



State of New Jersey
THE PINELANDS COMMISSION
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PHILIP D. MURPHY
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General Information: Info@pinelands.nj.gov
Application Specific Information: AppInfo@pinelands.nj.gov

LAURA E. MATOS
Chair
SUSAN R. GROGAN
Executive Director

MEMORANDUM

To: Members of the Pinelands Climate Committee

From: Susan R. Grogan 
Executive Director

Date: July 11, 2023

Subject: Meeting materials

Enclosed please find the agenda for the Pinelands Climate Committee's upcoming meeting on Wednesday, July 19, 2023. We have also included the following:

- The minutes from the April 19, 2023 Committee meeting;
- A copy of New Jersey's 2021 Dual Use Solar Act, which charges the New Jersey Board of Public Utilities (BPU) with establishment of a pilot program to permit construction of solar facilities on unreserved farmland, while maintaining the land in active agricultural or horticultural use; and
- A copy of a memorandum on the Dual Use Solar pilot program that was recently submitted to the BPU by a group of stakeholders (Lightstar Renewals, LLC, Bluewave, the New Jersey Farm Bureau and the American Farmland Trust)

Please note that representatives of the BPU and Lightstar Renewals, LLC will be making presentations at the Committee meeting on the pilot program and its implementation.

The Committee meeting will be conducted in-person and via teleconference. Specific access information will be provided to all Committee members in a separate email. The public will be able to attend the meeting in-person or view and participate in the meeting through the following YouTube link:

www.youtube.com/c/PinelandsCommission



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PINELANDS CLIMATE COMMITTEE MEETING

July 19, 2023 – 9:30 a.m.

This meeting will be held in-person and virtually

Richard J. Sullivan Center for Environmental Policy and Education
Terrence D. Moore Conference Room
15C Springfield Road
New Lisbon, New Jersey

Watch the meeting on the Pinelands Commission's YouTube channel:

www.youtube.com/c/PinelandsCommission

To Provide Public Comment, Please Dial: 1-929-205-6099 Meeting ID: 812 4703 3977

Agenda

1. Call to Order
2. Adoption of the April 19, 2023 Climate Committee meeting minutes
3. Dual-Use Solar Energy Pilot Program
 - Presentation by the New Jersey Board of Public Utilities
 - Presentation by Lightstar Renewables, LLC
 - Discussion of current CMP requirements and potential amendments
4. Update on state initiatives
5. Update on office initiatives
6. Public comment

PINELANDS CLIMATE COMMITTEE MEETING

This meeting was conducted in-person and available remotely.

The public could view/comment through Pinelands Commission YouTube link:

<https://www.youtube.com/c/PinelandsCommission>

Zoom Meeting ID: 850 9782 1311

April 19, 2023

MINUTES

MEMBERS IN ATTENDANCE: Chairman Mark Lohbauer, Commission Chair Laura E. Matos, Alan Avery, Theresa Lettman, Edward Lloyd

MEMBERS ABSENT: Jerome H. Irick

STAFF PRESENT: Susan R. Grogan, Charles Horner, Gina Berg, Brad Lanute, Steven Simone, John Bunnell, Ernest Deman, Paul Leakan, and Dawn Holgersen. Also present were Tom Holl and Janice Venables, with the Governor's Authorities Unit.

1. Call to Order

Chairman Lohbauer called the Pinelands Climate Committee meeting to order at 9:33 a.m.

2. Adoption of the February 15, 2023 Climate Committee meeting minutes

Commissioner Avery moved the adoption of the minutes of the February 15, 2023 Committee meeting. Commission Chair Matos seconded the motion. All voted in favor.

3. Update on state initiatives

Ms. Grogan delivered a presentation on state and office initiatives (*attached to these minutes and on the Commission's website at:*

<https://nj.gov/pinelands/home/meetings/documents/2023%20April%2019%20Committee%20presentation.pdf>)

Ms. Grogan said the Commission is participating in the Interagency Council on Climate Resilience (IAC). She said the current task is an extreme heat resilience action plan.

She said that the New Jersey Department of Environmental Protection (NJDEP) conducted a survey and hired consultants. She said the consultants analyzed the information received in the survey. She said there were few responses to the survey. She said the agencies were asked to compile a list of actions and recommendations.

Ms. Grogan said that a draft of the actions and recommendations will be due on May 17, 2023. She said the agencies were provided with a template for the draft. Drafts from all the agencies will be compiled into a single document. She said that expert advisory groups were assembled to review the information and provide advice.

In response to Commissioner Avery's question regarding an example of a potential action item, Ms. Grogan said that native plant species lists could be reevaluated to identify those that are more resilient to extreme heat. She said that the recommendations are not all based on rules; some will focus on education and outreach.

Chairman Lohbauer inquired as to the Pinelands specific information for extreme heat, as it may differ from other areas of the state. Ms. Grogan indicated the IAC document may have separate chapters to identify concerns for different areas of the state. She said the document will be broad and that the expert group will be working to organize the information.

Ms. Grogan said the Natural and Working Lands Strategy (NWLS) is a combined effort from NJDEP and the New Jersey Department of Agriculture. She said the goal is to increase carbon sequestration and reduce greenhouse gas emissions in and on farms, forests, grasslands, wetlands, and urban lands. She said the intent is to identify solutions and long-term actions.

She said the scoping document was released in December 2021. She said the targeted stakeholder sessions were held in spring 2023. She said the sessions were for aquatic habitats and wetlands, developed lands, agricultural lands, and forested lands. She said Commission staff attended each session. Ms. Grogan said that a final NWLS document is due to be released in September 2023.

She said the sessions were conducted by NJDEP and had many people in attendance. She said there is a NWLS website (<https://www.nj.gov/dep/climatechange/mitigation/nwls.html>) that details the numerous recommendations presented in the sessions. She said the presentations included targets for the recommendations.

She said that while there may not be information listed as Pinelands specific, there will likely be recommendations that will be helpful to the Commission.

In response to Chairman Lohbauer's inquiry as to the topic of cannabis cultivation during the agricultural session, Ms. Berg, the Commission's Planning Specialist, said that the only mention was regarding water use concerns.

In response to Chairman Lohbauer's question as to whether Commission action will be required in response to this strategy, Ms. Grogan said that formal action may not be necessary.

Commissioner Avery expressed concern that some recommendations may conflict with Pinelands standards.

4. Update on office initiatives

Ms. Grogan said that a request for quotes (RFQ) was issued for the purchase of two vehicles. She said the RFQ outlined the specifications required, such as electric or hybrid powered. She said the responses are due April 21, 2023. She said the RFQ was issued to vendors on state contract and a variety of other dealerships in the area. She said the RFQ also specifies the need for the vehicle to be available within 90 days to prevent an offer for a vehicle with a long wait.

Chairman Lohbauer suggested the Commission should consider selecting an electric vehicle. He said an electric vehicle supports the mission of the Committee. He also said the selection of a

hybrid vehicle would add additional years of fossil fuel consumption. He mentioned that the Ford F-150 Lightning and Rivian R1 meet the specifications needed for field use.

Ms. Grogan said the RFQ specifies both electric and hybrid vehicles to gain insight on the availability of those vehicles.

