David Miller Paper - He didn't get to finish it! [redacted]

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My name is David Miller, 1608 Franklin Crossroads Rd, Cecilia, Ky. I am very familiar with this area of Hardin County, being born in a farmhouse on one of the farms being considered for this solar site. This is where I first learned about farming. I have farmed in this area for over 40 years. I am a third generation farmer. Previously to owning my own farm, I taught Earth Science and Physical Geography on the college level with a background in Geology.

This 1072 acre site is unsuitable for an electric generating facility for several reasons. First, according to Dr. James C. Currans, U S Geological Survey, of the University of Kentucky. Dr. Currens is an Expert and was a well known authority on Karst Geology in this area of Kentucky and has written several articles. He retired in 2019 after 37 years studing Karst Geology. The geology of this area is common with sinkhoes and caves and underground limestone. If looking at overhead photographs the open sinkhoes are easily spotted. Some of these sinkhoes open into underground caves and directly into the underground water table. Several of these are easily seen along Black Branch Road South. This also creates another problem for pollutants flowing directly into the underground water supply through these sinkhoes. A utility scale solar facility with panels classified as hazardous material would not be suited for such an area.

Farmers have first hand experience with sinkhoes and are very careful not to spray herbicides or insecticides close to them because of this reason. In order to purchase herbicides, farmers are required to go through a training which emphasizes these hazards. There are some sinkhoes that are not seen by these photographs. They are covered by a thin layer of soil and are called, "cover collapse sinkhoes". Dr. Currens has studied over 300 of this these sinkhoes in Kentucky during his career. He also did an extensive study of Karst Hydrology in Radcliff. Dr. Currens stated in one of his papers June, 2012." Sudden and unpredictable collapse of unconsolidated cover over soluble bedrock defines cover collapse. Cover collapse sinkhoes in Kentucky frequently damages buildings, roads, utility lines, and farm equipment. It has killed livestock, including thoroughbred horses and has injured people at an estimated cost of 20 million. "Althrough the genesis of cover collapse is well understood, precisely predicting the time and place at which a collapse will occur is not yet possible" On the personal level, I have personally had two cover-collapse sinkhoes to fall in, damaging farm equipment in two different fields near this site. Two other farmers have had level land to suddenly fall in damaging their equipment. It is very scary when it occurs. One of my neighbors had a calve fall in one last year near this site and it took two men

with a long ladder to get the calve out. Fortunately the calf limp a little but was O K. Sounds funny but it was not fun for the calf.
Because of this phemomonen of new sinkhoes falling through at any moment, Dr. Currans stated , "It is unadvisable to build any type of development in the area which is common with cover collapse sinkhoes." A few years ago, you will remember that part of the corvette plant in Bowling Green lost several valuable corvettes during a cave in of a cover collapse sinkhoe. If a solar transformer or panels fall into a thinly covered sink hoe(cover-collapse type), it will short out and may cause a fire. How would local volunteer fireman put out such an electrical fire with hazardous materials? And would the elements from the panel flow into the water table before it could be retrieved.

Another very good reason this site is unsuited for the proposed energy facility is the value of the farmland this is being displaced on 1072 acres. Much of this farmland is classified as "Prime" by the Hardin County Planning and Development commission. Primed farmland is best suited to grow crops, corn, soybeans, wheat, hay, vegetable, etc . It is a green, renewable resource, taking in tons of carbon each day(36000 lbs of carbon/day for a typical acre of a cornfield, Mich. State) and giving us oxygen in return to breath.

How do you quantify prime farmland value? Now 1072 acres is a large chunk of land. This farmland being considered typically yields over 50 bushels of soybeans which in turn can produce 75 gallons of Biodiesel or 535 gallons of Soybean Oil with 2375 lbs of soybean meal left over for feed additive for that 50 bushels/per acre.(1.5 gal. of Biodiesel/bushel... 10.7 lbs. of soybean oil per bushel) 90% of most foods that you purchase have soybean oil in them.. Multiply those figures by 1072 acres and you get over 80,400 gallons of Biodiesel or over 573,520 gallons of Soybean Oil with 254,125 lbs. of soybean meal left over for feed additive.
Now if the farmer grows corn on those acres, the average yield is around 170 bushels conservatively. Each bushel of corn will give you 33.3 lbs of corn sweetener or 31.5 lbs of starch, or 3 gallons of ethanol with 17 lbs of distillers dried grain left over feed for animals. Multiply that bushel times the average yield of 170 bushels= 5,661 lbs. of sweetener, or 5355 lbs. of starch, or 510 gallons of ethanol with 2689 lbs. of distiller grain for livestock feed. That is per acre, now multiply by 1072 acres(the size of this project)= over 6,068,592 lbs of sweetener, or 5,740,560 lbs. of starch, or 546,720 gallons of ethanol with 2,882,608 lbs. of distillers grain left over for feed.
WOW Again 1072 acreage is a big chunk of land. Impressive and that is

each year. What about the other value of crops, the plants absorbing water and preventing erosion. Several experts have stated," We will need to double our food production by year 2050" Senator Paul Hornback recently stated that Kentucky alone is losing 16,000 acres of farmland each year.

