AMPLIFYING CLEAN ENERGY WITH CONSERVATION

PART ONE: POLLINATOR-FRIENDLY SOLAR

A REPORT BY CODY SMITH,
CENTER FOR RURAL AFFAIRS

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AMPLIFYING CLEAN ENERGY WITH CONSERVATION PART ONE: POLLINATOR-FRIENDLY SOLAR

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Part One: Pollinator-Friendly Solar

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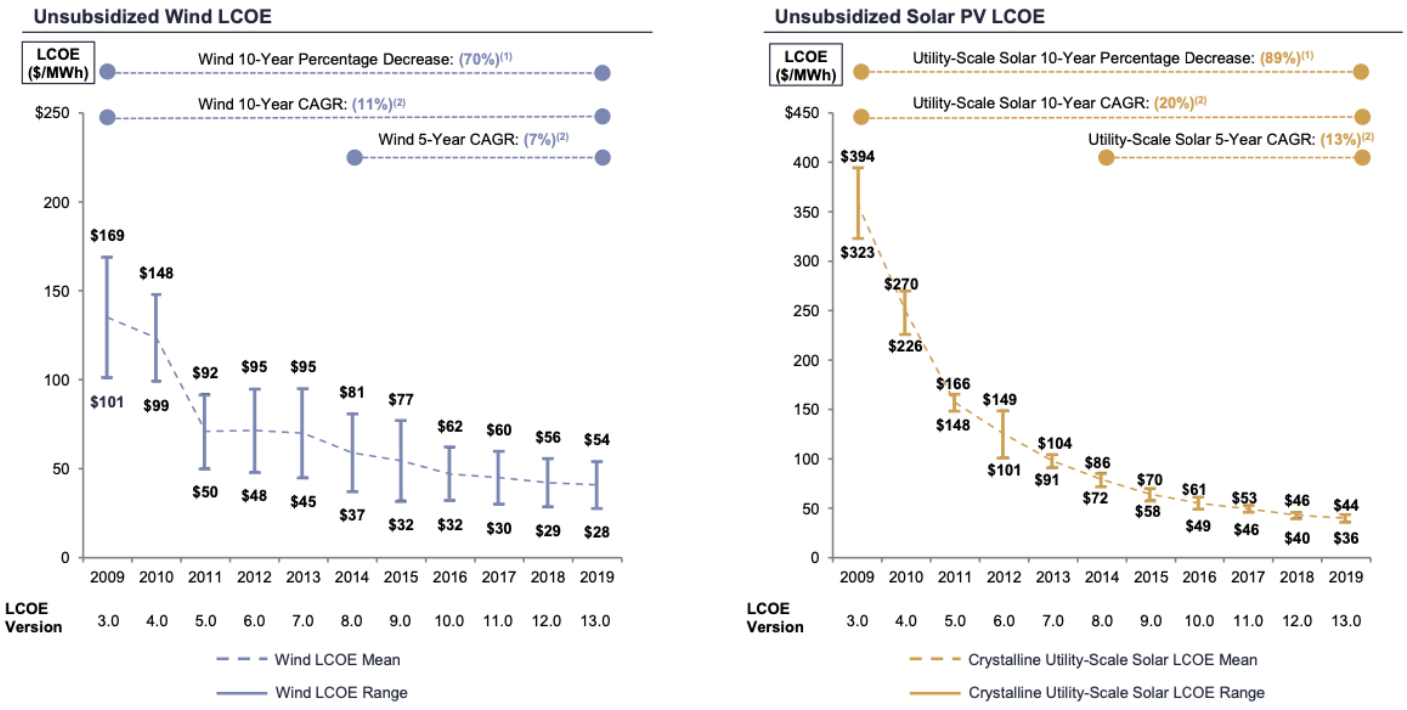


I. INTRODUCTION

A. MIDWEST EMBRACES SOLAR ENERGY BOOM

Throughout the Midwest region of the U.S., farmers, schools, and small businesses have been on the frontline of solar energy adoption. Collectively, states in the Midwest employ approximately 36,605 workers in the solar industry with 3,118.67 megawatts (MW) of installed solar capacity.[1] These jobs include workers in the installation, manufacturing, and sale of solar energy systems of all sizes. These economic windfalls come as many cities, counties, and states across the U.S. are taking advantage of affordable renewable energy sources, including solar energy.

Over the past nine years, the price of installing solar energy projects has decreased by 70 percent.[2] This rapid decline in cost has empowered Americans to embrace affordable, clean, and renewable energy. Meanwhile, several jurisdictions are setting ambitious clean energy goals aimed at reducing their carbon footprint in the face of a changing climate. Across the U.S., more than 150 cities, 10 counties, and 7 states, have adopted goals and policies to reach 100 percent clean energy.[3] See Figure 1.[4]

As the renewable energy economy continues to expand, projects bring jobs and tax revenue with them—stimulating local economies in a way which may have been previously unattainable, especially in rural communities. The solar energy industry is in the midst of an unprecedented boom. Supportive public policies, such as the federal Investment Tax Credit, have continued to spur development of this renewable energy source. The industry has expanded by 52 percent since the enactment of the Investment Tax Credit in 2006, empowering the solar energy workforce to employ more than 250,000 people across the U.S. and generate more than 2.5 percent of the nation's electricity as of the

