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Solar and agriculture is not a zero-sum proposition









Foundational premise

Land should never be used exclusively for solar power production.



Ecovoltaics

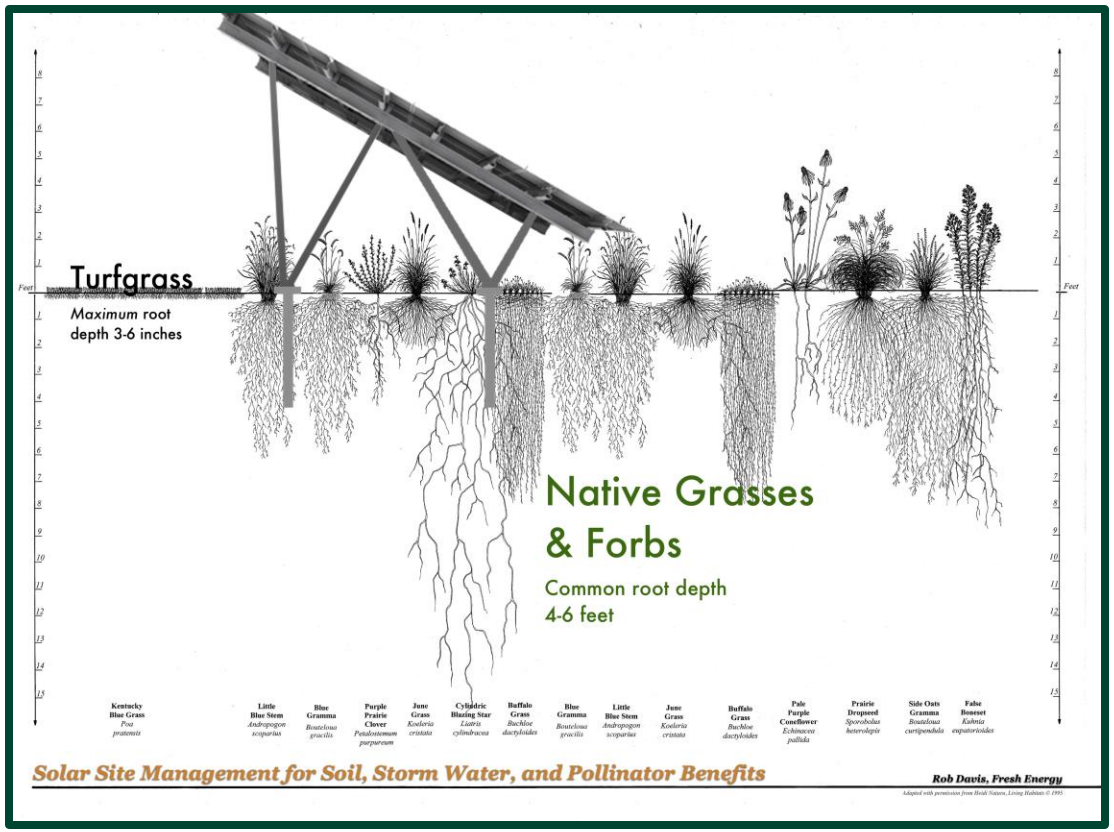




Photo credit: Matt Lamphere

Agrivoltaics



Photo credit: Charles Gould



Photo credit: Between the Rows, Savion LLC

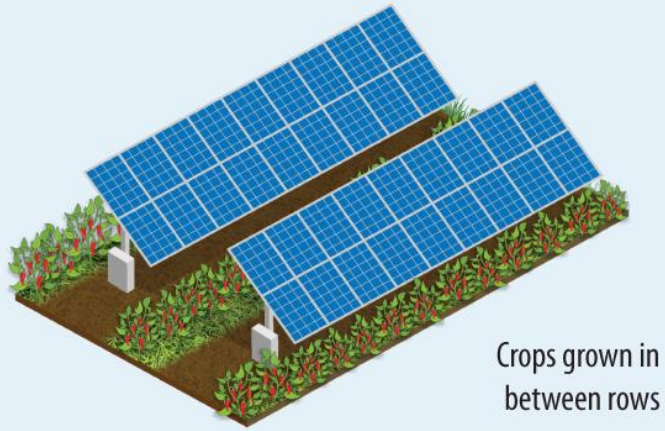


Agrivoltaic projects have two key features

- *Production of a marketable agricultural product throughout the full life of the solar array in accordance with a farm plan that details crop rotations, fallow periods, etc.*
- *Intentional design of the solar arrays, done in consultation with farmers or other experts, to ensure that these systems are constructed, installed, and operated so that land within the array is suitable for agricultural production.*

