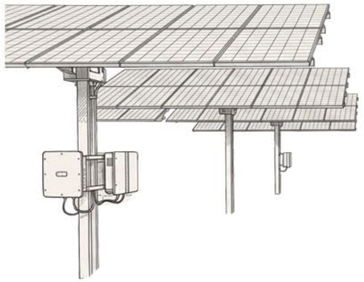


Agrivoltaics

Project Description

Agrivoltaics: our guiding questions

Project Description

We are focused on the following questions:

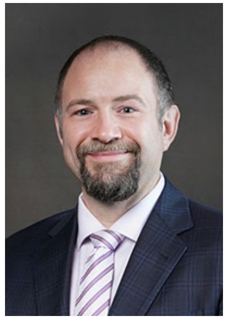
- Can agrivoltaics boost local and regional economic resilience to extreme weather?
- Can solar microgrids increase power security and reduce weather-induced outages?
- What types of agrivoltaic systems are most suitable in different regions?
- Can all of the above make solar more acceptable to local communities?

Task 1: Community Engagement

Lead: Kara Salazar & Aaron Thompson

Tamara Ogle

Petrus Langenhoven



Darrin Karcher

Task 2: Weather Risks & Projections

Lead: Dan Chavas

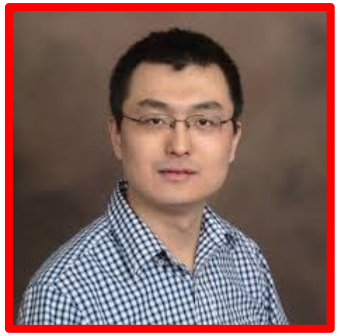
Melissa Widhalm
Midwest Regional Climate Center

Matt Huber

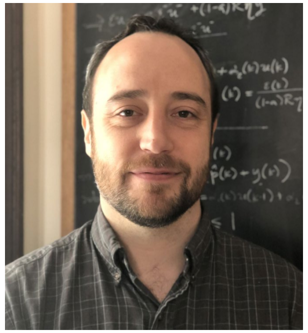
Task 3: Economic Modeling

Lead: Juan Sesmero

Task 4: Grid Resilience & Energy



Lead: Xiaonan Lu



Kevin Kircher

Siva Seetharaman

Andrew Liu

+ Rakesh Agrawal, Peter Bermel, Mitch Tuinstra

Purdue ISF

Lynne Dahmen

External partners

Tipmont

NiSource

CIRCS

MRCC
Midwestern Regional Climate Center

HALDERMAN
REAL ESTATE & FARM MANAGEMENT

DORAL LLC

FARM CREDIT
ILLINOIS

The Nature Conservancy
Indiana

NRECA
America's Electric Cooperatives

WHIN

FARM-TO-POWER

BECHTEL

CN Consulting LLC

always looking for more!

Phase I Planning Grant → Phase II Implementation

Phase I: Planning

- **Funding:** $500K over 24 months
- **Purpose:** Partnership building, planning, and concept development
- **Focus:** Stakeholder engagement, data collection, model development
- **Deliverable:** Agrivoltaics roadmap and Phase II proposal

→

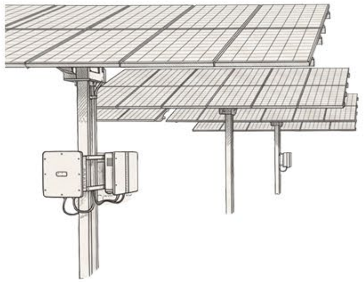
Phase II: Implementation

- **Funding:** Up to $3M/yr for 5 years
- **Purpose:** Full-scale incubator implementation
- **Focus:** Scaling agrivoltaics solutions across the Midwest
- **Deliverable:** Transformed rural resilience through agrivoltaics

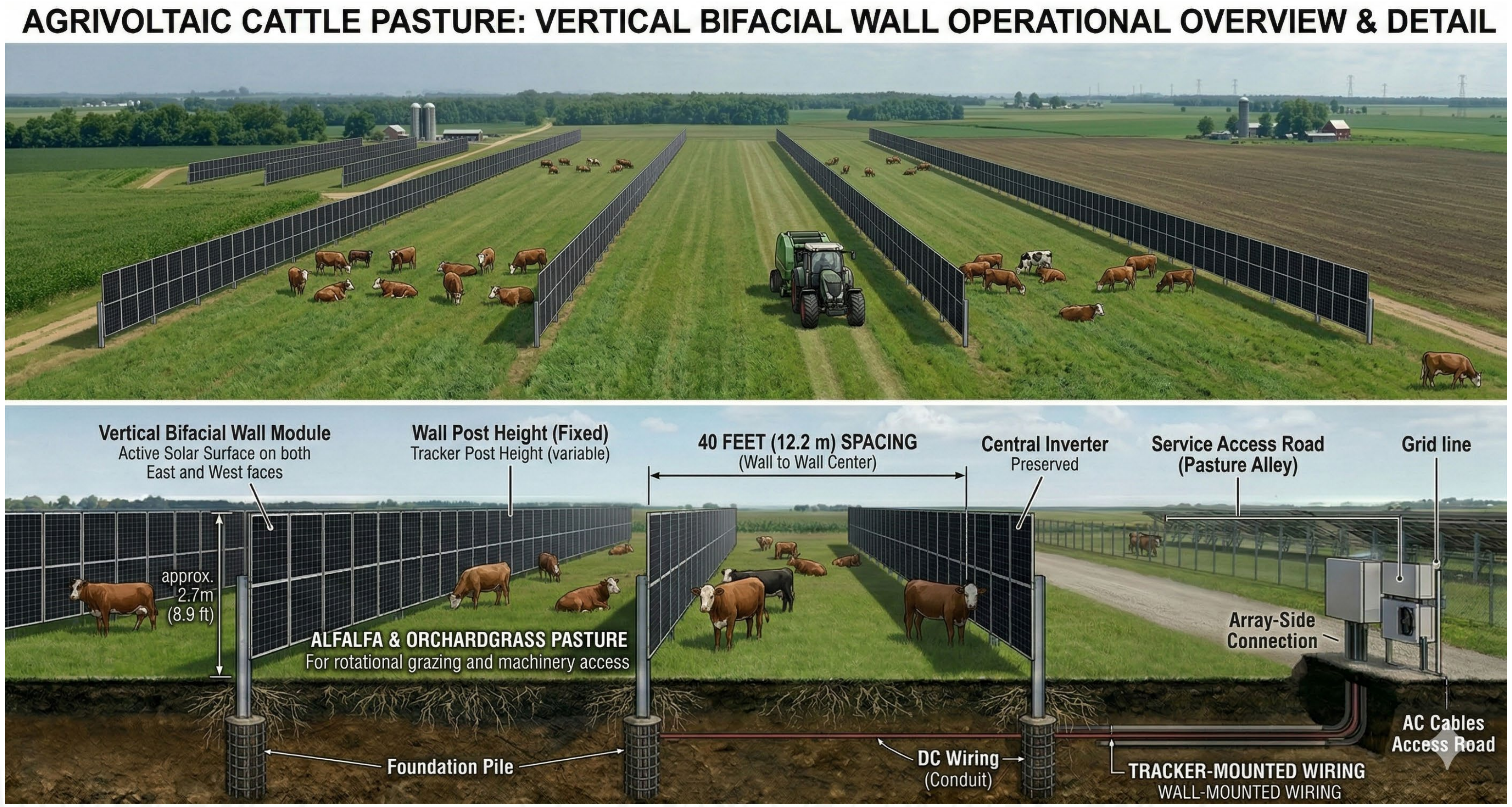
Official title: Midwest Agrivoltaics Incubator to Transform the Prosperity and Resilience to Extreme Weather of Midwest Farmers and Rural Communities

Tackle key barriers – three prongs

1. Extreme weather resilience (ag + energy)
2. Suitability (design)
3. Acceptability (trust)



Midwest Agrivoltaics for Resilient Communities (MARC)

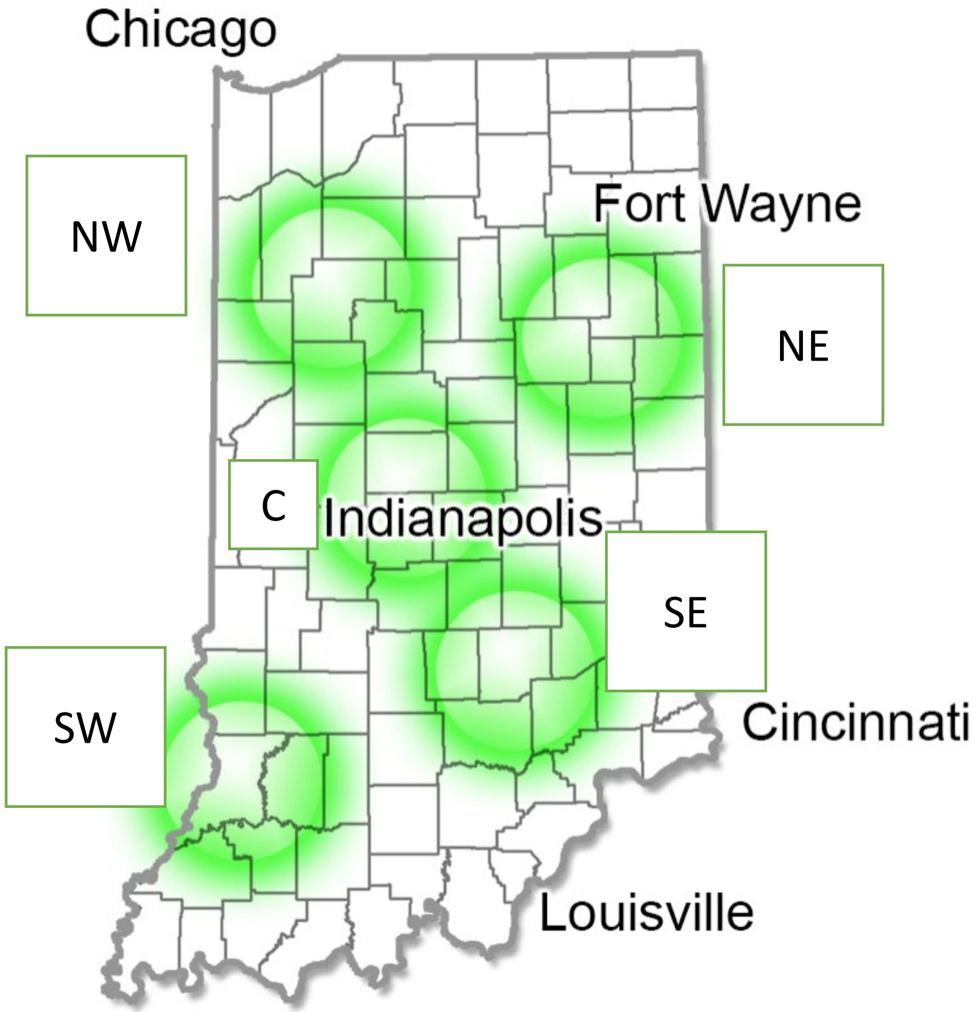


Agrivoltaics:

