

Fact Sheet:

Soil Health in Solar Development

As renewable energy development expands across agricultural landscapes, solar projects present a unique opportunity to promote soil health and long-term land productivity.

With energy developers' and farmers' increased interest and investment in solar projects, concerns have emerged about potential disruptions to agricultural land, soil degradation, and the possibility of diminished agricultural productivity after a project's decommissioning.

But solar projects can be designed to protect and enhance the land's soil and agricultural potential by implementing low-impact construction methods, establishing deep-rooted native vegetation, and integrating dual-use strategies such as grazing or crop production.

Soil health and conservation

Topsoil is essential for agricultural productivity because it contains rich minerals and organic matter vital for crop growth, supports a lively ecosystem, and affects water infiltration. In the Midwest, studies show that topsoil on agricultural land is being lost at a rate of 0.5 to 2 millimeters per year, outpacing natural formation, which takes more than 25 years per millimeter.¹

As solar energy expands onto agricultural land, protecting and preserving topsoil should be a priority. Soil erosion is a significant concern for solar installations, especially when land has been heavily disturbed or left bare.

Concerns may include:

- Erosion from water and wind
- Soil compaction
- Water accumulation
- Pollutants
- Loss of organic matter

Sources

1 Shojaeezadeh, Shadhab Aldin, et al. "Soil Erosion in the United States: Present and Future (2020-2050)." Science Direct, July 2024, doi.org/10.1016/j.catena.2024.108074. Accessed June 2025.

2 "Conservation Considerations for Solar Farms." Natural Resources Conservation Service, U.S. Department of Agriculture, March 2024, nrcs.usda.gov/sites/default/files/2024-03/Conservation_Considerations_Solar_Farms.pdf. Accessed June 2025.

3 Ibid.

4. Ibid.



Solar projects can be designed to protect and enhance the land's soil.

Without vegetative cover, wind and water can quickly degrade a site. Wind erosion can blow loose soil and dust onto solar panels, reducing their efficiency and risking long-term damage to equipment.² Water erosion from rainfall and runoff can wash away soil, form gullies, and damage infrastructure such as panel foundations, roads, and fencing.³ These effects not only increase maintenance and repair costs but can also cause harmful off-site effects by transporting sediment into nearby waterways.

For successful solar projects, land management principles should be considered throughout the planning, construction, operation, and decommissioning processes.

Four principles to support healthy soil are:⁴

- Maximize soil cover
- Minimize soil disturbance
- Maximize living roots
- Maximize biodiversity





The Alliant Energy Solar Farm at Iowa State University used low-impact construction practices, as seen in the photo above, which shows the land's natural curve being followed by using different panel leg heights instead of leveling the land.

Soil health and conservation, continued

Establishing stable ground cover, such as native perennial vegetation, and using low-impact construction practices are essential to reduce these risks, protect infrastructure, and ensure the long-term performance and sustainability of the solar project.

In addition, solar panels can promote soil health by creating microclimates that reduce evaporation and moderate soil temperatures. Microclimate refers to localized atmospheric conditions, such as temperature, humidity, and light, created within and immediately surrounding solar panels.⁵ These conditions help preserve soil moisture and enhance microbial life, which is particularly important in dry or degraded regions.⁶

Research on the impact of specific soil types across various climates is limited but increasing; broad generalizations about the effects on soils beneath the panels are difficult to make.⁷ However, adopting soil health best practices during development ensures optimal outcomes and minimizes any negative impacts on the land.

Sources, continued

5 Choi, Chong Seok, et al. "Multi-Year Analysis of Physical Interactions Between Solar PV Arrays and Underlying Soil-Plant Complex in Vegetated Utility-Scale Systems." ScienceDirect, July 1, 2024, doi.org/10.1016/j.apenergy.2024.123227. Accessed June 2025.

6 Ibid.

7 Ibid.

8 Ibid.

9 "Low-Impact Solar Development Strategies Primer." OpenEI, Innovative Solar Practices Integrated with Rural Economies and Ecosystems (InSPIRE), openei.org/wiki/InSPIRE/Primer. Accessed June 2025.

