chaberton ENERGY

# Chaberton Solar Sugarloaf

# FARMING REQUEST FOR PROPOSALS

April 23, 2026

# Table of Contents

# 1. Introduction and Background

**About Chaberton**

Chaberton Solar Sugarloaf I LLC ("Sugarloaf" or the "Project") is a community solar project developed by Chaberton Energy designed to incorporate agricultural activities alongside the solar panels as more fully described in this Request for Proposal ("RFP").

Chaberton Energy ("Chaberton") is a public benefit corporation headquartered in Maryland, dedicated to advancing sustainable infrastructure and renewable energy solutions. As a leader in community solar, Chaberton is committed to creating innovative projects that harmonize environmental stewardship with economic resilience. Our mission is to provide clean energy solutions that benefit local communities, landowners, and agricultural partners.

**About Okovate**

Okovate Sustainable Energy is a minority-owned and -operated Maryland-based firm that designs, develops, and consults on community solar projects that work in harmony with farming operations, accelerating the deployment of agrivoltaics. Okovate provides co-location modeling outputs and employs machine-learning algorithms and optimization techniques to balance system configurations, crop biomass, animal productivity, and array spacing to promote data-driven recommendations for agricultural strategies.

**Objective**

The goal of this RFP is to identify qualified farmers to farm approximately 18 acres at our Sugarloaf site, with a focus on supporting new, beginning, and historically underserved farmers. By providing access to land and infrastructure, we aim to help established and/or new / growing local farm businesses while encouraging sustainable and innovative agricultural practices. Given the combination of agricultural and solar/photovoltaics (commonly referred to as agrivoltaics) is new, Chaberton is interested in partnering with interested farmers that result in proof of concept to enable future projects that combine agricultural and solar aspects in new ways or prepare for larger scale agrivoltaics than represented by this Project.

Based on analysis by Okovate, attached as Appendix A, an Expression of Interest is specifically invited for activities that meet the definition of PUA § 7-306.2(a)(2), showcasing how renewable energy and agriculture can coexist harmoniously.

Together, we aspire to create a sustainable future for Maryland's farmland, farmers, and rural communities.

**About the Site**

The Sugarloaf project is in Montgomery County, Maryland feature high-quality soils and are designed to support grazing, and table crops separately to, or in combination with pollinator habitats. Elevated and appropriately spaced solar arrays create a unique microclimate that reduces water use, and may enhance soil health, and provide crop protection.

**Opportunity for Farmers**

This RFP provides farmers access to land without lease costs, with compensation for services provided, and the chance to participate in one of Montgomery County's first agrivoltaics projects. This cutting-edge Project aligns with Maryland's renewable energy and agricultural sustainability goals and is being developed in consultation with Montgomery County Office of Agriculture. Selected farmers will collaborate to develop tailored farm plans that integrate their expertise with the solar infrastructure.

Farmers also have access to the site-specific study produced by Okovate as an additional resource. The intent is to award multi-year contracts to selected farmer(s). Additionally, the Project may also entertain assisting in start-up or on-going costs for particularly innovative or "pilot" type solutions. Candidates should be prepared to discuss the type and magnitude of assistance requested during the structured interview process.

| Phase | Activity | Duration |
|---|---|---|
| 1 | RFP release | April 23 |
| 2 | EOI collection window | May 7 - May 21 |
| 3 | Initial screening & candidate shortlisting | May 21 - May 28 |
| 4 | Structured interviews | May 28 - June 11 |
| 5 | Reference checks & evaluation scoring | June 11 – June 18 |
| 6 | Field day / site familiarization (if applicable) | June 18 - June 25 |
| 7 | Selection Meeting | June 25- July 2 |
| 8 | Contract negotiation & execution | July 2 – July 17 |

# 2. Site Overview

**Location and Description**

The Project is in the agricultural reserve in Montgomery County, MD. Of note, successful farmers may be afforded the opportunity to expand to additional Chaberton project sites over time in Montgomery and surrounding counties.

**Sugarloaf:** Located at 20597 Darnestown Road, Dickerson, MD, this site spans 19 acres, with 16 acres covered by the solar array and a 3-acre buffer zone. Approximately 10 acres of in-between-row land and a total of 13 arable acres are available for agricultural use. This is a single-axis tracker system, meaning the panels move with the sun throughout the day. The project abuts an area recently afforested to the north and east (shown with cross hatches). The field is currently in rotational crop farming (e.g., soy, corn, etc). The panels are planned to be mounted at varying heights above the ground which may be of interest to determine the optimal panel height for certain crops. Additional details can be found in Appendix B.  Minor changes to the site plan below may occur prior to construction.

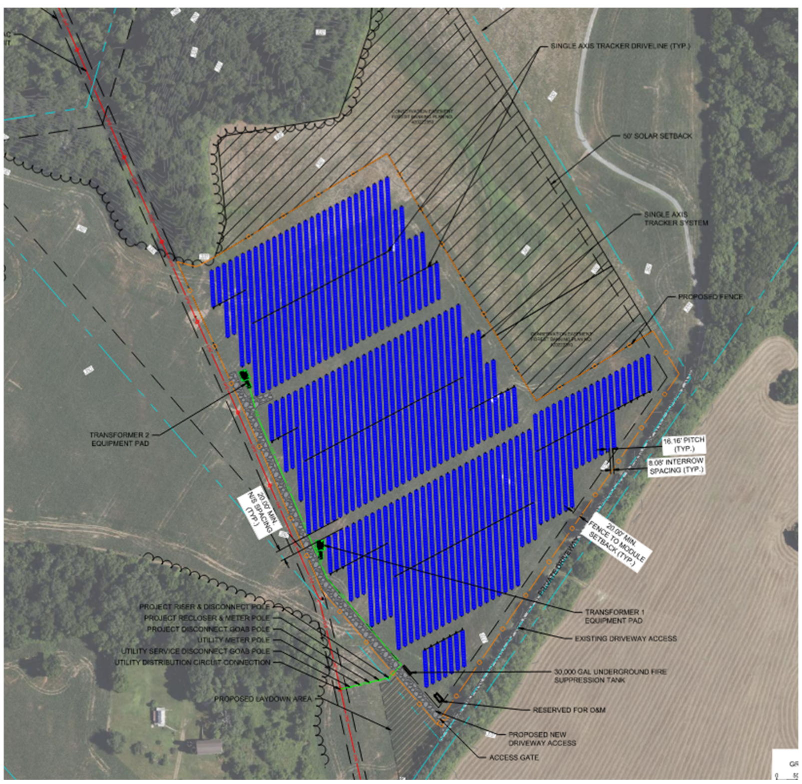


*Figure 1: Sugarloaf Current Site Plan*

## Agricultural Potential

To determine the agricultural potential of the site, Chaberton collaborated with Okovate (www.okovate.com) agronomists to conduct a comprehensive site assessment. The findings from this study have been compiled into a detailed report, attached as Appendix A to provide prospective farmers with site-specific insights and guidance.

## Infrastructure and Access

The Sugarloaf site is designed to ensure that farmers have access to the necessary infrastructure to carry out their agricultural activities effectively. Below is an outline of the key infrastructure and access provisions. Farmers should provide a response to each of the key infrastructure provisions regarding how they intend to utilize what is offered, or if additional infrastructure is needed and why—especially as it relates to Water Access, Electricity Access, and Tool Storage. Below is an outline of the key infrastructure and access provisions:

- **Site Accessibility:** Farmer shall have 24/7 access to the site. An access map will be provided as part of the agreement.
- **Panel Spacing:** Solar panels are spaced 8 feet apart, providing sufficient room for activities such as rotational grazing and select crop production, and allowing space for small-scale or specialized machinery.
- **Panel Height:** The space beneath the solar panels has not been included in the agricultural analysis. However, in practice, this area offers potential for agricultural use, as the panel edges will be approximately 2.5 feet +/- ~1 foot above ground at their lowest point, although the exact height of each panel is subject to change as the design is finalized. If a specific height (or heights) is critical, this should be specified in your submission. At the Sugarloaf site, the solar panels will feature a tracking system that follows the sun's path.
- **Fencing:** The site is enclosed by an outer perimeter fence for security, and an internal fence is planned around the critical electrical components (i.e., transformer and inverters). Farmers will be responsible for installing and maintaining any additional fencing required within the solar array to manage livestock or protect crops.
- **Water Access:** Water access may be available on site. If required/beneficial, please include in your Expression of Interest the anticipated amount of water to be used by season.
- **Electricity Access:** Access to 120V outlets can be provided inside the project area near the transformer/inverters to support various farming operations, including equipment usage, irrigation systems, or other energy needs.

- **Tool Storage:** Space for a small shed (exact dimensions TBD) can be made available on site, if desired.
- **Additional Infrastructure:** Farmers may outline any additional infrastructure improvements or equipment requirements in the structured interview process to include requests for potential grants that may be available from the Project, particularly if they align with project goals such as enhancing sustainability, improving productivity, conducting agrivoltaics proof of concept solutions through innovative practices, or promoting access to new and/or underserved farmers. Such grants, if made available, will be awarded at the sole discretion of Chaberton Solar Sugarloaf I LLC.
- This infrastructure framework ensures that the site is equipped to support sustainable and productive dual-use systems, balancing renewable energy generation with diverse agricultural activities. Farmers will discuss their specific infrastructure during structured interviews to ensure seamless operations.

### Constraints and Considerations

While this site is offered free of charge to the selected farmer(s), there are important constraints and considerations that must be taken into account:

- **Vegetation Management:** For the project, while an agricultural activity is in place, the farmer (or one of the awarded farmers in the case of multiple awards on site) may be responsible for maintaining vegetation under and around the solar panels to meet both agricultural, operational, and fire safety housekeeping requirements. This includes managing plant height and ensuring compatibility with agrivoltaic system specifications. If agricultural activities alone do not suffice for vegetation control, the farmer must ensure vegetation is maintained according to contract specifications. Depending on the extent of the vegetation area outside the area being used for an agricultural activity, the Project will reimburse the farmer for this maintenance activity commensurate with the applicable scope. Details to be discussed during structured interviews. A draft Vegetation Management Plan can be found in Appendix C which is expected to be amended for the agrivoltaics solution but will be subject to approval from state authorities. Please include your willingness and ability to provide mowing services in your Expression of Interest.
- **Communication:** Open and regular communication with the Project is critical for aligning project goals and site management. Farmers are expected to provide updates and collaborate on addressing any operational concerns with the designated project representative.

- **Risks:** Operating within a dual-use system carries risks, such as potential damage to equipment or crops due to panel shading or infrastructure challenges. Farmers must account for these risks during the structured interview process and outline mitigation strategies.
- **Public Engagement:** Awarded farmers will be included in certain publicity-related materials. The Project will provide a release for use of photographs, videos, and related materials. Willingness to engage in a limited number of public events, such as groundbreaking and media interviews is considered a plus.
- **Research Participation:** If applicable, farmers are requested to cooperate with ongoing research by collecting and sharing data annually to inform potential future agrivoltaic projects. This includes providing information on yields, operational challenges, and benefits of farming under agrivoltaic systems to improve future developments. Any data requested will strive to minimize the time required to collect/report the data.
- **Restricted Areas:** Certain sections of the site will be fenced off (e.g., transformer and inverter area) for safety or operational reasons. Farmers must respect these restrictions and avoid accessing these areas except for approved activities (e.g., vegetation maintenance).

## 3. Scope of Work

The selected farmer(s) will collaborate with Sugarloaf to manage the agricultural and vegetation aspects of the project site under a dual use agrivoltaic system. The farmer(s) will engage in sustainable practices to meet the following objectives:

**General Responsibilities**

- Maintain vegetation to comply with agrivoltaic system requirements, ensuring plant height and density do not interfere with solar panel operation.
- Utilize approved agricultural activities, including grazing, and crop cultivation, potentially in combination with pollinator-friendly practices in areas not used for agrivoltaics, to enhance soil health, improve biodiversity, and support research efforts.
- Manage land access and livestock (if applicable) to align with operational constraints, while actively communicating and collaborating with the Project to ensure seamless integration of agricultural activities with renewable energy generation and maintenance.
- Compliance with applicable state and local regulations, permits, and best practices.

## Permitted Agricultural Activities

- **Crop Production**: Hand-harvestable crops such as carrots, squash, or watermelon. Expression of Interest must account for panel spacing and microclimate effects, with a preference for small-scale or specialized equipment use.
- **Livestock Management**: Rotational grazing using sheep or other approved livestock that meets size and height constraints. Stocking rates must align with the agronomic assessment and ensure sustainable forage use.
- **Other Activities in accordance with PUA § 7-306.2(a)(2):** Additional consideration given to Expression of Interest also in accordance with Maryland Assessment Program Manual.

## Vegetation Management

Vegetation Management, in the form of mowing, may required to be maintained in accordance with the (to be) approved vegetation management plan. The following parameters are expected to be provided if willing and able to provide mowing.

- Vegetation under solar panels must not exceed 30 inches (2.5 ft) in height at any time unless approved by Ramiere, as applicable, to avoid shading the solar panels or interfering with system performance.
- Vegetation in buffer zones must be maintained below 36 inches (3ft), depending on its designated use and ecological objectives.
- Vegetation around the electrical infrastructure and access roads need to be maintained below 30 inches. The Project may provide payment for this service as discussed above.

## Sustainable Practices

The Project prioritizes agricultural practices that improve soil health, conserve water, and minimize environmental impact. Farmers should demonstrate how they plan to comply with Maryland and Montgomery County agricultural best practices. Structured interviews must outline specific sustainable practices, including:

- **Soil Health**: Use practices like cover cropping, composting, and reduced/no-till farming to enhance soil quality and carbon storage. Annual reports on soil amendments, herbicides and pesticides usage, and fertilizers will be required.
- **Water Conservation**: Include strategies like efficient irrigation, rainwater harvesting, and minimizing runoff to address site-specific microclimates.

- **Pest and Weed Management**: Preference on non-chemical approaches, such as integrated pest management, organic fertilizer, and crop rotation. The Project reserves the right to restrict inputs.
- **Nutrient Management**: Propose sustainable methods for fertilization and nutrient cycling, minimizing synthetic chemical inputs where possible.

**Safety and Risk Management**

- **Insurance:** Farmers must hold liability insurance, listing Sugarloaf, as applicable, as an additional insured. Proof of coverage or acknowledgment to obtain it is required. Farmer will maintain insurance coverage with the following minimum limits: (a) commercial general liability insurance ($1m per occurrence and $2m general aggregate); (b) farming/crop/livestock insurance ($2m combined single limit); (c) commercial automobile liability insurance to the extent required by applicable law; and (d) worker's compensation insurance to the extent required by applicable law.
- **Security:** Farmers are responsible for securing their equipment, crops, and livestock. Perimeter fencing is provided, but additional measures for livestock or crop protection must be outlined.
- **Communication:** From time to time, preventive and corrective maintenance for the solar components will be required. Sugarloaf will strive to provide at least forty-eight (48) hours' advance notice for preventive maintenance that might interfere with farming activities. Farmers will be notified as soon as possible regarding any corrective maintenance activities that might impact farming activities. Farmers are required to report any abnormal observations of solar equipment, landscaping, vegetation, etc so that these may be addressed as soon as possible. All reasonable commercial efforts will be made to avoid impacts to farming activities. Final contract must include designated contacts / responsible persons to serve as the primary and alternate points of contact for operational communications.

## 4. Submission and Applicant Process

**Expression of Interest (EOI)**

The Project seeks applicants with the qualifications, experience, and commitment necessary to ensure the success of the agrivoltaic system. Expression of Interest must address the following.

| Category | Information Collected |
|---|---|

| | |
|---|---|
| Contact & Location | Name, farm name, address, phone, email, distance from project site |
| Agricultural Background | Years of farming experience, primary commodities, acreage currently managed, livestock types and herd sizes |
| Equipment & Infrastructure | Owned equipment relevant to the operation (mowers, tractors, livestock handling, irrigation), access to additional equipment. Please be explicit on what infrastructure is being requested and reason for request, as well as what infrastructure is provided by farmer. |
| Business Structure | Entity type (sole proprietor, LLC, etc.), insurance coverage, existing contracts, lease arrangements, requested compensation for services provided. |
| Agrivoltaic Familiarity | Prior experience with solar grazing, dual-use farming, or shade-tolerant agriculture; experience operating under/between arrays, ability to provide mowing services. |
| Availability & Interest | Desired start date, capacity to take on additional acreage, long-term interest in the arrangement |

### Submission Process

EOIs are due on or before May 21, 2026, and must be submitted via Google Form located at chaberton.com/RFP26. A confirmation email will be sent upon receipt, and the Project may reach out for additional information. Questions can be submitted via email to agrivoltaics@chaberton.com, and responses will be shared publicly on chaberton.com/RFP26 to ensure all bidders have equal access to information.

### Structured Interviews

Shortlisted Candidates will be invited for structured interviews which will address the following information.

| Interview Area | Topics Explored |
| --- | --- |
| Operational History | Detailed review of the candidate's farming operation: what they grow or raise, how long, at what scale, and how they manage seasonal and year-to-year variability. |
| Agrivoltaic Readiness | Understanding of operating constraints in a solar environment: row spacing, panel height clearances, equipment maneuverability, vegetation management requirements, and livestock behavior around infrastructure. |
| Business & Financial Stability | Operating entity structure, existing revenue streams, financial capacity to sustain operations during ramp-up, and history of fulfilling contractual obligations. |
| Equipment & Logistics | Inventory of relevant equipment, maintenance practices, mobilization plan to the project site, and any capital expenditure plans to support the operation. Infrastructure requirements, responsible party for providing infrastructure, how infrastructure supports agrivoltaics efforts. |
| Risk Management | Approach to weather risk, crop/livestock loss mitigation, insurance coverage, and contingency planning for operational disruptions. |
| Long-Term Commitment | Interest in a multi-year arrangement, willingness to adapt practices as the site matures, and alignment with agrivoltaic and conservation stewardship goals. |
| References | Names and contact information for 2–3 professional references (landowners, extension agents, suppliers, or other business relationships). |

### Site Familiarization

Prior to final selection, shortlisted candidates will be invited to a site familiarization event organized by Okovate. The purpose is to ensure finalists can make an informed commitment and to allow the selection team to observe each candidate's practical understanding of the operating environment. The event will include a walk of the project site (or a comparable agrivoltaic site), an operational briefing covering panel heights, row spacing, equipment restrictions, vegetation management requirements, and a Q&A session. Attendance is expected for all shortlisted candidates. If the project site is not yet accessible, Okovate will provide a photo and video package in lieu of an in-person visit.

