

# Flowering Solar Farms

## “Agrivoltaics:” a Powerful Sweet Synergy

by JOHN JACOB, WITH CONTRIBUTIONS FROM ROB DAVIS



Hives managed by Bee the Change on a pollinator-friendly Engie solar array in Vermont. Photo courtesy Fresh Energy

The rapidly emerging practice and study of agrivoltaics has a tremendous potential to positively impact our industry and pollinator habitat. Agrivoltaics is the practice of agriculture in and around large-scale photovoltaic (PV) solar farms. Unlike “concentrated solar,” which uses heat and mirrors, PV solar is the most common kind — you see it in camping equipment and on rooftops. PV solar directly converts sunlight to electricity and is cool to the touch. Agrivoltaics was initially pioneered by Adolf Goetzberger and Armin Zastrow as early as 1981 (A). Since that time the price of solar power

er has plummeted — more than 99.9 percent — and, along with the cost of batteries, the cost of PV solar continues to fall. We all like cheaper and better, and in more and more states that accurately describes solar energy. The significance of this trend is that solar power is rapidly becoming one of the most popular sources of electricity. In fact, it is projected by many that solar will dominate the supply of electricity by 2050 (B).

Aside from helping their church, local government, or school district save money with solar, why should beekeepers care? Hint: It’s all about the seed mix under and around the panels. An alarming study was recently published in the journal *Biological Conservation*. Without exaggeration, media carried the headline “Plummeting insect numbers ‘threaten collapse of nature,’” summarizing the study’s findings that 40 percent of insects are threatened with extinction.

Pollinator habitat is rapidly disappearing because of changes to conservation acres in the Farm Bill, suburban and exurban development, and fencepost to fencepost farming practices. In my 22 years as a commercial beekeeper here in Southern Oregon I have witnessed many of my best bee yards slowly become devoured by neighborhoods and monocultures such as grapes and hemp. Literally thousands of acres of what once was prime honey bee forage have disappeared over the last two decades directly because of development. This pattern has resulted in up to a 75% loss in insect populations in some studies (C).

This is where agrivoltaics — solar systems designed and managed with

pollinator-friendly ground cover — enters the picture. Widespread adoption of agrivoltaic models designed to establish and maintain pollinator forage offers us a mechanism to realize even more benefits from the transition to a modern electricity system. Harnessing these trends to create thousands of acres of long-term quality forage for our bees is a win-win situation. This is especially exciting given that the expected lifespan of a large-scale solar site is 20-40 years.

And science is already showing that plants thrive on solar farms. On 10 acres of dry unirrigated farmland at Oregon State University–Corvallis, scientists noticed the green plants growing in the shade of the solar panels. The site wasn’t intentionally planted to have a thriving seed mix, but after launching a formal study, the researchers found the area under the solar array was producing double the amount of plant material and had consistently higher soil moisture. For nectar and pollen bearing plants the beneficial micro-climate under the panels can also mean a much longer blooming period.

### FIRST-HAND EXPERIENCE

As an advocate and early adopter of agrivoltaics for bees, my business Old Sol Enterprises has forged collaborations with a half dozen different solar companies in Oregon and beyond. The fruit of these endeavors has exceeded our expectations. One such collaboration with Pine Gate Renewables, a solar developer, and Fresh Energy, an independent nonprofit, has resulted in Old Sol operating the largest solar bee farm in North America and possibly the world; this



John Jacob of Old Sol Enterprises on a pollinator-friendly solar farm in Oregon managed by Pine Gate Renewables. Photo courtesy of Pine Gate Renewables



Dustin Vanasse of Bare Honey has hives on a pollinator-friendly solar farm designed by IPS Solar in Minnesota. Photo courtesy of Dennis Schroeder

will soon be surpassed by other projects we are working on and some new installations going in (F). The 40-acre Pine Gate site located near Medford has a nameplate capacity of 10 megawatts, has been planted with native species selected for nectar and pollen production, and scored more than 90 points on a pollinator-friendly solar scorecard (I). The surrounding area includes a stream, orchards, and open grassland. Coming to the site mid-way through the season, I was pleased with the harvest and look forward to continuing on the site in 2019.