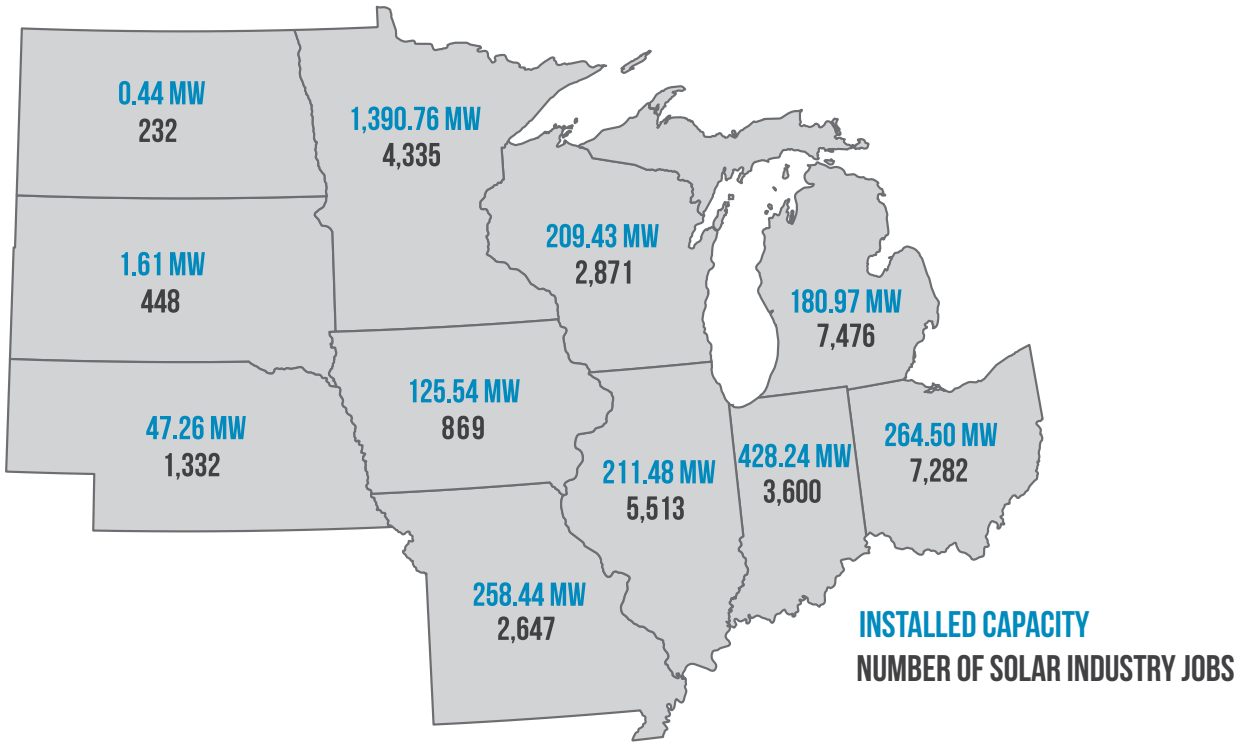
1 "Solar State By State." Solar Energy Industries Association, 2020, seia.org/states-map. Accessed August 2020.

2 "Growth in Solar is Led by Falling Prices." Solar Energy Industries Association, 2020, seia.org/solar-industry-research-data. Accessed August 2020.

3 "Committed." Sierra Club, 2020, sierraclub.org/ready-for-100/commitments. Accessed August 2020.

4 "Lazard's Levelized Cost of Energy Analysis—Version 12.0." Lazard, November 2018. lazard.com/media/450784/lazards-levelized-cost-of-energyversion-120-vfinal.pdf. Accessed September 2020.

FIGURE 2. MIDWEST SOLAR ENERGY INDUSTRY GROWTH BY THE NUMBERS



first quarter of 2020.[5,6] In addition to jobs and tax payments to states and counties, the solar industry generated $18 billion in investments to the U.S. economy in 2019 alone.[7] This rapid growth, paired with expectations that installed solar generation capacity will potentially double over the next five years, are leading many farmers, small business owners, municipalities, utilities, and corporations to expand their investments in solar energy.[8] See Figure 2.[9]

As the nation continues to embrace a clean energy future, fueled by renewable sources like solar, many Americans will be searching for ways to make sure these investments benefit everyone in their communities.

While the industry continues to plan, site, construct, and maintain an ever-growing amount of solar energy projects, working with local stakeholders can ensure the value of these renewable energy projects are amplified by investments in the conservation of our shared natural resources.

The solar industry generated $18 billion in investments to the U.S. economy in 2019. This growth will potentially double over the next five years.

5 "Solar Investment Tax Credit (ITC)." Solar Energy Industries Association, 2020, seia.org/initiatives/solar-investment-tax-credit-itc. Accessed August 2020.

6 "Solar State By State." Solar Energy Industries Association, 2020, seia.org/states-map. Accessed August 2020.

7 "Solar Industry Research Data." Solar Energy Industries Association, 2020, seia.org/solar-industry-research-data. Accessed August 2020.

8 Ibid.

9 "Solar State By State." Solar Energy Industries Association, 2020, seia.org/states-map. Accessed August 2020.

In general, there are three types of solar projects to be considered: residential (small-scale), community (medium-scale), and utility-scale (large-scale).

Utility-scale solar systems are installations above a certain capacity intended to produce electricity to sell into the market, not to directly supply end-use customers. These systems are larger than small-scale residential or business solar installations and many community systems, often covering more land area. Community solar systems are developed by a municipality, utility, or third party that typically allows community members to subscribe to the project. In Iowa, development of community solar projects is limited to utilities at this time. Residential or small-scale solar energy systems are installed at a residence or business to meet the electric demand at the location. These systems are typically intended to offset electricity use for the owner and are not intended to be net generators of electricity.

The opportunity for the combination of native and naturalized, non-invasive vegetation on project sites is greatest when solar farms cover several contiguous acres of land. With this in mind, potential for the conservation of natural resources and the restoration of pollinator and wildlife habitat is greatest on community- and utility-scale solar sites given their size.

A recent analysis found that nationwide, solar projects occupied 258,000 acres of land in 2018, while the National Renewable Energy Laboratory (NREL) at the U.S. Department of Energy estimates that solar panels will occupy 3 million acres by 2030.[10] This offers a unique opportunity for the practical co-usage of solar project land for the restoration of native and naturalized, non-invasive vegetation, helping achieve ecosystem services for everyone, and reducing financial obligations for project developers. In a display of the scale, using the average of 7 to 8 acres per megawatt, producing 10 percent of Iowa's electricity from solar energy would require 13,440 acres of land to be occupied by solar arrays. Though just .05 percent of Iowa's more than 26 million acres of farmland, this is an opportunity for project developers and site managers to demonstrate their commitment to environmental stewardship. Furthermore, even a small 50 megawatt project could offer more than 360 acres for the restoration of native vegetation.

10 Maltais, Kirk. "Struggling Farmers See Bright Spot in Solar." The Wall Street Journal, Sept. 23, 2019, wsj.com/articles/struggling-farmers-see-bright-spot-in-solar-11569242733. Accessed August 2020.

