



Cider Solar – Agricultural Integration Plan
Hecate Energy
Genesee County, New York

Prepared for:

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Introduction

Hecate Energy (Hecate) has enlisted Agrivoltaic Solutions, LLC (AVS) to develop an Agricultural Integration Plan (AIP) for its Cider Solar project (project). The project is planned to be a 500MW (AC) solar facility to be constructed on approximately 3,000 acres of private open land in Genesee County, New York State. An initial 327 acres of the proposed fenced solar array areas are identified for sheep grazing.

This AIP introduces and outlines planned agricultural integration measures to be taken at the Cider Solar project, with focus on managed sheep grazing. According to the recently released solar grazing census conducted by the American Solar Grazing Association (ASGA) ¹, solar grazing in the U.S. is now being practiced on roughly 100,000 acres and employs in the range of 1.5% of the nation's sheep. This growth has been extremely rapid, and managed grazing on solar arrays has been the most widely adopted form of agricultural colocation by a wide margin. There are some key advantages held by sheep grazing that makes it stand out:

Ease of integration. Sheep grazing can be easily integrated into “conventionally designed” solar facilities, without major modifications to racking dimensions, row spacing, DC collection lines, etc. Many of the solar sites that are currently being grazed were not necessarily designed with grazing in mind. Of course, with a utility scale solar array, planning and civil design considerations must be undertaken to create a site that can be effectively and efficiently grazed, but these will not be changes that will significantly alter the site plans. With small stature and docile behavior, sheep lend themselves to being able to work unobtrusively in the array and do not pose risk of damage to the site equipment or injury to themselves.

Synergy with site operations. A managed solar grazing program performs an essential part of the Operations and Management (O+M) scope at a solar facility and is successful at managing on-site vegetation to avoid panel shading.² In this arrangement, the goals of the partner farmer are aligned with those of the site owner/operator. This sets grazing apart as a form of agricultural co-location and means that it can work in concert with the other site operations, rather than needing them to work around it. Grazing can perform vegetation management at competitive cost to conventional mowing ³, while also directing this income stream into the local agricultural economy. ⁴

¹ American Solar Grazing Association (ASGA). 2024. How Big is Solar Grazing in the U.S.? ASGA, preliminary results.

² Kochendoerfer, N., C. E. McMillan, M. A. Zaman, S. H. Morris, and A. DiTommaso. 2022. Effect of Stocking Rate on Forage Yield and Vegetation Management Success in Ground Mounted Solar Arrays Grazed by Sheep Cornell Nutrition Conference No. 84. Cornell University Syracuse, NY. <https://ecommons.cornell.edu/handle/1813/112173>

³ McCall, J., J. Macdonald, R. Burton, and J. Macknick. 2023. Vegetation Management Cost and Maintenance Implications of Different Ground Covers at Utility-Scale Solar Sites. Sustainability 15(7):5895. <https://doi.org/10.3390/su15075895>

⁴ Kochendoerfer, N., Thonney, M.L. 2021. Grazing Sheep on Solar Sites in New York State: Opportunities and Challenges. Cornell University Atkinson Center for a Sustainable Future. Ithaca, NY. <https://solargrazing.org/wp-content/uploads/2021/02/Solar-Site-Sheep-Grazing-in-NY.pdf>

Production benefits from the site environment. Solar arrays provide an excellent environment for raising sheep.^{5 6} The abundant shade provided by the solar modules moderates the temperature during the hottest parts of the grazing season.⁷ Predation, which is normally one of the leading areas of loss for a sheep producer, can be nearly eliminated with a secure perimeter fence. Finally, a well-chosen seed mix can provide an opportunity to tailor the forage production in the facility to meet the needs of the animals. It is fair to say that in a correctly designed solar site there is no production loss for a grazed sheep flock. On the contrary, there is the potential to have increased production compared to a traditional pasture setting.

Benefits for farmers. Grazing sheep flocks in solar facilities helps producers to reap economic benefits.^{8 9} It has potential to lower the barriers of entry for young, beginning, diverse, and underserved farmers, and allow new farm businesses to contribute to the local economy as well as increase sheep farmer and flock owner viability.¹⁰ While the dairy industry is struggling from years of marginal profitability and an increasing median age of farmers lacking a farm succession plan^{11 12}, an emerging solar sheep industry could utilize available dairy resources like barns, supply services, feed mills, and veterinary services to help facilitate expansion aligned with the growth of renewable energy. In addition to marketing wool, leather, and meat products, farmers pursuing solar grazing can also benefit from access to specialty markets for sheep products. Solar grazed lamb may be offered at gourmet outlets, farm-to-table restaurants, and through specialty online sales while generating premium prices and regional market distinction. These marketing channels and development opportunities exist in New York State. There is a well-established set of privately and publicly funded opportunities to market meat from solar-grazed sheep. These include the publicly funded Certified New York Grown¹³ program, and the privately funded Certified Grassfed¹⁴ designation. Regional markets and livestock auctions are within reach; and growing multi-cultural markets in New York City, the greater Capitol Region, Rochester, and Buffalo, are expected to increase demand in small ruminant meat in future years.¹⁵

⁵ Andrew, A. C., C. W. Higgins, M. A. Smallman, M. Graham, and S. Ates. 2021. Herbage Yield, Lamb Growth and Foraging Behavior in Agrivoltaic Production System. *Frontiers in Sustainable Food Systems* 5 (Original Research). <https://www.doi.org/10.3389/fsufs.2021.659175>

⁶ Kampherbeek, E. W., L. E. Webb, B. J. Reynolds, S. A. Sistla, M. R. Horney, R. Ripoll-Bosch, J. P. Dubowsky, and Z. D. McFarlane. 2023. A preliminary investigation of the effect of solar panels and rotation frequency on the grazing behavior of sheep (*Ovis aries*) grazing dormant pasture. *Applied Animal Behaviour Science* 258:105799. <https://doi.org/10.1016/j.applanim.2022.105799>

⁷ Williams, H. J., K. Hashad, H. Wang, and K. Max Zhang. 2023. The potential for agrivoltaics to enhance solar farm cooling. *Applied Energy* 332:120478. <https://doi.org/10.1016/j.apenergy.2022.120478>

⁸ Mount Morris Agrivoltaic Study, Lamb Demand in Northeastern US, 2021, Julie Stepanek Shiflett, Juniper Economic Consulting, https://solargrazing.org/wp-content/uploads/2022/01/MountMorris-AgrivoltaicReport-FINAL_PRINT_ready.pdf

⁹ Kochendoerfer, N., A. Hain, and M. Thonney. 2019. The agricultural, economic and environmental potential of co-locating utility scale solar with grazing sheep, Atkinson Center for a Sustainable Future, Cornell University Ithaca, NY. https://bpb-us-e1.wpmucdn.com/blogs.cornell.edu/dist/c/9310/files/2020/12/Atkinson-Center-report-2018_Final-2213c5n.pdf.pdf