Co-locating solar farms and honey bee apiaries was pioneered in England around 2010, then jumped the pond to Canada and New England

(Mike Kiernan of Bee the Change), to Minnesota and the Midwest (Dustin and Grace Vanasse of Bare Honey), and onward to the Pacific coast. Pollinator-friendly solar has been highlighted in a webinar by the U.S. Department of Interior's National Conservation Training Service, in two *Scientific American* articles, a recent mainstage talk at the American Beekeeping Federation conference, and is being actively studied by the National Renewable Energy Laboratory, a division of the U.S. Department of Energy. The Pine Gate solar array near Medford is one of the sites included in a study, called InSPIRE, which is looking at co-location of solar and agriculture, as well as vegetation performance, on more than 20 solar sites nationwide.

It's not all serious though — the success of this site and apiary led to a fun collaboration with award-winning Caldera Brewing of Ashland, Oregon (J). Using some of the solar farm honey, Caldera created "Let's Bee Friends Honey IPA," to help bring farm, beekeeper, and energy folks together. The beer was created as a delicious way to spread awareness about pollinator-centric agrivoltaics and is available on draft and will be canned for distribution beyond Oregon. Public support for solar may be high, but public support for beer is nearly universal — especially a beer that celebrates clean energy and environmental stewardship.

#### SOME ROSES, SOME THORNS

Replicating this success is not as easy as one would think despite the

dire need for pollinator habitat and clean energy. Resistance to solar projects comes from many corners, including farm conservation groups, NIMBYs (Not In My Back Yards), and some farm organizations. Unfortunately, there are a lot of solar systems with bare ground or gravel, and surrounded by prison-style chain link fences. However, there are also a growing number of pollinator-friendly solar projects and designs. Beekeepers, as an industry, would be wise to address these various groups' concerns to help the dual-use solar movement create many thousands of acres of pollinator habitat.

There are several sticking points that come up when trying to get a solar/pollinator agrivoltaic project approved. One simply is getting local authorities and other stakeholders to recognize honey bees as livestock and a high-value farm use. This can be addressed by educating people about the role and economic value pollinators have in our agricultural system. According to Cornell University, insect pollination contributes more than \$29 billion to the U.S. agricultural economy (D). Another impressive number is the value of crops pollinated by a colony headed by a single industrious queen bee (E, see queen bee economics table on next page). In one year, a single queen can be the linchpin in the production of at least \$29,000 in agricultural production annually by a commercial beekeeper. Never let it be said that beekeepers are not performing high-value farming with our tiny and hardworking livestock.

#### MAKING PRODUCTIVE USE OF THE LAND

The next big area of contention that we run into is the accusation that a solar/pollinator agrivoltaic project is not a productive use of farmland and positive steward of the soil. This fallacy can be dispelled with several facts, not the least of which is the fact that pollinators add so much to the agricultural economy and are legally defined as livestock in most states. That said, even here in Oregon — a nationally leading state for pears and blackberries — people take bees and their beekeepers for granted. Read up on your state's Census of Agriculture report — Oregon's shows that we grow more than 300,000 acres of turfgrass seed that gets used for pasture, but also to permanently convert farmland into suburbs and soccer fields. Like turfgrass, there are many non-edible crops that can be compared to the pe-



Ground screws for anchoring solar panels are displayed at a solar conference. These could make great hive stands, too!