II. SOLAR SHINES SPOTLIGHT ON STEWARDSHIP

A. ILLUMINATING AN OPPORTUNITY FOR CONSERVATION

Solar presents an opportunity for substantial investments in the conservation of our natural resources as utility-scale projects can occupy hundreds of acres of land. According to the NREL, for every 1 megawatt of energy produced by a solar energy system, on average, 7.3 acres of land will need to be occupied by solar arrays.[11] Project developers, site managers, utilities, and other industry professionals can work together with local communities and natural resources professionals to ensure new electric generation projects provide value for both the landowner hosting the project and their neighbors.

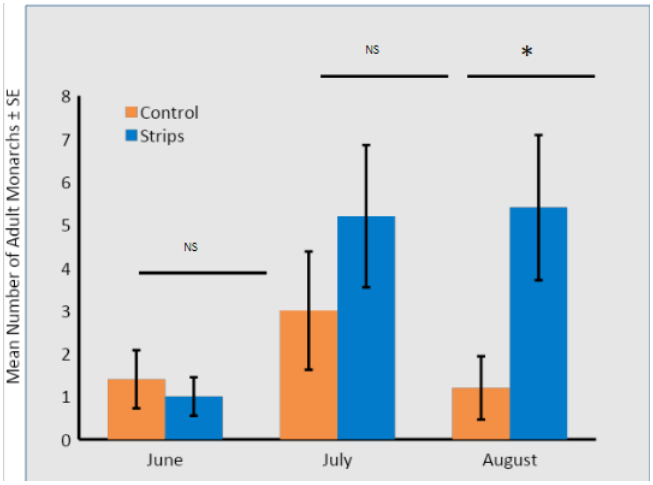
By combining native and naturalized, non-invasive species of vegetation with solar projects, new renewable energy generation can provide habitat for honey bees, native bees, and other critical species of pollinators, such as monarch butterflies. Wildlife, including upland nesting birds such as ring-necked pheasants and quail and at-risk birds such as the sedge wren, also benefit from these new investments. Furthermore, native vegetation, which is perennial, can improve water quality and build soil health with deep, complex root systems that filter out nutrients (i.e. nitrogen and phosphorus) before they leech to lakes, rivers, and streams. Perennial vegetation has also been shown to reduce peak stream-flows by up to 40 percent during flood events, building resiliency in times of stress.[12]

Designing projects to achieve these key environmental outcomes ensures ratepayers, including surrounding farms and communities, receive the greatest possible value for renewable energy generation investments. Local agricultural producers benefit from an increase in pollinators while the practice also reduces long-term operation and maintenance costs for project developers and site managers.

11 Ong, Sean, et al. "Land-Use Requirements for Solar Power Plants in the United States." National Renewable Energy Laboratory, U.S. Department of Energy, June 2013, nrel.gov/docs/fy13osti/56290.pdf. Accessed August 2020.

12 "Iowa Watershed Approach." Iowa Flood Center, The University of Iowa, iowafloodcenter.org/projects/iowa-watershed-approach-hydrologic-network-4/. Accessed August 2020.

FIGURE 3. NUMBER OF ADULT MONARCHS FOUND ON-SITE



B. POWERING ECOSYSTEM SERVICES

While all investments in conservation promote environmental improvement, developers can follow a few best practices to ensure project success. For example, native seed mixes undoubtedly offer the greatest return on investment when it comes to providing ecosystem services, such as habitat for pollinators and wildlife, as well as improved water quality and soil health. If possible, project developers should prioritize native seed selections over naturalized, non-invasive species of vegetation. However, equipment, cost, and on-site limitations may make the selection of naturalized, non-invasive species, such as clover, a more practical or cost effective option. "Naturalized, non-invasive species" refers to vegetation which is not native to the region, but still offers value for achieving environmental outcomes. For example, clover is not native to the region but is a valuable source of pollen for honey bees in central Iowa.

If the decision is made to seed naturalized, non-invasive species on a site, developers should note these plants will move to other areas of the project and compete with native species, regardless of where they were planted. Additionally, if these species are included in a mix, they will likely not provide the same level of environmental benefits and the cost of the mix should be lower. Setting goals for the project and a holistic evaluation of all factors will help equalize costs for a project while balancing ecological outcomes.

In all, pairing native and naturalized, non-invasive vegetation with new solar energy projects saves developers money, conserves natural resources, and provides ratepayers with the greatest return on investment—ultimately, amplifying the value of a quickly-approaching renewable energy future. Sites with native vegetation are more commonly referred to as "pollinator-friendly solar sites." Pollinator-friendly solar project sites offer a prime opportunity to jumpstart populations of at-risk pollinators and wildlife while improving water quality and building soil health. Even with modest investments in habitat creation, honey bees, native bees, monarch butterflies, ring-necked pheasants, and quail can experience vibrant and measurable expansions in overall population.

Pollinators play a critical role in the robust food, fuel, and fiber production economy of the Midwest. By pollinating agricultural crops, this group of insects is crucial to ensuring economic and food security. Research shows pollinator-friendly solar sites lead to significant increases in the populations of butterflies and bees[13] In fact, the populations of all pollinators, including honey bees, native bees, and monarch butterflies, were three and a half times

13 Montag, Hannah, et al. "The Effects of Solar Farms on Local Biodiversity: A Comparative Study." Clarkson and Woods, Wychwood Biodiversity, April 2016, solar-trade.org.uk/wp-content/uploads/2016/04/The-effects-of-solar-farms-on-local-biodiversity-study.pdf. Accessed August 2020.

greater on sites with investments in the reestablishment of native and naturalized, non-invasive vegetation in central Iowa when compared to control sites.[14] Meanwhile, the same team at Iowa State University found a significant increase in the number of adult monarchs in late August on sites with native vegetation, due in part to a greater abundance of flowering resources at that point in the growing season.[15] See Figure 3 on page 4.[16]

In addition to facilitating notable expansions in pollinator and other desirable insect populations, investments in native and naturalized, non-invasive vegetation create habitat for a variety of upland nesting birds. Ring-necked pheasants and quail, as well as other grassland birds like the sedge wren and dickissel, each benefit from these efforts. Investments in habitat are critical to species success given the loss of habitat in recent years for these wildlife species. Between 1990 and 2018, upland wildlife (i.e. ring-necked pheasants) lost more than 1.8 million acres of habitat in Iowa alone.[17] Expressed as square miles, this group of wildlife species lost nearly 3,000 square miles of habitat during that period, an area nearly 400 square miles larger than the entire state of Delaware.[18] Pollinator-friendly solar projects offer previously unavailable opportunities to invest in this critical wildlife habitat.

