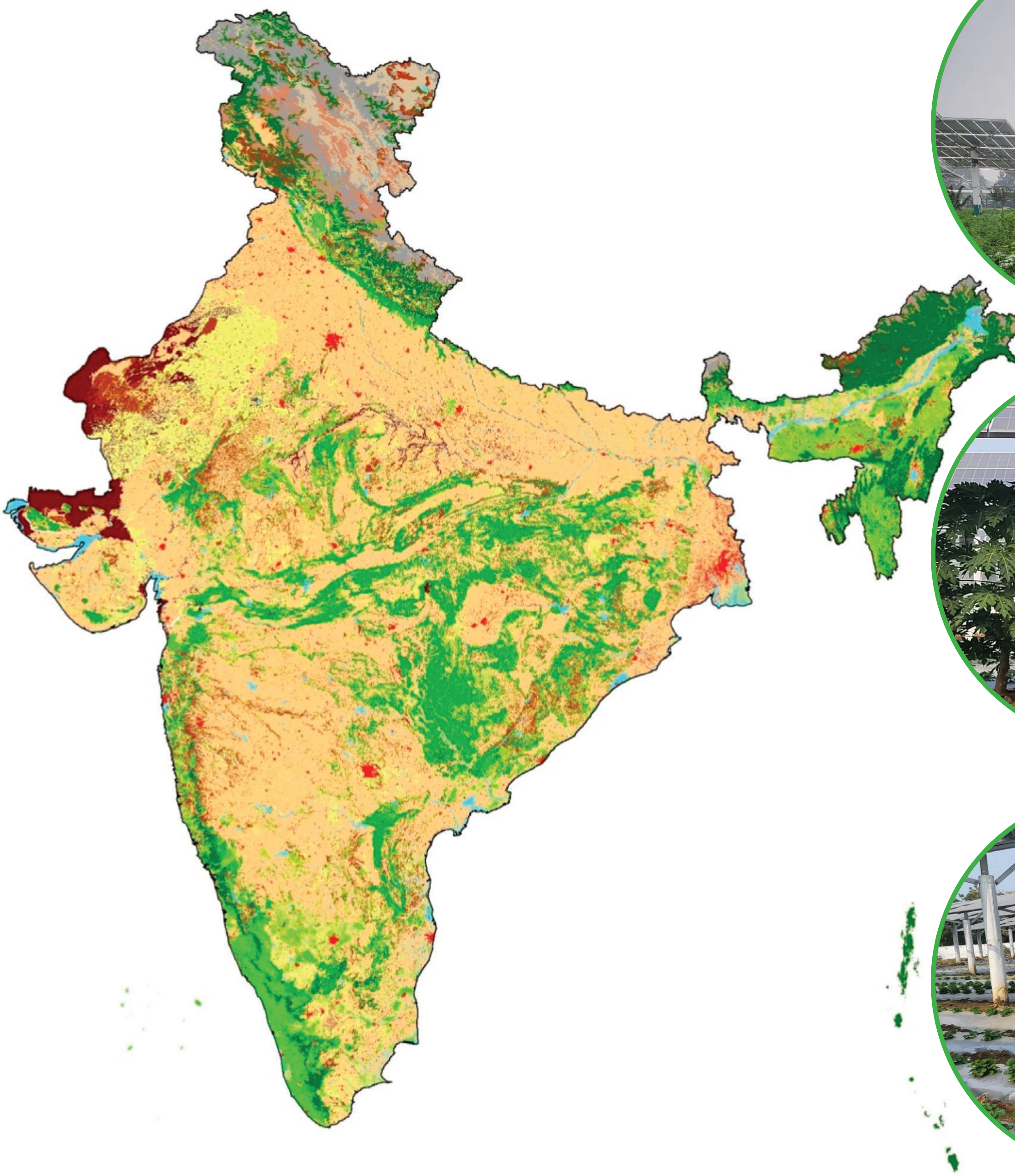
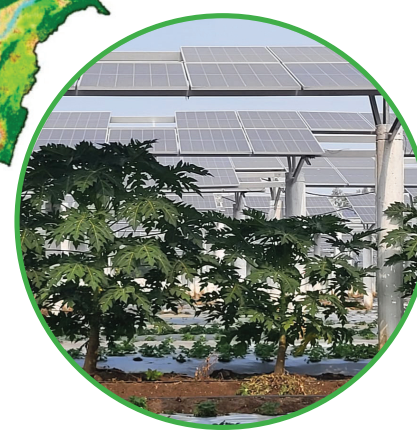
Unlocking Solar at Scale: How Agrivoltaics Overcome Land Constraints in India’s Energy Transition





Energy Transitions Commission

Global Energy Alliance for People and Planet
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The Energy Transitions Commission (ETC) is a global coalition of leaders from across the energy landscape committed to achieving net-zero emissions by mid-century, in line with the Paris climate objective of limiting global warming to well below 2°C and ideally to 1.5°C. The ETC is co-chaired by **Lord Adair Turner** and **Jules Kortenhorst**. The ETC team is led by **Ita Kettleborough (Director), and Mike Hemsley (Deputy Director).** The ETC also delivers regional programmes across key economies including Europe, the United States, China, India, Japan, Canada, Indonesia, Sub-Saharan Africa and Australia, working with local partners to develop country-specific transition pathways, engage policymakers, and translate global insights into actionable national strategies.

The ETC team that developed this briefing comprised:

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Introduction

India's electricity demand is expected to grow rapidly over the coming decades, rising by a factor of three to six[1] by mid-century as economic growth, industrial development, and electrification accelerate. Under high growth scenarios, some projections suggest electricity requirements could increase by as much as sixfold relative to current levels[2]. Solar power is widely recognised as a cornerstone of meeting this demand, given India's strong solar resource and the dramatic fall in the cost of solar generation. This trajectory is reinforced in India's evolving policy landscape, where recent national planning documents, including the draft National Electricity Policy[3], emphasise rapidly expanding electricity access, grid capacity and electrification to support both development and climate goals, aligned with broader commitments to emissions intensity reduction and net zero by 2070.

However, a persistent question has shaped debates around India's power transition: whether solar can scale at the pace required without intensifying land conflicts resulting from a perceived lack of available land for renewables and exacerbated through land ownership issues. Land acquisition challenges have repeatedly been cited as a key constraint for utility scale solar, with industry reporting indicating that annual solar installations fell by 44% in 2023 in part due to land related issues[4].

This briefing note addresses that question directly by examining the potential role of agrivoltaics (AgriPV) – the co-location of solar photovoltaic systems and agricultural production – in enabling large-scale solar deployment in a land-constrained context. While previous studies have highlighted the theoretical promise of AgriPV in India[5,6], estimates of its potential have varied widely, creating uncertainty around how much solar capacity could realistically be delivered and under what conditions. At the same time, much of the existing analysis has relied on secondary data and assumptions, with limited systematic evidence on how AgriPV affects crop yields, crop quality, and agricultural productivity under Indian conditions. This has raised concerns that large-scale deployment of AgriPV could inadvertently undermine agricultural outcomes in a sector that remains central to livelihoods, food security, and economic stability.

To close this gap, The Energy and Resources Institute (TERI) and the Energy Transitions Commission (ETC), with support from the Global Energy Alliance for People and Planet (GEAPP), undertook a new analysis combining top-down land-use modelling with bottom-up evidence from operational AgriPV projects across India. The objective was not only to assess land availability, but also to understand the implications of AgriPV deployment for agricultural outcomes, solar generation, and power-system integration[7].

This briefing sets out the following:

1 TERI (2023) India's Electricity Transition Pathways to 2050: Scenarios and Insights

2 BNEF (2025) New Energy Outlook

3 Ministry of Power (2026) Draft National Electricity Policy 2026

4 Mercom India Research (2024) Solar Installations Fall 44% in 2023 Due to Land Acquisition Issues

5 GIZ (2024) Agrivoltaics in India

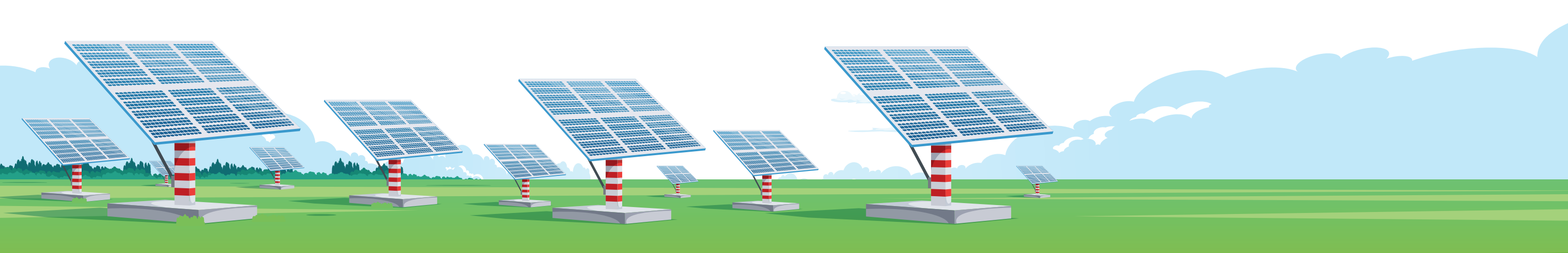
6 CPI (2025) Tapping the Potential of Agri photovoltaics in India

7 This deliverable is one of five deliverables produced under a wider multistage programme on AgriPV deployment in India. The preceding deliverable informing this work was the first report, which assessed national AgriPV potential. Additional deliverables include pilot plant studies, a project development framework, and a business model selection tool.

- Why land availability is perceived as a binding constraint on solar deployment in India
- How AgriPV could overcome land constraints, drawing on international experience and prior work in India before presenting new evidence from India showing the benefits of AgriPV on agriculture
- How much solar potential AgriPV could unlock
- The implications of these findings for solar deployment, power-system integration, the pace of India's energy transition, and the relevance of AgriPV for other geographies.

Key Findings

- **Land availability is not a binding constraint on solar deployment in India when agrivoltaics (AgriPV) is considered.** The scale of technically and practically deployable land materially exceeds projected mid-century electricity demand, indicating that system integration, grid expansion and financing rather than land scarcity will determine the pace of build out.
- **Starting from India's 160 million hectares of total cropland, a top-down national geospatial (e.g. ruling out land with excessive slopes, or subject to flooding) screening identifies 47.5 million hectares as technically suitable for AgriPV.** This represents 30% of cropland and 14% of India's total land area of 320 million hectares.
- **Pilot evidence confirms the operational feasibility of AgriPV on existing agricultural land and reflects different yield impacts across crop types.** Pilot results show that leafy vegetables and fruits achieve yield increases of 10-to-20% under AgriPV, with water savings averaging around 30%. For wheat, yield reductions were offset by quality improvements and higher realised prices, supporting farmer incomes despite lower volumes. Applicability on some 'least suitable' crops, particularly rice paddies, remains uncertain and requires further research into the impact of design adaptation.
- **A High Potential scenario,** showcasing what greater opportunity may be possible for the deployment of AgriPV on agricultural land in India, **shows that around 16 million hectares of cropland could host AgriPV systems.** This figure is reached by applying illustrative assumptions on crop compatibility and practical deployment to the 47.5 million hectares technical upper bound. Solar generation on this cropland alone could produce 12,775TWh of electricity (from around 8,000 GW of panels)
- **AgriPV deployed on cropland alone could meet India's projected electricity demand by 2050,** while solar installed across all available land could deliver 3–5 times projected demand. India's electricity consumption is expected to reach around 5,250–10,020 TWh by mid-century.
- **AgriPV systems can also be installed on pasture used for grazing.** India has approximately 10 million hectares of permanent pasture and grazing land; assuming illustratively that 50% of this area is deployable for AgriPV, this could yield around 4,500 TWh of additional annual generation (an additional 3,000 GW).
- **Bringing these findings together, this report finds that a total solar generation across suitable cropland, grazing land and other land categories could reach around 27,000 TWh per year, from installations covering approximately 29 million hectares of land** (around 17,000 GW). Other land categories suitable for solar include rural and urban rooftops, floating solar, and rail and road land.

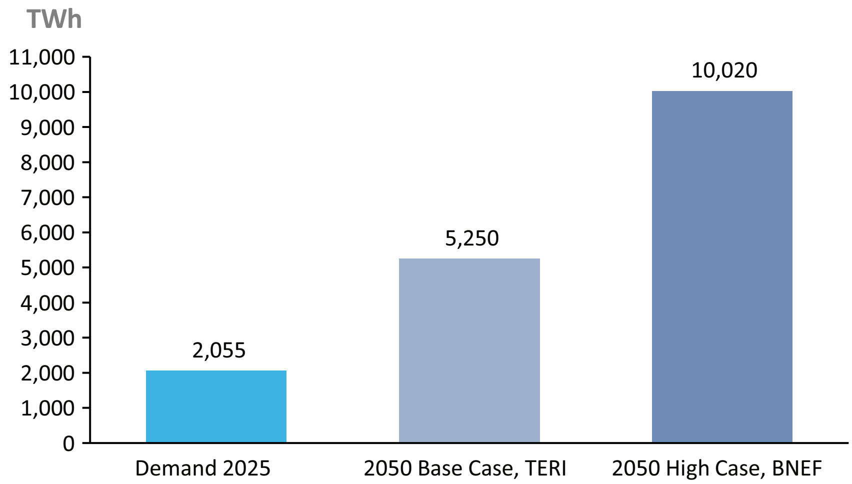


- **In practice this number could be larger, especially given the conservative assumptions applied to remove 84 million hectares of cropland constrained by solar irradiation or aspect.** If through technical modifications just 10% of this land was available for AgriPV, an additional 6,620 TWh could potentially be generated.
- **With land availability no longer the core constraint, the focus should shift to the key enablers required to scale AgriPV.** This includes distribution level grid capacity, clear policy and regulatory frameworks, and bankable financing structures.

Indian Land Constraints and the Future of Solar Deployment in India

India's power demand is expected to increase sharply over the coming decades, rising by a factor of three to six by 2050. From just under 2,100 TWh of electricity consumption today[8], demand is projected to reach approximately 5,250 TWh, or 2,100 GW of power capacity in 2050, under a recent estimate from TERI,[9] and electricity requirements could exceed 10,020 TWh under more ambitious electrification pathways[10]. This is showcased in Exhibit 1 below. Meeting this level of electricity requirements will therefore require a substantial expansion of installed power capacity.