¹⁰ Kochendoerfer, N., and M. L. Thonney. 2021. Grazing Sheep on Solar Sites in New York State: Opportunities and Challenges. Scope and scaling-up of the NYS sheep industry to graze ground-mounted photovoltaic arrays for vegetation management., Cornell University Atkinson Center for a Sustainable Future, Ithaca, NY. <https://bpb-us-e1.wpmucdn.com/blogs.cornell.edu/dist/c/9310/files/2021/03/Solar-Site-Sheep-Grazing-in-NY-v2.1.pdf>

¹¹ Farm Bureau New York. New York Agriculture. 2023. <https://www.nyfb.org/about/about-ny-ag>

¹² NYSAGM. Division of Milk Control and Dairy Services. 2021. New York State Dairy Statistics Report. <https://agriculture.ny.gov/>

¹³ New York State Grown & Certified. 2023. <https://certified.ny.gov/>

¹⁴ A Greener World. 2023. Certified Grassfed by AGW. <https://agreenerworld.org/certifications/certified-grass-fed/>

¹⁵ Mount Morris Agrivoltaic Study, Lamb Demand in Northeastern US, 2021, Julie Stepanek Shiflett, Juniper Economic Consulting, https://solargrazing.org/wp-content/uploads/2022/01/MountMorris-AgrivoltaicReport-FINAL_PRINT_ready.pdf

Ecosystem services. From an ecological perspective, prescribed sheep grazing facilitates development of perennial vegetation and contributes to soil health.¹⁶ ¹⁷ Grazing allows for diverse plant, insect, and pollinator habitats,¹⁸ and improves soil stability by nurturing vegetation to help prevent erosion by wind and water.¹⁹ Further, new research shows that photovoltaic installations maintain ecosystem function, and that managed grassland water cycling is only minimally impacted by construction of solar arrays.²⁰

This AIP lays out specific information necessary to demonstrate compliance with New York State Energy Research and Development Authority (NYSERDA) requirements for siting solar projects on agricultural lands. This includes compliance with requirements such as:²¹

- Facility designs that include planting vegetation compatible with animal grazing and which optimizes forage recovery periods, the soil hydrologic cycle, and that take wildlife into consideration.
- Creating a sheep grazing plan and stocking rates based on forage availability, time of year, weather conditions, animal characteristics, and producer requirements.
- A plan to distribute water to sheep on the site using municipal water, water wells, and/or trucking water with portable tanks as needed.
- Use of temporary, portable fencing to rotate sheep flocks according to a grazing plan.
- Implements a managed grazing system and plan that includes periods of occupancy/grazing and evasive grazing for rest and recuperation of the vegetation.
- Appropriate signage at facility entrances with contact information for the servicing farmer/grazing manager and which alerts visitors that sheep are on site and to close gates and not approach the sheep.

The AIP describes sheep flock health and welfare requirements and lays out elements of annual sheep management details of which inform a Prescribed Grazing Plan (PGP). The Cider Solar PGP is tailored to the Project. The PGP is a blueprint for managed grazing advocated by the United States Department of Agriculture (USDA) through its Natural

¹⁶ Amsili, J.P., H.M. van Es, R.R. Schindelbeck, K.S.M. Kurtz, and D.W. Wolfe, G. Barshad. 2020. Characterization of Soil Health in New York State: Summary. New York Soil Health Initiative. Cornell University, Ithaca, NY.

<https://bpb-us-e1.wpmucdn.com/blogs.cornell.edu/dist/6/7573/files/2018/04/Characterization-of-Soil-Health-in-New-York-State-Summary-Report.pdf>

¹⁷ New York State Department of Agriculture and Markets. 2023. Agricultural Environmental Management Planning Resources. Tier 2: Pasture Management Worksheet.

https://agriculture.ny.gov/system/files/documents/2022/07/aem_tier2_pasture-management.pdf

¹⁸ Kalies, L., G. Garrison, B. Tompkins, K. Markus. 2024. Impacts of conservation practices at solar facilities: vegetation, pollinator, and wildlife monitoring (2018-2021). The Nature Conservancy.

¹⁹ Thompson, L., Rowntree, J., Windisch, W., Waters, S., Shalloo, L., and Manzano, P., 2023. Ecosystem management using livestock: embracing diversity and respecting ecological principles, Animal Frontiers. <https://doi.org/10.1093/af/vfac094>

²⁰ Kannenberg, S. A., M. A. Sturchio, M. D. Venturas, and A. K. Knapp. 2023. Grassland carbon-water cycling is minimally impacted by a photovoltaic array. Communications Earth & Environment 4(1):238. <https://doi.org/10.1038/s43247-023-00904-4>

²¹ New York State NYSERDA, Solar Installations on Agricultural Lands, Solar Guidebook for Local Governments, <https://www.nyserdera.ny.gov/All-Programs/Clean-Energy-Siting-Resources/Solar-Guidebook>

Resource Conservation Service (NRCS) Conservation Standard Practice Code 528 (Code 528-CPS).²² The PGP is a master guidance document used to facilitate management of the Project site that achieves targets for vegetation control, animal production, and soil health. The PGP stocking rate is aimed at performing more than 90% of vegetation maintenance with grazing, with the balance of mechanical mowing to be performed by the contracted farmer on an as-needed basis.

The PGP covers 327 fenced, grazeable acres of the Cider Solar Project consisting of three (3) separate, individually fenced arrays. The sheep will rotate from one grazing paddock within an individually fenced array to another, approximately every 2 days. A sheep farmer/ grazing manager will be able to reference the materials presented in the PGP and use it as a planning tool for their grazing season.

Cider Solar Project Site Characteristics

Genesee County, NY is an important agricultural producer, and hosts a strong community of agricultural producers, with 177,000 acres of farmland and an average farm size of 407 acres as of 2022 USDA NASS data. Genesee County has a large percentage of cropland (141,000 acres), with only a small portion of the farmed acres in pasture production (6,000 acres). The cropland is intensively managed and there is adoption of progressive techniques such as 14% no-till, 28% reduced or no-till, and 20% cover crops. 66% of the share of sales are livestock, poultry and products, with the balance of the sale share being crops.

Genesee County ranks 1st in the State in vegetables, melons, potatoes, and sweet potatoes sales, 4th in the State in sales of grains, oilseeds, dry beans, and dry peas. The county ranks 5th in the State for mil sales from cows, and 12th for small ruminant sales (including milk and wool). Approximately 34,000 acres are utilized for forage (hay and haylage) production, and the livestock inventory shows 1,500 sheep and lambs.²³

The project is located close to Interstate 90. Via I-90, access is provided to urban centers along the east coast, as well as to the Midwest. This ensures an opportunity to easily move lambs to market, as well as to source the flock base to graze the project.

