

# Agrivoltaics In Practice: A Policy Approach to Climate Resilience and Rural Economics Development

ECON-295D: Energy Economics  
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## Policy Question

How can policy support agrivoltaics (AV) to serve as both a climate resilience strategy and an economic development tool for rural agricultural communities? Are policy tools like feed-in tariffs, subsidies, production tax credits, and pilot programs effective in enabling the adoption of AV?

## Introduction

### Motivation

- 57% of U.S. land is used for agriculture
- Solar PV is land-intensive: 20,000m<sup>2</sup>/~5 acres/MW
- AV combines farming & solar, resolving land-use competition by enabling co-location of crops and photovoltaic (PV) systems on the same land.



Next2Sun installs bifacial solar panels on its patented vertical mounting system (Electrek 2023)

### Key Policy Challenge

- Without policy, 83% of new solar installs will occur on farmland (AFT, 2025)
- High capital costs, uncertain returns, and the absence of national policy support inhibit AV development.
- Represents a classic positive externality: socially beneficial but underproduced without policy intervention.



Photo by Lightsource bp

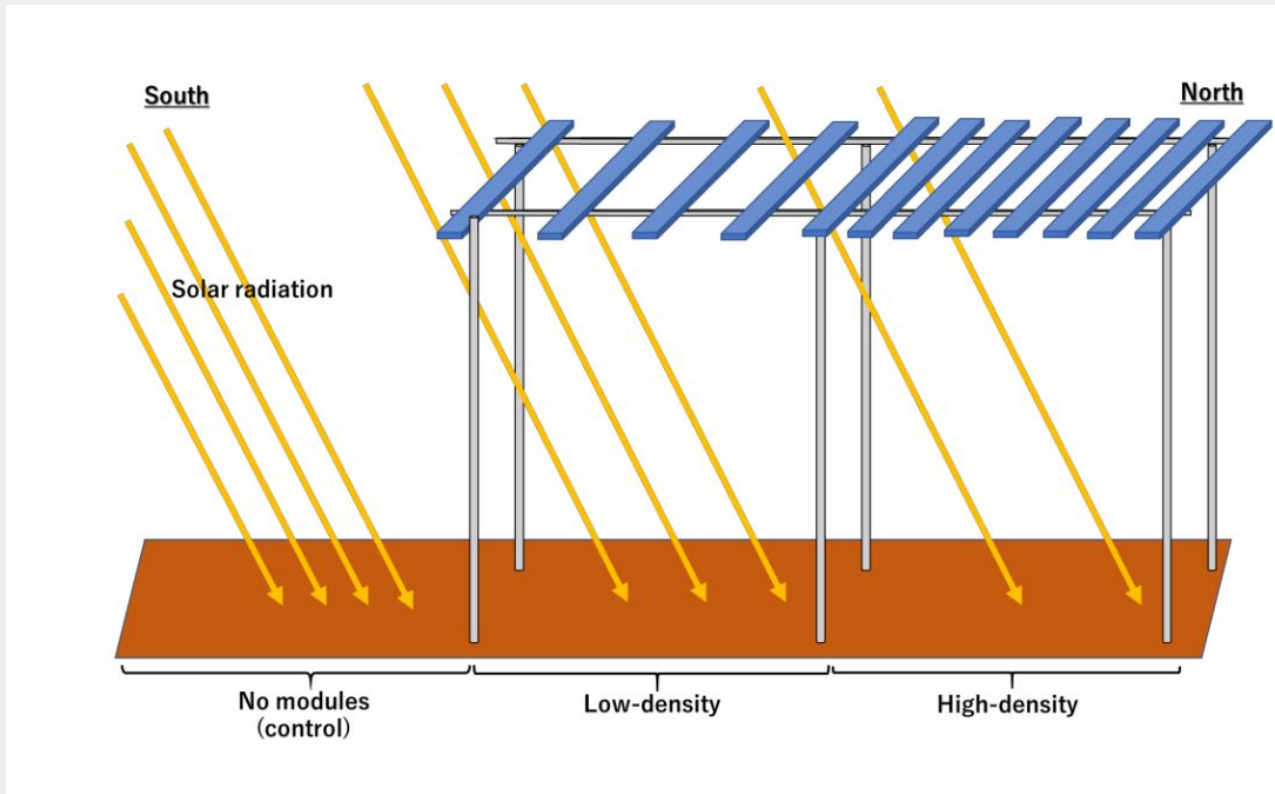
### Why AV Matters

- Integrates food and clean energy production.
- Reduces biodiversity loss, mitigates water evaporation, and provides shade for crops.
- Generates dual income streams for farmers and supports energy security.
- US agrivoltaic market is expected to grow at a compound annual rate (CAGR) of 11.6%: \$323.6 million in 2024 → \$721.4 million by 2031 (Coherent Market Insights, 2024).