So how do we quantify the value of farmland.........it is impossible.

It's Priceless

Grey farm Looking North to Rt.86 – IBV Site

Projected Industrial solar project

From Denise Miller

#3

Chemical composition determination of impurities and effect on the toxicity degree of solar panel components

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Abstract. By 2050, according to the conclusion of the European Commission, the amount of solar panels waste will reach 78 million tons. 85% of all solar panels produced today belong to polycrystalline solar panels. The subject of this paper is the polymer components of polycrystalline solar panels EVA (ethyl vinyl acetate) and Tedlar® (polyvinyl fluoride). The paper reflects studies to determine the chemical composition of impurities of the solar panel components, and the degree of impurities influence on the toxicity of polymer components.

1 Introduction

Due to PV modules versatility, simplicity of installation and great respect for the environment, solar photovoltaic (PV) technology is positioned as one of the main sources of renewable energy with more installed electrical power both worldwide and in Europe. Currently, the International Renewable Energy Agency (IRENA) establishes that the world PV power installed in 2017 is 385 GW, where 28.46% belongs to Europe, when in 2000 only 815 MW were available and in 2010 39 MW. It is also considered a fast growing market, where according to different future scenarios, it is expected that in the year 2050 the PV will contribute from 2.5% to 25% of the global electricity demand [1].

Although PV technology is the most environmentally friendly technology of all energy and electricity generation technologies and one of the most popular sources of renewable energy, PV modules have a useful lifespan of approximately 30 years [2].

With the enormous growth in the development and utilization of solar-energy resources, the proliferation of waste solar panels has become problematic. In addition, we have very little information on the PV-waste toxicity, low biodegradability and the huge landfill areas required [3].

Taking into account the proportion of elements that make up a PV module and that in 2017 the PV power installed in Europe was 109.48 GW, it is expected that by 2042 there may be around 10 million tons of crystalline silicon photovoltaic waste only in Europe; 7 million tons of glass, 977 thousand tons of aluminum, 962 thousand tons of polymers, 54 thousand tons of copper, 474 tons of silver, 11 thousand tons of tin, 11 tons of Zinc, 317 thousand tons of Silicon and 56 thousand tons of lead [4].

In July 2012, the European Union formally revised the Waste Electrical and Electronic Equipment (WEEE) Directive, adding photovoltaic components as rejected electronic devices to be included in ten WEEE categories. Photovoltaic solar cells are now included in the electronic waste management system and must be collected and recycled [5].

2 Materials and methods

2.1 Qualitative Analysis of PV-panels Polymer Components

Qualitative analysis of the samples was carried out on a wave-dispersive X-ray fluorescence spectrometer SPECTROSKAN MAX after which the spectra were analyzed using the "Spectrum-Kvant" software.

Wave-dispersive X-ray fluorescence spectrometry allows you to determine the presence in a sample of a specific element or group of elements. Most often, it is supposed to search for foreign elements and impurities that should not be part of the sample.

In addition, wave-dispersive X-ray fluorescence spectrometry can detect a wide variety of items, even multiple items at the same time. This method is non-destructive, fast, highly effective and environmentally friendly. Also it can be used with various types of samples such as bulk, liquid, powder and gas. [6,7].

For devices with an evacuated spectrometric chamber, 4 different types of crystals are used - LiF200, C002, PET, KAP (or RAP). From the point of view of

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qualitative analysis, they differ in the range of the recorded wavelengths and, accordingly, the determined elements. Table 1 shows the main elements that can be identified on each of the crystals[14].

Table 1. Identification of the main elements by X-ray fluorescence spectrometer.

Crystal	Determined elements
LiF200	K-series: Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Br, Rb, Sr, Zr, Nb, Mo, Ga, Ge, Se, Sn, Nd, Ag, Cd, Sn, Sb, Cs, Pd L-series: Y, Ba, La, Ce, Pr, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Hf, Ta, W, Re, Os, Ir, Pt, Au, Hg, Tl, Pb, Bi, Th, Pa, Te, I, U
C002	K-series: S, Cl, Ar, K, Ca L-series: Ru, Rh, Pd, Ag, Cd, In, Sn, Sb, Te, I, Cs, Mo
PET	K-series: Si, P L-series: Zr, Nb
KAP	K-series: Na, Mg, Al, Si

In our work to determine impurities of PV-panes polymeric waste we used LiF200 and C002 crystals.

