Co-Location of Agriculture and Solar:

Opportunities to Improve Energy, Food, and Water Resources

Jordan Macknick
JISEA Annual Meeting
March 14, 2019

InSPIRE Project Overview

Low-impact site preparation

Pollinator and native vegetation solar

Solar-agricultural co-location

Department of Energy Funded (2015-2021)

Extensive Industry Partnerships

Field and Analytical Modeling Work

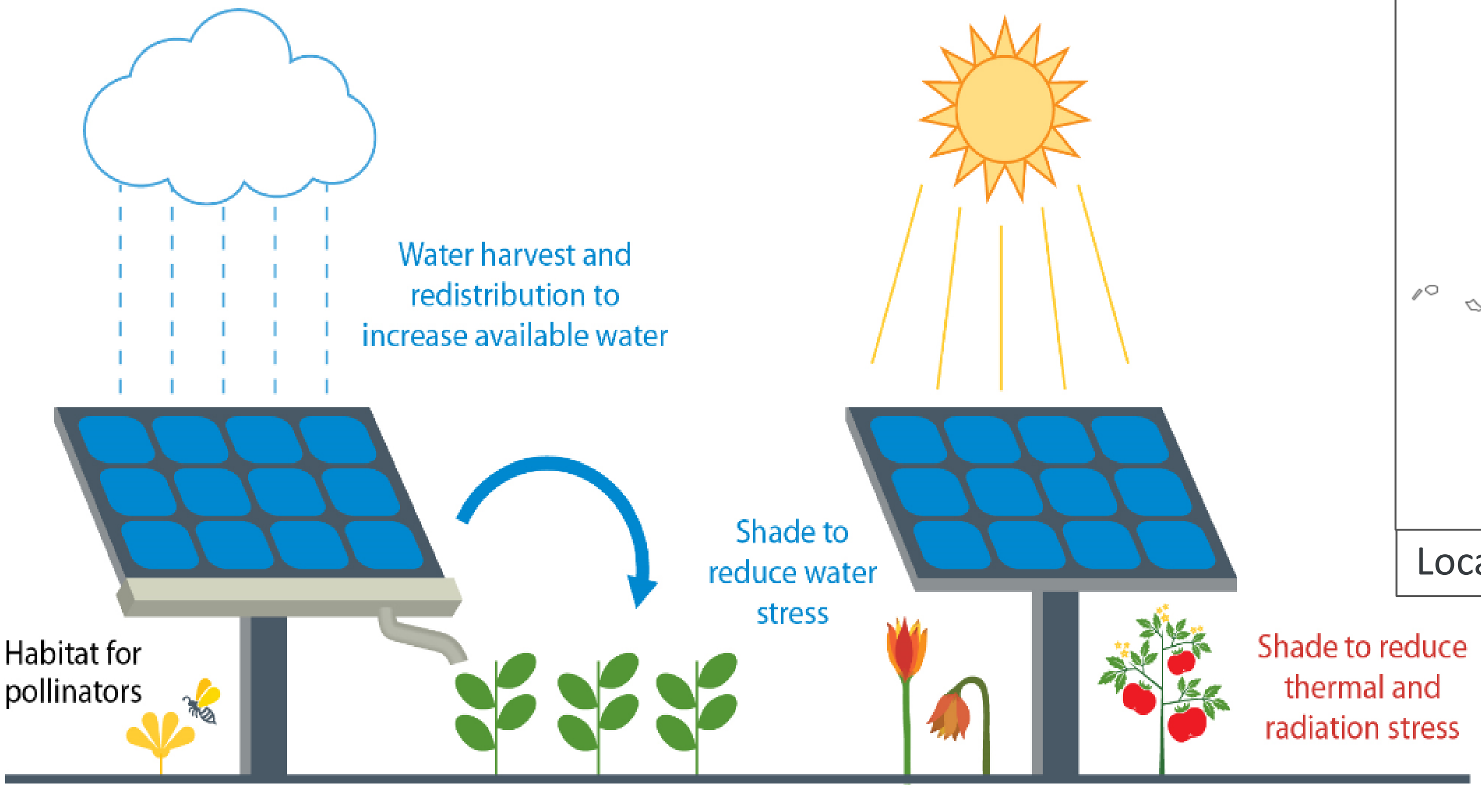
Benefits of Low-Impact Solar Development for Energy, Water, and Agricultural Resources