Focus Group Summary

Focus Group Summary

- The research team conducted five regional Indiana focus groups (two hours each) during Spring 2026, covering Northwest, Northeast, Central, Southeast, and Southwest regions.
- **Agrivoltaics Design, Siting Considerations**



Focus Group Summary

- Participants included 38 individuals across the following groups:

Agricultural

Landowners and producers

Economic

Developers and utility representatives

Governance

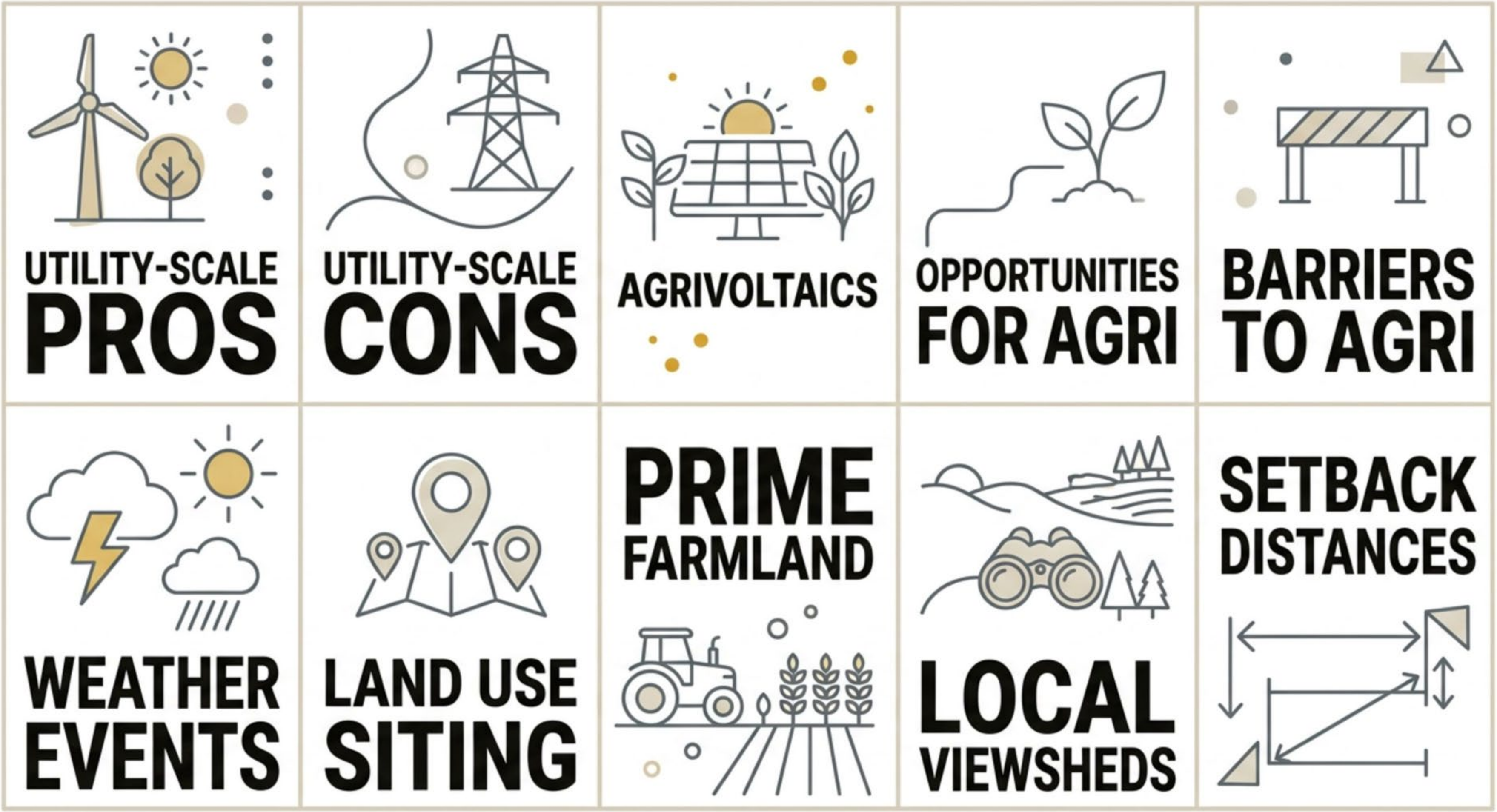
Local elected officials and land use professionals

Conservation

Conservation professionals and nonprofits

Focus Group Summary

- Key Themes



(+) Considerations: Economic Benefits

The most consistent pro argument was economic. Solar lease income provides a reliable revenue floor for farmers facing thin and volatile margins.

> "You put a crop in the ground and you only get $1,000 to $1,200 an acre, gross, not net, gross. And if there's solar in there, you're going to get... five times that." — **SE Landowner**

> "The margins are slimming, but the input costs are going up exponentially... if you can build a baseline revenue into your budget for these crops, it would be good just from a financial risk management perspective." — **SW Landowner**

(+) Considerations: Rural Development

Rural Economic Development

Communities that have lost major employers actively welcome solar. A Central developer noted: *"A SW IN county had five coal mines go out, so my gosh, they've got five solar projects coming in. I mean, they welcome that because they don't have any alternatives."*

Local Energy Independence

A NE Extension professional described local officials discussing solar as a grid resilience tool: *"If we had a local source of energy, that would help bring us online a lot quicker if we had something like that in our own county as opposed to relying on far away sources of electricity on the grid."*

Growing Energy Demand

A SE landowner made the structural argument: *"Power needs are going to grow... there's national policies that limit how you generate the power, so if you're going to use more power, you've got to generate more."*

(-) Considerations: Agricultural Land & Soil

Permanent Loss of Farmland

The most fundamental objection was that solar removes productive farmland from agricultural use. A NW landowner stated: *"When people put 300 acres into solar, then that's 300 acres that you're not going to get a crop off of."* Community signs conveyed that "solar should not be on agriculture ground."

Soil Damage

Early northern Indiana installations graveled under panels and removed topsoil during leveling, undermining the promise that land could return to farming after 30–35 years. A Central landowner noted a logical contradiction: *"If we put stone underneath the panels, now we're going to go to some weed preventer... and one of our selling points is we're going to reduce the amount of pesticides, herbicides."*

(-) Considerations: Community Chaos

Restrictive Zoning as De Facto Ban

The Central session described a layered exclusion zone covering an aquifer drainage area across the entire county. A NE Extension professional described a proposed setback jumping from 400 to 1,500 feet — making development "almost impossible."

Social Resentment

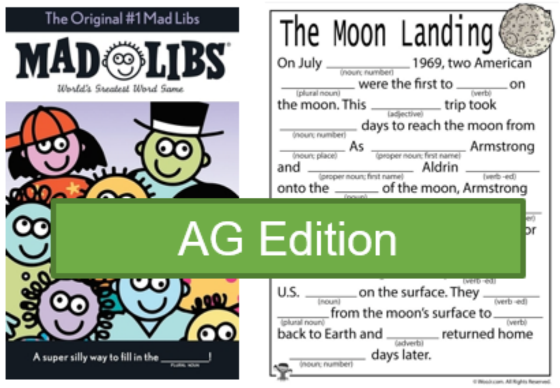
The SE session surfaced interpersonal dynamics where opposition was tied to personal dislike of specific landowners who signed leases. This social dimension — driven by *who* signed rather than *what* was proposed — was identified as a significant and underappreciated driver of resistance.

Siting Alternatives

Participants questioned why solar targets productive farmland. A SE conservation professional asked: *"Why don't we put it on top of the Amazon warehouses, the parking lots?"* A SW planner added: *"Why is crop ground our target when there's other underutilized properties?"*

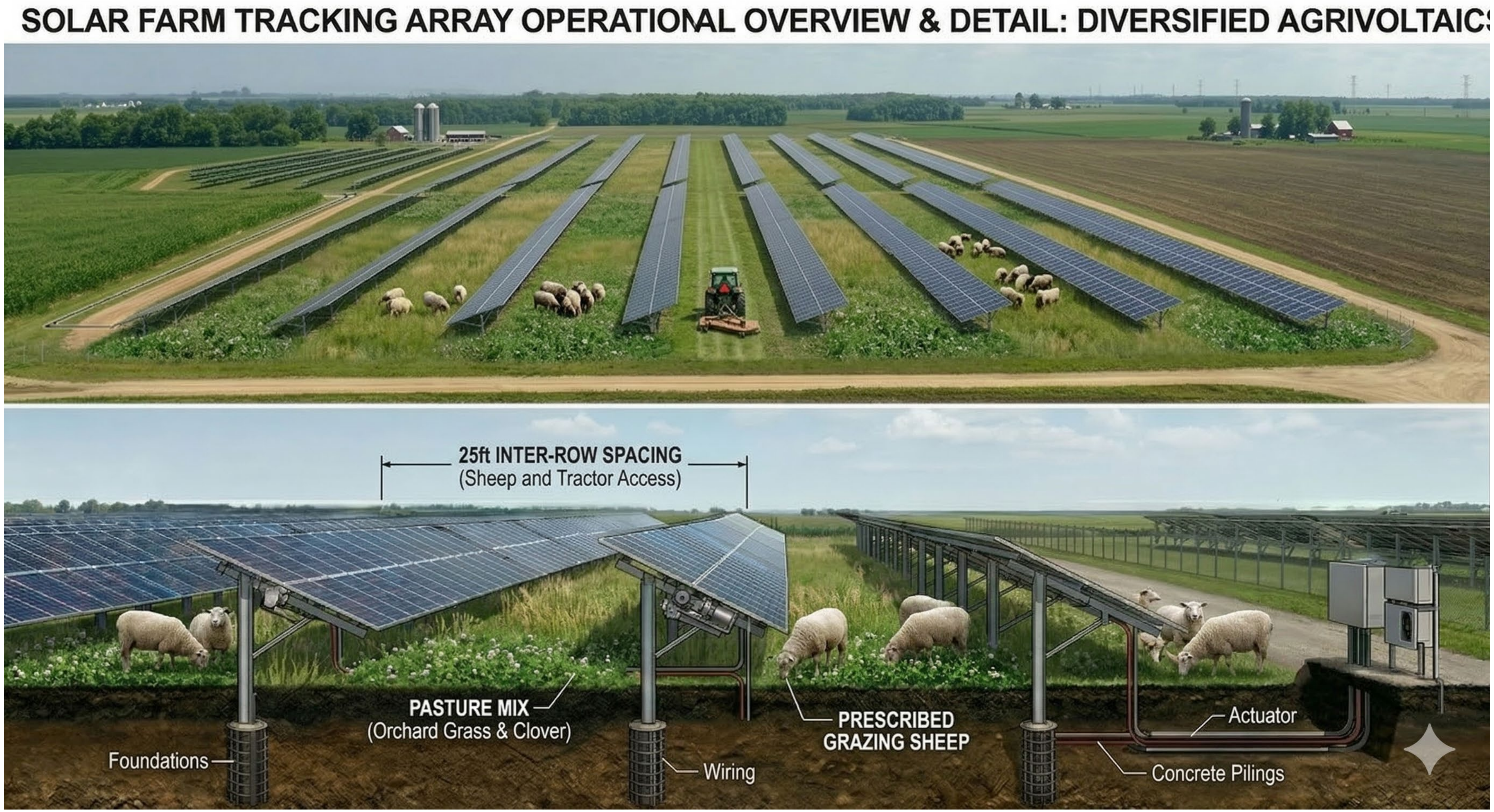
The Agrivoltaic Design Statement

Fill in the blanks below using the word bank and options on the following cards.
You are encouraged to suggest your own ideas beyond the listed options.



