by Cotula 2012[16], Dell'Angelo et al. 2017[17], Franco, and Borras in 2019[18], and Scheidel and Sorman in 2012[19]. This land rush, primarily occurring in the global south, has given rise to a phenomenon known as "green grabbing," where access to resources or land is restricted in the name of environmental or sustainability objectives, as described by Fairhead, Leach, and Scoones in 2012[20].

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[10] Roy, Ashim, Benny Kuruvilla, and Ankit Bhardwaj, 'Energy and Climate Change: A Just Transition for Indian Labour', in Navroz K. Dubash (ed.), India in a Warming World: Integrating Climate Change and Development (Delhi, 2019; online edn, Oxford Academic, 19 Dec. 2019) https://doi.org/10.1093/oso/9780199498734.003.0017

[11] Shukla, & Sharma. (2021, September 17). A 'just transition': Is India's green transition inclusive? *Observers Research Foundation*. Retrieved September 4, 2023, from https://www.orfonline.org/expert-speak/a-just-transition-is-indias-green-transition-inclusive/

[12] Sahu, A. (2023, May 17). India can create up to 35 million green jobs by 2047: Report. Moneycontrol. https://www.moneycontrol.com/news/business/india-can-create-up-to-35-million-green-jobs-by-2047-report-10604431.html; UNDP. (2021, July 22). Green Jobs and Eco-Entrepreneurship Opportunities for Women in India. https://www.undp.org/india/publications/green-jobs-and-eco-entrepreneurship-opportunities-women-india; Kidwai, Naina Lal (n.d) Green jobs in India. FICCI Blog. http://blog.ficci.com/archives/7385/3

[13] Stock, R. (2022, September 13). Power for the Plantationocene: solar parks as the colonial form of an energy plantation. *The Journal of Peasant Studies*, *50*(1), 162–184. https://doi.org/10.1080/03066150.2022.2120812

[14] Situations like these can be linked back to colonial land governance policies in India. According to Judith Whitehead (2012), the concept of "wasteland" has frequently been employed in colonial land policies, serving as the legal foundation for land dispossession during both colonial and post-colonial periods. [Whitehead. (2012, February). John Locke, Accumulation by Dispossession and the Governance of Colonial India. *Journal of Contemporary Asia*, *42*(1), 1–21. https://content.csbs.utah.edu/~mli/Economies%205430-6430/Whitehead-Governance%20of%20Colonial%20India.pdf]

[15] Jacobson, Delucchi, Bauer, Goodman, Chapman, Cameron, Bozonnat, Chobadi, Clonts, Enevoldsen , Erwin, Fobi, Goldstrom, Hennessy, Liu, Lo, Meyer, Morris, Moy, . . . Yachanin. (2017, September 6). 100% Clean and Renewable Wind, Water, and Sunlight All-Sector Energy Roadmaps for 139 Countries of the World. *Joule*, *1*(1), 108–121. https://www.sciencedirect.com/science/article/pii/S2542435117300120

[16] Cotula, L. (2012, April 10). The international political economy of the global land rush: A critical appraisal of trends, scale, geography and drivers. *The Journal of Peasant Studies*, *39*(3–4), 649–680. https://doi.org/10.1080/03066150.2012.674940

[17] Dell'Angelo, D'Odorico, Rulli, & Marchand. (2017, April). The Tragedy of the Grabbed Commons: Coercion and Dispossession in the Global Land Rush. *World Development*, *92*, 1–12. https://www.sciencedirect.com/science/article/pii/S0305750X15310445?via%3Dihub

[18] Franco, & Borras Jr. (2019, May). Grey areas in green grabbing: subtle and indirect interconnections between climate change politics and land grabs and their implications for research. *Land Use Policy*, *84*, 192–199. https://www.sciencedirect.com/science/article/abs/pii/S0264837718316715?via%3Dihub

[19] Scheidel, & Sorman. (2012, August). Energy transitions and the global land rush: Ultimate drivers and persistent consequences. *Global Environmental Change*, *22*(3), 588–595. https://www.sciencedirect.com/science/article/abs/pii/S0959378011002068

[20] Fairhead, J., Leach, M., & Scoones, I. (2012, April). Green Grabbing: a new appropriation of nature? *Journal of Peasant Studies*, *39*(2), 237–261. https://doi.org/10.1080/03066150.2012.671770

Operationalizing infrastructure in this manner has resulted in the enclosure of significant portions of agricultural and communal land, facilitating the widespread expansion of "*sustainable*" energy networks. However, according to the IPCC (2022)[21], relying solely on technocratic solutions like solar power parks has exacerbated conflicts over land and resources for local communities in proximity to these developments. As they argue, *Some mitigation options can increase competition for scarce resources including land, water and biomass. Consequently, these can also reduce adaptive capacity, especially deployed at larger scale and with high expansion rates, exacerbating existing risks in particular where land and water resources are very limited.*

In India, where plans for renewable energy projects are being formulated, the land, whether publicly or privately owned, serves various purposes and is utilized by different stakeholders. As reported by Mongabay India[22]experts contend that no land remains unutilized or devoid of ecological significance, often playing a crucial role in local ecosystems and livelihoods. However, if authorities persist in allocating such land without conducting a thorough assessment of its social and environmental impacts, it may result in adverse consequences.

According to Powell, Sati, and Tomar[23], the installation of solar PV modules covering 100 hectares necessitates clearing between 31 to 43 hectares of unmanaged forest [24]. In India, the same land requirement would result in the clearing of 27 to 30 hectares of forest. However, this plan stands in stark contrast to another often overlooked commitment in the Nationally Determined Contributions (NDCs), which involves the creation of carbon sinks to capture 2.5 - 3 billion tonnes of CO2. The absence of reconciliation between renewable energy installations and reforestation efforts highlights significant inconsistencies within the country's zero-carbon initiatives.

Currently, renewable energy sources make up 12 percent of India's total energy generation[25]. Within this renewable energy mix, solar energy contributes 7.5 percent, wind accounts for 2.5 percent, hydro power contributes 0.4 percent, and biomass and biogases make up 0.8 percent. During February 2023, solar energy generation in India saw a significant growth of 31% when compared to the same month in the previous year. Notably, Northern India played a leading role in this increase, with solar power generation in the region growing at an impressive annual rate of 50%. Ever since the inception of the JNNSM (JawaharLal Nehru National Solar Mission)- inaugurated in January 2010-India has been actively working to increase its solar energy generation capacity. With India receiving an annual solar energy influx of 5000 trillion Kwh, well above the global average, and considering the favorable geographical topography, the potential exists to fulfill up to 94% of the country's electricity needs through renewable energy sources[26]. However, the extensive deployment of solar infrastructure also raises environmental and social concerns.

