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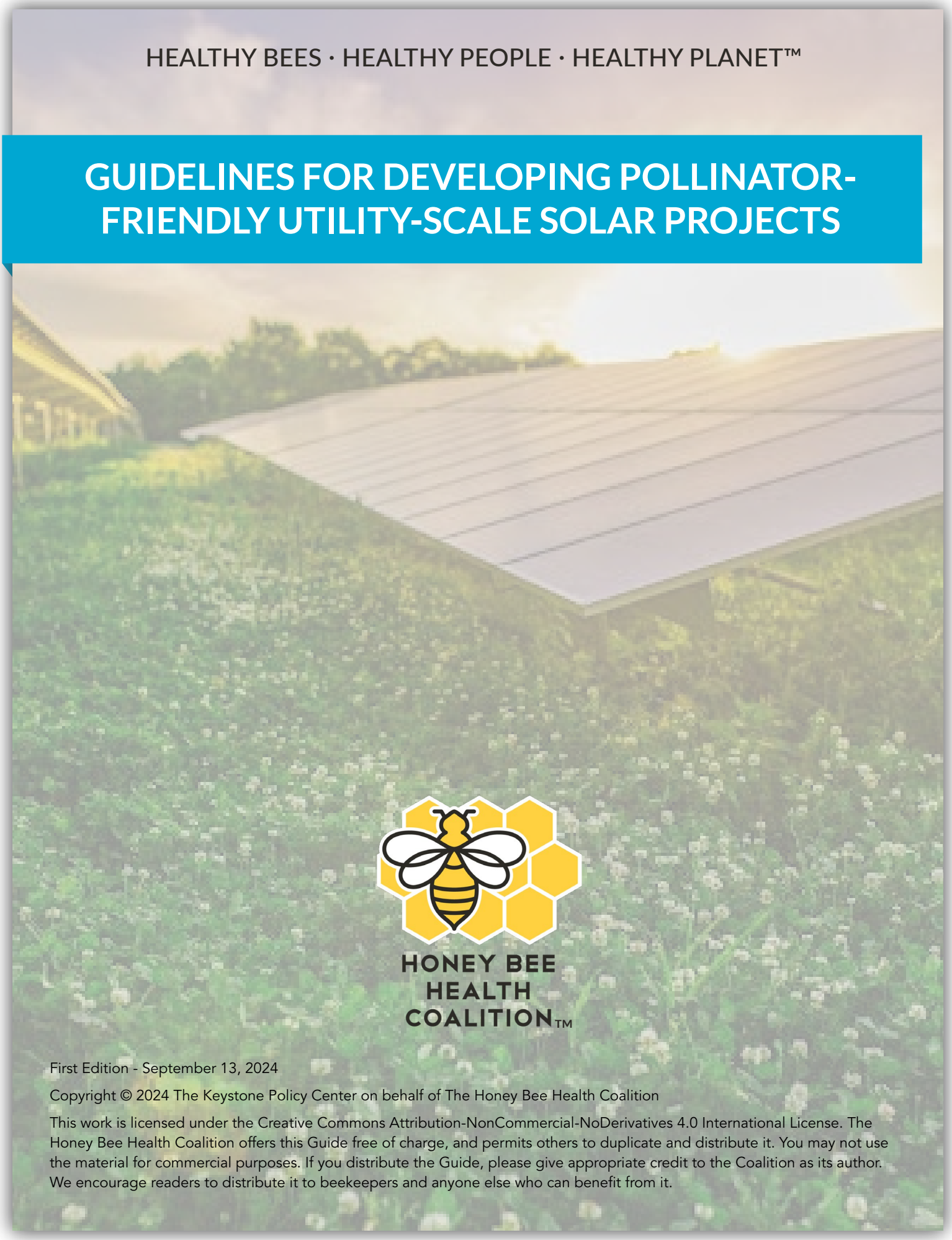
GUIDELINES FOR DEVELOPING POLLINATOR-FRIENDLY UTILITY-SCALE SOLAR PROJECTS



HONEY BEE HEALTH COALITION™

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ACKNOWLEDGEMENTS

This Guide has been developed in partnership with the Honey Bee Health Coalition. The Coalition (HBHC) is a collection of beekeepers, growers, researchers, governmental agencies, conservation groups, manufacturers and consumer brands that are working to improve the health of honey bees. The HBHC mission is to collaboratively implement solutions that will help achieve a healthy population of honey bees and other pollinators in the context of productive agricultural systems and thriving ecosystems.

The Honey Bee Health Coalition would like to give special thanks to members and peer reviewers that helped compile information, draft, review and edit the *Developing Pollinator-Friendly Utility-Scale Solar Projects* guide.

For more information on the Coalition and its key focus areas/products, please visit: http://honeybeehealthcoalition.org.

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INTRODUCTION

The Opportunity

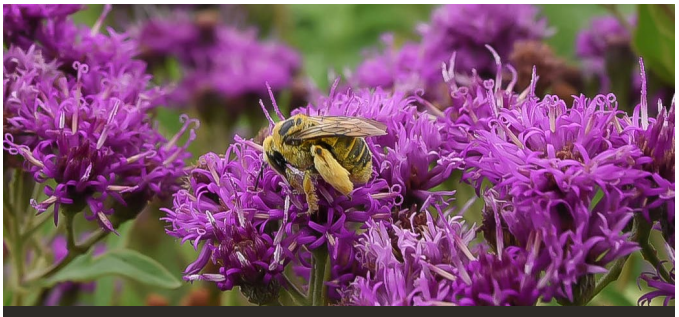
The Honey Bee Health Coalition (HBHC) developed this guide for Utility-scale solar (USS) projects that are seeking to include pollinator health and habitat benefits in their project design and management. A Utility-scale solar project is defined as a site that produces solar energy for an electrical utility for distribution to a regional grid. It is estimated that over 10 million acres (1,000-2,000 gigawatts) of USS projects will be installed between 2023 and 2033. These projects will help the U.S. transition to more renewable energy sources. They also offer a unique opportunity to provide significant pollinator health and habitat benefits, but come with challenges. This guide reviews the opportunities and challenges of including pollinator-friendly habitats within USS projects and provides specific guidelines for success.

When it comes to pollinator health and habitat, "a rising tide lifts all boats." This statement reflects the belief that pollinator-friendly USS projects benefit the widest range of species when they address the overall health and habitat needs of honey bees, native bees, butterflies, grassland songbirds and other wildlife.