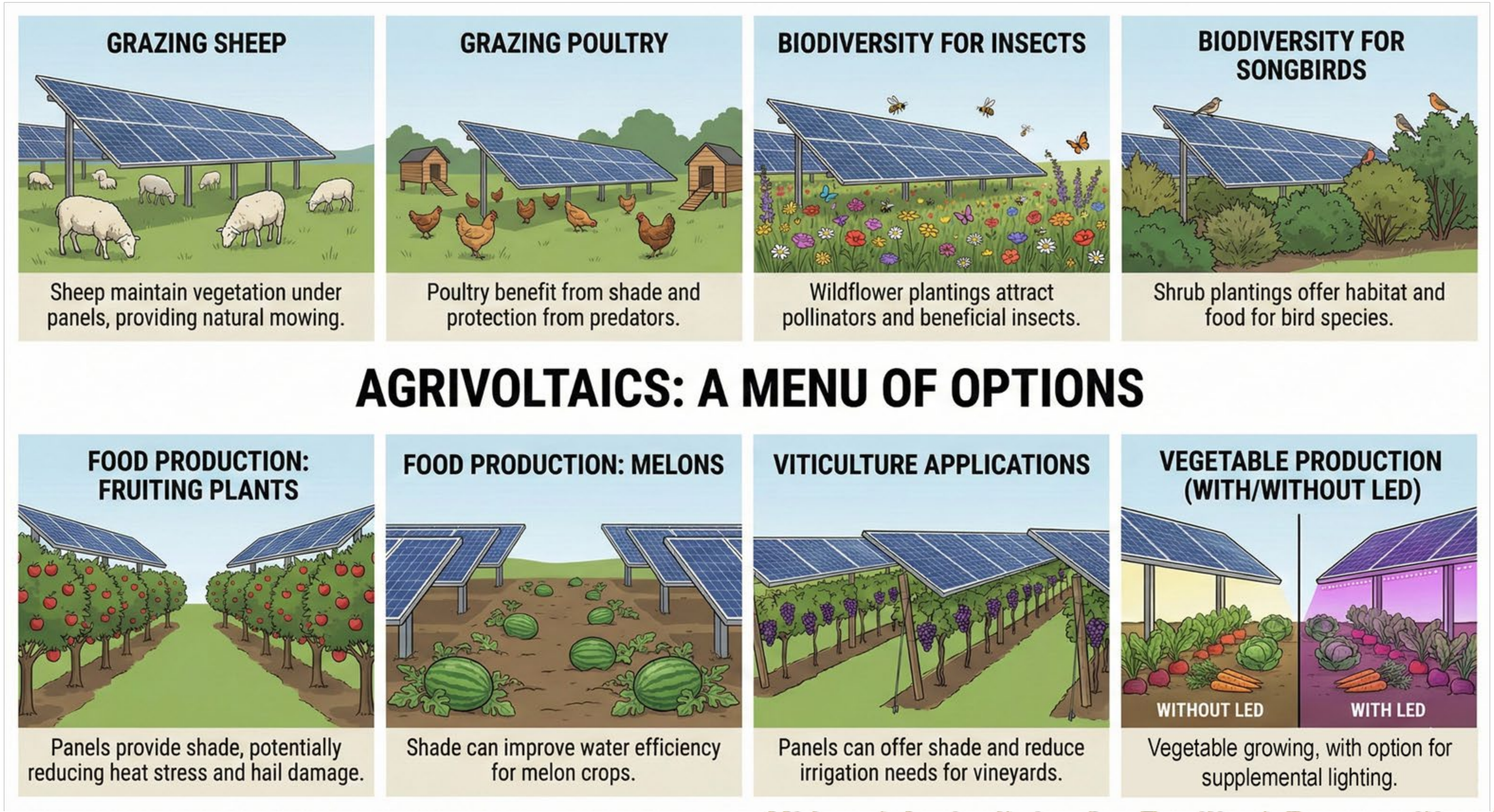
"In a rural Indiana landscape, we are designing a solar farm that prioritizes **[Type of Agricultural Use]**. The solar panels are mounted on **[Type of Racking System]** and are spaced approximately **[Number]** feet apart to allow for **[Farm Equipment, Labor, or Animals]** to pass through. To support this agrivoltaic system, the ground is covered in **[Type of Ground Cover]** to support **[Agricultural, Social, or Conservation]** goals."

Prescribed Sheep Grazing



"In a rural Indiana landscape, we are designing a solar farm that prioritizes **prescribed sheep grazing**. The solar panels are mounted on **single axis trackers** and are spaced approximately **25 feet** apart between solar panel rows to allow for **sheep and a tractor with a rotary mower** to pass through. To support this agrivoltaic system, the ground is covered in **pasture made up of orchard grass and clover** to support **maximum efficiency for a diversified farm** goals."

What types of agrivoltaic systems make sense for your community?



Cattle Grazing

NW

In a rural Indiana landscape, we are designing a solar farm that prioritizes **Grazing Black Angus Cattle**. The solar panels are mounted on a **single axis tracker that is higher than normal elevated 12 feet tall** and are spaced approximately **32** feet apart to allow for **Tractors and Mowers** to pass through. **Additionally, the solar farm would need a water trough, a front-loader tractor, and a farm tractor with a hay bailer to operate between panels.** To support this agrivoltaic system, the ground is covered in **pasture made up of orchard grass and clover** to support **hay production and rotational grazing to support freezer beef sales** goals.

Apiary & Cut Flowers

NW

In a rural Indiana landscape, we are designing a solar farm that prioritizes **beekeeping/apiary and berry production.** The solar panels are **single-axis trackers** and are spaced approximately **32 feet** apart between solar panel rows to allow for **small tractors and machine berry picker trailer behind the tractor** to pass through. To support this agrivoltaic system, the under the panels and extending out 10 feet on either side of each row is covered in **pasture made up of sunflowers, wildflowers and clover and the interrow areas have rows of blueberry bushes** to support **cut flower production and agritourism** goals.

Community-Engagement

AI Imagery Exercise

The AI-generated imagery exercise conducted in all five sessions consistently produced the **most positive participant reactions** of any session segment.

> "I just think that is not what I think of when I think of a solar farm... if I was going to try to market that anywhere in a rural community, I would use that picture right there." **— NW Economic Developer**

> "I don't know why anybody would complain about that. That would just looks like Indiana to me." **— NW Landowner**