The architecture of Large Scale Solar Power Parks in India

One important aspect to consider regarding solar energy in India is that the country's efforts in solar energy generation go beyond fulfilling its Nationally Determined Contributions. India's promotion of solar energy is closely intertwined with objectives related to energy accessibility, affordability, security, and overall development. In the realm of solar energy production in India, the government has significantly increased its efforts to harness the potential of the country's geographical features. India receives a substantial amount of solar energy, approximately 5000 trillion kilowatt-hours per

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[21] Shukla, Skea, Slade, Fradera, Pathak, Khourdaiji, Belkcemi, Diemen, Hasija, Lisoba , Louz, Malley, McCollum , Some, & Vyas. (2022). Climate Change 2022 Mitigation of Climate Change. In *IPCC*. IPCC. Retrieved December 13, 2023, from https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_FullReport.pdf ; pg -55

[22] Aggarwal, M. (2021, July 23). *Land conflicts on the horizon as India pursues a clean energy future*. Mongabay-India. https://india.mongabay.com/2021/07/land-conflicts-on-the-horizon-as-india-pursues-a-clean-energy-future/

[23] Powell, Sati, and Tomar (2023, March 16). *Renewable energy in India: The demand for land*. ORF. https://www.orfonline.org/expert-speak/renewable-energy-in-india/

[24] Jan Van de Vemn, Capellan-Perez, Arto, Cazzcarro, Castro, Patel, & Eguino. (2021, February 3). The potential land requirements and related land use change emissions of solar energy. *Scientific Reports*. https://www.nature.com/articles/s41598-021-82042-5

[25] Paul, M. (2023, March 30). *India's renewable energy capacity at 122 GW in February | Mint*. Mint. https://www.livemint.com/news/india/indias-renewable-energy-capacity-at-122-gw-in-february-11680179203975.html

[26] Behuria. (2020, February). The politics of late late development in renewable energy sectors: Dependency and contradictory tensions in India's National Solar Mission. *World Development* , *126*. https://www.sciencedirect.com/science/article/pii/S0305750X19303754; Harris White, Rohra, & Singh. (2009, November). Political Architecture of India's Technology System for Solar Energy. *Economic and Political Weekly*, *44*(47), 49–60. https://sci-hub.se/http://dx.doi.org/10.2307/25663812

year, which significantly exceeds the global average [28]. According to certain estimates, solar energy has the capacity to fulfill as much as 94% of India's electricity demands by the year 2031-2032[29].

Initially a major impediment to the deployment of solar energy in India had been high price of solar power and thus the difficulty in the establishment of grid parity[30]. Despite facing such challenges in harnessing solar energy, it has been a part of energy policy discussions since the 1960s[31]. Although there was relatively slow progress during those years, the trajectory of solar energy generation took a significant turn around 2010. In 2010, as a component of the National Action Plan on Climate Change, the Jawaharlal Nehru National Solar Mission was initiated. The responsibility for overseeing this mission was placed under the Indian Government's Ministry of New and Renewable Energy (MNRE). Besides meeting renewable energy targets, the motivation to position India as a global leader in solar energy generation has been a driving force behind this solar mission. Initially, under the leadership of Prime Minister Manmohan Singh, the government aimed to achieve a solar energy generation capacity of 20 Gigawatts by 2022, utilizing both photovoltaic (PV) and concentrated solar power technologies. Another objective was to attain grid parity by the year 2022.

In India, solar energy parks are predominantly developed on marginal public land, often at the expense of smallholding peasants. The rapid expansion of utility-scale solar projects in rural areas, justified in the name of powering a more sustainable system, has altered the local agrarian political economy. This transformation is characterized by the emergence of extensive, grid-like energy infrastructure on land that was once fertile farms[32].

Across India, the establishment of solar power parks has had adverse effects on the lives of peasants, leading to land and resource enclosure, exclusionary planning processes, encroachment on the environment, and the deepening of social vulnerabilities[33]. While writing this report, according to the data by Land Conflict Watch, the development of renewable energy infrastructure has triggered 18 ongoing land-related conflicts, affecting 10,997 people, and impacting an area of 23,325 hectares, involving investments valued at Rs 63,385 (in crores). Among these conflicts arising from the transition to renewable energy, 66.66% are related to solar parks.

As Simanta (2017)[34] notes, if the institutional scaffolding of the solar power parks are taken into account, they share similar characteristics with special economic zones. In this case, solar parks become conduits for financial and globalized capital for domestic and multinational firms. The state over here ensures that the land is worth investing on, warranting minimal financial risk for the investors. To this end, it has also blocked, or rolled back land distribution policies, remoulding the land suitable for market friendly operations, and green economy[35]. Such models of solar parks have been widely acknowledged and applauded by multilateral agencies.

Financing the Solar Power Parks in India

To encourage private sector investments in the development of solar power parks, the Government of India has undertaken a series of initiatives to address challenges within the renewable energy sector. As explained by Dwivedi and Munshi (2021)[36], the government has implemented the following measures to facilitate the establishment of solar power parks:

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[28] Sharma, Tiwari, Sharma, Tiwari , & Sood . (2012, January). Solar energy in India: Strategies, policies, perspectives and future potential Author links open overlay panel. *Renewable and Sustainable Energy Reviews*, *16*(1). https://www.sciencedirect.com/science/article/abs/pii/S1364032111004643

[29] Harriss-White, Rohra, & Singh. (2009, November 21). Political Architecture of India's Technology System for Solar Energy. *Economic and Political Weekly*, *44*(47), 49–60.

[30] Grid parity in the renewable energy sector is achieved when the cost of generating electricity from renewable sources, like solar or wind, becomes equivalent to or even cheaper than the cost of electricity generation from traditional sources, such as coal or natural gas.

[31] Kapoor, Pandey, Jain , & Nandan . (2014, December). Evolution of solar energy in India: A review. *Renewable and Sustainable Energy Reviews*, *40*, 475–487. https://www.sciencedirect.com/science/article/abs/pii/S136403211400570X

[32] Stock, R. (2022, September 13). Power for the Plantationocene: solar parks as the colonial form of an energy plantation. *The Journal of Peasant Studies*, *50*(1), 162–184. https://doi.org/10.1080/03066150.2022.2120812

[33] Sovacool . (2021, March). Who are the victims of low-carbon transitions? Towards a political ecology of climate change mitigation. *Energy Research and Social Science*, *73*. https://www.sciencedirect.com/science/article/abs/pii/S2214629621000098

[34] Siamanta. (2017). Building a green economy of low carbon: the Greek post-crisis experience of photovoltaics and financial "green grabbing." *Journal of Political Ecology*, *24*(1), 258–276. https://journals.librarypublishing.arizona.edu/jpe/article/id/1997/

[35] Franco, J. C., & Borras, S. M. (2021, September 30). The global climate of land politics. *Globalizations*, *18*(7), 1277–1297. https://doi.org/10.1080/14747731.2021.1979717

[36] Dwivedi, & Munshi. (2021, March). Solar Power in India A report on Rewa Ultra Mega Solar Power Project. In *Centre for Financial Accountability*. Centre for Financial Accountability. Retrieved October 18, 2023, from https://www.cenfa.org/wp-content/uploads/2021/05/Rewa-Report-Final.pdf

1. **Identification of Suitable Land for Solar Power Parks**: The initial step involves identifying extensive tracts of unproductive land that have no alternative use. This approach repurposes barren land for the generation of clean energy.

2. **Utilization of Reverse Auctions for Viability Gap Funding:** Reverse auctions for viability gap funding have been employed as a pivotal strategy to instill competitiveness in the solar power market and ascertain competitive solar power prices. Reverse bidding auctions are market-based instruments that enable distribution companies to procure renewable energy at competitive rates[37]. This approach has garnered recognition for its cost-effectiveness[38].

3. **Amendments to the Electricity Act of 2003 and the National Tariff Policy of 2005:** Proposed amendments to the Electricity Act of 2003 and the National Tariff Policy of 2005 aim to align electricity generation through solar energy with the evolving dynamics of the renewable energy sector. These amendments create a favorable regulatory framework conducive to the growth of solar energy.

4. **Procurement of Bundled Solar Power:** Distribution companies are encouraged to procure bundled solar power from generators on a cost-plus basis[39]. This practice ensures a consistent power supply while promoting the use of solar energy sources.

5. **Establishment of India Smart Grid Task Force and Forum:** The government has established the India Smart Grid Task Force and Forum, fostering a public-private initiative aimed at modernizing the power grid to accommodate the solar energy sector efficiently.

6. Payment Guarantee Mechanism: To attract and facilitate greater involvement of private sector entities in the renewable energy market, the Government of India has implemented a payment guarantee mechanism. This mechanism assures that private sector investors in solar projects will receive payment, even in the event of default by the purchasing company. Public sector enterprises such as NTPC and SECI (Solar Energy Corporation in India) provide these guarantees, reducing the risk for private investors and enhancing the attractiveness of investing in solar projects.
These initiatives collectively aim to create a conducive environment for private sector investments in solar power parks, promoting the growth of clean and sustainable energy in India.