Climate

Genesee County is located at 900 ft elevation. Monthly rainfall in the forage growing season is on average between 2.9 inches (April) and 3.6 inches (September), with average temperatures between 36 and 57° F (low, April) and 60 and 81° F (high, July). Mean annual rainfall is 36 inches and mean annual high and low temperatures are 81 and 16° F. The soil within the grazeable area is frost-free between 100 and 190 days.²⁴ Conditions are ideal for forage growth.

²² USDA/NRCS Prescribed grazing (Ac.) (528) Conservation Practice Standard. https://www.nrcs.usda.gov/sites/default/files/2022-09/Prescribed_Grazing_528_CPS.pdf

²³ United States Department of Agriculture, National Agricultural Statistics Service, 2022 Census of Agriculture, U.S. Summary and State Data, Genesee County, New York. https://www.nass.usda.gov/Publications/AgCensus/2022/Online_Resources/County_Profiles/New_York/cp36037.pdf

²⁴ National Oceanic and Atmospheric Administration. National Centers for Environmental Information. <https://www.ncei.noaa.gov/>

Soil

The proposed grazing area within the Cider Solar project is exclusively on intensively managed, tilled crop land. According to data from the United States Department of Agriculture (USDA) National Resource and Conservation Service (NRCS) Web Soil Survey ²⁵, most of the proposed grazing area (204.4 acres, 62.5%) is planned on Prime farmland, the balance of the of the project is planned on land classified as Prime farmland if drained (97.9 acres, 29.9%), Farmland of statewide importance (20.1 acres, 6.1%) and 4.8 acres (1.5%) built on Not prime farmland. About 39.3% (128.8 acres) are considered “Well drained”, 24.9% (81.1 acres) “Moderately well drained”, 29.9% (97.9 acres) “Somewhat poorly drained”, and 5.9% (19.4 acres) “Poorly drained”.

Dominant soils in the project are Ontario loam, Ovid silt loam, Hilton loam, and Arkport very fine sandy loam. A total of 300.2 acres (91.8%) of the soils are rated to have medium susceptibility for compaction with a smaller portion (27 acres, 8.2%) rated with low susceptibility for compaction. According to the Web Soil Survey, soils ranked with “medium” susceptibility have a significant risk of compaction, leading to possible restrictions in growth rates of seedlings after equipment passes. However, after the initial equipment pass and resulting compaction, soils may be able to support subsequent equipment passes without a further increase in compaction, and thus allow for seedling growth. This is beneficial for pasture seed mixes, as a relatively fast establishment can be assumed.

Site Preparation and Seed Mixes

The site preparation strategy, quality of work, and specific plant seed mixes will all impact expected forage growth following construction and into site operations. Seed mixes should contain native and regionally adapted pasture grasses, legumes, and forbs. Ideally a pasture plant distribution should be 70% grass, 20% legumes, and 10% forbs, for optimal nutritional content and palatability for a sheep flock, and for sod-formation and bare-ground avoidance for prevention of wind and water erosion.

The project is built on former woodlands, pasture, hay ground, and tilled cropland. These project areas will have to be prepared and seeded with a grazing appropriate seed mix. The site preparation strategy, quality of work, as well as chosen plant seed mixes will impact expected forage growth following construction and into site operations. Sheep will graze successfully on a diverse array of grass, legume and forb species. An ideal seed mix will contain regionally adapted pasture grasses, legumes, and forbs. Ideally a pasture plant distribution should be 70% grass, 20% legumes, and 10% forbs, for optimal nutritional content and palatability for a sheep flock, as well as sod-formation and bare-ground avoidance for wind and water erosion prevention. Any species of Fescue or Ryegrass in the chosen mix will be of an *endophyte free* or *novel endophyte* variety to avoid issues with palatability and endophyte toxicity.

In addition to the planted seed mix it is expected that due to presence of existing pasture plant species, the site species composition will change and stabilize over time due to existing seeds present in the soil “seed bank.” Cool season grasses which require temperatures between 40° F and 75° F, like Orchard Grass (*Dactylis glomerata*), Virginia Bluegrass (*Poa pratensis*), and Perennial Ryegrass (*Lolium perenne*) as well as legumes which require temperatures between 70° F and 90° F like White clover (*Trifolium repens*), Red clover (*Trifolium pratense*), and Alfalfa (*Medicago sativa*) will likely be present at the location under optimal growth conditions.

²⁵ United States Department of Agriculture, Natural Resource and Conservation Service, Web Soil Survey.
<https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx>

Successful seed germination in the first year of a new planting is critical to establishment of a healthy vegetative cover on the property to comply with U.S. Environmental Protection Agency (EPA) Stormwater Pollution Prevention Planning (SWPPP) ²⁶, and New York State Department of Environmental Conservation (DEC) Standards and Specifications for Erosion and Sediment Control. ²⁷

Pasture Production

AVS used the United States Department of Agriculture (USDA) National Resource and Conservation Service (NRCS) Web Soil Survey to estimate site specific forage production potential. ²⁸ Forage production is expressed in Animal Unit Months (AUM). Under the given soil and climate, assuming a high level of management and current conditions (2024) of a well-established stand of mixed pasture grasses, 6.8 Animal Unit Months (AUM) are the expected annual pasture yield. This corresponds to an annual stocking rate of 3.1 sheep per acre after the successful establishment of seed mixes. AVS estimates that in the first years of seed mix establishment the productive capacity of the site will more likely be in the range of 75% of the full AUM figure. To prevent overgrazing and facilitate sod development, an annual stocking rate of 2.4 sheep per acre should likely not be exceeded in the first years of grazing and during stand establishment. It is advised to utilize supplemental mechanical mowing on these areas of the project to avoid overgrazing. The final determination of stocking rate during these years should be made by the grazing manager, as on-site conditions will vary.

After seed mix establishment, and the start of sheep grazing, it is advisable to take a representative set of forage samples each year prior to the start of grazing and to submit the samples to a forage laboratory to determine quantity and quality (nutritional content) of the vegetation. These results can then further inform the PGP and (if samples are taken continuously throughout the grazing season) define stocking rates more conclusively, and confirm the assumptions made in the PGP.