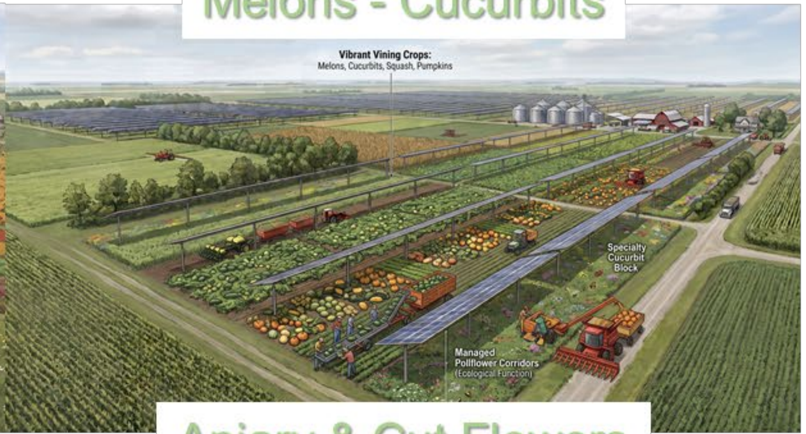
Discussion & Visualization are Needed

Outcome: 9 Agrivoltaic Systems

High-Clearance Row Crops

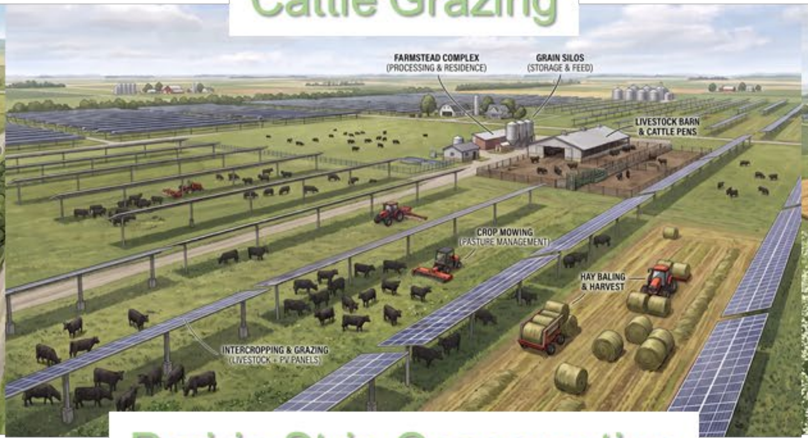
Sweet Corn and Vegetables

Melons - Cucurbits

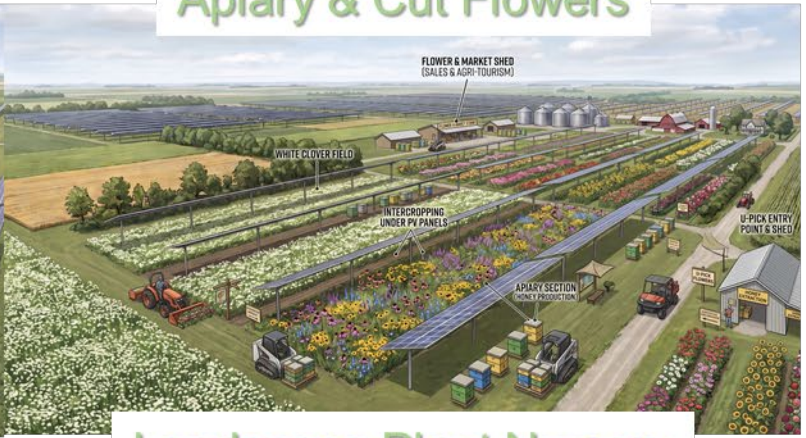


Prescribed Sheep Grazing

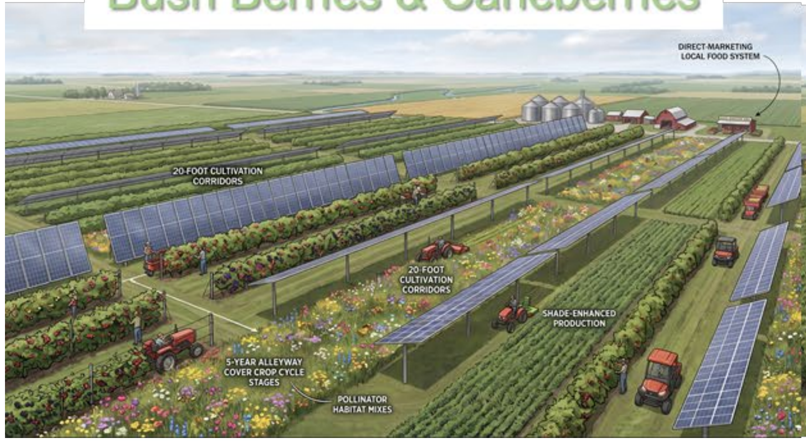
Cattle Grazing



Apiary & Cut Flowers



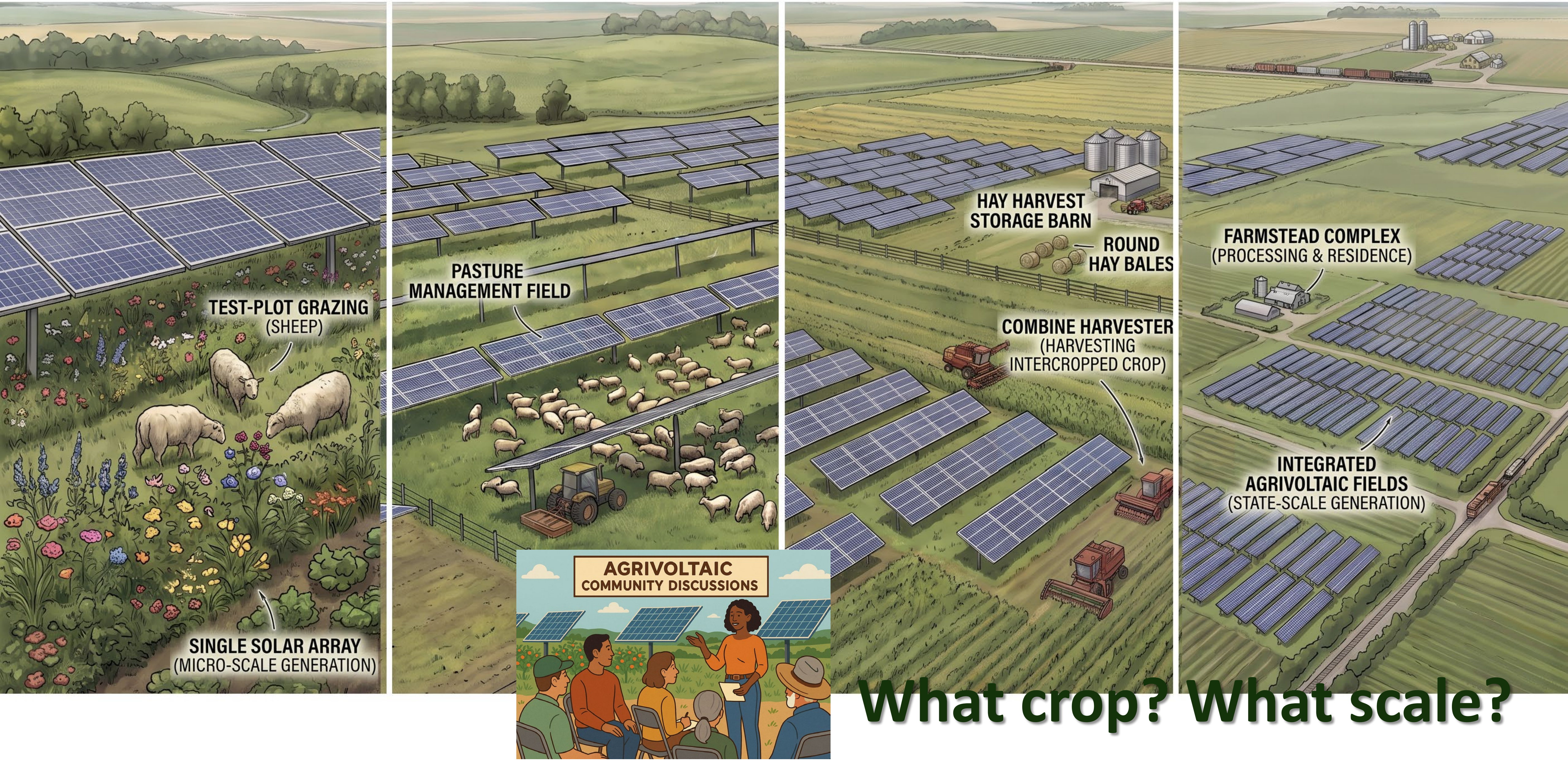
Bush Berries & Caneberries



Prairie Strip Conservation

Landscape Plant Nursery

4 ACRES - MICRO-SCALE HIGH-DIVERSITY INTERCROPPING | 40 ACRES - OPERATIONAL-SCALE PASTORAL-GRAZING | 400 ACRES - COMMERCIAL-SCALE FIELD CROPS & HARVEST | 4000 ACRES - REGIONAL-SCALE AG-DISTRICT INTEGRATION



What crop? What scale?

Tackle key barriers – three prongs

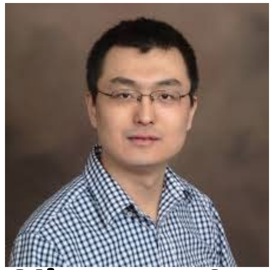
1. **Extreme weather resilience (ag + energy)**
2. Suitability (design)
3. Acceptability (trust)

Dan Chavas

Earth, Atmospheric, and Planetary Sciences

Juan Sesmero

Agricultural Economics



Xiaonan Lu

Engineering Technology
Electrical & Computer Eng.

Aug 11, 2026 derecho

~300,000 customers (9% of Indiana) lost power


NORTHWEST INDIANA

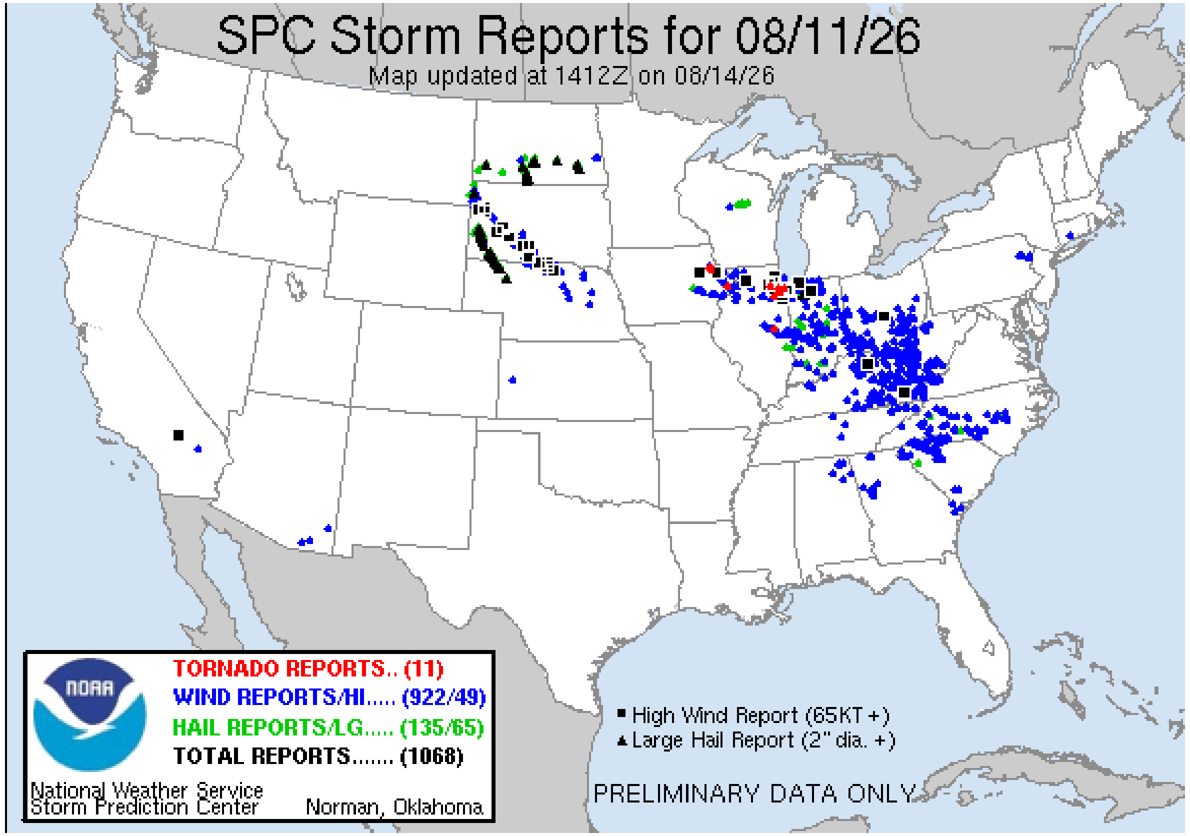
Northwest Indiana residents dealing with 'largest outage event on record' after waves of storms, NIPSCO says

southern Lake County, IN
https://www.farmprogress.com/corn/indiana-derecho-damage-what-can-you-do-

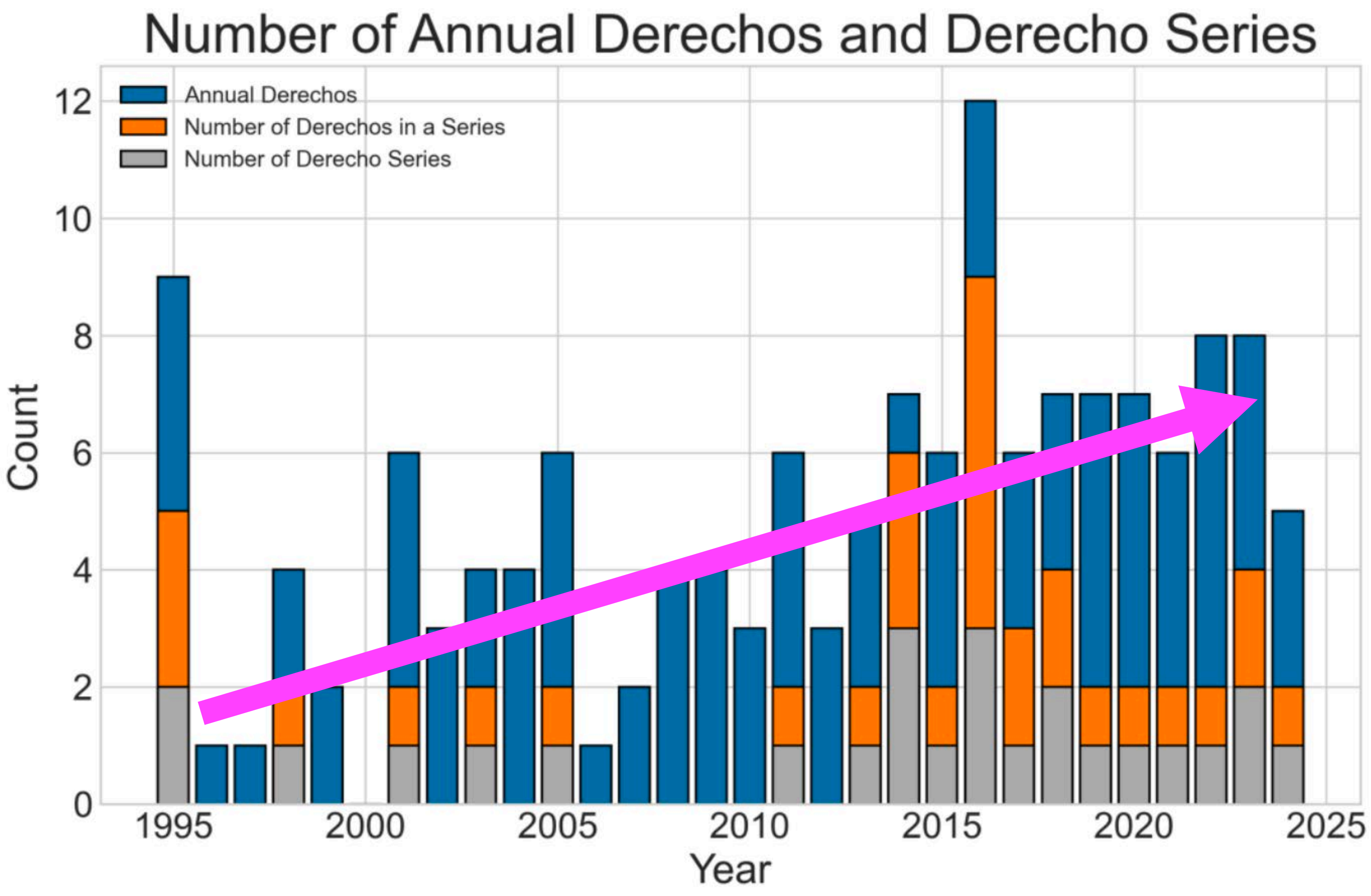
NIPSCO facebook page

Aug 11, 2026 derecho

A widespread straight-line wind event, with a few embedded tornadoes (IL)