2.2 The chemotactic biotesting method

A biotest analysis was chosen as a method for determining the toxicity degree of polymeric materials, as the one of the main methods for detecting environmental toxicity using test objects that shows danger, regardless of which substances and in what combinations changes in vital functions were caused test - organisms. [8].

For biotestesting we can use different test objects. In this study, Paramecium caudatum was chosen as a test object because are very close to higher animals and humans, which makes it possible to extrapolate data obtained in biotesting using ciliates per person [9-11].

The method for determining the toxicity of samples is based on the ability of test objects to respond to the presence of substances that are dangerous for their life activity in samples and to move directionally along the concentration gradient (in the direction of changing concentrations) of these substances (chemotactic reaction), avoiding their harmful effects [11].

If the test sample does not contain toxic substances, in the cuvette there will be a concentration of ciliates in the upper zone. The presence of toxic substances in the test sample leads to a different character of the redistribution of ciliates in the cuvette, namely: the higher the toxicity of the sample, the smaller the proportion of ciliates moves to the upper zone (the test sample). The biotest chemotactic technique is presented in Figure 1 [12].

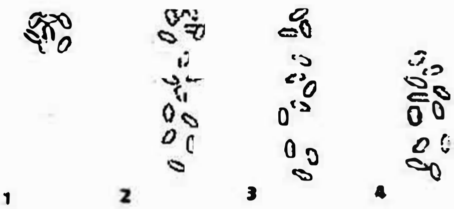

Fig. 1. Biotest chemotactic technique: 1 - harmless sample; 2,3 - a sample of moderate toxicity; 4 - toxic test.

The toxic effect is a significant difference in the number of ciliates cells observed in the upper zone of the cuvette in the sample containing no toxic substances (control), compared with this indicator observed in the test sample (experiment).

A quantitative assessment of the test - reaction parameter characterizing the toxic effect is made by calculating the ratio of the number of ciliates cells observed in the control and the studied samples, and is expressed as a dimensionless quantity - the toxicity index (T) [13].

3 Research

To determine the chemical composition of impurities of the solar panel components and its effect on the toxicity level of components sample preparation was carried out by the method of mechanical separation of the polycrystalline solar panels components. Disassembly includes the separation of the aluminum frame, cables, rear part and connection box of the PV sandwich panel, which is composed of polymers, semiconductor and glass. For disassembly, electric tools, heat guns, general-purpose tools (screwdrivers, cutters, mallets, etc.) and personal protective equipment (gloves, masks, protective visor for electric grinder and protective glasses) were used.

Fig. 2. Samples of waste polymer components EVA and Tedlar® of polycrystalline solar panels.

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3.1 Determination of impurities of waste polymer components EVA and Tedlar

In the work, analysis of the chemical composition of impurities was carried out in accordance with Qualitative Analysis Guide by Company "NPO" SPECTRON "(2017) [14].

The obtained samples (weighing 10 grams each) were analyzed on an X-ray fluorescence spectrometer SPECTROSKAN MAX using LiF200 and C002 crystals.

The results are presented in fig. 3 and 4.

Fig. 3. Determination of impurties of waste polymer components EVA and Tedlar® of polycrystalline solar panels. Crystal LiF200 (green line is a control).

Fig. 4. Determination of impurities of waste polymer components EVA and Tedlar® of polycrystalline solar panels. Crystal C002 (green line is a control).

As can be seen from the spectrograms, polymer samples taken from the waste of solar panels contain impurities of Ti, Ca, Ag, Pd, As, Cl, S, Pb, Zn Cu, Ni, Fe. The last five elements are heavy metals.

According to GOST 17.4.1.02-83 for pollution control, 3 hazard classes of heavy metals and metalloids were identified: high-, moderate and low-hazard but most of the elements have not yet been assigned a hazard class [15].

Table 2. Hazard degree of heavy metals and metalloids.

Danger degree	Elements
High	As, Cd, Hg, Se, Pb, Zn
Moderate	Co, Ni, Mo, Cu, Cr, Sb
Small	Ba, V, W, Mn, Sr
Unknown	Ge, Sn, Ce, La, Bi, V, Rb, Cs, etc.

In accordance with the above regulatory document, at least 5 elements have moderate and high toxicity classes.

3.2 Determination of the toxicity index of the test samples

To study the degree of toxicity of EVA and Tedlar® polymers, obtained samples (weighing 2 grams each) of the studied components were mixed with distilled water (volume 50 ml), after which the resulting solution was mixed for several hours on the apparatus for shaking the liquid.