- Energy
  - Improved solar PV efficiencies due to cooler microclimate underneath panels
  - Reduced O&M costs
  - Reduced construction and acquisition/permitting costs

- Water
  - Reduced evaporation
  - Reduced runoff
  - Improved water use efficiency of crops and pollinator habitat

- Agriculture
  - Compatibility with crop production and livestock
  - Pollinator habitat can improve local agricultural yields
  - Improved soil health

InSPIRE Project Overview



Location of current and under-development research sites

Field-based research across multiple sites is driven by key scientific questions to provide foundational insights that will support economic, environmental, and agricultural evaluations of solar-agriculture co-location. Research topics include:

(1) Economic viability of solar-agriculture co-location configurations. *(University of Massachusetts-Amherst and Minnesota)*

(2) Increasing agricultural yields in arid environments. *(University of Arizona Biosphere 2 and Colorado State University)*

(3) Energy, water, and food security in remote, off-grid areas. *(Puerto Rico and Indonesia)*

(4) Pollinator habitat and ecological services *(Cornell University, Illinois, and Minnesota)*

Specific research activities for field studies

Study Design

Crop Planting

Harvesting

Data Collection and Analysis

Soil Carbon

Temperature Probe

Relative Humidity Probe

Rain Gauge

Datalogger

Soil Heat Flux Plate

Wind Anemometer

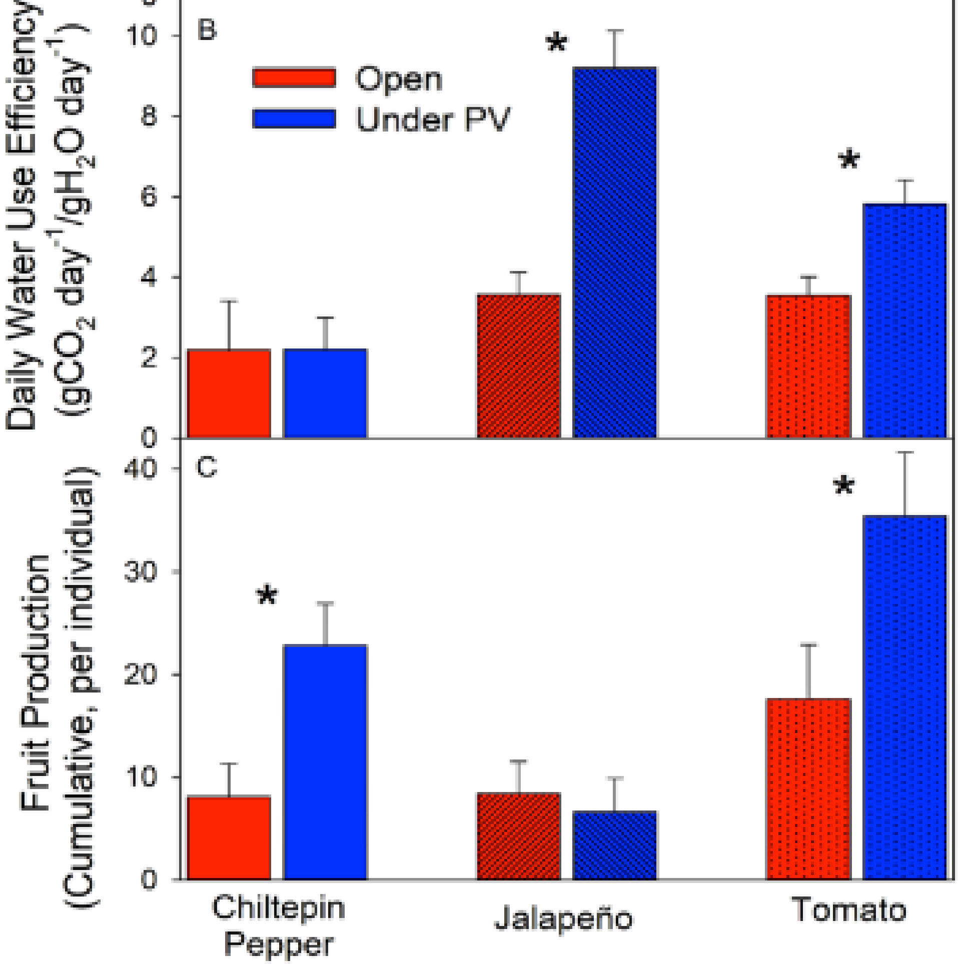
Soil Thermocouple

Pyranometer

Armstrong et al., 2016

Soil Moisture Reflectometer

PV Panel Thermocouple



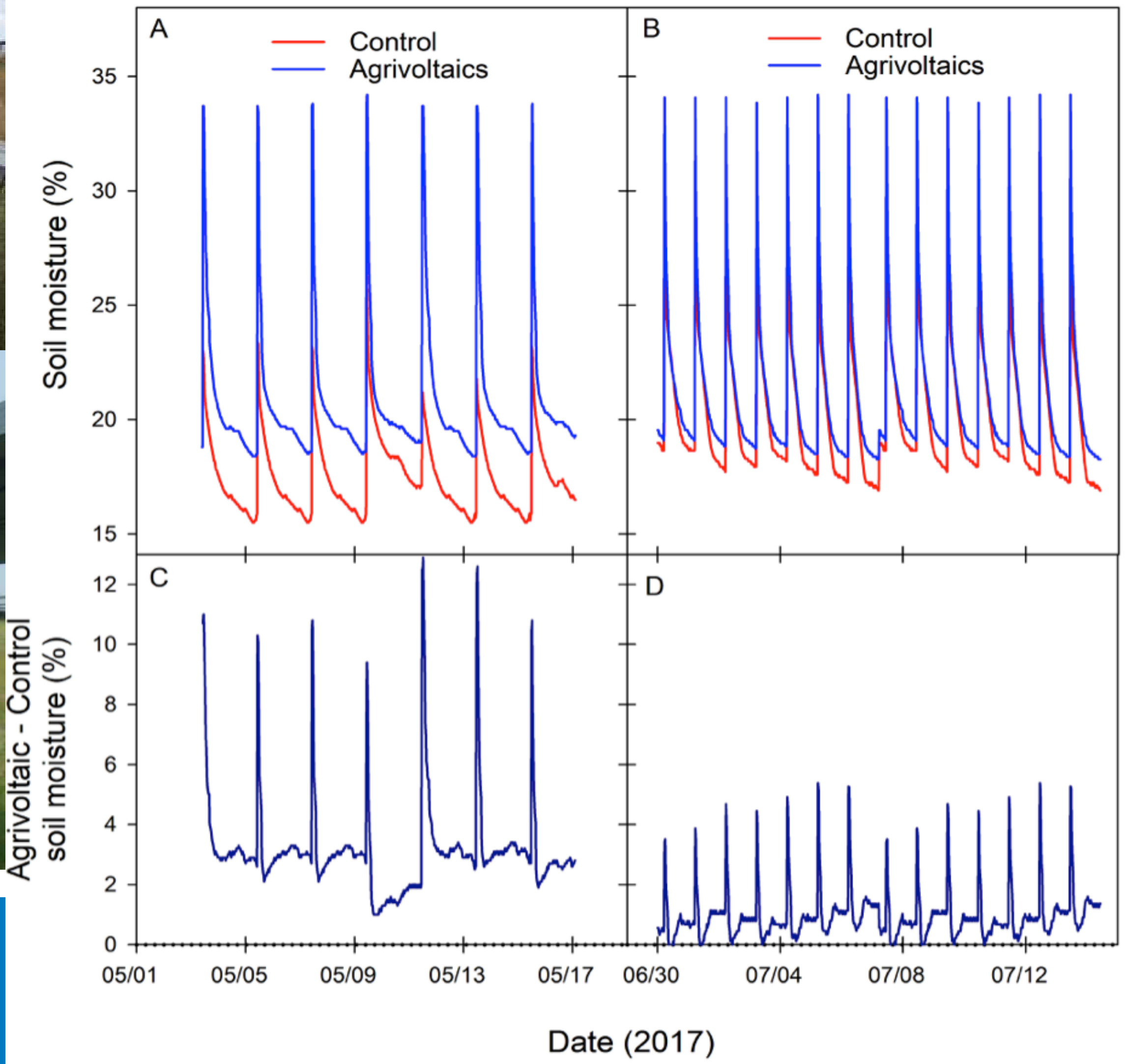
Key Highlight: Co-Location can lead to Higher Crop Yields with Less Water