Benefits of Pollinator-Friendly Utility-Scale Solar

USS projects can be permitted, designed, constructed, and operated to yield a wide range of environmental benefits. ***Some of those benefits include:***

- Improved pollinator health and habitat
- Increased domestic honey production
- Increased carbon sequestration
- Improved soil health
- Reduced Stormwater Runoff
- Enhanced water quality
- Grassland songbird habitat and health benefits
- Reduced operation and maintenance costs of the USS site
- Contributions to corporate sustainability goals and objectives
- Greater public acceptance of USS projects



Native bees have demonstrated significant pollinator health and habitat benefits from appropriately designed vegetative cover on solar projects.

Challenges of Pollinator-Friendly Utility-Scale Solar

LOWER PANEL HEIGHT

Many USS projects are now being designed with a lower panel height at full tilt of 18" to 22" above the ground, so the final vegetative cover established within the solar array area must be shorter than this to avoid panel shading. This height restriction limits how vegetation seed mixture can be designed and used. However, pollinator-friendly seed mixes that produce vegetation with heights at maturity of less than 18" to 20" are available and will be discussed in this guide.

WATER AVAILABILITY

In drier Western areas of the United States, water availability is a major factor to consider when selecting pollinator-friendly vegetation for USS projects. This guide will cover strategies for successful dry climate projects.

Areas of solar projects without panels located on them are prime locations for highly diverse pollinator seed mixtures.

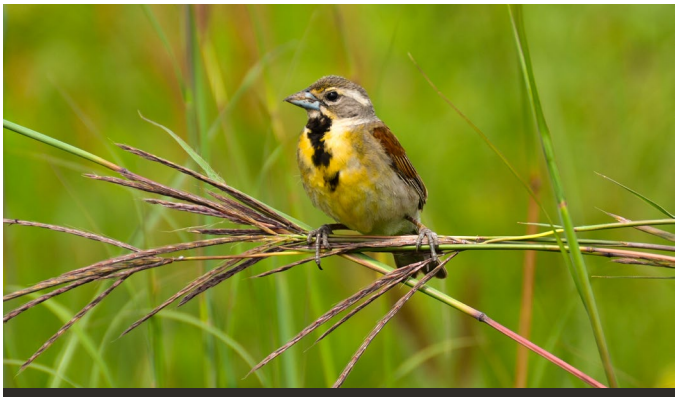
Who is this Guide For?

The Honey Bee Health Coalition developed this guide primarily to provide support for solar developers and the owners/operators of USS projects.

Other audiences for this guide include USS decision makers and stakeholders like:

- Planning and zoning boards
- Permitting agencies
- Landowners considering enrolling their properties into solar projects
- Pollinator conservation advocates

These audiences often play a major role in determining what constitutes the final vegetative cover, how ground cover functions, future management activities and how it will perform over the life of the project's lease agreement.



Grassland songbirds like this Dicksissel are able to benefit from the vegetative cover designed for use on solar sites.

What's in This Guide?

This guide will provide important considerations for project design and future management. ***Those considerations include an outline of:***

- Considering how the height of the lower panel above the ground impacts the final vegetative cover design.
- How access to high quality habitat/forage impacts beekeeping sustainability and US honey production.
- The potential benefit to native pollinator species and grassland songbirds from USS projects.
- Key design considerations to include when selecting a final vegetative cover.
- Key considerations for site preparation and establishment of a final vegetative cover
- The importance of short and long term management activities.
- Vegetation Management Plan considerations and the timing of its introduction to the project Engineering, Procurement, and Construction (EPC) team.

Utility-scale solar projects are significantly different from smaller solar projects in their design, function, and overall objectives. Those differences contribute to the opportunity to design vegetative cover to thoughtfully mesh pollinator health and habitat with USS project objectives.

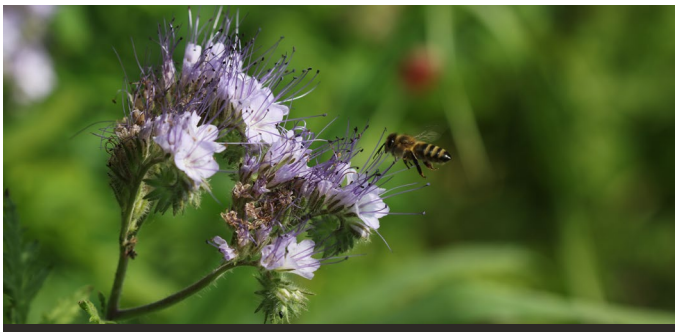
The Importance of Pollinators

Managed vs. Wild bees

There are over 4,000 species of wild bees in North America. These bees differ from the managed bees that pollinate the food we eat. Managed bees are typically European honey bees and were brought to North America in the 1600's.

Honey bees and native pollinators are both vital to our ecosystems and U.S. agriculture (see call out box). Bees perform pollination services for the majority of our fruits, nuts, and vegetables; more than 140 crops benefit from pollination. Honey bees also provide pollination benefits to non-farm blooming plants, trees, and shrubs in gardens and natural areas. In addition, they produce surplus honey, which is harvested for food.

Unfortunately, honey bees and their beekeepers are in peril. In recent years, annual hive death losses have been increasing, and now average near 40% across the U.S. Hive shortages during pollination seasons are more and more common. US-sourced honey production has declined nearly 50% in the past 20 years.



Honeybees are especially able to benefit from the vegetative cover designed for solar sites.

The removal of pollinator-friendly plants from roadsides through broad herbicide applications like this one have contributed to pollinator population declines.

The U.S. annual domestic honey supply now only meets about 25% of total US consumer demand, so most honey is now imported.

Habitat loss is a major cause of both honey bee health decline and reduced honey production. Changes in agriculture, conservation policy, and expanding development have all continued to reduce the amount of flowering habitat available for honey bees. These same issues also affect other pollinators and many wildlife species which lack an explicit economic metric, yet provide important ecosystem services. The good news is redeveloping habitat, especially with proper pollinator focus and design, has been improving pollinator health. There is an incredible opportunity to make pollinator-friendly habitats an integral part of solar energy projects, which will provide substantial benefits for honey bees and other pollinators.