Commission Chair Matos agreed on the significance of selecting an electric vehicle. She commented that the current inability to charge the vehicle on the Commission grounds and limited charging locations in the area may be an issue.

Ms. Grogan said that a grant application will be sent to the Board of Public Utilities (BPU) to fund the purchase and installation of electric vehicle charging stations. She said the BPU recommended the Commission apply for and install a community charging station that would be available to the public. She said the Commission is seeking funding for the installation of two fast-charging stations.

She said the grant application is due by May 12, 2023 but it is not clear when the grant decisions will be made.

She also said fast-charging stations in the area are few and far between. She expressed concern regarding the difficulty that may arise if the staff needs to use an off-site, slow-charging facility for charging Commission field vehicles on a daily basis.

Commissioner Avery inquired about the cost of installing a community charging station. Ms. Grogan said the grant would provide funding for the charging station itself as well as \$25,000-\$35,000 in make ready costs. She said there will be other expenses for improvements associated with the installation of the stations.

In response to Commissioner Avery's question regarding protocol for installing a charging station, Ms. Grogan said that other agencies have already installed charging stations that can be used as an example of the process. She also said there is a list of state-approved contractors for the installation of the stations.

Commission Chair Matos said there is also guidance being provided to municipalities that could be used to guide the Commission in the process.

Chairman Lohbauer said a community charging station may encourage more people to visit the Commission. He mentioned that the process to install a private charging station at his home took about five weeks.

Ms. Grogan said that the Commission may be financially responsible for associated improvements to facilitate the installation of the chargers. She said funds have been set aside in the Energy Conservation Reserve for this expense.

At 10:09 Janice Venables from the Governor's Authorities Unit joined the meeting and Tom Holl exited.

Ms. Grogan outlined the proposed topics for upcoming meetings. She said that dual-use solar legislation and identification of Pinelands Comprehensive Management Plan (CMP) amendments for solar facilities could be discussed at the May 17, 2023 meeting. She said the

July 19, 2023 meeting could focus on the results of the management area boundary analysis and discuss recommendations. She said that proposed CMP solar facility amendments could be discussed at the September 20, 2023 meeting.

She said that there are less staff resources available for additional research due to a staff member's retirement. She said the Commission is seeking to hire a Climate Resiliency Coordinator.

Chairman Lohbauer commented that he was impressed to see the use of solar facilities on active farmland. Ms. Grogan said that the staff would like to have BPU make a presentation to discuss the possibility of dual use solar in the Pinelands.

In response to Commissioner Avery's question regarding presentation of proposed CMP amendments, Ms. Grogan said they could be presented to this Committee or to the Policy and Implementation (P&I) Committee due to the committees having most of the same members.

Chairman Lohbauer commented that while the members are similar for both committees, there is a difference in the matters each committee focuses on.

5. Pinelands management area boundary analysis

Ms. Berg delivered a presentation on the Pinelands management area boundary analysis (*attached to these minutes*).

She said that an analysis of Pinelands management area boundaries was identified as a fiscal year 2023 priority for the Committee. She said the purpose of the analysis is to identify areas within Regional Growth Areas (RGA), Pinelands Towns (PT), and Pinelands Villages (PV) that are vulnerable to climate change.

She said the analysis would be based on maps of risks, uses and threatened and endangered (T&E) species. She said the categories of data are flood hazards, wildfire hazards, T&E species, preserved land, existing land use/land cover, and municipal zoning.

Ms. Berg said the flood hazard map is provided by NJ Flood Mapper/Rutgers University. She said the data is from 2020. She said it includes flood insurance rate map data. She said the map also has inundation data for a five-foot sea-level rise used to assess flood risk.

In response to a question from Chairman Lohbauer, Ms. Berg said the five-foot sea-level data was obtained from an identified "perfect storm" scenario. She said the Flood Mapper tool allows the user to select storm scenarios for mapping. She said the parameters were discussed during prior Committee meetings.

She said that the wildfire risk mapping was provided by the National Aeronautics and Space Administration (NASA) and closely matches Commission data.

She said that wildfire risk is assessed based on several factors including vegetative cover and remoteness/ease of access. She said the five categories are extremely low, low, moderate, high, and extremely high. She said the evaluation focused on high and extremely high areas.

In response to a question from Commissioner Avery regarding mapping from NJDEP, Ms. Berg said the NASA data was used because it is more defined.

Ms. Berg said the location, ranges and migration of T&E species will be considered in the analysis.

She said additional factors will be included in the analysis, such as preserved land, land use/land cover data, and zoning.

She said that an overlay of all the data will be used to identify potential management area boundary changes. She said potential actions that may result from this analysis are amendments to the Pinelands Land Capability Map, municipal zoning boundaries, reductions in permitted development intensities, new or amended CMP environmental standards, and targeted land acquisition/preservation.

She said the next steps are to complete identification and analysis of areas potentially impacted with information being presented at the July Committee meeting. She said priorities will be identified for a round of permanent land protection. She also said any potential CMP amendments for management area boundary changes would be brought to the P&I Committee for review.

Charles Horner, the Commission's Director of Regulatory Programs, delivered a presentation on CMP fire hazard mitigation standards (attached to these minutes).

Mr. Horner said the CMP requires all residential development of 100 dwelling units or more in high or extremely high hazard areas to have a 200-foot perimeter fuel break between all structures and the forest. Within the fuel break, shrubs, understory trees and bushes, and groundcover are to be selectively removed, mowed or pruned and maintained. He said that it does not require clear cutting.

He said the application that was mentioned in a previous management report is in the RGA. He said the fire hazard mitigation standards apply to all management areas. He said when the application was initiated in 2001 there was less development in the area. He said at the time, the 200-foot fuel break was required for the application. He said the proposed development consists of about 250 dwelling units on 115 acres of land.

He said that in the years after the application, other development consistent with CMP rules has occurred in the area.

Mr. Horner said the town contacted the Commission with concerns about the fuel break. He said the town implemented it through an easement. The town inquired as to whether relief could be sought from the easement. The Commission's review determined that the town would be responsible for granting relief.

He said the Commission receives many questions regarding CMP language requiring the fire break to be between all structures and the forest. He said the question arises as to what is considered a forest. He said that the issue concerns the current status of the proposed 115 acre development in regard to the location of forests in the area, as the area has changed over time due to other development.

He said that the fuel break determination is made on a case-by-case basis. He said some municipalities have determined that a fuel break would not be required. He said that Commission staff also contact fire officials for guidance in making the determination.

Chairman Lohbauer expressed concern regarding the maintenance of a fuel break in a high risk area being the only requirement for a large residential development. Mr. Horner replied that there are additional fire hazard mitigation standards such as development of 25 units or more requiring at least two access points. He mentioned another standard being the requirement for turn-around areas at dead-ends of roads to be large enough to accommodate emergency vehicles.

Commissioner Avery asked how often the perimeter fuel break standard is applied to large residential development. Ms. Grogan replied that the Commission receives relatively few proposals of that size; most applications for residential development are for much smaller numbers of units.

Chairman Lohbauer suggested that consideration be made when analyzing management area boundaries to avoid locating large residential development projects in a high fire risk area.