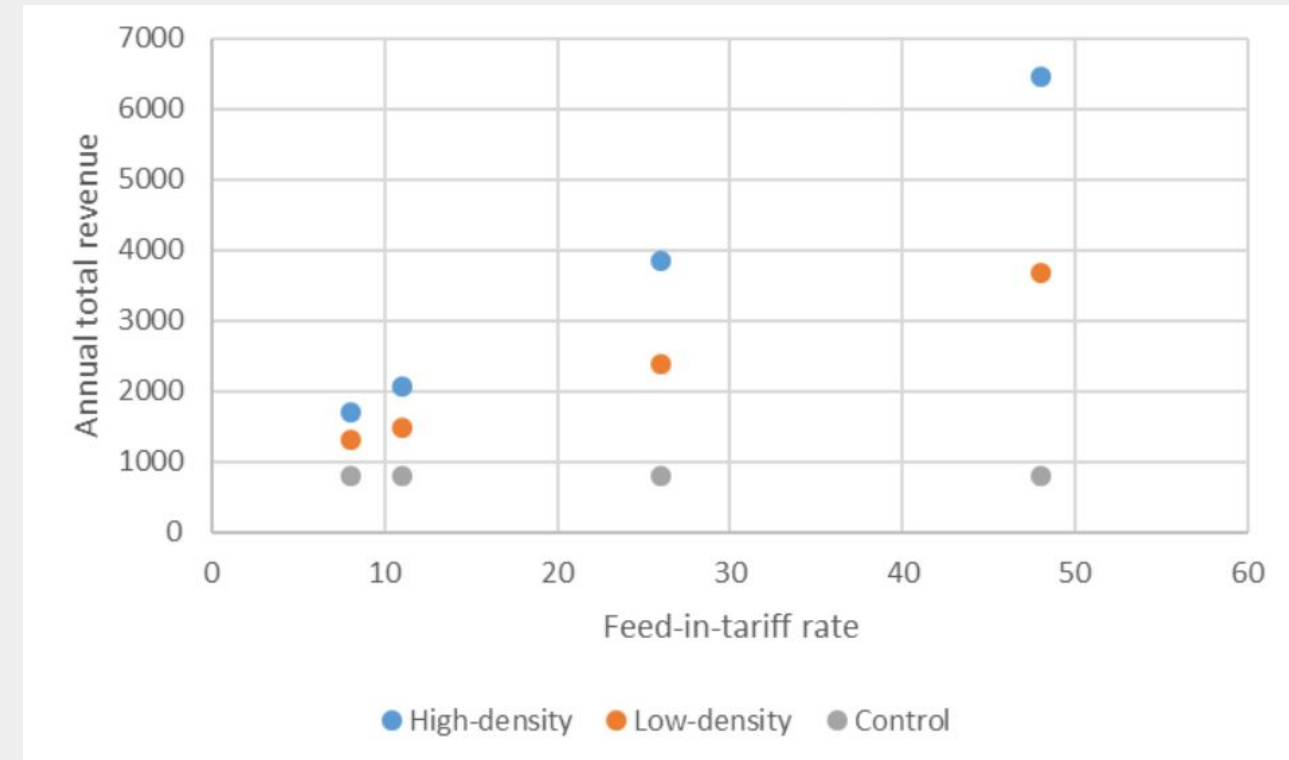
## Global Case Studies of Agrivoltaics in Practice

### Japan - Takashi (2019): Shade-Intolerant Corn Trial

- AV systems tested with high- and low-density panel configurations.
- Corn under low-density panels yielded 5.6% more than control crops.
- High-density PV produced 8.3x more revenue vs. control; low-density produced 4.7x.
- Break-even in 10 years; significant profits by year 20.
- Financial feasibility sensitive to feed-in tariff (FIT) rates: a 48 JPY/kWh FIT made AV viable.