E. Queen Bee Economics Table

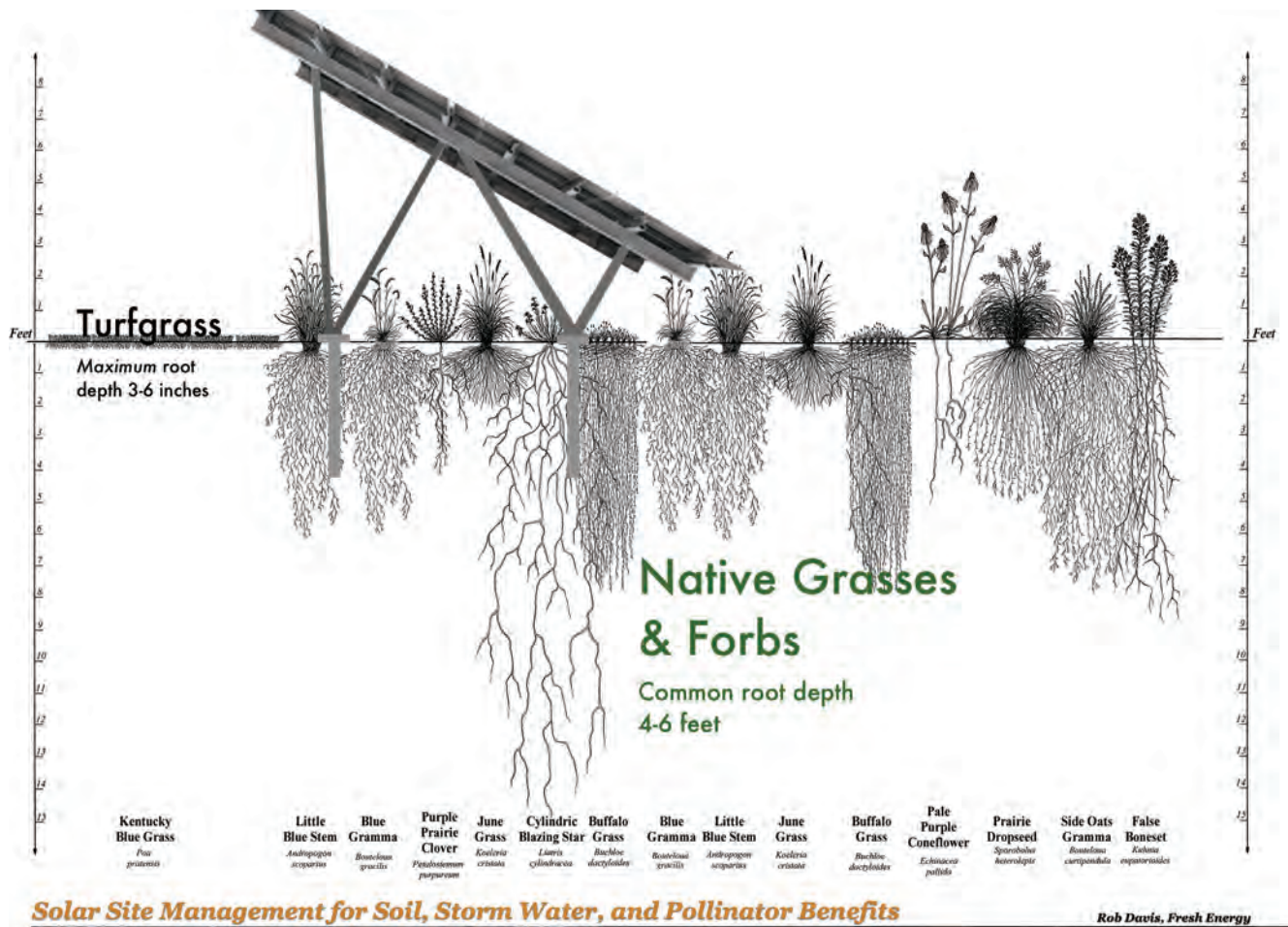
References	Item	Yield per queen	Average retail value	
Old Sol Enterprises LLC	Queen	3	\$34.00	\$102.00
Old Sol Enterprises LLC	colony produced/split	3	\$180.00	\$180.00
Old Sol Enterprises LLC	almond pollination service	1	\$200.00	\$200.00
Old Sol Enterprises LLC	Pear pollination service	1	\$50.00	\$50.00
Old Sol Enterprises LLC	blueberry pollination service	1	\$85.00	\$85.00
Old Sol Enterprises LLC	lbs honey crop	40	\$8.00	\$320.00
Sansoni Agri Enterprises, personal communication	lbs almonds/queen*	1400	\$7.00	\$9,800.00
<a href="http://arec.oregonstate.edu/oaeb/files/pdf/EM8822-E.pdf">http://arec.oregonstate.edu/oaeb/files/pdf/EM8822-E.pdf</a>	Lbs pears/queen*	2,100	\$1.40	\$2,940.00
<a href="https://blueberries.ces.ncsu.edu/wp-content/uploads/2012/10/evaluating-the-profitability-of-blueberry-production.pdf?fwd=no">https://blueberries.ces.ncsu.edu/wp-content/uploads/2012/10/evaluating-the-profitability-of-blueberry-production.pdf?fwd=no</a>	Lbs other pollination/queen (blueberry)*	4,000	\$3.88	\$15,520.00
*Assume 2 hives/acre for pollination service				
			Direct \$ impact per queen Sub Totals	\$29,197.00

rennial flowering vegetation on a agrivoltaic solar project.