Furthermore, MNRE has established a government-owned public limited company known as the Indian Renewable Energy Development Agency Limited (IREDA). IREDA operates as a Non-Banking Financial Company (NBFC) and is tasked with the promotion, development, and provision of financial assistance for the implementation of projects related to new and renewable energy sources.

Additionally, the World Bank and the International Finance Corporation (IFC) have forged close collaborations with the Government of India (GoI) in support of the national solar mission. Specifically, the World Bank is partnering with the GoI to facilitate the deployment of grid-connected rooftop solar PV systems (amounting to US$ 648 million (Rs 5388.04 crores) and to showcase innovative technologies within the renewable energy sector, including solar-wind hybrids, energy storage solutions, and floating solar PV totaling US$ 200 million (Rs 1662.90 crores). The World Bank has also granted a US$ 100 million loan (Rs 831.46 crores) to IREDA for the 'Shared Infrastructure for Solar Parks Project.' Furthermore, the IFC has been actively involved in supporting solar projects through advisory services, investments, and financial loans.

According to the estimates of a data portal[40] by Centre for Financial Accountability (CFA), in India, presently there are 63 projects around solar parks and plants, generating 21 GW of solar electricity.

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[37] One thing which should be noted in this case is, the government's attempt in maintaining minimum tariff have resulted in tenders getting rejected. According to Behuria(2020), in many cases developers who won bids in this reverse auction funding have either stalled or abandoned their projects because of the added cost due to goods and services tax.
[38] Altenburg, & Englemeir. (2013, August). Boosting solar investment with limited subsidies: Rent management and policy learning in India. *Energy Policy*, *59*, 866–874. https://www.sciencedirect.com/science/article/abs/pii/S030142151300308X
[39] When an item is purchased at a cost plus basis, the service or the item is purchased on a basis of a fixed amount in addition to the cost it takes to produce one unit of product. It is a markup price.
[40] Center For Financial Accountability - Data Portal. (n.d.). https://datacorner.cenfa.org/

These are being developed by 119 private, and 24 public enterprises. A total amount of Rs 38,082 crores) has been invested. The top national financers in these infrastructures are Larsen and Toubro Finance, State Bank of India, and HDFC bank, pooling money of Rs 7130 crores. The top international lenders are International Finance Corporation, Bank of Tokyo-Mitsubishi UFJ Ltd., and Mizuho Corporate Bank, having investments up to an amount of Rs 9950 crores.

Given the significant investment in solar power generation, the issue of regulation is becoming increasingly important. Currently, in order to encourage growth in the solar industry, it is exempt from environmental and social regulations related to land use, water use, and mineral extraction. This exemption is based on the belief that the renewable energy sector has minimal environmental impact and does not cause pollution. However, these technological measures have largely ignored social considerations. As the sector has expanded and presented new challenges, there is a growing need for specific regulations.

As of December 8, 2022, the Indian government has approved 57 solar parks and ultra-mega solar power projects with a capacity of 39,285 GW across the country. The policies adopted by the state in this regard clearly indicate a consequentialist approach aimed at promoting the growth of renewable energy. However, such stances tend to overlook the potential socio-economic impacts of renewable energy infrastructure. Most of these solar parks are being established in low-income areas where residents may lack the resources to advocate for their own interests.

In the case of India, as argued by Stock, solar power parks essentially result in dispossession. The establishment of these parks is fraught with procedural injustices, including the withholding of information from residents and the denial of opportunities for them to participate in decision-making processes[41]. It is important to note that for land acquisition for solar power parks, the central government has allowed states to establish alternative mechanisms, bypassing the Land Acquisition, Rehabilitation, and Resettlement Act of 2013. This has deprived many people of their participatory rights protected by such laws. Furthermore, the enclosure of marginal public lands for solar parks has also deprived women of access to firewood and grazing land[42]. These frameworks and strategies for establishing solar parks have eroded the fundamental citizenship rights of those whose lands have been acquired.

Examples like these underscore the glaring absence of accountability on the part of both the state and public/private financial institutions that contribute the necessary capital for large-scale infrastructure projects like these. When delving into the issue of accountability, it becomes imperative to closely examine investments in renewable energy made by both domestic and international financial institutions, thus advocating for these institutions to adopt proper safeguard policies, and ensuring their implementation. Safeguard policies will guarantee responsible and sustainable practices within the renewable energy sector.

[41] Yenneti, K. D. R. (2015). *Procedural (in)justice in the implementation of solar energy: The case of Charanaka solar park, Gujarat, India*. ideas.repec.org. https://ideas.repec.org/a/eee/enepol/v86y2015icp664-673.html

[42] Stock, R., & Birkenholtz, T. (2019, December 15). The sun and the scythe: energy dispossessions and the agrarian question of labor in solar parks. *The Journal of Peasant Studies*, *48*(5), 984–1007. https://doi.org/10.1080/03066150.2019.1683002

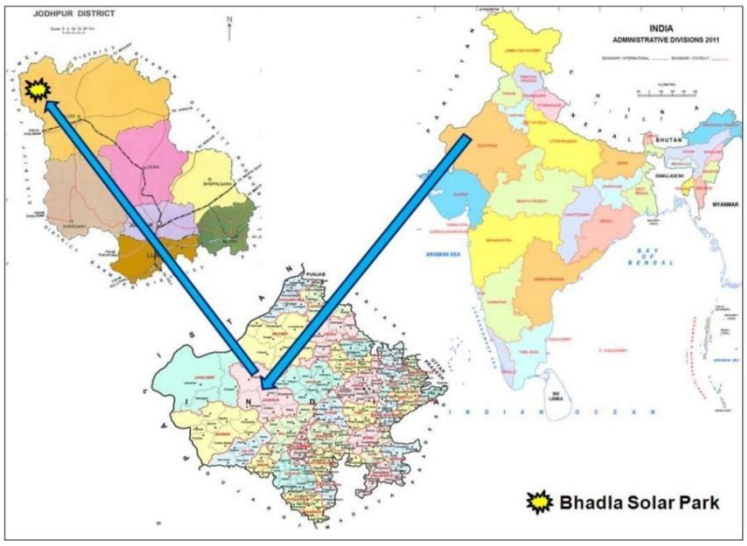
Chapter Two: A Critical look into the Case of Bhadla Solar Power Park

On September 11th, 2023, the state of Rajasthan introduced the preliminary draft of the 2050 Rajasthan Energy Policy[43], unveiling an ambitious vision for the state's energy landscape. At present, approximately 70% of the state's energy consumption relies on fossil fuels, with renewable energy accounting for just 20%. However, a significant transformation is anticipated by 2050[44]. The state aims to reverse this energy consumption pattern, targeting renewable energy sources to constitute 70%, while fossil fuels are projected to make up a mere 20%. To ensure a just, democratic, and inclusive transition process, the state has actively engaged subject experts. However, as we shall observe, in the context of Bhadla and other solar power parks within the state, these professed commitments to a just and impartial transition have largely remained hollow, as the grievances of those who have lost their land and access to livelihood resources remain unaddressed.

According to official accounts, Rajasthan's advantageous geographical location within the Thar Desert, and the availability of extensive *barren* lands, makes it a prime candidate for solar energy generation. According to a report by the MNRE, Rajasthan boasts the nation's most substantial installed solar capacity, totaling 7,737.95 Megawatts[45]. However, the development of solar installations and future expansion plans is occurring at the expense of existing village commons, and local floral and faunal resources. Presently Rajasthan houses the largest solar power park in the world, in the Jodhpur district of Rajasthan, in the village Bhadla.