Traditional utility-scale configurations

Crop Production



Crops grown in between rows

Animal Husbandry

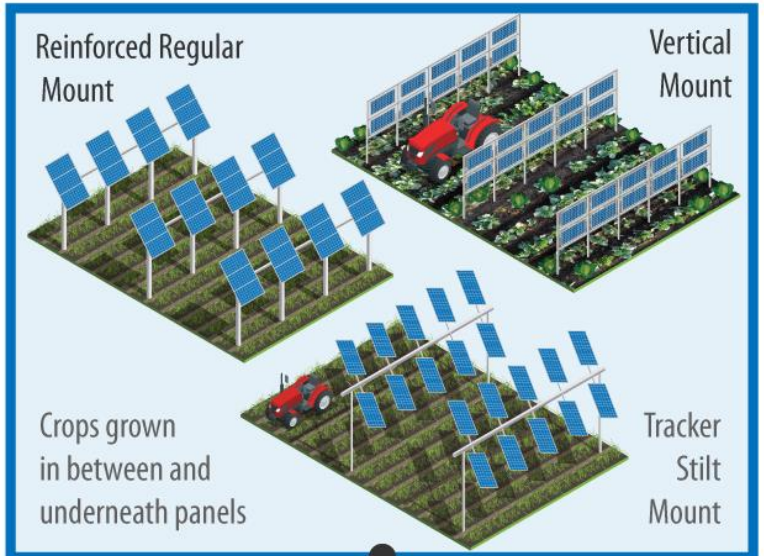


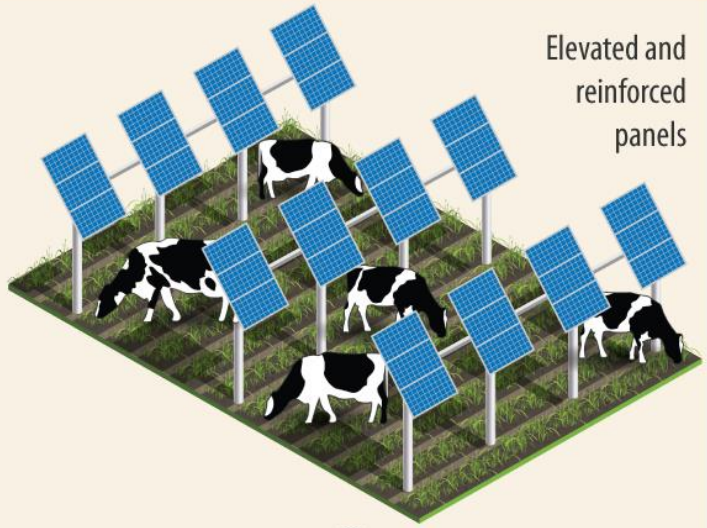
Grazing in between and underneath panels

Ecosystem Services

Vegetation grown in between and underneath panels







Greenhouse Solar



Alternative configurations



Cropping systems and livestock systems

- *Cropping systems refer to the combination of:*
  - *The type of crop planted*
  - *Growing and management methods*
  - *The sequence of crops previously planted on the same land*
- *Livestock systems refer to production practices that consider and utilize animal, plant, and soil characteristics within an environmental framework.*
- *Effective systems are crucial for food security, environmental sustainability, and economic viability in agriculture.*
- *Of necessity, systems interact with farm resources, other farm enterprises, and available technology.*



Photo credit: Jack Werner NREL

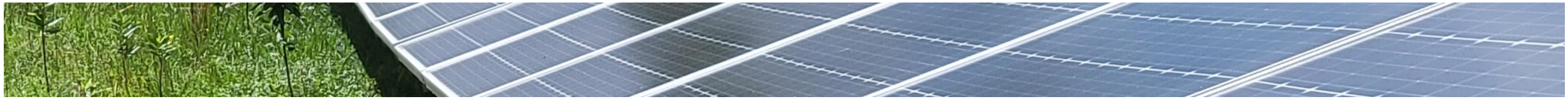
Photo credit: Charles Gould

Agrivoltaics

- *Example of a solar site that incorporates rotational grazing as part of an overall vegetative maintenance plan.*