10 Choi, Chong Seok, et al. "Multi-Year Analysis of Physical Interactions Between Solar PV Arrays and Underlying Soil-Plant Complex in Vegetated Utility-Scale Systems." ScienceDirect, July 1, 2024, doi.org/10.1016/j.apenergy.2024.123227. Accessed June 2025.

Construction considerations

During the installation of a solar farm, developers and landowners have an opportunity to improve the soil quality for the long term. Conventional construction practices for utility-scale solar energy often modify the landscape, which can include vegetation removal, soil removal, grading, and compression of soil.⁸ These practices can decrease soil quality, increase erosion, and reduce long-term land productivity.⁹ Alternative practices can minimize disruption and preserve the land's natural integrity.

A study in Minnesota showed that solar arrays with minimized land modification and re-established native vegetation experienced reduced erosion and retained total soil carbon and nitrogen levels.¹⁰

The lifespan of a solar project and land lease agreement typically is 20 to 30 years, making low-impact installation and vegetation maintenance essential.



Table 1: Conventional vs. low-impact solar construction¹¹

Conventional practices	Low-impact practices
Clearing and grubbing of soil and vegetation	Preserve or replace existing vegetation with native, deep-rooted species that stabilize soil and enhance biodiversity
Stripping and stockpiling topsoil	Keep topsoil in place, avoiding removal or storage that can degrade the soil's health
Land grading and leveling using heavy machinery	Follow the land's natural contours by adjusting panel leg heights instead of leveling the terrain, which reduces soil disturbance and erosion risk
Soil compaction using heavy equipment	



Cattle graze under solar panels at Huwa Enterprises in Colorado. Photo provided by Huwa Enterprises.

Grazing

Incorporating livestock, such as sheep or cattle, on solar sites is a natural, effective way to manage vegetation. Rotational grazing helps control plant growth without the need for mechanical mowing or using chemical herbicides. This reduces operational costs and promotes healthier soil.

Grazing contributes to improved soil structure by sequestering carbon and increasing microbial diversity.¹² As animals move across the land, their hooves aerate the soil, while their manure serves as a natural fertilizer, enriching the soil with essential nutrients.¹³

When paired with native vegetation, grazing can help reduce runoff, increase soil productivity, and promote soil biodiversity.



Sources, continued

¹¹ Ibid.

¹² Gray, Jess. "Benefits of Solar Grazing." Gray's Lambscaping, Jan. 10, 2024, grayslambscaping.com/benefits-of-solar-grazing. Accessed June 2025.

¹³ Ibid.

Native vegetation

Establishing deep-rooted, perennial native vegetation beneath and around solar arrays can help prevent soil erosion, minimize stormwater runoff, and sequester carbon.

Some solar facilities use a turfgrass or gravel ground cover, which increases stormwater discharge and soil erosion at the base of the panels.¹⁴ Native vegetation develops extensive root systems that anchor the soil, reduce compaction, and promote water infiltration. The deep roots often reach several feet underground, which enhances soil structure and prevents erosion, especially at the base of solar panels.

Turfgrass roots only extend a few inches, leading to increased soil erosion. Runoff from solar sites covered in turfgrass can be 38% higher than sites with deep-rooted vegetation.¹⁵ In addition, long-term maintenance of turfgrass is more expensive than deep-rooted perennials due to mowing, reseeding, and herbicide application costs.¹⁶

Additionally, vegetation beneath the panels helps cool the panels themselves through natural evaporation, which improves solar panel efficiency.¹⁷

Pollinator habitat

Well-designed pollinator seed mixes, with a variety of flowering species blooming throughout the growing season, support healthy populations of bees, butterflies, and other beneficial insects. These habitats can also attract ground-nesting birds like pheasants and quail. By fostering a pollinator-friendly environment, native vegetation can increase crop yields on nearby farmland, adding value beyond the solar site itself.¹⁸



Native vegetation thrives under solar panels. Photo provided by Center for Pollinators in Energy.

