

Means and Metrics: The Standard Checklist for Solar Grazing

Research surrounding the science and practice of agrivoltaics and solar grazing systems continues to grow, and the need to understand the means of successful implementation and metrics for evaluating these multi-use systems compared to their single use counterparts is increasingly important for graziers, developers, and managers. The following comprehensive checklist is derived from a full report that describes in detail each checklist section. The purpose of the checklist is to provide useful record-keeping tools to support project planning, monitoring, and evaluation of solar grazing stakeholders. Each checklist section includes columns formatted for relevance to section subject matter, including space to log descriptive information, make note of the responsible party, or provide a time stamp of completion.

These checklists are not meant to be interpreted as “requirements” for solar grazing, rather, they are intended to offer a holistic suite of considerations, which can serve as a template that can be further prioritized at the discretion of the partners of a solar grazing project. We recommend that solar grazing stakeholders access the services of land grant universities, extension agencies, local Natural Resource Conservation Services (NRCS) offices, and conservation districts for further assistance.



ASGA

The American Solar Grazing Association (ASGA) provides educational programming and resources for farmers, establishes professional standards and best practices for solar grazing, and educates the general public and key stakeholders on the economic, social, and environmental benefits of solar grazing. A wide variety of resources are available for their membership network. For more information, please visit ASGA's website: solargrazing.org

Name of Site: _____ Solar Operator: _____
Grazier(s): _____ Date: _____

SOCIAL FACTORS

Item	Yes	No	Describe
Does the site provide economic opportunities for the local community and farmers?			
Is the site located on public property?			
Does the site and management plan maintain local interests?			
Does the management plan for the site promote a fair and just distribution of economic benefits across the local community?			
Will products be used/sold locally?			
Do local supply chains benefit from agrivoltaic products (e.g. honey, meat, wool, etc.)?			
Does the site incorporate multi-use?			
Are socio-geographic factors considered in the site design (e.g. viewshed obstruction, perimeter fence type)?			
Are cultural factors considered for site planning and management?			
Are there aesthetic issues that need to be addressed, like panel washing, fencing, tidiness, vegetation management, etc.?			
Are there plans to provide opportunities for community outreach and engagement before and during operations?			

ECONOMIC FACTORS

CAPITAL COSTS

Item	Yes	No	Responsible Party	Cost	Date
Are all site development (pre-installation) costs identified?					
Are there multi-use-related site development costs?					
Are all site installation (construction) costs identified?					
Are all vegetation establishment (post-installation, but may include pre-seeding) costs identified?					
Is a livestock-friendly seed mix used?					
Are there any plants that are toxic to grazing animals or dogs, and, if so, is there a plan for removal?					
Is there on-site water access?					
Is equipment needed for livestock transportation?					
Is additional livestock needed for purchase?					
Is a livestock guardian dog allowed on-site?					
Do livestock guardian dogs need to be purchased?					
Are water transportation equipment, water tanks, troughs, and/or a water transfer pump needed?					
Is temporary interior fencing needed?					
Is a portable solar charger needed?					
Is permanent interior fencing present on-site?					
Is a permanent corral present on-site?					
Is a portable corral system needed?					
Is signage with grazer contact information present?					
Is mowing/weed/mechanical vegetation maintenance equipment identified?					
Are necessary personal protective equipment and safety equipment identified?					

ECONOMIC FACTORS

O&M COSTS

Item	Yes	No	Responsible Party	Cost	Date
Is there remote monitoring in place?					
Is there a plan for groundskeeping in the margins outside the grazed portion of the solar site?					
Is there a plan for equipment cleaning?					
Is there a plan for troubleshooting, diagnosis, and repair of equipment?					
Is there a plan for panel and wire management/maintenance to ensure safety of animals?					
Are ongoing vegetation management plans and costs identified?					
Is there a plan for insurance coverage?					
Is liability and health insurance coverage for the grazer and livestock current?					
Is there a plan for maintenance, health, and care of livestock?					
Is there a plan for maintenance, health, and care of guardian dogs?					
Are there transportation costs for livestock management?					
Is additional labor needed by the grazer?					
Is there a plan for fence repair?					
Is there a plan for mineral and nutritional supplements?					
Is there a plan for veterinary costs?					
Is there a shearing plan in place for woolled and wool-hair crossbred sheep?					
Are additional livestock needed?					
Is there a plan for forage sampling?					
Is there a plan for soil sampling?					