Video credit: Charles Gould



Factors to consider

- *By 2035, 50% of the world's electricity production will come from solar.*
- *People who live three miles or less from an agrivoltaic site are 7x more likely to support solar.*
- *Lead with agriculture!*



Photo credit: Charles Gould

Rand, J. et al. (2024) Perceptions of Large-Scale Solar Project Neighbors: Results from a National Survey. Lawrence Berkeley National Laboratory, Berkeley, CA. https://live-lbl-eta-publications.pantheonsite.io/sites/default/files/ccsd_t2_results_summary_final.pdf.

How is this done?

Implement a company-wide paradigm shift.

Hire an agronomist.

Get to know the farming community and agricultural commodity groups.

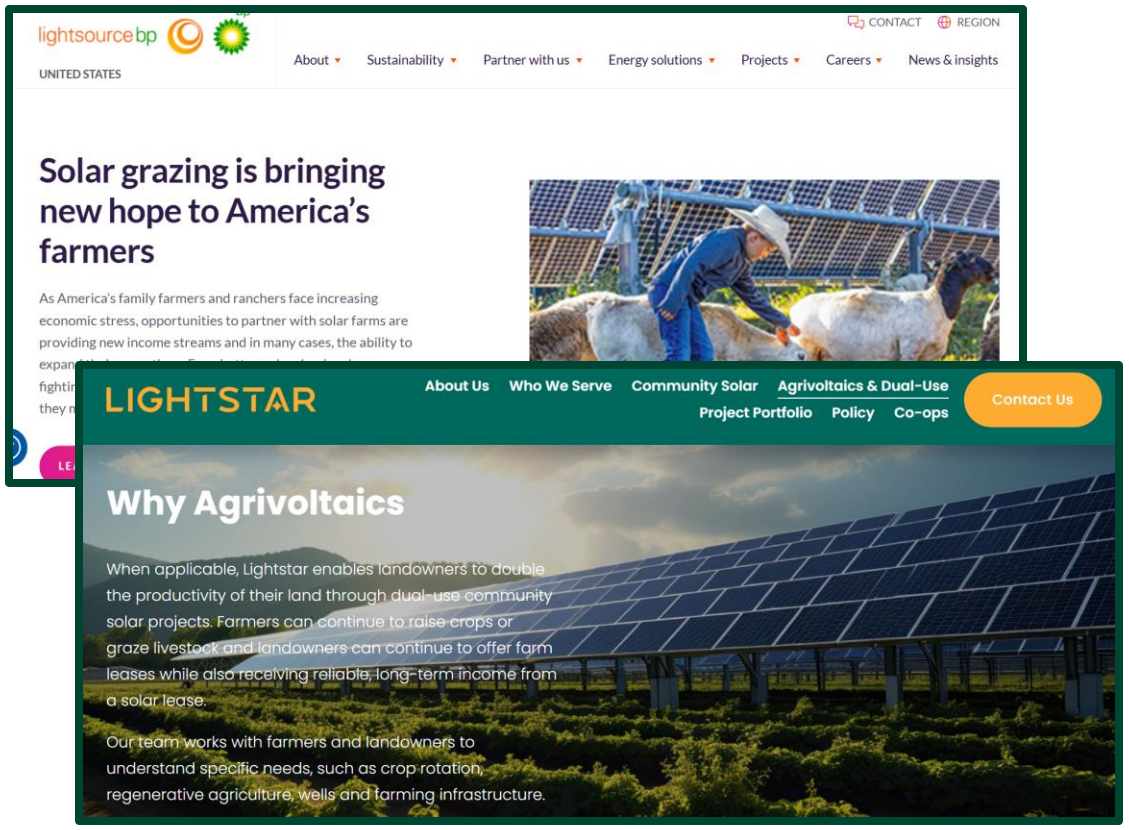
Work with universities to answer agrivoltaic questions.

