American Farmland Trust

Policy Recommendations to Increase Agrivoltaic Development

INTRODUCTION AND GOALS

The development of solar energy to increase domestic energy production while reducing carbon emissions is driven in large part by its cost-competitiveness in the marketplace. American Farmland Trust's (AFT) Farms Under Threat 2040 solar modeling projects that, without policy intervention, 83% of new solar development is expected to occur on farmland and ranchland (agricultural land), with almost half on America's most productive land for growing food and other crops. While this new development can support rural vitality by providing important economic benefits to rural landowners and communities, it must be done in ways that address host community concerns around farmland conversion and its effect on the local farm economy—especially with respect to utility-scale solar.

Agrivoltaics is a promising, emerging, and rapidly evolving area of energy development that integrates agricultural production into solar arrays to keep land in farming as solar development advances. Expanding the development of agrivoltaic projects that keep land in production is a key pillar of AFT's Smart Solar Principles, which include 1) prioritizing solar on the built environment, contaminated land, and marginal land; 2) conserving soils and water on farmland converted to solar; 3) increasing agrivoltaic development; and 4) advancing equity and farm viability.

Agrivoltaics research has demonstrated the potential of this novel land use strategy to conserve water, protect crops and livestock from extreme weather, and increase

About AFT & Smart Solar

AFT's mission is to save the land that sustains us by keeping land in farming, keeping farmers on the land, and supporting voluntary adoption of environmentally sound practices. Relevant to all areas of this mission, AFT has a dedicated Smart Solar℠ program with national and regional specialists that provide guidance, resources, technical assistance, and other support to farmers and landowners interested in agriculturally compatible solar. In addition, AFT is at the forefront of identifying and advancing federal, state, and local policies to achieve a Smart Solar buildout that simultaneously strengthens the economic viability of farms, ranches, and rural communities.

AFT has historically served as a convener, connecting different sectors to achieve policy goals that advance its mission. In working to increase agrivoltaic development, AFT aims to build on what has already been achieved while creating further bridges between agricultural communities, farmland protection and conservation advocates, environmental organizations, solar developers, utilities, and other stakeholders.

farm incomes.[1] Agrivoltaic crop trials show significant variability in its impacts on crop yield, with results differing depending on a wide range of factors, including crop type, variety, location, solar design, position within the array, and weather. Further research is needed to better understand and predict yield impacts, identify suitable crop varieties, and adapt solar designs for specific locations, crops, and production systems. Still, recent surveys from AFT and the Solar and Storage Industries Institute (SI2) show that approximately two-thirds of farmers and ranchers who responded to the survey are open to engaging in agrivoltaics production, primarily motivated by supplemental income to support their operation. Similarly, the solar industry is anticipating future growth in agrivoltaics, with 80% of solar developers that responded to SI2's survey indicating that they plan to develop agrivoltaic projects in the future.

However, agrivoltaics currently represent a small share—less than 5%—of solar capacity in the U.S.[2] And while agrivoltaic research is still evolving, conventional solar development is advancing at a rapid pace. As evident in states—like Massachusetts and New Jersey—and in countries—like Italy, France, and Germany—policies and programs incentivizing agrivoltaic development could increase the share of solar arrays that keep land put into solar in agricultural production as solar development continues.

Because many agrivoltaic systems cost more than traditional ground-mounted solar arrays, or otherwise need to be designed differently to accommodate the farm operation, incentives are often needed to increase their development. **A key challenge facing policymakers in establishing such incentives is that the term "agrivoltaic" is defined differently by each developer, government body, and organization engaged in this issue.** This has led to confusion and potential misuse of the term. For policies, like incentives, to yield true agrivoltaic projects that support a farm operation, especially when public funding is involved, careful choices must be made about what qualifies.

To expand development of agrivoltaics, AFT has created a recommended statutory definition that can be adapted for different incentive programs at the local, state, and federal level. **The definition and the incentive recommendations below were crafted to achieve the following goals**:

- Ensure farming can take place within solar arrays for their full life (30-40+ years) and beyond, and that there is value for the farm production component, not just the energy production
- Protect and conserve soil and water resources
- Develop agrivoltaic projects that contribute to the broader farm and ranch economy

[1] Note: The landowner who secures the solar lease is not always the farmer operating within the array. Benefits from agrivoltaic projects accrue differently for the landowner, the farmer operating within the array, and the farm community as a whole, and must be accounted for separately.