Arizona co-location facility: higher yields, less water, longer growing season

Massachusetts co-location facility: higher yields in hot, dry years

New sites planted or under development in Colorado, Oregon, Puerto Rico, United Arab Emirates, and Indonesia

Key Highlight: Vegetation under PV can Improve Soil Moisture Retention

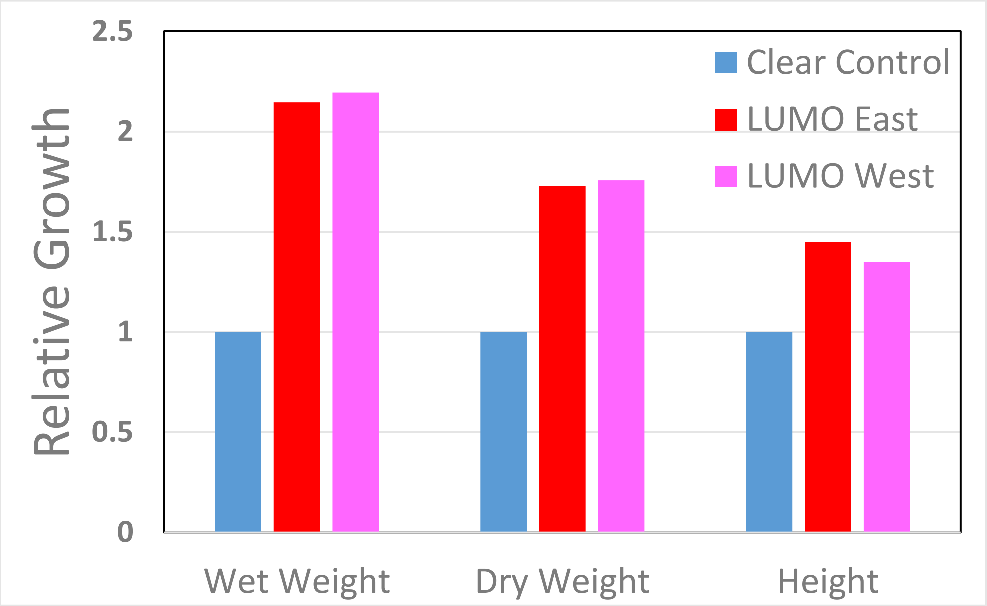


Higher soil moisture in solar array area than in non-shaded (non-solar) control area

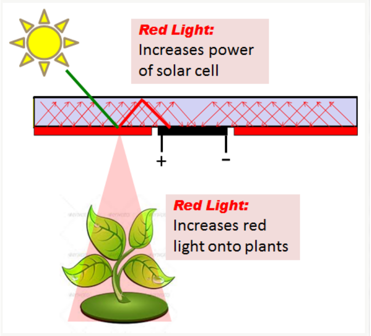
Significant variation in soil moisture levels depending location within array (directly underneath panels, in between rows, etc.)