The concentration of ciliates in the cuvette was measured using the BIOTESTER 2M instrument, developed at the Department of Environmental Engineering at St. Petersburg Electrotechnical University "LETI". The device is intended to measure the spectral transmittance caused by moving microorganisms. The principle of operation is based on the natural features of ciliates moving up. (If the medium is not toxic, then a large number of individuals will emerge; if there is a toxicant, so the more the substance is toxic, then the smaller the number of ciliates will come up). Each of the test samples was analyzed in 3 cuvettes, 10 readings of the BIOTESTER-2M instrument were taken from each cuvette.

According to ERD F 16.3.16-10, to prevent gross errors during the analysis, the acceptability of the control sample was promptly evaluated according to the following inequality:

$$|Ik_{max} - Ik_{min}| \leq 0,2I_{av.k} \quad (1)$$

where Ik_{max} - maximum readings of the device for control samples, Ik_{min} - minimum readings of the device for control samples, $I_{av.k}$ - average readings of the device for control samples [16-19].

Assessment of the toxicity of the sample was carried out by the relative difference in the number of ciliates in the upper zone of the cuvette in the control and analyzed sample. In accordance with PND F T 16.3.16-10 the toxicity index is calculated by the formula:

$$T = \frac{|I_{av.c} - I_{av.s}|}{I_{av.c}} * K, \quad (2)$$

where $I_{av.c}$ – average readings of the device for control samples, $I_{av.s.}$ – average readings for the test samples, K – coefficient of dilution of the sample (factor).

The toxicity index T is a dimensionless quantity and can take values from 0 to 1 in accordance with the degree of toxicity of the analyzed sample.

According to ERD F 16.3.16-10, depending on the value of the index, samples are classified according to their toxicity into 3 groups:

I. Acceptable toxicity (0.00 <T ≤ 0.40).

II. Moderate toxicity (0.40 <T ≤ 0.70).

III. High degree of toxicity (T> 0.70).

When the toxicity index takes a value close to 1, then such a study cannot unambiguously characterize the true level of toxicity of the sample. Then, the test sample should be diluted with distilled water or Lozin-Lozinsky medium so that the value of T does not reach 1, and the resulting new index value is smart for the dilution coefficient. The sample is considered non-toxic, under the condition T ≤ 0.40 [16,20].

[17] Russian National Standard, Water, Determination of toxicity by survival of freshwater ciliates Paramecium caudatum Ehrenberg, 57166-2016 (2016)
[18] Guidelines for the application of bioassay methods to assess the quality of water in drinking water supply systems, MR No. TsOS PV R 005-95
[19] ERD F 16.3.12-07, The methodology for determining the toxicity of ash and slag waste by biotesting based on the survival of paramecium and ceriodaphnia, Federal number FR.1.39.2007.04104, soil science faculty of Moscow State University and OJSC All-Russian Thermotechnical Institute
[20] ERD F 14.1:2:3.13-06, ERD F 16.1:2.3:3.10-06, Methodology for determining the toxicity of wastes, soils, sewage, surface and groundwater sediments by biotesting using equidimensional ciliates Paramecium caudatum Erenberg, Federal number FR.1.39.2006.02506, LETAP, Moscow State University

From Denise Miller

Hazardous constituents in PV modules

- Lead
- Cadmium
- Chromium
- Antimony
- Gallium
- Selenium
- Tellurium
- Other metals

Test Methods

FEDERAL	CALIFORNIA
• Toxicity Characteristic Leaching Procedure (TCLP)	• Total Threshold Limit Concentrations (TTLC) • Waste Extraction Test (WET) - Soluble Threshold Limit Concentrations (STLC)

Toxic Chemicals in Solar Panels

The toxic chemicals in solar panels include cadmium telluride, copper indium selenide, cadmium gallium (di)selenide, copper indium gallium (di)selenide, hexafluoroethane, lead, and polyvinyl fluoride. Additionally, silicon tetrachloride, a byproduct of producing crystalline silicon, is highly toxic. Sciencing.com - Apr 30, 2018

Cadmium Telluride

Cadmium telluride (CT) is a highly toxic chemical that is part of solar panels. In the journal, "Progress in Photovoltaics," it reported that male and female rats that received CT through ingestion did not gain weight as they normally should have. This lack of weight gain occurred at low, moderate and high doses. When inhaled, CT also prevented normal weight gain and caused lung inflammation and lung fibrosis, a hardening of lung tissue. From low to high doses of inhaled CT, the weight of the lungs increased. Moderate to high doses of inhaled CT proved lethal.

Copper Indium Selenide

The study of rats in "Progress in Photovoltaics" showed that ingestion of moderate to high doses of copper indium selenide (CIS) prevented weight gain in females but not males. Moderate to high doses of inhaled CIS increased the weight of a rat's lungs and increased lung fibrosis. Lungs exposed to CIS produced high amounts of fluid. Another study of CIS on rats, reported in "Toxicology and Applied Pharmacology," revealed that inhaling CIS caused rats to develop abnormal growths in their lungs.