The acreage planned to be built on cropland can be expected that ecosystem biodiversity and soil organic carbon will increase over time. ²⁹ Grazing can greatly improve the biodiversity of land. ³⁰ This will ensure that agricultural lands, especially those that are prime farmland or farmland of local importance remain in production and keep or improve their quality. Overall, soil quality (mainly sequestered soil carbon) is high in pastures. ³¹

²⁶ US EPA. 2007. Developing Your Stormwater Pollution Prevention Plan. https://www.epa.gov/sites/default/files/2015-10/documents/sw_swppp_guide.pdf

²⁷ NYS DEC. 2005. Standards and Specifications for Erosion and Sediment Control. <https://ehs.cornell.edu/resources/new-york-state-standards-and-specifications-erosion-and-sediment-control-blue-book-2016>

²⁸ United States Department of Agriculture, Natural Resource and Conservation Service, Web Soil Survey. <https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx>

²⁹ Amsili, J.P., H.M. van Es, R.R. Schindelbeck, K.S.M. Kurtz, and D.W. Wolfe, G. Barshad. 2020. Characterization of Soil Health in New York State: Summary. New York Soil Health Initiative. Cornell University, Ithaca, NY. <https://bpb-us-e1.wpmucdn.com/blogs.cornell.edu/dist/6/7573/files/2018/04/Characterization-of-Soil-Health-in-New-York-State-Summary-Report.pdf>

³⁰ Schrama, M., C. W. Quist, G. Arjen de Groot, E. Cieraad, D. Ashworth, I. Laros, L. H. Hansen, J. Leff, N. Fierer, and R. D. Bardgett. 2023. Cessation of grazing causes biodiversity loss and homogenization of soil food webs. *Proceedings of the Royal Society B: Biological Sciences* 290(2023):20231345. doi: <https://doi.org/10.1098/rspb.2023.1345>

³¹ Amsili, J.P., H.M. van Es, R.R. Schindelbeck, K.S.M. Kurtz, and D.W. Wolfe, G. Barshad. 2020. Characterization of Soil Health in New York State: Summary. New York Soil Health Initiative. Cornell University, Ithaca, NY. <https://bpb-us-e1.wpmucdn.com/blogs.cornell.edu/dist/6/7573/files/2018/04/Characterization-of-Soil-Health-in-New-York-State-Summary-Report.pdf>

Applicable Regulations

Pursuant to 19 NYCRR §900- 10.2 and §900- 10.3, the Project has been planned to include co-utilization strategies to mitigate adverse impacts to agricultural resources. The Project is designed to integrate a managed rotational sheep grazing system to control the growth of vegetation under and around solar infrastructure. Grazing will be employed as the primary vegetation management strategy on the facility site following construction and establishment of vegetative cover. Managed grazing, primarily using sheep, is an increasingly common practice on ground-mounted solar arrays across the world. Managed sheep grazing is a form of targeted grazing ³², and is an established conservation practice promoted by the USDA, NRCS, that is recognized as foundational to ecosystem restoration by the DEC: ³³

“Controlled grazing by domestic livestock is a sustainable alternative to herbicide or mowing for control of invasive plants in natural areas. The use of sheep or goats to graze invasive plants can not only help meet Department of Environmental Conservation goals of pesticide reduction but can also improve plant biodiversity and soil health. Grazing can be an effective substitute for mowing (especially in areas too steep to mow safely), while also reducing fuel costs, and minimizing plant litter and thatch. In areas with sensitive wildlife populations, managed grazing can be much safer for wildlife than mowing.”

Compliance with USDA/NRCS - NYS NRCS Code 528-CPS

The Cider Solar Agricultural Integration Plan integrates a managed rotational sheep grazing system as a strategy consistent with the NYS NRCS Code 528-CPS to broadly:

- Maintain and improve desired species composition, structure and/or vigor of plant communities.
- Improve or maintain quantity and/or quality of forage for grazing and browsing animals' health and productivity.
- Maintain and improve surface and/or subsurface water quality and quantity.
- Maintain and improve riparian and watershed function.
- Reduce soil erosion, maintain, and improve soil health.
- Maintain and improve the quantity, quality, and connectivity of food and cover available for wildlife.
- Manage fine fuel loads to achieve desired conditions.³⁴

The PGP for the Cider Solar facility is also designed to meet additional criteria such as:

- Paddock design and layout based on an accounting of environmental, ecological, and agricultural resources within the project site.
- Soil sampling and analysis, estimated forage density, and dry matter yields inform the plan.

³² Society for Range Management Blog, Accessed at: www.targetedgrazing.org

³³ NYS DEC - Conservation Grazing for Land Stewardship, www.dec.ny.gov/lands/86641.html

³⁴ USDA/NRCS Prescribed grazing (Ac.) (528) Conservation Practice Standard. https://www.nrcs.usda.gov/sites/default/files/2022-09/Prescribed_Grazing_528_CPS.pdf

- A plan that utilizes the impacts of animal activity, periods of recuperation, and/or delayed activities and which incorporates flexibility to account for dynamic environmental conditions and allow for modified management decision-making.
- Contingency plans for environmental and animal health, and human welfare.
- Ongoing monitoring of site-specific needs, assessment, and plan modification.³⁵

Compliance with New York State Department of Agriculture and Markets (NYSAGM)

The Cider Solar Agricultural Integration Plan proposes seasonal movements of sheep to/from the solar facility and temporary residency within designated areas of the site during scheduled periods of grazing.

A key aspect of this plan is following protocols for animal health, disease identification, and control that are consistent with procedures established by the New York State Department of Agriculture and Markets (NYSAGM).³⁶ These protocols include maintaining updated information on diseases of concern to New York sheep flocks and the greater New England region, as well as routine health checks, tagging, and tracking of immunized animals moving from one area to another with certificates of veterinary inspection, and contingencies for safe collection and removal of sick, injured or diseased animals.

NYSAGM also suggests participation in the New York State Sheep and Goat Health Assurance Program (NYSSGHAP) administered by Cornell University, an *“integrated disease prevention program that utilizes a team of advisors to develop a farm-specific herd/flock health plan. The objectives of this integrated herd/flock plan are to increase the herd’s/flock’s health, productivity, and profitability; assure food safety, public health, and consumer confidence in animal agriculture; and promote environmental stewardship.”*³⁷

These protocols may also be included in the long-term grazing contracts held by sheep producers working with Hecate to manage vegetation at the Project.

Facility Upgrades

Hecate is making several facilities upgrades to better accommodate managed sheep grazing at the Cider Solar Project. These upgrades are so that the planned grazing activities can happen in a safe and timely manner with attention to efficiency of labor and cost. Upgrades will also help the grazing activities to integrate more seamlessly with other routine site operations. Most importantly, modifications to the Project layout and designs will help to facilitate a continuation of agricultural land use that may coexist with energy production. Investments under consideration for the Project by Hecate Energy include:

- Perimeter fencing material and installation specifications to ensure security of grazing sheep from pressure by natural predators.