## 5. Evaluation Criteria and Selection

### Evaluation Criteria

Proposals will be reviewed by a selection team composed of Sugarloaf staff and Okovate. The evaluation process will focus on how well the applicant's qualifications, experience, and proposed solution align with the goal of this RFP, to integrate renewable energy and sustainable agriculture. Sugarloaf may award one or multiple contracts in its sole discretion. Multiple applicants may be grouped into one proposal to optimize use of the agricultural space.

| Evaluation Criterion | Scoring Guidance |
|---|---|
| Agricultural Experience & Skill | Depth and relevance of experience; track record of sustained, productive agricultural operations. |
| Agrivoltaic Suitability | Demonstrated understanding of or willingness to adapt to agrivoltaic operating conditions; prior dual-use or solar grazing experience is strongly preferred. |
| Equipment & Operational Capacity | Adequate and well-maintained equipment; realistic mobilization plan; ability to self-perform without subcontracting critical functions. |
| Proximity to Site | Closer operators score higher; proximity reduces response times, travel costs, and risk of delayed operations. |
| Financial & Business Stability | Established business entity, insurance in place, history of meeting financial obligations, no pending liens or defaults. |

| | |
|---|---|
| Long-Term Alignment & Commitment | Interest in a sustained, multi-year partnership; alignment with conservation and land stewardship values. |
| References & Reputation | Quality of professional references; standing in the local agricultural community. Okovate will contact references for all shortlisted candidates prior to final selection. |

**Selection**

While non-conforming bids are a reason for non-selection, the Project reserves the right to waive inconsistencies or missing components in proposals if it serves the project's best interests or is not applicable to the agricultural activity proposed.

Notification of selected applicants and lease signing will occur following the review process, with onboarding planned for the months leading up to the start of the first agricultural season, likely in the winter of 2026.

Shortlisted candidates who are not selected for this site will be retained in Okovate's candidate pool and may be contacted for future agrivoltaic opportunities at other Chaberton project sites.

## 6. Awardee Information

**Contract Duration**

The farmer will be offered a multi-year contract, with Sugarloaf retaining the right to terminate the agreement if contractual obligations are not upheld. The initial term is expected to be between 3 to 5 years; however, the Project is open to considering alternate durations with reasonable justification.

The agricultural operations agreement between Sugarloaf (or the applicable project entity) and the selected farmer will address, at minimum, the following terms: (a) scope of permitted agricultural operations, including crop types, livestock types, stocking densities, and seasonal schedules; (b) site access rights, operating hours, and site conduct requirements; (c) compensation structure, revenue share, grants, or vegetation management payments; (d) insurance requirements, indemnification, and liability allocation; (e) contract term, renewal options, and termination provisions; (f) reporting obligations, including vegetation management logs, grazing records, soil health data, and incident reports; and (g) dispute resolution mechanisms. Specific terms will be negotiated with the selected farmer following the conclusion of the RFP process.

**Compensation**

The lease of this land is provided free of charge. As discussed above, the Project may consider awarding grants to assist with upfront and/or on-going costs at their sole discretion. Compensation is also available for vegetation maintenance and agricultural activities. Bids for compensation should be provided in the Expression of Interest.

**Agrivoltaics Plan Requirements**

Farmers or agricultural operators awarded through the RFP process will work with the Project to write and submit to the relevant Authority Having Jurisdiction, a comprehensive Agrivoltaics Plan that provides a clear vision for how they will utilize the agrivoltaics site (Sugarloaf) and outlines their approach to vegetation management, agricultural production, and sustainable practices. Note that the Agrivoltaics Plan is a post-selection deliverable developed collaboratively between the selected farmer and the Project; it is not required as part of the Expression of Interest or structured interview process. The components below are provided for applicants' awareness of what the plan will need to cover following selection.

**General**

- **Vision Statement**: Include a concise vision for the proposed activities, demonstrating alignment with the goals of this RFP to integrate renewable energy and agriculture while enhancing soil health and biodiversity.
- **Innovative Use of Space**: Describe how available space will be utilized, including opportunities under and around the solar panels, while complying with site constraints.
- **Size of Area**: Indicate whether the proposed agricultural activity will take place in the entire area available or whether a smaller area is desired. If a smaller area is desired, indicate whether the proposed activity may be conducive to other activities collocating near/adjacent at the same site.

**Specific Agricultural Solution**

- **Crop Cultivation**: Detail the crop rotation plan, including how it will enhance soil health and sustain productivity. Describe pest management strategies, such as integrated pest management or other sustainable practices and intended pesticide/fertilizer use. Outline soil conservation measures like cover cropping to maintain soil quality and prevent erosion and explain how compliance with vegetation height requirements will be maintained. Include information about equipment to be used and how it aligns with the spatial constraints of the panels. If manual labor and hand-harvesting are planned, describe the approach, including workforce logistics and scheduling, and outline strategies to mitigate risks such as worker safety and labor shortages.

- **Grazing**: Describe the rotational grazing strategy, including stocking rates, breeds, animal age, rest periods for pasture, and prevention of overgrazing. Include information about logistics and animal transport, and outline the approach to animal health and welfare, including parasite management and veterinary care.
- **For Pollinator-Friendly and Mixed-Use Proposals**: Describe how pollinator-friendly vegetation will be established and maintained in areas not used for Agrivoltaics or how multiple agricultural activities will be integrated. Describe how the vegetation standards will be met. The plan must include methods to monitor the effectiveness of pollinator-friendly practices, such as conducting surveys or partnering with ecological organizations.

**Economic Viability**

The Agrivoltaics Plan must demonstrate the financial sustainability of the proposed agricultural activities under the agrivoltaic system and should address the following.

1. **Budgeting**: A detailed budget demonstrating that the proposed operation is financially viable, including:
    - Expected income from agricultural activities, such as crop sales, livestock production, pollinator-friendly practices, and compensation for services provided.
    - Anticipated operational expenses, including transportation, equipment, seed or feed costs, water usage, and vegetation management.
    - If applicable, estimated costs associated with the proposed activities, including equipment and infrastructure needs such as fencing, water systems, or other improvements.
2. **Nature of the Business**:
    - Indicate whether the proposed agricultural operation will serve as the applicant’s primary business or a part-time or supplemental activity.
    - For part-time operations, an explanation of how consistent and reliable site management will be ensured.
3. **Infrastructure needs**:
    - Any infrastructure improvements or equipment required to execute the proposed activities effectively.

- Cost estimates for any infrastructure not already in possession, and how any potential financial support from Sugarloaf would be used to improve the sustainability and efficiency of the operation.

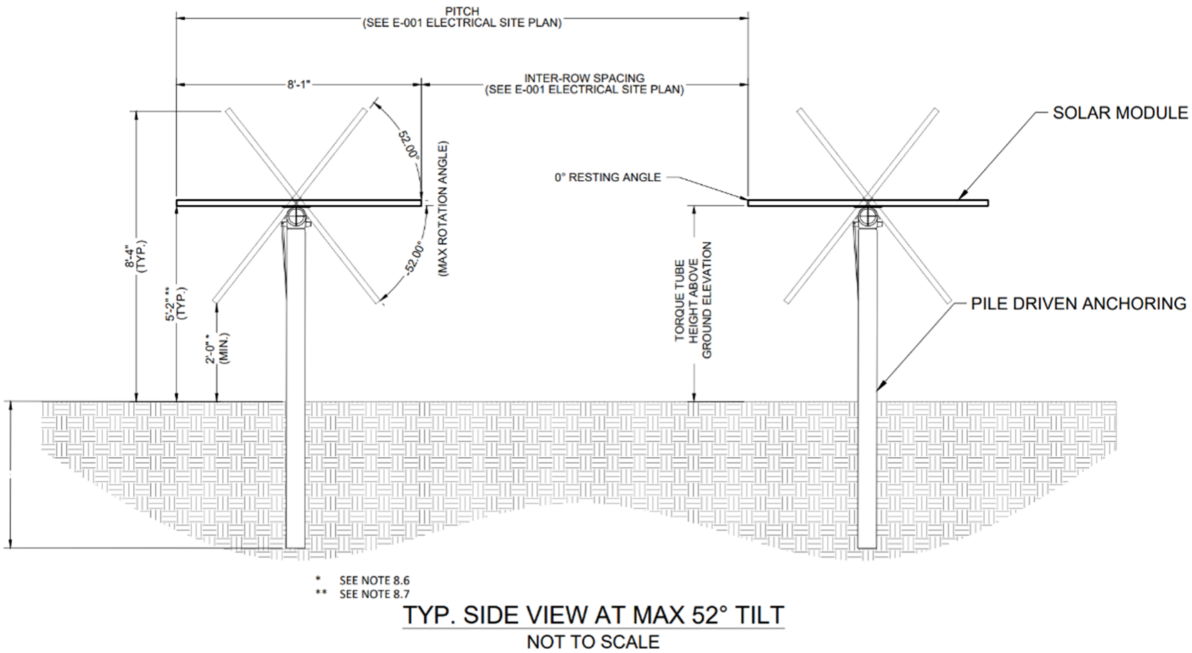


*Figure 3: Preliminary design at Sugarloaf with single-axis tracker. Height dimension may change to favor agrivoltaics*

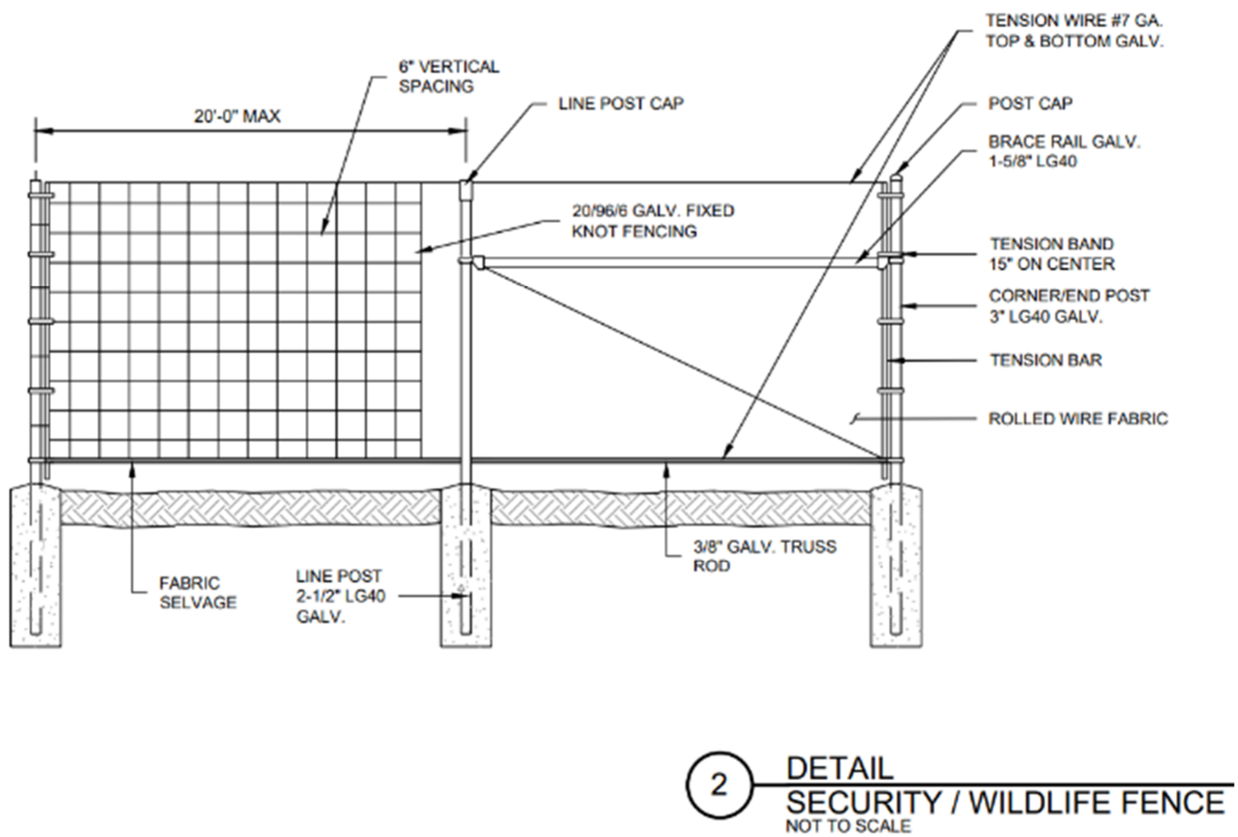


*Figure 4: Typical perimeter fencing around solar sites.*

# Appendix

## Appendix A. Okovate APV Report


# Sugarloaf & Ramiere Agrivoltaic Planning Report

For Chaberton Energy and Key Stakeholders

Okovate Sustainable Energy, Inc.

# Executive Summary

Chaberton Energy, a public benefit corporation headquartered in Maryland, is committed to developing sustainable infrastructure and renewable energy projects that serve local communities. With over 650 MWdc in secured site control and nearly 1.5 GW of projects in development, Chaberton is at the forefront of renewable energy innovation, bringing together creativity, excellence, and humanity in every project.

For their agrivoltaics projects at **Sugarloaf** and **Ramiere**, Chaberton seeks to integrate solar energy with agricultural practices, providing a sustainable solution that maximizes land-use efficiency. By maintaining agricultural productivity while producing clean energy, these projects will help local communities thrive, benefiting landowners, neighbors, and stakeholders alike. These dual-use systems are key to Chaberton's mission of fostering long-term sustainability and community engagement.

Okovate Sustainable Energy is a minority-owned and -operated Maryland-based firm that designs, develops, and consults on community solar projects that work in harmony with farming operations, accelerating the deployment of agrivoltaics. Okovate partners with a Stanford-backed group, Fundusol, that provides co-location modeling outputs and employed machine-learning algorithms and optimization techniques to balance system configurations, crop biomass, animal productivity, and array spacing to strengthen Okovate's data-driven recommendations for agricultural strategies.

In this report Okovate carries out two comprehensive site studies evaluating potential agrivoltaics integration into Chaberton's Ramiere and Sugarloaf solar projects in Maryland. Our approach, powered by advanced machine-learning models in collaboration with our partner Fundusol, examine for each site what the optimal agrivoltaic land use would be to combine agriculture and solar energy production, ensuring high efficiency, economic viability, and environmental sustainability.

## Okovate's Commitment

We are committed to delivering solar projects that align with Maryland's goals for sustainability, agricultural preservation, and community development. By integrating agrivoltaics, our tailored solutions support the state's renewable energy targets while enhancing local agricultural productivity. Okovate's ongoing stakeholder collaboration ensures long-term success, contributing to Maryland's leadership in clean energy innovation and protecting its agricultural heritage.

## Key Focus Areas

- **Design and Optimization:** Tailoring agrivoltaic designs using machine learning, Okovate balances solar panel placement, crop selection, and grazing management to maximize efficiency and viability.
- **Community Engagement:** Okovate fosters community buy-in and streamlines the permitting process by building strong relationships with local stakeholders.
- **Regulatory Compliance:** Efficiently navigating Maryland's regulatory environment to secure necessary permits.
- **Environmental Impact:** Ensuring that project designs are carried out with minimal environmental impact to protect the land for agriculture and proactively mitigate any potential environmental risks.

- **Long-Term Partnership:** Ongoing support to Project Sugarloaf and Ramiere throughout the project lifecycle, including development, construction, and operational assistance to Project Sugarloaf and Ramiere, the landowners, and tenant farmers.

## Methodology

- **Crop Production:** In Partnership with Fundusol, we modeled crop performance under agrivoltaic conditions through comprehensive irradiance studies and microclimate assessments. By analyzing empirical and local yield data alongside site-specific factors such as climate and soil we provide an overview of crop suitability optimizing both environmental conditions and economic viability.
- **Livestock:** We assessed optimal stocking densities, pasture species, and management strategies under the shading effects of solar panels in the agrivoltaic system. This approach allows us to balance vegetation control and herd productivity, supporting sustainable land use and economic viability.
- **Apiary:** Coupled with sustainable land management practices like grazing, we suggest collaborating with local beekeepers to install and manage hives, optimizing hive density based on the future vegetation and a pollen analysis, and potentially supplementing with pollinator-friendly plantings to enhance honey production.

Okovate's core values center on farmland protection, ensuring that solar energy development compliments agricultural activities that work in practice, not just on a theoretical basis. We are committed to creating a future where communities thrive by using local land to generate clean energy and sustainably produce food.