Improved soil moisture retention for vegetated groundcover PV than for non-vegetated groundcover PV

Key Highlight: Solar-Integrated Greenhouses can Improve Yields



SOLICULTURE

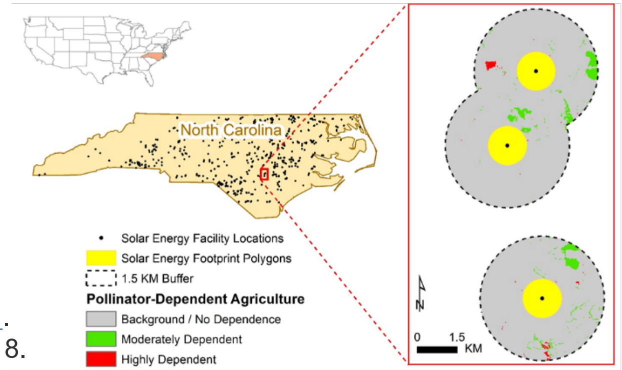


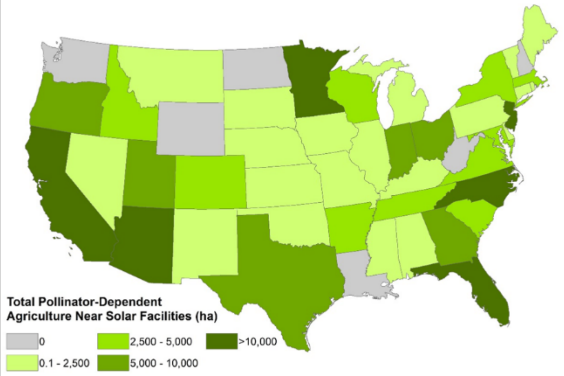
Chervil: *annual herb related to parsley with a delicate anise-like flavor*

Plants that received the altered light spectrum of LUMO in the late afternoon performed significantly better than chervil grown under a greenhouse with clear covering.

Key Highlight: Pollinator-Friendly Solar

Over 860,000 acres of agricultural land would benefit if existing solar facilities had pollinator-friendly vegetation





[Examining the Potential for Agricultural Benefits from Pollinator Habitat at Solar Facilities in the United States.](). Leroy J. Walston, Shruti K. Mishra, Heidi M. Hartmann, Ihor Hlohowskyj, James McCall, Jordan Macknick 2018. Environmental Science & Technology Vol. 52 (13) 3 July 2018 pp. 7566-7576.


Solar Power World
TOP SOLAR CONTRACTORS SOLAR ARTICLES PRODUCTS LEADERSHIP SUBSCRIBE

Pine Gate Renewables, Old Sol Apiaries create largest solar farm apiary in America

By Kelsey Misbrener | June 15, 2018

Utility-scale solar developer Pine Gate Renewables, headquartered in Charlotte, North Carolina, is pleased to announce that honey bees are now living on Eagle Point solar farm in Jackson County, Oregon, thanks to the company's SolarCulture initiative. SolarCulture is a Pine Gate environmental stewardship initiative that promotes sustainable agriculture and collaborations with the community to support research for smarter solar development.