Site managers of pollinator-friendly solar projects can improve water quality and build soil health with investments in native and naturalized, non-invasive vegetation. Beyond clearly-visible impacts such as reducing on-site erosion, these investments offer a multitude of benefits for soil and water quality. For example, this practice has been proven to significantly reduce surface water runoff, helping retain toxic nutrients, such as nitrogen and phosphorus on the landscape and preventing them from leaching to lakes, rivers, and streams. Excess nutrients in water bodies lead to hypoxia, or a lack of oxygen caused by the bloom and decay of algae and other aquatic plant life.[19] Strips of perennial native vegetation have been shown to reduce nitrogen loss by 60 percent and phosphorus loss by 90 percent.[20] The deep root systems of native plant species can absorb and filter more water, making it an effective flood reduction practice as well. In fact, perennial vegetation has been shown to reduce peak stream-flows by up to 40 percent during flood events.[21]

With investments in native and naturalized, non-invasive vegetation, site managers of renewable energy projects can help power a variety of ecosystem services. These services include the creation of habitat for at-risk pollinators and vulnerable wildlife species, as well as helping promote cleaner water and healthier soils in the surrounding areas. Holistically, these investments help ensure that surrounding local stakeholders, project developers, and landowners hosting projects each see a return on investment for renewable energy projects.

C. POLLINATOR-FRIENDLY SOLAR ADDS VALUE

By implementing this practice, project developers can slash their operations and maintenance costs by up to three times over 20 years when compared to mowing and maintaining turf grass. See Figure 4 on page 6.[22] This illustrates the mutually-beneficial outcomes for developers, site managers, pollinators and wildlife, and surrounding communities.

1. PLANNING, COST, AND SEEDING

Planning — At least one year before the seed goes into the ground, planning is recommended to allow for a holistic consideration of all factors. With adequate time to plan, site managers can reach out for technical assistance, review and select a site location, determine the existing domi-

14 Schulte, Lisa A., et al. "Prairie strips improve corn–soybean croplands." Proceedings of the National Academy of Sciences of the United States of America, October 2017, 114 (42) 11247-11252; DOI: 10.1073/pnas.1620229114.

15 "Research Highlight: Prairie strips help honey bees and wild pollinators." Iowa State University, February 2020, nrem.iastate.edu/research/STRIPS/files/publication/strips_ffar_infosheet_20200203.pdf. Accessed August 2020.

16 Ibid.

17 Bogenschutz, Todd, et al. "2019 Iowa August Roadside Survey." Iowa Department Of Natural Resources. September 2019.

18 Ibid.

19 Schulte, Lisa A., et al. "Prairie strips improve corn–soybean croplands." Proceedings of the National Academy of Sciences of the United States of America, October 2017, 114 (42) 11247-11252; DOI: 10.1073/pnas.1620229114.

20 "A Landowner's Guide to Prairie Conservation Strips." Iowa State University, extension.iastate.edu/alternativeag/info/Landowners%20Guide%20to%20Prairie%20Conservation%20Strips.pdf. Accessed August 2020.

21 "Flood Resilience Program." Iowa Watershed Approach, Iowa Department of Homeland Security and Emergency Management, 2017, iowawatershedapproach.org/programs/resilience/. Accessed August 2020.

22 Argonne National Laboratory, produced for the U.S. Department of Energy's InSPIRE Study. Obtained via personal communication with Fresh Energy, April 2020.

FIGURE 4. COST REDUCTIONS FOR SOLAR PROJECT DEVELOPERS

Preliminary Cost Benefit Analysis - Native Vegetation vs. Grass, 100-acre facility operation and maintenance over 20 years, Midwest

Pollinator habitat assumptions:
- Seed:
  $600-$1,200/acre;
  $150 more/acre for planting
- Mowing/maintaining:
  $120/acre; $12,000 mow 3-4x/year first four years, then 1x/year

Low-growth grass assumptions:
- Seed:
  $300-$500/acre;
  $150 more/acre for planting
- Mowing/maintaining:
  $670/acre/year (includes weekly or biweekly mowing)

Pollinator habitat 20-year seed and mow costs:
- **Low $435,000; high $519,000**

Grass 20-year seed and mow costs:
- **~$1.4 mil**

Seed/mow total cost of pollinator habitat up to 3x less than grass

nant vegetation (if any), and conduct the appropriate herbicide applications to remove it. Two or more herbicide applications are recommended to suppress existing vegetation, but site managers should make these decisions after evaluating the conditions and needs of each site. Additionally, this planning window allows site managers to consult with natural resources professionals, retailers, and others to formulate and gather quotes for a native seed mix.[23] For developers constructing and managing projects in and immediately around Iowa, the Tallgrass Prairie Center at the University of Northern Iowa has compiled the 2020 Iowa Seed and Service Provider List which contains resources in the region.[24]

Cost — As with any new investment, the uncertainty presented can often be discouraging, or even a deterrent, for project developers and site managers. However, a fair evaluation of all costs and beneficial outcomes will help ensure a smooth process. When considering total project cost, a primary variable is the number of acres of native and naturalized, non-invasive vegetation that will be established. Determining the number of acres to be established will allow site managers to identify the quality and price of the seed mix for a project, as well as full consideration of the management options for the site. For example, seeding expenses may be different if a site manager is hand-broadcasting a 2-acre community solar project as compared to drilling a 850-acre utility-scale solar project site. Depending on the project size, different management approaches may be necessary, as well as additional equipment like mowers or other machinery.

> Per acre in Iowa, $500 to $1,000 for a seed mix is a reasonable range for most projects.[25] To assist with planning purposes, a site manager should budget $700 per acre for the seed mix and $100 per acre for seedbed preparations. These numbers are expected to fluctuate based on the needs of different project sites.[26]

Site managers should include native vegetation in the initial planning of a project. Incorporating this desired outcome into the process will allow for a holistic consideration of all factors including construction, management, establishment, and more.

23 "Iowa Monarch Conservation Consortium." Iowa State University, monarch.ent.iastate.edu/. Accessed December 2019.

24 "Iowa Prairie Seed And Service Providers." Tallgrass Prairie Center, University of Northern Iowa, 2020, tallgrassprairiecenter.org/seed-service-providers. Accessed May 2020.