Derechoes are happening more often (particularly Corn Belt IA-IL-IN)



Shourd and Kaplan (2025, EJSSM)

Severe wind storms dominate

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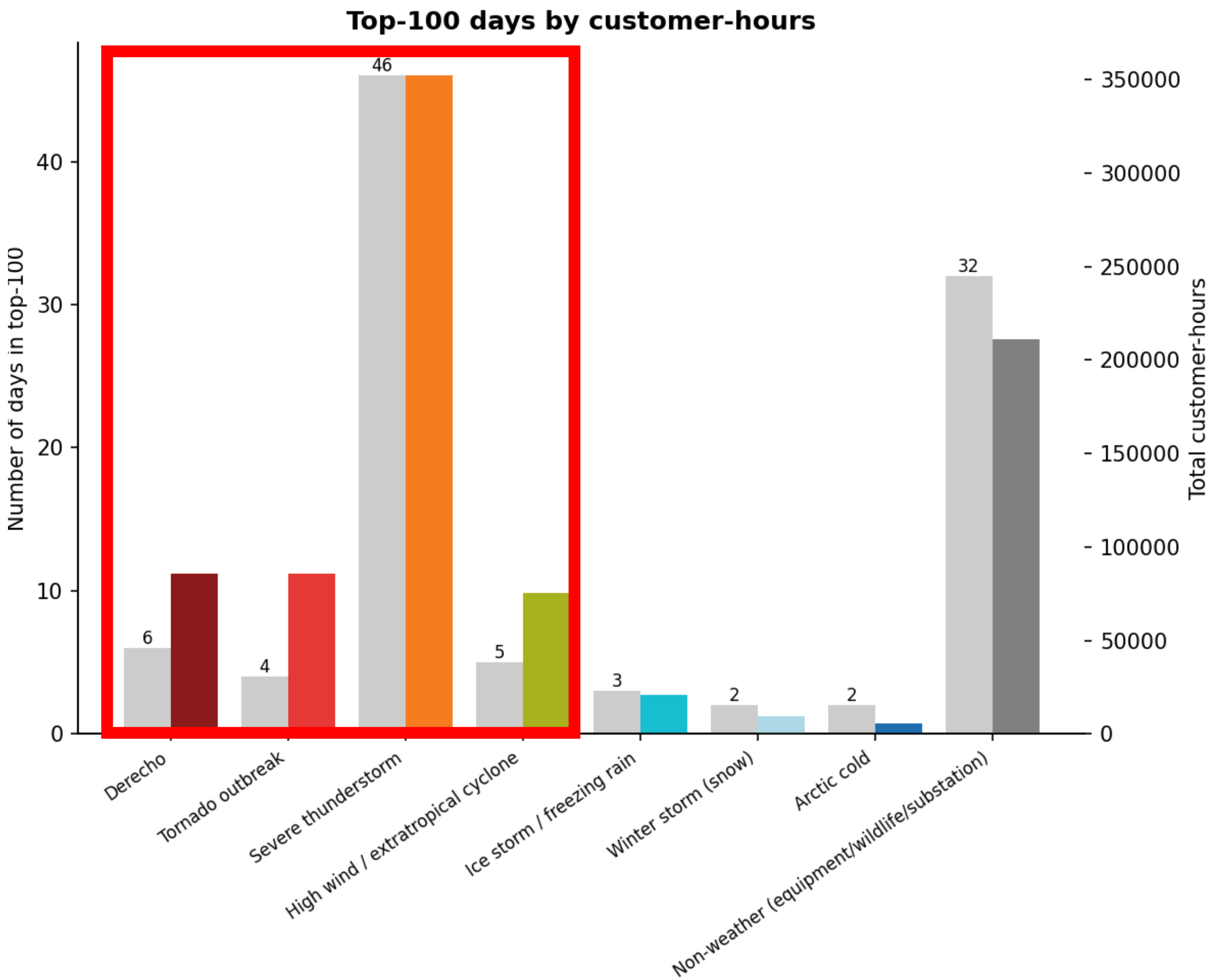
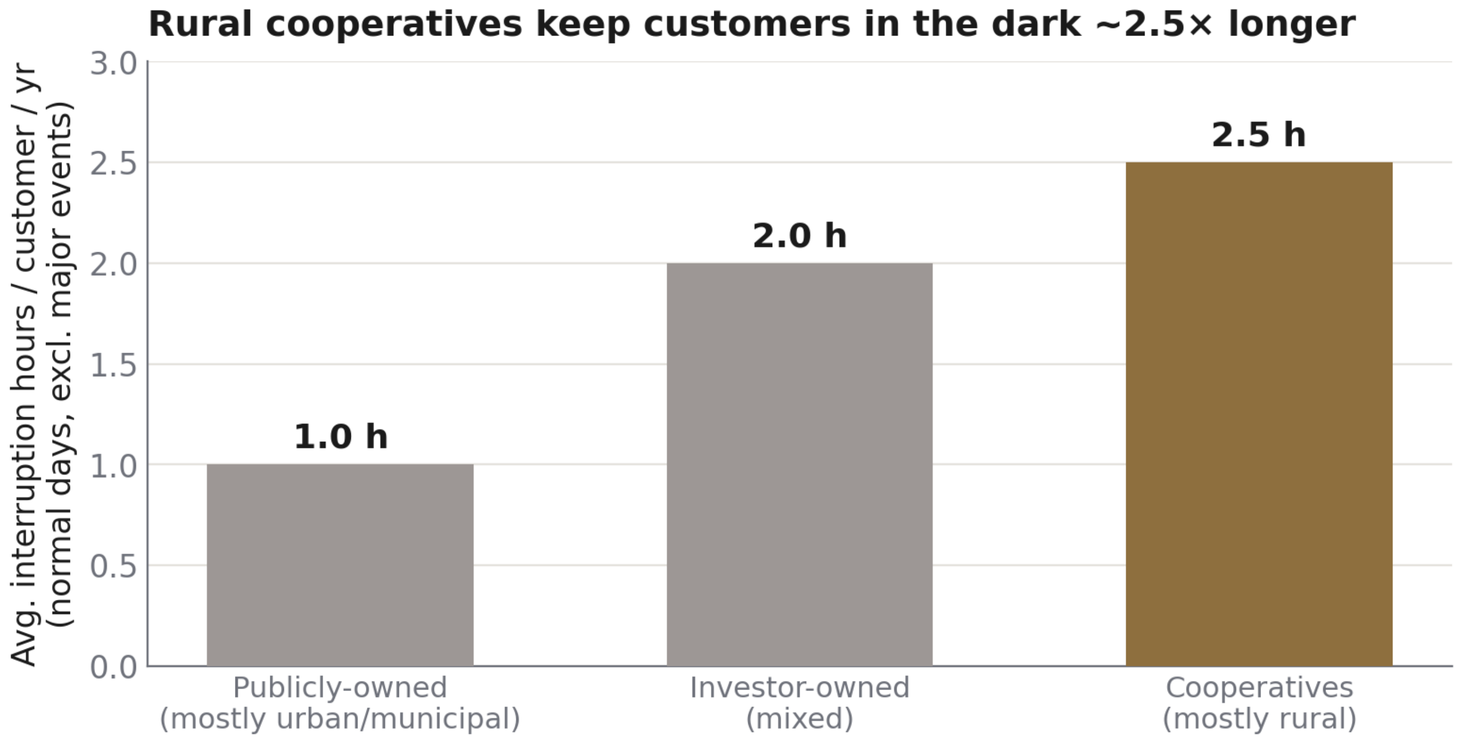


Reproduced MARC worst-daily-outages analysis · Tipmont REMC outage history, 2015–2026 · weather drivers attributed per NWS/SPC.

POWER OUTAGES · RURAL VS. URBAN

Rural communities stay in the dark longer



The rural reliability gap

Fewer customers per mile

Rural cooperatives maintain long circuits serving sparse populations — more line, more exposure per household.

More tree & storm exposure

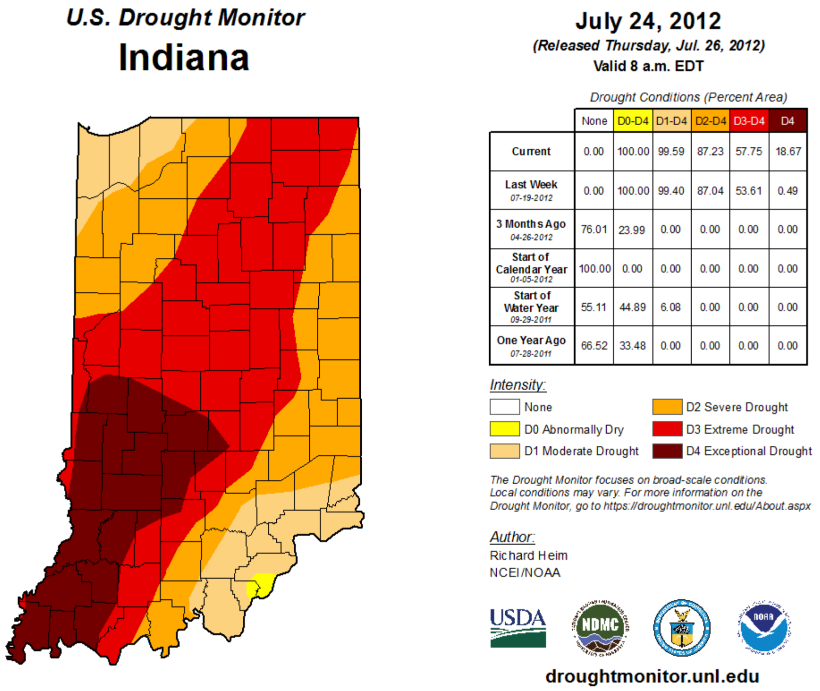
Longer overhead lines through forested, open terrain take more weather damage.