While Okovate empowers Chaberton and the Montgomery County Office of Agriculture to choose which agricultural solution to implement, our comprehensive analysis of the Sugarloaf and Ramiere sites revealed several key insights:

1. **Landscape assessment:** Located within Montgomery County's Agricultural Reserve, both sites benefit from a resilient agricultural economy with small-scale farms and a diverse crop and livestock base. Sugarloaf, with sandy loam soil and limited water retention, is suited for grazing, while Ramiere's fertile silt loam soil supports greater agricultural flexibility. The region's climate, with an annual rainfall slightly below evapotranspiration needs, makes agrivoltaics advantageous for reducing water deficits during. Key challenges at the sites include erosion, limited water retention and soil compaction risks. Mitigation measures, such as non-invasive construction and maintaining ground cover, help address these issues, ensuring sustainable agrivoltaic productivity.

2. **Crop Modeling:** Crop modeling analysis, conducted in partnership with Fundusol, revealed that certain crops, such as carrots, watermelon, and summer squash, show potential for cultivation within the agrivoltaic systems. However, due to limited row spacing and the small amount of tillable land at these sites, the viability of crop production is low.. Gaining market access was identified as one of the main challenges for crop production at these sites. Other challenges identified for some crops were high price volatility, disease risk, or physical limitations.

3. **Livestock Feasibility:** Livestock grazing, particularly with sheep, is a compatible option for both sites. We determined that smaller sheep breeds under rotational grazing are ideal for balancing pasture health and revenue. With recommended stocking densities of 3 ewes per acre under solar panels and 7 ewes per acre on open pasture, these sites can sustain a sheep herd of 80 ewes. This makes sheep grazing a viable option, especially for already established local farmers with additional land. Our analysis indicates that agrivoltaic sheep grazing could yield higher profits per sheep at these sites if including vegetation management payments to the farmer.

4. **Apiary:** The potential for integrating apiaries into the agrivoltaic systems was explored and recommended due to the benefits of co-locating beehives with solar farms, including increased honey production, creation of valuable pollinator habitats through installation of native grasses. The two sites can support a combined 450,000 honeybee population. We reviewed the costs of 1-lb honey sales from several local Maryland apiaries and determined that onsite apiaries would be profitable in Year 1 if Chaberton were to cover the nominal costs of hive installations.

| Agricultural Activity | Best fit | Feasibility Score (1-5) | Economic for Local Farmer |
|---|---|---|---|
| Crop Production | Carrots, Summer Squash, Watermelon | 2 | Lack of market access and not enough space for equipment |
| Livestock | Sheep grazing | 5 | Suitable option, especially if local farmer is found |
| Apiary | Pollinator habitat with apiary | 5 | Yes if hive installation covered by Chaberton |

Based on these insights, a phased approach is recommended for Chaberton, prioritizing livestock grazing (sheep recommended) as the primary agricultural activity and considering the integration of apiaries simultaneously or in later phases. This approach allows for flexibility, adaptability, and optimization of the agrivoltaic system over time. Okovate recommends Chaberton follow the RFP process outlined in the report to source local livestock farmers and beekeepers.

# Contents

## Project Overview

**Project Sugarloaf** is a 4 MW-AC community solar installation located on approximately 19 acres of a 52.7-acre property at 20507 Darnestown Road, Dickerson, Montgomery County, Maryland. The solar array covers around 16 acres, and the buffer zone outside the array about 3 acres. The system features 8 ft interrow spacing and uses a single-axis tracker to optimize solar energy production while maintaining agricultural use. The project will support approximately 634 households and reduce greenhouse gas emissions by about 5,100 tons per year, benefiting both the local community and the environment.

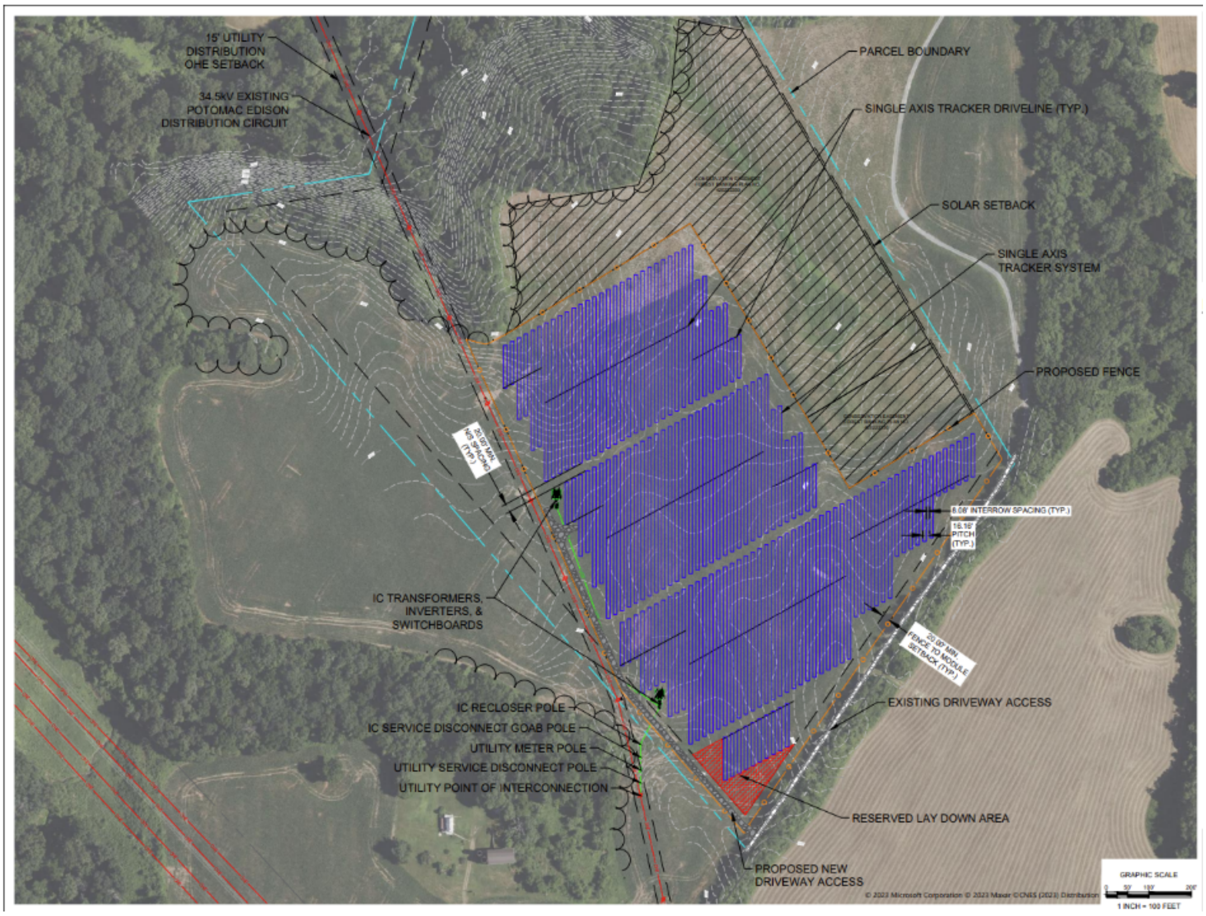

*Figure 1: Sugarloaf project design*

**Project Ramiere** is a 3 MW-AC community solar installation on approximately 11 acres of a 118-acre property at 17600 Whites Ferry Rd., Poolesville, Montgomery County, Maryland. The solar array covers around 8 acres, and the buffer zone outside the array about 2 acres. The project incorporates 8 ft interrow spacing to maintain agricultural productivity. The project will support approximately 415 households and reduce greenhouse gas emissions by about 3,820 tons of $CO_2$ every year, while supporting local economic growth.

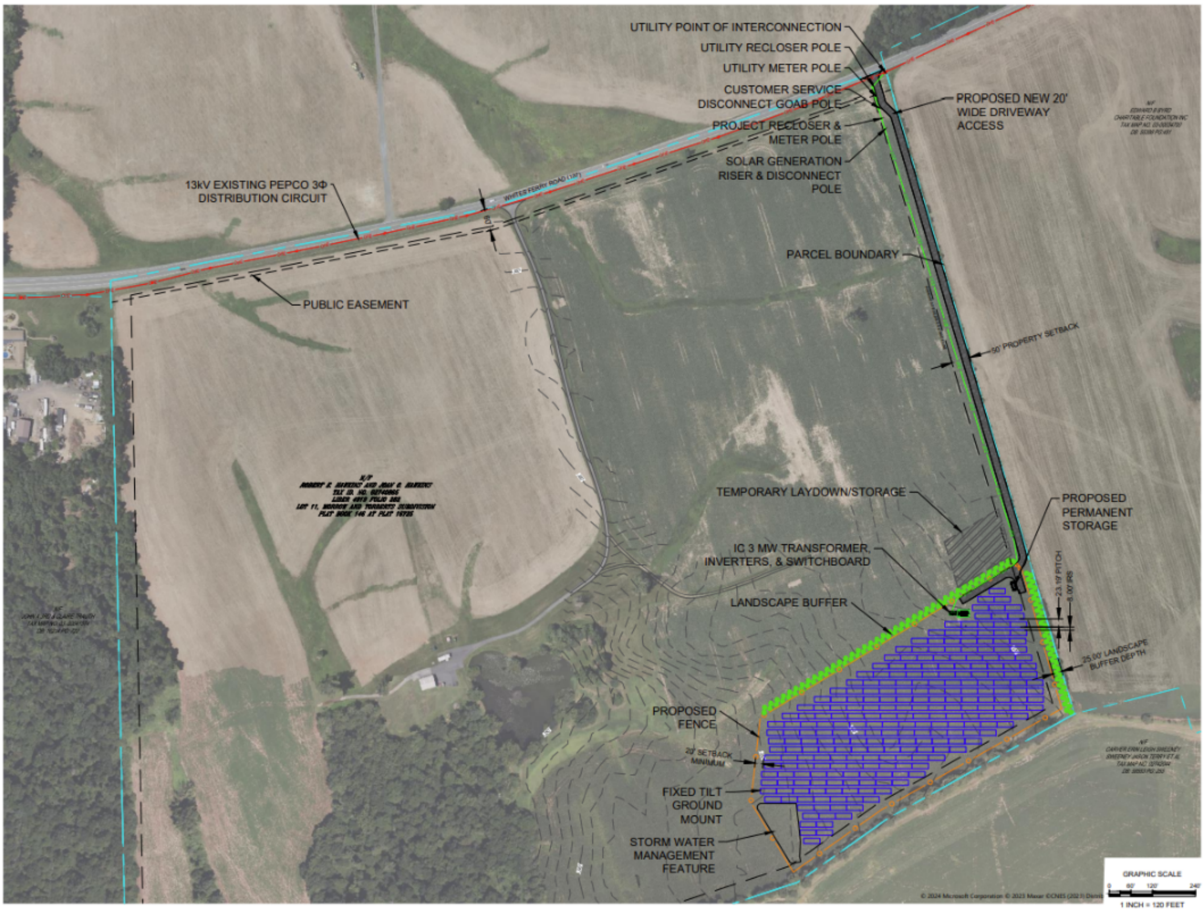


*Figure 2: Ramiere project design*

## Scope of Analysis

Chaberton requested Okovate to analyze various agricultural solutions that might be feasible to incorporate in conjunction with the planned solar projects and recommend one or more alternatives based on their ability to be sustainably and economically integrated on these sites. Chaberton indicated it was important to comply with Maryland Department of Agriculture guidelines regarding agrivoltaics, HB 0908, to incorporate local considerations specific to agricultural practices in Montgomery County and these sites in particular and ensure any recommended solution would have a high confidence of success over the life of the project.

To achieve this, Okovate considered the following:

- Maryland Department of Agriculture guidelines regarding agrivoltaics HB 0908
- Proposed CPCN licensing condition per Case Numbers 9733 (Ramiere) and 9726 (Sugarloaf)
- Feasibility of solutions based on local soil and sunlight conditions.
- Economic feasibility based on current market conditions
- Use of sustainable development best practices.
- For each proposed solution, Okovate provides:
    - Tailored design solutions that maximize land-use efficiency.
    - Agronomic assessment and agricultural co-location modeling.

- Full support through the permitting process to meet all agrivoltaics regulatory requirements.
- Stakeholder engagement and farmer sourcing plans.

## Agrivoltaics

To achieve the goal of maintaining agricultural land use in conjunction with the proposed solar projects, Chaberton aims to utilize agrivoltaic practices. Agrivoltaics, or dual-use solar, integrates solar energy production with agricultural activities on the same land, potentially increasing land-use efficiency by over 60%. This dual-use approach can not only provide an additional income stream but also offers significant environmental benefits. Solar panels create microclimates that protect crops from extreme weather, reduce evapotranspiration, and conserve water, improving crop resilience in drier climates. Additionally, they help prevent soil erosion and preserve soil moisture, promoting long-term soil health and sustainability. This synergy enhances the economic viability of both agriculture and renewable energy, making agrivoltaics a powerful tool for optimizing environmental and economic outcomes.

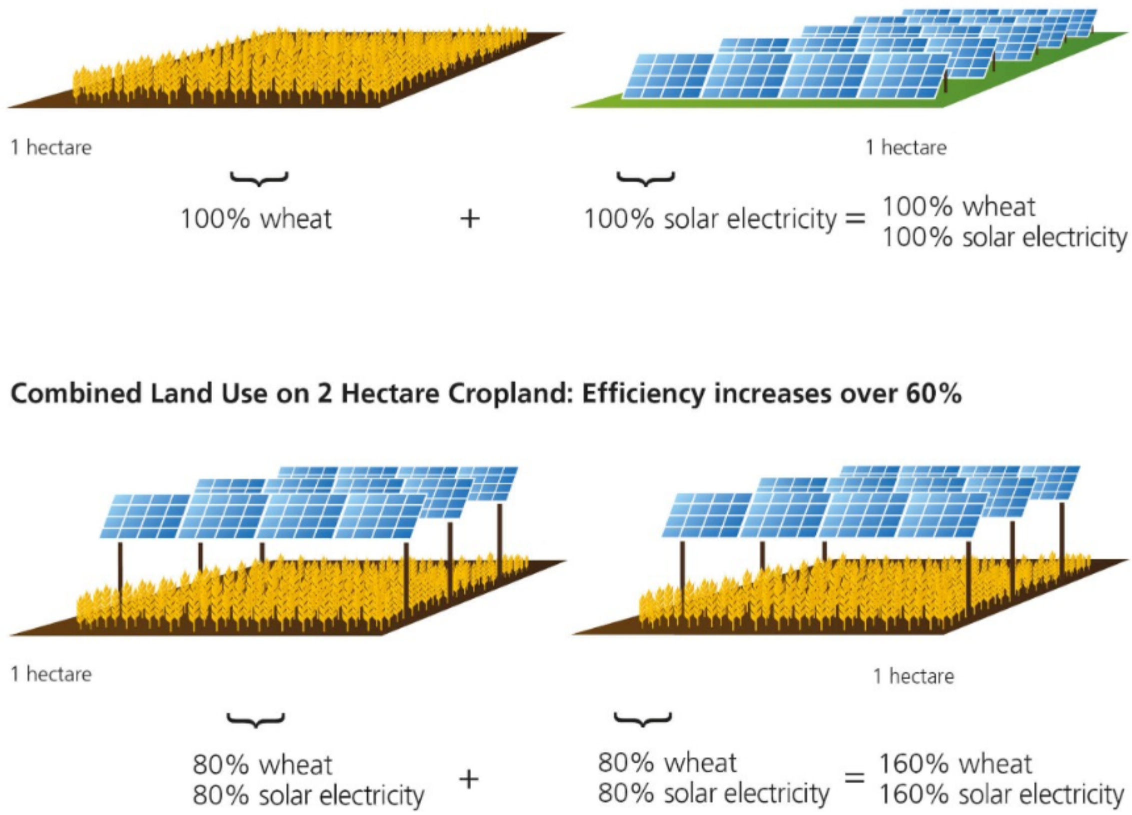


*Figure 3: Dual Land use (Source: Fraunhofer Institute)*

Successful agrivoltaic systems require thoughtful design that balances agricultural productivity with energy generation. Key factors include optimizing the tilt and spacing of photovoltaic panels to maximize sunlight distribution for both crops and energy production, as well as selecting appropriate crop varieties based on their light requirements. Additionally, the integration of environmental factors such as soil health, water management, and microclimate conditions under the panels is critical to ensure that both solar and agricultural outputs are optimized[1]

## Montgomery County Regulatory Landscape

The County has evolving policy on solar development, driven by the need to balance farmland preservation with renewable energy goals. While the County discourages solar project on prime agricultural soils (Class I and Class II), agrivoltaics systems are permitted in the Agricultural Reserve (AR) zone, with specific conditions and limitations. For example, a solar array only qualifies as agrivoltaics if it is accessory to the primary agricultural use of the land. That means that farming must remain the primary activity, and solar cannot displace agricultural production.

Chaberton follows all of the County's guidelines relating to project development and seeks authority to develop projects above the 2 MW-AC limit on Class II soils in the Agricultural Reserve. However, Chaberton complies with all other Montgomery County's regulations:

- No development activity on wetlands or floodplains
- No scraping of topsoil planned in civil work
- Very minimal grading and soil removal that will not impact soil quality requisite to host operating agriculture
- Proper setbacks and screening to minimize visual impacts on surrounding properties and public roads
- Designated pollinator-friendly under Maryland Pollinator-Friendly Designation Program where sites are not incorporating agriculture
- Grazing, crop production, and/or apiary activities (in conjunction with grazing or crop production) at both sites
- Formal approval of interconnection from Potomac Edison (Sugarloaf) and PEPCO (Ramiere)
- Concrete-use solely for pad transformers and electrical equipment and pavement as required by Montgomery County Fire and Rescue
- Undisturbed forestry and natural landscaping

## State of Maryland Regulatory Landscape

Chaberton's commitment to compliance extends beyond Montgomery County to encompass state-level legislation aimed at promoting responsible solar development

**House Bill 0908:** Enacted in 2022 to streamline the approval process for community solar projects while encouraging the integration of agriculture. Per HB 0908, Maryland defines agrivoltaics as the simultaneous use of land for both solar energy generation and agriculture, which includes:

- Raising grains, fruits, herbs, melons, mushrooms, nuts, seeds, tobacco, or vegetables
- Raising poultry, including chicken and turkeys, for meat or egg production
- Dairy production, such as the raising of milking cows
- Raising livestock, including cattle, sheep, goats, or pigs

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[1] Dupraz, C., et al., "Combining solar photovoltaic panels and food crops for optimizing land use: Towards new agrivoltaic schemes," Renewable Energy 36, no. 10 (2011): 2725-2732, https://doi.org/10.1016/j.renene.2011.03.005.