³⁵ NYSAGM, Sheep and Goats – Sections: Health, Identification, Import & Export.

www.agriculture.ny.gov/animals/sheep-goats

³⁶ NYSAGM, Sheep and Goats – Sections: Health, Identification, Import & Export.

www.agriculture.ny.gov/animals/sheep-goats

³⁷ NYSAGM. New York State Sheep and Goat Health Assurance Program (NYSSGHAP). <https://www.vet.cornell.edu/animal-health-diagnostic-center/programs/nyschap/modules-and-documents>

- Sleeving of electrical wiring below 36" in height throughout the site.
- Simple exclusion fencing around site equipment pads to prevent sheep access.
- Full Prescribed Grazing Plan for use by site operators and future grazing contractors.
- Vegetation seed mixes chosen for sheep grazing and as desirable pollinator fodder, focused on a diverse species mix of native and naturalized grasses, legumes, and forbs.
- Plant species evaluated for toxicity and palatability to sheep, and avoidance of New York State invasive plant species.

Final determination of design accommodations for grazing will be based on final project layout and discussions with grazing contractors.

Decommissioning

Pursuant to 19 NYCRR §900-2.16(e) and aligned with 19 NYCRR §900-6.6, facility upgrades that were made as provisions of co-located animal grazing and to address potential impacts of co-located agricultural activities are predominately semi-permanent (portable fencing, exclusion panels, and surface waterlines), and require little in the way of meeting decommissioning standards beyond physical collection and disposal. Waste will be brought to a regional Waste Transfer Facility.

The plant species selected for revegetating and stabilizing the facility site will be a locally appropriate, naturalized, herbaceous seed mix commonly found in local hayfields and pastures and consistent with existing agricultural uses. This mix of plant species is expected to persist after site decommissioning until or unless the site is tilled and replanted by the landowner in the future.

Sheep Flock Requirements

Sheep Flock Details

The health needs of sheep flocks vary during different periods of their maturity and require modified grazing and health management strategies, often making it a disadvantage to graze different aged production groups together. The daily feed intake and level of management responsibility of a given grazing flock is defined by the production stage of the flock and body weights of the animals. This also informs the land base/acres that are needed to support different management groups. Grazing groups of uniform production stage can integrate into a solar operation and help to ensure successful vegetation management more optimally. This also allows for more uniform forage intake, the mowing result, land use planning, and calculations.

Sheep flocks are best divided by stages of production for grazing solar sites; groups of growing lambs, yearling ewes, dry (non-lactating) ewes, open (non-pregnant) ewes, or rams and neutered males (wethers) may be grazed together. The most adaptable management groups are growing lambs, yearlings, and dry (and breeding) ewes. It may be impractical to graze utility scale solar sites with a lambing flock due to the degree of management required in pasture lambing and the variety of health concerns associated with a lambing flock, which is difficult to address in land under panels.

If the intention is to graze lamb groups, it is recommended that lambs be near 60 lbs. or 50% of their mature body weight (BW) to help them thrive on pastures. If growing feeder lambs for a fall market are being grazed (“stockers”), they should either be of the same sex, or the males should be castrated (wethered), to avoid uncontrolled breeding.

Typical commercial scale sheep breeds in the US Northeast are haired or shedding breeds such as the Katahdin and Dorper, and woolled breeds including the Polypay composite, Dorset, and Rambouillet sheep. All are adapted to grazing and all have different mature body weights and nutritional requirements.

Nutritional and Water Requirements

Sheep nutritional and water intake requirements change depending on the animal body weights. Most common US sheep breeds are adapted to grazing. Further, different grazing breeds develop different mature body weights, determining their level of daily feed intake. Feed intake in ruminant nutrition is given in weights of dry matter (DM). Dry matter of forages is the dry weight of the plant material (after water is extracted by drying). Table 1. below gives an overview of levels of intake (in %BW) ³⁸:

Table 1. National Research Council (NRC) estimates of nutritional requirements (levels of intake, %BW):

Breed	Stage of production	Body weight, lbs	Feed intake, DM %BW	Feed intake, lbs DM
Katahdin hair sheep	Growing lamb, 50% mature BW	65	2.5	1.6
	Yearling	110	3.0	3.3
	Open, dry ewe	130	3.5	4.6
Polypay composite	Growing lamb, 50% mature BW	80	2.5	2.0
	Yearling	130	3.0	3.9
	Open, dry ewe	160	3.5	5.6
	Growing lamb, 50% mature BW	90	2.5	2.3
Texel	Yearling	150	3.0	4.5
	Open, dry ewe	180	3.5	6.3

Sheep flocks of any stage of production must always have water available free choice. The water must be fresh and offered in clean troughs. Typically, and depending on climate, dry matter percentage of the available feed, and stage of production (growing, lactating, or dry animals), a sheep will consume in the pasture of 5 – 15% of their body weight in water, daily. Water requirements in solar sites are much lower than in pastures without shade. Due to the sheep spending much of their time in the shade under the panels in the hot summer months, with grazing concentrated from dawn until dusk, sun exposure is minimized, and water intake decreases. New agrivoltaics research show a significant cooling effect under panels where temperatures in shaded areas may be 10° C lower compared to temperature

³⁸ NRC. 2007. Nutrient Requirements of Small Ruminants: Sheep, Goats, Cervids, and New World Camelids. The National Academies Press, Washington, DC. <https://nap.nationalacademies.org/catalog/11654/nutrient-requirements-of-small-ruminants-sheep-goats-cervids-and-new>

surrounding the panel ³⁹. No specific research is known to identify how much water intake under panels is impacted by the shaded, cooled environment, but experience from grazing managers in the field shows less water is consumed by sheep grazing solar arrays.

Table 2. below gives an overview of water intake in comparable climate:

Table 2. Water requirements. ⁴⁰

Stage of production	Weight Pasture, lb.	Water requirements, Gal per day ^a	Average water use, Gal per day ^b
Growing lamb	60 – 110	1.0 – 1.4	1.2
Gestating ewe, ram	175	1.1 – 1.7	1.4
Lactating ewe, unweaned lambs	175+	2.4 – 2.8	2.6

^a Result of the animals' environment and management.

^b Typical daily water consumption across one year under average conditions in Ontario, Canada.

Further, to satisfy mineral and salt requirements of the grazing flock, a formulated mineral mix, for example Cargill Lamb and Sheep Mineral Mix ⁴¹ that can be sourced at locally should be offered ad libitum on site throughout the entire grazing season. Both water and minerals may be placed within the grazing area to help direct and control animal grazing behavior to avoid overgrazing, critical habitat, and riparian areas.