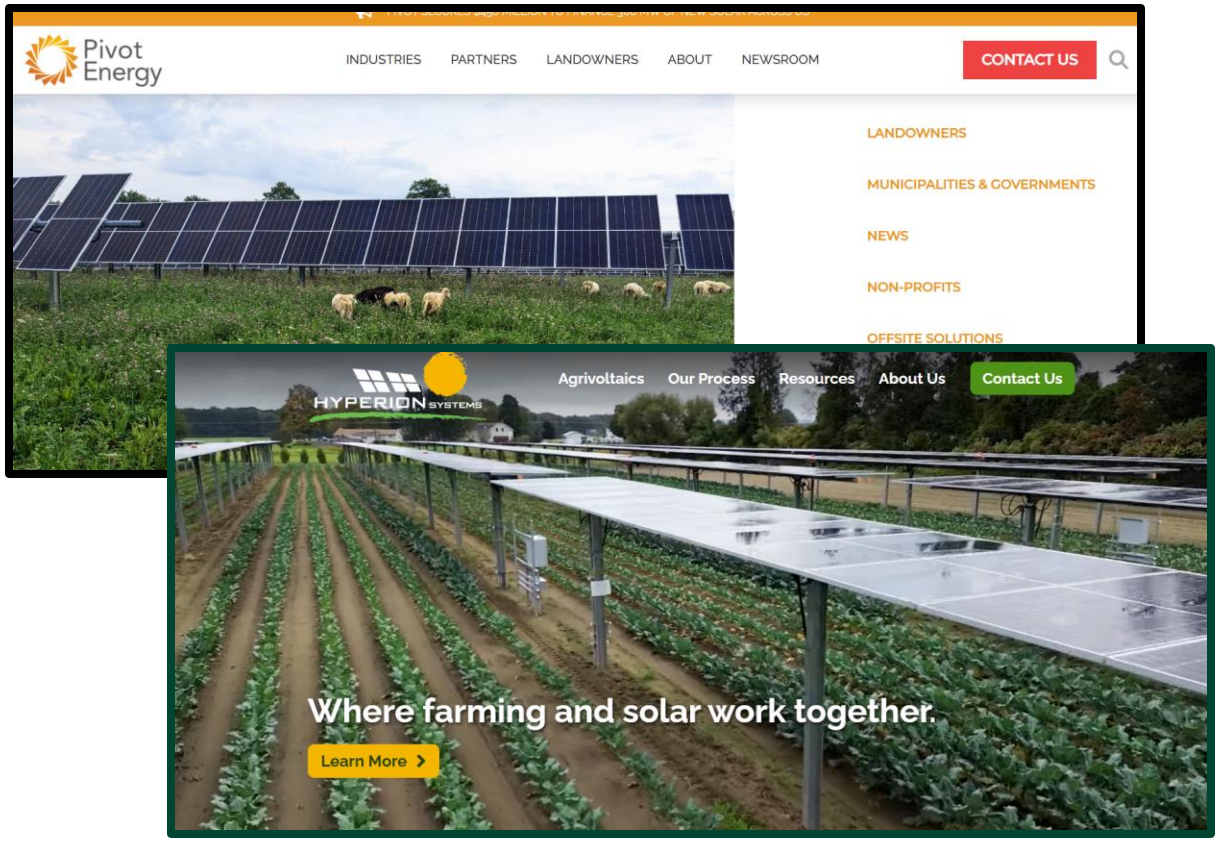


Photo credit: Charles Gould



Solar companies vested in agrivoltaics







Assessing Readiness and Needs of Michigan Sheep Producers to Graze Solar Sites

General attitude towards solar grazing

Attitude	N	%
Strongly support	*40*	*63*
Somewhat support	*19*	*30*
Strongly oppose	*3*	*5*
Somewhat oppose	*2*	*3*
Total	**64**	**100**

Motivation for grazing solar sites

Motivation	Ranking (1=most important, 4=least important)			
	1	2	3	4
Additional income	*19*	*16*	*5*	*3*
Land access	*14*	*16*	*12*	*1*
Environmental benefits	*9*	*11*	*23*	*0*
Other (No recorded responses)	*1*	*0*	*3*	*39*

State of solar grazing in Michigan

- *Genesee County sheep producer grazed:*
  - *156-acre Wexford County solar site (2x)*
  - *174-acre Calhoun County solar site (1x)*
  - *Flock expansion*
    - *12/24 – 200 ewes*
    - *7/25 – 479 ewes and lambs*
    - *Currently – 1,100 ewes and lambs*
  - *Changed his business plan to solely focus on solar grazing.*





Agrivoltaics



Photo credit: Charles Gould



Photo credit: Charles Gould

Elevated racking system at Grafton Solar (MA) to accommodate specialty crops and cattle.