- Horse boarding, breeding, or training
- Turf farming
- Raising ornamental shrubs, plants, or flowers, including aquatic plants
- Aquaculture
- Silviculture

While this definition emphasizes the dual-use nature of the land and requires that agricultural activities remain a primary focus, it is very broad. Chaberton's Sugarloaf and Ramiere projects aim to advance agrivoltaics by innovatively integrating agricultural practices that are comparable to the activity in the state and Montgomery County. They recognize that agrivoltaics is not merely about co-locating solar panels and agriculture but about creating a synergistic system where both solar energy and agriculture can thrive.

Chaberton's projects align with this legislation by prioritizing dual-use land and incorporating agricultural practices. They go beyond simply placing solar panels on farmland; they actively seek ways to enhance agricultural productivity through engaging groups like Okovate to analyze practices such as pollinator-friendly plantings, managed grazing, crop production, and apiary activity beneath the panels. This approach maximizes land use efficiency and ensures that solar development complements, rather than displaces, agricultural activities.

**House Bill 1309:** Passed in 2021, this bill established the Maryland Pollinator-Friendly Solar Energy Generating System Designation Program. Chaberton actively participates in this program by incorporating pollinator-friendly ground cover and creating suitable habitats for bees and other pollinators where agrivoltaics is not implemented. This not only benefits local ecosystems and supports biodiversity but also contributes to the productivity of nearby farms by enhancing pollination services. Chaberton's commitment to pollinator-friendly practices showcases their understanding of the interconnectedness between solar energy, agriculture, and environmental health.

## Current State of Agrivoltaics

National Renewable Energy Laboratory (NREL) manages a map of all U.S.-based agrivoltaics projects called InSPIRE (Innovative Site Preparation and Impact Reductions on the Environment). This initiative within NREL focuses on researching and promoting agrivoltaics to maximize the benefits of solar development while minimizing environmental impacts. Last updated in June of 2024, this map shows that there are 584 solar projects utilizing over 62,000 acres, representing over 10 GW, that qualify as agrivoltaics either for sheep grazing, crop production, or pollinator habitat[2]. Of these over 70% of the sites incorporate a pollinator habitat and nearly 40% incorporate grazing, being especially prevalent on larger sites (average of 226 acres/project). Only 6% (35 sites representing 360 acres) incorporate crop harvesting. In addition to the small number, these projects are small, with an average of only 10 acres / project demonstrating that this form of agrivoltaics is extremely nascent; dominated by what would be considered pilot or demonstration projects. Of note, none of these are located in Maryland. On the positive side, agrivoltaics is growing rapidly be a core part of the solar industry. The Solar Energy Industries Association (SEIA) states that as of September 9, 2024, there a

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[2] InSPIRE, Agrivoltaics Map https://openei.org/wiki/InSPIRE/Agrivoltaics_Map

re 209.8 GW of installed solar capacity in the U.S.[3] This means that agrivoltaics makes up at least 4.7% of solar projects in the United States. With more and more projects coming online incorporating agrivoltaics – at least with pollinator friendly habitats – this percentage is growing rapidly.

## Okovate Credentials

Okovate is a minority- and woman-owned and operated firm headquartered in Maryland making community solar deployment more sustainable and economic through agrivoltaics. We prioritize farmland protection and ensure that solar development works with the food system instead of against it. Our team has a deep background in agriculture and agronomy alongside experience in solar project design in order to understand how best to optimize these projects.

Our vision is to create a future where communities thrive by harnessing local land to simultaneously generate clean energy and sustainably produce food through innovative technologies.

We are a leading innovator in agrivoltaic solutions, specializing in the research, design, and implementation of systems that seamlessly integrate agricultural practices with solar energy production. Our expertise lies in developing customized agrivoltaic strategies that optimize land use efficiency, enhance agricultural yields, and promote sustainable farming practices. Our deep understanding of both the agricultural and solar sectors allows us to create synergistic systems that maximize the benefits of both.

This report was spearheaded by Okovate's Chief Agricultural Officer, Jorrit Becking. Mr. Becking brings extensive experience in the development and implementation of agrivoltaic projects across the globe. His educational background includes a Master of Science degree in Plant Science from Wageningen University, a renowned agricultural research institution in the Netherlands, and a Master of Environmental Management from Yale University.

### Collaboration with Fundusol

Backed by experts at Stanford University and Carnegie Mellon University, Fundusol's proprietary agrivoltaic software provides optimized system designs for electricity and agricultural performance, across locations, crop profiles, and livestock systems. They provided co-location modeling outputs to strengthen our data-driven recommendations for agricultural strategies. They employed machine-learning algorithms and optimization techniques to balance system configurations, crop biomass, animal productivity, and array spacing. Their model integrates ASCE standards, cost functions, and environmental constraints, producing scenario analyses that explore the spatial and economic interactions between solar energy and agriculture.

[3] Solar Market Insight Report, SEIA, https://seia.org/research-resources/us-solar-market-insight/

# Landscape Assessment

This chapter explores key environmental and agricultural factors at the Sugarloaf and Ramiere sites, focusing on soil, water, and climate conditions. These factors are crucial in determining the viability of integrating agrivoltaic systems with farming practices.

## Montgomery County

### Agricultural Economy

Montgomery County's agricultural landscape is characterized by various crop and livestock operations. With 583 farms spanning nearly 70,000 acres, more than 75% of these farms are under 50 acres, reflecting the small-scale nature of much of the county's agriculture[4]. Montgomery County's farmland is overwhelmingly used for commodity grain production, primarily feeding into the livestock industry. However, with a market value of $26,725,000, the Montgomery County horticultural industry still ranks fourth in the State[5]. The County's agricultural economy has remained resilient, with net farm income increasing and the number of farms holding steady since 2017, even amid reduced government support. This reflects a strong and diversified agricultural community, providing the foundation to support successful agrivoltaics projects.[6]

### Agricultural Reserve[7]

Both sites are in the Montgomery County Agricultural Reserve. The Montgomery County Agricultural Reserve, created in 1980, protects 93,000 acres of farmland and open space by limiting development to one house per 25 acres through the Rural Density Transfer Zone and the Transferable Development Rights (TDR) program. These measures, alongside the Building Lot Termination (BLT) program, have preserved over 63,000 acres for farming, supporting 540 farms. However, rising land values, limited diversification options, and reliance on fluctuating TDR markets create financial challenges for farmers, potentially impacting the Reserve's long-term sustainability as land-use demands shift.

### Climate

The climate in Montgomery County, Maryland, plays a significant role in shaping the agricultural potential and the feasibility of agrivoltaic systems at the Sugarloaf and Ramiere sites. The region experiences a temperate climate characterized by moderate rainfall and warm summers, making it conducive for both crop cultivation (mainly soybeans, corn, hay, and wheat) and livestock grazing.

With an annual rainfall of approximately 1,028 mm, the region generally provides sufficient moisture for agricultural activities. However, the evapotranspiration rate of 1,115 mm suggests that, during warmer months, there can be a slight water deficit. This is where agrivoltaics offers a potential

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[4] United States Department of Agriculture, National Agricultural Statistics Service. (2022). *2022 Census of Agriculture County Profile: Montgomery County, Maryland* (Publication No. cp24031). https://www.nass.usda.gov/Publications/AgCensus/2022/Online_Resources/County_Profiles/Maryland/cp24031.pdf

[5] https://www.montgomerycountymd.gov/agservices/ag-facts.html

[6] https://www.nass.usda.gov/Publications/AgCensus/2022/Online_Resources/County_Profiles/Maryland/cp24031.pdf

[7] Montgomery County Planning. (n.d.). *Agricultural Reserve Award.* Retrieved from https://montgomeryplanning.org/awards/ag-reserve-award/

advantage over traditional farming. The partial shading from solar panels can reduce the water needs of crops by minimizing evapotranspiration, helping to conserve water during drier periods.

## Sugarloaf

Project Sugarloaf presents strong potential for agrivoltaic systems thanks to its well-drained sandy loam soil. Although the pH level of 4.6[8] is slightly lower than optimal, indicating that some soil treatment might be necessary to support production, the site benefits from excellent drainage, reducing the risk of waterlogging. The soil's erosion risk (K factor) is low, which supports long-term land stability, but wind erosion is a moderate concern, highlighting the importance of maintaining vegetative cover. The water holding capacity is somewhat limited at 0.13 cm/cm, increasing the need for irrigation during drier crop seasons. Given these conditions, grazing is more suitable than intensive crop production, as it requires fewer inputs and is less affected by the site's susceptibility to drought and wind erosion.

*Table 1: Sugarloaf environmental parameters[9]*

| Category | Value | Score |
|---|---|---|
| Soil Type | Sandy Loam | 6.5 |
| pH Level | 4.6 | 5 |
| Erosion Risk (K Factor) | 0.28 | 10 |
| Wind Erosion Risk | Moderate | 7 |
| Drainage | Well Drained | 8 |
| Water Capacity (cm/cm) | 0.13 | 7 |

## Ramiere

Project Ramiere offers promising conditions for agrivoltaic systems, particularly due to its well-drained silt loam soil, which provides better fertility and water retention compared to sandy loam soils. The site's pH level of 5.5[10] is closer to the optimal range for most crops, reducing the need for soil treatment. However, the higher erosion risk (K factor of 0.49) and susceptibility to soil compaction highlight potential challenges for intensive crop production, necessitating careful land management practices. Wind erosion is also a moderate concern, reinforcing the importance of maintaining good ground cover. With a strong water-holding capacity of 0.16 cm/cm, irrigation demands are less pronounced than in other sites, making this location more flexible for agricultural u

[8] USDA Web Soil Survey: https://websoilsurvey.nrcs.usda.gov/app/
[9] USDA Web Soil Survey: https://websoilsurvey.nrcs.usda.gov/app/
[10] USDA Web Soil Survey

se. Nonetheless, the susceptibility to erosion and compaction makes grazing a more sustainable than crop farming, ensuring the land remains productive over time with fewer inputs.

*Table 2: Ramiere Environmental Parameters[11]*

| Category | Value | Score |
|---|---|---|
| Soil Type | Silt Loam | 7.5 |
| pH Level | 5.5 | 7 |
| Erosion Risk (K Factor) | 0.49 | 4 |
| Wind Erosion Risk | Moderate | 7 |
| Drainage | Well Drained | 9 |
| Water Capacity (cm/cm) | 0.16 | 10 |

## Agronomic Assessment

This chapter provides a comprehensive analysis of the agrivoltaic potential for crops and grazing at the Chaberton Ramiere and Sugarloaf sites, including financial analyses. The crop modeling evaluates the performance of different crops under solar panels, examining yield variations and the financial impact of reduced production. The grazing section outlines sheep stocking densities, management strategies, and economic viability assessments.

Based on the ground coverage ratio of around 40% in the designs, we calculated the tillable in-between-row acreage at Sugarloaf to be around 10 acres and around 5 acres at Ramiere. Combined for both sites there is an additional 5 acres outside the solar array but within the project boundary, that could be used for agricultural activities. However, these 5 acres are only included in the grazing assessment, as straight rows required for crop farming are not feasible in this area. These numbers were used to calculate the total yields since the area directly under the solar panels will be less productive. Due to the proximity of both sites and the total acreage of the plots, the total tillable land will be around 20 acres, allowing for a wide range of agricultural activities. In our assessment, we model the yields and profits for farmers under agrivoltaics and, for comparison, calculate the same metrics for conventional agriculture at the same site. For conventional agriculture (without solar) we assumed a land lease of $250 for cropland and $50 for pasture and for agrivoltaics we use a $250 vegetation management subsidy. Final rate decisions will be up to Chaberton.

[11] USDA Web Soil Survey: https://websoilsurvey.nrcs.usda.gov/app/

## Crop Modelling

We modeled a variety of common Maryland crops to evaluate their performance, profitability and feasibility in an agrivoltaics design. We combined all results in the table below. Further information on sources and assumptions for this analysis can be found in the table in Annex 1. The risk score is based on crop vulnerability and market vulnerabilities. The APV feasibility score is based on the physical limitations of crop production in the proposed designs, it deals mainly with equipment access and plant height. In both categories, a high score indicates optimal conditions for agrivoltaics: a high-risk score signifies low risk, while a high feasibility score means the crop is highly feasible.

Since both locations are so similar, and closely located we modeled Ramiere and utilized the results for Sugarloaf as well. The results for crops show that for all cases, the crop profits are lower than without agrivoltaics. However, when considering the additional income from solar leases, the total economic output of the land is significantly higher. Important to note is that for this analysis we used a $250/ acre cash rent for conventional agriculture, and a $250/acre payment to the farmer for the agrivoltaics analysis.

The best performing crops were watermelon, summer squash and carrots.

We modeled for different designs. Interestingly, elevating the panels resulted in an insignificant increase in irradiance but negatively impacted crop yields. This occurs because, with the same row spacing, the shading effect remains almost consistent, while the micro-climate benefits diminish as panel height increases.

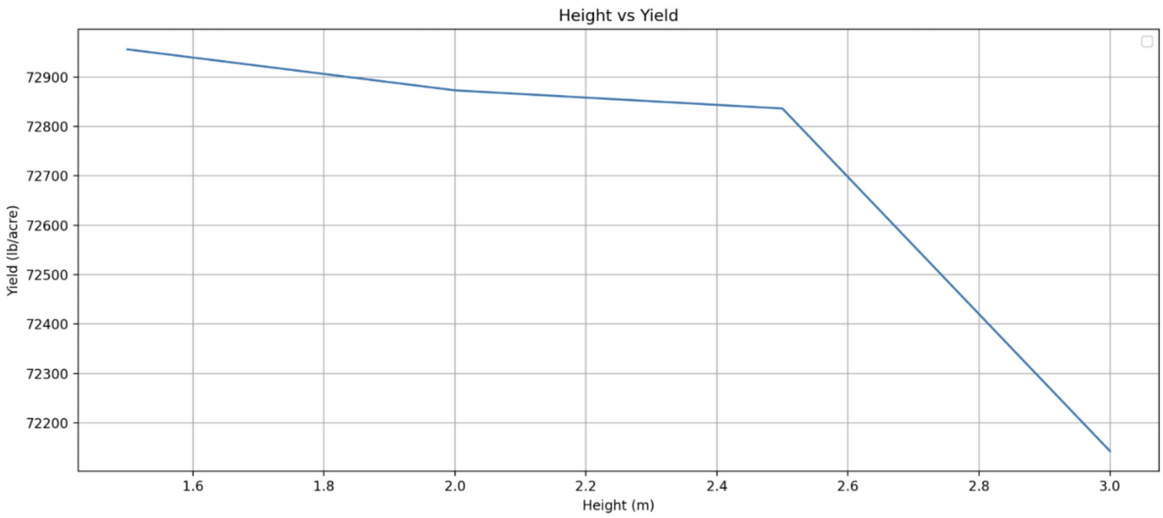


*Figure 4: Panel height and tomato yield at Ramiere*

*Table 3: Crop analysis results for Ramiere and Sugarloaf I. Annex II for references.*

| Crop System | Conventional agriculture | Agrivoltaics | Agrivoltaics + subsidy | Risk Score | APV Feasibility |
|---|---|---|---|---|---|
| **Sweet Corn** | | | | 4 | 2 |
| Yield (lb/acre) | 12,000 | 10,560 | 10,560 | | |
| Revenue ($/acre) | 4,020 | 3,538 | 3,538 | | |
| Costs ($/acre) | 3,200 | 2,950 | 2,700 | | |
| Profit ($/acre) | 820 | 588 | 838 | | |
| **Soy** | | | | 3 | 3 |
| Yield (lb/acre) | 2,820 | 3,187 | 3,187 | | |
| Revenue ($/acre) | 556 | 628 | 628 | | |
| Costs ($/acre) | 549 | 299 | 49 | | |
| Profit ($/acre) | 7 | 329 | 579 | | |
| **Lettuce** | | | | 1 | 5 |
| Yield (lb/acre) | 23,100 | 16,586 | 16,586 | | |
| Revenue ($/acre) | 16,586 | 11,909 | 11,909 | | |
| Costs ($/acre) | 13,780 | 13,280 | 13,030 | | |
| Profit ($/acre) | 2,806 | -1,371 | -1,121 | | |
| **Tomato** | | | | 3 | 3 |
| Yield (lb/acre) | 13,000 | 11,440 | 11,440 | | |
| Revenue ($/acre) | 6,370 | 5,606 | 5,606 | | |
| Costs ($/acre) | 14,587 | 14,337 | 14,087 | | |
| Profit ($/acre) | -1,587 | -2,897 | -2,647 | | |
| **Carrot** | | | | 3 | 4 |
| Yield (lb/acre) | 27,500 | 34,375 | 34,375 | | |
| Revenue ($/acre) | 10,340 | 12,925 | 12,925 | | |
| Costs ($/acre) | 8,820 | 12,820 | 12,570 | | |
| Profit ($/acre) | 1,520 | 105 | 355 | | |
| **Potato** | | | | 3 | 2 |
| Yield (lb/acre) | 25,500 | 18,870 | 18,870 | | |
| Revenue ($/acre) | 3,698 | 2,736 | 2,736 | | |
| Costs ($/acre) | 2,698 | 2,948 | 2,698 | | |
| Profit ($/acre) | 1,000 | -212 | 38 | | |
| **Watermelons** | | | | 3 | 4 |
| Yield (lb/acre) | 13,300 | 7,980 | 7,980 | | |
| Revenue ($/acre) | 7,730 | 4,788 | 4,788 | | |
| Costs ($/acre) | 4,700 | 4,450 | 4,200 | | |
| Profit ($/acre) | 3,030 | 338 | 588 | | |
| **Summer Squash** | | | | 5 | 5 |
| Yield (lb/acre) | 25,000 | 15,000 | 15,000 | | |
| Revenue ($/acre) | 15,000 | 9,000 | 9,000 | | |
| Costs ($/acre) | 8,438 | 7,938 | 7,688 | | |
| Profit ($/acre) | 6,562 | 1,062 | 1,312 | | |

## Crop analysis results

Our assessment indicates that certain crops are better suited for growth under solar panels in agrivoltaic (APV) systems at the Sugarloaf and Ramiere sites. Summer squash, watermelons, and carrots performed best in our analysis, with carrots expected to yield 25% more under agrivoltaics.