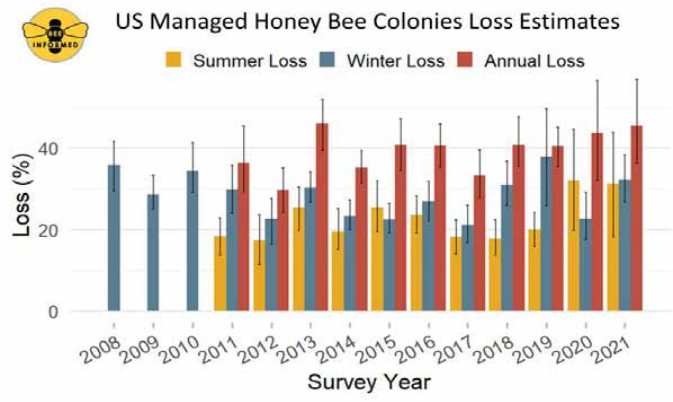


Table 1: Seasonal honey bee colony loss rates in the United States across years. Annual loss estimates (from one 1 April to the next 1 April) combine winter (1 October – 1 April) and summer (1 April – 1 October) losses. The loss rate was calculated as the total number of colonies lost divided by the number of colonies "at risk" during the season. Colonies at risk were composed of viable colonies and new colonies made or acquired, while excluding colonies sold or parted with.

DETAILED GUIDELINES

To provide pollinator health and habitat benefits that mesh with the other objectives of a Utility-scale solar project, it is critically important to design a comprehensive Vegetation Management Plan (VMP) as soon as possible in project development. In most cases, it is beneficial to include this plan in the project's Request For Proposal to Engineering, Procurement, and Construction (EPC) firms. This will increase the likelihood that the USS project's final design will be developed, established and managed in a fashion that avoids conflicting goals in the project's design and helps ensure a positive outcome over the project's lifespan.

An effective Vegetation Management Plan addresses several key factors:

- Site preparation activities
- Previous crop herbicide residual effect evaluation
- Pre vs. post construction planting options
- Available planting timelines and dates
- Cover crop planting options and methods
- Planting methods
- Seed mixture design
- Management plans for year one, year two and year three+
- Invasive plant species monitoring and control
- Vegetative quality targets
- Seed mixture planting maps

Vegetation Management Plan

Site Suitability

Many USS projects are being designed and located on lands that were formerly in agricultural crop production. When the crops and agricultural activities that were on the land in the last cropping season are appropriately considered, these sites can lend themselves to a successful establishment of a final vegetative cover that produces multiple benefits. Determining site suitability for pollinators involves assessing factors like access to water, length of growing season, appropriate native/non-invasive seed mixes that would be successful AND would support pollinators.

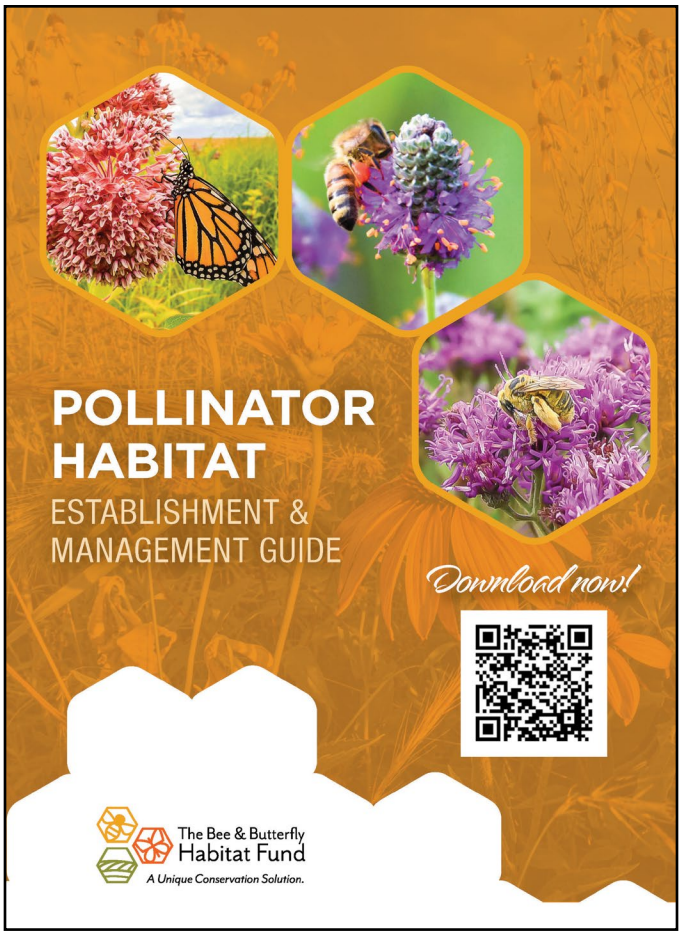
Native grasslands and uncultivated rangelands in the western U.S. are less desirable for establishing pollinator-friendly USS vegetation. Many of the recommendations in this guide may not be suitable for those locations. In most cases, USS sites located on rangeland will be designed to maintain the existing cover. On these sites, suitability for pollinators would include things like access to water, growing season, appropriate native/non-invasive seed mixes that would be successful AND would include pollinators.

Site Preparation

Proper site preparation is the single most important factor that will determine both the initial establishment and the long-term success of the final vegetative cover planting. When located on lands that were formerly in agricultural production, USS projects will have to contend with significant weed competition, especially in the initial year of establishing the final vegetative cover. However, these locations will also benefit from the significant amount of site preparation already in place.

It is critical that the developer understands what agricultural management practices have been formerly grown on the project site. For example, some common agricultural herbicides can remain active in the soil for 18 months or longer and can affect the germination and growth of the project seed mixtures during that time. In this situation, a cover crop mixture should be designed and established to bridge the herbicide residual effect period.

Often a grower will have one final year of growing agricultural crops prior to development of the USS site. If one more year of crop production is possible, growing legumes (soybeans) in that final year is a great way to strategically prepare the site prior to construction. A soybean crop, for example, provides several key benefits to the establishment of a project's final vegetative cover. It's advised that the developer consult a vegetation management specialist to help them with this process and realize some or all of the following benefits.