Exhibit 1: India electricity requirements, 2025 vs. 2050



Source: BNEF (2025) New Energy Outlook 2025; TERI (2023) India's Electricity Transition Pathways to 2050: Scenarios and Insights; Ember (2025), Global Electricity Trends

Today, coal remains the dominant source of electricity in India, accounting for approximately 65% of total generation and over 40% of installed capacity, underscoring its central role in meeting existing

8 Ember (2025), Global Electricity Review 2025 – Global Electricity Trends

9 TERI (2023) India's Electricity Transition Pathways to 2050: Scenarios and Insights

10 BNEF (2025) New Energy Outlook

demand and its significance for overall carbon emission in India.[11] At the same time, solar and wind capacity have grown substantially in recent years to nearly half of total capacity, reflecting policy support for cleaner energy alongside continuing reliance on thermal generation.[12]

A range of generation sources could, in principle, contribute to meeting this growing demand. However, solar power has emerged as a particularly compelling component of India's future power mix, given both the country's resource endowment and the rapid decline in generation costs.

- India benefits from strong solar resources, with irradiation levels comparable to other global solar leaders such as Spain, Portugal, and parts of Australia and Africa, enabling high and relatively predictable generation potential across much of the country.[13]
- At the same time, solar has become the lowest-cost source of new power generation in India. Levelised cost of electricity estimates for 2024 place utility-scale solar at approximately USD 27.5/MWh (₹2500/MWh), compared with around USD 56.6/MWh (₹5100/MWh) for new coal capacity.[14]

Evidence from recent auctions suggests that real-world solar costs may be even lower. The lowest solar tariff awarded in 2024 was USD $25/MWh, with the five lowest bids all falling below USD 30.5/MWh.[15] In November 2025, a new round of bid procured 1 GW of renewable generation at USD $49/MWh (₹4350/MWh) at extremely favorable contract terms: Round the Clock generation, which required providers to deliver electricity 75% of all hours, raising to 85% in three years' time, and in fixed nominal terms, which means that in real terms the price will fall by about 50% during the 25 years of the contract duration. By contrast, new coal generation remains significantly more expensive; for example, a Letter of Award issued to Torrent Power in August 2025 for a 1.6 GW coal-based plant implied a delivered power price of approximately USD 67/MWh[16].

Meeting India's future electricity demand under deep electrification pathways is likely to be dominated by solar capacity – as highlighted in the ETC's 2025 *Power Systems Transformation* report[17]. Power system modelling by TERI in 2023 suggests that solar PV capacity could rise from 173GW[18] today (Exhibit 2 below) to reach around 1,470 GW by 2050 (70% of total capacity) in an unconstrained renewables scenario, rising to around 1,840 GW in a no fossil fuel scenario (80% of total capacity), reflecting solar's central role in a least cost decarbonised power system.[19] Further research by TERI into the maximum potential of solar applications across the country found that 960 GW of capacity could, in principle, be delivered through distributed rooftop solar installations.[20]

11 NITI Aayog (2025) India Climate and Energy Dashboard

12 Press Information Bureau, Government of India (2025) The Solar Surge: India's Bold Leap Toward a Net Zero Future

13 Global solar atlas

14 BNEF (2025) New Energy Outlook

15 Mercom India (2025) Five lowest solar auction bids in infographics

16 Times of India (2025), Torrent power to invest RS22000 crore in 1–6GW thermal project

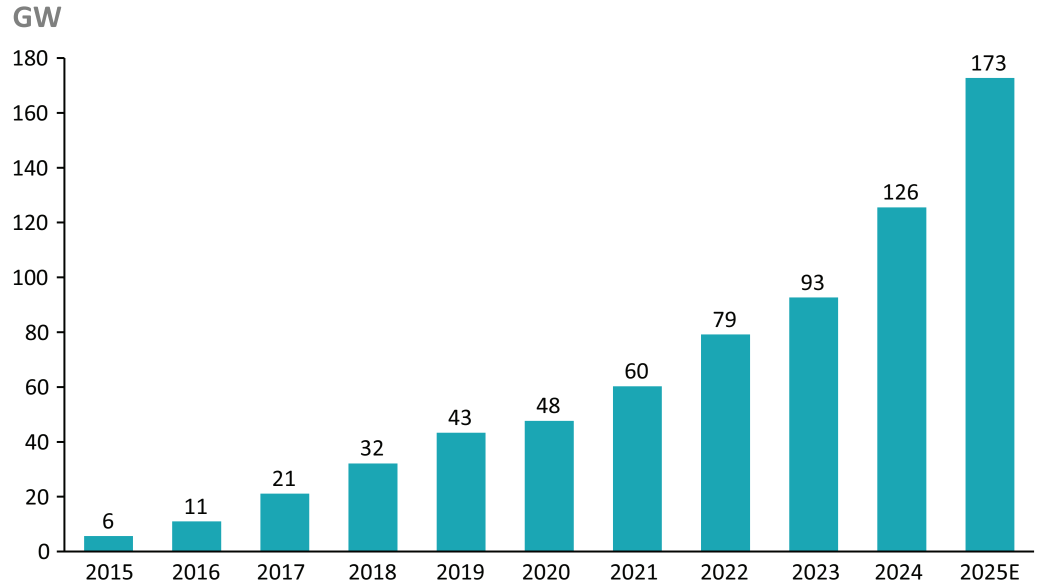
17 ETC (2025) Power Systems Transformation

18 IEA (2025) Solar PV – IEA

19 TERI (2023), India's Electricity Transition Pathways to 2050: Scenarios and Insights

20 TERI (2025), Reassessment of Solar Potential in India: A Macro-level Study

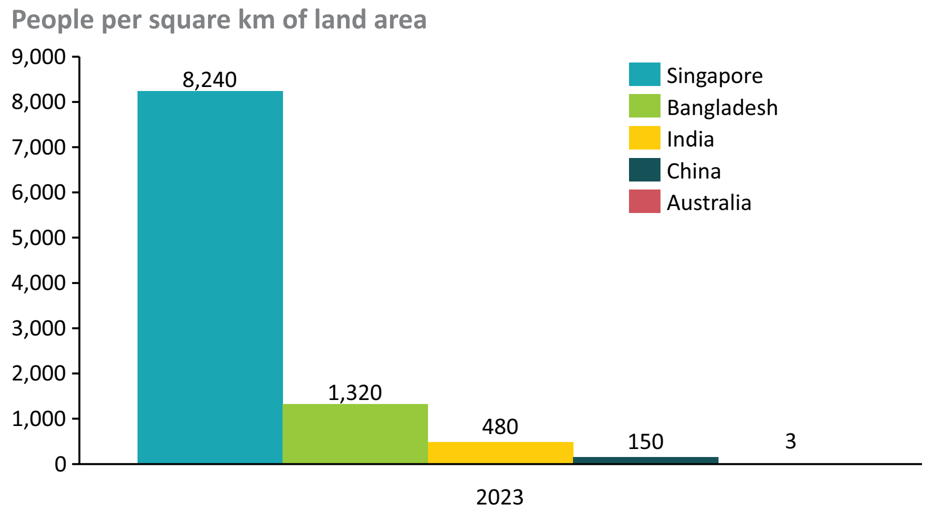
Exhibit 2: BNEF Solar deployment in India



Source: BNEF (2026) Global Power Capacity

Even under optimistic assumptions, this implies that several hundred gigawatts of additional solar capacity would need to be deployed on land. Despite the strong resource base and favourable economics, land availability has long been viewed as a potential constraint on the scale and speed of solar deployment in India.[21] This reflects not a lack of solar irradiation, but the complex and contested nature of land use in a country that supports a large share of the world's population, livestock, and biodiversity. As shown in Exhibit 3 below, India has a population density of roughly 480 people per square kilometre, compared with around 150 in China and 3 in Australia, underscoring the intensity of land competition.

Exhibit 3: Population density, 2023 People per square km of land area



Source: World Bank (2025) World Development Indicators

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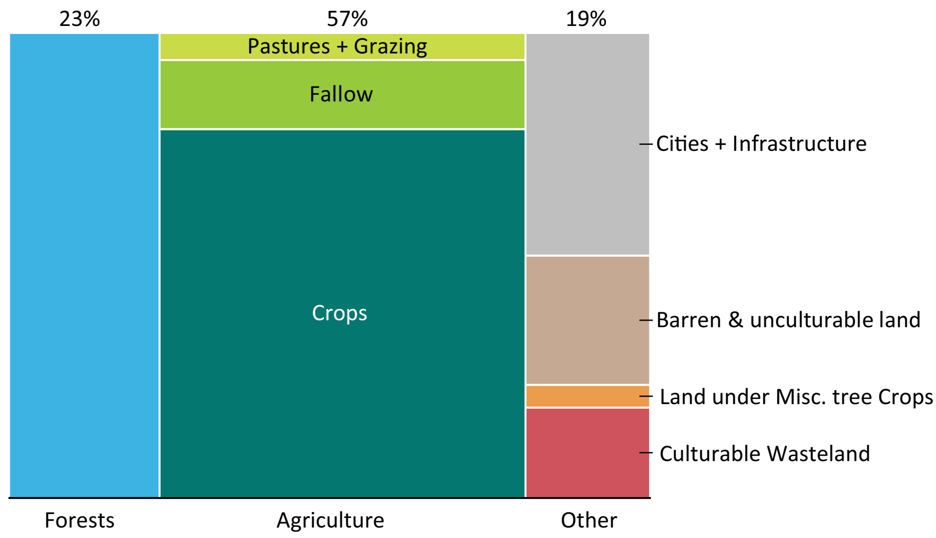
21 Policy Circle (2025) Overcoming land constraints for India's solar energy future

Approximately 80% of land is classified as agricultural land or forest, reinforcing the perception that land represents a structural bottleneck for large-scale solar deployment.[22] Government analysis has explicitly identified land availability and acquisition as a major source of delay for infrastructure projects in India. Planning assumptions indicate that land costs in some cases can account for more than half of total project costs and that conversion of agricultural land can take up to two years in certain states, further reinforcing the perception of land as a deployment bottleneck[23].While land ownership and acquisition remain important determinants of project viability, this analysis focuses on the availability and use of land for solar generation rather than on land tenure or acquisition mechanisms.

Exhibit 4 shows the breakdown of India's 320 million hectares of land. Forests account for 23%, while agriculture dominates at 57% of total land area. Cropland alone represents roughly 43% of national land, making it the single largest land category. The remaining 19% comprises cities and infrastructure, barren and unculturable land, culturable wasteland, and land under miscellaneous tree crops.

Crucially, barren and unculturable land accounts for only around 5% of India's total land area. Early assessments of solar potential often assumed that large-scale deployment could be accommodated primarily on this land category, on the basis that it avoids direct competition with agriculture.

Exhibit 4: Land-use by type (2023–2024)



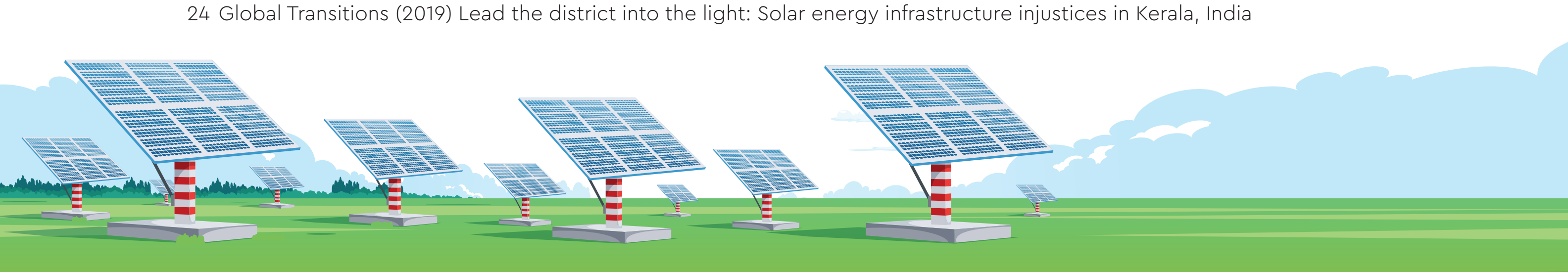
Source: Indian Ministry of Agriculture and Farmers Welfare (2025), Land use statistics at a glance 2023-2024; CEEW (2024) Unlocking India's RE and Green Hydrogen Potential An Assessment of Land, Water, and Climate Nexus

However, this assumption has been challenged with evidence from project-level experience and academic research suggesting that this land is frequently actively used for livelihood activities that are not fully captured in official land-use classifications.[24] Moreover, even where land is formally

22 Indian Ministry of Agriculture and Farmers Welfare (2025), Land use statistics at a glance 2023–2024

23 Ministry of Power. 2023. Renewable Electricity Roadmap 2030. Government of India.

24 Global Transitions (2019) Lead the district into the light: Solar energy infrastructure injustices in Kerala, India



designated as barren, it is often privately or communally owned, meaning that solar development can still face fragmented ownership, land acquisition challenges, and local opposition. As a result, reliance on barren land does not necessarily avoid the social, legal, or practical constraints associated with large-scale solar deployment.

Beyond the potential limitations of barren land, there is a more fundamental spatial challenge: areas with the strongest solar irradiation frequently overlap with land that is already intensively used for agriculture or grazing. This overlap has contributed to concerns within India that large-scale solar expansion could intensify pressures on agricultural land and rural livelihoods, particularly given the central role that farming plays in employment, income security and social stability across much of the country. Agriculture contributes close to 20% of India's GDP and supplies most of the food consumed domestically, making any perceived threat to agricultural productivity politically and socially sensitive.[25]

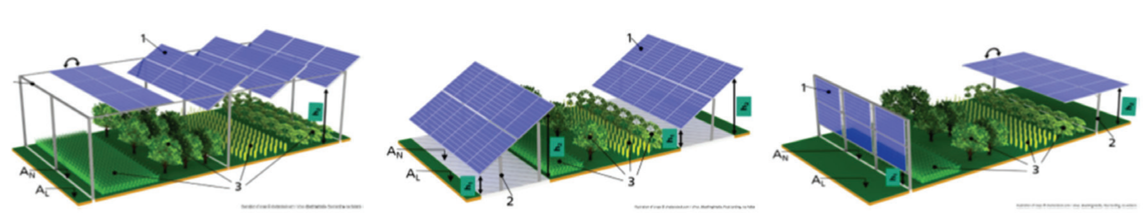
AgriPV as a Response to Land-Use Constraints

Against this backdrop of mounting land-use pressures and uncertainty over how much solar capacity can realistically deploy without displacing other essential land uses, agrivoltaics (AgriPV) have emerged as a promising solution to land constraint facing solar development.