Slower restoration

Crews travel farther to isolate and repair faults, extending rural outage duration.

U.S. EIA (2018), interruption duration by utility type (SAIDI, excl. major events). Cooperatives serve mostly rural areas.

2012 — the drought that set Indiana's record



	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.00	100.00	99.59	87.23	57.75	18.67
Last Week 07-19-2012	0.00	100.00	99.40	87.04	53.61	0.49
3 Months Ago 04-26-2012	76.01	23.99	0.00	0.00	0.00	0.00
Start of Calendar Year 01-05-2012	100.00	0.00	0.00	0.00	0.00	0.00
Start of Water Year 09-29-2011	55.11	44.89	6.08	0.00	0.00	0.00
One Year Ago 07-28-2011	66.52	33.48	0.00	0.00	0.00	0.00

U.S. Drought Monitor — Indiana, July 24 2012. D4 “exceptional” across the southwest.

What happened

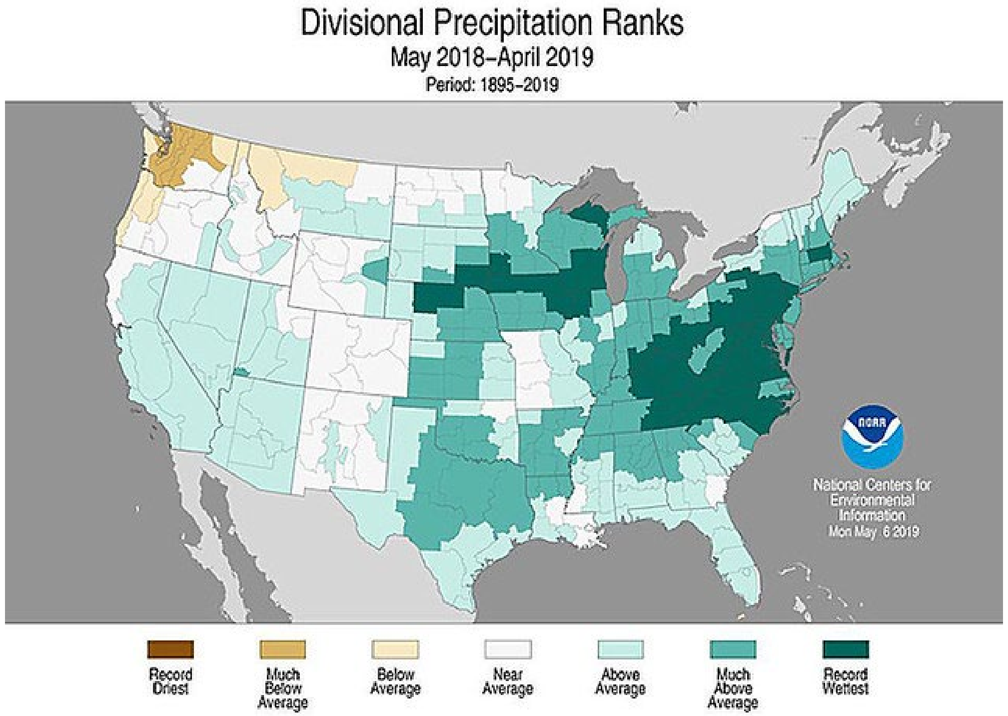
A persistent upper-level ridge parked over the central U.S. through summer 2012 — suppressing rain and driving extreme heat. It was Indiana's worst crop-condition year since 1988.

Statewide corn fell to ~99 bu/ac, about 40% below normal. Late-summer rains partly spared soybeans (43.5 bu/ac, ~10% low).

$1.04B in crop-insurance payouts — double the previous state record. Corn losses alone: ~$900M.

U.S. Drought Monitor (droughtmonitor.unl.edu); Purdue Agriculture (2013); USDA-RMA cause-of-loss data.

2019 — the wettest year washed out planting



Divisional precipitation ranks, May 2018–April 2019 — record-wettest across the Corn Belt.

What happened

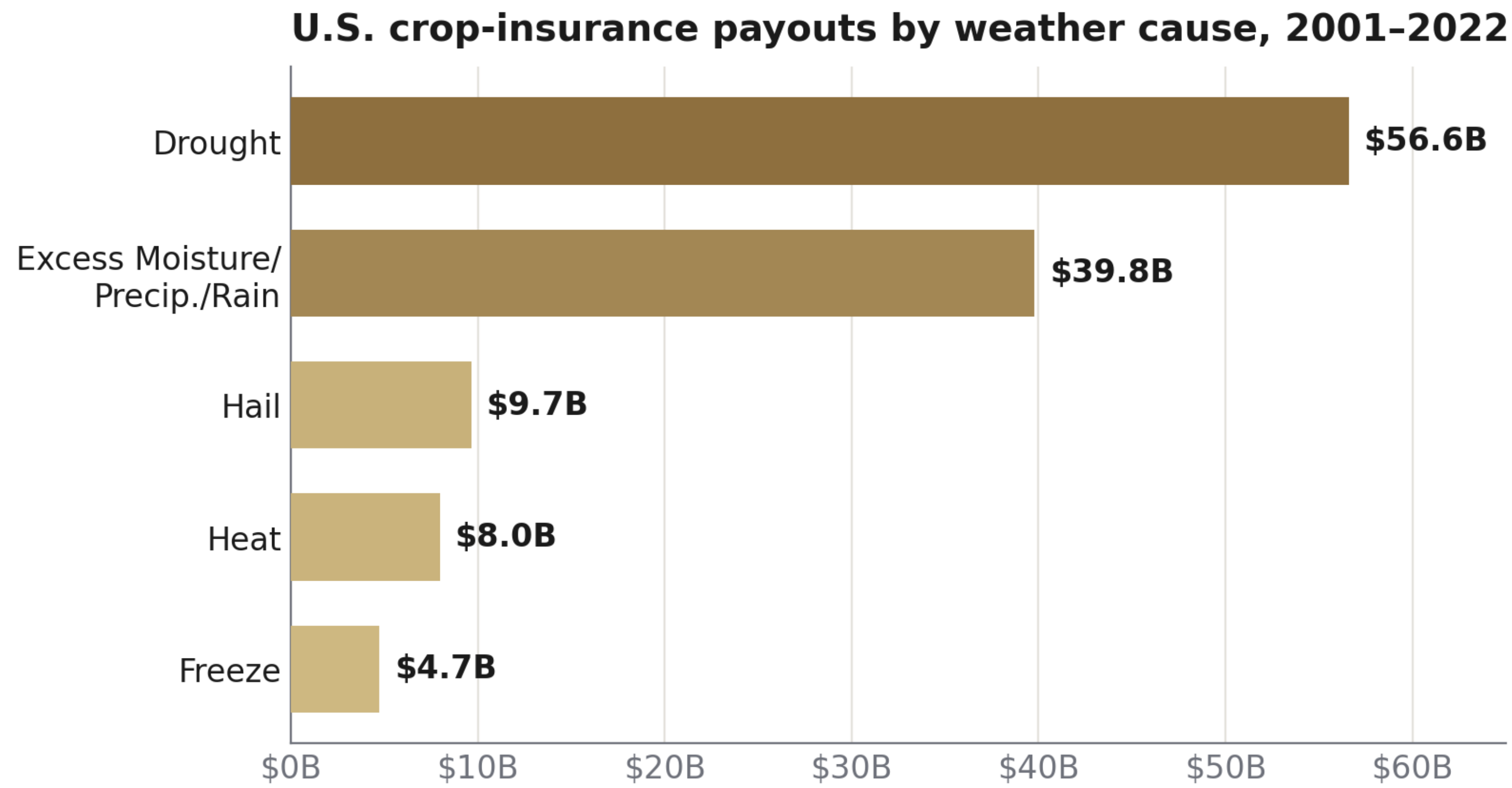
A relentless storm track and saturated soils capped the wettest 12-month period on record for the Lower 48 — 36.20", some 6.25" above the 20th-century mean — through spring 2019.

By May 19 only 49% of Midwest corn and 19% of soybeans were planted, the slowest pace on record.

In Indiana ~850,050 acres went unplanted (prevented planting), driving roughly $240M in excess-moisture indemnities.

NOAA/NCEI divisional precipitation ranks; USDA (Rippey, 2019); prevented-planting from USDA-RMA.

Drought and excess moisture dominate crop losses



$118.8B

Total weather-related crop-insurance payouts, 2001–2022 (73% of all payouts)

60%

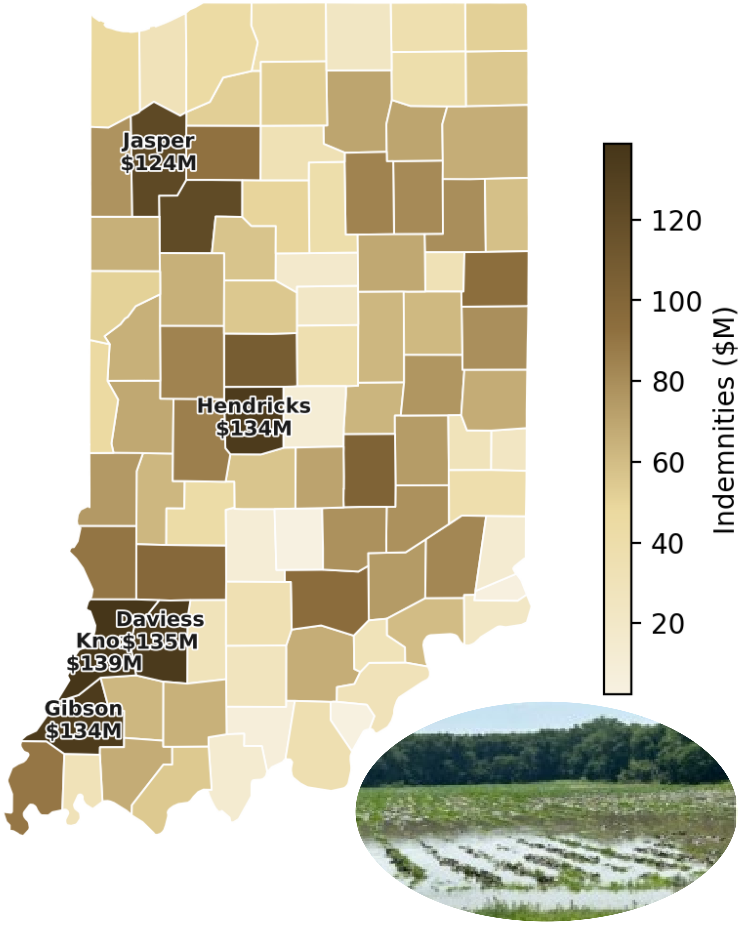
of that total came from drought + excess moisture alone

Indiana lies in the heart of the Corn Belt, so it is directly exposed to the two dominant perils.