Although sweet corn and soy also showed positive results, these crops are less feasible at these sites due to plant height requirements (sweet corn) and the need for large equipment (soy). While soy is anticipated to yield 13% more in agrivoltaic systems, limited equipment access would likely render its cultivation impractical, as harvesting soy by hand is not feasible.

Crops such as lettuce, tomatoes, and potatoes are not suitable for these sites due to their high light requirements and sensitivity to humidity in the soil (which increases disease pressure).

An important consideration for all crops grown at these sites is the challenge of establishing reliable market access. Many crops are perishable, and supply chain logistics heavily influence their viability. For specialty crops, farmers often depend on local markets, such as farmer's markets or co-ops, due to challenges in transporting them over long distances.

Additionally, although our analysis indicates that squash and watermelon can generate substantial profits, these crops cannot be grown in the same soil year after year. Crop rotation is essential to prevent disease build-up and allow the soils to rest. Using a rotation of carrots, squash, and watermelon, the average profit per acre is $500 without a solar subsidy and $750 with it. For the total tillable acreage (15 acres), total profits would range from $7,500 to $11,250 per year, respectively. This demonstrates that, for these sites, crop production may not be feasible unless a nearby farmer is found that can easily extend their operations to these sites.

# Crop-Specific Analysis

### Sweet Corn

Sweet corn demonstrates reasonable adaptability to agrivoltaic systems, but its taller plant structure can interfere with solar panel layout.

### Soy

Significant marketing challenges exist for small-scale soy production, which traditionally benefits from economies of scale. Additionally, specialized equipment requirements increase the complexity of production under agrivoltaics. For the row spacing at these solar sites, this likely means that equipment needs to be important from countries where these small-scale systems are more prevalent, like China.

### Lettuce

Lettuce is a high-risk crop due to its sensitivity to environmental conditions and high spoilage potential. Its perishability makes it vulnerable to fluctuating temperatures, a concern in partial shade environments that may not provide consistent microclimate conditions ideal for lettuce production. Lettuce can be grown in small-scale systems, and its production doesn’t interfere with solar yield. However, the modeling analysis shows that lettuce can be expected to have a yield reduction of 40%. This makes the crop unprofitable.

### Tomato

Tomato production is impacted by high price volatility. Shade conditions can increase the risk of diseases like blight because of the more humid environment. Plant height complicates integration with agrivoltaics. However, the models show that the reduction of tomatoes is only reduced by 12% under the agrivoltaic setup. Still, due to the high production costs, tomatoes are not expected to be profitable on these sites.

### Carrot

Carrots are moderately compatible with agrivoltaic systems, as they can tolerate partial shading and perform well in cooler, stable conditions. though labor requirements and limited availability of small-scale equipment pose production challenges. Carrots are moderately sensitive to diseases such as alternaria leaf blight and bacterial blight, which thrive in moist, shaded conditions often created by APV. They require good soil quality and consistent moisture levels, which APV systems help maintain. This also shows from our modeling where carrots yield up to 25% more in the APV system. However, in the cost analysis, we added 300 hours of labor for the agrivoltaics cost calculation because traditional harvesting equipment can't access the crops with the current row spacing.

### Potato

Potatoes show moderate suitability for agrivoltaics. They are highly sensitive to certain pests and diseases and the soil often needs to 'rest' several years in the crop rotation before potatoes can be planted again. Factors such as soil type and irrigation practices play a significant role in maximizing yield potential under partial shade systems. Potatoes will likely need to be hand-harvested in an APV system adding to the production costs.

### Watermelons[12]

Watermelons are highly susceptible to pests like cucumber beetles and diseases such as fusarium wilt, which is soil-borne and requires a crop rotation of 5-6 years for control. Watermelons have a stable market demand but are hindered by high spoilage risks and considerable water requirements. Agrivoltaic shading can aid in moisture retention, potentially reducing irrigation needs and helping maintain crop quality. However, the crop also has high light requirements, and yield reductions might be significant under partial shade. We estimated a yield reduction of 40% which still allows for some profits, but the long crop rotation reduces long-term profitability.

### Summer Squash[13]

Summer squash aligns well with agrivoltaic conditions, showing low spoilage risk and strong market demand. Most varieties are relatively resilient to pests and diseases, but crop rotation is important to avoid the build-up of soil-borne pathogens. We estimate a 40% yield reduction for summer squash under APV and the crop still remains profitable. Squash is highly dependent on pollination,

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[12] University of Maryland Extension. (1999). *Crop Profile for Watermelons in Maryland.* University of Maryland Extension.

[13] University of Kentucky Center for Crop Diversification. (n.d.). *Summer squash* (CCD-CP-121). University of Kentucky. Retrieved October 27, 2024, from https://www.uky.edu/ccd/sites/www.uky.edu.ccd/files/summersquash.pdf

which could pose an additional risk which could potentially be mitigated by pairing with an apiary and pollinator friendly plantings.

## Modeling Methods

For the expected control yields, USDA data was sourced (unless otherwise specified) from the USDA/NASS Quickstats Ad-hoc Query Tool.[14] For each crop, the most specific location available was used (Maryland in most cases), and the most recent year available for that location was used. For crop budgeting, we strived to find the most accurate budgeting tool. This meant that the tools needed to be locally relevant, with up-to-date costs and prices. We accounted for inflation when budget tools were from before 2022. Unskilled labor cost was estimated at $15/hr. Finally, for all crops, a land lease of $250/acre was assumed, and for all agrivoltaic budgets, a subsidy of $250/acre was assumed.

One of the most critical factors for plant growth is irradiance. To assess the agrivoltaic potential of a site, we first evaluate the light available for crops in the spaces between solar panel rows. Modeling analysis by Fundusol indicates that the current setup results in an approximate 36% reduction in between-row irradiance. While raising the panels slightly increased light availability, the effect was minimal. Additionally, we observed that irradiance is slightly lower for single axis tracker systems. Consequently, the irradiance at Sugarloaf is about 5% lower than at Ramiere. However, given the similarities between the sites and the small scale of this difference relative to other modeling factors, we consider the two sites as comparable. For our estimates, we use a conservative irradiance reduction value of 40%.

*Table 4: Daily Light Integral figures between rows (Ramiere)*

| | **DLI** | **Reduction** |
|---|---|---|
| Control (same site, no panels) | 83055 $Wh/m^2$ | |
| With panels at the listed height (2.46m): | 53594 $Wh/m^2$ | 35.7% |
| With panels at 2.7m | 54448 $Wh/m^2$ | 34.44% |

With the irradiance results the modeling simulations were done using Fundusol's in-house agrivoltaic modeling suite (described below) with crop growth modeled over the growing seasons described in the University of Maryland Extension Planting Calendar.[15] The model was run twice for each crop: once as a control and once with the solar panel setup. This produced the following changes in crop yield for each crop. Since both sites have a very similar design (differences in crop yield between both sites are <5%), we only modeled for Ramiere.

*Table 5: Modeled Crop Yield Changes Under Agrivoltaics System*

| **Crop** | **Change (Ramiere site)** |
|---|---|
| Corn | -12% |
| Soy | +13% |
| Lettuce | -39% |

[14] https://quickstats.nass.usda.gov/results/5B142C1E-343F-3ADB-B746-531600CB1811
[15] https://extension.umd.edu/resource/vegetable-planting-calendar

| | |
|---|---|
| Tomato (fresh market) | -12% |
| Carrot | +25% |
| Potato | -26% |
| Watermelon | -40% (based on estimate, no modeling data available) |
| Summer Squash | -40% (based on estimate, no modeling data available) |

*Table 6: Model Assumptions*

| | **Sugarloaf** | **Ramiere** |
|---|---|---|
| Panel height | 5'2" panel height | 8' maximum panel height |
| Row spacing | 8.08' interrow row spacing | 8' interrow row spacing |
| Tilt | Single-axis tracking system | Fixed-tilt system |

Fundusol's modeling suite consists of proprietary thermal and irradiance models, which are then fed into publicly available research-based biomass models. For soybeans, the WOFOST model was used, and for the remaining crops, the SIMPLE model was used.

### Thermal Model

Fundusol's thermal model provides a detailed, climate-responsive prediction of microclimate temperature distributions at both the panel and crop level, along with relative humidity. Temperature predictions integrate environmental and system-specific variables like array height, using energy conservation and computational Fluid Dynamics (CFD) principles to predict thermodynamics. The projections also factor in the influence of crops, especially through evapotranspiration, on humidity and temperature. The model then calculates relative humidity beneath the panels and supplies this data to Fundusol's crop biomass models.

### Irradiance Model

Fundusol's irradiance model leverages PV system geometry to assess solar projects' impact on ground-level irradiance. Using local irradiance data and matrix-based ray tracing, the model evaluates irradiance over hundreds of field points hourly, aggregating to daily light integrals (DLI). To ensure DLI aligns with crop growth, it applies a Light Saturation Point (LSP) cap tailored to each crop's light saturation limit, refining inputs for Fundusol's biomass models.

### WOFOST Model

The WOFOST model, a mechanistic and dynamic system, calculates daily crop growth by examining processes such as photosynthesis and respiration and how they are influenced by environmental conditions. Crop-specific parameters include initial dry weight, life span of leaves, rate of phenological development, death rates, fractions of assimilates partitioned to plant organs, and the minimum and maximum nutrient concentrations per plant organ. Climate data inputs required include minimum, average, and maximum air temperature (°C), irradiation (W/m$^2$), humidity (relative humidity in %), windspeed (m/s), monthly rainfall (mm), and number of rainy days (count). WOFOST has been utilized by researchers worldwide and applied to many crops across various climatic and management conditions. For further information, reference Wit, et. Al. 2019.[16]

[16] https://doi.org/10.1016/j.agsy.2018.06.018

## SIMPLE Model[17]

The simple generic crop model (SIMPLE) model was calibrated and evaluated for the simulated crops using observations for biomass growth, solar radiation interception, and yield from 25 detailed field experiments for a total of 70 treatments from 17 sites, resulting in an RRMSE of 25.4% for final yield. The paper has been cited 125 times. The parameters involved include the cumulative temperature requirement from sowing to maturity (°C d), potential harvest index, cumulative temperature requirement for leaf area development to intercept 50% of radiation (°C d), maximum daily reductions in leaf area index due to heat stress and drought stress (°C d), the threshold temperature to start accelerating senescence from heat stress (°C), the relative increase in radiation use efficiency per ppm elevated CO2 above 350 ppm, and the sensitivity of radiation use efficiency (or harvest index) to drought stress measured by the ARID index, which is calculated based on water scarcity. Environmental variables required to run the SIMPLE model include daily maximum temperature (°C), rainfall (mm), irrigation (mm), solar radiation (MJ $m^{-2}$), atmospheric CO2 concentration (Ppm), sowing date, and harvesting date.

All simulations were conducted (apart from where otherwise noted) using the data listed for the Ramiere site. Environmental data fed into all models was based on ten-year averages of local data.

[17] Please read the full formulation in the paper "A SIMPLE crop model" by Zhao et. al.

# Animal System Modeling

## Grazing modelling

This section covers our modeling and resulting recommendations regarding grazing density, pasture species selection, and grazing management strategies to protect both animals and solar panels. Additionally, we provide a financial scenario analysis to better understand the costs and benefits of grazing-integrated agrivoltaics. For successful grazing at these sites, we recommend raising the ground clearance to at least 3.5 feet. This will ensure animal safety and allow for easier access to farming activities. In Appendix B, an overview can be found of Fundusol's construction cost estimates. While we focus on sheep grazing given the high level of compatibility with solar, a discussion of other potential grazing options is included as well.

### Grazing Management Strategies

Across the two projects, which would ideally be farmed by the same tenant, the total pasture acreage will be around 170 acres of which 30 acres will be on the solar array. To manage the land effectively, a grazing plan needs to be designed to optimize sheep production, pasture health, compliance with vegetation management obligations, and the logistics of co-location with a PV site. Below we summarize several grazing strategies that can be employed. Typically, the more intensive management strategies lead to higher revenues but also increase costs. We recommend rotational grazing, but the decision will be up to the tenant farmer, which may also be impacted by additional sites the farmer has under contract

- **Continuous grazing:** Sheep have unrestricted access to the entire pasture, reducing fencing costs and maintenance. However, this can result in uneven grazing, overgrazing of preferred plants, weed growth, and long-term issues like parasites. An unknown of this system is that sheep can access the solar array for shelter when they like, which could mean they don't fulfill their proper vegetation management role around the panels, but it can also lead to overgrazing and soil degradation on those sites if they prefer them more.
- **Rotational grazing:** Sheep rotate through multiple paddocks with shorter grazing periods, typically lasting a few days to a week. This promotes better pasture recovery, more even grazing, improved forage, and better weed control, but it requires higher upfront costs for fencing and water infrastructure. To reduce the labor intensity of this grazing strategy, the farmer could use geofencing; this technology uses geo-located collars and warns the sheep when they leave their virtual paddock.
- **Intensive rotational grazing:** Pastures are divided into numerous small paddocks, with sheep moved every 1-3 days. This system maximizes pasture productivity and soil health but demands significant investment in fencing, water infrastructure, and frequent management.[18]

[18] https://www.sheep101.info/201/grazingsystems.html

## Pasture Species

Solar grazing can easily be combined with pollinator-friendly habitat. Sheep are selective grazers meaning that they favor the more digestible forage, which allows for more biodiversity in the species mix. We recommend the Fuzz and Buzz seed mix from the American Solar Grazing Association[19].

For the estimation of the appropriate stocking rate below, we simplified the pasture mix and use ryegrass for the purpose of our calculations and assumed that other pasture species in the mix have similar yields. The dry matter (DM) yield for perennial ryegrass on well-managed pastures in Maryland typically ranges from 2.5 to 5 tons/acre/year, depending on the intensity of management and environmental conditions. Lower yields around 1 to 2 tons/acre/year are observed in unimproved or less intensively managed pastures[20].

## Stocking Density

For an Agrivoltaic site, the number of sheep per acre will differ from a typical sheep grazing operation. The stocking density is a management decision based on the expected pasture yield. The pasture yield is influenced by the following factors:

- Pasture improvement: liming, fertilization, weed removal, a healthy mix of grasses and legumes, appropriate shading, and water.
- Correct level of nutrition available for the sheep depending on their production stage.
- Appropriate grazing management strategy (continuous grazing, low rotational grazing, moderate rotational grazing, intensive rotational grazing).[21]

As can be seen from this list, pasture growth rates are highly variable and largely determined by environmental and management conditions, with irradiance (Photosynthetically Active Radiation - PAR) being one of the most significant drivers[22]. To make an estimate of the pasture yield under solar, at both sites, we assume a directly proportional relationship between the yield and PAR irradiance. Based on our irradiance studies, we estimate an in-row PAR reduction of around 40% at both sites. This would mean that the range for ryegrass production would be reduced to a DM yield of 1.5 – 3 tons/acre/year with a mid-point of 2.25. For this analysis, we use the Katahdin sheep breed**,** one of the most common breeds for solar grazing[23]. They are very docile and have little complications with lambing. A mature ewe weighs between 120 to 160 pounds**,** with a midpoint of 140 pounds[24]. The recommended dry matter (DM) intake is 3% of body weight, amounting to 4.2 lbs./day of DM per sheep[25]. This means that for pasture in the solar array, the stocking rate is estimated at 2.7 to 4.1 ewes per acre, with a midpoint of 3.4 ewes/acre. And for the pasture outside the

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[19] https://solargrazing.org/fuzz-and-buzz-solar-seed-mix/

[20]: Barrett, P. D., Laidlaw, A. S., & Mayne, C. S. (2005). Giria, K., Chia, K., & Chandra, S. (2019). USDA NRCS Idaho State Office. (2008). University of New Hampshire, College of Life Sciences and Agriculture. (2021). Smith, R. G., Atwood, L. W., & Warren, N. D. (2014).

[21] https://extension.wvu.edu/files/d/38c2e0b8-0c0c-4f1e-8dd8-68c3496a9690/stocking-rate.pdf

[22] Barrett, P. D., Laidlaw, A. S., & Mayne, C. S. (2005).