What is AgriPV and learnings from existing international projects

AgriPV refers to the combined use of land for both agricultural production and photovoltaic electricity generation, typically through the cultivation of crops beneath elevated solar panels or between rows of panel arrays designed to allow continued farming activity (see Exhibit 5). By enabling the co-location of solar infrastructure and agriculture on the same parcel of land, AgriPV offers a pathway to expand solar generation without requiring conversion of productive farmland.

Exhibit 5 – Types of AgriPV Photovoltaics



Overhead Stilted | Interspace | Interspace vertical

Source: GIZ (2024), Agrivoltaics in India

25 Gandhi, V. P., & Zhou, Z. (2014). Food demand and the food security challenge with rapid economic growth in the emerging economies of India and China. Food Research International, 63, 108–124; Lee, J. Y., Naylor, R. L., Figueroa, A. J., & Gorelick, S. M. (2020). Water-food-energy challenges in India: political economy of the sugar industry. Environmental Research Letters, 15(8), 084020.

AgriPV systems can, at least in theory, benefit both solar power generation and farming at the same time:

- Partial shading from solar panels can reduce water lost through evaporation, helping to maintain soil moisture and biological activity and potentially lowering irrigation demand.
- Partial shading can also reduce peak solar radiation which may limit heat stress and scorching for certain crops, while the physical presence of panels can provide shelter from wind, reducing soil erosion.
- For livestock farming, shaded areas beneath AgriPV installations can provide comfort for grazing animals, reducing heat stress. While appropriate system design can ensure continued grazing activity beneath and between panel structures.
- From an energy perspective, better airflow around panels in AgriPV systems can improve cooling, leading to slightly higher efficiency and more stable power output compared to conventional ground-mounted solar.

Because of these benefits, AgriPV is now seen as an important option for expanding solar power in areas where land is in short supply.

Experience from other geographies suggests that these benefits can be realised under certain conditions.

- In France, where AgriPV capacity has already been deployed extensively with an aim of installing 2.6GW per year by 2026[26], several pilot projects have reported improvements in crop yields and quality for selected crops[27].
- Germany has similarly observed yield benefits for specific crop types where system design and crop selection are well aligned.
- Japan has gone further still, with more than 2,000 AgriPV installations across the country, demonstrating that yield stability can be maintained across a wide range of crops, including crops like rice that were previously thought unsuitable for AgriPV[28].
- In China, evidence from World Resources Institute shows that Agri-PV systems can also be deployed at scale in large agricultural systems, with early experience emphasising the importance of careful system design and land management to balance energy generation with agricultural productivity[29].
- International experience also showcases that grazing-based AgriPV systems have been deployed at scale in countries including France[30] and the United States[31]. Evidence from these markets indicates co benefits such as reduced heat stress for animals and improved pasture moisture retention.

Together, these experiences indicate that AgriPV can support continued agricultural production alongside solar generation in many contexts, while highlighting the importance of site-specific design and operational practices.

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26 Strategic Energy (2025), France enters the "2.0 era of agrivoltaics" and aims to install up to 2 GW per year by 2026

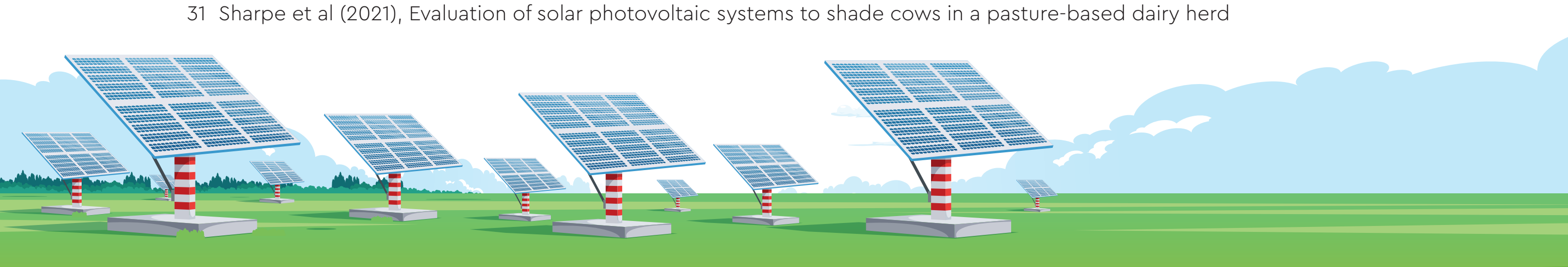
27 PV Magazine (2025), France agrivoltaics trials show early crop and livestock gains

28 Mehta et al (2025) Crop selection in Agri-PV: international review based strategic decision-making model

29 WRI China (2025), Agrivoltaics in China: Status, Potential and Pathways for Synergistic Energy-Agriculture Development

30 Madej et al (2024), One Year of Grassland Vegetation Dynamics in Two Sheep-Grazed Agrivoltaic Systems

31 Sharpe et al (2021), Evaluation of solar photovoltaic systems to shade cows in a pasture-based dairy herd

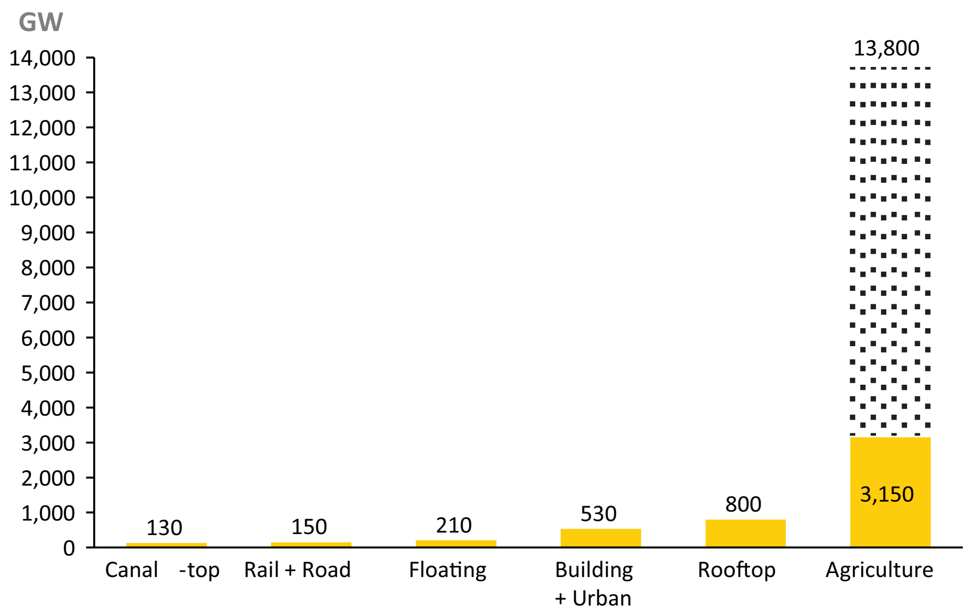


Understanding the theoretical potential for AgriPV in India

Recognising the growing relevance of AgriPV in the Indian context, the German Corporation for International Cooperation (GIZ) published a series of reports in 2024 that used secondary data to assess the solar potential of AgriPV alongside other new and innovative solar applications.[32] These assessments relied on existing datasets, including national land use statistics, crop distribution data, solar irradiation maps, satellite imagery, and published agricultural productivity and water use data, rather than primary field measurements.

As shown in Exhibit 6 below, the GIZ assessment estimates that India's technical AgriPV potential lies between 3,150 GW and 13,800 GW, depending on assumptions about crop suitability, system design, and land availability. Even the lower end of this range is greater than the combined potential of all other innovative solar applications assessed in the study.

Exhibit 6: India solar potential by application



Source: GIZ (2024) ISUN Potential Assessment of New and Innovative Solar Applications in India

For comparison, TERI's Electricity Transition Pathways analysis suggests that India will require around 1,450 GW of installed solar capacity by 2050 in the generation mix to meet a total electricity demand of 5,250 TWh. This means that the minimum AgriPV potential alone is more than double the solar capacity needed under that scenario, and the mid-range estimate would be sufficient to meet total electricity demand outright.[33]

However, the wide range of estimates reflects significant uncertainty around the scale and conditions under which AgriPV could be deployed. In particular, there is a limited evidence base on how AgriPV performs across India's diverse agro-climatic zones. Much of the existing analysis has relied on high-level land-use data and theoretical assumptions, with limited empirical data from Indian field conditions. In addition, there has been little systematic assessment of how AgriPV affects

32 STAAI: Solar Technology & Application Atlas of India

33 TERI (2023), India's Electricity Transition Pathways to 2050: Scenarios and Insights

crop yields, crop quality, water use, and soil health at scale. Given the central role of agriculture in India's economy and society, this lack of evidence has raised concerns that large-scale deployment of AgriPV could inadvertently undermine agricultural productivity or rural livelihoods.

As a result, while AgriPV has been widely cited as a promising solution to India's land-use challenge for solar, fundamental questions have remained unanswered: how much land is realistically suitable for AgriPV deployment, which crops are compatible, and what the implications are for both electricity generation and agricultural outcomes. Addressing these questions requires moving beyond theoretical potential to empirical, India-specific evidence – an evidence gap that this project has sought to fill.

Reassessing AgriPV at Scale in India: Land Suitability, Pilot Results, and Deployable Potential

To move beyond theoretical estimates of AgriPV potential and directly address the longstanding concerns around land availability and agricultural impacts, our work combines a top-down spatial assessment with bottom-up evidence gathered from operational AgriPV sites across India. This integrated approach was designed to resolve two central questions that earlier studies left unanswered: how much land in India is genuinely suitable for AgriPV deployment, and what the real-world implications are for both electricity generation and agricultural outcomes under practical operating conditions.

A revised, top-down assessment of land availability

As the first pillar of the analysis, a new geospatial land-use model to estimate the amount of land potentially suitable for AgriPV deployment across India. The assessment focused explicitly on agricultural land[34] and drew on Geographic Information System (GIS) data from the Government of India and international sources. Starting from approximately 160 million hectares of the total national cropland as a base, the model applied a series of five exclusion criteria to screen for conditions relevant to both agricultural viability and energy deployment, including environmental constraints, land-use restrictions, and technical considerations. These included:

1. Slope filter: Cropland with slopes greater than 8 degrees was excluded to avoid erosion-prone and technically challenging terrain.
2. Soil productivity filter: Cropland classified as non-productive was excluded to ensure AgriPV does not compromise agricultural value. This maintains the principle that AgriPV should enhance, not displace, productive farming systems.
3. Minimum solar irradiation and aspect filter: Areas receiving less than 4.5 kWh/m^2/day of Global Horizontal Irradiance were excluded to ensure sufficient solar yield for economically viable PV generation alongside crop cultivation. In addition, north-facing slopes were also removed due to lower solar exposure, ensuring both agronomic stability and viable solar performance.

34 Categories included in this analysis are Cropland ("Net Area Sown"), Fallow land ("Current Fallow" and "Fallow Lands Other than Current Fallows"), and Pastureland ("Permanent pastures & other grazing lands") as defined by the Indian Ministry of Agriculture and Farmers Welfare (2025), *Land use statistics at a glance 2023–2024*

4. Flood and climate risk exclusion: Cropland at high flood risk was removed to reduce long-term damage risk to both crops and PV infrastructure, prioritising climate-resilient and economically stable sites.
5. Protected area buffer: A 1 km buffer was applied around national parks, wildlife sanctuaries and other protected areas to avoid biodiversity conflicts and ensure compliance with conservation safeguards.

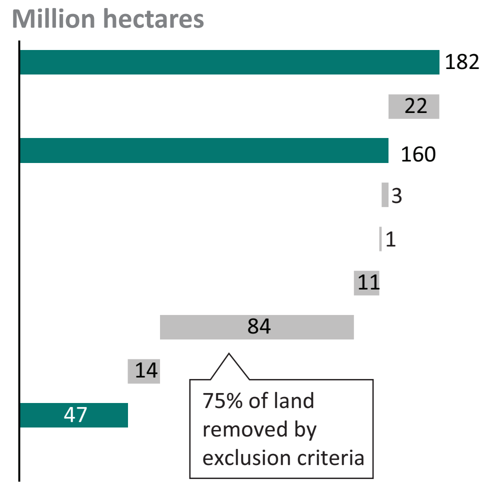
More detail can be found in the TERI report on AgriPV potential in India[35].

The combined effect of these exclusions is to produce a cautious lower bound of AgriPV cropland potential of approximately 47.35 million hectares of agricultural land that could, in principle, be suitable for AgriPV applications, equivalent to around 14% of India's total land area[36].

The screening framework applied by TERI in their paper Agri-Photovoltaics Potential in India: Pathways for Sustainable Energy–Food Solutions [37] applies uniform and conservative thresholds at a national scale, such that land is excluded if it breaches any single criterion. As shown in Exhibit 7[38] below, the largest share of excluded cropland falls within the land constrained by solar irradiation and aspect. This category alone accounts for 75% of the total cropland removed through the exclusion filters.

Exhibit 7: Land-use filter criteria and resulting excluded areas

Land categories	
Initial agricultural land	Total agricultural land in India
Fallow and pastureland	Removed to showcase cropland
Cropland	National cropland base
Topography	No slope greater than 8°
Protected areas	No historical areas or biodiversity sites
Soil productivity	No wasteland
Solar GHI and aspect	Nothing less than than 4.5 kWh/m²/day, no north-facing sites
Disaster risk	Nothing at risk of flooding or high winds
Resulting AgriPV	Land that's a good fit for AgriPV



Source: Systemiq analysis for the ETC (2026): TERI (2026) Agri-Photovoltaics Potential in India: Pathways for Sustainable Energy–Food Solutions

35 TERI (2026) Agri-Photovoltaics Potential in India: Pathways for Sustainable Energy–Food Solutions

36 Department of Agriculture and Famers Welfare (2024), MoA & FW

37 TERI (2026) Agri-Photovoltaics Potential in India: Pathways for Sustainable Energy–Food Solutions

38 Cropland with annual average solar irradiation below 4.5 kWh per m² per day is excluded using Global Solar Atlas data. This mainly affects eastern and northeastern states, Himalayan regions, and some coastal areas, where persistently higher cloud cover and monsoon intensity reduce annual solar yield. The threshold is applied conservatively to ensure reliable long-term solar performance.