6. Public comment


Heidi Yeh, from the Pinelands Preservation Alliance (PPA), suggested the Commission pursue both community and residential type electric vehicle charging equipment. She said it may encourage staff to purchase electric vehicles for personal use that could be charged while they work.

Ms. Yeh also recommended the Committee work with the Pinelands Municipal Council to help town leaders to discuss climate matters. She said NJDEP provides information to towns but the Council seems to be underutilized.

She encouraged the Commissioners to attend a climate forum being hosted by the PPA on May 19th.

There being no further discussion, Commission Chair Matos moved the closing of the meeting. Commissioner Avery seconded the motion. The meeting concluded at 10:56 a.m.

Certified as true and correct:



Dawn Holgersen
Office Assistant
June 21, 2023

Climate Committee Update: State and Office Initiatives



1

Interagency Council on Climate Resilience

- Extreme Heat Resilience Action Plan
 - Analysis of survey results (DEP consultants)
 - Compilation of initial actions identified by state agencies
 - “50% draft homework” due May 17

2

Natural and Working Lands Strategy

- Partnership between NJDEP and the NJ Department of Agriculture
- Goal: increase carbon sequestration and reduce greenhouse gas emissions in and on farms, forests, grasslands, wetlands and urban lands
- Identify and prioritize near-term, cost-effective and pragmatic solutions, as well as longer-term actions

3

Process and Timeline

- Scoping Document released – December 2021
- Targeted Stakeholder Sessions – Spring 2023
 - Aquatic Habitats, Tidal and non-Tidal Wetlands
 - Developed Lands
 - Agricultural Lands
 - Forested Lands
- Final NWLS Strategy released –September 2023

4

March 2023 Stakeholder Sessions

- Numerous recommendations listed
- Targets for 2030 and 2050 identified
 - (e.g., # of new rain gardens)

5

Office Initiatives

- Electric/hybrid field vehicles (2)
 - RFQ issued
 - Specifications identified
 - Responses due by April 21
- EV charging station
 - Community charging facility
 - Two DCFC (fast charging) stations
 - Grant application due to BPU by May 12

6

Upcoming Committee meetings

- May 17
 - Discussion of new dual use solar legislation
 - Identification of CMP amendments for solar energy facilities
- July 19
 - Results of management area boundary analysis
 - Discussion of recommendations
- September 20
 - Proposed CMP solar facility amendments

7

Pinelands Management Area Boundary Assessment for Climate Risks

PINELANDS CLIMATE COMMITTEE
APRIL 19, 2023

1

FY 2023 CLIMATE COMMITTEE PRIORITIES

- ▶ Amendments to CMP solar energy facility standards
- ▶ Analysis of Pinelands Management Area boundaries to identify areas within Regional Growth Areas, Pinelands Towns and Pinelands Villages that are vulnerable to climate change

2

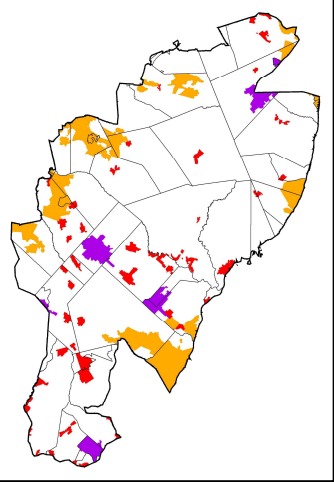
GIS-based analysis: Risks, Uses, T&E

Flood Hazards	Wildfire Hazards	Threatened & Endangered Species
Preserved Land	Existing Land Use/Land Cover	Municipal Zoning

3

Growth-Oriented Management Areas

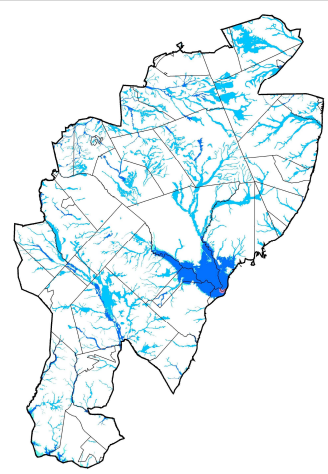
- 24 municipalities with Regional Growth Areas (orange)
- 7 Pinelands Towns (purple)
- 47 Pinelands Villages (red)



4

Flood Hazard Layers

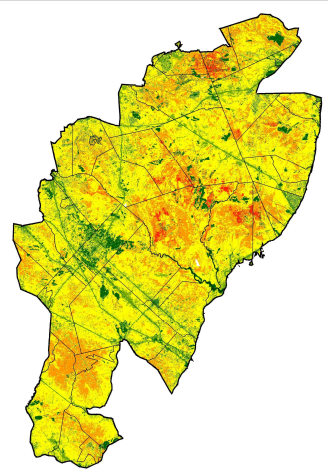
- Source: NJ Flood Mapper/Rutgers University
- Composite FIRM Data 2020 (shown)
 - Combination of effective and preliminary mapping data from 2020
 - Produced by FEMA for Flood Insurance Rate Maps (FIRMs)
 - National standard for quantifying current flood hazards
- Mean Higher High Water
 - Inundated coastal areas under future sea level rise scenarios
 - Inundation in hydrologically disconnected low-lying areas
 - The 5-foot SLR scenario mapping



5

Wildfire hazard layer


- Source: NASA/NJPC
- Fire Risk Assessment Map
 - Determines wildfire risk based on several factors, including vegetative cover and remoteness/ease of access
 - Five categories of risk:
 - Extremely Low (dark green)
 - Low (light green)
 - Moderate (yellow)
 - High (orange)
 - Extremely High (red)
 - Evaluation focused on "High" and "Extremely High" areas



6


Threatened & Endangered Species

- ▶ Sources: NJDEP, NJPC
 - ▶ NJDEP's Endangered and Nongame Species Program
 - ▶ Commission Staff Records
- ▶ Ranges
- ▶ Migration

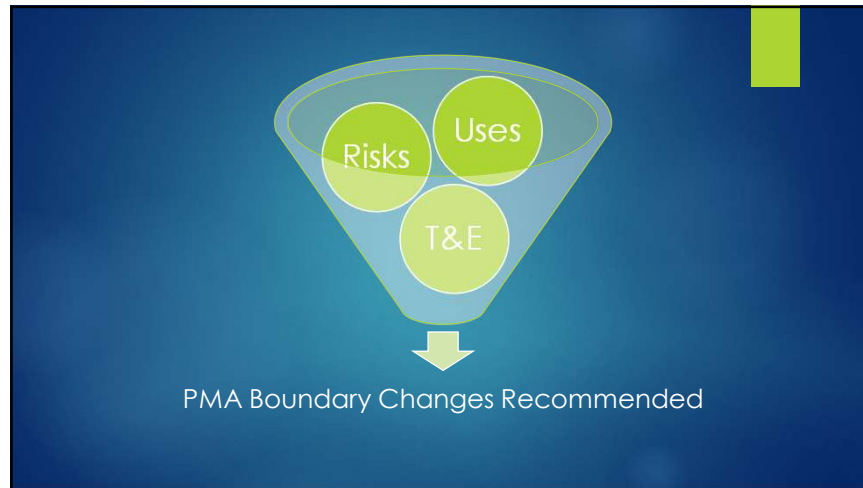


7

Additional factors -Use

 <p>Preserved Land</p> <p>PCF Acquisitions PDC Severances Farmland Preservation Open Space 502 & 20 Target Areas for land protection</p>	 <p>Land Use/Land Cover Data</p> <p>Vacant vs. Developed Wetland vs. Upland</p>	 <p>Zoning</p> <p>Types of Development Redevelopment Areas Adjacent Management Areas</p>
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8