The low-growing meadows of native plants on a solar/pollinator agrivoltaic project hold the topsoil on site and improve it over the life of the project. Deep root systems can

bring minerals and nutrients to the topsoil and over time vastly improve tith (H). Pollinator-centric agrivoltaic sites can be thought of as the ultimate long-term CRP that will both improve fertility and protect topsoil due to lack of chemical inputs and annual tilling.

Agrivoltaics offers many additional benefits to current and future farm uses such as reduced water use, which can immediately relieve pressure on tight water supplies, as well as providing enhanced pollination services to nearby farm and garden operations.



H. This graph shows the advantages of native plants in soil preservation.



# Solar Site Pollinator Habitat Assessment Form for Project Planning

For solar companies and local governments to meet pollinator/wildlife habitat certification



## 1. PERCENT OF PROPOSED SITE VEGETATION COVER TO BE DOMINATED BY WILDFLOWERS

- 31-45 % +5 points
- 46-60 % +10 points
- 61+ % +15 points

Total points

Note: Projects may have "array" mixes and diverse border mixes; forb dominance should be averaged across the entire site. The dominance should be calculated from total numbers of forb seeds vs. grass seeds (from all seed mixes) to be planted.

## 2. PLANNED % OF SITE DOMINATED BY NATIVE SPECIES COVER

- 26-50% +5 points
- 51-75%. +10 points
- 76-100% +15 points

Total points

## 3. PLANNED COVER DIVERSITY (# of species in seed mixes; numbers from upland and wetland mixes can be combined)

- 10-19 species +5 points
- 20-25 species +10 points
- 26 or more species +15 points

Total points

Exclude invasives from species totals.

## 4. PLANNED SEASONS WITH AT LEAST 3 BLOOMING SPECIES PRESENT (check/add all that apply)

- Spring (April-May) +5 points
- Summer (June-August) +5 points
- Fall (September-October) +5 points

Total points

See BWSR [Pollinator Toolbox](#) about bloom seasons

## 5. AVAILABLE HABITAT COMPONENTS WITHIN .25 MILES (check/add all that apply)

- Native bunch grasses for nesting +2 points
- Native trees/shrubs for nesting +2 points
- Clean, perennial water sources +2 points
- Created nesting feature/s (bee blocks, etc.) +2 points

Total points

Note: Measurements of percent "cover" should be based on "absolute cover" defined as the percent of the ground surface that is covered by a vertical projection of foliage as viewed from above. To measure cover diversity it is recommended to use plots, and/or transects in addition to meander searches for accurate measurements. Wildflowers in question 1 refer to "forbs" which are flowering plants that are not woody, and are not graminoids (grasses, sedges, etc) and can include introduced clovers and other non-native species beneficial to pollinators.

## 6. SITE PLANNING AND MANAGEMENT

- Detailed establishment and management plan developed +15 points (see [example plan](#)) with funding/contract to implement
- Signage legible at forty or more feet stating pollinator friendly solar habitat (at least 1 every 20ac.) +5 points

Total points

## 7. SEED MIXES

- Mixes are composed of at least 40 seeds per square foot +5 points
- All seed genetic origin within 175 miles of site ([pg.7-8 of Guidance](#)) +5 points
- At least 2% milkweed cover to be established from seed/plants +10 points

Total points

## 8. INSECTICIDE RISK

- Planned on-site insecticide use or pre-planting seed/plant treatment (excluding buildings/electrical boxes, etc.) -40 points
- Communication/registration with local chemical applicators about need to prevent drift from adjacent areas. +10 points

Total points

Grand Total

Provides Exceptional Habitat >85  
Meets Pollinator Standards 70-84

Project Name: \_\_\_\_\_  
 Vegetation Consultant: \_\_\_\_\_  
 Project County: \_\_\_\_\_  
 Project Size: \_\_\_\_\_  
 Projected Seeding Date: \_\_\_\_\_

Send completed forms, project plans, seed mixes and any communication with pesticide applicators to [dan.shaw@state.mn.us](mailto:dan.shaw@state.mn.us)

Dr. Marla Spivak contributed to Minnesota's pollinator-friendly solar scorecard. Best Practices suggest that the beekeeper ask the developer to fill out a version of this before placing hives on the project.