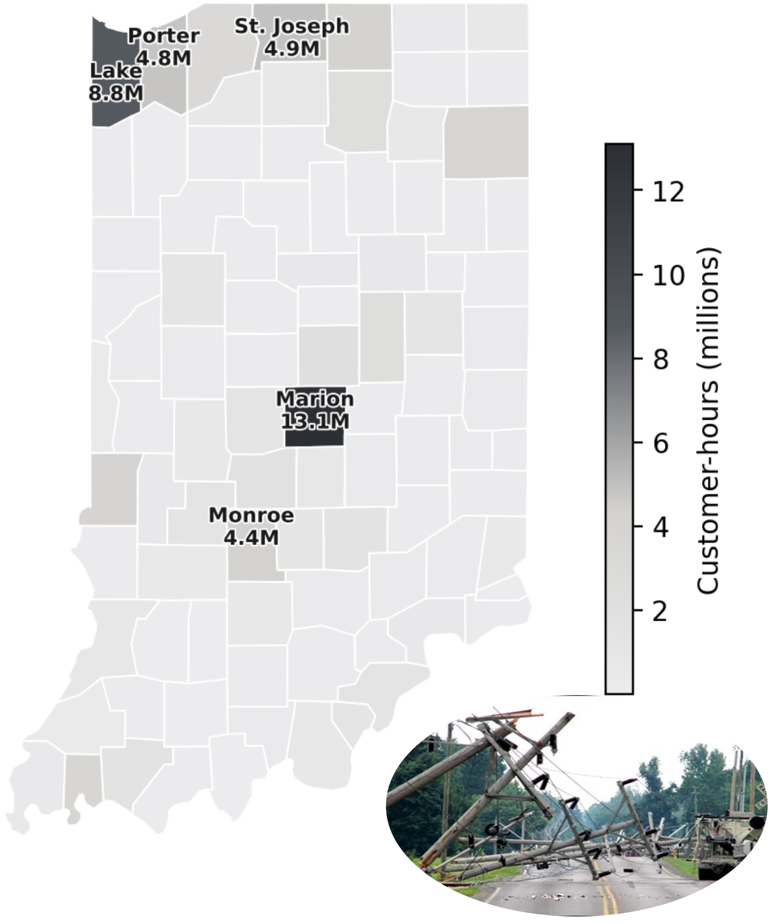
Environmental Working Group / USDA-RMA · ewg.org/research/crop-insurance-pays-farmers-billions-dollars-weather-related-losses-closely-linked-climate

Two geographies of weather risk

Crop-loss total (indemnities, 1989–2025)



Outage total (customer-hours, 2020–2025)



Total indemnities (RMA, 1989–2025) vs. total customer-hours (EAGLE-I, 2020–2025). Crop dollars follow farmland; outage-hours follow population. Rank correlation: −0.11.

Extreme Weather Threatens Midwest Rural and Agricultural Communities

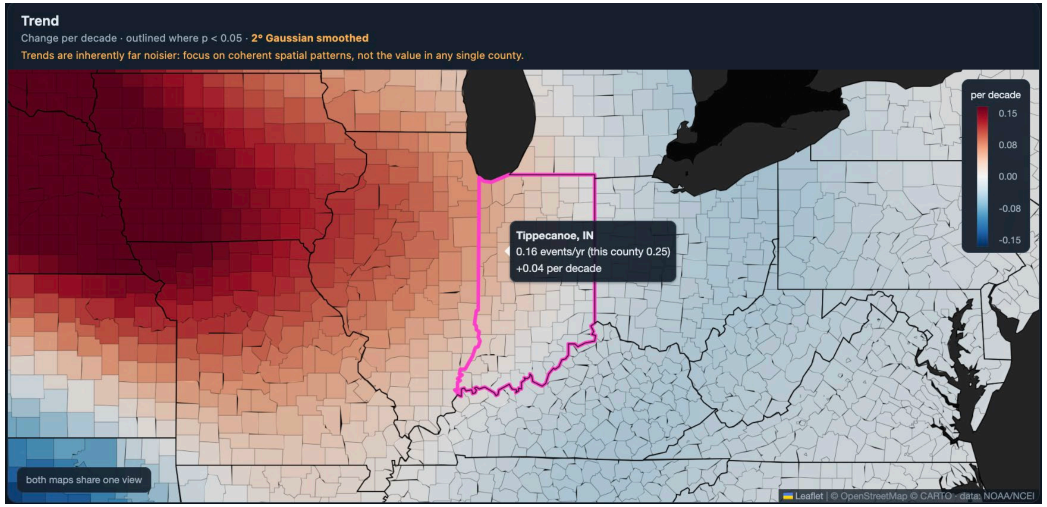
- Extreme weather, including hailstorms, droughts, and severe wind events, reduces crop yields and farmer income each year and cause multi-day power outages in rural communities
- Electricity costs continue to rise as energy demand skyrockets with the growth of AI and Data Centers.
- The agricultural workforce is steadily shrinking

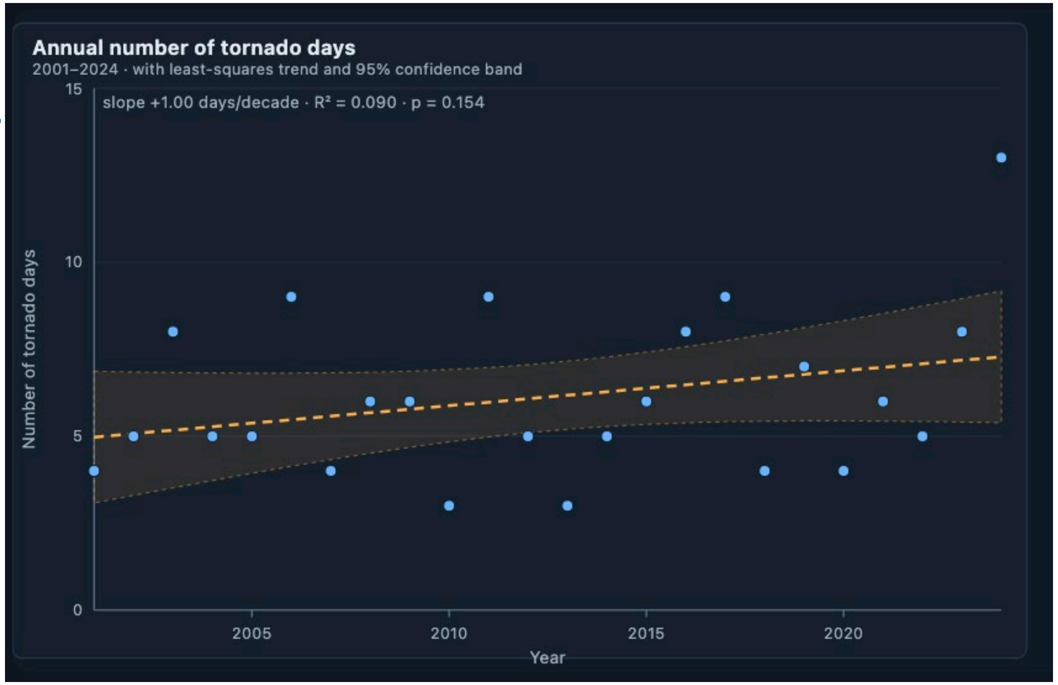
These community risks are expected to continue to grow in the future

Tackle key barriers – three prongs

1. **Extreme weather resilience (ag + energy)**
2. Suitability (design)
3. Acceptability (trust)

Task: Extreme weather data for agrivoltaics





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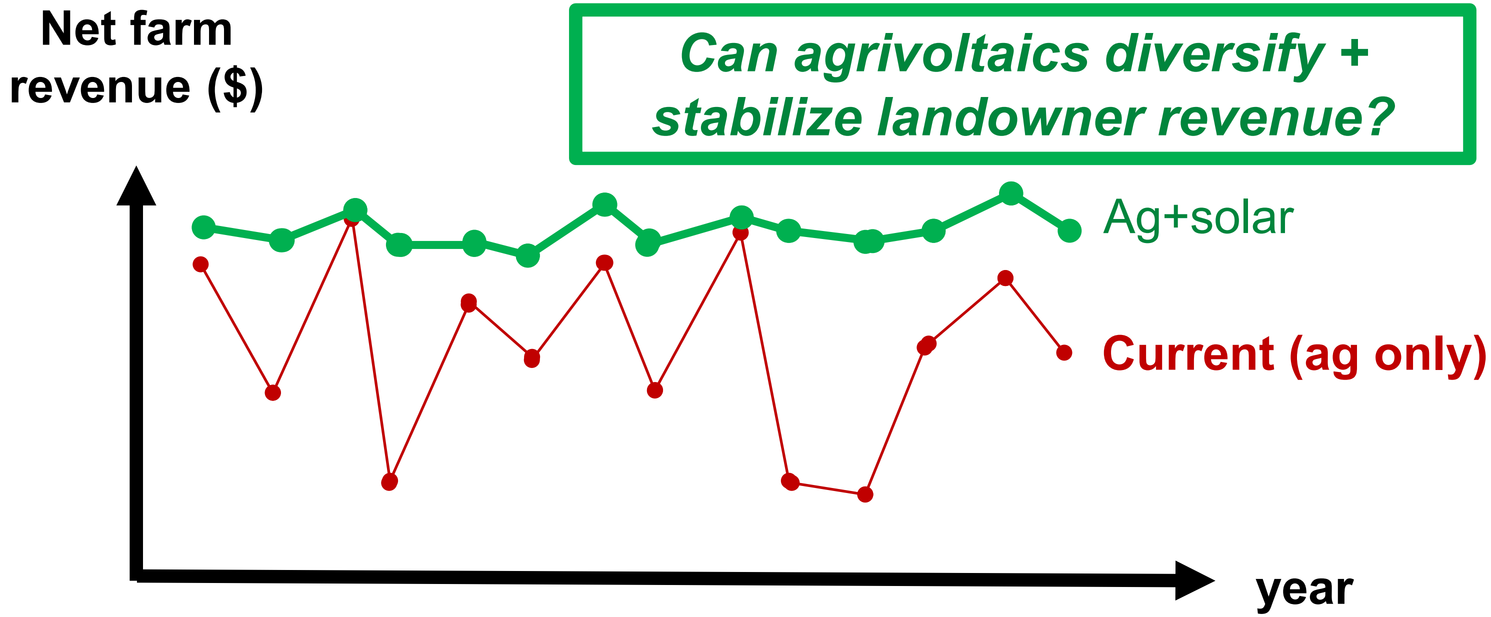
Midwestern Regional Climate Center

We need accessible data

on the frequency and severity of weather hazards – and how they are changing today

to inform decision-making.