The Bhadla Solar Power Park: An overview

Location:
Millions of glistening panels sprawl across an expansive 5,783 hectares in the Bhadla village, in Phalodi tehsil, Jodhpur district. It is situated 220 kilometers away from Jodhpur on the Bap-Bhadla Road. The nearest important town to Bhadla is tehsil headquarters Phalodi at a distance of 83 km. This location, despite its harsh conditions, proves ideal for the solar power park due to its scorching daytime temperatures ranging between 46-48 degrees Celsius. Additionally, the absence of rainfall and consistently clear skies throughout the year further enhance its suitability[46]. A location of the Bhadla Solar Power Park in the map is provided below.



Location of the Bhadla Solar Power Park. Source of Image: India: Rajasthan Renewable Energy Transmission Investment Program: Project 1
Initially, in India's solar power landscape, the Pavagada Solar Park held the title of the world's largest park with a capacity of 2,050 MW. However, in 2020, Bhadla surpassed it to claim the top spot, generating solar energy of 2245 MW.

[43] Hazarika. (2023). Rajasthan Aims to install 90 GW of renewable Energy Capacity by 2030. *Mercom Clean Energy Insights*. Retrieved December 13, 2023, from https://www.mercomindia.com/rajasthan-aims-to-energy-capacity-by-2030
[44] See, Heena Moiwala. (2023, September 11).*Rajasthan aims for a revolution: targeting 70% green energy by 2050* Udaipurtimes Website. https://udaipurtimes.com/news/rajasthan-energy-policy-2050/cid12159686.htm
[45] Saini. (2021, September 23). 'Rajasthan leads solar installed capacity in India': Govt report. *Hindustan Times*. Retrieved December 13, 2023, from https://www.hindustantimes.com/cities/jaipur-news/rajasthan-leads-solar-installed-capacity-in-india-govt-report-101632399358078.html
[46] Rajasthan receives approximately 5.72 kWh/meter square/day of solar radiation.

Nasa Earth Observatory Image of Bhadla Solar Park. Source: Nasa earth observatory

Bhadla Solar Power Park. Source: NS Energy

Impacted Villages

The Bhadla Solar Power Plant project has been allocated land by the Rajasthan Renewable Energy Corporation (RREC). In the initial two phases, RSDCL secured a lease for 1,800 hectares of land. During the third phase of the project, an extensive land allocation of 2,470 hectares was earmarked for the development by Shaurya Urja Company of Rajasthan Limited. In the subsequent fourth phase, a substantial land area totaling 1,330 hectares was designated for the Adani Renewables Energy Park Rajasthan Limited.

As per a resettlement plan, named, "India: Rajasthan Renewable Energy Transmission Investment Program: Project 1", prepared by Rajasthan Rajya Vidyut Prasaran Nigam Limited, and submitted to the Asian Development Bank, the park area and its environs have been identified as the project's areas of influence. This delineation further distinguishes between direct areas of influence and indirect project areas of influence. The direct project influence area encompasses the village of Bhadla in its entirety, with specific hamlets within the park area. On the other hand, the indirect project influence area encompasses the surrounding region[47]. The villages directly and indirectly impacted by the project are:

- Gammo ki Basti (Direct)
- Choro ki Basti (Direct)
- Kalro ki Basti (Direct)
- Ajeri (Indirect)
- Chinnu (Indirect)
- Noorey Ki Bhuj (Indirect)
- Rola (Indirect)
- Bodana (Indirect)

The Development of Bhadla Solar Power Park: Ownership Structure, Solar Power Park Developers, and Solar Project Developers

While the overall project at Bhadla, is developed by Rajasthan Renewable Energy Corporation Limited, the entire project is being executed in four phases, with the Rajasthan Solar Park Development Company Limited (RSPDCL) - a subsidiary of Rajasthan Renewable Energy Corporation Limited - overseeing the first two phases, Saurya Urja Company of Rajasthan managing the third phase, and Adani Renewable Energy Park handling the fourth phase. The estimated investment for the project amounts to Rs 9850 crore.

Phase one of the park encompasses seven solar power plants with a combined capacity of 65 MW, while Phase two boasts ten solar power plants with a combined capacity of 680 MW. Phase three and phase four will each feature ten solar power plants, with combined capacities of 1000 MW and 500 MW, respectively. It's important to note that all the entities responsible for overseeing the development of the solar energy infrastructure in Bhadla, namely Rajasthan Solar Park Development Company Limited, Saurya Urja Company of Rajasthan Limited, and Adani Renewable Energy Park, are designated as *Solar Power Park Developers (SPPDs)*.

In the context of solar parks in general, SPPDs can take on various forms, such as being a state government designated agency, a joint venture company (JVC) between the state government designated agency and the Solar Energy Corporation of India (SECI), or a partnership between the state government designated agency and a private entity. In the case of Bhadla, the mix of SPPDs, for the four phases, include fully state-owned entities like RSPDCL, JVCs like Saurya Urja Company of Rajasthan Limited (a 50:50 joint venture between the Government of Rajasthan and IL&FS Energy Development Company Limited), and Adani Renewable Energy Park Rajasthan Limited (a joint venture in between Adani Renewable Energy Park Rajasthan Limited and Government of Rajasthan).

According to the Ministry of New and Renewable Energy, SPPDs bear a range of fundamental responsibilities. These include procuring land, obtaining the necessary land-related approvals,

[47] page 40, India: Rajasthan Renewable Energy Transmission Investment Program: Project 1.

establishing access roads to individual plots, creating and maintaining an internal transmission system, facilitating grid connections (whether to ISTS or the State Transmission Network), offering basic drainage solutions, and ensuring a minimum essential water supply. Beyond these core duties, SPPDs also shoulder optional responsibilities, such as land leveling and development, construction of offices, housing, and common infrastructure, overseeing forecasting and scheduling, managing operational and maintenance (O&M) functions, gathering solar radiation data, guaranteeing metalled roads throughout the park and within each array, sustaining internal power and water supply, implementing robust security measures, and actively managing cleanliness and waste disposal to minimize waste generation whenever feasible.

Throughout the four phases, the Solar Power Park Developers (SPPDs) have delegated the responsibility of developing solar parks to sixteen project developers, or as officially noted, Solar Project Developers (SPDs)[48]. Among these project developers awarded contracts for solar panel installation in Bhadla, all except one are privately-owned enterprises. This process of subcontracting happened through a process of auctioning[49], monitored by National Thermal Plant Corporation (NTPC), and Solar Energy Corporation of India (SECI).

In *the first phase* of the project, the SPDs who received the contracts[50] were:

- Aditya Birla Renewables: 20 MW
- Sun Gold Energy: 5 MW
- Star Solar Power: 5 MW
- Roha Dyechem[51]: 27.5 MW
- Sidhidata Solar Urja: 5 MW
- LNB group: 5 MW

The SPDs who won the bid for the development of parks in the *second phase* of the project were:

- Charisma Energy Services Limited- Sunseap International Pte Limited-Rising Sun Energy Pvt Ltd:140 MW[52]
- ENGIE: 140 MW[53]
- Fortum Solar: 70 MW
- Vector Green: 70 MW
- NTPCREL: 260 MW[54]

In the *third phase*, the construction of solar power plants was carried out by the following companies:

- Hero Future Energies: 300 MW
- Softbank Group: 200 MW
- ACME Solar: 200 MW
- SB Energy: 300 MW

Meanwhile, in the *fourth phase*, the responsibility for developing solar power plants was taken on by:

- Azure Power: 200 MW
- ReNew Solar Power: 50 MW
- Phelan Energy Group: 50 MW
- Avaada Power: 100 MW
- SB Energy: 100 MW

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[48] The guidelines set forth by MNRE (Ministry of New and Renewable Energy) for the advancement of solar power dictate that state governments should appoint solar park project developers (SPPDs) as executing bodies responsible for leasing appropriately developed land to solar power developers (SPDs) who act as investors. As also mentioned in the main text, this leasing decision is contingent on SPPDs' assistance in obtaining government clearances, establishing transmission evacuation systems, ensuring water access, facilitating road connectivity and communication networks, and providing other shared facilities. Additionally, MNRE extends capital subsidies to SPPDs through SECI (Solar Energy Corporation of India) with the aim of reducing investment costs for SPDs and ultimately lowering the tariffs for the purchase of solar power.