Bee and Butterfly Habitat Fund's ***Pollinator Habitat: Establishment & Management Guide*** offers a site preparation and pollinator habitat plantings strategies. It is often referred to it as '*The Gold Plan*' of site preparation. Scan the QR code above or go to this link for more information: beeandbutterflyfund.org

BENEFITS OF SOYBEANS AS A FINAL CROP

- Reduced likelihood of a crop herbicide residual effect, as compared to corn as the final crop.
- Soybeans are a legume that naturally fixes Nitrogen from the atmosphere into the soil. The increased plant available nitrogen is a 'free' ingredient that will boost the establishment of the final vegetative cover.
- Soybean crop residue is a ground cover that lends itself to either broadcast seeding or drill seeding the final vegetative cover. Unlike corn stubble, soybean residue has a composition and density that does not require the site to be disked prior to planting.
- Soybean crop fields typically have fewer furrows that will require field finishing (disking) to be removed prior to project construction and/or planting the final vegetative cover.
- Several of the grass and forb species components of the array area seed mixture require a significant amount of nitrogen to be maintained successfully on the site each year. The inclusion of clover and other legume species in the seed mixture is a critical component that will produce significant long-term benefits to the grass establishment, growth, and longevity on the site.

Early successional weedy plant species will emerge on former agricultural crop lands as soon as crop production and herbicide applications have ended. It is important to address this issue in the VMP. A failure to address weed competition in the first and second years of the project can significantly increase future operation and management (O&M) costs and possibly jeopardize the successful establishment of the final vegetative cover. A clear focus on applying timely, appropriate and strategic mowing activities in year one and two can produce significant future cost-savings for the project's O&M efforts.

Properly completed and timed site preparation techniques are critical to the overall success or failure of the vegetative cover establishment on solar sites.

Planting the final agricultural crop on a solar site to soybeans is a significant site preparation technique that can produce multiple benefits.

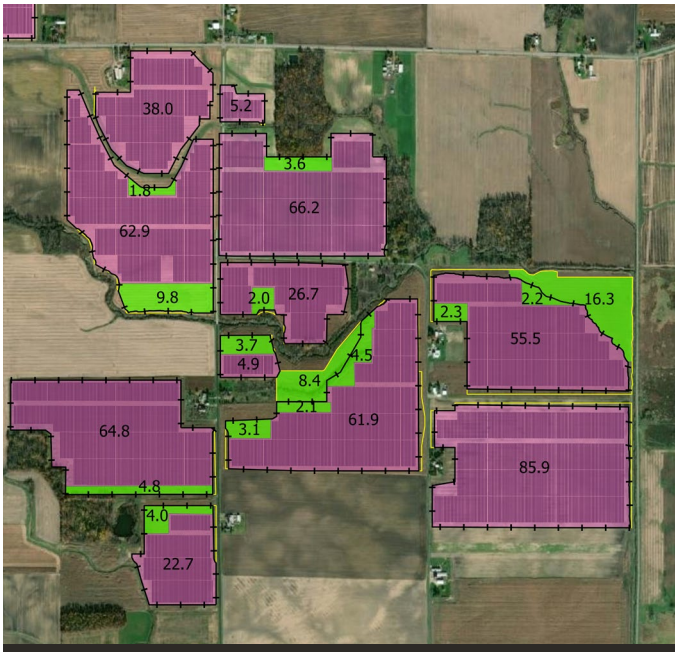
Designing Pollinator Seed Mixtures

The recommendations below are designed specifically for USS projects that require the lower vegetative height restrictions (18" to 22" lower panel height). These projects only allow a narrow range of plant species and opportunities in the final vegetative seed mixtures. For USS projects that have a vegetative height restriction of 36" or more above the ground, a much wider range of plant species and opportunities can be incorporated into the final vegetative seed mixtures plan.

The seed mixtures recommended for USS projects should be designed to maximize pollinator health, balanced with a wide range of critically important and diverse objectives. This challenge can be met with careful and thoughtful consideration. A strategy that has been proven to be widely successful is a two-seed mixture approach that combines a solar array area seed mixture with a buffer area seed mixture.

SOLAR ARRAY AREA SEED MIXTURE

A seed mixture that is developed to be used throughout the project where the height of the final vegetative cover is a concern as it relates to the generation of power. This seed mixture is designed for use under solar panels, in rows and alleys, and on most of the site that is located inside the project fence.



In this real world example, the pink colored areas are planted to a solar array area seed mixture and the green areas are planted to a highly diverse pollinator seed mixture.

A Reasonable Substitute for Native Plants

Native plant language in local statutes and the need broaden statute language to include "non-invasive/naturalized" in order to meet the project criteria.

When a USS project requires a final vegetative cover that does not exceed 18" to 20" in height, seed mixtures are often designed with a combination of low growing grasses and clover (*Trifolium spp.*) species. Including clover within the seed mixture provides significant pollinator health and habitat benefits for a wide range of species and meets important project objectives like ease of establishment, low height at maturity, cost effectiveness, adaptation to a wide range of sites, reduced fire danger, significant regrowth following mowing activities, and tolerance to partial shading.

While clover (*Trifolium spp.*) is a naturalized, introduced plant species, its significant and unique attributes in a USS project setting typically outweigh the desire to use only native plant species on the site. Clover is an attractive nectar source for both honey bees and native bees. In addition, clovers are very well known and are commonly used in agriculture as a source of hay and forage. Clovers can meet every one of the considerations in the 'Factors to Consider' list on page 10. Perhaps the greatest attribute of clovers is their ability to respond to mowing and/or haying activities with vigorous regrowth and produce floral resources throughout the entire growing season. Native plant species options often have a negative response to regular mowing activities and tend to be eliminated quickly from the planting with regular mowing.

In the past several years, solar array area seed mixtures that combine low growing grasses and clover have been used with great success on USS projects across the country.

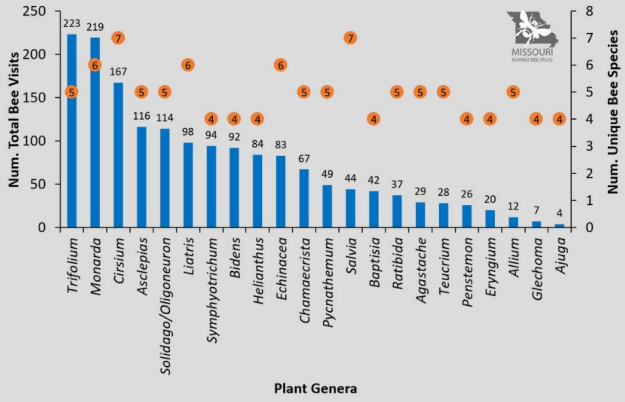
Solar array area seed mixtures are typically designed with a seeding rate of 350 to 600 pure live seeds (PLS)/ft^2. This seeding rate will ensure a fast, complete establishment within the array area that can quickly begin competing with and suppressing early weed growth. Note: This seeding recommendation applies an updated design methodology based on seeds/ft^2 that is more cost-efficient than using the more antiquated pounds of seed/acre methodology.

