Solar Farms on U.S. Farmland: Comprehensive Analysis 2025-2026

Solar development on U.S. farmland remains minimal on a national scale but is highly concentrated in agricultural areas. As of 2025-2026 data, solar farms occupy approximately 550,000-600,000 acres with capacity-based estimates ranging to 1.25 million acres of farmland — representing between 0.06-0.14% of America's 897 million total farm acres. The impact is concentrated, with over 70% of rural solar projects installed on agricultural land. Recent peer-reviewed research provides nuanced findings on which types of farmland are being developed (see "Prime Farmland: What the Research Shows" below).

Current Solar Installation Data (2025-2026)

National Solar Capacity

- **Total U.S. Solar Capacity (2025):** 279 GWdc installed
- **2025 Additions:** 43.2 GW (solar represented 54% of all new U.S. electricity capacity for the fifth consecutive year)
- **Utility-Scale Solar:** Utility-scale continues to dominate new additions
- **Community Solar:** Continued growth across key state markets

Source: SEIA Solar Market Insight Report 2025 Year in Review

Total U.S. Farmland Data (2025)

Current Farmland Statistics

- **Total U.S. Farmland:** 897 million acres (Winikoff et al. 2026, USDA ERS)
- **Number of Farms:** 1.88 million farms
- **Average Farm Size:** 466 acres
- **Total Cropland:** 328 million acres
- **Prime Farmland:** Approximately 313.7 million acres (note: USDA does not publish a single authoritative national figure; this estimate is derived from soil survey data and should be treated as approximate)

Source: Winikoff et al. 2026 (USDA ERS); USDA NASS; NRCS Soil Survey data

Solar Development on Farmland: The Numbers

Current Solar Footprint on Agriculture

Current Estimate:

- **Solar on Farmland:** Approximately 550,000 – 600,000 acres (peer reviewed measurement through 2021), with capacity-based estimates ranging to 1.25 million acres.
- **Percentage of Total Farmland:** 0.06% - 0.14% depending on measurement method.
- **Measurement Methods:** Direct facility footprint measurements vs. Capacity calculations (GW x acres/MW assumptions).

Land Cover Findings from Recent Studies:

Maguire et al. 2024 (USDA Economic Research Service):

- **71% of utility-scale solar capacity (2009-2020) was sited on agricultural land** (cropland + pasture-range combined)
- 43% on cropland; 28% on pasture-range
- 96% of wind capacity was sited on agricultural land
- Regional variation: Midwest = 66% continuous cropland; West/Plains = 51-60% pasture-range

Fujita et al. 2025 (Lawrence Berkeley National Laboratory):

- Prior land cover of analyzed facilities: **58% agricultural**, 10% shrub/scrub, 13% forest, 5% grassland, 5% brownfields/contaminated sites
- Mean capacity density: 0.268 MWdc/acre
- Fixed-tilt systems: 0.294 MWdc/acre; Single-axis tracking: 0.232 MWdc/acre

Hu et al. 2025 (Communications Earth & Environment):

- Analysis of 719 utility-scale PV facilities in Western U.S.
- 38% built on land previously classified as cultivated crops

Sources: Levin et al. 2025 (Journal of Environmental Management); Maguire et al. 2024 (USDA ERS); Fujita et al. 2025 (LBNL); Hu et al. 2025 (Communications Earth & Environment)

Understanding Data Variations

Estimates of solar land use vary significantly based on measurement methodology:

Measurement Approach Differences:

- **Panel Array Only:** Measures just the solar panels and spaces between rows (smaller estimate)
- **Full Facility Footprint:** Includes everything within the fence line – panels, access roads, equipment, buffer areas (29-34% larger than array-only measurements)
- **Capacity Calculations:** Estimates based on total of GW capacity x assumed acres per MW x percentage on farmland (varies by assumptions used)

Research Findings:

A 2025 peer-reviewed study (Levin et al., Journal of Environmental Management) comparing three major solar databases found:

- Panel array measurements: 623-668 km² (154,000-165,000 acres) through 2018
- Full facility footprint: 939 km² (232,000 acres) through 2018
- The difference matters for understanding actual land impact

Key Data Sources for Solar Land Analysis:

Dataset	Best Use	Notes
USPVDB (USGS/LBNL)	Most accurate for ≥1 MW projects	Array polygons, high transparency
Kruitwagen et al.	Broad identification	Includes smaller arrays
Wiki-Solar	Full facility impact	Fenceline footprint

Two Primary Land Cover Classifications:

- **NLCD (USGS):** Broader categories (cultivated crops, developed, forest)
- **CDL (USDA):** Crop-specific (corn, soybeans, hay, pasture-range)

Studies using different data sources and classifications yield different percentages. The USPVDB database is updated annually and incorporates AI/ML techniques for improved accuracy.

Why This Matters:

When reviewing solar development data, clarify whether figures represent:

- Panel-covered area only
- Total fenced facility area
- Capacity-based calculations
- Time period covered

All approaches are valid but serve different purposes. For land use impact analysis, full facility footprint measurements provide the most complete picture.

Source: Levin et al. (2025). "Variation in estimates of the footprint of large, ground-mounted photovoltaic solar energy in the United States." Journal of Environmental Management 394.

Prime Farmland: What the Research Shows

The question of whether solar development disproportionately affects prime farmland is actively debated. Recent peer-reviewed research and advocacy analyses offer different perspectives:

Peer-Reviewed Research: Winikoff et al. 2026 (USDA Economic Research Service)

Published in *Renewable Energy*, this study from USDA's Economic Research Service examined the relationship between farmland quality and utility-scale solar siting:

Key Findings:

- **No significant positive relationship** between overall farmland quality and the likelihood of utility-scale solar development
- **Prime farmland is neither more nor less likely** to host solar development once parcel-level and location controls are included
- Solar development is more strongly associated with **non-soil factors**: proximity to transmission infrastructure, flatter terrain, and policy/market conditions
- Crop types most commonly converted include corn, soybeans, and hay, reflecting regional agricultural patterns

Important Caveat: The authors note that losses of high-quality farmland may be **geographically concentrated** in regions with favorable transmission access, solar resource, or policy incentives—even if national averages do not show strong relationships with prime farmland status.

Advocacy Analysis: American Farmland Trust Projections

AFT's Smart Solar Program analysis projects future risk rather than analyzing historical patterns:

- **83% of future solar development** projected on farmland (if current trends continue)
- **49%** of agricultural solar development projected on "Nationally Significant" land
- "Nationally Significant" = most productive, versatile, and resilient soils

Reconciling These Perspectives

These analyses address different questions:

- **Winikoff et al.** asks: *Has* prime farmland been disproportionately targeted historically? (Answer: No, when controlling for other factors)
- **AFT** asks: *Could* prime farmland be at risk going forward without smart siting policies? (Answer: Yes, particularly in certain regions)

Both findings support the case for **thoughtful siting policies** that direct solar development toward lower-quality lands, brownfields, and dual-use configurations while preserving the nation's most productive agricultural soils.

Why Agricultural Land Attracts Solar Development

Solar developers often site projects on agricultural land because it offers:

- Flat, cleared terrain (reduces site preparation costs)
- Proximity to existing electrical infrastructure (reduces interconnection costs)
- Large contiguous parcels (simplifies land assembly)
- Rural zoning with fewer land-use restrictions

These characteristics—**not soil productivity**—appear to drive siting decisions, according to Winikoff et al.

Land Density

Capacity Density: How Much Land Does Solar Require?

Source	Capacity Density	Acres per MW	System Type
Fujita et al. 2025	0.294 MWdc/acre	3.4 acres	Fixed-tilt
Fujita et al. 2025	0.232 MWdc/acre	4.3 acres	Single-axis tracking
NREL/Industry estimates	Varies	5-7 acres	Typical utility-scale

Key insight: Land requirements vary by mount type (fixed vs. tracking), project vintage (newer projects are denser), and whether measuring array footprint vs. full fenceline.