25 Ibid.

26 Personal communications with Amy Yoakum of Conservation Corps Iowa & Minnesota, and Tim Younguist, Iowa State University STRIPS Project, March 2020.

Seeding — When considering the seeding of a project site, timing is key to success. Frost-seeding between Nov. 1 and June 1 is ideal for maximum germination and ensuring a strong stand establishment through a full growing season.[27] Native plants need time to establish their deep, complex root systems which enable their effectiveness at water filtration and nutrient cycling. August and late summer should be avoided as a stand won't have enough time to establish before cold temperatures arrive. Remember, establishing this practice on solar project sites takes time and requires a great deal of patience.

> "In year one prairie sleeps, in year two prairie creeps, and in year three prairie leaps."[28]

To establish the needed firm seedbed, conventional methods include discing at least twice, and culti-packing, although these decisions should be made based upon the conditions of each site. As site managers work to identify seeding methods, broadcast, drill, and hand-broadcast are each techniques that can be considered. Important to remember in this process is that native grass seeds need good seed-to-soil contact and should never be planted deeper than one-fourth of an inch in the soil. Ideally, newly-cast native prairie seeds should rest on top of the soil.[29]

Best practice: A site may take time to establish aesthetic native vegetation. Signage that says, "Pollinator habitat in progress" can mitigate public concern during the one to three year establishment period. Site managers should keep in mind each seedbed is different and may not need discing or other disturbance—these decisions should be made with a natural resources professional while reviewing site-specific information such as existing vegetation, moisture levels, and soil type. For site managers trying to reduce erosion through the construction phase, cover crops like cereal rye can be used prior to seeding, but should be terminated before the final mix is distributed on the site.

2. CONSTRUCTION, DESIGN, AND MANAGEMENT

Construction and design — Site managers should be flexible when it comes to the height of a solar energy system; this will help ensure project success. Across the energy industry, 3 to 4 feet of ground clearance between the lowest, titled edge of a ground-mounted solar energy system and the ground is widely viewed as the maximum clearance without substantially increasing material costs and/or creating the need for elevation of workers for operations and maintenance.[30] Workers who need to be elevated for project upgrades and maintenance often require more safety equipment and work longer hours.

> Total project height refers to the overall height of the solar array and is different than the clearance between the lowest edge of the solar panel and the ground; oftentimes, total project height is regulated by city, county, or state codes.

When designing a pollinator-friendly solar project, a seed mix should include plants that do not reach a peak height that could shade the lowest, tilted edge of ground-mounted solar energy systems unless site managers plan to use strategic mowing or livestock grazing (i.e. sheep) to avoid interfering with project efficiency.

Best practice: Although site managers may have to strip-mow to maintain project efficiency, they should remember that taller, more diverse native and naturalized, non-invasive vegetation will provide better habitat for wildlife and pollinators.[31] Striking a balance between vegetative quality and diversity and ground clearance height can equalize overall project costs.

27 "Habitat How-To." Iowa Monarch Conservation Consortium, Iowa State University, 2019, monarch.ent.iastate.edu/habitat-how. Accessed December 2019.

28 Personal communication, Matt O'Neal, entomologist at Iowa State University, March 2020.

29 "Management Overview, Science-Based Trials of Row Crops Integrated with Prairie Strips." Iowa State University, 2019, nrem.iastate.edu/research/STRIPS/content/management-overview. Accessed December 2019.

30 Personal communications, City of Cedar Falls, Oct. 26, 2019; and Kertech, LLC, Oct. 30, 2019.

31 "Native Seed Program." Iowa Pheasants Forever, 2019, iowapf.net/native-seed-program. Accessed December 2019.

Management — While it is helpful to have robust management timelines which can help with planning, every site is unique and all timelines should be adjusted to fit the needs of each site. Evaluating the ratio of native and desirable species to invasives and weeds before making mowing and other management decisions will facilitate greater progress in a site's establishment. Pollinator-friendly solar projects will require more up-front management, particularly during the establishment period between years one and three. However, as noted in Figure 5 on page 6, major cost reductions can be realized after this period.

Contrary to typical management of native prairies in the Midwest, the preferred management option for pollinator-friendly solar project sites is mowing—this reduces concerns of fire damage to on-site equipment.

- Year one: Site managers should expect to conduct regular mowings (three to four times) during the first growing season. This prevents weeds from shading out seedlings and going to seed which facilitates greater spread. The first mowing should be at a height of 4 to 6 inches soon after seeding, and the next two mowings should be at a height no less than 8 inches.[32]

- Year two: With a successful planting, years subsequent to establishment provide the opportunity for site managers to enjoy less overall maintenance. During year two, sites need only an occasional disturbance to encourage desirable species.[33] At this point, mowing based on the needs of a site is appropriate, but these decisions should be made in conjunction with a natural resources professional and should consider the ratio of desirable to undesirable species.

- Years three and four: Site managers can expect to begin realizing substantially less maintenance needs during this period. At this time, mowing and baling approximately every three years is the preferred management option for pollinator-friendly solar project sites.[34]

Some sites have seen success with rotational grazing of sheep as a management option; however, waiting until after the establishment period of one to three years before using this practice will help avoid risks of overgrazing and failed establishment.

3. TIMING IMPACTS FOR WILDLIFE AND POLLINATORS

Management actions on pollinator-friendly solar sites should consider timing to avoid negatively impacting populations of wildlife and pollinators and reducing overall project value. After year two, site managers should avoid or minimize mowing between April 1 and Aug. 1 to reduce disturbances during the nesting season of upland birds, such as ring-necked pheasants and quail.[35] Delaying mowing even further to late September facilitates a more welcoming habitat for migrating pollinators, such as monarch butterflies. This date is preferred because the highest population of monarch eggs is often found on milkweed plants in late July and early August.[36] However, site managers could use spot mowing and/or herbicide application during this period if site conditions deem it necessary.

Best practice: Every site is unique and all timelines should be adjusted to the needs of a project rather than arbitrary timelines. Evaluating the ratio of native and desirable species to weeds and invasive vegetation before making mowing and other management decisions will help site managers reach their goals more quickly. If native and desirable species of vegetation are struggling to establish a strong stand, mowing is likely necessary; if the opposite is occuring, mowing may not be in a site's best interest.

32 "Habitat How-To." Iowa Monarch Conservation Consortium, Iowa State University, 2019, monarch.ent.iastate.edu/habitat-how. Accessed December 2019.