Internal Parasite Mitigation

Internal parasites are one of the biggest challenges to successfully grazing flocks in the US. Internal parasite infection can have devastating effects on grazing flocks with significant losses in production and increased, high mortality rates. To avoid increasing contamination of pasture with parasite larvae and their intermediate hosts, pastures must be rested (unoccupied by grazers) between grazing intervals, and continuous grazing (without deferment) must be avoided. Pastures should be rotationally grazed, allowing for rest periods in between services – an “evasive grazing” strategy in which animals are moved before they may be reinfected by parasites, can be a successful means of mitigating parasite infection risk.⁴² Consecutive grazing days in paddocks should be kept to a minimum, and rest periods should be maximized. The guidelines for evasive grazing are that grazing days do not exceed 4 consecutive days per pasture, with rest periods of 28-40 days in between grazing visits. Due to solar site paddock layout, these targets are sometimes hard to achieve, with panel rows influencing paddock sizes, yet the goal should be to establish rest periods of 28 days or more. Sheep flocks should be kept in a parasite management protocol that uses diagnostic and preventative tools like:

³⁹ Williams, H. J., K. Hashad, H. Wang, and K. Max Zhang. 2023. The potential for agrivoltaics to enhance solar farm cooling. *Applied Energy* 332:120478.

<https://doi.org/10.1016/j.apenergy.2022.120478>

⁴⁰ Ontario Ministry of Agriculture, Food & Rural Affairs, <http://www.omafr.gov.on.ca/english/engineer/facts/07-023.htm#5>

⁴¹ Cargill Lamb and Sheep mineral Mix. <https://blogs.cornell.edu/newsheep/management/feeding/agway-sheep-mineral-mix/>

⁴² Eysker, M., N. Bakker, F. N. J. Kooyman, and H. W. Ploeger. 2005. The possibilities and limitations of evasive grazing as a control measure for parasitic gastroenteritis in small ruminants in temperate climates. *Veterinary parasitology* 129(1):95-104.

<https://doi.org/10.1016/j.vetpar.2004.12.022>

- 1.) Body Condition Scoring (BCS), a process in which the animals are assessed (either visually by experienced sheep flock managers, or physically in a working chute) based on their visual appearance using uniform conditions and weight as a measurement.
- 2.) FAMACHA® scoring,⁴³ A second form of uniform visual assessments used for accurate judgement of *haemonchus contortus* (Barberpole worm) infection by scoring parasite induced anemia (blood pigment) in eyelids of animals and thus allow for treatment plans.
- 3.) The 5-point check ⁴⁴, evaluating animals based on 5 indicators caused by various internal parasites, including anemia (FAMACHA®), nasal discharge, bottle jaw, body condition (BCS), and diarrhea (scours).

Animal Welfare and Predation

It is the responsibility of the Producer to check flocks frequently to assure the health and welfare of the animals, minerals and water is freely accessible, and forage available to the captive flock. Certain flock management tasks must be performed before the sheep move on site. Hooves must be trimmed, the flock must be checked for parasites, animals must be tagged and recorded, and wool sheep must be shorn, or a shearing date must be scheduled. Sheep flocks entering New York State must have certificates of veterinary inspection (CVI) stating that the animals are clinically free from infectious diseases and sourced from a flock that is Scrapie⁴⁵ free for at least five years. Additional requirements apply for intact breeding animals.⁴⁶

It is recommended that sheep flocks are enrolled in health assurance programs like the New York State Sheep and Goat Health Assurance Program (NYSSGHAP)⁴⁷, a voluntary disease management program offered by NY State Ag and Markets. A yearly check by a veterinarian will identify challenges (if any) and assist with a clear path forward.

A cornerstone of solar site design for sheep grazing are the facility exterior fences. Fences and gates must be flush to the ground with closure of any gaps or holes that would allow for predators (mainly coyotes and stray/wild dogs) to enter the site and prey on the grazing flock. Prior to moving the flock on site, the perimeter fence should be inspected, and any gaps and holes should be amended before introducing a flock.

Depending on agreements with the Operations and Maintenance or Asset Management teams of the project site, livestock protection dogs (LPDs) may be deployed to help in securing the flock at the site. Solar sites provide shade and shelter to working dogs that, like sheep, may find ideal living conditions under panels. Feed and water must be provided to all protection animals on a schedule. It is further recommended that dogs be identified with tags, a collar, microchip, tattoo, or ear tag. Owners should maintain a current vaccination record for each dog and schedule of routine worming for internal parasites.

⁴³ Wyk, J. A. V., and G. F. Bath. 2002. The FAMACHA system for managing haemonchosis in sheep and goats by clinically identifying individual animals for treatment. *Vet. Res.* 33(5):509-529. <https://www.vetres.org/articles/vetres/abs/2002/05/08/08.html>

⁴⁴ Bath, G. F., and J. A. van Wyk. 2009. The Five Point Check® for targeted selective treatment of internal parasites in small ruminants. *Small Ruminant Research* 86(1):6-13. <https://doi.org/10.1016/j.smallrumres.2009.09.009>

⁴⁵ USDA Animal and Plant Health Inspection Service, Scrapie Disease Information https://www.aphis.usda.gov/aphis/ourfocus/animalhealth/sa_animal_disease_information/sheep-goat/disease-info

⁴⁶ Washington State Department of Agriculture, WSDA, Goats, Sheep, Llama, and Alpaca Import Requirement. <https://agr.wa.gov/departments/animals-livestock-and-pets/animal-health/import-requirements/goat.-sheep.-llamas.-and-alpacas-import>

⁴⁷ NYSAGM. New York State Sheep and Goat Health Assurance Program (NYSSGHAP). <https://www.vet.cornell.edu/animal-health-diagnostic-center/programs/nyschap/modules-and-documents>

All entrances to the facility site should be posted with information identifying that livestock protection dogs are working within the site and operations staff should be provided basic information about the dogs by the dog owner/producer. These and other recommendations for the general use, care, and training of livestock protection dogs is available through the American Sheep Industry Association.⁴⁸

Prescribed Grazing Plan

The goal of any grazing operation within a solar power plant is the on-site vegetation management to prevent panel shading and fire fuel load/fire hazard. To implement a successful solar grazing operation on a solar site, the nutritional, flock management, and animal welfare needs of a sheep flock must be coordinated with the specific site characteristics. The operational management must be well planned to guarantee multiple benefits.

A PGP helps to ensure that the vegetation management targets of a given solar site are met. It enables the grazing manager to adapt the plan to specific seasonal weather and forage growth conditions while providing guidance to ensure the vegetation remains below a targeted height. A PGP adapts grazing management to specific site characteristics and helps co-location benefits to be realized.

This PGP entails a site-specific sheep stocking plan guided by conservation practice standards established by the USDA/NRCS Code 528 for Prescribed Grazing⁴⁹ and following protocols recognized by the USDA Conservation Planning Activity of the *Grazing Management Plan (CPA 110)*.⁵⁰ The stocking plan establishes an initial annual stocking rate, or the number of sheep per acre a site can accommodate over a specific time, as this is the major planning consideration for any involved grazing manager, and determines many things like access roads, water infrastructure, marketing, scaling of flock, etc. The determining factor of stocking numbers is the forage production potential across the grazing season.