Agrivoltaics



Photo credit: Charles Gould

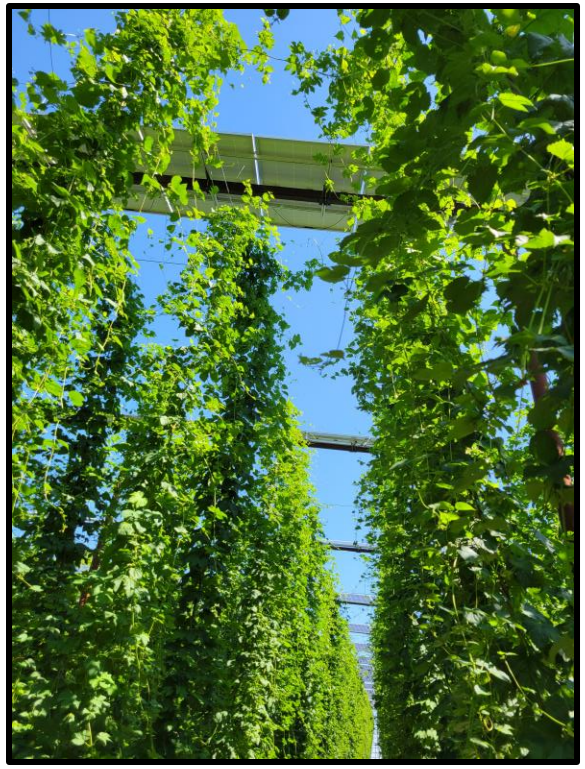


Photo credit: Charles Gould

Examples of crops that can be grown around solar arrays

- *Greens (lettuce, spinach, kale, Swiss chard)*
- *Brassicas (broccoli, cauliflower, cabbage, Brussel sprouts)*
- *Root crops (carrots, rutabaga, beets, radishes, potatoes, garlic)*
- *Herbs (parsley, mint, coriander, basil, cilantro)*
- *Berries (strawberries, blueberries, gooseberries)*
- *Peas, bush beans, peppers, tomatoes, leeks, onions*
- *Field crops (alfalfa, small grains, mustards)*
- *Flower seed production*
- *Fruit trees*
- *Hops*



Agrivoltaics

Vertical bifacial panel reduces snow and dust accumulation.

Provides two output peaks during the day, with the second peak aligned to peak electricity demand.



Photo credit: Jean-Philippe Delacre

Khan, M., Hanna, A., Sun, X., and Alam, M. (2017). Vertical Bifacial Solar Farms: Physics, Design, and Global Optimization. Applied Energy. 206. 10.1016/j.apenergy.2017.08.042.



Co-locating solar and agricultural could yield several significant benefits to multiple ecosystem services

- *Water: maximizing the efficiency of water used for plant irrigation by decreasing evaporation from soil and transpiration from crop canopies.*
- *Crops: preventing depression in photosynthesis due to heat and light stress, thus allowing for greater carbon uptake for growth and reproduction.*
- *Energy: transpirational cooling from the understorey crops lowering temperatures on the underside of the panels, which could improve PV efficiency.*



Photo credit: AgriSolar Clearinghouse



Agrivoltaic-related Projects

- *BAE Capstone Project*
- *Growing REstorative Agroenergy Landscapes (REAL) to Strengthen Agriculture, Energy, and Rural Communities Project*
  - *How is solar energy affecting the landscape and surrounding communities today?*
  - *How can we fuse knowledge, practice, and community engagement to help the US build a stronger, more productive, and more resilient agroenergy landscape?*
- *Renewable Energy Siting through Technical Engagement and Planning (R-STEP) Project*
  - *The Renewable Energy Academy is a one-stop-shop for large-scale renewable energy in Michigan, hosting a hub for resources, tools, and experts in the field and providing no-cost technical assistance to communities.*