Key Highlight: Solar-Powered Honey Production

Hives can be located in or outside of project fence

Innovative branding and marketing opportunities

Ongoing work evaluating honeybee and native bee preferences

Key Highlight: Solar-Integrated Grazing

Sustainable grazing practices can improve soils

Cost reductions from standard mowing practices

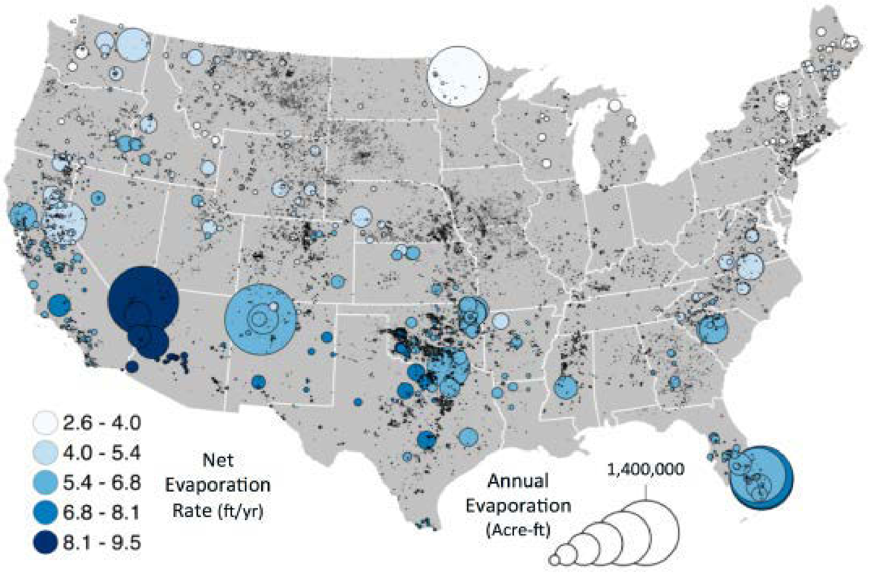
Ongoing work evaluating pastureland performance

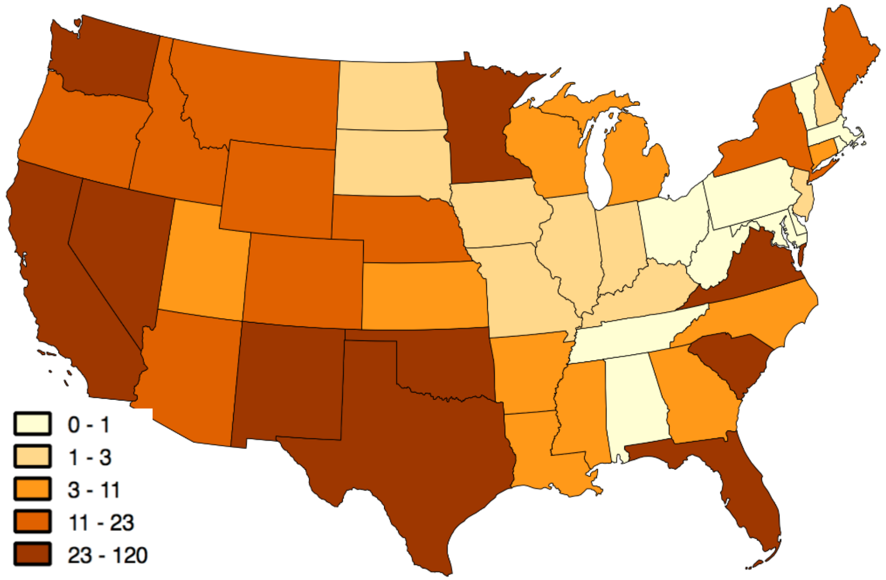
Key Highlight: Floating Solar on Agricultural Reservoirs

Siting on reservoirs can reduce evaporation and algae growth

Avoid conflicts with land used for agriculture

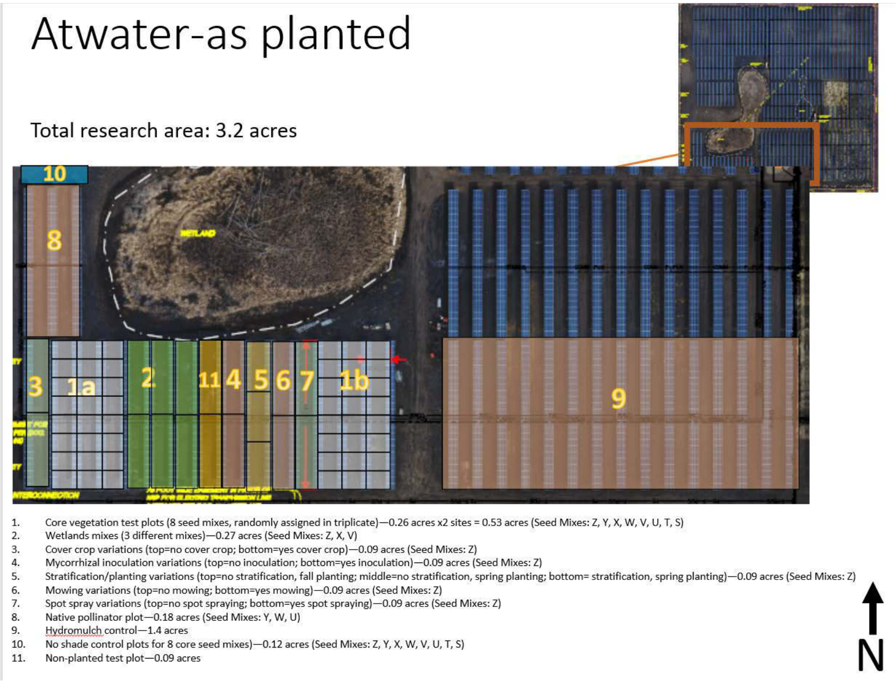
Recent NREL study identified over 25,000 man-made reservoirs that could supply 10% of U.S. power