9

- ## Potential Actions
- ▶ Amendments to the Pinelands Land Capability Map
 - ▶ Redesignation of management areas from growth-oriented to conservation-oriented
 - ▶ Municipal rezonings or reductions in permitted development intensities
 - ▶ New or amended CMP environmental standards
 - ▶ Targeted land acquisition/preservation
 - ▶ Pinelands Conservation Fund
 - ▶ Green Acres
 - ▶ Non-Profits

10

- ## Next Steps
- ▶ Complete identification and analysis of areas potentially impacted – May 2023
 - ▶ Climate Committee discussion of staff findings and recommendations – July 2023
 - ▶ Permanent Land Protection Round priorities
 - ▶ P&I Committee review of potential CMP amendments for PMA boundaries

11

questions & comments?

12

CMP Fire Hazard Mitigation Standards N.J.A.C. 7:50-6.124(a)

5. All residential development of 100 dwelling units or more in high or extreme high hazard areas will have a 200-foot perimeter fuel break between all structures and the forest in which:

- i. Shrubs, understory trees and bushes groundcover are selectively removed, mowed or pruned and maintained on an annual basis;
- ii. All dead plant material is removed;
- iii. Roads, rights-of-way, wetlands and waste disposal sites shall be used as fire breaks to the maximum extent practical;
- iv. There is a specific program for maintenance.

1



2

CHAPTER 170

AN ACT concerning dual-use solar energy projects on unreserved farmland, supplementing P.L.1999, c.23 (C.48:3-49 et al.) and P.L.1964, c.48 (C.54:4-23.1 et seq.), and amending P.L.2009, c.213.

BE IT ENACTED by the Senate and General Assembly of the State of New Jersey:

C.48:3-87.13 Rules, regulations for “Dual-Use Solar Energy Pilot Program.”

1. a. No later than 180 days after the date of enactment of P.L.2021, c.170 (C.48:3-87.13 et al.), the Board of Public Utilities, in consultation with the Secretary of Agriculture, shall adopt, pursuant to the “Administrative Procedure Act,” P.L.1968, c.410 (C.52:14B-1 et seq.), rules and regulations establishing a “Dual-Use Solar Energy Pilot Program” to permit the construction, installation, and operation of dual-use solar energy projects that are connected to the distribution or transmission system owned or operated by a New Jersey public utility or local government unit and located on unreserved farmland, while maintaining the affected land in active agricultural or horticultural use.

b. The rules and regulations developed by the board, in consultation with the Secretary of Agriculture, for the Dual-Use Solar Energy Pilot Program shall establish:

(1) a 10 megawatt, as measured in direct current, capacity limit for each individual dual-use solar energy project;

(2) annual capacity targets, such that the total capacity of all dual-use solar energy projects approved under the pilot program shall not exceed 200 megawatts, as measured in direct current, for all dual-use solar energy projects approved under the pilot program, except as otherwise provided pursuant to subsection e. of this section;

(3) financial incentives available to dual-use solar energy projects approved pursuant to the pilot program;

(4) a prohibition on siting a dual-use solar energy project on prime agricultural soils and soils of Statewide importance, as identified by the United States Department of Agriculture's Natural Resources Conservation Service, which are located in Agricultural Development Areas certified by the State Agriculture Development Committee, unless the project is in association with a research study undertaken in coordination with a New Jersey public research institution of higher education, as approved by the board in consultation with the Secretary of Agriculture;

(5) a prohibition on siting a dual-use solar energy project on any of the following unless the board, in consultation with the Department of Environmental Protection and the Secretary of Agriculture, grants a waiver based on unique factors that make the project consistent with the character of the specific parcel:

(a) land located within the preservation area of the pinelands area, as designated in subsection b. of section 10 of P.L.1979, c.111 (C.13:18A-11);

(b) land designated as forest area in the pinelands comprehensive management plan adopted pursuant to P.L.1979, c.111 (C.13:18A-1 et seq.);

(c) land designated as freshwater wetlands, as defined pursuant to P.L.1987, c.156 (C.13:9B-1 et seq.), or coastal wetlands, as defined pursuant to P.L.1970, c.272 (C.13:9A-1 et seq.); or

(d) land located within the Highlands preservation area as designated in subsection b. of section 7 of P.L.2004, c.120 (C.13:20-7);

(6) the requirement that the land on which the dual-use solar energy project is installed continues to be actively devoted to agricultural or horticultural use;

(7) the requirement that the project comply with all applicable federal, State, or local laws, rules, regulations, or ordinances;

(8) an application process for owners who wish to develop a dual-use solar energy project as part of the pilot program, including such fees or deposits as shall be determined by the board; and

(9) criteria, consistent with the provisions of paragraph (1) of subsection c. of this section, for evaluating and scoring proposed projects to determine which projects should be allowed to participate in the pilot program and be awarded incentives pursuant to paragraph (3) of this subsection.

c. (1) An owner proposing a dual-use solar energy project shall submit an application to the board before constructing, installing, or operating the project. The board shall consult with the Secretary of Agriculture in the review and approval of all dual-use solar energy projects under the Dual-Use Solar Energy Pilot Program. In reviewing and making decisions on dual-use solar energy projects, the board and secretary shall give consideration to criteria including, but not limited to:

- (a) proposals for monitoring the quality of agricultural or horticultural use of the land;
- (b) the incentive level sought by the applicant;
- (c) geographic location;
- (d) interconnection planning;
- (e) proposals for minimizing negative impacts to farmland;
- (f) proposals to address decommissioning;
- (g) proposals for addressing stormwater runoff and other environmental issues;
- (h) technical feasibility;
- (i) technical innovation;
- (j) the quality of any research committed to during the evaluation period; and
- (k) any other criteria as may be deemed advisable by the board.

The review shall also consider whether the selected projects are of varying sizes, and, collectively, involve diverse types of agricultural and horticultural production. The board, in consultation with the Secretary of Agriculture, shall, within 180 days after receipt, approve, disapprove, or approve with conditions an application submitted pursuant to this section.