Missouri Bumble Bee Atlas

Understanding which plants bumble bees utilize throughout the season and across the state is a valuable source for conservation practitioners which to support these imperiled pollinators. Between 2020-2021, nearly 97% (2,315) of all Atlas observations were submitted with a floral host! Bumble bees were observed on 136 different plant genera, though 55% of visits were to ten genera.

On the charts below, we've listed all plant genera that has been visited by at least four different species of bumble bees. The blue bar represents the number of bumble bee visits to each genus, while the orange dot represents the number of bumble bee species that visit each genus.

Learn more at mobumblebeeatlas.org



BUFFER AREA SEED MIXTURE

Buffer areas are parts of the site that are not subject to vegetative height restrictions and which lend themselves to being managed differently than the areas being planted to the array area seed mixture. In most cases, buffer areas include those locations of the site within the project boundary without solar panels that are 2.0 acres in size or greater. These areas can be located outside or inside of the project fence and usually comprise 10% to 20% of the total project site (see example map on page 17).

A buffer area seed mixture typically consists of diverse native plant species that are adapted to the geography and soil type, provide floral resources across the entire growing season, and are known to persist in plantings with minimal management activities.

These seed mixtures are typically designed at a minimum seeding rate of 40 PLS seeds/ft^2. Applying the PLS methodology to seed mixture design is especially important when the seed mixture includes very small seeds. The more outdated methodology of pounds of seed/acre tends to significantly increase the cost of the overall seed mixture and create a mixture that is overbalanced to grasses, instead of wildflowers.

The use of two seed mixtures on a USS project has been an innovative solution to meeting project objectives and providing significant pollinator health and habitat benefits. In locations where a 'Solar-Pollinator Score Card' has been developed, this approach has consistently allowed USS projects to meet the score card designation of 'providing pollinator health benefits'.

Highly diverse pollinator seed mixtures like this one are established in the buffer areas of the project.

Requirements for Native Species

Permitting language sometimes requires the inclusion of native species in the final vegetative cover for USS sites. However, that language tends to produce unintended negative consequences and outcomes. For example, native wildflowers typically grow taller, cost more, are slower to establish, and do not tolerate regular mowing activities. If mowing is conducted more than one time during the growing season, most native wildflower species will be eliminated from the planting within a short time span.

The two seed mixture approach works well on USS projects by establishing native wildflowers in buffer areas that don't have vegetative height restrictions and establishing grasses and clover species that can respond positively to mowing activities in solar array areas.

Keys to Success

- Properly prepare the site (including using soybeans as a final crop prior to transition to solar).
- Have a VMP included in the project RFP distribution.
- Consider all of the factors listed on page 10 when developing a seed mixture.
- Use a qualified vegetation management specialist who is an expert in including pollinator habitat in solar projects.

Factors to Consider

When drafting a RFP for a consultant to develop seed mixtures and/or a VMP, developers should include these factors in the RFP to ensure the success of the project and the habitat.

- Vegetative growth height restrictions
- Overall pollinator value of the seed mixture design
- Response to future mowing activities
- Cost-effectiveness of the seed mixture
- Commercial availability of the seed mixture
- Ease and speed of establishment
- Water requirements of the seed mixture
- Longevity and ability of the seed mixture to persist in plantings
- Species that are adapted to the geography, soil and site conditions
- Tolerance to partial shading
- Erosion and stormwater control attributes
- Soil health benefits
- Fire danger considerations
- Soil type/quality (Note: Soil testing may be helpful in choosing an appropriate seed mixture.)
- Construction timelines and seasonality of growth

Potential additional objectives and considerations:

- Carbon sequestration benefits
- Albedo effect of the seed mixture on bifacial panel designed projects
- Support for sheep grazing as a future management tool
- Seed mixture diversity to provide benefits over the entire growing season

Selecting plant species for planting on solar sites that come with high pollinator value are key seed mixture design considerations.

Selecting plant species that are able to tolerate some shading are an important consideration.

Cost of Pollinator-Friendly Seed Mixtures

Seed costs may vary locally and year to year based on availability. While every project is unique in its design and objectives, we have found that the final vegetative cover seed mixtures recommended for USS projects are very comparable to turf-type grass plantings. In our experience, solar array area seed mixtures typically cost between $200 and $290/acre and buffer area seed mixtures typically cost between $275 and $390/acre.

Construction and Establishment

A final vegetative cover can be established in either a pre-construction phase or a post-construction phase. Establishment during pre-construction depends on several factors: the sequence of construction, the timeline within the growing season, how much of the site will be graded, and how much of the site will need to be replanted after construction activities.

Pre-construction establishment of the final vegetative cover offers several key advantages:

- Avoids the need to establish and subsequently terminate a cover crop planting.
- Allows all necessary site preparation activities to be completed more effectively.
- Produces a final vegetative cover that is evenly and completely established across the entire site.
- Allows the entire site to be planted with a no-till grass drill that will significantly increase the seed germination rate and shorten the time needed for establishing vegetation.
- Makes it easier to apply management/mowing activities to the final vegetative cover in a timely and cost-effective manner.
- Eliminates the outcome where the final vegetative cover is established differently under the panels versus in the alleys.
- Supports easy assessment of establishment success and identification of any locations .that need additional attention or replanting.

If the decision is made to establish the final vegetative cover during or after construction, a cover crop will often be needed to stabilize the soil and suppress weed establishment and growth during the construction time period. Weed growth is very common on former agricultural fields and very challenging to control if allowed to get started. It's critical to prevent weed growth from starting. The final vegetative cover is typically planted during or after construction on the site.

Before planting a seed mixture, areas where the soil has been compacted by construction or agricultural activities to a rate greater than 200 PSI will need to be de-compacted before replacing topsoil and/or preparing the site for planting. For shallow decompaction, use a disk with a minimum of two passes. For deeper, more significant compaction, use a winged subsoiler or straight ripper shank, followed by a disk with a minimum of two passes. Many soil disturbing activities require soil erosion and stormwater controls by permitting agencies. Inspections may be required until vegetation is established on 70% or more of the site.

Monitoring and addressing soil compaction due to site construction is an important consideration in vegetative establishment success.