[49] Sanjay . (2020, March 19). With 2245 of Commissioned Solar Projects, World's largest solar park is Now at Bhadla. *Mercom Clean Energy Insights*. Retrieved December 13, 2023, from https://www.mercomindia.com/world-largest-solar-park-bhadla

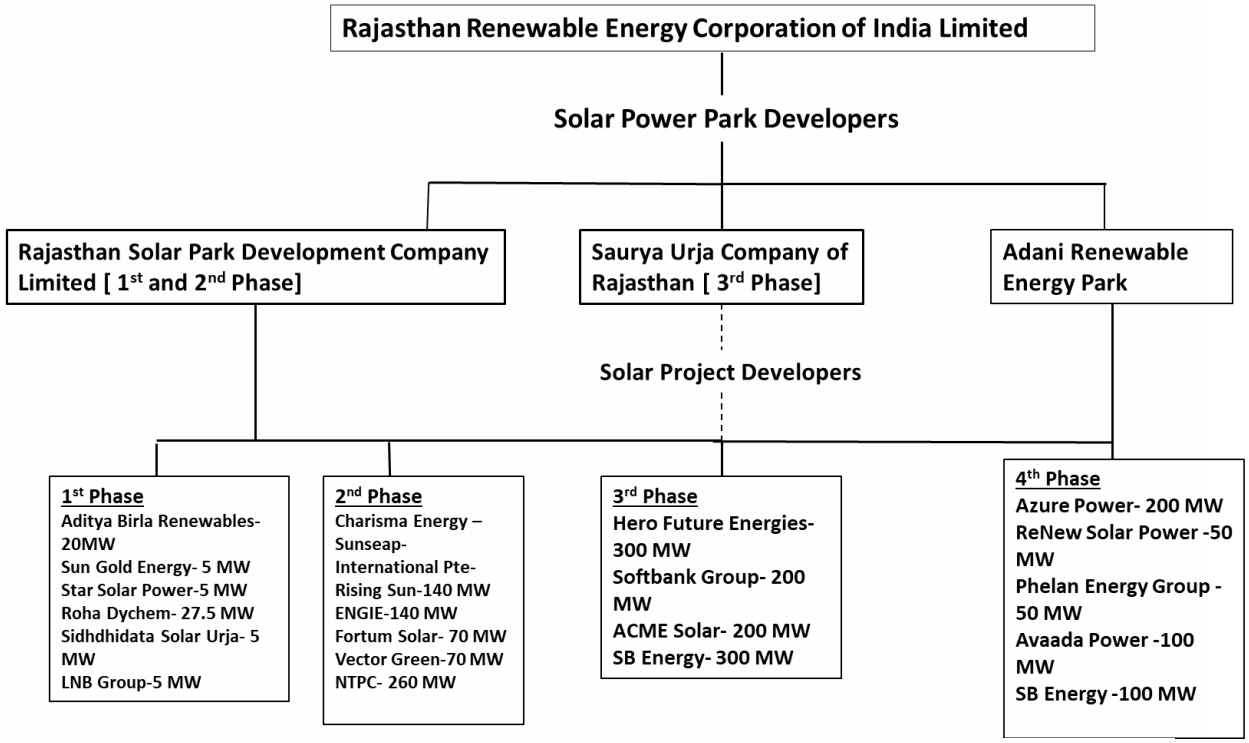
[50] Tripathy, S. (2015, December 1). *Bhadla park shines bright on solar radar*. The Times of India. https://timesofindia.indiatimes.com/city/jaipur/bhadla-park-shines-bright-on-solar-radar/articleshow/49994366.cms

[51] (2015, October 20). Roha Dyechem commissions 27.5-MW solar project in Jodhpur. *Business Standard*. Retrieved December 2023, from https://www.business-standard.com/content/b2b-chemicals/roha-dyechem-commissions-27-5-mw-solar-project-in-jodhpur-115102000675_1.html

[52] *Charisma Energy Services and Sunseap win 140MWp solar tender in India*. (2016, January 21). Eco-Business. https://www.eco-business.com/press-releases/charisma-energy-services-and-sunseap-win-140mwp-solar-tender-in-india/

[53] *French President Macron, Indian Prime Minister Modi and ENGIE CEO Isabelle Kocher inaugurate ENGIE's Mirzapur solar power plant in India | ENGIE*. (n.d.). Engie.com. https://www.engie.com/en/journalists/press-releases/solar-power-plant-in-india

[54] The National Thermal Power Plant Corporation Renewable Energy Limited, a subsidiary of NTPC Limited, developed 260 MWs of solar power by itself. The remaining 420 MWs of power was conducted by NTPC through reverse auctions. .



A diagrammatic representation of the organizational structure for the development of Bhadla Solar Power Park. Source: Author's Compilation

Through the leasing of land and other services provided by Solar Park Project Developers (SPPDs), Solar Power Developers (SPDs) can invest in solar panels and infrastructure. This allows them to generate solar energy within these parks, which they can subsequently sell to central utilities like NTPC[55], state distribution utilities, third-party entities, or captive users through power purchase agreements. The pricing for the sale of solar energy in case of Bhadla Solar Park has been determined through competitive bidding processes.

Investment on Transmission Lines

The Government of India, along with the Asian Development Bank and the Clean Technology Fund[56], collaborated to set up the energy evacuation transmission infrastructure. This initiative aims to link Bhadla to the state and national grid, forming an integral part of the Rajasthan Renewable Energy Transmission Investment Programme.

In 2018, in the first tranche[57] of the Rajasthan Renewable Energy and Investment Program, the construction of a substantial portion of a 220 km, 400 Kv transmission line stretching from Bhadla to the "line in line out" point of the Jodhpur-Merta transmission line was completed.
The investment on the transmission infrastructure of the Bhadla Solar Power Park, is a part of the large scale investment on transmission infrastructure financed by the Asian Development Bank. As noted by the Ministry of Finance[58], in April 2017, the Indian government and the Asian Development Bank (ADB) inked a loan agreement amounting to US$175 million (Rs 1455.07 crores)[59]. This financial arrangement aimed to fund the development of a high-voltage transmission system, facilitating the transfer of power generated by solar parks to the national grid. The recipient of this loan was the Power Grid Corporation of India Limited.

[55] Following the policy guidelines established by the Jawaharlal Nehru National Solar Mission, solar project developers in Bhadla have the opportunity to enter into power purchase agreements with the National Thermal Power Corporation and the Solar Energy Corporation of India (SECI) as a means of reducing the risks associated with energy off-take.
[56] The Clean Technology Fund (CTF) operates as a multi-donor trust fund within the framework of the Climate Investment Funds (CIF). Initiated in 2008 by the World Bank and various other multilateral development banks, the CIF was created with the primary objective of providing funding for pilot projects and initiatives aimed at lowering greenhouse gas emissions and promoting sustainable development in developing nations
[57] The first tranche of RRETIP comprised a $62 million ADB loan, an $88 million CIF loan, and $2 million in CIF grants.
[58] India and ADB Sign $175 Million Loan Agreement to help improve Solar Transmission System. (n.d.). https://pib.gov.in/PressReleasePage.aspx?PRID=1487122
[59] The conversion rate which has been used is 1 USD- Rs 83. 1

It's noteworthy that, in addition to the US$ 175 million (Rs 1455.07 crores) ADB loan, the project to finance the transmission infrastructure also encompasses a co-finance component of US$ 50 million (Rs 415.73 crores) from the Clean Technology Fund (CTF). The CTF, part of the Climate Investment Fund (CIF) with a total allocation of US$ 5.8 billion (Rs 48225.49 crores) is dedicated to providing essential financial resources to developing nations. These funds are intended to support investments in low-carbon technologies and facilitate the transition to clean and renewable energy sources.