(2) An owner who receives approval from the board pursuant to this section shall obtain all necessary permits and other approvals as may be required pursuant to federal, State, or local law, rule, regulation, or ordinance, prior to the construction of the dual-use solar energy project.

d. The Secretary of Agriculture may request that the board suspend or revoke an approval issued pursuant to this section for a violation of any term or condition of the approval or any provision of this section.

e. The Dual-Use Solar Energy Pilot Program shall continue for 36 months after the adoption of the rules and regulations required pursuant to subsection a. of this section, except that the board may extend the pilot program by no more than two additional 12-month periods if the board, in consultation with the Secretary of Agriculture, determines that such extensions are necessary to adequately evaluate the performance of the projects selected for construction as part of the Dual-Use Solar Energy Pilot Program. If the board extends the Dual-Use Solar Energy Pilot Program, it may increase the total capacity limit of all projects under the program by no more than 50 megawatts, as measured in direct current, per additional 12-month period.

f. Notwithstanding any law, ordinance, rule, or regulation to the contrary, a dual-use solar energy project approved pursuant to this section shall be a permitted use within every municipality.

g. No later than 36 months, or no later than 48 or 60 months if applicable due to extensions of the Dual-Use Solar Energy Pilot Program pursuant to subsection e. of this section, after adoption of the rules and regulations required pursuant to subsection a. of this section, the board, in consultation with the Secretary of Agriculture, shall adopt rules and regulations, pursuant to the “Administrative Procedure Act,” P.L.1968, c.410 (C.52:14B-1 et seq.), to convert the Dual-Use Solar Energy Pilot Program to a permanent program as part of the permanent successor to the solar incentive program established pursuant to P.L.2021, c.169 (C.48:3-114 et al.). The rules and regulations for the permanent program shall set forth standards for dual-use solar energy projects that take into account the results of the pilot program and any research studies on the efficacy of dual-use solar energy in New Jersey, and shall include, but not be limited to:

- (1) a capacity limit for individual dual-use solar energy projects;
- (2) a total annual capacity limit;
- (3) provisions to protect New Jersey’s prime agricultural soils and soils of Statewide importance, as identified by the United States Department of Agriculture’s Natural Resources Conservation Service, which are located in Agricultural Development Areas certified by the State Agriculture Development Committee, and provisions to protect the State’s agricultural and horticultural diversity;
- (4) standards for: installation and decommissioning techniques that minimize negative impacts to farmland, which may include the posting of a performance bond for decommissioning; impervious coverage; and water management, including, but not limited to, water recapture and filtration;
- (5) provisions to ensure the continued active agricultural or horticultural use of land on which dual-use solar energy projects are installed;
- (6) siting criteria and restrictions, which may differ from those established pursuant to section 6 of P.L.2021, c.169 (C.48:3-119) to the extent necessary to accomplish the purposes of the dual-use solar energy program; and
- (7) an application process, including such fees, escrows, or deposits as shall be determined by the board.

h. As used in this section:

“Dual-use solar energy project” means the energy generation facilities, structures, and equipment for the production of electric power from solar photovoltaic panels located on unreserved farmland in agricultural or horticultural production that ensures the continued simultaneous use of the land below and adjacent to the panels for agricultural or horticultural production.

“Owner” means the owner of the unreserved farmland, the owner of the dual-use solar energy project, or a representative duly authorized to act on the owner’s behalf.

“Preserved farmland” means the same as the term is defined in section 4 of P.L.2009, c.213 (C.54:4-23.3c).

“Unreserved farmland” means any land that is valued, assessed, and taxed pursuant to the “Farmland Assessment Act of 1964,” P.L.1964, c.48 (C.54:4-23.1 et seq.), and is not preserved farmland.

C.54:4-23.3e Land used not considered in agricultural, horticultural use.

2. a. No land used for a dual-use solar energy project constructed, installed, and operated pursuant to the Dual-Use Solar Energy Pilot Program established pursuant to section 1 of P.L.2021, c.170 (C.48:3-87.13) shall be considered land in agricultural or horticultural use or actively devoted to agricultural or horticultural use for the purposes of

the “Farmland Assessment Act of 1964,” P.L.1964, c.48 (C.54:4-23.1 et seq.), except as provided in this section.

b. Land used for a dual-use solar energy project constructed, installed, and operated pursuant to section 1 of P.L.2021, c.170 (C.48:3-87.13) may be eligible for valuation, assessment, and taxation pursuant to P.L.1964, c.48 (C.54:4-23.1 et seq.), provided that:

(1) the dual-use solar energy project is located on unreserved farmland that is continuing to be in operation as a farm in the tax year for which the valuation, assessment, and taxation pursuant to P.L.1964, c.48 (C.54:4-23.1 et seq.) is applied for;

(2) in the tax year preceding the construction, installation, and operation of the dual-use solar energy project, the acreage used for the dual-use solar energy project was valued, assessed, and taxed as land in agricultural or horticultural use;

(3) the land on which the dual-use solar energy project is located continues to be actively devoted to agricultural and horticultural use, and meets the income requirements set forth in section 5 of P.L.1964, c.48 (C.54:4-23.5);

(4) the approval issued for the dual-use solar energy project by the Board of Public Utilities pursuant to section 1 of P.L.2021, c.170 (C.48:3-87.13) has not been suspended or revoked; and

(5) all other requirements of P.L.1964, c.48 (C.54:4-23.1 et seq.) are met.

c. No generated energy from a dual-use solar energy project shall be considered an agricultural or horticultural product, and no income from any power sold from the dual-use solar energy project may be considered income for eligibility for valuation, assessment, and taxation of land pursuant to P.L.1964, c.48 (C.54:4-23.1 et seq.).

d. Within one year after the date of enactment of P.L.2021, c.170 (C.48:3-87.13 et al.), the Division of Taxation, in consultation with the Secretary of Agriculture and the Board of Public Utilities, shall:

(1) adopt, pursuant to the “Administrative Procedure Act,” P.L.1968, c.410 (C.52:14B-1 et seq.), such rules and regulations as may be necessary for the implementation and administration of this section; and

(2) incorporate information concerning dual-use solar energy projects into the guidelines provided, and the continuing education course offered, to municipal tax assessors, county assessors, county tax administrators, and other appropriate local government officials pursuant to section 1 of P.L.2013, c.43 (C.54:4-23.3d).

e. As used in this section:

“Dual-use solar energy project” means the same as the term is defined in section 1 of P.L.2021, c.170 (C.48:3-87.13).

“Preserved farmland” means the same as the term is defined in section 4 of P.L.2009, c.213 (C.54:4-23.3c).

“Unreserved farmland” means the same as the term is defined in section 1 of P.L.2021, c.170 (C.48:3-87.13).

3. Section 4 of P.L.2009, c.213 (C.54:4-23.3c) is amended to read as follows:

C.54:4-23.3c Land use for taxation purposes.

4. a. (1) No land used for biomass, solar, or wind energy generation shall be considered land in agricultural or horticultural use or actively devoted to agricultural or horticultural use for the purposes of the “Farmland Assessment Act of 1964,” P.L.1964, c.48 (C.54:4-23.1 et seq.), except as provided in this section or, in the case of unreserved farmland used

for a dual-use solar energy project, as provided in section 1 of P.L.2021, c.170 (C.48:3-87.13).