Another area that I've seen push-back on from the farm community is the misconception that the racking systems the panels are mounted on will result in a lot of concrete and gravel in the ground. The industry standard is actually removable ground screws or pile-driven posts. These systems are designed from the start to be removable in order to allow the adoption of new technologies or the conversion of the site for another purpose.

Dealing with fearful neighbors and citizens is nothing new to beekeepers, and as we all know, dealing with NIMBYs is a task best dealt with through education, exposure to the truth, and a little taste of the sweet rewards of beekeeping. Keep some samples of solar farm honey with you — it's amazing how people warm to the concept once they've tried the harvest.

Sometimes the basic economic argument for supporting pollinators just doesn't work for people. But when you bring it back to food — that's when you can reach people. If you eat food, you are a participant in agriculture, and therefore dependent on pollinators. My co-author does this particularly well in his TEDx talk (find it via Google) titled "This Unlikely 1960s Space Tech Can Help Save the Bees." Our need for pollinators is a matter of survival and prosperity; however, many cannot get beyond the notion that food just comes from the grocery store or drive-thru window.

Solar farms are popular and are being developed in areas that may have been corn and beans for the last 70 years. As a result, people want to know if solar installations will have any influence on their property values. Despite the appeal of a quiet neighbor, or in spite of the change in scenery, multiple assessments and property appraisals around the nation have shown that there is no positive or negative valuation effect (G). Sure, some people don't like the look. But I say beauty is in the eye of the *bee holder* — and we can all appreciate the aesthetics of clean air and clean water.

Another issue that comes up with regularity is the "why here?" question. Siting of a large-scale solar farm has many limitations. For starters they must be located on relatively flat or even land within a mile or two from an electrical substation, and the substation has to have available capacity to get the electricity into the grid. For most projects, long-distance power transmission is prohibitively expensive and the economics work out best if the electricity is produced near where it is needed. And with commodity crop prices these days, it's just smart farming to lease some land for a solar farm so you have dependable revenue. Farm bankruptcies are up and it doesn't make any sense to deny a farmer their freedom to use their land for an agrivoltaic solar project.

Gaining public support for pollinator-centric agrivoltaics will be

### I. POLLINATOR-FRIENDLY SOLAR SCORECARDS (Opposite Page)

Vetted by entomologists including Drs. Marla Spivak, May Berenbaum, Dennis VanEngelsorp, Scott McArt, Harland Patch, and Adam Dolezol, pollinator-friendly solar scorecards tell you whether a solar farm provides beneficial habitat — whether the benefits are real, or something else. Fresh Energy publishes links to regional pollinator-friendly solar scorecards on its website at [BeesLoveSolar.org](http://BeesLoveSolar.org).

Solar arrays are first and foremost energy generation facilities, but, outside of the desert southwest, every project has to use some kind of ground cover to stabilize the soil. The seed mix for ground cover can be specially designed to create a low-growing meadow that is resilient to droughts and downpours — and also beneficial to honey bees and native bees. The forage won't result in huge hundred-plus pound hauls of honey — the ground cover needs to be diverse in order to mitigate risk of any one species failing — but it will provide a healthy source of honey bee nutrition and also benefit the broader ecosystem. Ellen Topitzhofer's work (F) at Oregon State University reinforces the importance of a diversity of pollen sources to overall honey bee health.

Whatever the ground cover, make sure you're only placing hives on or near solar farms that meet these pollinator-friendly solar standards. Selling honey from apiaries on a solar farm covered in turfgrass or gravel hurts us all. We all need acres of healthy forage for our bees, and the public loves rewarding companies that help "save the bees" with repeat business and positive word-of-mouth marketing.