33 Ibid.

34 "Iowa Monarch Conservation Consortium." Iowa State University, monarch.ent.iastate.edu/. Accessed December 2019.

35 "Native Seed Program." Iowa Pheasants Forever, 2019, iowapf.net/native-seed-program. Accessed December 2019.

36 "Habitat How-To." Iowa Monarch Conservation Consortium, Iowa State University, 2019, monarch.ent.iastate.edu/habitat-how. Accessed December 2019.

TABLE 1. SPECIES CONSIDERATIONS FOR SEED MIX SELECTIONS

			Bloom time and color							
Latin name	**Common name**	**Height**	**April**	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Insect attractiveness rating**
Zizia aurea	Golden Alexanders[2]	3'								HA, PP
Tradescantia ohiensis	Ohio Spiderwort (common spiderwort)[3]	3'								PP
Baptisia alba	Wild White Indigo[4]	4'								
Penstemon digitalis (Penstemon hirsutus)	Foxglove beardtongue[5]	3'								MA, PP
Asclepias tuberosa	Butterfly Milkweed[6]	2'								MA, LH, N
Coreopsis palmata (Coreopsis lanceolata)	Prairie Coreopsis[7]	2'								HA, PP
Euphorbia corollata	Flowering Spurge	3'								
Ruellia humilis	Wild Petunia	1'								
Ceanothus americanus	New Jersey Tea[8]	3'								L/NA, PP
Rosa arkansana (Rosa setigera)	Wild Rose[9]	2'								MA, PP
Amorpha canescens	Lead Plant[10]	3'								L/NA, PP
Asclepias syriaca	Common Milkweed	3'								
Dalea candida	White Prairie Clover	2'								
Drymocallis arguta	Prairie Cinquefoil[11]	2'								
Liatris aspera	Rough Blazing Star[12]	3'								MA, N
Pseudognaphalium obtusifolium	Sweet Everlasting[13]	2'								
Verbena stricta	Hoary Vervain[14]	2'								MA, PP
Heliopsis helianthoides	Early Sunflower[15]	5'								PP
Rudbeckia hirta	Black-eyed Susan[16]	2'								LN, H
Desmodium canadense	Showy Tick Trefoil[17]	5'								L, NA
Chamaecrista fasciculata	Partridge Pea[18]	2'								PP
Dalea purpurea	Purple Prairie Clover[19]	2'								PP
Eryngium yuccifolium	Rattlesnake Master[20]	4'								PP
Gentiana alba	Cream Gentian	3'								
Pedicularis lanceolata	Marsh Betony	3'								
Solidago speciosa	Showy Goldenrod[21]	5'								MA, N, PP
Symphyotrichum oolentangiense	Sky Blue Aster	3'								
Symphyotrichum ericoides	Heath Aster[22]	2'								PP
Symphyotrichum pilosum	Frost Aster	3'								
Bouteloua curtipendula	Side-oats Grama	2'								
Carex brevior	Plains Oval Sedge	1'								
Koeleria macrantha	June Grass	2'								
schizachyrium scoparium	Little Bluestem	3'								
Alternatives										
Symphyotrichum novae-angliae (formerly Aster novae-angliae)	New England Aster[23]									HA
Asclepias tuberosa	Butterfly Weed									MA

KEY:

HA = Highly Attractive

MA = Moderately Attractive

L/NA = Low/No Attractiveness

PP = Attracts Pollinators and Predatory Insects

LH = Larval Host

N = Provides Nectar for Butterflies

= Value added to pollinators

= Value added to monarchs

= Value added to grazing livestock

4. SELECTING A SEED MIX FOR POLLINATOR-FRIENDLY SOLAR SITES

When planning for a solar project site with native and naturalized, non-invasive vegetation, site managers should carefully consider several variables. While the ground clearance between the lowest, tilted edge of a solar panel and the ground is a primary consideration when crafting a mix of seeds for the site, there are other factors site managers should evaluate when designing, constructing, and planning their pollinator-friendly solar sites.

To aid in the identification of valuable native and naturalized, non-invasive species of vegetation for a pollinator-friendly solar project, site managers are encouraged to use the following steps as a resource.

Step one: Consult with natural resources professionals to evaluate the following site-specific information:

- Project location (i.e. floodplain, steep slopes).
- Soil type and moisture (i.e. wet, wet-dry, dry, etc.).
- Site history (past vegetation, previous uses).
- The species of vegetation native to the area (local ecotype varies by region).
- Planned management methods for the site (mowing, grazing, equipment).

Step two: Set goals to help guide decision making

Managing a site to provide value for certain insect and wildlife species can require special considerations. Setting goals for the vegetation placed on a solar project site can help guide management decisions. Site managers should work with local stakeholders to help identify goals that will add the most value to a solar project site.

Wildlife generally responds more to the structure of vegetation instead of specific plant species. For example, seed mixes which contain too many grasses could restrict the navigability of the site for upland nesting birds, such as ring-necked pheasants and quail, negating the value of the site to these birds. When formulating a seed mix, site managers should evaluate the ratio of grasses to forbs to inform their seed selection process. A desired seed mix for upland nesting birds would be closer to 30 percent grasses and 70 percent forbs.

When managing a site to achieve value for a variety of pollinators, including native bees, honey bees, and monarch butterflies, a diversity of flowering plants that bloom during the entire growing season is crucial to provide ample pollen and nectar resources. This can help improve overall honey production in beehives placed on a project site as well as provide crucial resources for migrating monarch butterflies. Additionally, monarch butterflies only lay eggs on milkweed plants, making this species of vegetation a crucial component of a seed mix intended to maximize project value for this flagship species.