(2) No generated energy from any source shall be considered an agricultural or horticultural product.

b. Land used for biomass, solar, or wind energy generation may be eligible for valuation, assessment and taxation pursuant to P.L.1964, c.48 (C.54:4-23.1 et seq.), provided that:

(1) the biomass, solar, or wind energy generation facilities, structures, and equipment were constructed, installed, and operated on property that is part of an operating farm continuing to be in operation as a farm in the tax year for which the valuation, assessment and taxation pursuant to P.L.1964, c.48 (C.54:4-23.1 et seq.) is applied for;

(2) in the tax year preceding the construction, installation, and operation of the biomass, solar, or wind energy generation facilities, structures, and equipment on an operating farm, the acreage used for the biomass, solar, or wind energy generation facilities, structures, and equipment was valued, assessed and taxed as land in agricultural or horticultural use;

(3) the power or heat generated by the biomass, solar, or wind energy generation facilities, structures, and equipment is used to provide, either directly or indirectly but not necessarily exclusively, power or heat to the farm or agricultural or horticultural operations supporting the viability of the farm;

(4) the owner of the property has filed a conservation plan with the soil conservation district, with provisions for compliance with paragraph (5) of this subsection where applicable, to account for the aesthetic, impervious coverage, and environmental impacts of the construction, installation, and operation of the biomass, solar, or wind energy generation facilities, structures, and equipment, including, but not necessarily limited to, water recapture and filtration, and the conservation plan has been approved by the district;

(5) where solar energy generation facilities, structures, and equipment are installed, the property under the solar panels is used to the greatest extent practicable for the farming of shade crops or other plants capable of being grown under such conditions, or for pasture for grazing;

(6) the amount of acreage devoted to the biomass, solar, or wind energy generation facilities, structures, and equipment does not exceed a ratio of one to five acres, or portion thereof, of land devoted to energy generation facilities, structures, and equipment and land devoted to agricultural or horticultural operations;

(7) biomass, solar, or wind energy generation facilities, structures, and equipment are constructed or installed on no more than 10 acres of the farmland for which the owner of the property is applying for valuation, assessment and taxation pursuant to P.L.1964, c.48 (C.54:4-23.1 et seq.), and if power is being generated, no more than two megawatts of power are generated on the 10 acres or less; and

(8) for biomass energy generation, the owner of the property has obtained the approval of the Department of Agriculture pursuant to section 5 of P.L.2009, c.213 (C.4:1C-32.5).

c. No income from any power or heat sold from the biomass, solar, or wind energy generation may be considered income for eligibility for valuation, assessment and taxation of land pursuant to the "Farmland Assessment Act of 1964," P.L.1964, c.48 (C.54:4-23.1 et seq.), and, notwithstanding the provisions of that act, or any rule or regulation adopted pursuant thereto, to the contrary, there shall be no income requirement for property valued, assessed and taxed pursuant to subsection b. of this section.

d. Notwithstanding any provision of this section, section 3 of P.L.1964, c.48 (C.54:4-23.3), or section 4 of P.L.1964, c.48 (C.54:4-23.4) to the contrary, the construction,

installation, or operation of any biomass, solar, or wind energy generation facility, structure, or equipment in the pinelands area, as defined and regulated by the “Pinelands Protection Act,” P.L.1979, c.111 (C.13:18A-1 et seq.), shall comply with the standards of P.L.1979, c.111 and the comprehensive management plan for the pinelands area adopted pursuant to P.L.1979, c.111.

e. The Division of Taxation, in consultation with the Department of Agriculture, shall adopt, pursuant to the “Administrative Procedure Act,” P.L.1968, c.410 (C.52:14B-1 et seq.), such rules and regulations as may be necessary for the implementation and administration of this section.

f. For the purposes of this section:

“Biomass” means an agricultural crop, crop residue, or agricultural byproduct that is cultivated, harvested, or produced on the farm, or directly obtained from a farm where it was cultivated, harvested, or produced, and which can be used to generate energy in a sustainable manner, except with respect to preserved farmland, “biomass” means the same as that term is defined in section 1 of P.L.2009, c.213 (C.4:1C-32.4).

“Dual-use solar energy project” means the same as the term is defined in section 1 of P.L.2021, c.170 (C.48:3-87.13).

“Land used for biomass, solar, or wind energy generation” means the land upon which the biomass, solar, or wind energy generation facilities, structures, and equipment are constructed, installed, and operated. In the case of biomass energy generation, “land used for biomass, solar, or wind energy generation” shall not mean the land upon which agricultural or horticultural products used as fuel in the biomass energy generation facility, structure, or equipment are grown. “Land used for biomass, solar, or wind energy generation” shall not include land used for a dual-use solar energy project.

“Preserved farmland” means land on which a development easement was conveyed to, or retained by, the State Agriculture Development Committee, a county agriculture development board, or a qualifying tax exempt nonprofit organization pursuant to the provisions of section 24 of P.L.1983, c.32 (C.4:1C-31), section 5 of P.L.1988, c.4 (C.4:1C-31.1), section 1 of P.L.1989, c.28 (C.4:1C-38), section 1 of P.L.1999, c.180 (C.4:1C-43.1), sections 37 through 40 of P.L.1999, c.152 (C.13:8C-37 through C.13:8C-40), or any other State law enacted for farmland preservation purposes.

“Unpreserved farmland” means the same as the term is defined in section 1 of P.L.2021, c.170 (C.48:3-87.13).

4. This act shall take effect immediately.

Approved July 9, 2021.

New Jersey Agrivoltaic (Dual-Use, AgPV) Stakeholder Brief

Stakeholder Activity

To date stakeholders have met several times over zoom and once in person during the Rutgers University Agrivoltaics Roundtable in May 2022. Building on the Department of Energy's FARMS award to Rutgers University, there is significant interest and enthusiasm amongst the solar and agricultural communities and public institutions for the pilot program to be successful and a source of information for solar going forward in New Jersey. This brief will outline the learnings from other state programs, European efforts, and recommendations that stakeholders have found consensus on in terms of the structure of the program. Lightstar Renewables, BlueWave, the American Farmland Trust, and the New Jersey Farm Bureau have collaborated on the proposed structure of the program and our hope is that we can provide initial context to expedite the Board's straw proposal process.

Program Structure and Stakeholder Consensus Recommendations

The stakeholders involved in this brief would like to see the program operate with both flexibility and rigor. The pilot program is an opportunity for New Jersey to demonstrate a diversity of system designs, operational approaches, and farmer engagement strategies in order to better understand how agrivoltaics can work for farmers at commercial scale. The BPU should incentivize a diversity of crops in addition to hay/forage and livestock grazing, while allowing for standardized design requirements that will minimize ratepayer costs.

Structure and Permanent Program Connection

The dual-use program should aim to mirror the community solar permanent program structural requirements as much as possible so there can be a seamless absorption of the pilot into the permanent program structure. This keeps administrative burden to a minimum and allows for familiarity and certainty for developers and farmers.

Our preferred approach for any solar program is to award capacity through a first-come-first-serve allocation. For the dual-use pilot program, project selection may be preceded by review from Rutgers to assure that the pilot program spans a diversity of designs, approaches, and farm plans. We recommend that the Board request basic and non-binding project information (such as size, location, initial farm plan and PV design) from developers prior to the opening of the pilot program in order to assess the potential market. After discussion with the Agricultural Extension, stakeholders have agreed that Rutgers would be an ideal clearing house to collect this information from developers. If the desired variety of projects is not immediately available, we recommend reserving a portion of the pilot program capacity for the desired project type(s). This

approach could be further expanded as needed to provide enhanced incentives for more intensive, and therefore costly, project designs.