This exclusion should be seen as a conservative estimate, not a hard limit. The initial screening prioritised sites with the strongest baseline solar conditions, excluding areas with lower irradiation or north-facing orientation. However, emerging evidence suggests that solar systems can still operate effectively in some of these locations through adapted designs, including east–west oriented arrays, bifacial modules that capture reflected light, and tracking systems that optimise panel exposure throughout the day[39]. In AgriPV systems, panel spacing and elevation are already adjusted to accommodate agricultural activity, which can further expand the range of technically viable sites[40]. Taken together, these developments suggest that a portion of land excluded under the solar irradiation and orientation filter could become deployable following more detailed site-specific assessment, meaning the current estimate should be interpreted as a conservative baseline for AgriPV land availability.

At a national level, this large portion of land suggests that land availability for solar, in principle, is not the primary constraint. However, this assessment reflects a technical screening of land characteristics rather than crop specific compatibility.

The key question therefore becomes not whether sufficient land exists in aggregate, but how much of this land is currently planted with crops that are compatible with AgriPV deployment. Crop type, planting structure, seasonal profile and agronomic requirements will materially determine the proportion of this screened land that can realistically host AgriPV systems without compromising agricultural output.

The next section moves from this top-down assessment to a bottom-up analysis of crop distribution within the suitable land base, to estimate how much of it is aligned with crops that are compatible with AgriPV.

Bottom-up evidence from operational AgriPV projects

The second pillar of the analysis draws on primary data from operational AgriPV pilot projects in India to test key assumptions underpinning the system level land and generation estimates.

Specifically, performance data from pilot sites are used to assess crop compatibility with AgriPV systems, including impacts on yield, crop quality, and other metrics. While the pilot evidence remains limited in scale and geography, it provides practical validation of technical feasibility and agronomic performance under Indian conditions. This bottom-up evidence is used to refine and ground the top-down estimates of deployable land and potential generation.

Background to Pilot Plant Studies

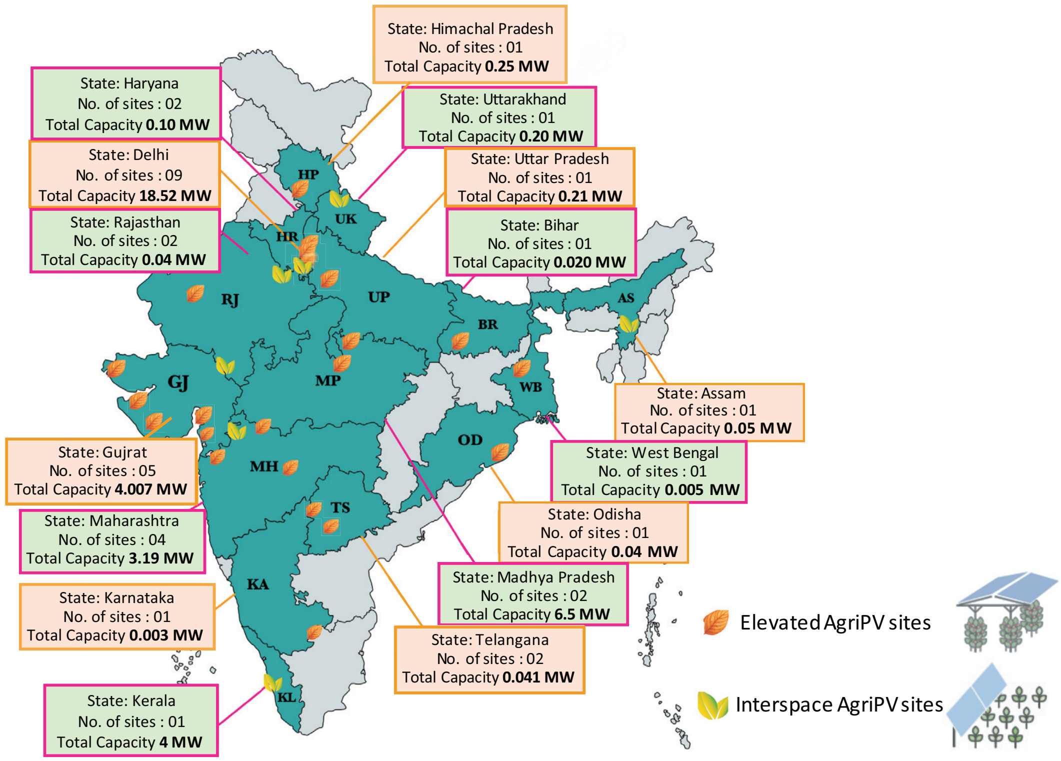
As of August 2025, India has 36 operational AgriPV installations with a combined installed capacity of 37 MW, as illustrated below in Exhibit 8[41]. This portfolio provides the first structured evidence base on how AgriPV systems perform across different crops, agro-climatic conditions, system configurations, and ownership models.

39 Fraunhofer ISE (2023) Agrivoltaics: Opportunities for Agriculture and the Energy Transition

40 Macknick et al. (2022) Agrivoltaics: Opportunities and Challenges for Scaling Solar Energy Production

41 TERI (2026) Agri-Photovoltaics Potential in India: Pathways for Sustainable Energy–Food Solutions

Exhibit 8: Existing AgriPV sites in India



Source: TERI (2026) Agri-Photovoltaics Potential in India: Pathways for Sustainable Energy–Food Solutions

Across ten representative sites performance data shows how partial shading affects solar generation, on site electricity use, crop yields and quality, water consumption, and soil conditions. The dataset enables comparison across crop types and climatic zones, providing early insight into agronomic performance, resource efficiency, and operational integration between energy and agriculture. Structured interviews with farmers and developers further contextualise these quantitative findings, highlighting practical implementation dynamics and commercial considerations.

Prior to the pilot visits, a crop suitability matrix was developed to test how different crops perform under partial shading conditions. The matrix ranks crops from most suitable to least suitable based on agronomic characteristics such as shade tolerance, canopy height, water requirements, and heat sensitivity. Field observations from the pilot sites are being used to assess whether real world outcomes align with these rankings. A simplified version of the matrix is presented in Table 1 below, with full synthesis of results to be published in TERI's AgriPV feasibility study[42].

42 TERI (2026) Agri-Photovoltaics Potential in India: Pathways for Sustainable Energy–Food Solutions

Table 1 – Crop Suitability Matrix

Suitability Rank	Crop Characteristics	Representative Crop Types	Example Crops
A – Most Suitable	Shade-tolerant, low height, short duration, high-value crops suited to partial shading	Leafy vegetables, plantation crops, spices, fodder, medicinal herbs	Spinach, cabbage, tea, coffee, grapes
B – Suitable	Moderate height, adaptable to partial shading, diversified cropping systems	Vegetables, pulses, selected fruits, spices, flowers	Tomato, chickpea, sesame, citrus, strawberry
C – Moderately Suitable	Medium height, semi-shade tolerant, potential competition for light or water	Cereals, oilseeds, selected fruits and flowers	Wheat, maize, soybean, banana, cotton
D – Less Suitable	Tall canopy, dense foliage, water-intensive or wide spacing crops	Tall field crops, plantation crops, fodder crops	Sugarcane, pigeon pea, jowar, mango (low height)
E – Least Suitable	Very tall, dense, or water-intensive monocropping systems likely to interfere with panel layout	Flooded systems, tall ornamentals, perennial tree crops	Paddy mono-cropping systems, coconut

Source: TERI (2026) Agri-Photovoltaics Potential in India: Pathways for Sustainable Energy–Food Solutions

Crops are grouped into five suitability categories (A–E), with A–C generally considered suitable for AgriPV deployment and D–E less suitable under standard configurations.

Suitability is assessed against key agronomic and system compatibility parameters, including:

- Shade tolerance and response to partial shading
- Canopy structure and crop height relative to panel clearance
- Rooting depth and below-ground competition
- Water requirements and irrigation intensity
- Sensitivity to heat stress and microclimatic variation
- Compatibility with raised panel configurations and mechanization

Pilot Plant Findings

Overall, while results vary by site and remain indicative rather than conclusive, the site level evidence suggests more positive outcomes than initially anticipated across several dimensions. At the time of writing, AgriPV pilot visits are ongoing, with evidence drawn from seven sites visited to date. The final insights will be incorporated into TERI's forthcoming report, which will synthesise and present the findings from the pilot plants. Some images from pilot plant visits captured by the TERI team are shown below.

Exhibit 9 – Images from Pilot Plants

Picture Credit : TERI Team

The results of these assessments are summarised below in Table 2 below.

Table 2 – Summary of TERI Pilot Plant Studies

Site	Type of panels	Crops grown on site and results relating to suitability to AgriPV	Water / Irrigation Outcomes
KVK Ujwa, Delhi	Elevated overhead, fixed tilt	Suitable: Vegetables, gourds roots Moderate: Wheat (trial but not continued)	Approximately 30% water saving with drip irrigation; one irrigation cycle reduced per year
Sahyadri Farm, Nashik, Maharstra	Elevated overhead with single axis trackers	Suitable: Fruits (Grapes-mostly, citrus, berries)	Drip irrigation used; approximately one irrigation cycle reduced per year
GroSolar, Dhule, Maharastra	Interspace ground mounted fixed tilt	Suitable: Nursery crops, citrus, herbs (lemongrass)	Drip irrigation used; approximately one irrigation cycle reduced per year

Site	Type of panels	Crops grown on site and results relating to suitability to AgriPV	Water / Irrigation Outcomes
Khargapur, Madhya Pradesh	Elevated overhead, fixed tilt	Suitable: vegetables, gourds, roots Moderate: Wheat, barley, Cereals, pulses Least: Rice	30 to 50% water saving with micro irrigation including drip; one irrigation cycle reduced per year
Sagar, Madhya Pradesh	Elevated overhead, fixed tilt	Suitable: Fruits (mainly strawberry, papaya, dragon fruit), Vegetables Moderate: Cereals and pulses Least: Rice	25 to 30% water saving with micro irrigation including drip; one irrigation cycle reduced per year
IARI Pusa, Delhi	Elevated overhead with singe axis tracker	Suitable: Medicinal crops and vegetables Moderate: Pulses	Drip irrigation combined with elevated tracker systems; approximately one irrigation cycle reduced per year
Dayalbagh University, Agra, Uttar Pradesh	Elevated overhead with single axis tracker	Suitable: Vegetables, fruits (Papaya, Lemon), pulses Moderate: Wheat Least: Rice, mango	50% treated wastewater use combined with drip irrigation: approximately 30% water saving

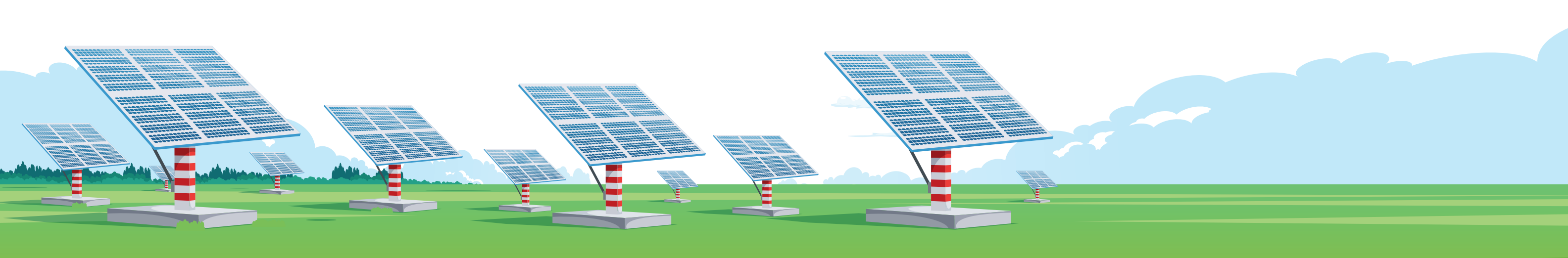
Source: TERI field visit insights

Overall, the pilot results show that the crop suitability matrix provides a useful starting point for assessing performance under AgriPV. Crops initially classified as highly suitable, particularly leafy vegetables and fruits, have generally demonstrated stable or higher yields, often in the range of 10 to 20%, reflecting improved growing conditions beneath the panels. Taken together, the site visits revealed several key trends in crop yields:

- **Leafy vegetables and fruits (Categories A, B and C)** appear highly suitable for AgriPV, with reports from farmers noting consistent yield increases of around 10 to 20% under AgriPV systems, reflecting reduced heat stress and improved microclimatic conditions beneath the panels. This includes crops such as spinach, coriander, lettuce and cabbage, as well as fruits such as tomato, grapes, raspberry and strawberry. In one pilot, AgriPV enabled strawberry cultivation for the first time, as excessive solar radiation had previously prevented successful production.

Results for other crop categories are more mixed but remain encouraging.

- **Flowering vegetables (Categories A and B**) have shown yield reductions of around 20% under current configurations; however, this has in some cases been offset by improved crop quality, attributed to lower thermal and pest stress. Higher quality produce has achieved improved realised prices, partially compensating for lower volumes.
- A similar dynamic has been observed for **wheat (Category C)**: although wheat was initially classified as less suitable in crop suitability matrix and yields under AgriPV were lower, quality improvements enabled sale at higher prices in some pilot sites.
- By contrast, **rice and mango (Category E)** have shown weaker performance in current pilots, with yields reported below baseline levels. Evidence from three rice sites suggests that this may reflect system design and configuration challenges rather than intrinsic crop incompatibility,



noting that rice has performed well under AgriPV in other geographies[43], and should be considered if AgriPV is to be scaled across a breadth of crops.

Overall, these findings support the conclusion that AgriPV combined with production on the right type of cropland can increase overall agricultural productivity.

Beyond yields, early pilot evidence suggests that AgriPV systems can deliver meaningful water savings and soil quality co-benefits, while maintaining agricultural activity, though further multi season monitoring is required to confirm the scale and persistence of these effects.