MANAGEMENT AND MAINTENANCE

First Growing Season

The management and maintenance activities that follow the planting of the final vegetative cover in the first growing season are extremely critical. During this time period, control or elimination of undesired or invasive plant species should be addressed with a combination of management tools that could include mowing and/or herbicide use.

All projects with high quality pollinator resources and pollinator benefits require a specific long-term management plan so pollinator benefits are maintained into the future. Natural succession will move the plant community through a cycle to where it eventually becomes dominated by grasses, while the pollinator forb (broad leaf) species drop out over time.

Future management options on USS projects include:

- Mowing
- Herbicide Application
- Sheep Grazing
- Combinations of the above

MOWING GUIDELINES

Conduct mowing activities in the following manner:

Use a flail-type mower to prevent the build-up of a thatch that could negatively affect the establishment and growth of the installed seed mixture.

Use a mower height of 3" to 6" on the solar array area seed mixture. Use a mower height of 9" to 12" on the buffer area seed mixture.

Mow before vegetation grows tall enough (>20") that mowing would create a vegetative mulch that can smother the plant seedlings that are being established.

Conduct mowing activities to ensure that volunteer plant species that show up in the first few years of establishment (years one-three) are not allowed to flower and/or produce viable seeds.

Maximize the pollinator value of seed mixture plantings by conducting mowing activities late in the growing season. This will allow plants to produce the nectar and pollen resources that pollinators feed on as well as help redistribute ripened seed throughout the pollinator planting.

With proper timing and management techniques, solar array area seed mixtures can quickly become established and out-compete weed competition on the site. This photo represents a final vegetative cover planting conduction pre-construction just four months after planting.

Proper mowing height is a critically important management technique that determine the speed at which the vegetative cover becomes fully established.

Throughout the life of the project, mow in a manner that considers and protects ground nesting bird activities. When mowing between May 1st and August 31st, train staff conducting mowing activities to identify and protect avian ground nests as well as other protected species.

Year One

Effective mowing in the first growing season of the final vegetative cover is extremely critical. The timing, frequency and height of those mowing activities often determine the success or failure of a planting and/or the length of time required for the planting to be determined a success.

Conduct all mowing activities to ensure that volunteer weed species are not allowed to mature, flower, and/or produce viable seeds. If they do, the final vegetative cover establishment will be in danger of failing and re-planting may be required.

Mowing at the correct time, frequency and height will avoid creating a mulch that can smother and inhibit the final vegetative cover as it is working to become established.

SOLAR ARRAY AREA SEED MIXTURE MOWING

Mow early and mow often in the first growing season.

With timely and regular mowing, the final vegetative cover can begin to outcompete and suppress the volunteer weed species and transition to a fully established vegetative cover by the end of the second growing season. When planted in the spring, it is likely the established vegetative cover will require three or more mowing events to control volunteer weed growth and establishment during the first growing season.

Conduct mowing at a height of 3" to 6" during the first growing season. Mowing at a lower height may damage the final vegetative cover as it is working to become established.

BUFFER AREA SEED MIXTURE MOWING

Mow at a height of 9" to 12" during the first growing season to avoid damage to the final vegetative cover as it is becoming established.

Years Two and Three

SOLAR ARRAY AREA SEED MIXTURE MOWING

The timing and frequency of mowing during the second and third years of establishment should be evaluated and recommended by a vegetation management specialist familiar with the establishment and management of pollinator habitat.

Determine the frequency of mowing activity based on the abundance of undesirable and/or volunteer plant species that show up in the planting. Watch the video, "Habitat Tip: Mowing Considerations," which outlines and demonstrates this technique. (https://youtu.be/ind8BaWzotc)

Select mowing equipment that is able to conduct mowing activities at the appropriate height.

BUFFER AREA SEED MIXTURE MOWING

Buffer area seed mixtures are slower to establish than the solar array area seed mixtures due to their designed seeding rate and the species included. This means that the timing and frequency of management activities during the years of establishment are key factors that determine the overall speed and success. While mowing during the years of establishment is important, it is a delicate balance of how and when to mow to enhance the planting and not damage the planting. Since projects are individually distinct, we recommend a vegetation management specialist with a pollinator habitat design, establishment and management experience be consulted to obtain recommendations specific to your project.

A buffer area planting located outside of the project fence is an ideal location for planting a highly diverse seed pollinator seed mixture.

Future Years

If proper management has occurred in years one and two, the project can move into the maintenance phase. This phase of O&M will allow for a much more limited number of mowing activities and management activities to occur when the site conditions call for that management. In future years, mowing and herbicide applications may be performed on a spot, or as needed, basis.

MOWING

When solar array area seed mixtures are designed to meet the height restrictions listed in the Designing Pollinator Seed Mixtures (see page 7) section of this document, the need for future mowing activities should decrease significantly because the shading of solar panels by vegetative growth should not be a problem. This offers the opportunity for significant financial savings in future operations and management budgets. When mowing activities are needed, they should always be conducted at a height, frequency and rotation that supports the continuation of the final vegetative cover and provides pollinator habitat benefits. Develop a VMP that clearly outlines how future mowing activities should be applied to maintain both the vigor of the established cover and the pollinator health and habitat benefits.

Seed mixtures for use on the site can be designed to include plant species that benefit key pollinator species like this Monarch Butterfly.

COMMUNICATING WITH MAINTENANCE CONTRACTORS

Make sure that EPC's and maintenance contractors are aware of the VMP and able to follow it. Enshrine the VMP into the permit; that will mandate that maintenance contractors follow the plan as part of their scope of work.

HERBICIDE USE

If undesirable or invasive plant species show up during the years of establishment, it is important to address their control and removal as soon as possible. Undesirable or invasive species should not be allowed to mature enough to produce viable seeds. Depending on the plant species to be addressed, an effective plan of control may include spot mowing, spot use of herbicides, or both.

If the undesirable or invasive plant species are forb-based plants (broad leafed plants), the safe use of a non-selective herbicides like glyphosate or broad-leaf herbicides (e.g., 2,4-D, Garlon, etc.) can be used on individual plants or on a spot treatment basis. Take care to limit the herbicide application to the specific plant species you want to eliminate, as the herbicide will also eliminate components of the final vegetative cover plant species and other actively growing vegetation where it is applied.