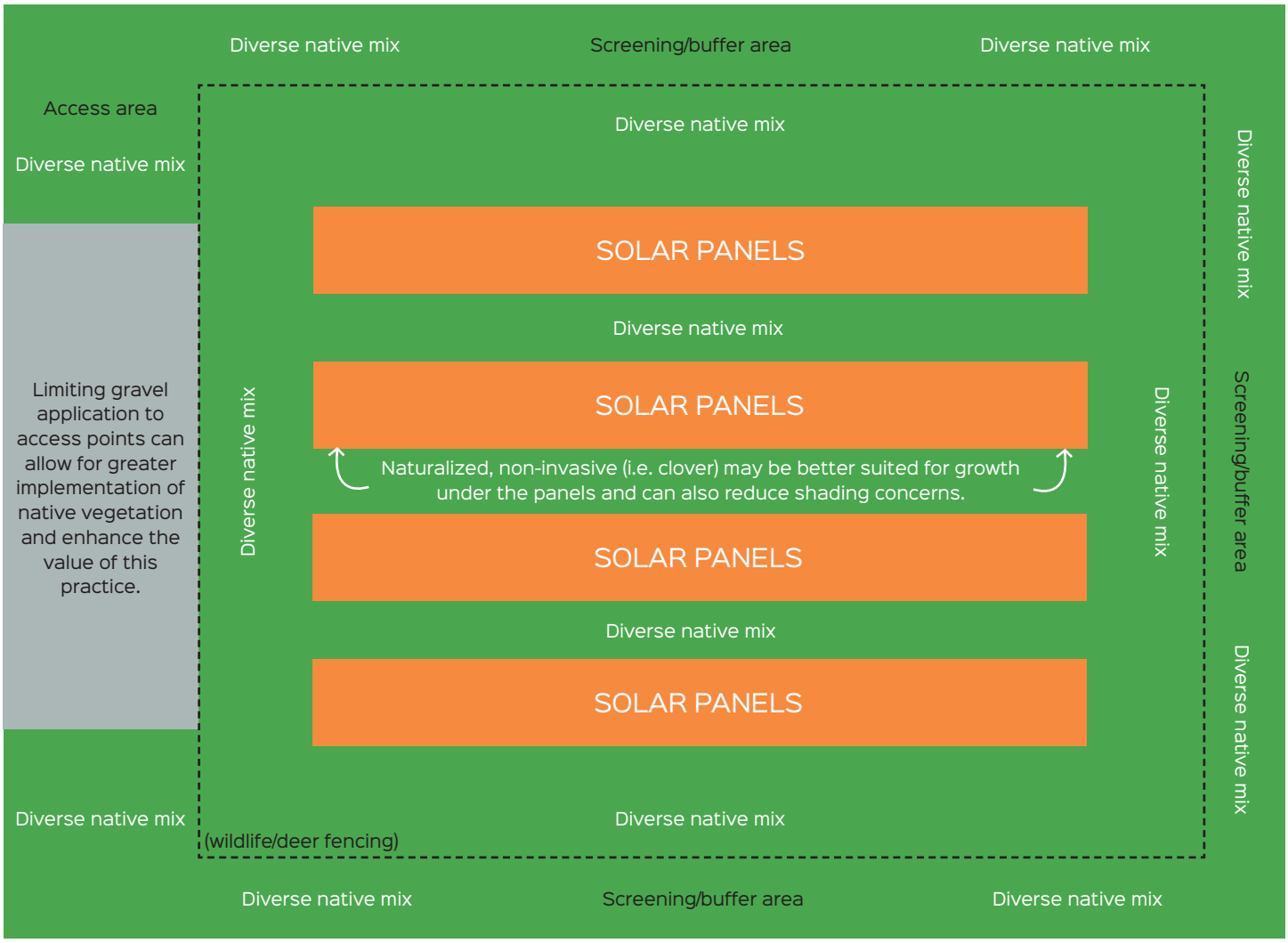
Importantly, wild bees benefit significantly from vegetation native to the location. However, naturalized, non-invasive species (i.e. clover) could offer similar or enhanced value. Honey bees have been proven to benefit from both native and naturalized, non-invasive species. Table 1 on page 9 displays some species which offer valuable nectar and pollen resources for this species.

Many pollinator-friendly solar site developers may want to consider species of vegetation which could make the site more valuable for the grazing of livestock. Given the significant cost of the equipment installed at a solar farm, sheep offer the lowest amount of risk for grazing. Other livestock, such as goats, may jump up on the panels and/or chew crucial wiring. Meanwhile, cattle would be expected to utilize the solar array as a scratching post, posing potential risks of equipment damage. Sheep are flexible grazers and Table 1 on page 9 highlights species which could help enable grazing value at the site. However, site managers are encouraged to avoid the introduction of sheep grazing until after the vegetation establishment period of one to three years. Delaying the introduction of grazing ensures the site does not encounter emergence issues and reductions in pollinator value. Once sheep grazing is introduced, site managers should consult with natural resources professionals and livestock managers to formulate a robust rotational grazing plan.

Other pollinator considerations:

- Grasses, such as Little Bluestem, have limited value for pollinators.
- Clovers are very valuable for honey bees, recognized as a source of nectar for honey production and have been identified as the most common source of pollen for honey bees in central Iowa.
- Goldenrods (Solidigos) and Birdsfoot Trefoil (Lotus corniculatus) have been proven to be used as a source of pollen for honey bees.

FIGURE 5. PROJECT SITE PLACEMENT OPPORTUNITIES FOR NATIVE AND NATURALIZED, NON-INVASIVE VEGETATION



Step three: Determine site placement and workability

Once the plants have been identified to meet the goals of the project, their practicality for solar operations is a key consideration. Placement of certain species may be better suited for specific areas of the project, including around the border of the solar farm, between the solar arrays, underneath the panels, and in screening/buffer areas which surround the solar project. See Figure 5. Some of the plants listed in Table 1 on page 9 may be too tall to plant between the panels and should be limited to the border around the solar farm to avoid shading concerns—this should be determined in conjunction with site managers and natural resources professionals using site-specific information.

Step four: Determine seed source and suitability

Once the plant species have been identified, selecting a retailer who can source the seeds is a key project need. Retailers who offer local ecotype seeds, meaning they're best suited for establishment within the site's conditions and native to the region, are recommended to ensure maximum project value. When consulting with retailers about a seed mix, the following factors should be considered:

- Is the seed locally-sourced?
- Given my site history, do you have suggestions for how I can ensure desirable species?
- What is your recommended seeding rate?
- What is the total cost per acre for this seed mix?