- **Water use:** Early evidence from AgriPV pilot sites also indicates material net water savings, averaging around 30% and in some cases reaching up to 50%. These net savings are observed at the field level and are consistent with reduced evapotranspiration and improved soil moisture retention beneath panel arrays. Separately, farmers reported reductions in irrigation requirements, measured through fewer irrigation cycles per year rather than volumetric monitoring. Across pilot sites, crops typically require two to three irrigation cycles annually, with wheat generally at the higher end; under AgriPV, farmers reported the avoidance of approximately one irrigation cycle per year.
- **Soil condition:** Soil sampling across multiple sites provides further support, with soils under panels showing improved condition relative to adjacent control plots due to lower moisture loss, reduced wind erosion, and protection from peak solar radiation.
- **Grazing compatibility:** Evidence from two sites shows that grazing and dairy systems are fully compatible with AgriPV, with cattle, buffaloes, goats and poultry operating within installations without disruption, while supporting productive dairy activity alongside solar generation.

Overall, the findings support the structure of the matrix and assumptions around cropland suitability but point to a need to update category boundaries and assumptions, as will be done by TERI in their upcoming final report.

For example, on crops:

- Some crops initially classified as moderate, such as wheat, have shown stronger economic performance than anticipated due to quality improvements and higher realised prices, even where yields declined. This suggests that more crops may be viable under AgriPV than previously assumed
- Rice and mango have performed less well under current configurations, although design and layout appear to play a significant role. This has direct implications for land estimates: if a broader set of crops can generate acceptable yields under AgriPV, the share of cropland and number of farmers that could realistically participate may be larger than initially projected.

From site-level performance of AgriPV to system-scale potential for solar

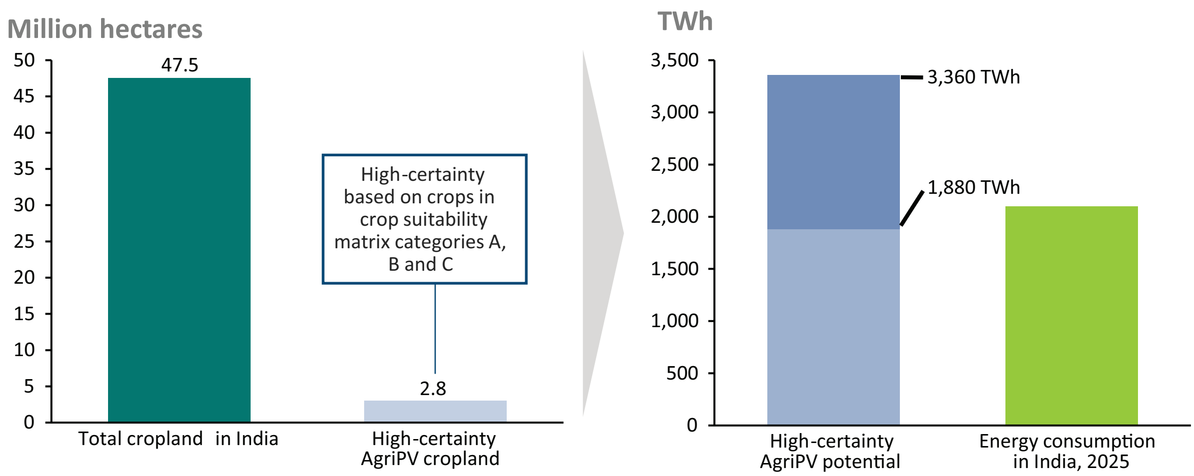
A central aim of this analysis is to translate site-level AgriPV performance into system-scale energy potential. By combining empirical evidence from pilot projects with national land-use data, it is possible to get an indicative view of the scale of installed capacity and electricity generation that AgriPV could contribute to India's energy system.

43 Okada et al. (2025), Case study of rice farming in Japan under photovoltaic system

To establish a high-confidence, conservative lower bound, study focuses exclusively on crops with the strongest demonstrated compatibility with AgriPV systems.[44] Starting from the 47 million hectares of cropland identified as suitable, the team used state-level crop data to identify land being used to grow six crop categories, including fruits, vegetables, plantation crops, spices, and flowers, that fall into categories A, B and C in the suitability matrix. This identified approximately 2.8 million hectares of land, implying that 6% of the initially identified 47.5 million hectares can be considered high-certainty under these conservative assumptions.

Applying conservative AgriPV power-density assumptions of 0.42–0.75 MW per hectare yields an estimated national potential of 1,190–2,130 GW of installed capacity, corresponding to 1,800 – 3,360 TWh of annual generation[45]. This is shown in Exhibit 10 below.

Exhibit 10: Land comparison of total cropland vs. high certainty AgriPV | High-certainty AgriPV electricity potential compared with 2025 demand



Source: TERI (2026) Agri-Photovoltaics Potential in India: Pathways for Sustainable Energy–Food Solutions

Importantly, this estimate represents a robust high certainty figure focusing on crop types and land areas where AgriPV integration is most likely to be technically feasible and agronomically compatible. Even under these conservative assumptions, the resulting generation would be sufficient to meet India's current electricity demand, underscoring both the scale of the opportunity and the potential for AgriPV to contribute meaningfully to India's energy transition while maintaining agricultural production.

However, capturing the full system-scale opportunity for AgriPV in India requires looking beyond this lower bound. While the TERI estimate intentionally concentrates on a narrow subset of crops and land where compatibility is well established providing a strong basis for near-term deployment—evidence from pilot projects and international experience indicates that AgriPV can be successfully deployed across a broader range of crops when system design is adapted to local agronomic conditions.

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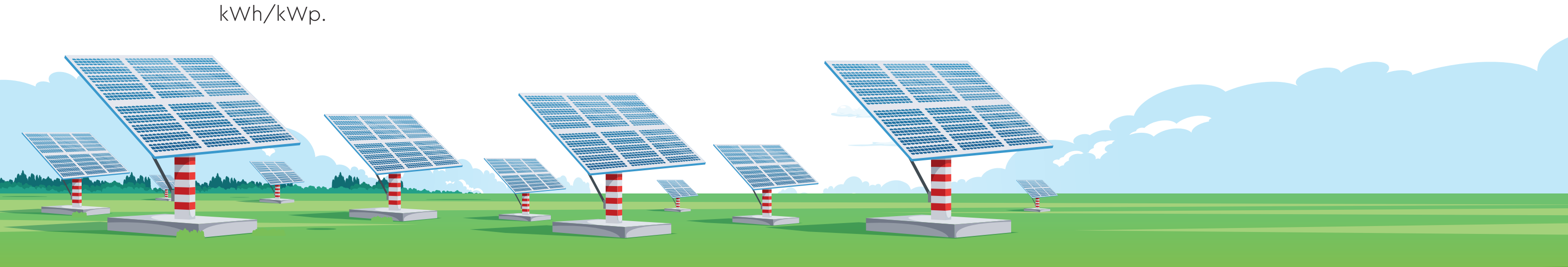
44 TERI (2026) Agri-Photovoltaics Potential in India: Pathways for Sustainable Energy–Food Solutions

45 Note: all solar generation calculations assume an AgriPV capacity density of 0.5 MW/ha and an annual yield of 1,576.8 kWh/kWp.



Crop distribution and land availability

The analysis that follows therefore builds on the TERI work to explore this broader technical potential. By combining crop distribution data with land-suitability analysis, it assesses how AgriPV deployment could extend beyond the conservative crop subset used in the TERI estimate and estimates the share of India's cropland that could realistically host AgriPV under a wider set of deployment assumptions.

To do this, we examine how cropland is distributed across the crop-suitability categories defined in the TERI matrix, and how this distribution shapes the scope for AgriPV deployment beyond the conservative lower bound. National cropped-area statistics are matched to the 90 crops included in TERI's suitability matrix to build an indicative picture of land use by crop. This draws on Ministry of Agriculture data provided by TERI, alongside government datasets covering foodgrains, pulses, oilseeds, and horticulture crops. The resulting dataset covers 210 million hectares of cropland, slightly above that of the 160 million hectares identified through TERI's geospatial analysis. This discrepancy can be explained as national cropped-area statistics can include multiple cropping cycles within a given year, meaning that land cultivated more than once can be counted multiple times.

Of the 210m hectares of total national cropland, 191m hectares (91%) can be directly mapped to crops within TERI's suitability matrix. The remaining 20m hectares (9%) relate to crops not covered by TERI's matrix and are treated as a separate excluded category. An overview of land area by suitability category is presented in Table 3 below (the crops not covered by TERI's suitability matrix are placed in Category E).

This analysis provides a baseline for understanding the relative size of crop types that are more or less suitable for integration with AgriPV, and therefore how AgriPV deployment could extend beyond the conservative crop subset used in the TERI estimate. However, the dataset is subject to several important caveats:

1. The underlying data are drawn from three separate government sources with differing reporting formats, requiring harmonisation of crop names and classifications. While care has been taken to align these datasets, minor inconsistencies may remain where labelling is not fully consistent.
2. The statistics report gross cropped area rather than net sown area. Given that land in India is frequently used for multiple cropping cycles within a single year, aggregation across crop categories can overstate the physical land footprint if interpreted as unique hectares. This consideration is particularly relevant when comparing crop groups or mapping cropped area against land-suitability layers.

Table 3 – Total cropland in India, per suitability category

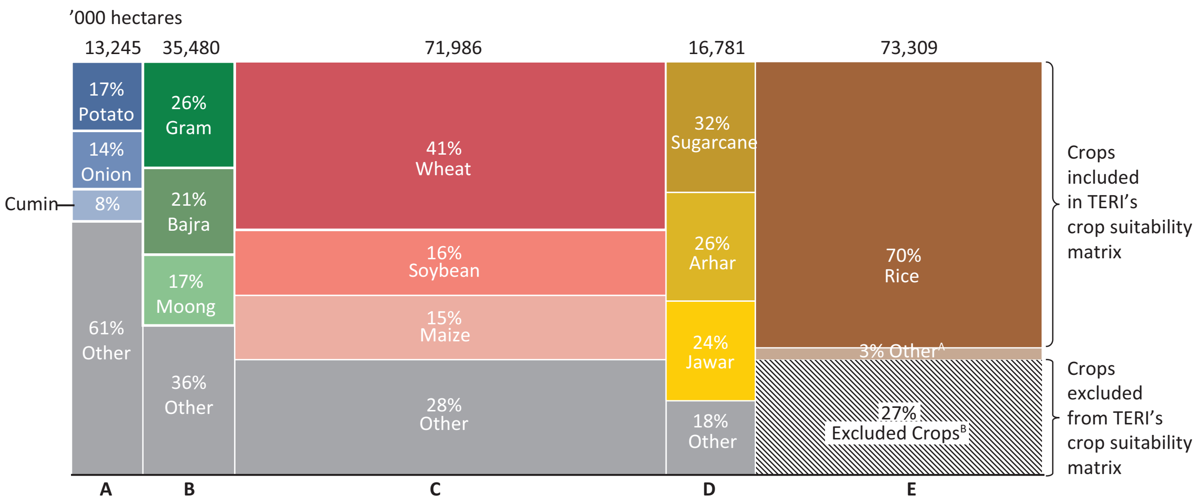
Crop Category	Amount of land ('000 hectares)	Share of land by category
Suitable cropland (Category A)	13,245	6%
Suitable cropland (Category B)	35,480	17%
Moderately suitable cropland (Category C)	71,985	34%
Less suitable cropland (Category D)	16,780	8%
Less suitable cropland (Category E)	73,310[46]	35%

Source: Government of India, Ministry of Agriculture and Farmers Welfare (2024), Land Use Statistics at a Glance, 2022–23. Note: Figures based on 210 million hectares of total national cropland.

46 Note: includes the 19,527 thousand hectares falling outside the TERI suitability matrix

Exhibit 11 shows the dominant crops within each suitability category. Together, the table and graph showcase that most cropland in India falls within Categories C and E, reflecting the dominance of staple crops such as wheat and rice. This reflects the structure of Indian agriculture, where a limited number of staple crops account for a large proportion of total land area. Category E is the largest single category by land area, covering 73m hectares – approximately 35% of total 210 million national cropland outlined above. Of this, 20m hectares comprises crops that fall outside TERI's suitability matrix and have therefore been incorporated into Category E as an excluded category, as depicted by the hatched section at the base of the column. These are primarily grains and horticultural products with small individual land-use footprints. Examples include tobacco, barley and oil seeds such as linseed, all which fall outside the scope of TERI's assessment but collectively represent a meaningful share of national cropland.

Exhibit 11: Cropland distribution by AgriPV suitability category



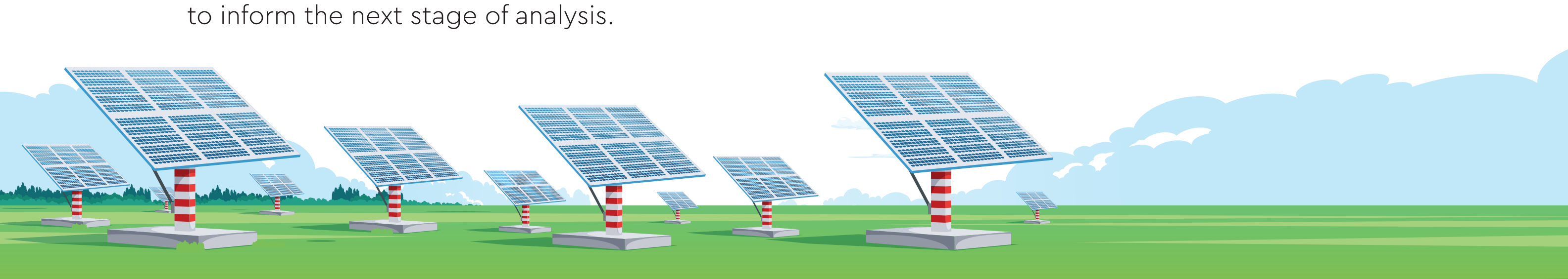
Source: Systemiq analysis for the ETC (2026): Government of India, Ministry of Agriculture and Farmers Welfare (2024), Land Use Statistics at a Glance, 2022–23. Note: Figures based on 210 million hectares of total national cropland.

The distribution in Exhibit 11 highlights that a large share of cropland within each suitability category is concentrated in a small number of major crops. Wheat and rice account for a substantial proportion of total cultivated area, while soybean, maize, groundnut, bajra, gram, moong, arhar and jowar dominate within their respective categories.