Site Layout and Grazing Rotation

One of the first considerations of the design of a managed grazing program on a utility scale solar site is the spatial distribution of the fenced arrays, and the division into distinct areas. While some sites may have large, contiguous sections of array, other sites can be comprised of many smaller sections. Because sheep must be rotated across the entire grazed area, logistical constraints to movement, such as public roads, woodland, and non-project landowners must all be considered. If there are many of these constraints or if extensive trucking would be required to move the flock through their rotation, it will make sense to break the project down into several spatially distinct grazing areas that will each host its own smaller flock.

AVS has determined that the proposed grazing area of the Cider Solar project is spatially close enough to graze with one (1) singular flock and treat the area's 3 individually fenced arrays as one (1) management area. (Figure 2). The

⁴⁸ Reece, B. Brown, B. American Sheep Industry Association's Recommended Best Management Practices for Livestock Protection Dogs https://www.sheepusa.org/wp-content/uploads/2022/06/ASI-MPB-for-LPDs_2015-1.pdf

⁴⁹ United States Department of Agriculture Natural Resources Conservation Service, Prescribed Grazing (Ac.) (528) Conservation Practice Standard <https://www.nrcs.usda.gov/resources/guides-and-instructions/prescribed-grazing-ac-528-conservation-practice-standard>

⁵⁰ United States Department of Agriculture Grazing Management Plan CPA 110: <https://www.nrcs.usda.gov/sites/default/files/2023-09/FY24-CPA-110-Grazing-Management-Plan-10-22.pdf>

separate sections (individually fenced arrays) within the management area, can further be subdivided into smaller grazing paddocks, at the discretion of the grazing manager.

Throughout the project, the fixed perimeter fencing may serve as outside fencing for grazing paddocks. There is the opportunity to create smaller grazing paddocks with flexible Electronet® fencing or poly-wire fencing. This fencing is portable and can be set up once in spring for the entire season or moved with each flock move into a new grazing paddock, at the discretion of the grazing manager. For the calculations of this PGP, AVS has used an assumed total of 22 grazing paddocks.

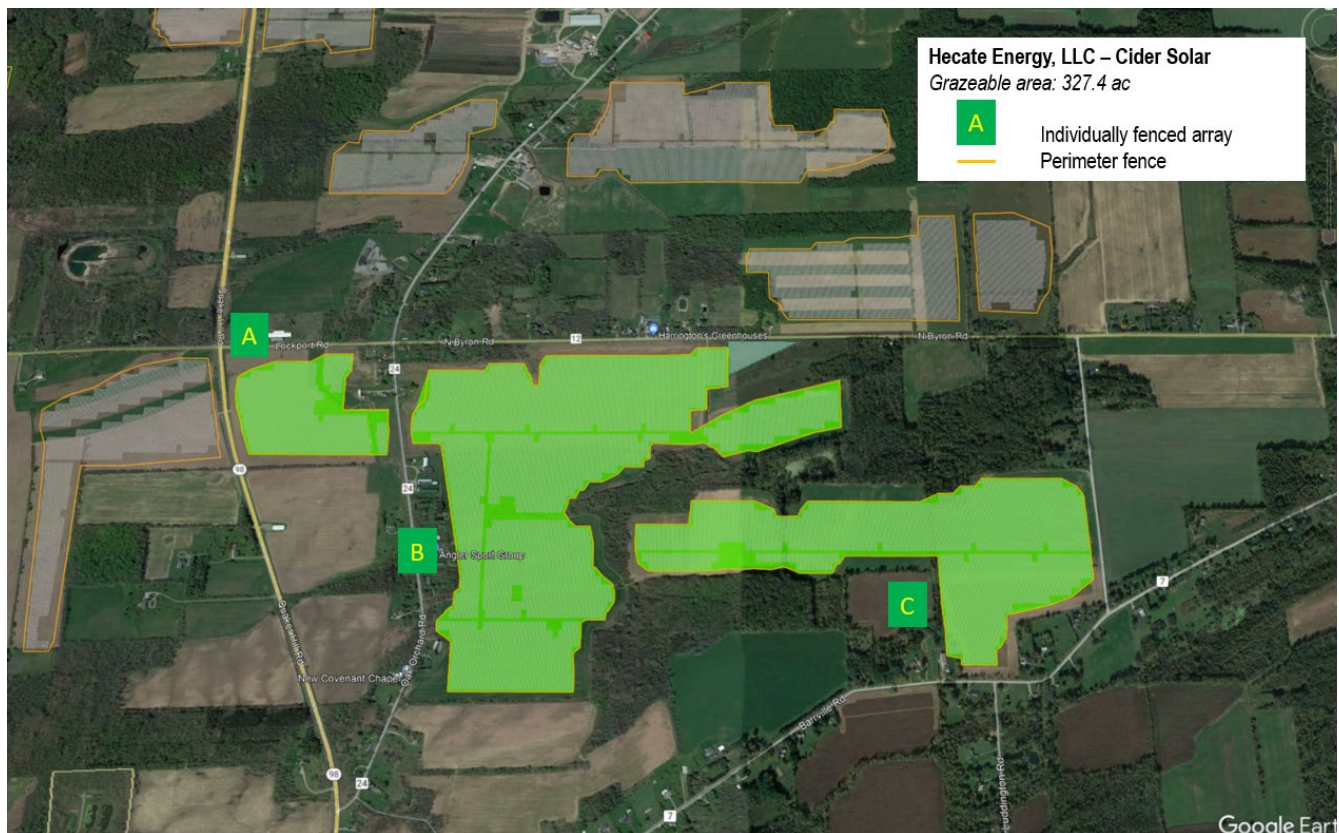


Figure 1 . Cider Solar Project area grazeable acreage layout.

The project is regarded as one (1) management area, which is further subdivided into smaller units (individually fenced arrays, labelled A, B, C) containing the grazing sheep flock as it moves sequentially through the arrays. The arrays can further be subdivided into smaller grazing units (“paddocks”), at the discretion of the grazing manager.

Project → Management area → Array → Grazing area (“paddock”)

Array size and suggested grazing paddock subdivisions		
Array	Size, ac	Max. number of grazing paddocks
A	35.5	2
B	186.0	12
C	105.0	7
Total	326.5	22

Initial Stocking Rate Calculation

The initial stocking rate is established via a grazing rotation plan that utilizes terminology defined by the NRCS.⁵¹ Establishing an initial stocking rate as a guide will prevent over-grazing and detrimental effects to the vegetation root system. The initial stocking rate can then be verified over time by grazing experience.

Based on weather, climate, and forage growth data, it can be assumed that the sheep will be grazing year-round. It should be assumed that the site will be serviced approximately 4 times throughout the season to ensure successful vegetation management and keep the vegetation below the leading panel edge.