### BEST PRACTICES FOR SOLAR FARM APIARIES

1. Ensure it is a pollinator-friendly solar site.
  - Ask the developer to provide a completed copy of your state's pollinator-friendly solar scorecard, or a scorecard from a state with similar climates and soils. When in doubt, contact Rob Davis at the Center for Pollinators in Energy — [davis@fresh-energy.org](mailto:davis@fresh-energy.org).
2. Have more than a handshake.
  - Draw up an agreement with the landowner or solar company that includes the apiary location and your right to access, any planned movement of the hives, as well as price and pre-payment arrangements for a portion or all of the honey.
3. Offer professional packaging options.
  - Many solar companies will love to have their name or the project name on a jar or other packaging option that they can share. Some solar companies are even providing honey to the people who get electricity from the site.
4. Location, location, location.
  - Place and orient the hives to ensure bee droppings do not accumulate on the panels and bees do not interfere with regular operations and management.
  - Request to closely inspect nearby panels for droppings at least once per year.
5. Know the landscaper or ecologist.
  - Exchange phone numbers with the vegetation management contacts.
  - Agree upon who will be managing the vegetation near the hives to be free of any invasive or noxious weeds.
6. Keep it separate.
  - Extract and keep the honey from the pollinator-friendly solar farm separate from the honey harvested from your other bee yards.
  - Consumers strongly support solar energy and creating habitat to help save the bees. Honey from solar sites encourages the adoption of pollinator-friendly solar as a best practice.
7. Take precautions.
  - Have liability insurance and provide a copy to the landowner and/or solar company.
  - Install two or more swarm traps at 6' off the ground nearby.
8. Engage with local media and the community.
  - Partner with clean energy non-profits and the solar company to educate more people about the importance of solar sites that provide healthy forage.
  - Take and share photographs and video of the site. Tell a story with each shot by including the flowering vegetation, the bees or hives, and the solar array.
  - Tag your social media posts with #BeesLoveSolar.

crucial to helping this movement advance. Whether we like it or not, solar is the future and will be built with gravel, bare ground, ditch grass, or something meaningfully beneficial to pollinators.

**SHEEP: FRIEND OR FOE?**

It's easy to find photos of solar farms with grazing sheep — it's a common practice in Europe as well as North Carolina — but are those sheep devouring all the pollinator forage? It's the method of grazing, not the grazing itself that's the problem. A practice called Continuous Grazing — putting a herd of sheep out in the solar farm and letting them follow their fancy — is the problem. In addition to eating all the pollinator forage down to the root, Continuous Grazing often results in sheep finding ways to rub on and damage the panels, poop all over the inverter pads, and attract predators. In stark contrast, the practice known as Conservation Grazing, and also known as high-intensity rotational grazing, moves a herd of sheep between paddocks defined by flexible electric fences. Conservation Grazing enriches biodiversity and improves soil health. The American Solar Grazing Association (Solar-Grazing.com) recommends Conservation Grazing as a best practice for solar farms.

**LOOKING TO THE FUTURE**

Given the current state of affairs in our industry, including high annual colony losses and disappearing habitat, partnering with pollinator-friendly solar developers will have a huge benefit for both our managed and unmanaged pollinators. It is more important than ever that we work together to help solve these problems. Energy demands and populations are only moving in one direction: upward. The opportunity for synergy between meeting the demands of growth and creating long-term pollinator sanctuaries in every bioregion should be realized.

As beekeepers, we have become used to getting the leftovers, margins, fence lines, and meager hedge rows; basically, whatever is not getting sprayed with Roundup or Dicamba. Pollinator-friendly, agrivoltaic solar offers us a synergistic path to a much healthier and more prosperous model where pollinators and beekeepers can actually have reasonably prime ground affordably dedicated to long term pollen and nectar crops.

**CITATIONS**

- A. <https://en.wikipedia.org/wiki/Agrivoltaic>
- B. <https://uk.reuters.com/article/us-solar-iaa-electricity/solar-energy-could-dominate-electricity-by-2050-iaa-idUK-KCN0HO11K20140929>
- C. <https://www.theguardian.com/environment/2017/dec/14/a-different-dimension-of-loss-great-insect-die-off-sixth-extinction>
- D. <http://news.cornell.edu/stories/2012/05/insect-pollinators-contribute-29b-us-farm-income>
- E. "Effects of pollen collected by honey bees from pollination dependent agricultural cropping systems on honey bee nutrition" Oregon State University <https://ir.library.oregonstate.edu/downloads/v979v637n>
- G. <https://www.cleanenergyresourceteams.org/blog/chisago-county-boards-real-estate-update-shows-solar-has-no-impact-property-values>

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