Cadmium Indium Gallium (Di)selenide

Cadmium indium gallium (di)selenide (CIGS) is another chemical in solar panels that is toxic to lungs. The "Journal of Occupational Health" reported a study in which rats received doses of CIGS injected into the airway. Rats received CIGS three times a week for one week, and then researchers examined lung tissue until three weeks after that. The scientists used a low, moderate and high dose of CIGS. All doses resulted in lungs that had spots that were inflamed, meaning they were damaged. Lungs also had spots that produced excessive fluid. These spots worsened as time went on after the one week of exposure.

Silicon Tetrachloride

One of the toxic chemicals involved with solar panels is not what's in the panels but is a byproduct of their production. Crystalline silicon is a key component of many solar panels. The production of crystalline silicon involves a byproduct called silicon tetrachloride. Silicon tetrachloride is highly toxic, killing plants and animals. Such environmental pollutants, which harm people, are a major problem for people in China and other countries. Those countries mass-produce "clean energy" solar panels but do not regulate how toxic waste is dumped into the environment. The country's inhabitants often pay the price.

Lead

Exposure to high levels of lead may cause anemia, weakness, and kidney and brain damage. Very high lead exposure can cause death. Lead can cross the placental barrier, which means pregnant women who are exposed to lead also expose their unborn child. Lead can damage a developing baby's nervous system.

From Denise Miller

Hardin County Tornado History

History of Tornado Activity in Hardin County

March 29, 1974, F2
April 3, 1974, F4
October 1, 1977, F2
March 12, 1986, F1
July 11, 1986, F1
May 14, 1995, F1, 3 tornados
May 18, 1995, F2
March 28, 1997, F1
April 28, 2002, F1
May 11, 2003, F2
January 2, 2006, F2
February 6, 2008, F2, 2 tornados
May 21, 2010, F1
April 26, 2011, F1, 2 tornados
February 29, 2012, F2
October 31, 2018, F 1

From Denise L. Miller

#1

Considerations For Future Utility Scale Solar Farm Developments

Important Facts

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September 2020

College of Agriculture,
Food and Environment

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September 2020

An effort to rely on renewable resources instead of nonrenewable has the potential to meet the increased global demand for electricity. Both solar and wind energy have the potential to offset a significant fraction of non-renewable electricity demands, yet it occupies extensive land when deployed at levels large enough to meet global demand. With continuing cost declines, led by federal and state incentives, solar power is playing an increasingly important role in how states meet their energy needs. There is growing concern that large renewable energy installations will displace other land uses. This brief explores the considerations for individual farmers, communities, and local leaders before any final decisions are made and/or contracts signed.

Figure 1 (next page) highlights the expected demand in new solar utility-scale installations. Each year, this forecast for increased capacity roughly translates into a minimum of 134,000 acres of land.[1] Robert van der Horst (2019) explored the impacts after grassland and partial cropland in the Netherlands dedicated to grain & starch farming were converted into solar farming land.[2] He found that if 1% of the Dutch agricultural land area was dedicated to solar farming, land and food prices only deviated by 0.5%. However, when significant larger tracks of agricultural land were dedicated to solar energy production, sparing potential of solar energy development across four nonconventional land cover types: the built environment, salt-affected land, contaminated land, and water reservoirs (as floatovoltaics), within the Great Central Valley in California, a globally significant agricultural region where there is significant competition between land for food production, urban development, and conservation. Their study reveals that this area could accommodate solar energy development on nonconventional surfaces in ways that may preclude loss of farmland and nearby natural habitats that also support agricultural activities by enhancing pollinator services (e.g., wild bees) and crop yields. In addition, a recent article highlighted potential renewable energy sites including abandoned mine lands, brownfields, superfund sites, etc.[3]

Land is more valuable if building a solar farm is less expensive to construct. Ideally, land would be: flat (less than 5 degrees of slope; more is acceptable if it slopes to the south), clear of trees, structures or other obstacles, free of ponds, streams, creeks, etc., and bordered by a road that will provide easy access to construction crews.[4] These conditions are typically found on prime agricultural farm land.

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[1] Simple rule of thumb is that 1MW solar power should require about 7.9 acres. Depending on the specific technology, a utility-scale solar power plant may require between 5 and 10 acres per megawatt (MW) of generating capacity. Source:

[2] Robert R. van der Horst, "Solar Farms on Agricultural Land: a Partial Equilibrium Analysis." MSC Thesis, Wageningen University and Research, September 25, 2019.