Detailed Analysis by Project Scale

Utility-Scale Solar (≥1 MW)

- **Total Projects:** 6,000+ projects nationally
- **Average Size:** 15-20 MW per project
- **Land Requirement:** 3-7 acres per MW (varies by technology and site)
- **Geographic Distribution:** All regions, concentrated in rural areas

Community Solar

- **Projects:** Thousands of projects across 40+ states
- **Average Size:** ~2.3 MW per project
- **Key Markets:** New York, Massachusetts, Minnesota, Maine, Illinois, Colorado

Source: [NREL Community Solar Data]

Comparison: Solar vs. Other Land Uses

Context for Solar Land Use

- **Solar on Farmland:** 550,000-1.25 million acres (0.06% - 0.14%) depending on measurement method and time period
- **Conservation Reserve Program:** 25.8 million acres enrolled (2.9% of total farmland); only 7.76 million acres in General CRP (true land retirement)

- **Conservation Stewardship Program:** 70 million acres enrolled (working lands—remains in production)
- **Urban Development:** Consumes approximately 1 million acres of farmland annually (Source: American Farmland Trust "Farms Under Threat")
- **Solar Growth:** Even at the highest estimates, solar uses less land than lost to sprawl in a single year

Reversibility

- Solar requires minimal water
- Solar installations are designed for 25-40 year lifespans and are removable vs. permanent urban development

Sources: USDA FSA CRP Statistics; NRCS Program Data

Agrivoltaics: The Emerging Solution

Agrivoltaics—the co-location of agriculture and solar generation—is emerging as one of the most promising strategies to transform the perceived conflict between renewable energy development and agricultural land preservation into collaboration.

- NREL reports that suitable land area for agrivoltaics in the United States could exceed 1 million square miles—far more than would ever be needed for either agriculture or solar development alone.
- Research shows that partial shading from solar panels can reduce crop irrigation needs by up to 40% while maintaining or even improving yields for certain crops.
- Variable-height mounting systems allow farming equipment to operate underneath panels.
- Colorado State University and other institutions are advancing vertical bifacial solar installations that integrate wireless soil monitoring probes and accommodate large-scale agricultural tillage, planting, and irrigation equipment.
- Shade-tolerant crops like lettuce, kale, and herbs often perform better under partial shade conditions.

Current U.S. Agrivoltaics Scale (2025)

According to NREL InSPIRE data:

- **596 agrivoltaic sites** across the United States
- **65,699 acres** in agrivoltaic use (up from 27,000 acres in 2020)
- **10,473 MW (10.5 GW)** total capacity—sufficient to power approximately 7.5 million homes

November 2025 — DOE Midwest Agrivoltaics Initiative

The U.S. Department of Energy awarded **$20 million** for Midwest agrivoltaic pilot projects combining corn and soybean farming with vertical bifacial solar panels to demonstrate economic viability at commercial scale.

Research and Development

Academic institutions across the United States are leading groundbreaking research into agrivoltaic applications, creating a robust foundation of scientific knowledge that supports the technology's expansion:

The University of Arizona received $1.725 million from a $10 million USDA grant for the SCAPES project (Sustainably Colocating Agricultural and Photovoltaic Electricity Systems) to study agrivoltaics across different land types and climate scenarios. U of A also led the first field-data assessment of agrivoltaics in the United States, finding that agrivoltaics increases the efficiency of both solar panels and crop production through cooling effects.

University of Massachusetts Amherst operates a three-year research project supported by the U.S. Department of Energy evaluating the impacts of dual-use solar on crop productivity and the agricultural economy, studying butternut squash, lettuce, hay production, and cranberry cultivation. UMass developed a pollinator-friendly certification program for solar PV facilities in Massachusetts, working with state and federal agencies, pollinator experts, and stakeholders. And researchers developed analytical spreadsheet tools published in the Journal of Extension to help farmers make informed decisions about incorporating agrivoltaics into their operations.