The surge in investment in transmission infrastructure is not unique to India alone. The Asian Development Bank (ADB) allocated a substantial US$ 8.5 billion (Rs 70,667.67 crores) to clean energy projects for the Developing Member Countries (DMCs)[60] between 2016 and 2020.

The Ecosystem of Financial Investment by MDBs in and around Bhadla

In addition to investing in transmission and distribution, the ADB has extended loans to two Special Purpose Vehicles (SPVs): Rising Bhadla 1 Private Limited and Rising Bhadla 2 Private Limited . These SPV entities, operating under Rising Energy, are responsible for generating 140 MW of solar power in phase two of the Bhadla Solar Power Park. Each of these SPVs received a loan of US$ 29.15 million - Rs 242.24 crores.

Located approximately 6-7 kilometers away from Bhadla's project site, the International Finance Corporation (IFC) and Asia Infrastructure Investment Bank (AIIB) are funding another solar power endeavor. This new project aims to generate 250 MWs of electricity at village Noore Ki Bhoorj in the Bap tehsil of Rajasthan's Jodhpur district.

IFC has channelised a IFC A loan[61] of USD 43.3 million for the development of grid connected solar photovoltaic power plant at Noore ki Bhoorj. Additionally, parallel loans totaling up to US$ 106.7 million (or around Rs 747 crores) have been earmarked for its development, construction, operation, and maintenance. Simultaneously, AIIB has invested US$ 65 million (Rs 5416.5 crores) in Hero Future Energies for the solar power project's development at the same site.

The Local Geography of Bhadla

Geophysical Particularities:

In Bhadla, desert sands bake in the tropical sun, where the temperature varies in between 46 degree celsius to 48 degree celsius. Bhadla is a region located in the arid landscapes of Rajasthan, India. The primary peculiarity of Bhadla is its abundant sunshine and extreme aridity. This region receives an exceptionally high amount of solar radiation throughout the year, making it an ideal location for solar energy generation. The intense sunlight, with an annual solar insolation exceeding 5.5 kWh/m^2, has made Bhadla a prominent hub for solar power projects and installations.

Furthermore, Bhadla's terrain is mostly flat and sandy, which offers favorable conditions for solar panel installations and maximizes the efficiency of solar energy production. The region's dry and hot climate, with temperatures often exceeding 40°C during the summer, enhances the performance of solar panels and is conducive to harnessing solar energy.

The Bhadla region faces a severe scarcity of water resources. According to the "Proposal of Water Supply for Solar Park Bhadla under Deposit Fund," to address the water supply needs for the Bhadla Solar Power Park, the Joint Secretary of Energy has confirmed the reservation of water at the Indira Gandhi Nahar[62]. This planned water supply initiative aims to cater to both the solar park's needs and those of the nearby villages in Bhadla.

As outlined in the document titled "Proposal of Water Supply for Solar Park Bhadla under Deposit Fund," the current infrastructure for water distribution in these villages is inadequate, leading to

[60] For a list of the Developing Member Countries, see, http://www.worldlii.org/catalog/2994.html
[61] The Loan that IFC retains for its own account is called 'A' Loan.
[62] The Indira Gandhi Canal was built primarily for Thar Desert irrigation in Rajasthan, starting from the Harike Barrage near the Satluj-Beas river confluence in Punjab and extending to irrigate the Thar Desert in Rajasthan's northwest. It spans seven districts, including Jodhpur, where Bhadla is located.

the distribution of brackish and insufficient water. As mentioned in the proposal, the reservation of water from the Indira Gandhi Nahar has been proposed to cover the solar park and village in the scheme.

Demographic Details:

According to the resettlement plan prepared by Rajasthan Rajya Vidyut Prasaran Nigam Limited (RRVPNL) in Bhadla, a significant 87% of households are Muslim families. Furthermore, approximately 86% of households belong to other backward castes, and nearly two-thirds of families are nuclear. The data reveals that within the project's jurisdiction, merely 4% of households have pucca housing, indicating the challenging socio-economic conditions prevalent in the area.

Based on the survey findings in Bhadla, it was determined that the average family size within the sampled households is 4.66. The gender distribution in these households is skewed, with 785 females for every 1000 males, indicating a notably low sex ratio. In comparison to other project districts and the state of Rajasthan, the literacy rate in the project area is alarmingly low, standing at only 29%. The quality of education in the region is subpar, with a glaring absence of early education opportunities for children, as evidenced by the enrollment rate of only 31% among children aged 4 to 5 years. Among children aged 6 to 15 years, nearly half are illiterate. Similarly, among adolescents and young adults, approximately 63% lack basic literacy skills, and very few have achieved a graduate-level education. For individuals aged 6 to 17 years, approximately 46% have never been enrolled in any school, with an even higher rate of 51% among females.

The predominant occupation trend among adult members in the project area is farming and agricultural labor. Many households in the region are engaged in animal husbandry, although most do not perceive it as a formal profession. Surprisingly, only 3% of households reported being involved in animal husbandry among adults aged 18 and above, but further investigation revealed that approximately 82% of households do have livestock[63].

White-collar jobs are limited in the project area, with only 2% of males working in this sector. In a significant number of households (75%), there is only one wage earner. The socio-economic survey indicated that only 3% of households have a woman who is earning.

Social and Environmental Implications of the Bhadla Solar Power Park

As per the claim by the Clean Development Mechanism, in addition to being the world's largest solar power park and producing the cleanest form of energy, the Bhadla Solar Park has been associated with a vision of comprehensive well-being. The National CDM (Clean Development Mechanism) Authority, a designated national authority for the Government of India under the Ministry of Environment,Forests & Climate Change, has identified four indicators of sustainable development that the Bhadla Solar Power Project is expected to achieve: social well-being, environmental well-being, economic well-being, and technological well-being. The project is expected to provide job opportunities for local people during construction, commissioning, and maintenance, and the visits of skilled technical and industrial experts to nearby villages are expected to lead to direct and indirect economic benefits. The project is also expected to generate both temporary and permanent employment.

Despite the optimistic vision of the Bhadla Solar Park, the reality for many local people is different. A news article by the Thomson Reuters Foundation[64] mentions that young women in Bhadla aspire to work at the solar park, but lack of access to quality education prevents them from doing so.

As the news article indicates, in the beginning, the solar power park in Bhadla held promise for many. As a part of their Corporate Social Responsibility (CSR) initiative, Saurya Urja Company, took the initiative of turning some non-operational government schools to learning centers. As detailed

[63] See, pg. 16 socio-economic profile, Resettlement Plan
[64] Srivastava. (2022). India solar park sparks desire for school, as girls dream of green jobs. *Thomson Reuters Foundation News*. Retrieved December 13, 2023, from https://news.trust.org/item/20220215110004-nz1uf/

in the article, a school situated in Bhadla, previously dormant within the village, saw a revival with the advent of the solar park. Initially, Saurya Urja deployed two teachers to conduct regular classes at the school. However, around 2020[65], the school ceased functioning due to lack of attendance. Saurya Urja, the solar company, discontinued its support for the classes and redirected its efforts toward a more extensive community-oriented approach, operating mobile health and veterinary clinics. This has shattered the ambitions of many girls of Bhadla, who aspired to associate themselves with the solar park in Bhadla after completing their education.

India's expanding renewable energy capacity has raised hopes among many, but these hopes often go unfulfilled due to inadequate social infrastructure. As one respondent in an interview to the news report said, even security guard positions require a 10th grade education, which is out of reach for many people who have lost their land to the solar park. Education is the only way for many people to earn a livelihood, but it is difficult to access.