SHEEP GRAZING

For projects that are interested in using sheep grazing as a future management tool, it will be important that a Grazing Management Plan be developed and used on the site to maintain the pollinator health and habitat benefits while grazing. ***A grazing management plan should include specific detailed guidance and recommendations related to the following items:***

- Stocking rates and frequency of grazing rotation
- Number of grazing paddocks established on the site
- Use of an annual grazing refugee area on the site
- Monitoring activities of grazing impacts on vegetative growth and pollinator benefits
- Timing of grazing activities throughout the growing season

A failure to develop and follow the recommendations of a grazing management plan can result in the significant elimination of pollinator health and habitat benefits and the performance of the final vegetative cover. It is very challenging to deliver the sustainability benefits of both pollinator health and sheep grazing on a project. When both of these objectives are part of a project, a VMP should be developed and a grazing management plan should be developed that clearly outlines how grazing activities should be applied to maintain pollinator health and habitat benefits.

REPLANTING WHERE HABITAT ESTABLISHMENT HAS FAILED

In the event that a portion of the habitat requires re-establishment, the first step should be to determine the reason for the poor or non-establishment of the final vegetative cover.

Reasons for poor or non-establishment and their remediation can include:

- Site preparation or existing vegetation competition. Correct the problems, then replant following the planting instructions listed in the vegetative management plan.
- Soil conditions or soil compaction. Remediate the area to ensure a successful planting, then replant.
- Weather. Replant when the appropriate weather conditions are obtained.

In all cases, replanting should be conducted in the earliest possible date within the available timeline listed for planting dates.

CONCLUSION

Utility-scale solar projects are a growing and unique opportunity to provide pollinator health and habitat on the landscape that are critical to pollinator populations. In addition, the size and scale of USS projects offer opportunities to produce significant positive outcomes. By strategically developing a VMP, we can create USS sites that deliver multiple benefits.

FAQ's

Why does this guide tend to focus on providing benefits for honey bees?

The HBHC sees USS projects as a unique and timely opportunity to produce significant benefits for honey bees and commercial beekeepers at a time when the sustainability of beekeeping is under serious threat. In addition, the plant species that honey bees most desire for healthy forage (clovers) are uniquely suited to meeting all of the objectives of the project's final vegetative cover needs. These seed mixture recommendations have been also documented to produce significant pollinator health and habitat benefits for native bees, butterflies and grassland songbirds.

Can the final vegetative cover selected for a project really make a difference for beekeeping and beekeepers?

Absolutely! In addition to the pollinator health and habitat benefits this guide is advocating for, we also think this collaboration offers the opportunity to create an increase in US-produced honey. Research has documented that access to high-quality forage may be the single greatest factor that can build hive health, increase honey production, and help resist the negative impacts of varroa mites.

Every Utility-scale solar site can be designed to provide key pollinator health and habitat benefits, especially for honeybees.

I've heard that pollinator habitat plantings are slow to establish. Is this true?

The solar array area seed mixtures described in this guide are designed to establish quickly, especially when they receive timely management activities during the year of establishment. For projects located on former agricultural lands, this typically requires three or more mowing activities during the year of establishment and one to two mowing activities in the second year.

The buffer area seed mixtures are slower to fully establish and often follow the saying of: "*In year one, it sleeps … In year two, it creeps … And in year three, it leaps*". This should not be interpreted to mean that the planting is not producing value in the first two years. A properly designed seed mixture contains a combination of annuals, biennials and perennial wildflowers. For the planting to fully mature and provide its maximum pollinator value will require time and specific management activities.

Regardless of which seed mixture is being considered, the most important factor that determines how quickly a site becomes established and how it performs into the future is the site preparation activities applied. Once the seed is planted on the site, there are few measures that can be applied to correct deficiencies that occurred during site preparation and planting.

A diverse seed mixture fully established and planted on the buffer area of the solar site.

What to do if local permitting language requires the exclusive use of 'Native Vegetation'?

While it is easy to understand how the language solely requiring 'native' vegetation makes its way into permitting language, that language can produce unintended negative consequences for the final vegetative cover. If the requirement to use native wildflowers is in place, those plant species typically grow taller, cost more, are slower to establish and do not tolerate regular mowing activities. If mowing activities are conducted with frequency during the growing season, most native wildflower species will disappear from the planting within a short time span.

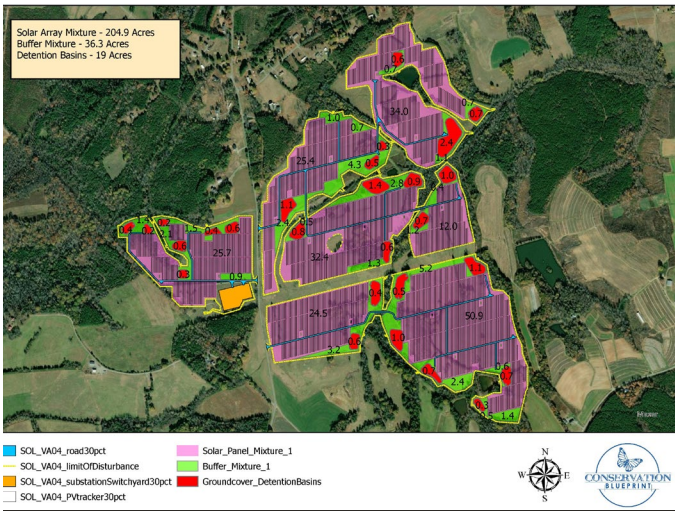
A 'Two Seed Mixture Approach' (see page 9) works well on USS projects that have an emphasis on including native vegetation. Establishing native wildflowers on the portions of the project that don't have vegetative height restrictions and establishing clover species that can respond positively to mowing activities in the array area is a solution that meets the maximum number of project objectives.

If a USS project were interested in establishing a diverse mixture of native wildflowers under and around the panels, how would this be best accomplished?

Without question, the single greatest limitation to seed mixture design for a solar project and the inclusion of native wildflower species is the maximum vegetative height that can be allowed on the site without mowing activities. If the exclusive use of native wildflowers is a project objective, the safest way to meet that goal is to raise the lower panel height to 40+" above the ground. Distributed Scale Solar projects frequently have a lower panel height of 36+" above the ground. This typically allows those projects to have greater freedom and creativity in how seed mixtures are designed, established and managed. When USS projects have a lower panel height of just 18" to 22", it creates significant limitations of seed mixture design, establishment, and future management.

How does the 'Two Seed Mixture Approach' work with state 'Solar-Pollinator Score Cards'?

In the states where solar-pollinator score cards are in place, we've experinced 100% of the projects this advisory committee were involved in have met the minimum requirements to be designated as supporting pollinator health and habitat. The combination of using two seed mixtures helps to bridge the lower point scores that are often generated by a cool-season grass + clover seed mixture used in the solar array area.