The following are additional recommendations to consider for the BPU's straw proposal development process:

- **Agricultural Eligibility:** Under any capacity allocation approach, Rutgers Extension should certify that farm plans for each project are based on farmer input and viable (crops could grow, contingency plans for additional crop applications) for participation in the program.
- **Compliance:** Projects will be eligible for farmland tax assessment and should projects fall out of compliance, a cure period should be allowed. Continued noncompliance will result in both loss of farmland assessment and incentive. Additionally:
 - Documentation should be monitored annually, and modified throughout the pilot program by the Agricultural Extension and/or equipped third parties.
 - Annual reporting beyond the agricultural tax assessment should contribute to the Extension's body of research, not used for compliance.
 - The role of the Extension and the Commission should be to establish a farm logistics form (submitted annually) that ensures that the parcel remains in production.
- **Incentive:** Dual-use projects should be compensated with an adder (similar to the public entities adder) under the ADI program. In order to expand affordable access to clean energy and minimize ratepayer costs, qualified dual-use projects should be able to apply for the community solar permanent program to serve community solar and low-income offtakers. This will allow a single project to achieve multiple policy goals by providing savings to low-income customers and preserving the state's agricultural land.
 - Dual-use projects would be eligible for net metered or community solar incentives based on offtake mix.
 - Each incentive covers the marginal cost of that activity (e.g. enrolling LMI subscribers, raising panels for tractor access) while remaining under New Jersey's Cost Cap.
 - Dual-use would be an acceptable land use within the community solar permanent program, with the goal to combine both permanent programs.
 - Capacity drawn from the 200 MW dual-use pilot block.
 - Pre-qualification requirements to articulate preference for diverse selection of dual-use systems in pilot program in terms of agricultural function and design (e.g. specialty crops, sheep grazing, hay), project capacity (MW), diversity of farmer participants (landowner, service provider, tenants).

- Demonstrated developer expertise necessary to develop, operate dual-use projects, including list of comparable projects in New Jersey or other markets (if applicable).

Existing Examples of Ratepayer Neutral Agrivoltaic Incentives and Compliance

In 2022, Maryland established a provision, without the use of a specific AgPV pilot program, to exempt personal property from county or municipal property tax if the property is machinery or equipment that is part of a community solar system and sited as agrivoltaics. The tax assessments, performed to ensure that a project meets all necessary requirements to be exempted from taxes, are a much needed and efficient method of compliance for AgPV. Such compliance checks prevent developers from poorly executing AgPV and ensure farmers and municipal requirements are protected during the development process. Tax exemption also provides an incentive, not tied to ratepayer funds, for farmers and developers to choose AgPV as a preferred siting mechanism.

Massachusetts has a similar method of compliance. Land in active agricultural or horticultural use is also entitled, under [M.G.L. c. 61A](#) (“Chapter 61A”), to reduced property tax rates. Additionally, after the passage of legislation in 2022, AgPV projects do not need to go through a special permitting process and any code enforcement officer will accept AgPV projects as a standard agricultural project. Since these projects are now deemed to have the same benefits as general agriculture, this means that setbacks, fencing, and other provisions found in bylaws regarding solar do not apply to AgPV projects unless the town can prove that it negatively impacts the health and safety of residents. In such reviews of health and safety, towns cannot consider metrics such as aesthetics, view shed, character, property value, and noise.

Local Regulation and Permitting

Recommendations for New Jersey

In New Jersey, the legislation enabling the dual-use program specified that:

- [C.48:3-87.13 \(1\) \(f\)](#) *Notwithstanding any law, ordinance, rule, or regulation to the contrary, a dual-use solar energy project approved pursuant to this section shall be a permitted use within every municipality.*

State regulations, as seen in Massachusetts, should pre-empt solar design standards in local ordinances, and pre-empt solar permitting regulations. In compliance with the law copied above, we recommend using agricultural permitting standards for wetlands, historic, and scenic impacts. Setbacks should be minimally required for agricultural management of border areas, i.e., fence construction and maintenance.

We also urge the BPU to provide guidance on agrivoltaics to municipalities regarding agrivoltaics and its benefits to communities. During permitting discussions with towns across the state, town officials have expressed the need for clarity from the BPU about specific parameters for AgPV projects. This ask for state endorsement of and guidance around AgPV underscores the need for an expedited implementation of the 2021 law.

Recommendations for Standardization of Projects in the Dual-Use Pilot Program

Layout & Configuration

- If fencing, fence the field, not the array, in order for proper maneuvering of agricultural machinery and to minimize impacted acreage.
- Agriculturally compatible fencing should be used (e.g. suitable for grazing livestock as applicable).
- 25' minimum clearance between racks/tables and parallel fences
- 40' minimum clearance between racks/tables and perpendicular fences to allow turns
- 25' minimum width travel lanes to access all portions of array

Structural Design

- Exclusion fences for inverters, batteries, and similar equipment
- All conduit buried or elevated:
 - 40" below surface
 - 80" above surface unless guarded (in row)
 - No aboveground cabling or drivelines across inter-row spaces

Structural Clearances (in line with [Fraunhofer guidance](#))

- Vertical clearance of 80"+ for:
 - Lowest panel edge for fixed tilt
 - Torque tube for SAT
 - Maximum row length with fixed linear obstructions below 80" not to exceed 300'
- Vertical clearance of 40"+ for:
 - Lowest panel edge for SAT
 - In-row drivelines
 - In-row cabling (protected adequately to allow cattle grazing)
- Horizontal clearances:
 - Inter-row aisle width 24'+ between structural posts

Agriculture-Friendly Design

- Look at whole field patterns

- Design provisions align with farmland tax assessment to ensure continued production on a value basis, rather than qualitative characteristics of individual crops
- Consider multiple ag uses within one array life
- Consider impacts of semi-transparent modules
- North-South rows create lower shading impacts than East-West rows
- Agricultural fencing should be an acceptable option for all zoning purposes and is in line with federal electric code, as it preserves the rural character of the farm and lends an added benefit to farmers by keeping wildlife away from crops
- Pre-construction soil testing to assess baseline for soil health, compaction, and productivity; recurring testing [every 3-5 years] as part of ongoing reporting and data collection. Baseline soils assessment to be used as reference for decommissioning (see below).

Wire Management & Electrical Safety

- No wires in lowest horizontal structural members
- Bundle and protect wire runs bridging tables/gaps
- No wires hanging below module edges
- Bundle wires at inverters & DC combiners; protect or elevate as necessary

Decommissioning

- Decommissioning surety to ensure the project can be fully removed at end of life, consistent with industry best practice and existing state guidelines for restoration.
- Include baseline/preconstruction soil testing (including compaction levels), and require decommissioning that restores or improves the site including, but not limited to, decompacting, nutrient or other soil amendments, topsoil treatment, and removal of all solar system materials, unless determined that some materials would be beneficial to the farming operation.

Farmer Engagement

- Demonstrated consultations with and input from agricultural landowner, including attestation of project benefits to the farm operator's continued financial viability and/or inter-generational transition planning.
- As applicable, demonstrated outreach to historically underserved farmers and potential agrivoltaic service providers, particularly with projects located in peri-urban areas with significant barriers to farmland access.
- Technical assistance and/or guidance provided to agricultural landowner by project developer and/or independent third-party such as American Farmland Trust, to develop the dual-use farm plan to guide operations, crop production/marketing/distribution.