[23] American Solar Grazing Association. (2019). *Solar Grazing: A New Farm Income*. Retrieved from https://solargrazing.org/wp-content/uploads/2019/06/Solar-Grazing-Brochure.pdf

[24] Oklahoma State University. (n.d.). *Katahdin Sheep*. Breeds of Livestock. Retrieved from https://breeds.okstate.edu/sheep/katahdin-sheep.html

[25] University of Maryland Extension. (n.d.). *Determining Your Pasture Stocking Rate*. Retrieved from https://extension.umd.edu/resource/determining-your-pasture-stocking-rate/

array, with a full yield of 2.5–5 tons/acre/year, the stocking rate increases to 4.6 to 6.9 ewes per acre, with a midpoint of 5.7 ewes/acre. For simplicity, we continue the calculations with 3 ewes/acre in the solar array and 7 ewes/acre on the rest of the land. It will again be up to the farmer to select an appropriate stocking rate and this calculation is mainly to support the broader analysis contained in this report to understand the options. Improved pastures can reach stocking rates of 10 sheep per acre.[26] Our estimates for the total stocking rates for the acreage of the two sites are around 80 ewes. It is important to note that we conservatively assume zero productivity on the land under the solar panels. In reality there will be grass growth under the panels as well so the total stocking rate will likely be slightly higher. But we chose to exclude this for conservatism against overgrazing.

*Table 7: Stocking rate calculation*

| | Solar array | Outside array | Total |
|---|---|---|---|
| Total acreage | 15 | 5 | 20 |
| Stocking rate / acre | 3 | 7 | 4 |
| Total sheep | 45 | 35 | 80 |

## Sheep Farmer Budget and Profits

To understand the expected profit a sheep farmer can make, a budget from The University of Maryland is shown below.[27] This is a typical commercial sheep budget that sells live lambs (hair or wooled) as its main source of income. It assumes that lambs are replaced annually. All costs in the model were increased by 20%, accounting for inflation since 2016. The selling prices were updated using the USDA *Centennial livestock sheep and goat auction prices* (October 23, 2024). Selling weights were adapted to the smaller Katahdin sheep. Current prices are: Male lambs at $1.91/pound, ewe lambs at 1.80, cull rams at 0.80, and cull ewes at $0.88/pound. We assumed no income from wool because Katahdin sheep don't grow enough fleece.

From our analysis (table 6), we find that a farmer could earn a yearly profit of $14,700 from sheep farming at both sites. This includes a payment to the farmer for vegetation management services around the solar array (including the areas directly below the panels). If we exclude this payment ($250/acre), total annual profit would be $7200. For comparison with a conventional grazing operation at this site, we assumed a $50 lease payment, total annual profit for both sites would be $17,200.

*Table 8: Sheep farming budget (based on the University of Maryland Ag. Extension Excel Tool)*

| | **Solar Array** | **Outside Array** | **Total** | **Conventional** | **unit** |
|---|---|---|---|---|---|
| Stocking density | 3 | 7 | 3 | 7 | Ewes/acre |
| grazable area | 15 | 5 | 30 | 30 | Acres |
| Ewes | 45 | 35 | 80 | 210 | |
| Relative sheep revenue | 294 | 294 | 294 | 294 | $/ewe |
| Total relative income | 882 | 2058 | 784 | 2058 | $/acre |

[26] https://www.raisingsheep.net/how-many-sheep-per-acre
[27] https://solargrazing.org/resources/solar-grazing-budgets/

| | | | | | |
|---|---|---|---|---|---|
| PV subsidy | 250 | 250 | 250 | | $/acre |
| Lease | - | - | | 50[28] | $/acre |
| Total income | 16980 | 11540 | 31020 | 60240 | $ |
| Relative annual expenses | 204 | 204 | 204 | 204 | $/ewe |
| Total annual expenses | 9180 | 7140 | 16320 | 42840 | $ |
| **Total profit** | **7800** | **4400** | **14700** | **17400** | **$** |
| **Relative profit** | **520** | **880** | **490** | **580** | **$/acre** |
| **Relative profit** | **173** | **126** | **184** | **83** | **$/ewe** |

### Wire Management

Effective wire management is crucial for the success of agrivoltaic projects, especially when integrating sheep grazing. To minimize interference with sheep movement and grazing, cables and conduits should be elevated to a height that allows sheep to pass comfortably underneath. This can be achieved through various methods, including:

- **Raised cable trays:** Installing cable trays suspended above grazing height.
- **Underground conduit:** Burying conduit below the grazing surface to protect cables and eliminate obstacles for sheep.
- **Pole-mounted wiring:** Using existing or dedicated poles to elevate cables above the grazing area.

These strategies are incorporated into Chaberton's design and installation considerations and will prevent sheep from becoming entangled in wires, reduce the potential for damage to the wiring system, and maintain a safe grazing environment.

## Other Animal Grazing Options

Other livestock options may be available such as miniature (e.g. Dexter) cows and certain types of pigs. The analysis of suitability for these animals is similar to those for sheep as discussed above.

However, the subset of animals suitable for grazing alongside solar projects is not very long. Animals like pigs, which dig, or goats, which climb and chew on cables/etc, pose risks to the system. Larger livestock might damage the panels or face electric shock hazards.

The integration of poultry with agrivoltaic systems presents another possible model for sustainable farming. For pasture-raised poultry, small-scale farmers can report gross profits of $2–3 per bird,

[28] https://extension.umd.edu/sites/extension.umd.edu/files/2023-10/2022Maryland%20Cash%20Rental%20Rates.pdf

depending on the management level and inputs[29]. Stocking rates for poultry typically range from 500 to 1,000 chickens per acre[30]. To avoid damaging the pasture, the chickens must be moved frequently, using mobile coops or chicken tractors. Combining poultry with agrivoltaic systems could be a viable and profitable option. However, it will likely be much more labor intensive than normal pasture poultry because the mobile coops must be small enough to fit in between the solar panels.

Combining Poultry, particularly when raised on pasture, contributes to soil fertility through manure deposition. However, challenges such as predator management, labor intensity, and maintaining pasture quality need to be addressed. Additionally, poultry operations are usually more limited by labor availability and disease pressure than space and are not common in Montgomery County, making this a less likely option for these projects.

# Apiary Solution

## Introduction

The concept of co-locating beehives with solar farms is gaining traction nationwide.  Studies have shown that solar sites can provide suitable habitats for honeybees, with the panels offering shade and shelter while the surrounding vegetation provides foraging resources.

According to the USDA, U.S. honey production has declined over the last several decades, while honey imports have only continued to grow[31]. In the U.S., over 70% of the honey we consume is imported. However, solar farms offer an opportunity to support and grow our U.S. honey industry.

By planting pollinator-friendly habitats, solar farms can serve as safe, stable homes for honeybees. In place of or in addition to the other options presented in this report, the project may opt to work directly with local beekeepers and private beekeeping businesses to locate hives at the solar farm.

Examples of Apiary-integrated solar in the U.S. include:

- Dominion Energy's 1.6 MW Black Bear Solar project in Buckingham County, VA[32]
- Pine Gate Renewable's 13 MW Eagle Point Solar Farm in Medford, OR[33]

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[29] University of Minnesota. (n.d.). Operating Costs and Revenues of Pastured Poultry Systems: A Comparative Analysis. University of Minnesota Digital Conservancy. https://conservancy.umn.edu/server/api/core/bitstreams/36b16705-a53d-47ca-89e0-e1d27673d93e/content

[30] Salatin, J. (2016). Pastured Poultry Profits: How to Net $25,000 in 6 Months on 20 Acres. Polyface Farms.
[31] USDA (2022), Honey imports continue to rise, offsetting declining U.S. production, https://www.ers.usda.gov/data-products/chart-gallery/gallery/chart-detail/?chartId=104135
[32] Paullin, C. (2024). Dominion Energy pairs solar with honey bees to preserve agricultural land, https://virginiamercury.com/2024/10/18/dominion-energy-pairs-solar-with-honey-bees-to-preserve-agricultural-land/
[33] Peters, A. (2018). This new solar farm combines clean energy and beehives, https://www.fastcompany.com/40588875/this-new-solar-farm-combines-clean-energy-and-beehives

- Lightsource BP's 153 MW Briar Creek Solar project outside of Dallas, TX[34]
- Lightsource BP's 173 MW Bellflower Solar project near Indianapolis, IN[35]

Dominion's Black Bear Solar Project is a prime example of a distributed generation, small-scale solar project that integrates an apiary system. The array hosts 4 beehives (3.5/acre) that are home to about 180,000 bees in total. Mountain House Apiaries manages the beehives and are responsible for installation and maintenance costs but get to benefit from the free pollinator and natural grass production on the site. This is a model that can be replicated at Sugarloaf and Ramiere, integrated with sheep grazing.

| Projects | Array Acreage | # of Hives | Beekeper Installation Costs | Hive Population | Honey Production (pounds) | Honey Revenue (65% of production) | Profitable in Year 1? |
|---|---|---|---|---|---|---|---|
| **Sugarloaf Bees w/o PV** | 17.9 | 6 | $4800 | 270,000 | 210 | $1,841 | No |
| **Sugarloaf Bees w/APV** | 17.9 | 6 | $0 | 270,000 | 300 | $2,630 | Yes |
| **Ramiere Bees w/o PV** | 10.6 | 4 | $3200 | 180,000 | 140 | $1,227 | No |
| **Ramiere Bees w/APV** | 10.6 | 4 | $0 | 180,000 | 200 | $1,753 | Yes |

*Table 6: Cost model for Beekeeping with Agrivoltaics*

## Hive Density

Determining the appropriate number of beehives per acre involves considering the availability of floral resources within and around the solar farms.  A common guideline suggests 2-3 hives per acre, but this can be adjusted based on the diversity and abundance of flowering plants[36].  For instance, the Minnesota Native Landscapes project discovered that solar sites with diverse native plantings supported larger bee populations and increased honey production.  A careful assessment of the existing vegetation at Sugarloaf and Ramiere, along with a pollen analysis, will inform the optimal hive density for these specific locations. Chaberton can engage local beekeepers in an RFP to receive a proposed apiary layout, given their expertise.

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[34] https://lightsourcebp.com/us/project/briar-creek-solar/

[35] Ludt, B. (2023). Lightsource bp completes 152 MW pollinator-friedly solar project in Indiana, https://www.solarpowerworldonline.com/2023/05/lightsource-bp-completes-pollinator-friendly-solar-project-in-indiana/

[36] College of Agriculture, Purdue University, Whitford, F. (et. al), The Complex Life of the Honey Bee, https://ag.purdue.edu/department/extension/ppp/resources/ppp-publications/ppp-116-pol-9.html

*Figure 8: Depicting Potential Hive Locations at Project Sugarloaf*

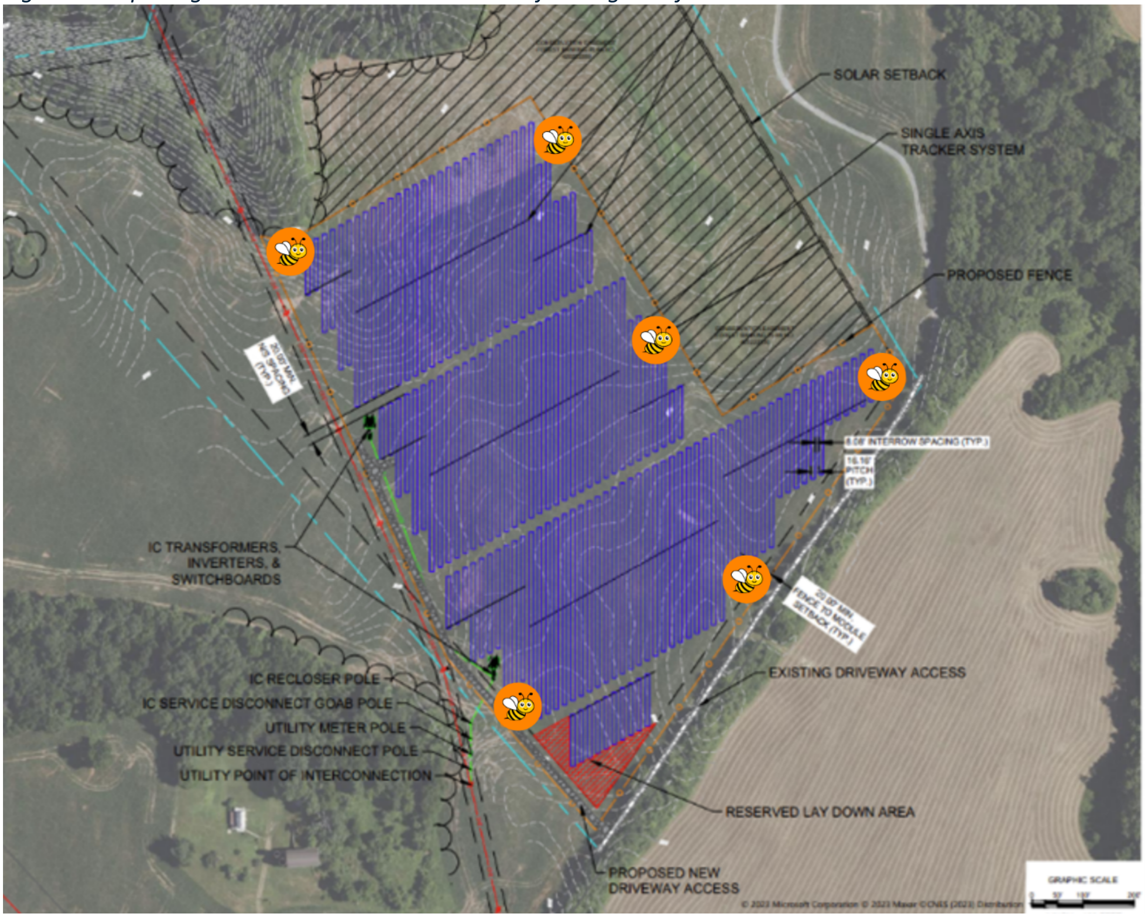
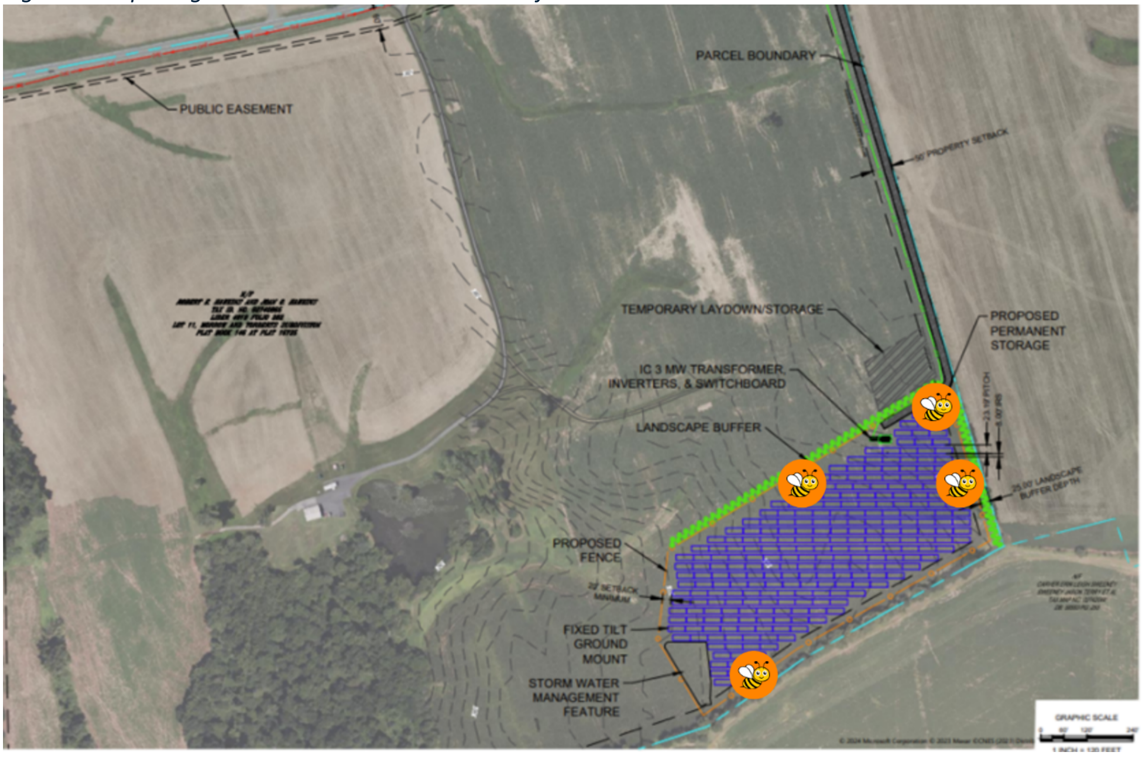



*Figure 9: Depicting Potential Hive Locations at Project Ramiere*



### Hive Population

A single healthy beehive can house a population of 40,000 to 60,000 bees at its peak. This number naturally fluctuates throughout the year, influenced by factors such as weather patterns, the availability of nectar and pollen, and the overall health and productivity of the colony. The solar panels at the two sites create unique microclimates that can be beneficial for bees. The panels provide shade, reducing harsh temperatures and water evaporation, which can be especially important during hot Maryland summers. This moderated environment can help flowering plants thrive beneath the panels, providing a consistent and diverse source of nectar and pollen for bees. Additionally, the panels can offer shelter from wind and rain, further enhancing the habitat's suitability for pollinators. These stable microclimates, coupled with abundant forage, can lead to increased bee activity, stronger colonies, and potentially higher honey yields.

### Honey Production

Honey yields vary significantly based on the richness of floral resources in the surrounding landscape, weather conditions throughout the season, and beekeeping management practices. In Maryland, a typical hive can produce 30-60 pounds of honey annually. However, research by the National Renewable Energy Laboratory (NREL) indicates that hives located on solar farms with pollinator-friendly plantings can often exceed these averages[37]. Cultivating a diverse mix of flowering plants at Sugarloaf and Ramiere, Chaberton, partnered with local beekeepers, can create a thriving environment for bees and potentially boost honey yields compared to standard apiaries. The APV-case used in Figure 6 is 50 pounds of honey produced at each beehive in the APV scenario, hosting pollinator-friendly vegetation for sheep. The base case in which the site is farmed for soy, hay, and corn rotations, uses 35 pounds per beehive production given the lower number of resources for bees.

