

# Agrivoltaics Boost the Yield

**Placing solar panels on biofuel-purposed farmland could result in a substantial increase in the land's energy density.**

*Written by Nancy Kristof*

## **GIVEN THE AMOUNT OF SUNLIGHT THAT CROPS NEED TO THRIVE,**

the addition of solar panels to croplands may seem counterintuitive. But researchers at Cornell University have found that precise integration of photovoltaics on existing corn ethanol croplands would improve the energy density of that land by more than 30 times when compared to using that land solely for corn ethanol production.

As discussed in "[Ecologically informed solar enables a sustainable energy transition in US croplands](#)," recently published in the *Proceedings of the National Academy of Sciences*, the research team's comparisons showed that converting just 3.2 percent of the 12 million hectares of land in the United States currently used to grow corn ethanol to add agrivoltaics increases the production of utility-scale solar energy from 3.9 percent to 13 percent.

There is more to this approach than just adding solar arrays to agricultural lands, explained Matthew Sturchio, a postdoctoral research associate at Cornell and first author of the study. It's an opportunity to altogether rethink "these energy agricultural landscapes," he said.

**“When you look at the transmission that’s built for wind already, the transmission taking electricity into the grid, there are a lot of opportunities for co-locating these ‘ecovoltaic’ sites near wind arrays as well.”**

*—Matthew Sturchio, postdoctoral research associate at Cornell University*

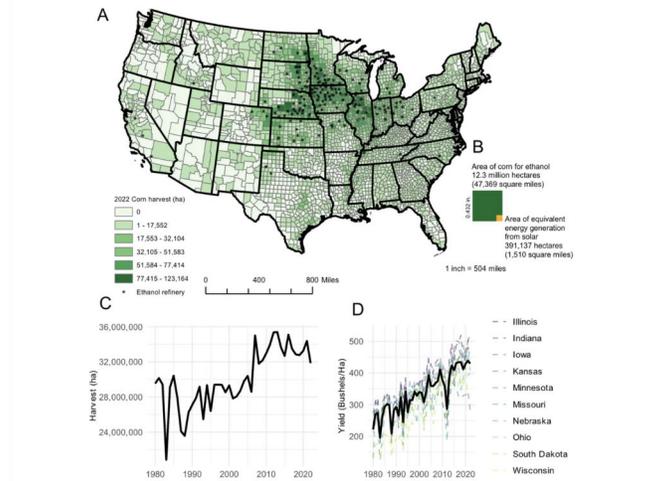
### **A SOLID PAIRING**

The Cornell team reviewed land uses in the Midwest, where much of the corn ethanol in the U.S. is grown for use primarily as an additive to gasoline, resulting in homogenized monocultures. “A lot of grasslands have been converted into corn grown specifically for ethanol because of policies that support that,” Sturchio noted.

Using multiple datasets related to corn and ethanol production and utility scale energy, the researchers also drew on existing research from the National Renewable Energy Laboratory and the Argonne National Laboratory showing how [perennial vegetation at solar sites can improve the health](#) of local ecosystems when determining the land’s energy density.

“We looked at the actual amount of land area that corn ethanol is taking up and did a conversion of what is the actual British thermal units of energy produced by that corn ethanol per land area,” Sturchio said. The team then measured energy produced from solar arrays on the same amount of land area, comparing the two.

The results showed that one hectare of utility scale solar generates as much energy as 31 hectares of corn-ethanol crops.



(A) Spatial overlap of corn harvest and ethanol refineries in 2022. (B) Visual representation of land area required for equivalent energy content of corn ethanol from utility-scale solar energy. (C) Total area of corn grain harvest from 1980 to 2022 and (D) corn grain yield (BU/ha) of top 10 corn producing states from 1980 to 2022; the black line represents average yield (BU/ha) over time. Note that corn-ethanol land use (B) represents 30 to 40 percent of total corn land use (A) in the contiguous U.S.

*Credit: Sturchio et al.*

“That’s a pretty stark difference right away,” Sturchio said. Upon establishing the energy delta between agrivoltaics and corn ethanol-only land use, the next step was to take advantage of the transmission infrastructure that “already exists in the ag-energy matrix of the Midwest,” he added.

Using spatial analyses, the researchers identified target locations where an integrated agrivoltaic land use approach could take advantage of the existing transmission infrastructure to minimize the costs of getting energy to the grid. It’s here where the team found another opportunity to improve consistency and reliability of energy on the grid: the coupling of intermittent energy systems.

“When you look at the transmission that’s built for wind already, the transmission taking electricity into the grid, there are a lot of opportunities for co-locating these ‘ecovoltaic’ sites near wind arrays as well,” Sturchio said.

Another benefit of looking to existing infrastructure for strategically siting corn ethanol crops is the opportunity to put them “in places where you’d be able to reduce the amount of nutrients going into waterways from fertilizer,” he said, adding that the intent is to “find easy wins, things you could just plug and play.”

## **SHIFTING MINDSETS**

In the meantime, finding ways to encourage solar developers to consider placing ecovoltaics on corn-producing land could mean developing methods to reduce the amount of steel supporting solar arrays that are designed for corn crop heights and optimizing the way energy makes it to the grid, Sturchio added.

But the biggest immediate challenge may be “trying to effectively communicate what is going on and how to take the next steps,” he said.

Overcoming some common objections to integrating ecovoltaics into agricultural land will be key—one of the most notable of which being the conception that solar installations should be installed on top of the existing built environment and farmlands should be reserved for farming.

“The bigger sites are more effective for providing cheaper electricity to the grid,” Sturchio said of the vast swaths of corn ethanol cropland. “Maxing that [solar on the built environment] out is a great idea,” but some buildings just don’t have the infrastructure to support solar. Even if they did, there are not enough of them to meet the expected 75 percent growth in energy demand by 2050.

small proportion in places where we could have these ecological synergies,” Sturchio said.

The conversion of the 350,000 hectares (3.2 percent) of ethanol croplands to agrivoltaics to achieve the same amount of energy from ethanol alone “isn’t even going to make a dent in the annual variability of ethanol production,” he added.

It will also be important to get this data out to policymakers to help convince the farming industry of the returns and benefits. It’s an opportunity for farmers to create new diverse revenue streams to mitigate circumstances such as droughts or other impacts to successful crop yields that result in agricultural economic instability, especially for smaller-sized farms.

“Being able to provide some relief for that economic instability with this consistent income from energy generation, the next step is just really demonstrating that and getting that into the hands of people,” Sturchio said. “It just requires getting everybody at the table thinking about what is sustainable.”

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