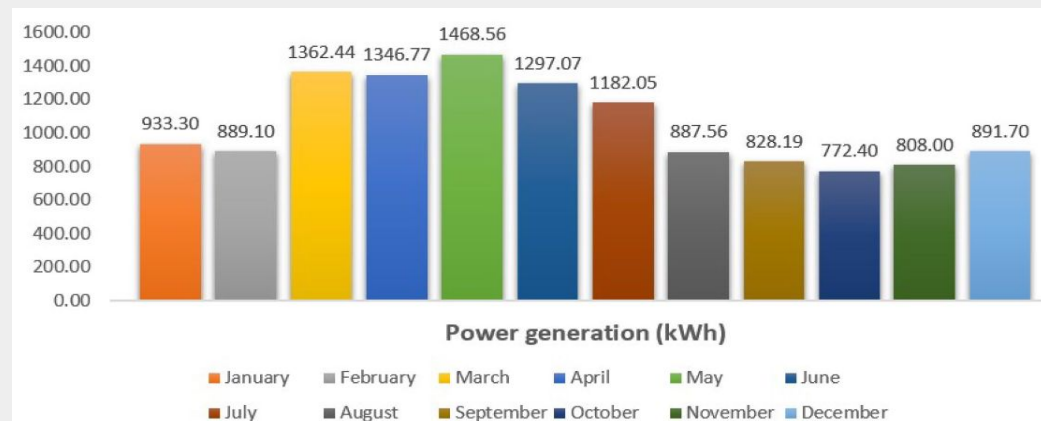
PV Module configurations at the agrivoltaic experimental farm



Sensitivity of annual total revenue per square meter to changes in the feed-in-tariff rate

### India – Patel et al. (2023): Tomato Microclimate Study

- Tomatoes yields increase +6.98% to +15.09% depending on treatment.
- Best-performing treatment had a BCR of 2.59 and payback of 7.9 years.
- AV systems improved temperature (-2° C) and humidity (+10%).
- LER reached 1.65, meaning 1 hectare of AV outperformed 1.65 hectares of separate farming + solar.



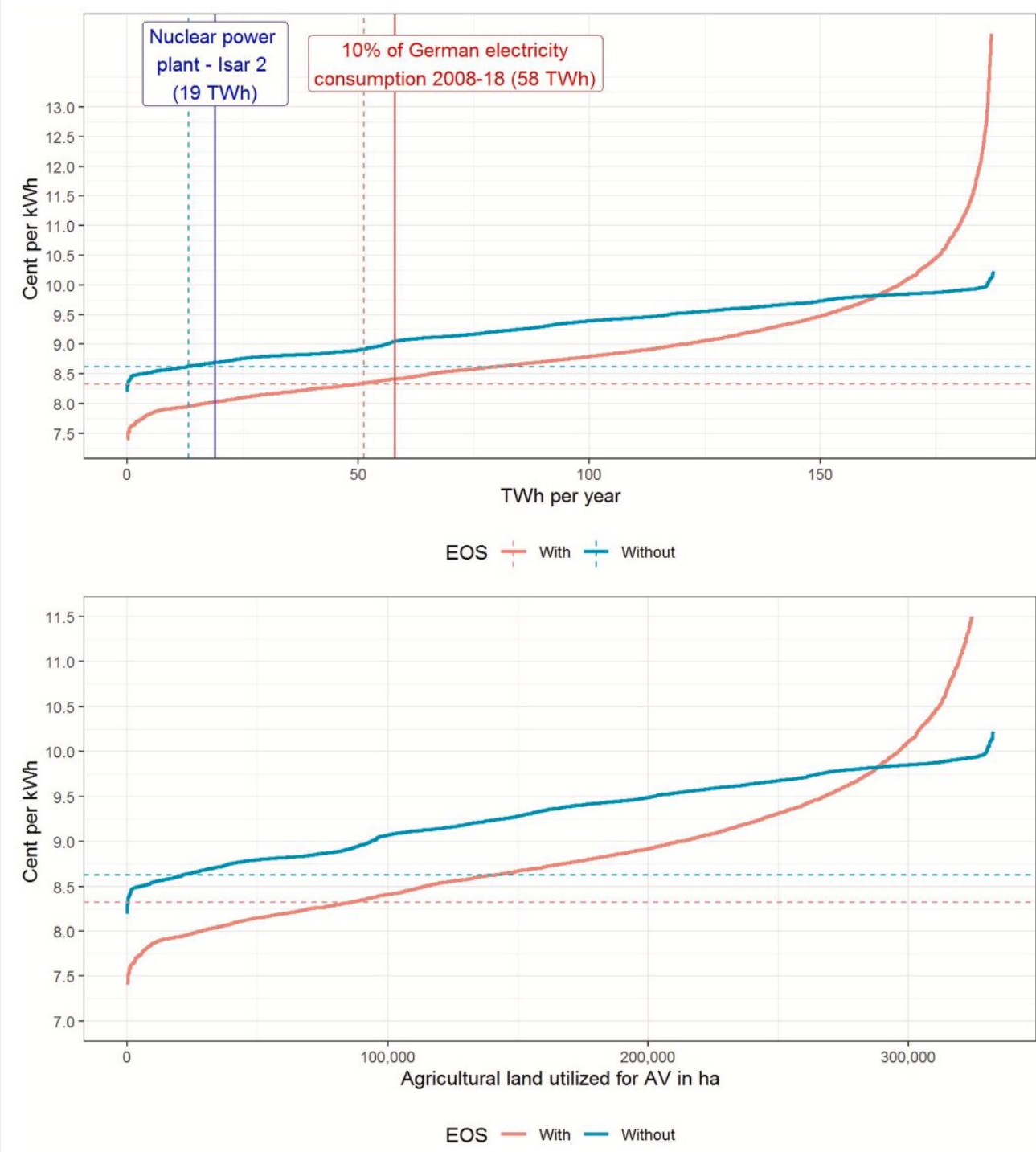
Monthly energy generation for 09/2017 to 08/2018 from AV structure