ECOLOGICAL FACTORS

NUTRIENT CYCLING

Item	Yes	No	Describe	Date
Is irrigation monitored?				
Is there a plan to use chemical fertilizers?				
Is there a plan to use chemical herbicides?				
Is forage above-ground biomass monitored?				
Is soil sampled, tested, and monitored?				
Is total carbon monitored?				
Is total nitrogen monitored?				
Is carbon storage/sequestration monitored (requires bulk density measures)?				
Is grazing managed in response to nutrient cycling monitoring?				

SOIL STABILITY AND EROSION

Item	Yes	No	Describe	Date
Is soil type known?				
Is soil pH monitored?				
Is soil compaction monitored?				
Is organic matter content monitored?				
Are changes in bulk densities monitored?				
Is erosion monitored?				
Is pasture condition scoring used?				
Is sediment export monitored?				
Is soil tillage minimized?				
Is soil cover maintained?				
Are there perennial plant species present (year-round living roots)?				
Is grazing managed in response to soil stability and erosion monitoring?				

ECOLOGICAL FACTORS

SOIL MOISTURE

Item	Yes	No	Describe	Date
Is soil moisture distribution monitored?				
Is soil temperature monitored?				
Are water infiltration rates monitored?				
Are water discharge rates monitored?				

FORAGE QUALITY

Item	Yes	No	Describe	Date
Is forage availability monitored?				
Is forage nutritional value, quality, and yield tested and monitored?				
Is a forage nutritive value analysis needed?				
Is residual (post-grazing) forage stubble monitored?				
Is pasture condition scoring used?				
Is forage moisture content monitored?				
Is dry matter monitored?				
Is crude protein monitored?				
Is acid detergent fiber monitored?				
Is neutral detergent fiber monitored?				
Is lignin monitored?				
Is crude fat monitored?				
Is grazing managed in response to forage quality monitoring?				

ECOLOGICAL FACTORS

BIODIVERSITY

Item	Yes	No	Describe	Date
Is plant biodiversity monitored?				
Is native vegetation present on-site?				
Is pasture condition scoring used?				
Is percent vegetative cover monitored?				
Is the ratio of non-grass to grass plant species monitored?				
Is a multi-benefit seed mix being used for pre- or post-construction?				
Is grazing managed in response to biodiversity monitoring?				

POLLINATOR HABITAT

Item	Yes	No	Describe	Date
Is the abundance of pollinators monitored?				
Is the ecosystem service value of pollinators known or monitored?				
Is intensity and timing of grazing managed with impact on pollinator abundance in mind?				
Will a commercial beekeeper be hired to host pollinators on-site?				

LIVESTOCK FACTORS

ANIMAL HEALTH

Item	Yes	No	Describe	Date
Is there a veterinarian-client-patient relationship (VCPR) established?				
Is there a herd health monitoring plan?				
Is body condition scoring used?				
Is the treatment of disease and other medical interventions recorded?				
Is the frequency of dewormers, antibiotics, vaccines, and other treatments appropriate?				
Are the above questions monitored throughout the different stages of an animal's lifetime?				
Are dietary requirements (ie. protein, energy, minerals, vitamins, and water) being met according to production stage of livestock?				
Are animals up to date on vaccinations?				
Is there a plan for preventing parasite infection (e.g. rotational grazing)?				
Is FAMACHA scoring used?				
Are fecal egg counts monitored?				
Are culling decisions recorded?				

LIVESTOCK FACTORS

ANIMAL WELFARE

Item	Yes	No	Describe	Date
Is animal welfare monitored during transport to and from the site?				
Is normal grazing behavior observed?				
Are additional nutrients and minerals provided?				
Do animals exhibit fear or distress?				
Is there a shearing plan in place for woolled and wool-hair crossbred sheep?				
Do animals have access to shelter?				
Do animals always have water access?				
Is on-site water assessed for quality?				
Are animals protected from electrical, wire, or other infrastructure dangers?				

ANIMAL PRODUCTION

Item	Yes	No	Describe	Date
Are pregnancy rates tracked and evaluated?				
Are lambing/calving rates tracked and evaluated?				
Are weaning rates tracked and evaluated?				
Are death/loss rates tracked and evaluated?				
Is rate of gain tracked and evaluated?				
Are harvest/carcass weights tracked and evaluated?				