Photo credit: AgriSolar Clearinghouse



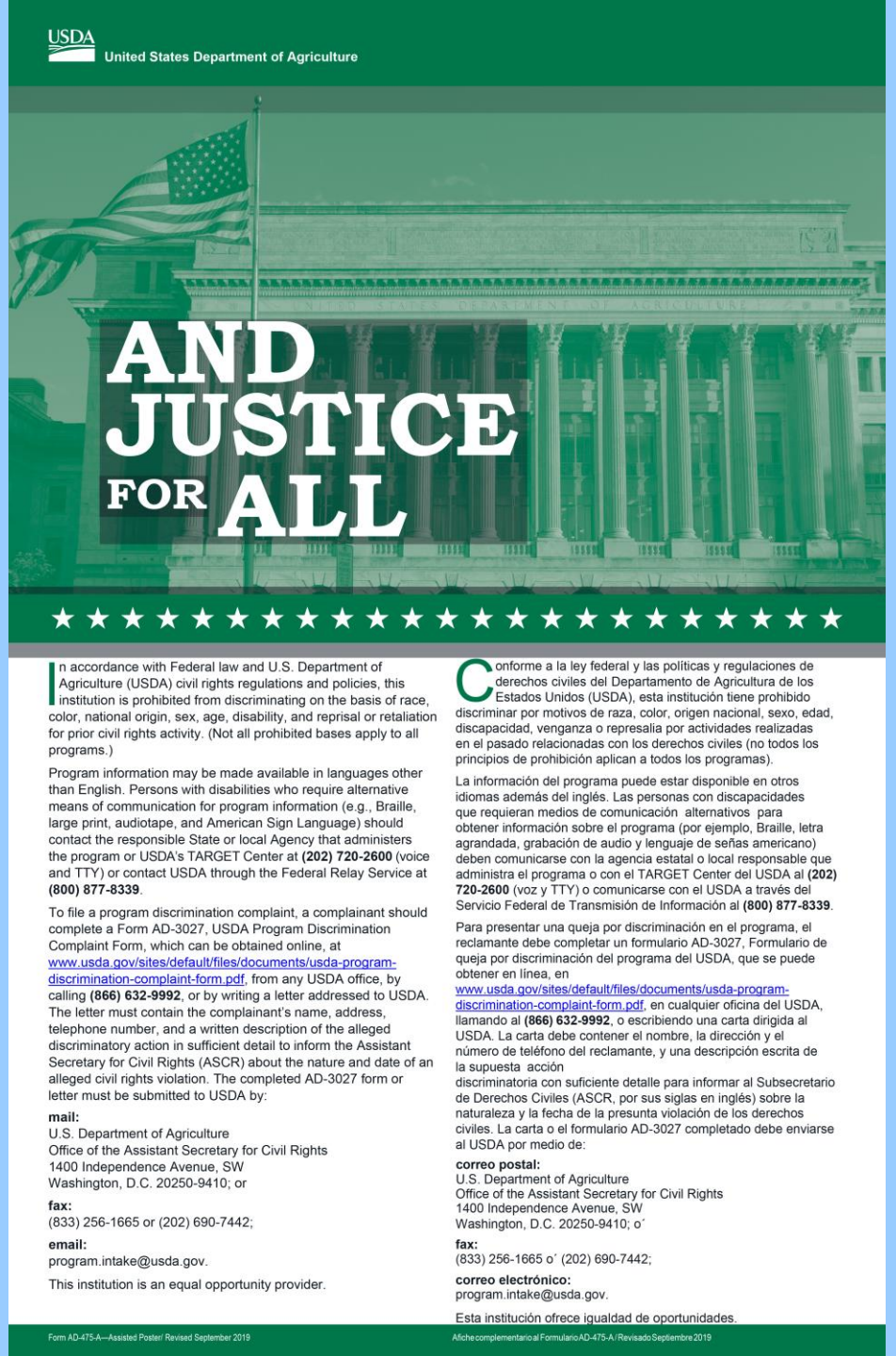
Take home messages

- *Land under solar arrays can be used to grow crops, graze livestock, and support pollinating insects.*
- *Implementing agrivoltaics in a solar project begins early in the planning process.*
- *Sheep producers have successfully grazed solar sites in Michigan.*
- *The paradigm shift is reimaging food production and energy generation systems.*



Photo credit: Charles Gould

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Form AD-475-A—Assisted Poster/ Revised September 2019

Afiche complementario al Formulario AD-475-A / Revisado Septiembre 2019

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