### Germany – Feuerbacher et al. (2022): National Adoption Simulation

- Modeled 137,925 farms using FADN data.
- With economies of scale (EOS): AV meets 8.8% of electricity demand using 1% of arable land.
- Without EOS: Only 2.3% covered.
- Key barriers: High upfront costs, solar radiation variability, and yield loss from shading.
- EOS reduces break-even electricity tariffs and expands adoption.



Movement of shadow over the day during crop growth



Top panel: cumulative AV electricity potential (TWh/year) by electricity tariff and EOS presence. The blue line marks Isar nuclear plant output; the red line marks 10% of national electricity demand. Dotted lines represent break-even prices for the most cost-efficient 10% of adopters.

Bottom panel: corresponding cumulative AV land use (ha) across tariffs.

| Country | Primary Crop(s)           | Yield Impact                      | Benefit-Cost Ratio (BCR)                | Payback Period                  | Key Insight                                                                      |
|---------|---------------------------|-----------------------------------|-----------------------------------------|---------------------------------|----------------------------------------------------------------------------------|
| Japan   | Corn (shade-intolerant)   | 5.6% increase (corn, low-density) | 1.90 (high-density), 1.78 (low-density) | ~10 years (high FIT rate)       | Corn yield can improve with low-density AV; PV revenue far exceeds crop revenue. |
| India   | Tomatoes (shade-tolerant) | 15.09% increase (tomatoes, S1T1)  | 2.59 (S1T1)                             | 7.9 years (no subsidies)        | AV boosts yield and profit; climate moderation helps tomato growth.              |
| Germany | Various (simulated)       | Up to -40% (due to shading)       | Modeled indirectly via margins          | Not specified (simulated model) | EOS critical for adoption; AV on 1% land can meet 8.8% of electricity demand.    |

Summary of Agrivoltaics Cases from Japan, India, and Germany

## Policy Recommendations

### 1. Feed-in Tariffs (FITs)

Ensure stable, above-market rates for renewable energy. Drawback: Potential cost to ratepayers/taxpayers.

### 2. Installation Subsidies

Offset high capital costs for farmers. Drawback: Government budget strain.

### 3. Production Tax Credits (PTCs)

Incentivize long-term clean energy generation. Drawback: Risk of inequity in benefit distribution.

### 4. Regional Pilot Programs

Focus on climate-vulnerable agricultural zones. Drawback: Risk of low scalability.

## Conclusion

Agrivoltaics offers a transformative opportunity to align food security, clean energy goals, and economic resilience in rural communities. Evidence from Japan, India, and Germany demonstrates AV’s financial viability, environmental co-benefits, and potential to reduce land-use conflict. To unlock its full potential, the U.S. must implement a coordinated support system blending tariffs, tax credits, and pilot funding. Without strategic intervention, AV will remain underutilized despite its promise to reshape our agricultural and energy landscapes.

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