[2] Estimate of agrivoltaics as less than 5% of solar projects is based on National Renewable Energy Laboratory InSPIRE Agrivoltaics Map (filtered for "Crop Production" & "Grazing") estimate of 7.9 GW of agrivoltaics capacity and Solar Energy Industries Association Q4 2024 Solar Market Insight Report estimate of 219.8 GW existing solar capacity. This may be an undercount, but the current share is somewhere between ~4%-7%.

- Create projects that are designed and installed in ways that give farmers the flexibility to change productions systems or which agricultural products they produce in response to market demand or other factors throughout the full lifetime of the solar array
- Expand the breadth of production systems and types of crops or livestock that are integrated into solar arrays across the U.S.
- Eliminate the potential for incentive program loopholes, and certify that developers receiving public benefits to develop agrivoltaic projects are making the changes necessary to support a farm operation for the full life of the array
- Generate relevant and realistic policies so developers are effectively incentivized to innovate and incorporate agricultural production and work to achieve these goals
- Advance all sizes of agrivoltaic array from community to utility scale

To develop these recommendations, AFT staff reviewed existing and proposed definitions and incentives from within the U.S. and around the world, and engaged experts from agriculture, academia, state and federal government, and the energy industry. It should be noted that agrivoltaics is a rapidly evolving and experimental area of research, policy, development, and law. As such, AFT will continue to update its policy recommendations to achieve the above goals as the field continues to advance. AFT also recognizes that there are numerous equity considerations related to agrivoltaics and the siting of renewable energy. These include—but are not limited to—who owns that array, displacement of farmer-renters, impacts on farmland prices and availability, intersection with heirs' property issues, access to capital, and implications for ratepayers. As an organization, AFT remains committed to continuing to learn and build partnerships in this field of policy to further shape its recommendations and address these and other concerns.

RECOMMENDED AGRIVOLTAIC DEFINITION AND REGULATORY PROCESS

Currently, there is lack of clarity on what terms like "dual use" and "agrivoltaics" mean, including in law. Agrivoltaic projects fall under the larger umbrella term of "dual use"[3] that pair solar energy generation with another use or benefit. A more universally agreed upon, precise definition for agrivoltaics will help advance this newer type of solar development in ways that truly benefit producers, farm economies, and host communities.

Agrivoltaic projects have two key features:

1) 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., and

[3] Some other examples of other dual use projects include ecovoltaics (solar+ ecosystem services like pollinator habitat), floatovoltaics (solar on water), and carport solar (solar on parking lots for shade).

2) Intentional design[4] 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.

Agrivoltaic projects can provide important benefits for host communities, including continued farm and food production, local economic activity, and ecosystem services. But because many agrivoltaic systems are more costly than conventional ground-mounted solar, incentives are needed to spur their development when policies favor least-cost energy development, as they do throughout much of the U.S.

To ensure incentive programs result in agrivoltaic projects that have these key features and achieve the above identified goals, **AFT recommends the following statutory definition** for agrivoltaic projects (see the Appendix A and B for examples and more information on the rationale for language):

An **agrivoltaic system** is defined as a ground-mounted photovoltaic solar energy system that:

(1) Has been intentionally planned and designed with agricultural producers and/or experts, and

(2) Is constructed, installed, and operated to achieve integrated and simultaneous production of both solar energy and marketable agricultural products by an agricultural producer:

   a. On land beneath and/or between rows of solar panels

   b. As soon as agronomically feasible and optimal for the agricultural producer after the commercial solar operation date and continuing until decommissioning.

(3) Agricultural products and activities include:

   a. Crop production,

   b. Grazing, or

   c. Animal husbandry.

(4) Exclusion.—agrivoltaic systems do not include pollinator habitat as the sole dual use. Apiaries are also excluded, unless the solar array has been designed and installed to enable the agricultural producer the flexibility to change what they produce, raise, or grow at any point throughout the life of the project.[5]

[4] AFT recognizes that retrofitting conventional ground-mounted arrays may enable agrivoltaic projects in the future, however these systems would still need modifications to make farming possible, such as new fencing, improved cable management, soil decompaction from installation (as needed), access to water, and more.
[5] This definition is meant to be used to detail what would qualify a developer for financial incentives for agrivoltaics. Excluding beekeeping and pollinator habitat is not to minimize their value, but to ensure that financial benefits (in the form of taxpayer dollars) are conferred only to agrivoltaic projects that are

In addition to defining agrivoltaics, **AFT recommends legislative bodies direct the government agency responsible for agriculture to lead a separate regulatory process to adapt this definition for each program or agrivoltaic incentive**. Should a committee be created for this purpose, AFT recommends the department responsible for agriculture lead the committee, working in direct collaboration with agricultural producers, academic institutions, extension, Tribal communities, and conservation groups, and in consultation with energy agencies, utilities, solar developers, and others. This process can be further enhanced by detailing specific goals for the department to achieve in crafting and implementing the incentive program or policy, which might include any of the following:

- Supporting the economic viability of farm operations for farmer-landowners, tenant farmers, and farm communities
- Reducing the conversion of USDA prime farmland out of agricultural production
- Increasing the breadth of agricultural production systems integrated into solar arrays
- Increasing development of agrivoltaic arrays that, wherever feasible, enhance agricultural yields and efficiency
- Retaining water rights and conserving water in drought-prone areas
- Increasing opportunities for underserved producers to benefit from agrivoltaic projects
- Advancing the development of new technologies and innovative designs that enhance farm production (such as novel tracking systems, module technologies, or installation methods) across all scales of agrivoltaic array
- Continuing historic agricultural production systems within arrays when feasible, or enabling transition to more economically viable production systems
- Generating agrivoltaic arrays that are designed to allow producers to shift what they produce throughout the life of the project to respond to market demand or other factors
- Reducing farmworker risk for heat-related illnesses

In the following section, AFT provides general recommendations for the types of incentives that this definition can be used for, and how to design these policies and programs to achieve the goals outlined in the introduction above. Additional details and recommendations for each incentive will be provided by AFT soon.

intentionally designed to support active farm operations that can adapt to market demand. Placing bee boxes and/or pollinator habitat in the array does not typically involve array design changes that would meet this important criteria for farm viability. AFT encourages smaller incentives for these other beneficial dual uses.

INCENTIVIZING AGRIVOLTAIC PROJECTS

Many different programs and policies are being used to incentivize agrivoltaic projects across the country and around the world. These include:

- Incentives within energy policies and programs (e.g., community solar programs, utility-scale solicitations, bid preferences, pilots, feed-in-tariffs)
- Reductions or forgiveness of farmland conversion mitigation fees
- Property tax reduction or abatement
- Favorable or streamlined treatment in local or state permitting processes
- Locally granted exceptions within land use laws

Designing programs and policies that integrate viable agricultural production into a solar array while advancing innovation in this rapidly evolving sector is not easy. **Incentive programs that have the highest chance of success at achieving the above stated goals have five key features:**

1. A clear and strong definition for what qualifies as an agrivoltaic project, such as the recommended definition above[6]
2. An incentive whose size is calculated based on 1) the additional cost incurred to modify the array to successfully integrate the agricultural production system, with higher incentives offered for integrating production systems that sustain and advance the local farm economy, and 2) the percentage of the array in agricultural production, with higher incentives for arrays that keep more or all of the land in production
3. Authority *and* capacity for annual monitoring and compliance, with penalties and/or clawback provisions should the acreage in agricultural production decline or cease
4. Regular review and periodic recalibration of incentive amounts and program rules to ensure program goals are being met
5. Carveouts, greater incentives, or prioritization for applications submitted for projects that will be farmed by underserved producers, young and beginning farmers, and/or the prior tenant-farmer

These recommendations, along with AFT's Smart Solar recommendations for federal, state, and local governments, are designed to achieve AFT's four Smart Solar principles. AFT will continue to release and refine policy recommendations for how to achieve these principles, including more detailed recommendations on which incentives meet these five criteria, and how to design incentives to achieve the above stated goals. To learn more about AFT's Smart Solar policy and programmatic work, please visit www.farmland.org/solar.

[6] Note: Statutory definitions for agrivoltaics meant to qualify projects for research and demonstration funding can be more general in order to spur innovation, but must be adapted further for use to qualify agrivoltaic projects for incentives.

APPENDIX A: EXPLANATION OF AFT AGRIVOLTAIC DEFINITION

Each word in AFT's suggested statutory definition was chosen to carefully convey what should qualify as an agrivoltaic array for the purposes of an incentive program. AFT chose language that was specific enough to produce arrays that met the goals outlined in the introduction, but broad enough to be applied more universally, accounting for variations in production systems, project designs, and growing conditions. Below is an explanation for why each word was chosen. Appendix B includes some of the examples that AFT reviewed while developing its own recommendation. AFT suggests this agrivoltaic definition be used as written, with select portions adapted where indicated below.

- **"Has been intentionally planned and designed with agricultural producers and/or experts":** This language is meant to ensure that design accommodations for the farm (e.g., placement of cables, row spacing and height, access to water) are made by developers in direct consultation with a farmer or experienced agrivoltaic expert to maximize the chances of producers successfully farming the land throughout the full life of the solar array. "Has been" was intended to include a potential future where agrivoltaic designs that successfully incorporate different production systems become more standardized.