[3]

[4]

The protection of prime soils and prime farmland should be prioritized. Other farmland and marginal farmland should be pursued for standard ground-mounted solar array, dual-use should also be considered, if possible (AFT, 2020).[5] If solar projects are still proposed on prime soils, they should be agricultural dual-use projects, ensuring continued production is prioritized. Dual-use projects will be a challenge for lands that have been used for crop and livestock production but would be better suited for small animal grazing, i.e. sheep (but not goats).

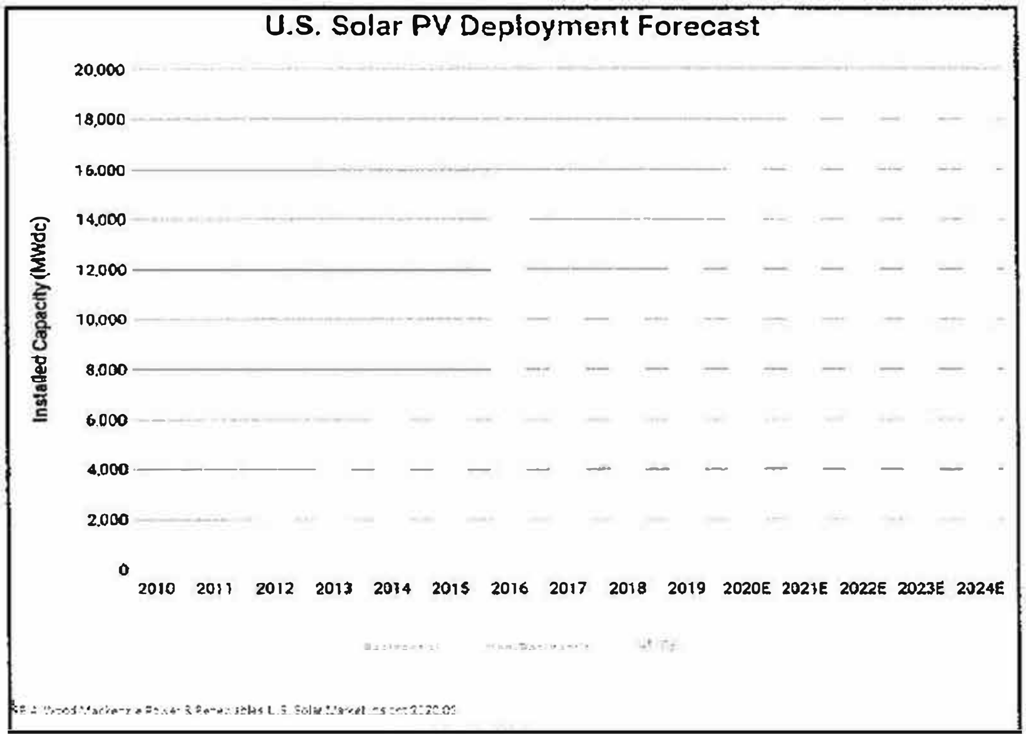

Figure 1. U.S. Photovoltaic Installation Forecast, 2010-2024

There are federal and often times state incentives that make solar farming technology economically feasible. However if these incentives disappear and/or the technology changes that impacts the cost effectiveness of existing solar arrays, what impacts would this have on the existing lease and the potential abandonment of the farm? Solar farms left idle will decrease the land values of both the solar farm as well as nearby property values. It is essential that the contract is reviewed by legal experts. In the state of Ohio, solar developers must post a bond to pay for decommissioning if the company ceases operations or goes bankrupt.

Currently, most solar operators include a decommissioning plan, however those plans vary by developer and might not provide the degree of protection that will ensure land is restored back to its prior use. Panels only have an expected life span of 20-25 years. PV panels are made of

[5] Solar Siting Guidelines for Farmland, American Farmland Trust New England, Northampton, MA: American Farmland Trust, January 2020.

mostly recyclable materials, including glass and aluminum, making it possible to recover and reuse the materials after the panel's life. Only recently, have there been efforts to identify mechanisms for recycling the panels to manage solar PV waste and end-of-life disposal of the panels. Make sure that the solar company has a viable decommissioning plan that spells out the terms of disposal, land grading, restoring soil quality (particularly if concrete is used in construction) and restoration of the site to its original condition. Because of these known issues, ensure developers include a comprehensive decommissioning plan, based on the actual construction of the site, as well as requiring developers to post a bond to make sure they are still around at decommissioning time. During the lease negotiation, it is important to clearly articulate who will be responsible for large financial liabilities, including real estate taxes, landowner insurance premiums, and other expenses associated with the property.