### Honey Consumption and Winter Survival

A crucial aspect of managing apiaries, especially in temperate climates like Maryland, is ensuring that honeybee colonies have adequate food stores to survive the winter. This involves understanding the colony's consumption patterns and conserving a sufficient percentage of honey within the hive. Honeybees rely on honey stores as their primary energy source during the winter when foraging opportunities are limited. The amount of honey a colony needs to survive depends on factors such as colony size, winter length and severity, and the availability of alternative food sources like pollen. Research and beekeeping practices suggest that a colony should retain approximately 30-45% of the total honey produced during the active season.

- **Northern climates:** In colder regions with longer winters, colonies may require the higher end of this range (45% of honey retained).
- **Southern climates:** In milder regions with shorter winters, colonies may survive with less honey (30% of honey retained).

[37] National Renewable Energy Laboratory, Dreves, H., Beneath Solar Panels, the Seeds of Opportunity Sprout https://www.nrel.gov/news/features/2019/beneath-solar-panels-the-seeds-of-opportunity-sprout.html

The local beekeeper chosen by Chaberton shall be responsible for proper hive management, including disease control, swarm prevention, and providing adequate space for honey storage, which can optimize honey production. To understand how much honey is produced and how much to conserve, the beekeeper may need to weigh the hives and the bees from season to season. For the purposes of this report, we will assume 35% of honey is retained for the bees to survive Maryland winters.

### Native Grasses, Sheep Grazing, and Bees

Integrating native grasses with sheep grazing can further enhance the ecological value of solar farms. The grasses provide additional foraging resources for bees, while the sheep help manage vegetation growth, reducing competition for resources and promoting plant diversity. This managed grazing can also create open areas within the grasslands, which are essential nesting sites for many native bee species. The combination of native grasses, sheep grazing, and pollinator-friendly plantings creates a dynamic and resilient ecosystem that supports a wide range of pollinators, including honeybees.

### Installation Costs

Establishing a new beehive involves costs for the hive itself, essential equipment, and the initial colony of bees. These can be up to $800 per hive.[38] Additional costs include smokers, protective gear for beekeepers, hive tools, and ongoing maintenance expenses such as varroa mite treatments and supplemental feeding during lean periods. Careful budgeting and planning can help manage these costs and ensure the long-term sustainability of the apiary. Chaberton can choose to offset the costs of beehive installation to make beekeeping more attractive to farmers on both sites. This is evidenced by the Beekeeper incurring no installation costs in the “w/o APV” scenarios in Table 6.

### Honey Revenue

Locally produced, raw honey is a sought-after commodity, often commanding a premium price in the market. Farmers in Maryland can generally sell their honey for $10-$20 per pound, with the final price influenced by the honey variety, packaging, and marketing strategy.

| Apiary | Cost per 1b of Raw Honey | Locality |
|---|---|---|
| Chesapeake Queen Company | $16.50[39] | Frederick, MD |
| McDaniel Honey Farm | $15.00[40] | Manchester, MD |
| John Newman Honeybee Co. | $18.99[41] | Baltimore, MD |
| Cybee’s Honey | $13.49[42] | Jarrettsville, MD |

[38] Anderson, C. (2023), Beekeeping Costs, https://carolinahoneybees.com/cost-of-beekeeping/
[39] https://www.chesapeakequeencompany.com/product-page/1-pound-jar-of-raw-honey
[40] https://themarylandstore.com/products/pure-natural-honey-1lb-bottle?srsltid=AfmBOor92CmKvVRmwe-tBxKPhtNi6ZRDnksDjD82rryxDr-6NgE5IxaZ
[41] https://www.thejohnnewmanhoneybeeco.com/
[42] https://freedomvalleyfarmmd.com/shop/honey-and-produce/maryland-raw-honey/

Furthermore, exploring value-added products like beeswax candles, lip balms, and lotions can diversify income streams and enhance the economic viability of the apiary. Replicating the Dominion Black Bear Solar project model, a local apiary will be selected through an RFP process to install and manage the apiary integration for the project's life. We have used the lowest price from Figure 7 ($13.49) to calculate the potential revenue from selling solely raw honey from the two sites. Chaberton would not be responsible for selling or marketing apiary products.

By thoughtfully integrating apiaries into the Sugarloaf and Ramiere agrivoltaic projects, Montgomery County can demonstrate a commitment to sustainable land use that benefits both the environment and the local agricultural economy. Though beekeeper(s) will be solely responsible for the economics of the apiary-integration, Figure 6 shows that they can see profitability in Year 1 if combined with solar and nominal hive installation costs are covered by Chaberton.

# Farmer Sourcing Plan

## Introduction

By transferring vegetation management contracts from landscaping companies to farmers, solar developers can create mutually beneficial relationships. In this arrangement, the solar developer essentially pays the farmer a fee for his services as a contractor.

A **Scope of Work** (SOW) would be advertised, inviting farmers to submit crop or grazing management strategies that meet the specific criteria outlined by the solar developer, including maintaining appropriate plant height, effective weed management, and navigating solar infrastructure. These strategies would be thoroughly evaluated to ensure they align with the required vegetation management standards. Upon agreement, the responsibilities of both parties would be clearly defined, including the site manager's duty to provide compensation and maintain perimeter fencing, while the farmer manages interior fencing and ensures the health and welfare of the sheep or crops.

This collaborative approach allows both the solar developer and the farmer to establish a tailored agreement that meets the operational needs of the solar facility while supporting the farmer's agricultural practices. The following **Services Agreement** outlines some of the most important terms and conditions that govern this partnership.

## Services Agreement

This agreement outlines the terms between the site manager and the sheep farmer for grazing services as a method of vegetation management.

The sheep farmer agrees to manage grazing to control vegetation, ensuring it does not interfere with solar panel function. In return, the site manager will compensate the sheep farmer for these services. In cases where sheep cannot access certain areas or during times outside the grazing season, in accordance with the vegetation management plan filed with Case No 9726 and 9733.

The agreement should specify the duration of the contract, including conditions for renewal or termination. The sheep farmer is responsible for the health and welfare of the sheep, while the site manager must ensure access to a reliable water source.

Both parties will agree on a communication protocol regarding sheep health issues and any potential damage to solar equipment. The site manager is responsible for informing the sheep farmer of any required sheep relocation due to site maintenance. Prohibited plants and chemical usage must be agreed upon, and no unauthorized chemicals are allowed on the site.

Fencing responsibilities are shared: the site manager finances and maintains the permanent perimeter fencing, while the sheep farmer manages any interior fencing needed for effective grazing.

Both parties are indemnified from liabilities arising from a breach of contract by the other party. The sheep farmer must carry appropriate insurance—including general liability, auto liability, and workers' compensation—while the solar site must be insured separately by the site manager.

The site manager and sheep farmer can agree on additional terms such as a system for tracking third-party access, as well as recording the presence of both the site manager and sheep farmer. They can also establish rules for vehicle access and parking for sheep transport or solar site maintenance. Additionally, both parties can agree on protocols for informing third parties about proper interaction with the sheep to ensure safety.

## Application Process

In short, farmer sourcing will be conducted as a hiring search. See below for an outline of the application process, a list of places to advertise job postings and interview questions.

### Job Posting

Principally, a SOW will be disseminated within the farming community. The SOW and associated job posting will have the following characteristics.

1. General Farmer Profile
    i. Applicant's crop/livestock experience and years of experience with each
    ii. Applicant's vegetation/landscape management experience
    iii. Necessary access to equipment (what does the farmer need to bring to the farm site?)
2. Site Details
    i. Site location and description (size, irrigation, soil types, infrastructure, etc.)
    ii. Description of solar array, necessary considerations
3. Compensation structure
    i. Access to farmland
    ii. Annual payments. We recommend a range of $200 to $450 per acre per year for the tenant farmer in exchange for the contractual duties that the tenant needs to perform.
4. A contractual SOW

i. A legal contract delineating specific duties, obligations, indemnification, term, etc. It must contain a vegetation maintenance standard. See an example contract standardized through the American Solar Grazing Association (ASGA) here, and an example vegetation maintenance standard below:

### Vegetation Maintenance Standard for Agrivoltaic Solar Site

Farmer shall have all vegetation on the Solar Site to be maintained as follows at substantially all times on substantially all areas specified in SOW, subject to the following standards:

Check all that apply:

- ❑ Vegetation will not shade the solar panels.
- ❑ Vegetation will not reach a height taller than approximately _____ inches.
- ❑ Vegetation will remain between approximately _____ inches and ____ inches.
- ❑ *Describe other standard:* ___________________________________________

**[Vegetation Maintenance Standard for Other Areas.** Sheep Farmer shall cause all vegetation in [*describe area outside the fence line or other areas outside Solar Site itself that are subject to this SOW, if applicable*] to be maintained as follows at substantially all times on substantially all such areas, subject to the schedule set forth in Section 7 below:

Check all that apply:

- ❑ Vegetation will not reach a height taller than approximately _____ inches.
- ❑ Vegetation will remain between approximately _____ inches and ____ inches.
- ❑ *Describe other standard:* ___________________________________________][1]

### Dissemination of Job Post

This job posting will be placed on a list of job boards, organization sites, social media forums, and Maryland-specific forums aggregated by Okovate, Chaberton, and its partners:

#### Job boards:

- AgCareers.com - Large agricultural job site
- AgHires.com - Specialized in agriculture and food production jobs
- FarmWork.com - Focus on farm labor and management
- Indeed.com - General job site with farm category

- GoodFoodJobs.com - Sustainable food industry jobs
- Coolworks.com - Seasonal and year-round outdoor jobs including farming
- Attra.ncat.org - Sustainable agriculture network

### Organization sites:

- Montgomery County Land Link[43]
- National Farmers Union Job Board (nfu.org/careers)
- American Farm Bureau Federation (fb.org)
- Sustainable Farming Association Job Listings
- National Young Farmers Coalition (youngfarmers.org)
- Agrisolar Clearinghouse (agrisolarclearinghouse.org/)

### Social media forums:

- LinkedIn - Use hashtags: #AgJobs #FarmingJobs
- Facebook Groups:
    - "Agriculture Jobs and Careers"
    - "Farmers Helping Farmers"
    - "American Farmers"

### Maryland-Specific Job Resources

- Maryland Farm Bureau
- University of Maryland Extension
    - The Maryland Beginning Farmer Success Project
    - Maryland Rural Enterprise Development Center

### State Organizations

- Maryland Farm Bureau (mdfarmbureau.com)
- University of Maryland Extension
    - University of Maryland Extension Job Board
    - The Maryland Beginning Farmer Success Project
    - Maryland Rural Enterprise Development Center
- Maryland Department of Agriculture Career Page
- Southern Maryland Agricultural Development Commission (SMADC)

### Regional Job Boards

- MarylandJobNetwork.com - Agriculture section
- Delmarva Farmer Classifieds
- Lancaster Farming - Maryland section (lancasterfarming.com)

[43] https://www.mocolandlink.org/farm-listings/farmers-seeking-land

### Local Resources

- Future Harvest CASA (futureharvest.org)
- Maryland Organic Food & Farming Association (marylandorganic.org)

### County-Level Resources

- County Extension Offices - All 23 counties
- Local Soil Conservation Districts
- County Farm Bureaus

### Print Publications

- The Delmarva Farmer - Classified section
- Maryland Farmer Magazine
- Local county newspapers - Agriculture sections

## Application Screening

Initial review will identify applicants that match the criteria within the job posting. This can be done manually or with machine learning recruiting tools. Applicants will be screened through an interview in accordance with the following hiring Matrix.

Applicants will be scored on the following criteria. The interviewer will rank their score within each category on a scale of 0-3 (0 = No demonstrated experience/skill, 3 = Very high level of experience/skill) based on the applicant's answers to the questions. This system identifies farmers with the most compatible farming and vegetation management plans. See below for specific interview questions within each category.

- Experience with agrivoltaics:
    - Have they worked in an agrivoltaic system before?
    - If not, are they willing to learn and adapt their practices?

- Crop selection:
    - What crops do they recommend that are well-suited for partial shade conditions? [This is a resource Okovate can assist with]
    - How do they plan to optimize crop yield in areas with varying sunlight exposure? [This is a resource Okovate can assist with]

- Equipment and infrastructure compatibility:
    - Is their farming equipment compatible with the solar panel layout?
    - Do they have or need specialized equipment for working around solar installations?
    - What infrastructure (fencing, roads, toolsheds, wash/pack, etc.) do they need for their operation?

- Understanding of solar infrastructure:
    - How familiar are they with solar panel systems and their maintenance needs? [Okovate provides on-site training]

- Do they know how to work safely around the electrical components? [Okovate provides on-site training]

- Agricultural Practices:
  - How will they design the irrigation system to work with the solar array layout? [This is a resource Okovate can assist with]
  - Do they have experience with rainwater harvesting from solar panels or other structures, if applicable?
  - How do they plan to manage the unique microclimates created by the solar panels (e.g., shaded areas, heat islands)? [This is a resource Okovate can assist with]
  - What strategies will they use to maintain soil health in areas with less direct rainfall due to panel coverage? [This is a resource Okovate can assist with]

- Vegetation management:
  - How do they plan to manage vegetation growth under the panels, as determined by the solar developer? Something as simple as landscape fabric and weed-whacking as necessary.

- Adaptability / Collaboration:
  - How flexible are they in adjusting farming practices based on the performance and needs of the solar array?
  - How flexible are they with the solar company visiting the site and working on the panels, as necessary?
  - How will they coordinate their farming activities with necessary system maintenance? [This is a resource Okovate can assist with]
  - How do they envision working with solar technicians and energy managers in this integrated system?

- Long-term sustainability:
  - What ideas do they have for ensuring the long-term sustainability of their crop system, in coordination with the agrivoltaic system? [This is a resource Okovate can assist with]

- Data collection and analysis:
  - Do they have experience or willingness to participate in data collection to optimize the agrivoltaic system over time?

## Final Selection

The final selection phase of the Farmer Sourcing Plan is a collaborative process, ensuring that the most suitable farmer is chosen to manage vegetation in the agrivoltaic system. After the interviews and evaluations, all relevant stakeholders—including representatives from Okovate Sustainable Energy, Chaberton Solar Sugarloaf and Chaberton Solar Ramiere, and possibly external advisors with expertise in both agriculture and solar energy—will convene to review each applicant's scorecard, generated from the interview matrix. Stakeholders will compare notes on the highest-ranked candidates, discuss any concerns or additional considerations that arose during the interview process, and reach a consensus on the farmer who best aligns with the project's goals. The selected farmer will not only possess the necessary technical qualifications but will also demonstrate a strong commitment to working within this integrated solar-agriculture system.

# Community Benefits Plan

Okovate and Chaberton are dedicated to creating a thriving agrivoltaic project in Montgomery County that benefits both the environment and the local farming community. We recognize the value of local expertise and are committed to providing opportunities for Montgomery County farmers to participate in this innovative project.

### Engaging the Agricultural Community

- **Targeted Outreach:** We will directly contact farmers in Montgomery County through the Montgomery County Office of Agriculture, relevant agricultural organizations (e.g., Farm Bureau, Future Harvest CASA), and online platforms to inform them about the agrivoltaic project and the opportunity to farm the land.
- **Clear Contractual Agreements:** We will develop clear and concise lease agreements or farming contracts that outline the terms of the partnership, including land-use rights, crop selection, revenue sharing, and other relevant details.
- **Farmer Training and Support:** We will offer workshops and training sessions to familiarize interested farmers with agrivoltaic practices, including crop selection suitable for solar arrays, integrated pest management strategies, and any specialized techniques required for this type of farming.
- **Ongoing Collaboration:** We will establish a communication channel (e.g., regular meetings, online forum) to facilitate ongoing dialogue and collaboration between the project

developers and the selected farmer(s). This will ensure that both parties are informed and can address any challenges or opportunities that arise.

### Benefits for Montgomery County Farmers

- **Land Access:** Farmers gain access to land for agricultural production, which can be a significant barrier to entry in Montgomery County.
- **New Revenue Streams:** Participating in the agrivoltaic project can diversify income sources for farmers.
- **Sustainable Farming Practices:** The project promotes environmentally friendly farming methods that can benefit soil health, water quality, and biodiversity.
- **Community Partnership:** Farmers become active partners in a project that contributes to the county's renewable energy goals and agricultural sustainability.

### Selection Criteria

We will use a transparent and competitive process to select the farmer(s) who will work on the project. Criteria may include:

- **Farming Experience:** Demonstrated experience in agricultural practices relevant to the project (e.g., vegetable production, livestock grazing).
- **Commitment to Sustainability:** A commitment to environmentally sound farming methods and land stewardship.
- **Local Knowledge:** Familiarity with Montgomery County's agricultural landscape and climate.
- **Business Plan:** A clear and viable business plan for the proposed agricultural activities within the agrivoltaic system.

### Environmental Stewardship

The project will prioritize environmental stewardship through practices such as:

- **Improved Soil Health:** Implementing measures to enhance soil health, including organic matter accumulation, microbial activity, and reduced soil compaction.
- **Pollinator Habitat:** Creating pollinator-friendly habitats by planting native grasses and wildflowers.
- **Erosion Control:** Utilizing appropriate vegetation and soil management techniques to prevent erosion and protect water quality.
- **Carbon Sequestration:** Promoting carbon storage in the soil through healthy soil management practices.