This implies that AgriPV compatibility with a limited set of high area crops will materially influence overall deployment potential. Even incremental improvements in system design, economics or agronomic integration for these crops would affect a significant share of national cropland.

At the same time, the presence of a meaningful "other" segment across categories indicates that crop diversity remains important and that conclusions should not rely solely on a small subset of crops.

The preceding graphs show how crops are distributed across India's 160 million hectares of cropland. In the absence of pixel level land use data, these crop shares are applied to the 47.5 million hectares identified by TERI as suitable for AgriPV, allowing an indicative allocation of land area by crop type to inform the next stage of analysis.

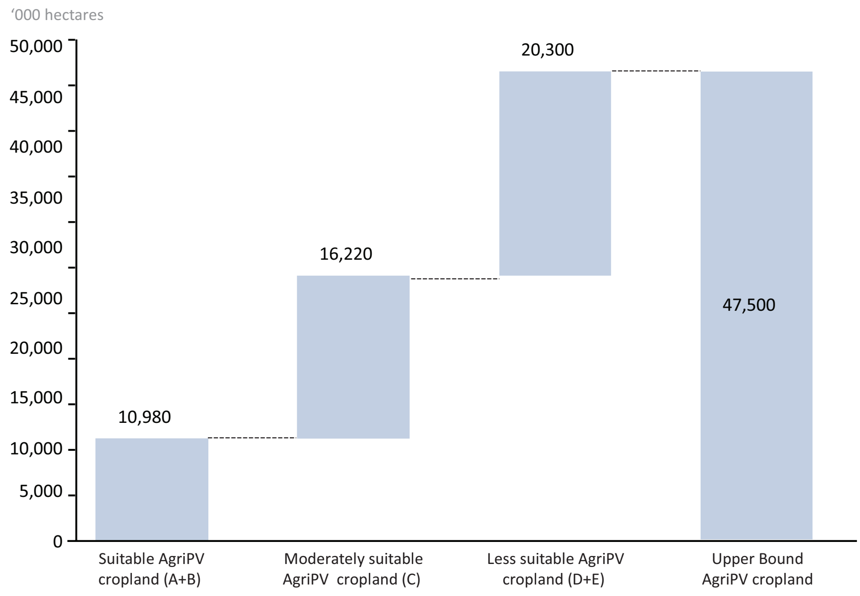


Resulting estimates of expanded land and solar potential for AgriPV

Cropland defines the core deployment potential for AgriPV, but it does not represent the full land envelope where dual land use solar systems can operate. The next step translates land availability into indicative solar generation potential across the land categories identified above. We first define the total theoretical land envelope for solar deployment, including an 'Upper Bound' scenario for AgriPV cropland that captures the full ~47.5 million hectares identified as suitable for AgriPV through TERI's geospatial screening.

While the TERI estimate translates this land base directly into installed capacity using conservative crop compatibility assumptions, the analysis here uses the same underlying land envelope to explore alternative deployment scenarios based on broader crop compatibility and different utilisation rates. This allows us to assess how much of this land could realistically host AgriPV systems under a range of deployment assumptions. Exhibit 12 below shows how the 47.5 million hectares of potential AgriPV cropland are distributed across Categories A to E, using the category splits derived from the government dataset as noted earlier in Table 3.

Exhibit 12: Land potential for AgriPV in India, 'Upper Bound' scenario



Source: Systemiq analysis for the ETC (2026); Government of India, Ministry of Agriculture and Farmers Welfare (2024), Land Use Statistics at a Glance, 2022–23; TERI (2026) Agri-Photovoltaics Potential in India: Pathways for Sustainable Energy–Food Solutions

In practice, it is neither realistic nor desirable to use all theoretically available land. To reflect credible deployment levels, we apply illustrative utilisation factors to each land category to define a 'High potential' scenario grounded in evidence from pilot studies on crop suitability and practical constraints including engineering limits and farmer adoption considerations, as shown in Table 4. The resulting estimates represent a realistic and evidence-based view of deployable potential rather than a theoretical maximum, yet the scale of opportunity they describe is substantial.

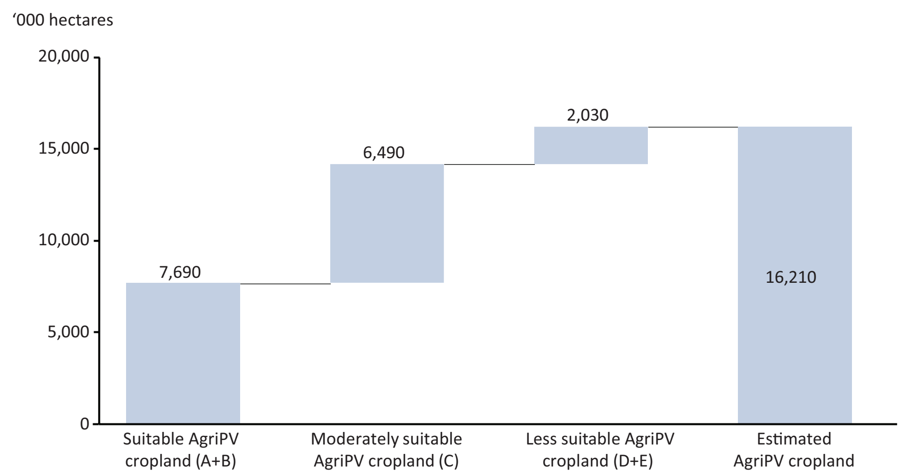
Table 4 – Percentage of land where AgriPV is likely to be deployed

Crop Category	Illustrative share of land where AgriPV is likely to be deployed (%)	Reasoning
Suitable Cropland (A+B Categories)	70%	Classified as highly suitable in the crop suitability matrix, but a recognition that not all land would have AgriPV deployed on it
Moderately suitable cropland (C Category)	40%	Demonstrated viability in some contexts; partial uptake assumed
Less suitable cropland (D+E Category)	10%	Limited suitability but evidence of success under adapted system designs in other locations[47]. Utilizing this larger land base will be important in enabling AgriPV to scale at meaningful levels.

Source: Systemiq analysis for the ETC (2026): TERI (2026) Agri-Photovoltaics Potential in India: Pathways for Sustainable Energy–Food Solutions

Applying these utilisation factors to the 47.5 million hectares identified through geospatial screening produces an estimate of the land area that could realistically host AgriPV systems. The resulting 'High potential' scenario for AgriPV cropland is shown in Exhibit 13 below, showcasing what greater opportunity may be possible for the deployment of AgriPV on agricultural land in India. The scenario shows that over 16 million hectares of cropland could host AgriPV in India. This represents 10% of India's total cropland identified through the geospatial screening (160 million hectares).

Exhibit 13: Land potential for AgriPV cropland in 'High potential' scenario, by crop type



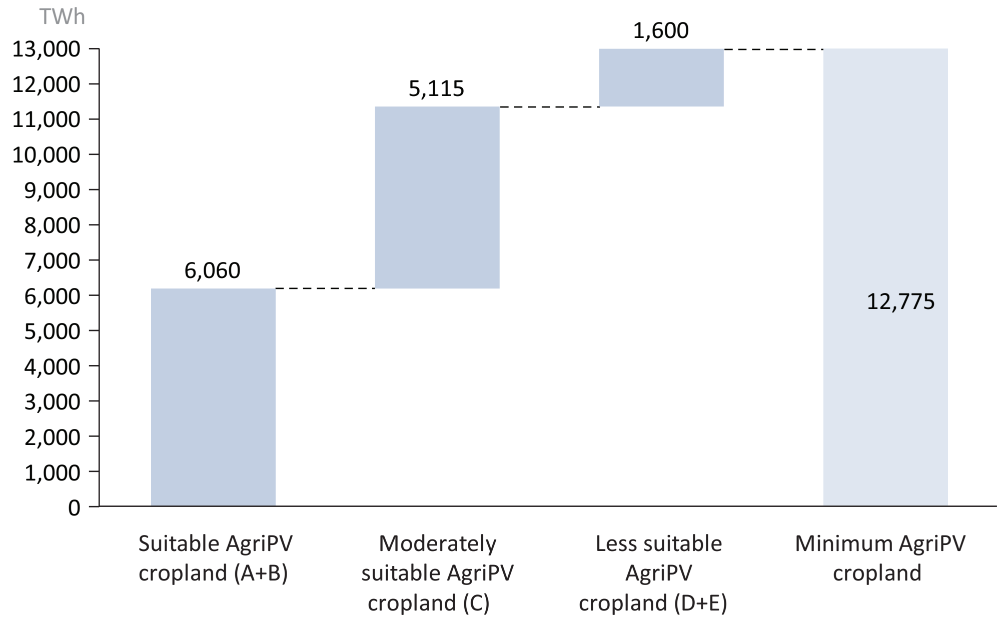
Total land area identified	10,980	16,220	20,300
Deployment assumption applied	70%	40%	10%

Source: Systemiq analysis for the ETC (2026); Government of India, Ministry of Agriculture and Farmers Welfare (2024), Land Use Statistics at a Glance, 2022–23; TERI (2026) Agri-Photovoltaics Potential in India: Pathways for Sustainable Energy–Food Solutions;

47 SPIE (2025) Solar panels and rice fields thrive together in Japanese agrivoltaics pilot

When converting this into potential solar generation, we find that 12,775 TWh of solar could be created from AgriPV cropland (Exhibit 14). This alone represents over twice the projected 2050 electricity requirements of 5,250 TWh and surpasses high scenario of 10,020 TWh.

Exhibit 14: AgriPV cropland electricity generation from 'High potential' scenario



Source: Systemiq analysis for the ETC (2026): Government of India, Ministry of Agriculture and Farmers Welfare (2024), Land Use Statistics at a Glance, 2022–23, TERI (2026) Agri-Photovoltaics Potential in India: Pathways for Sustainable Energy–Food Solutions

A few important points to note:

- **Highly suitable land (Categories A and B):** Offers high confidence based on crop characteristics and pilot performance. In the deployable scenario, this accounts for 7.6 million hectares, equivalent to around 5% of the total 160 million hectares of national cropland identified in the geospatial screening.
- **Moderately suitable land (Category C) drives scale:** This category contributes 6.4 million hectares in the deployable scenario, around 4% of national cropland.
- **Less suitable cropland (Category D and E) remains material:** Even assuming only 10% utilisation, this contributes 2 million hectares, around 1% of total cropland and 13% of deployable AgriPV land. While deployment here is more uncertain, it still provides meaningful upside.

Resulting estimates of land and solar potential on AgriPV cropland and other land types

Cropland does not define the full technical envelope for AgriPV. Evidence from pilot projects indicates that solar installations can coexist not only with crops but also with livestock systems, provided system design is adapted to local conditions. Permanent pasture and grazing land should therefore be incorporated into the deployable land assessment.

According to Government of India land use statistics, around 10.2 million hectares are classified as permanent pasture and other grazing land[48]. In practice, full deployment across this land class is unlikely. Constraints include competing uses for grazing livelihoods, land tenure fragmentation, transmission access limitations, and site-specific economic viability. A conservative assumption is that 40% of this land, approximately 4.1 million hectares, could be realistically considered for AgriPV deployment, as highlighted in Table 5 below. This provides a material but credible expansion of the land base.

Table 5 – Additional percentages of land where AgriPV is likely to be deployed

Crop Category	Illustrative share of land where AgriPV is likely to be deployed (%)	Reasoning
Pasture and grazing land	40%	Technically feasible, though unlikely to be deployed universally
Land constrained by solar irradiation or aspect	10%[49]	Conservative assumption reflecting potential over-screening of this land

Source: Systemiq analysis for the ETC (2026): TERI (2026) Agri-Photovoltaics Potential in India: Pathways for Sustainable Energy–Food Solutions

Land constrained by solar irradiation or aspect represents a further potential upside. Approximately 84 million hectares of cropland were excluded through the removal of GIS layers for land that received less than 4.5 kWh/m^2/ day or was north-facing. However, as discussed earlier in this report, emerging evidence suggests that solar installations can operate in these locations through adapted system designs such as elevated AgriPV structures, east–west oriented arrays, bifacial modules, and single-axis tracking[50], which can improve performance in lower irradiation or suboptimal orientations[51].

If 10% of this excluded cropland were deemed deployable under such adapted designs, the total AgriPV land opportunity would increase by roughly 30% relative to the cropland only baseline. Exhibit 15 below reflects the combined contribution of cropland, pasture, and selectively deployable land constrained by solar irradiation or aspect.

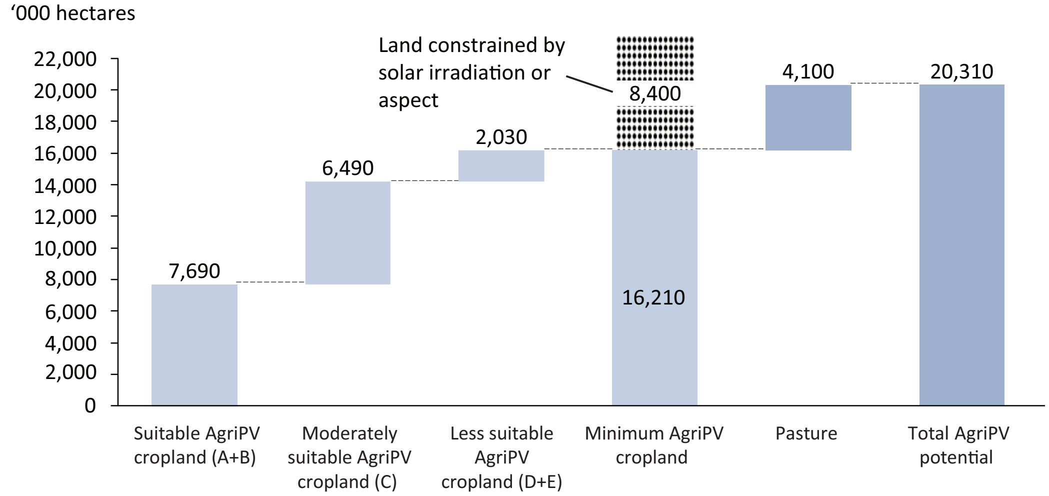
48 Government of India, Ministry of Agriculture and Farmers Welfare (2024), Land Use Statistics at a Glance, 2022–23

49 10% is applied relative to screened Solar GHI and aspect land category of 84 million hectares. It reflects partial reinstatement of excluded land and studies highlighting that solar PV and agriculture can be hosted on land at risk of flooding or high winds through design adaptations or modifications.