The nutritional requirements of sheep vary depending on the stage of production and development (growing lambs, mature ewes or rams, breeding, gestating, or lactating ewes). AVS recommends (and assumes for this initial analysis) that the grazed sheep are in uniform stages of production, and are mature ewes that are dry, breeding, or in early gestation. Forage removal by sheep (grazing success and shade prevention) depends on stage of production and body weight, as well as dry matter content of the forage.

In Spring and Fall, forage growth is slowed due to cooler temperatures, and dry matter content is low (18%-25%). Starting in mid- to late June and extending into August in the Northeast is typically when vegetation growth may outpace the rate of removal by grazing sheep. At the same time, stand height and forage dry matter content increases gradually (25%-30%). Both compounding factors can lead to tall stands of mature grass with lower palatability due to increased dry matter, causing the sheep to lower their feed intake due to heat-feed refusal.

Further terms used in the grazing plan are the bare ground ratio: areas without significant vegetation cover, including but not limited to access road, graveled areas surrounding inverter pads, or small patches without established ground cover, the refusal ratio, an estimate of forage mass refused by the grazing flock⁵², and the ground cover ratio (shading

⁵¹ Butler, L., J. Cropper, R. Johnson, A. Norman, G. Peacock, P. Shaver, and K. Spaeth. 2003. National range and pasture handbook. USDA National Resources Conservation Service, Washington, DC, USA:214.
<https://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=48472.wba>

⁵² Smith R., M, Panciera, A. Probst. 2010. Using a Grazing Stick for Pasture Management. Cooperative Extension Service. University of Kentucky College of Agriculture. <http://www2.ca.uky.edu/agcomm/pubs/agr/agr191/agr191.pdf>

rate)⁵³, the area shaded by panels. Compared to dry matter production in unshaded areas, forage production is lower in areas shaded by panels.^{54 55}

A rotational grazing system as should be employed on the project site, involves moving grazing animals from one pasture to another to achieve the desired management objective ovel panel shading avoidance (also referred to as *Prescribed Grazing by the NRCS*).⁵⁶ Any grazing system can be expressed by the number of subunits (paddocks) of the pasture entity, the number of services (rotations) per year, the length of each rotation, the grazing period (days within each paddock), and the deferment or pasture rest period after each grazing.

Then, a stocking rate calculation can be performed, expressed by the number of animals grazing a unit of land across a full year, described in animals per unit of land (acres). The relationship between the number of animals and area of land in each grazing area (paddock) at any given time is described as stocking density.

Summary of PGP Calculations

Taking into consideration Project site conditions, climate, and pasture production, Table 5 below summarizes the PGP calculations. Based on seasonal forage growth variation, speed and rotation timing, and deferment will be adjusted by the grazing manager to correctly address forage conditions. Based on expected site conditions and assumptions made above, AVS estimates that an average of 773 sheep could initially be grazed on the project.

Table 3. Prescribed Grazing Plan.

	Early season	Mid- season	Mid- season	Late season	Total / Average
Site details					
Grazing unit, ac	327	327	327	327	327
Grazing start, date	5/15/2024	6/15/2024	7/30/2024	9/5/2024	5/15/2024
Grazing end, date	6/15/2024	7/30/2024	9/5/2024	10/15/2024	10/15/2024
Grazing, da	31	45	37	40	153
Sheep flock details					
Sheep BW, lb	170	170	170	170	170
Daily intake, %BW	3	3	3	3	3
Daily intake, lb DM	5.1	5.1	5.1	5.1	5.1
Forage production details					
AUM	5.1	5.1	5.1	5.1	5.1
Forage availability, %	20	40	30	10	100

⁵³ Bousi, Erion, Schaal, A., Adam, N., Lefort, A., Schindele, S., Dennenmoser, M. 2024. Analysis of Agrivoltaics with sheep and cattle grazing. BayWa r.e..World Agrivoltaics Conference 2024. Denver, Colorado.

⁵⁴ Andrew, A. C., C. W. Higgins, M. A. Smallman, M. Graham, and S. Ates. 2021. Herbage Yield, Lamb Growth and Foraging Behavior in Agrivoltaic Production System. *Frontiers in Sustainable Food Systems* 5 (Original Research).
<https://www.doi.org/10.3389/fsufs.2021.659175>

⁵⁵ Kochendoerfer, N., C. E. McMillan, M. A. Zaman, S. H. Morris A. DiTommaso, and S. Grodsky. 2024. Co-location of sheep grazing and solar energy production yields agro-technological synergies. In preparation.

⁵⁶ USDA Natural Resource Conservation Service (NRCS) Prescribed Grazing (Ac.) (528) Conservation Practice Standard
<https://www.nrcs.usda.gov/resources/guides-and-instructions/prescribed-grazing-ac-528-conservation-practice-standard>

Forage, tons DM/ac	0.4	0.8	0.6	0.2	1.9
Bare ground ratio, %	10	10	10	10	10
Refusal ratio, %	30	30	30	30	30
Shading ratio, %	56	56	56	56	56
Forage prod. ratio in shade, %	42	42	42	42	42
Available forage, tons DM/ac	0.2	0.4	0.3	0.1	0.9
Grazing system					
Number of subunits (paddocks)	22	22	22	22	22
Number of services (rotations)	4	4	4	4	4
Rotation length, da	31	45	37	40	153
Grazing period, da	1	2	2	2	2
Deferment (rest period), da	30	43	35	38	33
Stocking calculation					
Stocking rate, sheep/ac	2.3	3.2	3.2	0.9	2.4
Stocking density, sheep/ac	51	71	71	20	52
Total sheep	763	1,051	1,051	296	773

Summary

In a plan using a high degree of management intensive, rotational grazing, within a typical year for Northeast pasture production, a total of 773 sheep, (2.4 sheep per acre annual stocking rate), may be grazed in 1 flock on the Hecate Energy Cider Solar project, using a 153-day grazing season in 4 annual rotations with an average of 2 grazing days per grazing paddock and 33 days deferment, a rotation defined as 1-1; 2: 33 da according to NRCS convention.

The Pasture production estimates used in this PGP originate with the NRCS Web Soil Survey. However, actual pasture production depends on many different variables including, but not limited to, annual precipitation, air and soil temperatures, successful establishment of potential seed mixes, historical pasture use, the previous level of soil and crop management and resulting nutrition levels, quality of hayfields, as well as the practice skill level of the producer in avoiding management mistakes. The PGP is intended to serve as a guidance document and can produce well informed estimates of pasture production amounts and resulting annual stocking rates, but it cannot predict with certainty the carrying capacity of the land, and it cannot replace ongoing observations made by the land manager/grazing manager. It is therefore advised to continuously check the assumptions made and not to rely solely on these predictions conclusively.