Land related implications of the Bhadla Solar Power Park

It becomes important to mention that, most of the land used for the solar park was previously used by local farmers to graze their cattle. Around 82% of the families have livestocks in their respective families. The loss of this land has had a devastating impact on their livelihoods. Although some jobs have been created, many of them are low-paying and do not provide enough income to survive. The local people feel left out of the development that is happening in their own backyard.

The interviews conducted through field visits at Bhadla Solar Power Park revealed a troubling trend where many families have lost access to common land due to the park's presence. One of the respondents, a woman in her early 70s, emphasized that all the land allocated to the solar power park developers was previously used by the villagers. As a result, they now find themselves in a state of extreme poverty, devoid of any form of land access.

The elderly woman recounted that in the past, her family owned 150 goats and sheep, but now, they are left with only a few. They were compelled to sell their livestock since the land where they once grazed them now falls under the solar power park's domain. At present, her family sustains itself through her old-age pension and the meager earnings from her son, who works as a security guard at the solar power park.

During the construction of the solar park, around 5,500 jobs[66] were created, and new businesses such as eateries and tea shops opened along a new highway. However, as the park neared completion, the jobs that remained required specialized knowledge of solar power. According to Saurya Urja officials, local people lack this technical knowledge and therefore cannot be employed in the solar park. This unplanned and non-participatory implementation of the solar power plant has led to a double marginalization of the local people. On the one hand, they lost access to land they had used for generations to graze their livestock. On the other hand, they were excluded from employment in the newly built solar energy mega-infrastructure.

Water related implications of Bhadla Solar Power Park

Another adverse consequence of the Bhadla Solar Power Park is the exploitation of the already limited water resources by the developers. Findings from the field research have revealed that the power park makes use of water from neighboring canals, tubewells, and ponds for the purpose of cleaning the solar panels. The project area lacks immediate access to water. Most households rely on public wells and canals for their drinking water needs. Every single household, a full 100%, obtains their water from external sources every day, spending an average of 29 minutes on this task.
Data gathered through field work highlighted, in addition to the water supply received from the local water department, which is evidently insufficient for the task of cleaning 10 million solar

[65] Nagraj , & Srivastava. (2022). Photo essay: India's solar energy boom has left some communities worried for their future. *Scroll*. Retrieved December 13, 2023, from https://scroll.in/article/1017600/photo-essay-indias-solar-energy-boom-has-left-some-communities-worried-for-their-future
[66] Srivastava. (2022). India solar park sparks desire for school, as girls dream of green jobs. *Thomson Reuters Foundation News*. Retrieved December 13, 2023, from https://news.trust.org/item/20220215110004-nz1uf/

panels, the company has adopted an innovative approach. They have outsourced the cleaning process to local villagers who now operate their own tanker trucks. These villagers source water from either the canal or relatively sweet water tubewells, paying a fee ranging from Rs 100 to Rs 130 per tanker. Some also access water from wells constructed by the villages to capture rainwater. The villagers mentioned that they initially charged 75 paisa per panel for the cleaning service, but this rate has since been reduced to a range of 45 to 50 paisa per panel.

The rapid expansion of solar power parks in India, especially in arid regions, has exerted increased pressure on the already limited water resources. In a recent interview with the Times of India[67], one of the sarpanches of Bhadla acknowledged the acute water scarcity in the area. Panels in solar parks, especially those situated in arid regions, necessitate frequent cleaning, with an estimated water usage of 7-8 liters per panel wash. According to Renewable Watch[68] 1 MW of Solar park with about 3000 panels would require roughly about 24,000 liters of water in a given week. Given the size of the Bhadla Solar Power Park, which boasts 10 million solar panels and a capacity of 2245 megawatts, it can be indicated that it demands an extensive 230,914.286 kilolitres of water per month to maintain cleanliness. Such an enormous water requirement raises valid concerns about the sustainability of these projects, particularly in a region already grappling with water scarcity.

While solar tariffs have considerably decreased in recent years, the cost of water has been on the rise, notably in Rajasthan, which has witnessed a doubling of its water costs over the past five years. According to the resettlement plan prepared by the Rajasthan Rajya Vidyut Prasaran Nigam Limited, the Bhadla region, including both direct and indirect project-impacted areas, comprises a total of 2,450 households, with an average household size of 4.66. The technical sanction package, "Proposal of Water Supply for Solar Park Bhadla under Deposit Fund," prescribes a water requirement of 70 liters per capita per day for individuals. Consequently, the daily household consumption of water is estimated at 799,190 liters, resulting in a monthly usage of 23975.1 Kilo liters.

This glaring disparity between the water allocation for the solar power park and the local population underscores the urgency for a comprehensive water resource management strategy in the region. It prompts critical questions regarding the prioritization and equitable distribution of water resources, especially in arid zones like Rajasthan. Balancing the demands of industrial and developmental projects with the fundamental needs of local communities is an imperative concern, necessitating the implementation of sustainable water management practices.

In Bhadla, although robots are being employed to clean solar panels, a method that conserves water, this technology is not yet suitable for panels mounted on uneven surfaces, posing a challenge for effective water conservation[69].

Eccopia, a robotics firm[70], has signed a deal with SB Energy, and ENGIE to deploy 2,000 robots across five project sites- developed during the third and fourth phase- within the Bhadla Solar Power Park in Rajasthan, cleaning panels which can generate 580 MWs worth of electricity. Apart from Eccopia, other enterprises related to robotics-like Greenleaps, and Miraikikai have secured contracts for solar panel cleaning at Bhadla.

Waste Management related issues at Bhadla Solar Power Park

The Bhadla Solar Park faces another pressing concern related to the substantial amount of electronic waste (e-waste) generated by its 10 million solar panels. Despite India's ambitious push towards solar power, there exists a glaring absence of a well-defined policy for managing the

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wastegenerated by these solar panels at the end of their operational life, as well as throughout their manufacturing process[71].

A research paper by Sikder et al. in 2022[72] sheds light on the issue, estimating that a 38.4 MW solar park generates approximately 2,663.374 tons of potentially recoverable waste. Extrapolating from this data, it can be indicated that the 2,245 MW solar capacity of the Bhadla Solar Park generates a staggering 155,710.277 tons of waste. The Bhadla Solar Park's solar systems are relatively new, with the first phase commissioned in 2018. Given that solar panels typically have a lifespan of 20-25 years[73], the critical aspect of waste management in Bhadla has been regrettably overlooked.

Currently, the scope of waste management in solar power parks in India is largely confined to the handling of hazardous materials during the construction phase, disregarding the waste generated by decommissioned solar panels. For example, the environmental due diligence report by the Indian Renewable Energy Development Agency only addresses waste management within the solar park during its construction and daily operations phases. The Waste Management Plan (WMP) detailed in the report identifies the types of waste anticipated during the plant's construction and operation, outlining practices for their collection, storage, treatment, and disposal. However, this plan falls short of addressing the complete lifecycle of solar panel waste.

It's crucial to emphasize that photovoltaic (PV) waste comprises materials such as glass panels with embedded circuitry, wiring, metals, binders, synthetic paints, glues, as well as inverters and battery systems. These materials contain potentially hazardous substances including lead, cadmium, chromium, and various rare earth metals[74]. Given the absence of the necessary infrastructure and institutional mechanisms for proper waste management, the waste generated from solar panels in Bhadla poses a substantial risk, with the potential for irreversible environmental and public health consequences in the local ecosystem.

A new study conducted by Bridge to India (BTI)[75], focused on managing India's PV Module Waste, projects that the waste generated by solar photovoltaic panels could reach 1.8 million tons by 2050.

Impacts of Transmission lines

According to the report, "India: Solar Transmission Sector Project", Asian Development Bank, under the ADB loan No. 3521-IND, is assisting in the funding of the transmission system of the solar power park at Bhadla. ADB selected this project to be implemented and monitored in line with the POWERGRID's Environmental and Social Policy Procedures (ESPP) and Action plan prepared for the use of the Country Safeguards System, to ensure that ESPP achieves and maintains full equivalence with ADB's Safeguard Policy Statement, 2009.