Best practices for establishing native vegetation on solar sites:

- Use native seed mixes with at least three flowering species per bloom period (spring, summer, and fall) to ensure continuous food sources for pollinators.¹⁹
- Incorporate wildlife-friendly mowing and rotational grazing practices that support nesting birds and synchronize with plant bloom cycles.²⁰

Sources, continued

14 Choi, Chong Seok, et al. "Multi-Year Analysis of Physical Interactions Between Solar PV Arrays and Underlying Soil-Plant Complex in Vegetated Utility-Scale Systems." ScienceDirect, July 1, 2024, doi.org/10.1016/j.apenergy.2024.123227. Accessed June 2025.

15 "Best Practices: Photovoltaic Stormwater Management Research and Testing (PV-SMaRT)." Great Plains Institute, January 2023, betterenergy.org/wp-content/uploads/2023/01/PV-SMaRT-Best-Practice.pdf. Accessed June 2025.

16 "Local Environmental Benefits of Solar Farming in Wisconsin." Clean Wisconsin, January 2025, cleanwisconsin.org/wp-content/uploads/2025/04/Environmental-benefits-of-solar-report.pdf. Accessed June 2025.

17 Srithar, K., et al. "Enhancing Photovoltaic Efficiency Through Evaporative Cooling and a Solar Still." ScienceDirect, Nov. 15, 2023, doi.org/10.1016/j.solener.2023.112134. Accessed June 2025.

18 Waltson, Leroy J., et al. "Examining the Potential for Agricultural Benefits from Pollinator Habitat at Solar Facilities in the United States." ACS Publications, May 28, 2018, pubs.acs.org/doi/10.1021/acs.est.8b00020. Accessed June 2025.

19 "Local Environmental Benefits of Solar Farming in Wisconsin." Clean Wisconsin, January 2025, cleanwisconsin.org/wp-content/uploads/2025/04/Environmental-benefits-of-solar-report.pdf. Accessed June 2025.

20 Ibid.



Crops

Many universities are researching the cultivation of both row crops and specialty crops under solar panels.

Solar panels create a moderated microclimate that benefits crops and soil health. The partial shade provided helps shield crops from intense heat and direct sunlight, keeping the soil several degrees cooler during the day and slightly warmer at night.²¹ This temperature regulation reduces evaporation, allowing soil to retain more moisture, which is especially important in dry or drought-prone regions.²²

Studies have shown that soil moisture is consistently higher under solar panels compared to full-sun plots, leading to improved growing conditions. These moderated conditions reduce drought stress on plants and enhance the environment for microbial life and plant root development, contributing to long-term soil health.

Shade-tolerant or specialty crops such as lettuce, tomatoes, herbs, berries, chiltepin peppers, and jalapeños have shown increased yields under panels. One study found chiltepin pepper yields doubled and cherry tomato yields tripled compared to full-sun plots.²³



Alliant Energy Solar Farm at Iowa State University features strawberries growing under solar panels.

Conclusion

Solar energy development can serve as a powerful tool for soil conservation and agricultural resilience when thoughtfully planned and managed. With low-impact construction techniques, the use of native vegetation, grazing practices, or agrivoltaics, solar projects can not only maintain but enhance soil health while producing renewable energy.

Additional Agrisolar Resources

- Cattle Voltaics: Maximizing Land Use with Solar Cattle Grazing
cfra.org/publications/cattle-voltaics-maximizing-land-use-solar-cattle-grazing
- Making the Case for Solar Grazing
cfra.org/publications/fact-sheet-making-case-solar-grazing
- Making the Case for Crops + Solar
cfra.org/publications/making-case-crops-solar
- Resource Guide: Native Seed Supply and Seed Mixes for Pollinator-Friendly Solar
cfra.org/publications/resource-guide-native-seed-supply-and-seed-mixes-pollinator-friendly-solar

Sources, continued

²² Ibid.

²³ Ibid.