50 Fraunhofer ISE (2023) *Agrivoltaics: Opportunities for Agriculture and the Energy Transition*

51 Macknick et al. (2022) *Agrivoltaics: Opportunities and Challenges for Scaling Solar Energy Production*

Exhibit 15: Land potential for solar PV in India, including 'high potential' scenario for AgriPV, by land type



Total land area identified	10,980	16,220	20,300	47,500	10,240
Deployment assumption applied	70%	40%	10%	NA	40%

Source: Systemiq analysis for the ETC (2026): Government of India, Ministry of Agriculture and Farmers Welfare (2024), Land Use Statistics at a Glance, 2022–23, TERI (2026) Agri-Photovoltaics Potential in India: Pathways for Sustainable Energy–Food Solutions

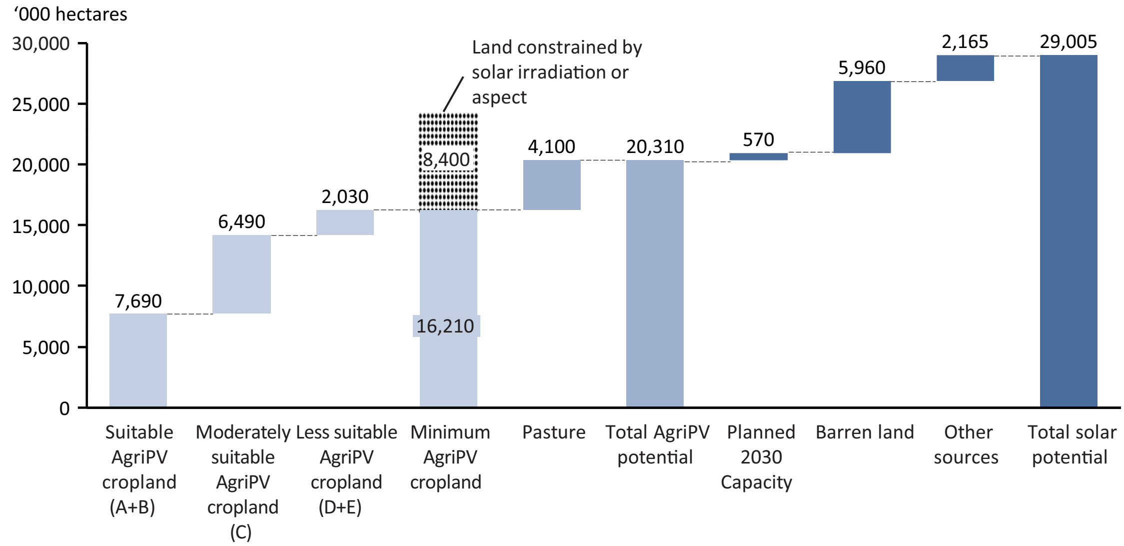
Beyond AgriPV, additional land and surface categories can host solar generation. These include barren and uncultivated land, as well as distributed and infrastructure integrated systems such as rural and urban rooftop solar, floating solar, and installations along rail, road, and other built environments. Estimates for these categories draw on analysis by The Energy and Resources Institute in its assessment of India's solar expansion potential[52]. Finally, planned deployment targets provide an important benchmark. The Government of India has announced a target of 500 GW of renewable capacity by 2030, of which approximately 300 GW is expected to be solar.[53] This can be termed 'Planned 2030 Capacity'.

As shown in Exhibit 16 below, when combined with identified AgriPV cropland, we find that a land area of 20 million hectares could technically host solar PV in India, assuming no further deployment constraints.

52 TERI (2025), Reassessment of Solar Potential in India: A Macro-level Study

53 ETC (2022) Roadmap to India's 2030 Decarbonization Target

Exhibit 16: Land potential for solar PV in India, including 'high potential' scenario for AgriPV, by land type



Total land area identified	10,980	20,300	20,300	47,500	10,240	57,740	570	5,960	2,165
Deployment assumption applied	70%	40%	10%	NA	40%	NA	100%	100%	100%

Source: Systemiq analysis for the ETC (2026): TERI (2026) Agri-Photovoltaics Potential in India: Pathways for Sustainable Energy-Food Solutions; TERI (2025) Reassessment of Solar Potential in India: A Macro-level Study

Using this land area, we then estimate solar generation potential by applying national solar resource and performance assumptions. The technical potential of this "High potential" scenario is shown in Exhibit 17 below[54], representing multiples of projected future electricity demand, which can also be seen in Exhibit 18[55].

54 This analysis translates screened cropland and pasture and grazing land areas into indicative power capacity and electricity generation using AgriPV power density and capacity factor assumptions. Assumes an average solar capacity factor of 18% (1,576.8 kWh per kWp per year) and AgriPV power densities of 0.5 MW per hectare on cropland and 0.55 MW per hectare on pasture, within TERI's 0.4–0.75 MW per hectare range.

55 Note: Electricity generation calculated using an average solar capacity of 18%.

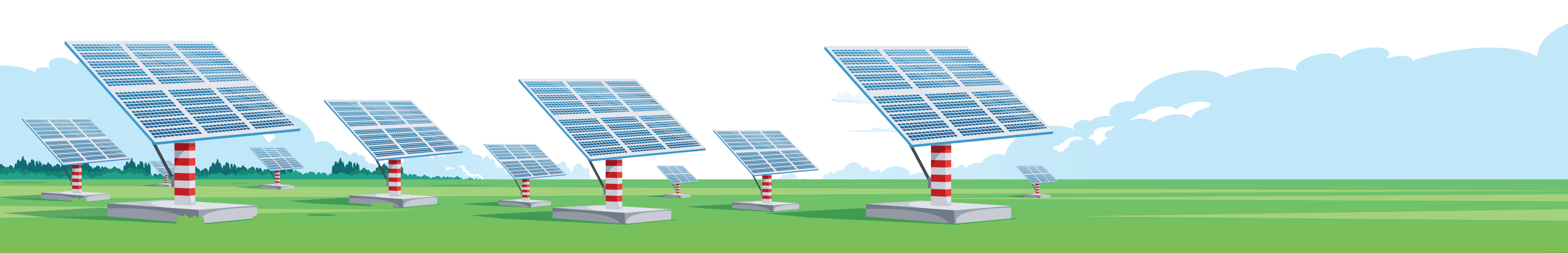
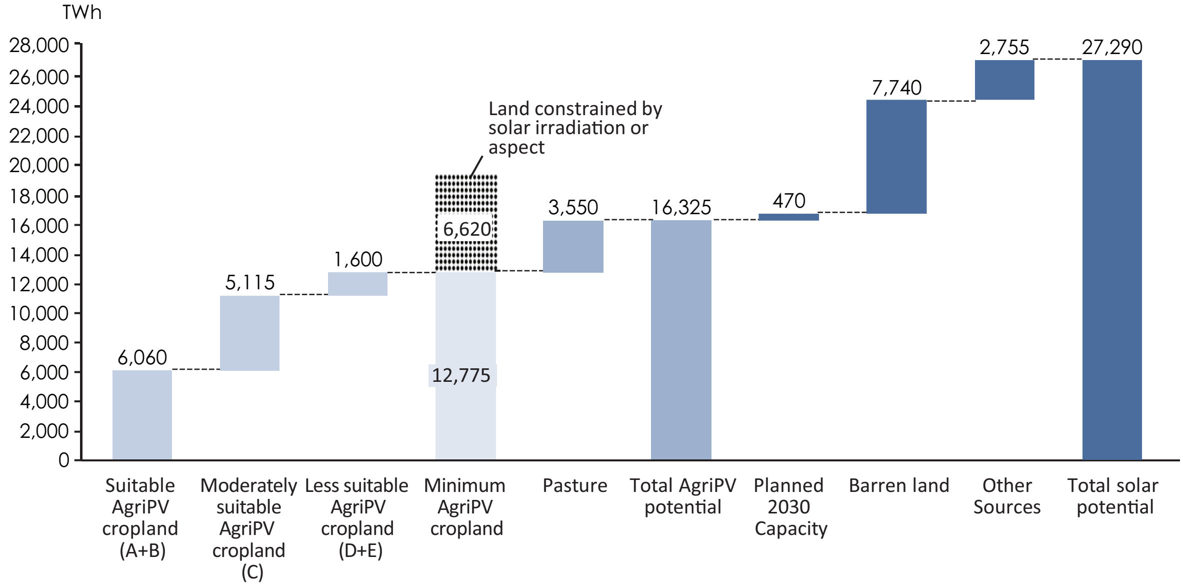


Exhibit 17: Electricity generation from 'high potential' scenario, by land category



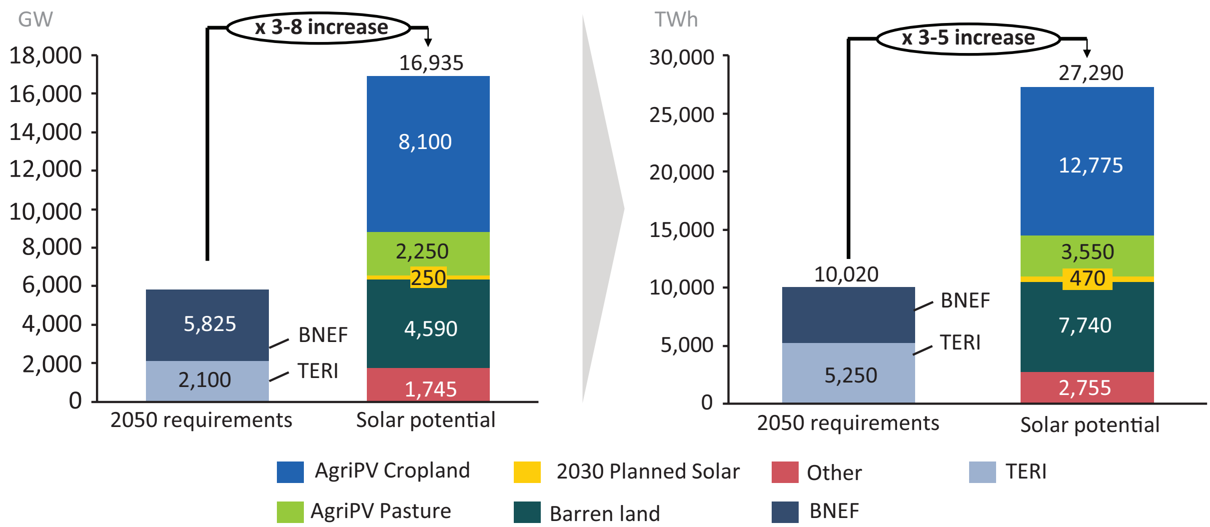
Source: Systemiq analysis for the ETC (2026): TERI (2026) Agri-Photovoltaics Potential in India: Pathways for Sustainable Energy–Food Solutions; TERI (2025) Reassessment of Solar Potential in India: A Macro-level Study

Building on these results, the key implications are as follows:

- India currently has 173 GW of installed solar capacity, producing approximately 300 TWh annually. Under current deployment trajectories, generation is projected to reach around 470 TWh by 2030.
- AgriPV deployment across suitable cropland in Categories A and B could deliver approximately 3,840 GW and 6,060 TWh annually. Extending deployment to moderately suitable land in Category C increases potential to around 7,090 GW and 11,175 TWh. Including less suitable cropland in Categories D and E raises total generation from cropland to approximately 8,100 GW and 12,775 TWh per year. If 10% of land excluded due to solar irradiation or aspect is used this increases to 12,300 GW and 19,395 TWh per year.
- Deployment on pastureland further expands potential, while data from TERI showcases that solar on barren land contributes approximately 7,740 TWh annually. Other solar sources, including floating solar and distributed rooftop systems, add an estimated 2,755 TWh per year.

While longer term deployment across broader land categories could unlock substantially higher generation potential, near-term action should prioritise the 2.8 million hectares identified by TERI as high certainty AgriPV land, as this represents the most immediately deployable opportunity with the lowest implementation risk. This would imply a potential of 1,400 GW and 2,207 TWh. In total, technical solar potential across land categories is around 27,290 per year, several times higher than India's projected electricity requirements. Even under BloombergNEF's high-electrification scenario, where demand reaches around 10,020 TWh by mid-century, AgriPV-enabled solar potential remains roughly three times higher than total demand.

Exhibit 18: Power capacity in 2050 compared with solar potential | **Electricity requirements in 2050 compared with solar potential**



Source: Systemiq analysis for the ETC (2026): TERI (2026) Agri-Photovoltaics Potential in India: Pathways for Sustainable Energy–Food Solutions; TERI (2025) Reassessment of Solar Potential in India: A Macro-level Study

While AgriPV will not supply all future electricity in practice, these results show that land availability is unlikely to be a binding constraint on solar deployment in India. Instead, the key challenges lie in grid integration, system planning, investment, and deployment pace, rather than physical land scarcity.

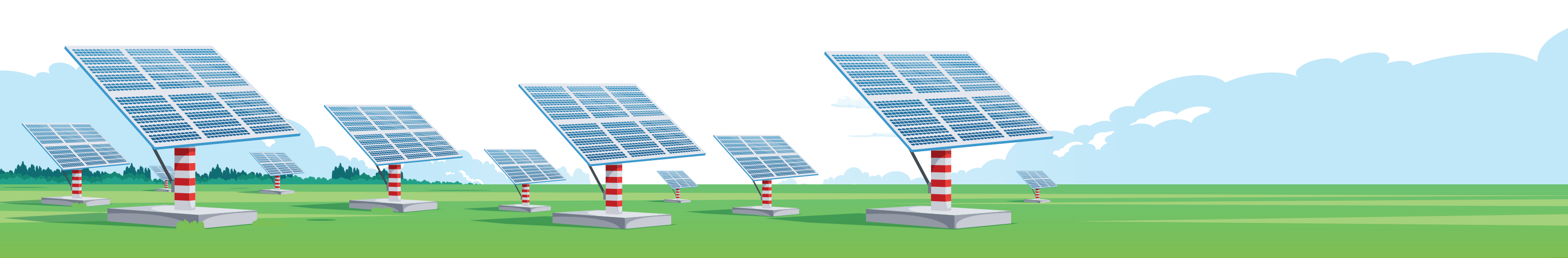
From land availability to system integration: implications for solar deployment and the energy transition

The analysis shows that large scale solar deployment in India can occur alongside continued agricultural production. Rather than requiring the conversion of productive farmland or relying on limited and contested categories of so called "unused" land, AgriPV offers a pathway to expand solar capacity within existing agricultural landscapes. As a result, the key challenge for scaling solar shifts away from land availability toward system integration, financing and deployment models.