Generation Potential (TWh/year)

[Floating Photovoltaic Systems: Assessing the Technical Potential of Photovoltaic Systems on Man-Made Water Bodies in the Continental United States.] Robert S. Spencer, Jordan Macknick, Alexandra Aznar, Adam Warren, and Matthew O. Reese. Environ. Sci. Technol., 2019, 53 (3), pp 1680–1689



Key Highlight: Education through field research

Educational benefits through internships, field trips, work experience, tours

Elementary school through PhD students

State agency, academic, and professional training

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USA: Where Solar Plants Help the Bees

Published on Wednesday, 28 February 2018

CORNELL CHRONICLE

Enel, NREL partner on three-year solar vegetation study

BRIEF

In bid to help bees, Xcel to require vegetation disclosure in solar RFPs

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Power Plant Research Program

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Solar Generation Facilities - Pollinator-Friendly Designation

The Pollinator-Friendly Designation Program bill (SB 1158) was signed by Governor Larry Hogan in May 2017. SB 1158

ORGANIC VALLEY

PRESS RELEASE: ILLINOIS POLLINATOR-FRIENDLY SOLAR ENERGY BILL PASSES, ADDS MOMENTUM TO SOLAR ENERGY DEVELOPMENT

Organic Valley Announces Next Phase of Community Solar Partnership To Become 100 percent Renewably Powered in 2019

NYLCV ABOUT US YOUR REGION ISSUES ENDORSEMENTS NYLCVEF LATEST NEWS

New York Pollinator-Friendly Solar Bill Unanimously Passes Assembly and Senate

06.11.18 // Shachar Sharon

New York League of Conservation Voters
(212) 361-6350

For Immediate Release: June 11, 2018
Contact: Shachar Sharon

New York Pollinator-Friendly Solar Bill Unanimously Passes Assembly and Senate, Healthy Pollinators from Solar Sites to Benefit Crops

Low-growing and flowering meadows of deep-rooted native plants to benefit honey bees, native pollinators, birds, and enrich agricultural soils

High-resolution photo courtesy Prairie Restorations, Inc. Caption: Pollinator-friendly solar arrays provide urgently needed habitat for honey bees and native pollinators.

DOER Massachusetts Department of Energy Resources

Solar Massachusetts Renewable Target (SMART) Program

Key Highlight: Broad Stakeholder Impacts

Pollinator-Friendly solar standards and scorecards

State Agency partnerships and technical assistance

Direct partnerships with solar and agricultural industry

University initiatives

Closing Thoughts

- There are many opportunities for synergies between agriculture and solar energy development
- Solar projects can be designed and constructed in ways that improve energy, water, and agricultural resources
- Low-impact designs can lead to reductions in some upfront and O&M costs for solar developers, while also increasing solar energy output
- There are many innovative configurations that can be employed and that still have not been tested

Thank you

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https://openei.org/wiki/InSPIRE

NREL/PR-6A50-73696

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JISEA Joint Institute for Strategic Energy Analysis

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