- Demonstrated benefit of solar energy from dual-use project to local low- and moderate-income customers.

Recent Research Findings Applicable to New Jersey

Below you will find a list of research and resources that should be considered when developing the program and the potential benefits of AgpV. In addition, the [AgriSolar Clearinghouse](#) is a fantastic resource for exploring agrivoltaic progress across the country, while the American Farmland Trust's [Smart Solar initiative](#) provides guiding principles for this work.

- Aroca-Delgado, R., Pérez-Alonso, J., Callejón-Ferre, Á., & Velázquez-Martí, B. (2018). Compatibility between Crops and Solar Panels: An Overview from Shading Systems. *Sustainability*, 10(3), 743. <https://doi.org/10.3390/su10030743>
- Barron-Gafford, G. A., Pavao-Zuckerman, M. A., Minor, R. L., Sutter, L. F., Barnett-Moreno, I., Macknick, J. E. (2019). Agrivoltaics provide mutual benefits across the food–energy–water nexus in drylands. *Nature Sustainability* (2), 848-855. <https://doi.org/10.1038/s41893-019-0364-5>
- Ghalehgalabbahani, A., Parker, B., & Skinner, A. (2022). Saffron and Solar Farms: A Win/Win for the Environment and Agriculture. *North American Center for Saffron Research and Development*. <https://www.uvm.edu/~saffron/info/reports/FinalreportiSunFebruary22022.pdf>
- Gomez-Casnovas, N., Blanc-Betes, E., Moore, C. E., Bernacchi, C. J., Kantola, I., & DeLucia, E. H. (2021). A review of transformative strategies for climate mitigation by grasslands. *Science of The Total Environment* (799). <https://doi.org/10.1016/j.scitotenv.2021.149466>
- Handler, R. & Pearce, J. (2022). Greener sheep: Life cycle analysis of integrated sheep agrivoltaic systems. *Cleaner Energy Systems* (3). 100036. [10.1016/j.cles.2022.100036](https://doi.org/10.1016/j.cles.2022.100036).
- Hassanpour, A. E., Selker, J.S., & Higgins, C. W. (2018). Remarkable agrivoltaic influence on soil moisture, micrometeorology and water-use efficiency. *PLoS One* 13 (11): e0203256. <https://doi.org/10.1371/journal.pone.0203256>
- Kampherbeek, E. W., Webb, L. E., Reynolds, B. J., Sistla, S. A., Horney, M. R., Ripoll-Bosch, R., Dubowsky, J. P., & McFarlane, Z. D. (2023). A preliminary investigation of the effect of solar panels and rotation frequency on the grazing behavior of sheep (*Ovis aries*) grazing dormant pasture. *Applied Animal Behaviour Science* (258). [105799]. <https://doi.org/10.1016/j.applanim.2022.105799>
- Khanna, M., & Miao, R. (2022). Inducing the adoption of emerging technologies for sustainable intensification of food and renewable energy production: insights

- from applied economics. *Australian Journal of Agricultural and Resource Economics* (66), 1-23. <https://doi.org/10.1111/1467-8489.12461>
- Laub, M., Pataczek, L., Feuerbacher, A., Zikeli, S., & Högy, P. (2022). Contrasting yield responses at varying levels of shade suggest different suitability of crops for dual land-use systems: a meta-analysis. *Agronomy for Sustainable Development* (42:51). <https://doi.org/10.1007/s13593-022-00783-7>
- Macknick, J., Hartmann, H., Barron-Gafford, G., Beatty, B., Burton... Walston, L. (2022). *The 5 Cs of Agrivoltaic Success Factors in the United States: Lessons from the InSPIRE Research Study*. United States. <https://doi.org/10.2172/1882930>
- Makhijani, A. (2021). Exploring farming and solar synergies: An analysis using Maryland data. Institute For Energy and Environmental Research. <https://www.agrisolarclearinghouse.org/exploring-farming-and-solar-synergies/>
- Miao, R., & Khanna, M. (2020). Harnessing Advances in Agricultural Technologies to Optimize Resource Utilization in the Food-Energy-Water Nexus. *Annual Review of Resource Economics* (12), 65-85. <https://doi.org/10.1146/annurev-resource-110319-115428>
- New York Power Authority and Electric Power Research Institute. (2023) *Agrivoltaic Leading Practices*. <https://info.nypa.gov/Health/Agrivoltaics23.pdf>
- Proctor, Kyle W., Ganti S. Murthy, and Chad W. Higgins. (2021). Agrivoltaics Align with Green New Deal Goals While Supporting Investment in the US' Rural Economy. *Sustainability* 13, no. 1: 137. <https://doi.org/10.3390/su13010137>
- Sturchio, M. A., Macknick, J. E., Barron-Gafford, G. A., Chen, A., Alderfer, C... Knapp, A. K. (2022). Grassland productivity responds unexpectedly to dynamic light and soil water environments induced by photovoltaic arrays. *Ecosphere*, 13(12), e4334. <https://esajournals.onlinelibrary.wiley.com/doi/epdf/10.1002/ecs2.4334>
- Towner, E., Karas, T., Janski, J., et al. (2022). Managed sheep grazing can improve soil quality and carbon sequestration at solar photovoltaic sites. *ESS Open Archive*. <https://doi.org/10.1002/essoar.10510141.1>
- Uchanski, M., Hickey, T., Boussetot, J., & Barth, K. L. (2023). Characterization of Agrivoltaic Crop Environment Conditions Using Opaque and Thin-Film Semi-Transparent Modules. *Energies*, 16(7), 3012. MDPI AG. <http://dx.doi.org/10.3390/en16073012>
- Walston, L. J., Barley, T., Bhandari, I., Campbell, B., McCall, J., Hartmann, H. M., & Dolezal, A. G. (2022) Opportunities for agrivoltaic systems to achieve synergistic food-energy-environmental needs and address sustainability goals. *Frontiers in Sustainable Food Systems*. 6:932018. <https://doi.org/10.3389/fsufs.2022.932018>
- Walston, L., & Hartmann, H. (2022). Ecosystem Services of Solar-Pollinator Habitat. Argonne National Laboratory. <https://www.agrisolarclearinghouse.org/ecosystem-services-of-solar-pollinator-habitat/>

- Walston, L. J., Li, Y., Hartmann, H. M., Macknick, J., Hanson, A., Nootenboom, C., Lonsdorf, E., & Hellmann, J. (2021). Modeling the ecosystem services of native vegetation management practices at solar energy facilities in the Midwestern United States. *Ecosystem Services* (47).
<https://doi.org/10.1016/j.ecoser.2020.101227>
- Weselek, A., Bauerle, A., Hartung, J. et al. (2021). Agrivoltaic system impacts on microclimate and yield of different crops within an organic crop rotation in a temperate climate. *Agronomy for Sustainable Development* (41), 59.
<https://doi.org/10.1007/s13593-021-00714-y>
- Williams, H. J., Hashad, K. N., Wang, H., & Zhang, K. M. (2023). The potential for agrivoltaics to enhance solar farm cooling. *Applied Energy* (332).
<https://doi.org/10.1016/j.apenergy.2022.120478>