Transformational potential: economic resilience and prosperity



Task: Quantify <u>economic</u> resilience benefits of agrivoltaics

CLIMATE SCIENCE

History of Daily weather
& warming experiments

AGRONOMY

Weather →
Crop Yields

AG ECONOMICS

History of Crop Prices

AG ECONOMICS

Crop prices,
costs & net returns

Row Crops Returns

Revenue – Cost
volatile return

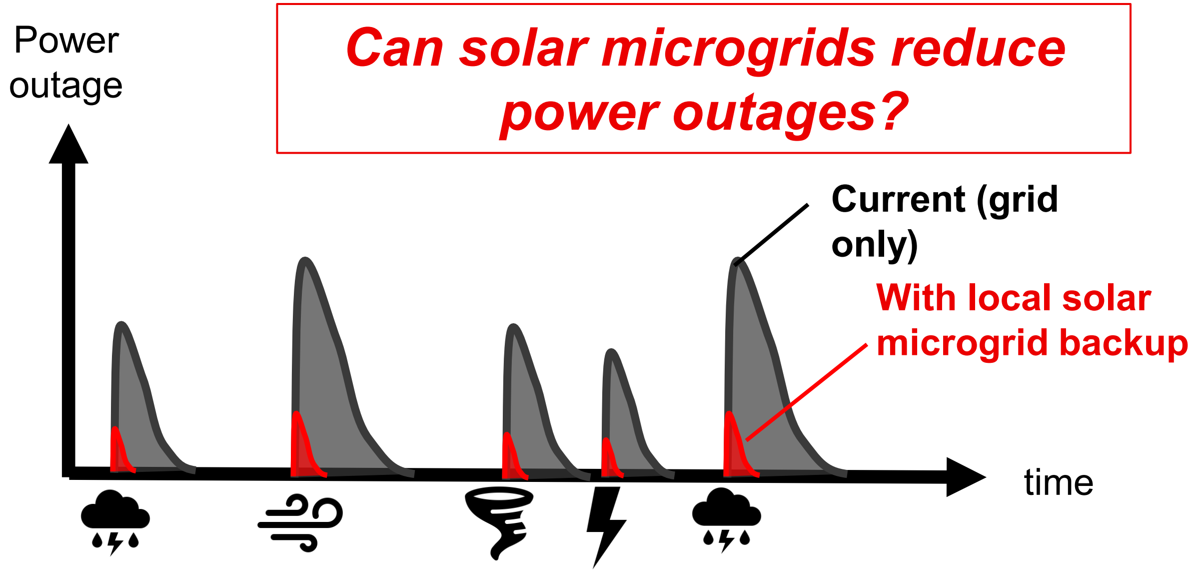
ENERGY / CONTRACTS

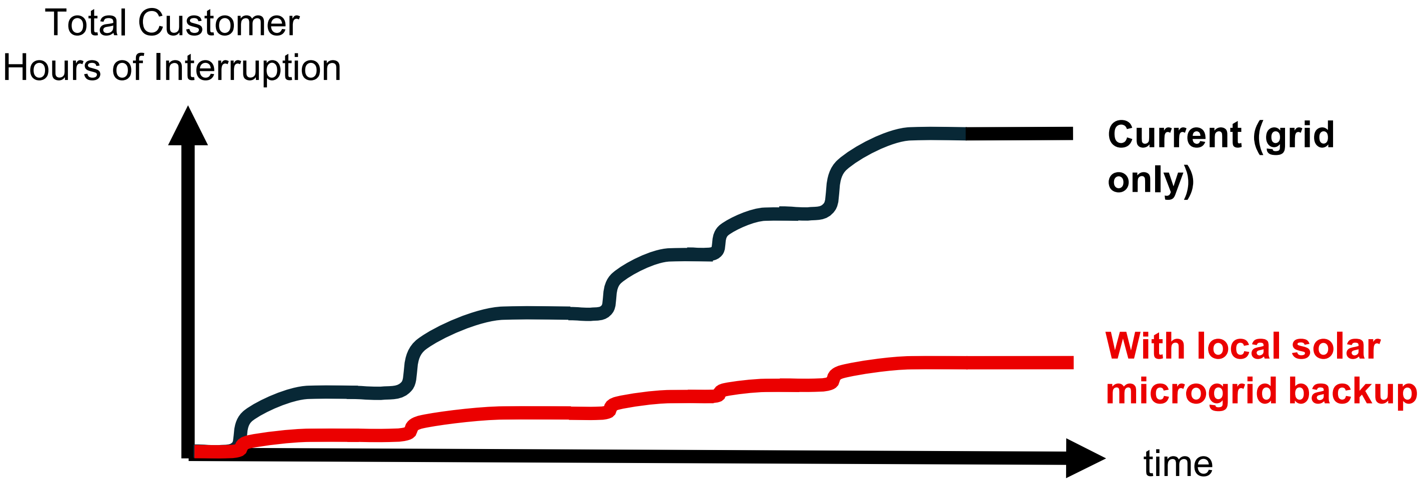
Fixed solar
lease income

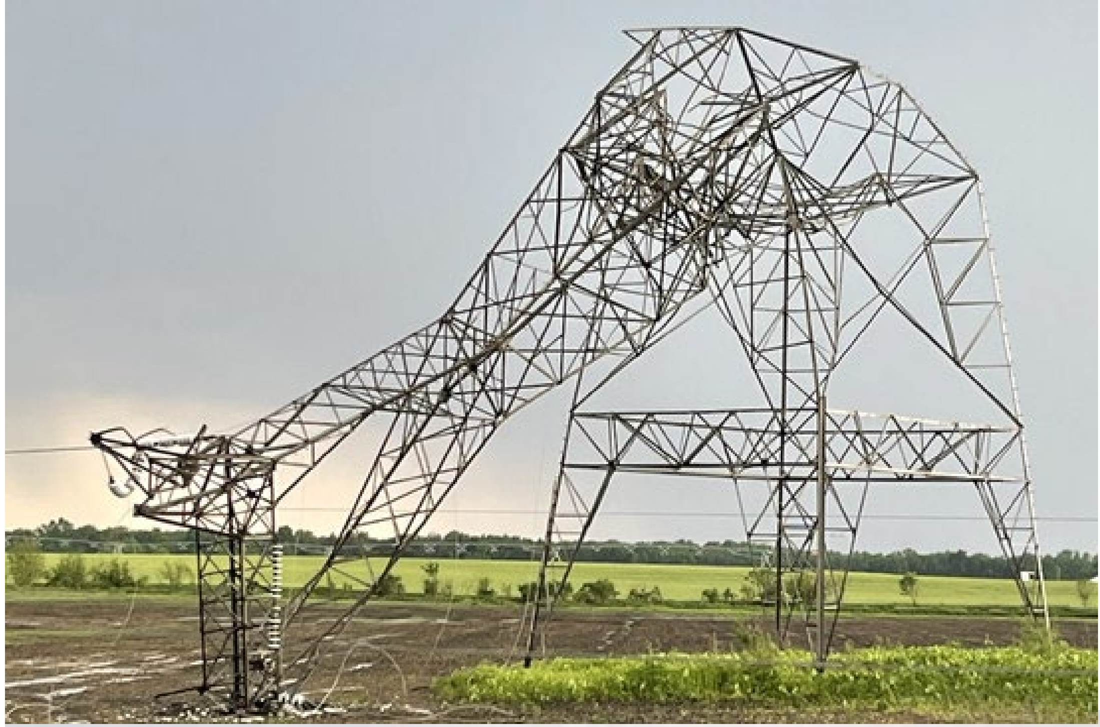
Model how adding solar to ag alters landowner year-to-year revenue + revenue *<u>variability</u>*

Transformational potential: energy resilience

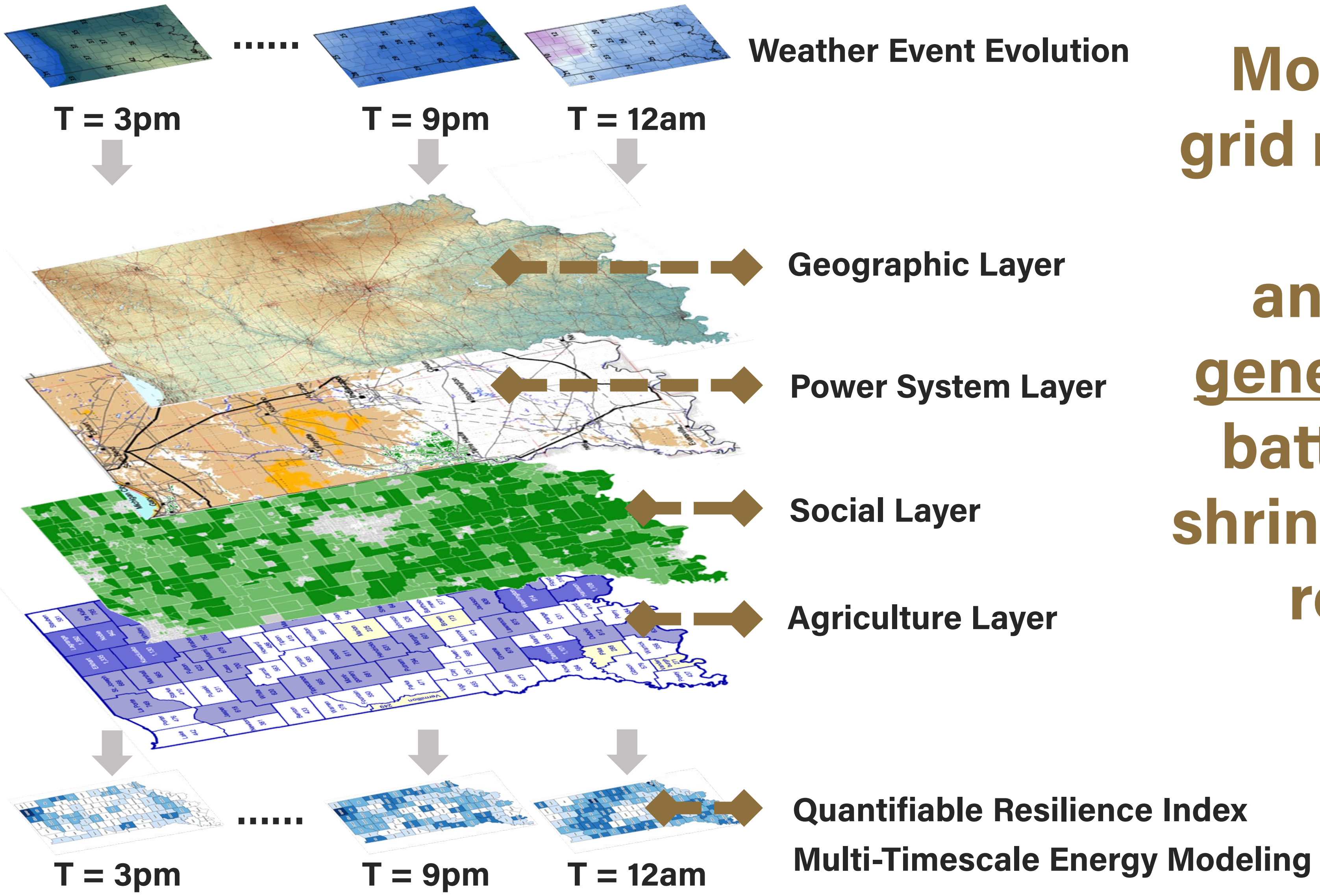
Can solar microgrids reduce power outages?







Task: Quantify <u>energy</u> resilience benefits of agrivoltaics



Model how the power grid responds to damage

and how <u>distributed generation</u> (solar farms, battery storage) could shrink the footprint of the resulting outages

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Midwest Agrivoltaics for Resilient Communities

SUSTAINABLE
RURAL
RESILIENT

PURDUE UNIVERSITY

Institute for a Sustainable Future

1) Deeper dive + imagine the future

Join our afternoon breakout

2) Ideas/partnerships?

Come talk to us!

Aaron Thompson: awthomps@purdue.edu
Kara Salazar: salazark@purdue.edu
Dan Chavas: dchavas@purdue.edu
Juan Sesmero: jsesmero@purdue.edu
Xiaonan Lu: lu998@purdue.edu

+ many internal and external partners!