Table 1 on page 9 contains species of native vegetation which provide value to pollinators, monarchs, and grazing while also detailing considerations, such as projected height for solar site operators. This seed mix recommendation was compiled after consultation with a local county conservation board, researchers at Iowa State University, and technical staff at a nonprofit conservation organization. Bloom times are also listed so site managers can take action to identify a replacement species if they must remove a species due to height or other considerations—this ensures ample pollen and nectar resources for pollinators throughout the blooming season. For site managers working to identify sources of natural resource expertise, the following list may prove useful:

- County conservation boards, natural resource districts, etc.
- Soil and water conservation districts
- State agriculture and natural resources agencies (Iowa Department of Agriculture and Land Stewardship, Iowa Department of Natural Resources, etc.)
- Natural Resources Conservation Service (NRCS)
- University extension and outreach professionals

D. POLICY CONSIDERATIONS FOR PUBLIC AND PRIVATE STAKEHOLDERS

1. POLLINATOR-FRIENDLY SOLAR PROGRAMS

Across the U.S., many states have recognized the value of pollinator-friendly solar projects and passed policies to ensure this practical co-usage of land is implemented. Several states, including Illinois, Maryland, Minnesota, and Virginia, have statewide pollinator-friendly solar programs.

In Minnesota, state code (§216B.1642)[37] authorizes the Board of Soil and Water Resources to establish statewide guidance for solar project developers aiming for recognition under the Habitat Friendly Solar Program. The statute reads, "…an owner of a solar site implementing solar site management practices may claim that the site provides benefits to gamebirds, songbirds, and pollinators only if the site adheres to guidance set forth by the pollinator plan provided by the Board of Water and Soil Resources."[38]

This guidance is based in part on the Minnesota Solar Site Pollinator Habitat Assessment Form for Project Planning, also known as a pollinator-friendly solar scorecard.[39] This form helps solar project developers and site managers implement pollinator-friendly solar projects by setting goals for percentage of the site coverage by wildflowers, native species, blooming species, and evaluating habitat resources, among other guidance. This guidance is then incorporated into local ordinances at the county and municipal levels, setting clear rules solar project developers must follow to be recognized on a publicly-available statewide listing of pollinator-friendly solar projects.

As solar energy continues to grow, states can work with stakeholders, including pollinator and natural resources professionals, solar project developers, and local government officials, to establish their own statewide pollinator-friendly solar programs. In addition to meeting on-site practical goals for project developers, such as reducing erosion, these programs ensure that all local stakeholders benefit from renewable solar energy. States with pollinator-friendly solar projects are facilitating investments in natural resources, pollinators, and rural communities with one common sense action.

Apart from statewide programs, local government officials with authority to regulate zoning within their jurisdiction can write requirements for pollinator-friendly solar projects into their solar energy ordinances. In Iowa, several counties have led the way on this innovative approach of requiring pollinator-friendly solar. Linn County, Iowa, for example, included the following language in its solar energy ordinance:

"…2) Soils shall be planted and maintained in perennial vegetation to prevent erosion, manage runoff, and build soil. Seeds should include a mix of grasses and wildflowers, ideally native to the region of the project site that will result in a short stature

37 "2019 Minnesota Statutes." Office of the Revisor of Statutes, Minnesota Legislature, revisor.mn.gov/statutes/cite/216B.1642. Accessed May 2020.

38 "Minnesota Habitat Friendly Solar Program." Minnesota Board of Water and Soil Resources, 2019, bwsr.state.mn.us/bwsr-habitat-friendly-solar-program. Accessed May 2020.

39 "Solar Site Pollinator Habitat Assessment Form For Project Planning." Minnesota Board of Water and Soil Resources, 2lwej44565rn2mmjlk31pmwq-wpengine.netdna-ssl.com/wp-content/uploads/2019/08/Minnesota-pollinator-scorecard.pdf. Accessed May 2020.

prairie with a diversity of forbs or flowering plants that bloom throughout the growing season. Blooming shrubs may be used in buffer areas as appropriate for visual screening. 3) Seed mixes and maintenance practices should be consistent with recommendations made by qualified natural resource professionals such as those from the department of natural resources, county soil and water conservation service, or natural resource conservation service. 4) Plant material must not have been treated with systemic insecticides, particularly neonicotinoids."[40]

Other counties and cities across the region could consider the inclusion of pollinator-friendly solar language in their renewable energy ordinances to ensure all local stakeholders benefit from expanded solar energy development. This allows all residents of the county, not just the landowner hosting the lease, to see a return on investments in solar projects.

V. CONCLUSION

The clean energy economy is growing rapidly and is fueled in large part by widespread adoption of solar energy. As the industry continues to create hundreds of thousands of jobs, stimulate local and state tax revenue, and help reduce greenhouse gas emissions, more stakeholders will continue to explore ways to add more value to solar energy for all stakeholders. By developing resources for site managers of pollinator-friendly solar projects, public officials at all levels are well positioned to add value to these projects for every ratepayer. Investments in native and naturalized, non-invasive vegetation ensure habitat for at-risk pollinators, including the monarch butterfly, while creating habitat for vulnerable wildlife species. These species are crucial for economic and food security in the Midwest and underwriting solar energy projects with native perennial vegetation improves quality of life for all.

Combining conservation with renewable energy projects and saving money are not mutually exclusive. The research has clearly demonstrated these investments can save project developers up to three times the cost of managing traditional turfgrass sites.[41] Simultaneously, pairing this practice combination with community- and utility-scale energy projects opens the door to numerous, scarcely-explored economic development opportunities, particularly in the rural Midwest. Developers and communities can work together to leverage these projects to generate more than just renewable energy. Looking forward, opening up project sites for beekeeping, investing in the local native seed supply chain by supporting local retailers and service providers, offers a way to further leverage solar energy to stimulate rural economies.

In all, when conservation is made a priority on solar energy sites, the value of these projects are amplified. Value for ratepayers, vulnerable pollinators and wildlife, soil and water quality, and economic stimulation rarely come in such a clear and practical package. As the Midwest looks forward to a future powered by a clean energy economy, this innovative and pragmatic approach to solar energy may offer the brightest path forward.

About the Center for Rural Affairs

Established in 1973, the Center for Rural Affairs is a private, nonprofit organization with a mission to establish strong rural communities, social and economic justice, environmental stewardship, and genuine opportunity for all while engaging people in decisions that affect the quality of their lives and the future of their communities.

40 Smith, Cody, et al. "Iowa Solar Siting Resource Guide: A Roadmap For Counties." Center for Rural Affairs, Iowa Environmental Council, cfra.org/publications/iowa-solar-siting-resource-guide. Accessed August 2020.

41 Argonne National Laboratory, produced for the U.S. Department of Energy's InSPIRE Study. Obtained via personal communication with Fresh Energy, April 2020.