Business models & grid integration

Given this expanded land potential, AgriPV presents a dual opportunity: enabling large scale solar deployment, while also creating additional and more resilient income streams for farmers.

In India, most AgriPV installations to date operate at pilot or early commercial scale and prioritise self-consumption models, where on-site generation offsets relatively high retail electricity costs for agricultural and commercial users. This model is particularly attractive where grid supply is unreliable



or costly, as it reduces dependence on diesel generators used for water pumping – which can typically exceed several thousand rupees per hectare per season[56] while improving the reliability of power for irrigation and on farm activities. As battery costs decline, pairing AgriPV with storage could further enhance reliability and reduce exposure to grid outages.

Beyond self-consumption, AgriPV can provide stable additional income through electricity exports under long term power purchase agreements (PPAs). Projects typically connect to local distribution networks at 11 kV or 33 kV and sell surplus electricity to distribution companies (DISCOMs) under fixed tariff PPAs[57], providing predictable cash flows. India's Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan (PM KUSUM), launched in 2019 by the Ministry of New and Renewable Energy, supports this model by offering capital subsidies for small scale solar installations and enabling assured procurement of surplus power by DISCOMs at pre-determined tariffs[58]. By combining upfront financial support with long term offtake agreements, the scheme improves revenue visibility and bankability while reducing merchant risk.

As deployment scales beyond pilot volumes, distribution network capacity is likely to become a binding constraint. Early pilots highlight limitations in feeder capacity, transformer sizing and hosting capacity at the local level. Unmanaged exports could create congestion if grid upgrades do not keep pace. One of TERI's reports within this AgriPV series will therefore focus on structured engagement with distribution companies to assess feeder level impacts, hosting capacity and cost-effective integration strategies under real world conditions.

Implications on India's energy transition and applicability to other geographies

The scale of technical potential identified implies that AgriPV could materially accelerate India's power sector decarbonisation trajectory. At the system level, AgriPV has the potential to contribute materially to the expansion of low-cost solar generation, displacing coal power and providing multiples of projected future electricity demand. [59] More broadly, the results highlight three strategic implications:

1. AgriPV unlocks India's solar advantage by enabling large scale deployment without significant land constraints. As land availability becomes less binding, the focus shifts toward distribution grid readiness, financing and project execution.
2. Well-designed AgriPV systems can reduce heat and water stress, enable self-consumption and the sale of surplus power, and strengthen farm cashflows through an additional and more stable income stream.

56 Gautum et al (2021), Economic and environmental benefits of replacing 7 HP diesel irrigation pumps with solar irrigation pumps in Rajasthan, India

57 Pronounce Solar (2025) PM-KUSUM 2026: The Ultimate Guide to Decentralised Solar Power Plants for Farmers, FPOs and Rural Entrepreneurs. Under the decentralised solar power route of the central PM-KUSUM programme, which aims to add 34,800 MW of solar capacity by March 2026, landowners, farmer producer organisations or developers install grid-connected solar plants (500 kW–2 MW) and enter 15 to 25-year PPAs with DISCOMs to sell electricity generated on farmland

58 Climate Policy Initiative (2025), Tapping the Potential of Agriphotovoltaics in India

59 Long term electricity system modelling by TERI shows that accelerated renewable deployment enables coal generation to peak and decline through falling utilisation rates rather than abrupt plant closures, delivering substantial power sector emissions reductions over time. The Energy and Resources Institute (2024), *India's Electricity Transition Pathways to 2050: Scenarios and Insights*

3. Co-location of agriculture and solar generation reduces pressure to convert forests or ecologically sensitive land, supporting renewable expansion while preserving natural ecosystems.

The scale identified in this study shows that the binding constraints shift from land scarcity to financing, infrastructure investment and policy design.

Alongside this report, TERI has produced several complementary outputs aimed at supporting practical deployment of AgriPV. These include pilot plant studies, a project development framework, and a business model selection tool. The work is summarised below:

- **AgriPV pilot plant baseline assessments –** Two site-specific studies for the Khare Energy Plant in Madhya Pradesh and the Renkube Plant in Telangana that document environmental, agricultural, energy and socio-economic conditions at each site and examine how solar generation and agricultural production are co-located in practice.[60]
- **AgriPV Detailed Project Report (DPR) Framework** – This report provides a structured framework for preparing DPRs across multiple AgriPV configurations, supporting developers, financiers and policymakers in planning and evaluating projects in a consistent and replicable manner[61].
- **AgriPV Business Model Selection Tool –** A decision-support tool designed to help stakeholders compare four alternative AgriPV business models based on financial viability and project context, enabling more informed project design and scaling decisions.[62]

Together, these outputs support the practical implementation of AgriPV and complement the analytical findings of this report. Many land constrained and high population density countries face similar tensions between agriculture and renewable expansion. The Indian evidence demonstrates that solar generation can be deployed alongside continued farming, with yield stability or improvement for selected crops and measurable water savings. These dynamics are particularly relevant for other fast growing sunbelt regions where electricity demand, agricultural activity and solar resources coincide. This includes parts of Southeast Asia, where land competition is acute and solar deployment is expanding rapidly; Latin America, where large agricultural systems coincide with strong solar irradiation; and Sub-Saharan Africa, where improving rural energy access while maintaining agricultural productivity is a central development priority. In these contexts, AgriPV could offer a pathway to scale solar generation while supporting farm incomes and reducing pressure to convert additional land for energy infrastructure.

International experience further shows that regulatory design shapes deployment pathways. France links AgriPV approval to demonstrable agricultural benefit, while Japan and China emphasise continued dual land use. The Indian findings strengthen the case that AgriPV can function both as an agricultural resilience tool and a land efficient renewable strategy, making it adaptable across diverse policy and market contexts.

Building on this work, further research should focus on three priorities:

1. Strengthening the evidence base:

While this study refines national land and generation estimates, greater certainty is required across crop types, seasonal performance and screening assumptions, including flood risk and paddy systems. Future work should combine high resolution remote sensing with standardised, multi season yield

60 TERI (2026) RA PV Baseline Assessment Report Madhya Pradesh; TERI (2026) RA PV Baseline Assessment Report Telangana

61 TERI (2026) AgriPV DPR Framework

62 TERI (2026) AgriPV Business Model Selection Tool

monitoring across agro-climatic zones to improve investment confidence and system planning. This should be supported by continuous measurement and learning across pilot deployments, covering impacts on crop yields, seed choice, water use, panel placement and biodiversity outcomes, in order to refine AgriPV system design and performance over time. Particular attention should be given to staple crops with large cultivation areas and high food security importance, including Category C wheat and Category E rice systems, to ensure AgriPV deployment does not compromise core agricultural production.

2. Enabling policy and market design:

In India, energy policy is largely determined at the national level, allowing the central government to set the strategic direction for renewable deployment. However, AgriPV intersects directly with land governance and agricultural policy, both of which are primarily determined at the state level[63]. This creates an additional layer of regulatory complexity for deployment. For example, in some states, farmland leasing regulations limit leases to short durations[64], in some cases to one year or less. Such restrictions can create a structural barrier for AgriPV projects, which typically rely on long-term power purchase agreements of 15 to 25 years to secure financing. Without regulatory clarity or exemptions allowing longer land use arrangements for AgriPV, developers may struggle to align project lifetimes with existing land laws.

Addressing these constraints will likely require coordination between national energy policy and state level land and agricultural regulations, including potential carve outs that allow AgriPV projects while continuing to protect agricultural land rights and farmer interests.

Enabling scaled deployment will require clear permitting standards, eligibility in procurement schemes, and business models that align farmer revenues, offtake structures, and distribution company incentives.

3. Assessing international replicability:

Although this study focuses on India, the findings have wider relevance for land constrained and high population density regions facing competing land use pressures. AgriPV may be particularly applicable in Southeast Asia and other sunbelt economies where food security and renewable expansion must progress in parallel. It may also support soil restoration and agricultural resilience in regions such as Brazil and Sub-Saharan Africa. Further research should assess crop compatibility, water impacts and scalable business models across diverse climatic and regulatory contexts to determine how AgriPV can be adapted and deployed internationally.

4. Exploring AgriPV enabled farm electrification pathways:

Building on the land and crop suitability analysis presented in this report, further work is needed to assess how AgriPV deployment alongside electrification of farms, food processing and storage, can strengthen the farm-level business case for AgriPV adoption. Rather than focusing primarily on exporting electricity to the grid, this approach would identify locations where electricity can be used locally to increase agricultural productivity, improve farmer incomes, and strengthen rural value chains. Potential applications include cold storage to reduce post-harvest losses, electrified crop drying and processing such as tea drying or fruit juicing, and electrifying farm machinery.

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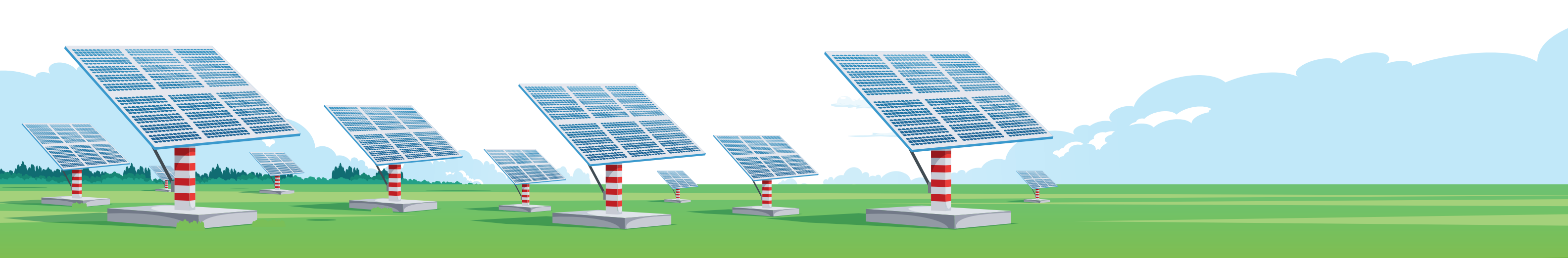
63 Government of India, NITI Aayog (2016) *Report of the Expert Committee and Model Law on Agricultural Land Leasing*

64 World Bank (2021) *Agricultural Land Leasing Reform in India: Strategies to Increase Poor Farmers' Access to Land*

Appendix:

Source: TERI (2026) Agri-Photovoltaics Potential in India: Pathways for Sustainable Energy–Food Solutions

Category	Plantation & Fruits	Vegetables	Others (Cereals / Pulses / Fodder / Oilseeds / Medicinal)	Spice Crops	Flower
A Most Suitable	Tea, Coffee, Grapes, Apricot; Apple (low height), Lemon, Sweet Orange, Mosambi, Ber, Aonla, Raspberries	Cabbage, Onion, Brinjal, Pea, Potato, Green Pea, Spinach, Cole crops (cabbage, cauliflower, broccoli), Exotic vegetables (capsicum, lettuce) , Other Green leafy vegetables, Beetroot, Amaranthus, Blonde Cucumber, Long Yard Bean, Turnip	Fodder Bajra; Sorghum(Jowar); Finger millet (ragi/ Mandua); Buckwheat; Medicinal herbs; Mustard (short-duration), Aloe Vera, Ashwagandha, Shankhpushpi, Vetiver (Khus), Basil (Tulsi), Mint (Pudina), Brahmi, Citronella, Roselle,	Turmeric, Coriander, Fenugreek, Garlic, Ginger, Lemongrass, Cumin, Ajwain	Anthurium, Geranium, Begonia, Petunia, Coleus, Allamanda, Eugenia
B Suitable	Kiwi; Strawberry; Dragon fruit, Citrus (General)	Tomato, Radish, Okra, , Carrot, Bitter-gourd, Ash-gourd, Ridge Gourd, Snake Gourd, Round Gourd (Tinda), Wax Gourd, Sponge Gourd, Chillis, Bottle Gourd, Pumpkin, Zucchini	Chickpea; Groundnut; Pulses (Moong, Lentil, Gram); Bajra; Sesame; Castor; Mustard; Guar; Early Mustard; Off-season Pea, Cowpea, Medicinal Herbs (Aloe, Basil, Mint)	Dill (Soya), Fennel, Annatto	Gerbera, Marigold, Carnation, Jasmine
C Moderately Suitable	Banana; Jute, Guava; Papaya; Pineapple; Plum; Watermelon; Muskmelon, Peach, Avocado, Grapefruit	Summer maize (Corn), French bean, capsicum (summer), Sweet Potato,	Wheat, Cotton; Soybean; Rapeseed; Maize	Curry Leaf, Cinnamon, Cardamom	Rose, Gladiolus, Tube Rose, Orchids (Moderate light), Lily, Tulip



Category	Plantation & Fruits	Vegetables	Others (Cereals / Pulses / Fodder / Oilseeds / Medicinal)	Spice Crops	Flower
D Less Suitable	Sugarcane; Oilseeds (except mustard/ rapeseed), Mango (low height); Almond; Cashew; Walnut	Mushroom, banana, Elephant Foot Yam, Pumpkin (large canopy)	Arhar (Pigeon pea); Jowar; Niger (Ramtil); Summer moong; Fodder crops	Black Pepper, Saffron, Bay Leaf (Tejpata),	Hibiscus (tall bushy), Sunflower (ornamental) Chrysanthemum,
E Least Suitable	Coconut; Palm; Drumstick (Moringa)	Jackfruit, Drumstick (Moringa)	Paddy mono-cropping; Water-intensive rice systems, Ashoka, Neem	Clove, Nutmeg (Jaiphal)	Very tall ornamentals (e.g., Sunflower fields)

*Note: where, A–B: Highly suitable crops — shade-tolerant, low-height, short-duration, and high-value varieties that thrive under partial shading conditions.

C: Moderately suitable crops — medium-height, semi-shade-tolerant species showing good adaptability but potential competition for sunlight or water.

D–E: Less suitable crops — tall, water-intensive, or dense-canopy species (e.g., paddy, sugarcane) that may obstruct solar panels or reduce overall system efficiency.

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