- **"Is constructed, installed, and operated":** This language is meant to capture several important points of action for successful implementation—that the array is constructed and installed in a way that preserves the ability to farm the land (e.g., topsoil remains in place and not compacted), and that the operation of the array is symbiotic to, and does not interfere with, the agricultural production. When considering whether to consider retrofitted arrays "agrivoltaic" for the purpose of providing incentives, the productivity of soils during each of these phases will need to have been maintained, or will need to be restored.

- **"To achieve integrated and simultaneous production of both solar energy and marketable agricultural products by an agricultural producer":** This language is meant to directly achieve a key goal for agrivoltaic arrays—that a farmer produces a marketable agricultural product, and there is value derived from the farm production, not just the energy production.

- **"On land beneath and/or between rows of solar panels":** This language clarifies that agricultural activities must be integrated—accounting for both the benefits and limitations of farming around and beneath steel infrastructure—and not just take place on array edges.

- **"As soon as agronomically feasible and optimal for the agricultural producer after the commercial solar operation date and continuing until decommissioning":** This language clarifies that while the agricultural activity does not need to commence immediately, it should begin as soon as the particular production

system can produce yields after energy production commences, and that agricultural activity needs to continue until the array has finished producing energy in order to be considered "agrivoltaic".[7]

- **"Agricultural products and activities include crop production, grazing, or animal husbandry":** This language for what is included should be used as a template and adapted to be relevant to, and meet the goals of, each jurisdiction adopting this definition.
- **"Agrivoltaic systems do not include pollinator habitat as the sole dual use. Apiaries are also excluded, unless the solar array has been designed and installed to enable the agricultural producer the flexibility to change what they produce, raise, or grow at any point throughout the life of the project":** The exclusion language was chosen carefully. While apiaries produce marketable agricultural products, part of the goal of this work is to develop projects that maximize flexibility for the agricultural producer to adapt what they grow in response to market demands and other conditions throughout the 30-40 year+ life of the array. This is an important element of farm viability, and without it, the chances of long-term success of the farm operating within the array is limited. In other words, placing bee boxes within or around the array and/or planting pollinator habitat does not typically involve array design changes that would meet this important criterion for farm viability. Therefore, those arrays, while beneficial, should not qualify as agrivoltaic and be eligible for robust developer incentives.

[7] Though not inherent to this definition, it is important to note that decommissioning should also be funded and planned to take place in such a way that the ability to farm the land is retained after the project is removed.

APPENDIX B: EXAMPLES OF AGRIVOLTAIC DEFINITIONS

A critical part of AFT's process developing its agrivoltaic definition was reviewing existing state and international definitions and discussing how well they, as written, would achieve the farm viability goals of this work. Below is a sample of the statutory, legislative, and regulatory examples AFT staff reviewed, with language organized by topic. For example, different definitions included or excluded different production systems, or dealt with the spatial and temporal aspects of agrivoltaic projects differently (or not at all). This chart is organized to enable the same kind of comparison AFT undertook in deciding which language would achieve the goals laid out in this document's introduction.

Definition	Integration language	Spatial	Production systems	Designed for Agriculture	Temporal	Exclusions	Process
Federal, proposed	"integrated manner"	"on the same piece of land"	"including crop or animal production"	(not addressed)	Through the duration of a project	Implicit but not stated	Rule-making at USDA
Colorado	"directly integrated"	(not addressed)	"including crop production, grazing, animal husbandry, apiaries, cover cropping for soil health benefits or carbon sequestration. Commodities for sale in the retail or wholesale market."	Property tax incentive for innovative designs that expand potential for ag (for the project and in general) *and* which protect habitat	(not addressed)	(not addressed)	(not addressed)

Maryland	"simultaneous use"	"of areas of land"	"grains, fruits, herbs, poultry, dairy, livestock, horse, turf, flowers, aquaculture, silviculture and any other activity recognized by Dept of Ag."	(not addressed)	(not addressed)	"pollinator habitat and apiaries" ONLY for mitigation fee and current use	(not addressed)
New Jersey	"ensures the continued simultaneous use"	"of the land below and adjacent to the panels"	"for agricultural or horticultural production"	(not addressed)	"continued simultaneous use"	Solar on Preserved land	(not addressed)
Germany	"combined use"	"same land area" Maximum 10% or 15% loss of land area due to solar installation	(not addressed)	Categories for overhead vs. interrow, specifications for light penetration "*agricultural production as the primary use and for electricity PV production as the secondary use"*	(not addressed)	(not addressed)	(not addressed)