By partnering with local farmers, Okovate and Chaberton aim to create a model agrivoltaic project that supports sustainable agriculture, strengthens the community, and contributes to a cleaner energy future for Montgomery County.

# Appendix A – Crop Modeling

*Table 9: Crop modeling data and resources*

| | Ent. budget | Unit price | USDA Yield Benchmark | Notes |
|---|---|---|---|---|
| **Corn** | University of Georgia College of Agricultural and Environmental Sciences. 2024 sweetcorn budget. https://agecon.uga.edu/extension/budgets.html | $33.5/CWT (MD, 2018) USDA Agricultural Marketing Service. | 120 CWT (MD, 2018) | Excluded marketing costs from budget |
| **Soy** | University of Maryland Extension. https://extension.umd.edu/resource/field-crop-budgets | $11.8/BU (MD, 2023) USDA Agricultural Marketing Service. | 47 Bushels (MD, 2023) | Assumed that smaller-scale equipment is available for harvests. |
| **Lettuce** | https://coststudyfiles.ucdavis.edu/uploads/cs_public/52/c9/52c99335-fcc8-44fe-9ce0-6a0bd5fbe006/2017headlettuce-final_-_5-25-2017.pdf | $71.8/CWT (USA, 2023) USDA Agricultural Marketing Service. | 231 CWT (USA, 2023) | Cost inflation of 20% added. Requires irrigation. |

| | | | | |
|---|---|---|---|---|
| Tomato (fresh market) | University of Arkansas Division of Agriculture. Tomato production budget. University of Arkansas System, Division of Agriculture https://www.uaex.uada.edu/farm-ranch/economics-marketing/farm-planning/budgets/Tomato.pdf | $49/CWT (MD, 2004) | 130 CWT (MD, 2004) | |
| Carrot | University of Georgia extension: https://agecon.uga.edu/extension/budgets.html | $37.6/CWT (USA, 2023) USDA Agricultural Marketing Service. | 275 CWT (GA, 2023) | Adding 300 hrs of labor at 15$/hr for agrivoltaics case, since machinery can't access for harvesting. (https://www.nofavt.org/sites/default/files/files/resources/carrots-cop-factsheet_0.pdf). (https://extension.umd.edu/resource/custom-work-charges-maryland-and-delaware/) |
| Potato | https://www.ag.ndsu.edu/potatoextension/non-irrigated-red-norland-crop-budget | $14.47 per CWT (https://tradingeconomics.com/commodity/potatoes) | 255 CWT ( MD, 2018) | 50 hrs of labor for hand harvesting added to agrivoltaics case https://www.uky.edu/ccd/sites/www.uky.edu.ccd/files/potatoes.pdf |

| | | | | |
|---|---|---|---|---|
| Summer Squash | Food and Agricultural Policy Research Institute. 2020 Squash Budget. Specialty crops. University of Missouri. https://fapri.missouri.edu/specialty-crops/ | We used a 0.8$/lbs price. USDA Agricultural Marketing Service. | Food and Agricultural Policy Research Institute. 2020 Squash Budget. Specialty crops. University of Missouri. https://fapri.missouri.edu/specialty-crops/ | Unable to find trustworthy information. Squash prices range from 0.6 to 1.6 $/lbs. Resulting in very high potential profits. But it is not clear if products can find a market in Maryland. |
| Watermelons | https://www.uaex.uada.edu/farm-ranch/economics-marketing/farm-planning/budgets/Watermelon.pdf | USDA Agricultural Marketing Service. (2023, March 1). Watermelon market prices | https://ipmwww.ncsu.edu/cipm | |

# Appendix B – Sheep Grazing

*Table 10: Variable System Attributes*

| System Attribute | Base Case | Sheep Case 1 | Sheep Case 2 | Unit |
|---|---|---|---|---|
| Pole height above ground | 2.5 | 2.7 | 3.0 | meters |
| Ground clearance | 0.6 | 0.8 | 1.1 | meters |
| Pole height below ground | 4.2728 | 4.6146 | 5.1274 | meters |
| Vertical pole steel density | 22.1996 | 23.9755 | 26.6395 | kg/meter |
| Steel per pole | 0.1506 | 0.1627 | 0.1807 | tonnes |

*Table 11: Variable Costs due to Sheep*

| Cost Component | Base Case | Sheep Case 1 | Sheep Case 2 | Unit |
|---|---|---|---|---|
| Insurance | 0.008 | 0.011 | 0.011 | $/W/year |
| Installation labor and equipment | 0.25 | 0.35 | 0.35 | $/W |
| Vegetation management | Sheep | Sheep | Sheep | |
| Vegetation management cost | 385 | 250 | 250 | $/acre/year |
| Steel | 34,047.60 | 36,771.40 | 40,857.11 | $ |

# Consultant C.V.

Jorrit Becking brings a wealth of experience and expertise to the field of agrivoltaics as the Chief Agricultural Officer at Okovate. His educational background reflects a strong foundation in environmental science, agriculture, and renewable energy. He holds a Master of Environmental Management degree from Yale University, where he focused on business, environment, and renewable energy. During his studies at Yale, he conducted independent research on decarbonizing the residential energy grid and ESG stakeholder materiality assessments. Prior to Yale, Jorrit earned a Master of Science degree in Agricultural Sciences from Wageningen University and Research Center in the Netherlands, specializing in natural resource management. His academic foundation also includes a Bachelor of Science degree in Environmental Engineering from the same institution, where he focused on soil science, meteorology, and hydrology.

Jorrit's professional experience is equally impressive. He currently serves as an Associate in Agrivoltaics Project Development at Pacifico Energy Partners in Munich, Germany, where he develops yield estimation tools and business cases for solar-regenerative agriculture projects. He has also collaborated with research institutions on agrivoltaics pilot projects. Before joining Pacifico Energy Partners, Jorrit worked as an Agriculture Consultant at the World Bank in Washington, DC, where he secured significant grant funding, led global teams on climate-related initiatives, and developed tools for climate adaptation risk screening.

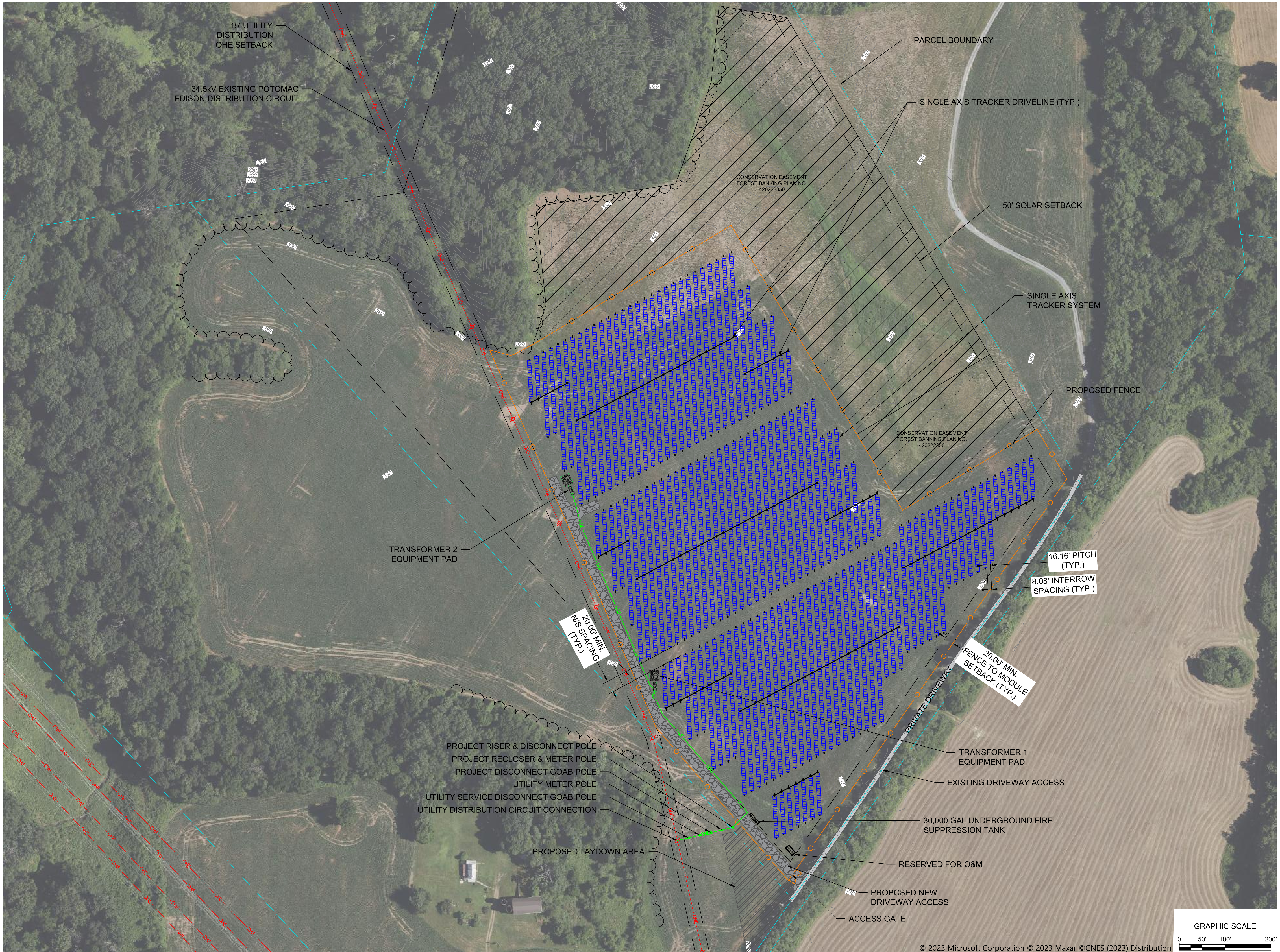
His previous roles include leading case studies on farming systems resilience with the SURE-Farm Project in Madrid, Spain, consulting on agricultural innovation for the "Countryside, The Future" exhibition at the Guggenheim Museum in New York with the Office for Metropolitan Architecture in Rotterdam, and developing a regenerative cattle ranching pilot project in Kenya with the Osotua Foundation.

Jorrit's expertise is further demonstrated through his authorship of various publications on sustainable agriculture, climate resilience, and farming systems analysis. His work has been featured in publications by the World Bank and presented at seminars of the European Association of Agricultural Economists. He is a dedicated and knowledgeable professional with a passion for sustainable agriculture and renewable energy, making him a valuable contributor to the field of agrivoltaics.

### Selected Publications


- Becking, J.B.T., Ramirez Diaz, M., Diaz Rios, L.B. (2021). *Building Pathways to Sustainable Cattle Ranching in Colombia*. Washington, D.C.: World Bank Group.
- Becking, J.B. (2019). *An assessment of the sustainability and resilience of two livestock farming systems in Europe using a participatory approach*.
- Isabeau, C., Bijttebier, J., Becking, J., et al. (2019). *Stakeholder assessment of the resilience of the Flemish dairy farming system.* 173rd Seminar of the European Association of Agricultural Economists, Bucharest.

## Appendix B. Site Conceptual Design




## SYSTEM SUMMARY

| | |
|---|---|
| DC SYSTEM SIZE | 5,981.76 kWdc |
| AC SYSTEM SIZE | 4,000.00 kWac |
| DC/AC RATIO | 1.495 |
| MODULES | Q.TRON XL-G2 620 (620Wp) OR EQUIV. |
| MODULE QUANTITY | 9,648 |
| INVERTERS | CHINT CPS SCH125KTL-DO/US-600 (125kW, 600V) OR EQUIV. |
| INVERTER QUANTITY | 34 |
| AZIMUTH | 177° |
| TILT | 0° |
| RACKING | SINGLE AXIS TRACKER |
| PITCH | 16.16 FT |
| INTERROW SPACE | 8.08 FT |

## LAYER LEGEND

| | |
|---|---|
| PROP. UNDERGROUND ELECTRIC | UGE |
| PROP. OVERHEAD ELECTRIC | OHE |
| EX. UNDERGROUND ELECTRIC | UGE |
| EX. OVERHEAD ELECTRIC | OHE |
| PROP. FENCE | |
| PROPERTY LINE | |

| | | | |
|---|---|---|---|
| SOLAR PV MODULES | | LANDSCAPE BUFFER | |
| ROAD | | WETLANDS | |
| CONCRETE | | FLOODPLAINS | |
| LAYDOWN AREA | | WATER | |

## GENERAL NOTES:

1. DRAWING FOR INTERCONNECTION APPROVAL AND EPC BID ONLY. NOT FOR CONSTRUCTION.
2. ALL EQUIPMENT SHALL BE UL LISTED FOR USE IN SYSTEM CONFIGURATION.
3. INSTALLATION SHALL COMPLY WITH THE LATEST STATE ADOPTED NEC.
4. EQUIPMENT LOCATIONS FOR PRELIMINARY DESIGN ONLY. EQUIPMENT LOCATION MAY BE SUBSTITUTED BY THE EPC AS APPROVED BY CEH.
5. SEE CIVIL ENGINEERING DRAWINGS FOR CIVIL SITE DETAILS.
6. PROPOSED INTERCONNECTION PATH AND UTILITY DISTRIBUTION CIRCUIT CONNECTION MAY BE SUBSTITUTED BY THE EPC AS APPROVED BY CEH.
7. IF REQUIRED, INVERTER AC OUPUT SHALL BE PERMANENTLY CURTAILED TO VALUES SHOWN IN THE INVERTER SUMMARY TABLE ON E-100.
8. MODULE AND FENCE LAYOUT ON E-001 SUPERSEDES THOSE SHOWN ON CIVIL DRAWINGS.
9. CONTRACTOR TO LOCATE TRANSFORMER PAD ON CREST OF HILL AND TO ENSURE PROPER DRAINAGE AWAY FROM PAD.

N S E W

# NOT FOR CONSTRUCTION

30% DESIGN SET 09/10/2025

**PROJECT**

CHABERTON SOLAR SUGARLOAF LLC
5.98 MWdc / 4.00 MWac SINGLE AXIS TRACKER AT
20597 DARNESTOWN RD
DICKERSON, MONTGOMERY COUNTY, MD 20842
39.2080°, -77.4233°

**DEVELOPER**

CHABERTON ENERGY
1700 ROCKVILLE PIKE, SUITE 305
ROCKVILLE, MD 20852

chaberton ENERGY

| REV. | DESCRIPTION | DATE |
|---|---|---|
| - | - | - |
| - | - | - |
| - | - | - |

APPROVED BY: PMG
CHECKED BY: EJA
DESIGNED BY: MDB

DRAWING TITLE
ELECTRICAL SITE PLAN

REVISION: ----

DRAWING NO.: E-001

## Appendix C. Vegetation Maintenance Plan

# Vegetation Management Plan: Project Sugarloaf I

## Project Installation

Project construction activities shall support long-term management of vegetation to maintain site integrity and minimize fire risk.

There are no trees or shrubs required for screening or buffering based on the existing natural treeline.

At the conclusion of construction, disturbed grounds will be stabilized with a slow growth, low maintenance, pollinator ground cover and seed will be applied with a hydroseeding method or equivalent. When selecting seed for the site, the Project Owner shall choose species per the approved Final Landscape Plan

## Operations & Maintenance Site Inspections

At a minimum, thorough site inspections will be performed by the Operations and Maintenance (O&M) team semiannually prior to the fire seasons to look for and mitigate fire risk factors or hazards. Maintenance of the site grounds will occur more frequently, at a minimum, as frequent as specified in the approved Final Site Plans. At these maintenance visits, the site grounds and landscaping will be inspected for:

- Dense vegetation that needs thinning
- Dry brush, grasses, or other foliage
- Dead branches, limbs, or leaves within the security fencing
- Debris piles such as grass cuttings, leaves, pine needles, pinecones, or other ground litter
- Tall grass, brush, or plantings that need cutting
- Areas of deterioration, erosion and/or obstructions of site access roads and aisles
- Electrical equipment obstructed by vegetation

## Vegetation Maintenance

Regular maintenance of the grounds at the site, both inside and outside the security fence, is required as specified in the approved Final Site Plans. The O&M team will adjust maintenance frequency based on time of year and weather conditions. Site maintenance shall include, at a minimum:

- Maintaining ground cover vegetation as specified in the approved Final Landscape Plan and/or Permanent Stabilization guidelines in the approved Sediment Control Plan. Most native plants will have extensive root systems by their first year, so mowing or grazing will not damage them. As needed, trimmers will be used to address areas around structural elements and other places a mower or grazer cannot reach. Any vegetation that has adhered to the solar modules will be cleaned off.

- Pruning trees and shrubs in accordance with approved Landscape Plan and/or AHJ requirements to
- Remove dead, injured or disproportionate branches
- Any dry or dead vegetation will be removed as necessary. Dead grasses and foliage will be mowed to the ground once the growing season has passed. Landscaping buffer trees or shrubs that have died will be removed and replaced as needed. At all times, the site shall be kept free of dead vegetation.
- Remove vegetative debris piles and/or any branches or limbs within the array security fence.
- Collect any items of trash accumulated since previous site visit and dispose of properly offsite.
- Re-seed and fertilize any areas where vegetation has grown sparse, as needed.
- Clear site access roads and replace gravel where needed.
- Mechanical methods shall be sparingly used to control vegetation. Mowing may occur 2-3 times per season, avoiding mowing during nesting season to the maximum extent practical from May to August, to allow for full growth cycles of pollinator friendly vegetation. Mowing height should be limited to a height of ten inches, unless required to be shorter for agrivoltaics or fire hazards. To control the spread of invasive or noxious weeds, mechanical control by spot mowing or string trimming will be performed once monthly. Herbicides shall not be used unless by express permission of Authorities Having Jurisdiction.

## References

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