GRAZING MANAGEMENT FACTORS

GROWING SEASON

Item	Yes	No	Describe
Is the quality of the available forage known?			
Is the site size (acreage) known?			
Is the date of construction completion known?			
Are the wiring system, inverters, or other important site equipment excluded from animal access?			
Is there on-site water access?			
Is the site properly predator-proofed?			
Are there any toxic plants on-site?			
Is forage established on-site?			
Is it known how the site climate will impact grazing and the available forage?			
Is stocking rate or density determined?			
Is the solar site near the home farm?			
Is the grazer available to be at the site daily and in case of emergencies?			
Does grazing management style align with the goals of the site operator?			
Does grazing management style prioritize the health of the animals?			
Is the maximum allowable vegetation height identified?			
Are grazing goals defined, and how will the management style meet those goals?			
Is a grazing management style (ie. rotational, continuous, intensive, targeted, seasonal, year-round, etc.) selected?			
If rotationally grazing, is there a plan for how to rotate animals (ie. herding dogs, grain, drones, e-collars, etc.)?			
Will lambing occur on site? If so, is there a veterinary plan in place in case assistance is needed?			
Will wethers be finished on site? If so, is there adequate forage quality to meet nutritional needs?			
Is there proper fencing to manage the decided grazing style?			

GRAZING MANAGEMENT FACTORS

GROWING SEASON - CONT.

Item	Yes	No	Describe
Is there a plan for euthanasia on-site if needed?			
Is there a plan for prompt removal of dead livestock?			
Are there requirements in place to promote pollinator health?			
If there are pollinator requirements, will this impact grazing management?			
Is there a communications plan between grazer and solar site operator?			
Is there a site access plan for graziers – time of day, days of week, who to contact, access to lock boxes, etc.?			
Is there training for solar operations staff on how to interact with graziers, sheep, and guard dogs?			
Is there an emergency flock removal plan identified?			
Is there a contingency plan for natural disasters, like fire, hurricane, tornado, flooding, or drought?			
Is there a contingency plan for contract delays?			

OFF-SEASON

Item	Yes	No	Describe
Is the site grazed year-round?			
If yes, will supplementary feed/hay be required?			
Is there a contingency plan to have supplemental feed/hay readily available?			
Is there a secondary location available for the off-season or in case of emergency?			
Is there an emergency flock removal plan identified?			
Is there contingency plan for contract delays?			
Is there contingency plan for natural disasters, like fire, hurricane, tornado, flooding, or drought?			

SITE DESIGN FACTORS

PANEL ORIENTATION AND SPACING

Item	Yes	No	Describe
In the case of new solar installation, will the site landscape impact panel height and orientation compatibility with grazing?			
Does the soil type impact panel height and orientation requirements?			
Does the site incorporate multi-use management objectives?			
Are there enough financial resources available to modify panel orientation and spacing as needed to incorporate livestock grazing at the site?			
Is the panel height at least 18" at the leading edge?			
Are the I-beams either raised or rotated to avoid harm to grazing animals?			

FENCING AND GATES

Item	Yes	No	Describe
Are perimeter and interior fences predator-proofed?			
Is permanent or semi-permanent interior fencing being used?			
If using electric fencing, is the equipment approved for use on-site?			
Have livestock been trained with the fencing type that will be used on-site?			
Are access gates available along the interior fencing to allow for easier rotational grazing and ease of performing livestock checks?			
Are rolling gates used on-site?			
Are gates inspected for gaps and modified as needed for predator management?			
Are gates wide enough to accommodate livestock and vehicle movement?			
Is there a dedicated corral/catchment pen area on-site?			
Are sufficient gates installed to move livestock between permanently fenced areas of the site efficiently?			



SITE DESIGN FACTORS

WIRE AND CABLE MANAGEMENT

Item	Yes	No	Describe
Are CAB systems and wires raised/buried for ease of grazing and managing animals?			
Are drive trains used for tracker movement? If yes, are these designed with animal safety in mind?			
Are inverters and other important solar equipment fenced out to prevent livestock interactions?			

WATER ACCESS

Item	Yes	No	Describe
Is there on-site stock water access from municipality or well sources?			
Can retention pond water be pumped or accessed by stock?			
Is water quality monitored?			
Can drilling a well be justified?			

GROUND COVER AND VEGETATION

Item	Yes	No	Describe
Is the previous groundcover or land management history known?			
Are the various method(s) of vegetation management for the site clearly identified (ie. grazing only, mowing, or hybrid)?			
If a hybrid management method is used, is the responsible party for vegetation management outside of grazing identified?			
Is there a plan in place for managing the balance of grazing vs mowing?			
Are multiple partners used to determine groundcover and vegetation selection?			
Are the objectives for vegetation management identified for both the O&M managers and for the graziers?			
Is there a vegetation establishment strategy and determined rest period before incorporating grazing?			