An example of planting map designed for a project that highlights the locations of three different seed mixtures being planted on a solar site.

What should the type of seed mixtures described in this guide be expected to cost?

Seed costs may vary locally and year to year based on availability. While every project is unique in its design and objectives, we have found that the final vegetative cover seed mixtures recommended on USS projects are very comparable to turf-type grass plantings. In our experience, solar array seed mixtures typically cost between $200 and $290/acres and buffer area seed mixtures typically cost between $275 and $390/acre.

Can sheep grazing and pollinator-friendly vegetation co-exist on a solar site?

The answer is a qualified yes. For projects that are interested in using sheep grazing as a future management tool, it will be important that a Grazing Management Plan be developed and followed. The failure to consider how grazing is conducted and its impacts can result in the significant elimination of pollinator health and habitat benefits and the performance of the final vegetative cover. It is very challenging to deliver the sustainability benefits of both pollinator health and sheep grazing on a project. When both of these objectives are part of a project, a VMP and a Grazing Management Plan should be developed that clearly outlines how grazing activities should be applied to maintain pollinator health and habitat benefits.

How can the seed mixtures described for use in the solar array area help to reduce the risk of fire?

Solar array area seed mixtures that are designed using cool-season grasses and clover will be actively growing and 'green' for a much longer period of the growing season, especially if mowing is being applied to the site. Conversely, a seed mixture comprised of native warm-season grasses and native wildflowers has a much shorter growing period, especially if mowing is being applied to the site. This means those plants will tend to become dormant (non-growing) more frequently and become a fuel that is very susceptible to incidental fire.

Highly diverse seed mixtures contain seeds with a wide range of sizes and shapes. This requires the project to follow the planting techniques and timing instructions of a VMP to be successful.

When fully established, a solar array area seed mixture is able to outcompete weeds, is fully established and does not grow taller than the lower panel height.

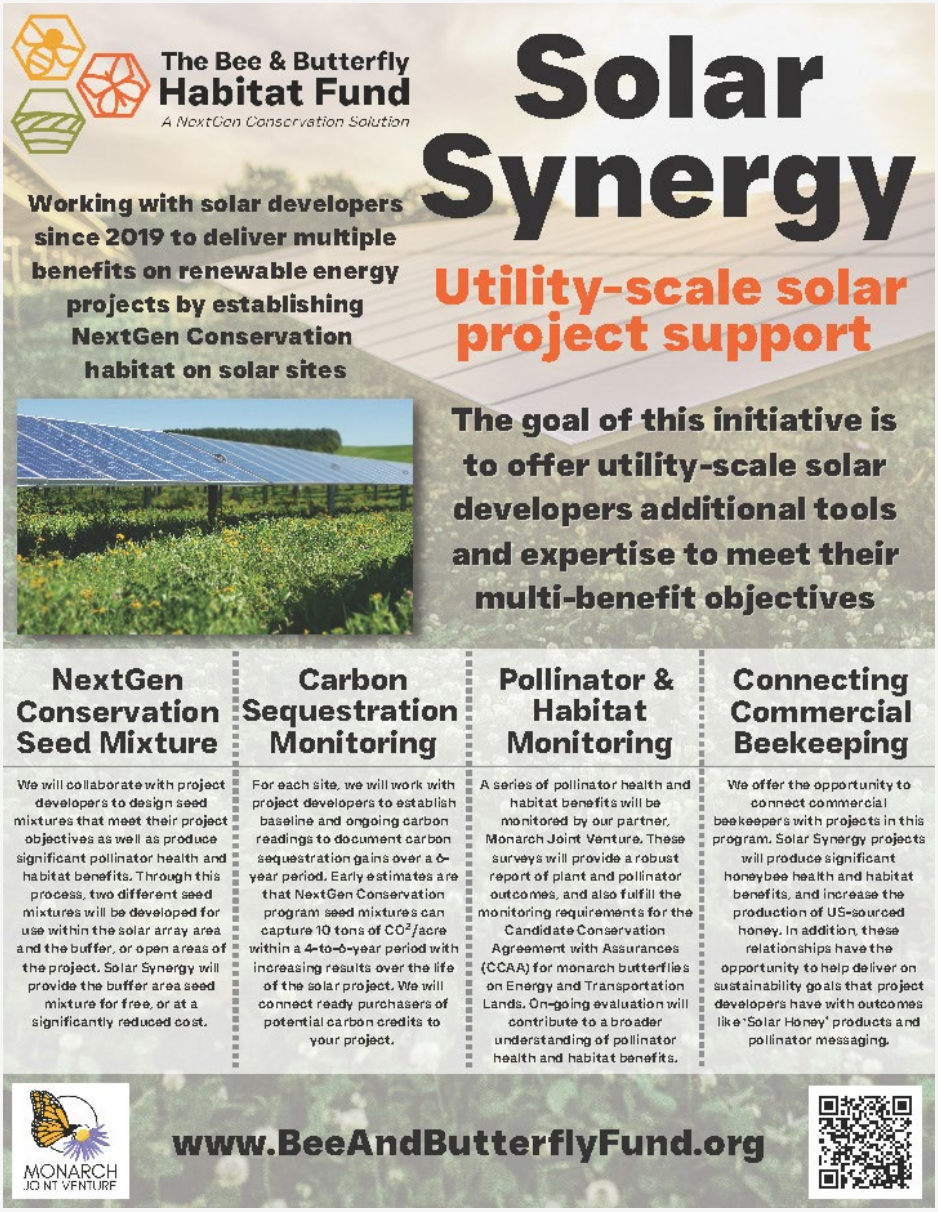
ADDITIONAL RESOURCES

Solar Pollinator Habitat, AgriSolar Cleaning House
https://www.agrisolarclearinghouse.org/solar-pollinator-habitat/

Pollinator Habitat Establishment & Management Guide, Bee and Butterfly Habitat Fund
https://www.beeandbutterflyfund.org/habitat-guide.html

Project Design + Seed Assistance, Conservation Blueprint
https://www.conservationblueprint.com/

Habitat Tip Video: Mowing Considerations, Conservation Blueprint
https://youtu.be/ind8BaWzotc



The **Solar Synergy** program is available to support utility-scale solar projects across the country.

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Photo courtesy of the Department of Energy

HONEY BEE HEALTH COALITION