To facilitate the pooling of power from various Solar Power Modules, and evacuate and transferring of power, a pooling substation of 765/400/220 kV has been proposed at Bhadla, along with 765 kV interconnection to Bikaner substation[76]. This has been further supplemented with 220kv and 400kv interconnection lines to the 765/400/220 kV substation[77].

According to the compliance status to Environment and Social frameworks, the diversion of forest area was necessitated only in the case of Bhadla- Bikaner 756 kV line due to the involvement of 11.36 ha of protected forest. To that end, PowerGrid has obtained forest clearance under the Forest Conservation Act, of 1980 from MoEFCC. Also, a NoC from the District collector has been

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[76] The total length of the 765kv Bhadla Bikaner line is 170.029 kms.

[77] See page number 6, India: Solar Transmission Sector Project.

obtained as a part of the compliance with FRA 2005, which is also an integral part of forest clearance [78].

There has also been compensation according to the Indian Telegraph Act, 1885 around Rights of Way (RoW). As per the provisions of section -10 (d), compensations have been provided for all damages, that includes damages to tree, crop, and others to affected landowners/ farmers. But land compensation for tower footing and corridor, as per MoP guidelines of October 15 has not been applicable in this case[79].

It is important to note that transmission lines can be one of the sources of externalities. The transmission lines integrating solar and wind parks to grid stations in arid regions has turned out to be a major reason of distress for Great Indian Bustards which thrive in open arid grasslands[80] . This has led to legal tussles between the government and the conservationists.

Though distanced from the main infrastructure, transmission lines have the possibility of creating notable environmental impacts, both during their construction and operational phases[81]. The primary environmental impacts associated with power lines mainly relate to the right of way (RoW), which is the area beneath the cables where vegetation is cleared and maintained to prevent interference with line structures and energy transmission safety. The width of the RoW can vary based on multiple factors, as outlined by Weedy in 1989[82], with wider RoWs typically required for higher voltage lines. Despite the relatively narrow disturbed area, the linear disturbance can span extensive distances, stretching for hundreds of kilometers, as demonstrated in studies such as Cardoso Junior et al. (2014)[83]. This necessitates careful consideration of environmental factors and mitigation measures when planning and implementing transmission line projects. In recent times, there has been a classification of transmission lines and roads as linear projects, which has led to them receiving numerous exemptions on the basis of being vital infrastructure with a supposedly lower environmental footprint due to their straight-line construction. However, the outcomes have contradicted this belief, as noted by environmental activist and researcher Manshi Asher[84].

[78] See page number, 22, India: Solar Transmission Sector Project.
[79] See page number, 24, India: Solar Transmission Sector Project.
[80] Sirur. (2021). From 1,260 to 150 — why power transmission lines are 'biggest threat' to Great Indian Bustard. *The Print*. Retrieved December 13, 2023, from https://theprint.in/environment/from-1260-to-150-why-power-transmission-lines-are-biggest-threat-to-great-indian-bustard/783286/
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Conclusion

In the face of the looming climate crisis, the global response has set in motion an extensive series of structural and infrastructural changes. These initiatives have been driven by the imperative to shift away from fossil fuels towards renewable energy sources. One notable outcome of this endeavor has been the proliferation of large-scale solar infrastructure projects across India, and other places. These projects have been facilitated and funded by international financial institutions such as the World Bank, IFC, the Asian Development Bank, AIIB, and other multilateral financial institutions.

However, the development of solar parks on previously underutilised rural lands has not unfolded without consequences. These endeavors have disrupted the existing agrarian political economy, leading to significant shifts in labour relations and labour geographies. These alterations to traditional livelihoods have the potential to exacerbate the climate and social vulnerabilities of rural peasants. As their livelihood options dwindle, many are left with little choice but to migrate to urban areas in search of employment opportunities, where they become all the more vulnerable to the direct and indirect effects of climate change[85].

The process of being alienated from their land and livelihoods due to solar-related dispossession has given rise to a marginalized population of landless peasants. This population is characterized by its racial and gender disparities, as these individuals often find themselves excluded from participation in the modern 'smart economy.' Instead, they constitute a precarious labor force that struggles to adapt to another wave of rural development, which seems to leave them behind[86].

Adding to the complexity of this situation is the fact that the solar energy generated from these peripheral regions often powers adjacent core urban areas and industries. This means that the very communities who have been dispossessed of their land and livelihoods by these solar projects find themselves in the dark, both literally and figuratively. As one individual from Bhadla lamented after the solar park became fully operational[87], "We produce electricity, but many villages in the nearby area still lack access to electricity. It's great that we have the largest solar power park, but it should bring about positive changes in our lives."

This scenario underscores the need for a more comprehensive and equitable approach to renewable energy development that takes into account the social and economic well-being of the communities affected by these projects. The transition to renewable energy sources must not only address climate concerns but also strive for social justice and inclusivity in its implementation.

Over here, it becomes important to emphasize on the urgent necessity for financial institutions to adopt environmental and social safeguard policies[88] facilitating a Just Energy Transition. As the world grapples with the imperative to shift from fossil fuels to renewable energy sources, the financial sector plays a pivotal role in ensuring a smooth and equitable transition.

First and foremost, safeguard policies are essential to protect vulnerable communities and individuals who may bear the brunt of this transition. The sudden shift away from fossil fuels can lead to job displacement and economic instability in regions heavily reliant on traditional energy industries. Financial institutions must adopt policies that prioritize the well-being of these communities through targeted investments, retraining programs, and social safety nets.

The Bhadla Solar Power Park, situated in the arid landscape of India, symbolizes the nation's stride towards renewable energy and its commitment to a sustainable future. With the capacity to generate an impressive 2,245 MW of solar power, this colossal undertaking is a crucial step in reducing India's carbon footprint, combating climate change, and fulfilling its energy needs.

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[85] See, Chaudhry. (2023, October 14). Climate change and health of the urban poor: The role of environmental justice. The Journal of Climate Change and Health . https://www.sciencedirect.com/science/article/pii/S2667278223000767?via%3Dihub

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However, as the Bhadla Solar Power Park continues to expand and contribute to India's renewable energy goals, the imperative of ensuring its proper construction and implementation, alongside comprehensive safeguards, becomes paramount.

In the contemporary world, the pursuit of clean and sustainable energy sources is more than an environmental ideal; it is a global necessity. The adverse effects of climate change are already palpable, with rising temperatures, extreme weather events, and environmental degradation threatening the planet's equilibrium. In this context, solar power stands out as a beacon of hope. Solar energy is abundant, renewable, and, when harnessed effectively, capable of mitigating greenhouse gas emissions and reducing our reliance on fossil fuels.

However, for this commitment to be truly impactful, it must be accompanied by meticulous planning and safeguards. The most pressing concern associated with solar power parks like Bhadla is the management of electronic waste (e-waste) generated by the millions of solar panels within the park. These panels contain materials that, if not handled properly, can pose serious environmental and health risks. Establishing a robust policy for e-waste management, from manufacturing through to disposal, is an imperative step.

Furthermore, addressing the environmental impact of solar panel waste is not just a local issue; it's a global concern. As the world's largest populous nation, India's actions carry weight on the global stage. Proper safeguards in the construction and operation of the Bhadla Solar Power Park can set a precedent for other nations to follow. Responsible waste management, recycling, and recovery of valuable materials from solar panels can reduce the environmental footprint of the solar industry, making it a more sustainable option for meeting energy demands.

In addition to e-waste management, the construction and operation of solar power parks like Bhadla must also prioritize land use and biodiversity conservation. Bhadla and other solar parks occupy vast areas of land, which can impact local ecosystems and natural habitats. Proper planning and safeguards can ensure that the land is used efficiently, and ecosystems are protected or even enhanced.

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