Colorado State University faculty are funded by USDA-NIFA's Sustainable Agricultural Systems program to build replicated Experimental Agrivoltaic Research Arrays over native Colorado grasslands and vegetable plots. CSU also received funding through Colorado's $500,000 agrivoltaics grant program to install research plots featuring raspberries grown under solar panels at the CSU Spur campus. CSU partnered with Sandbox Solar to complete a vertical bifacial agrivoltaic installation in 2024, studying field corn and horticultural crops growing between solar modules. This vertical bifacial approach is now being scaled through the 2025 DOE Midwest initiative.

Cornell University operates the Solar Grazing Project at the 54-acre Cascadilla Community Solar Farm, studying optimal sheep grazing management with six different stocking densities to determine effects on animal welfare, plant biodiversity, pollinator habitat, and soil carbon sequestration. Researchers are also investigating how sheep grazing density impacts soil organic carbon, pollinator habitat, and vegetation biodiversity in solar arrays through a multi-year USDA-funded study. Cornell established an Agrivoltaics Research Program in 2023 with $1 million in funding from New York State, focusing on crop production beneath solar panels.

Research is also happening at Oregon State University, North Carolina State University, Texas A&M and Purdue University. This extensive research network is generating peer-reviewed data that validates agrivoltaics as a scientifically sound approach to land use optimization. The growing body of research is helping farmers, developers, and policymakers make informed decisions about implementing dual-use systems across diverse agricultural regions and climate zones.

Sturchio et al. 2025 (PNAS) — Cornell "Ecovoltaics" Study

This peer-reviewed study evaluated how converting cropland to "ecologically informed solar" (ecovoltaics) could improve land-use efficiency and ecosystem services:

- Converting approximately **391,000 hectares (966,000 acres)** of certain cropland to solar with perennial vegetation could increase U.S. utility-scale solar electricity from 3.9% to 13%
- Such conversion would significantly reduce nitrogen and phosphorus application, with benefits for water quality
- Illinois, Minnesota, Kansas, Texas, and Nebraska contain substantial acreage where solar could be colocated with existing wind facilities

Tools and Maps for Tracking Solar Projects

1. CleanView Solar Farms Map
2. USGS Solar Photovoltaic Database (USPVDB)
3. SEIA Major Solar Projects List
4. InSPIRE Agrivoltaics Map

Additional Data Sources and Links

- USDA Economic Research Service
- Solar Energy Industries Association (SEIA)
- American Farmland Trust
- USDA NASS Farms and Land Data
- CleanView Solar Farm Tracker
- USGS Solar PV Database
- Siting Resource Center
- Lawrence Berkeley National Laboratory Solar Research
- Resources for the Future (RFF)

Key Takeaways for Landowners

5. **Solar uses a small fraction of U.S. farmland.** At 0.06-0.14% of total farmland, solar's current footprint is minimal compared to other land uses.
6. **Most solar is sited on agricultural land—but not necessarily prime farmland.** Recent USDA research finds no evidence that prime farmland is disproportionately targeted when other factors are controlled.
7. **Measurement methods matter.** When evaluating solar land use claims, clarify whether figures represent panel arrays, full facility footprints, or capacity-based estimates.
8. **Agrivoltaics is scaling.** With nearly 600 sites and 10+ GW of capacity, dual-use solar is proving that energy and agriculture can coexist productively.
9. **Thoughtful siting policies work.** The research supports directing solar toward lower-quality lands, brownfields, and dual-use configurations while preserving the most productive soils.
10. **Solar is reversible; urban sprawl is not.** Unlike permanent development, solar installations can be removed and land returned to agricultural use.

This brief was prepared by the Renewable Energy Farmers of America (REFA). For questions or to connect with farmers who have experience hosting renewable energy, visit renewableenergyfarmers.org.