Table 1. 2018 Cash Rents in Kentucky

Sub-Region	Cropland (Good/Fair)	Tobacco (With Barn/ Without Barn)	Hay (Improved/ Non-Improved)	Pasture (Improved/ Non-Improved)
Far West	$170/130	$410/250	$45/25	$55/25
Mid West	$210/150	$510/310	$55/35	$45/30
Near West	$160/110	$300/230	$50/35	$50/30
South Central	$180/130	$270/200	$50/30	$40/25
Bluegrass	$130/90	$400/290	$50/30	$45/25
North Central	$140/100	$350/220	$65/40	$45/25
North East	$140/100	$370/230	$50/35	$35/25
South East	$60/40	$100/50	$50/30	$35/25

Per acre per year value based on 2018 survey of Agriculture and Natural Resource County Extension Agents Total of 70 completed surveys.

Source:

Currently, solar farms are leasing land at prices ranging from $400 to $1,200 an acre. These lease rents are higher than the current cash rents Kentucky farmers are receiving for cropland and tobacco (Table 1). In the short-run there are financial benefits, particularly for older farmers who are battling a downturn in the agricultural economy. It is important to make decisions with the long term in mind. How does the present value of the lease payment offered by the developer compare to the expected long-term return if the land was in production? Agriculture, much like the national economy, has times of both expansion and recession, and this current downturn is not expected to be permanent. In addition, as rents rise because of the increased demand for land, other farmers will have a difficult time paying higher prices to farm the land. Loss in land will eventually result in the loss of local businesses who supply seed, fertilizer, and chemical dealers, hardware and lumber suppliers, equipment manufacturers and others. A long-term concern is after the solar lease agreements, will farmers be able to afford to put the land back into production? Those farmers who do end up leasing their land for solar development should have a farm transition plan in place prior to conversion. If a farmer chooses to only lease part of their land, it is important to recognize that farming depends on size of scale to make a profit. As a farmer scales down, it will become more and more difficult to remain in the farming business.

The figure below highlights that there are job impacts from the installation of solar systems, which are considered short-term employment impacts as these workers will move from site-to-site. The other employment impacts occur in manufacturing of the panels and trade and distribution, which currently do not exist within the state of Kentucky. Currently, a significant share of the electricity generated through these proposed solar farms are slated to be distributed to areas with higher populations, so Kentuckians might not benefit from or utilize the generated electricity. It is important to note that compared to other industries, the long-term revenues and job impact are negligible. For example, Topaz Solar Farm (5,000 acres) is located in San Luis Obispo. PG&E (Pacific Gas and Electric) buys the power from Topaz. There are zero solar-based utility revenues in San Luis Obispo County. All revenues and jobs are provided to San Francisco where PG&E is headquartered.

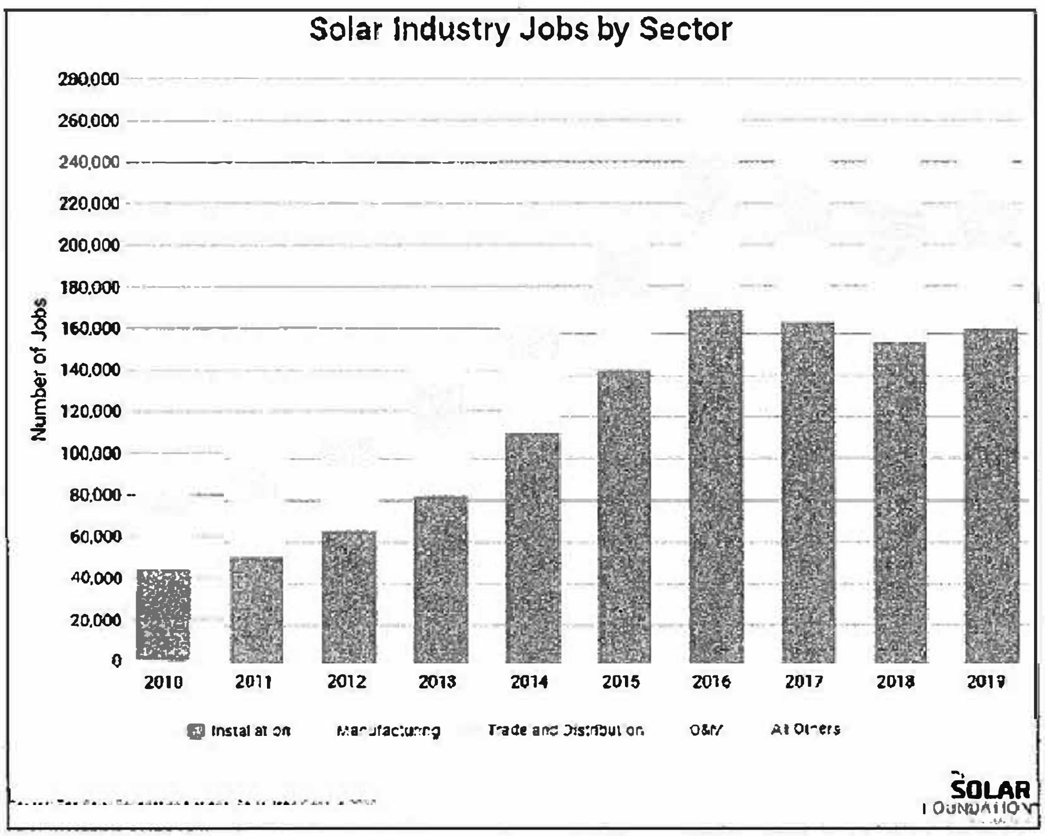

Figure 2. Solar Industry Employment

Source:

KRS 132.450 requires that agricultural or horticultural land be assessed at use value based on its income-producing ability and comparable sales of farm-land, rather than its fair market value for development. Agricultural land is defined as any tract of 10 acres or more used for the production of crops, livestock, tobacco or timber, any tract of five acres or more used for commercial aquaculture, or any tract meeting the requirements for payments for a participation in an agricultural program based on a contract with the state or federal government. Horticultural land is any tract of five or more acres used for the commercial cultivation of a garden or orchard, or for raising fruits, nuts, vegetables, flowers or ornamental plants. This statute was designed to be a leveling field for agriculture. When the land is converted to other purposes including other special use agriculture, residential, commercial, or industrial, there will be likely be an increase in tax revenues generated for the local community. In the long-term, when the lease ends, if the land is not usable for any other purpose or is abandoned, then the tax revenues could be reduced to zero.

Because solar panels capture 20% of the light for about 5 hours of the day, the rest of that solar energy will pass through to the ground. As a result grasses, broadleaf weeds, and eventually woody shrubs will grow. There are three ways that solar farms can address this potentially unwanted vegetation: herbicides, mowing, ground cover, or a combination of all three. It's likely that a non-trivial amount of herbicide will need to be used to minimize weeds. In addition, landowners will still need to maintain equipment to remove unwanted vegetation or soil, grade roads or paths, mowing etc. Ongoing weed, shrub, and small tree maintenance is needed.

> *"High rates of herbicides, frequent mowing, and the use of mulches, rock, or plastic will all have negative impacts on the land from herbicide residues, soil compaction and erosion, and particles of damaged panels left in the soil resulting in contamination from heavy metals and rare earth elements used in solar panels. Remember, you still own this land and you will be held responsible for water runoff, cleanup, and off-site effects and the eventual need to replace fertility lost."*
>
> – Ron Heiniger, NCSU Professor and Extension Specialist

Solar can be installed in flood plains, but all electrical equipment will have to be installed above the projected level of flooding. Raising equipment could increase the cost of installation and may negatively impact the project economics. Also, the cost of insurance will be higher for PV systems in a flooding area. An area that will not be flooded may be better suited for PV installation.

In 2018, researchers at the Department of Energy's Argonne National Laboratory found that stable pollinator populations facilitated by pollinator-friendly solar farms allowed nearby agricultural land to be pollinated and, ultimately, boosted crop yields. Planting pollinator-friendly vegetation in solar farms provides multiple ecological and economic benefits to stakeholders. Using native plants as ground cover can help recharge groundwater, reduce erosion, and improve soil carbon sequestration.[6] Minnesota was the first to pass state legislation designating "pollinator friendly" sites as means to incentivize practices to minimize a utility's ecological footprint. These practices include: (1) provide native perennial vegetation and foraging habitat beneficial to gamebirds, songbirds, and pollinators, and (2) reduce storm water runoff and erosion at the solar generation site. To the extent practicable, when establishing perennial vegetation and beneficial foraging habitat, a solar site owner shall use native plant species and seed mixes. Illinois, New York, Maryland, Vermont, and South Carolina have passed similar pollinator-friendly legislation.

There are mixed results evaluating the impact of solar farming on wildlife. In California, environmental reports underestimated the number of desert tortoises that would be displaced by the Ivanpah Solar Generating System in California's Mojave Desert. In addition, at the same solar farm, there were an increasing number of bird deaths, due to the heat, were reported on its premises.[7] Much of the problem appears to lie in the "lake effect," in which birds and their insect prey can mistake a reflective solar facility for a water body, or spot water ponds at the site, then hone in on it. Because of the power of the lake effect, the federal investigators described such solar farms as "mega-traps" in their report.[8] While it's safe for animals to graze near the solar panels, there is a risk for injury if wires are chewed on. Larger animals, such as cattle, could do harm to the system, as could goats. Sheep and chickens are possible if the panels are lifted 4 feet off the ground.

Kentucky is not yet a significant player in utility-scale solar farming. Currently, Kentucky is ranked 40th as measured by the number of annual new installations. California and the other Southwestern states, and even the state of New York have been dealing with solar farming for several more years and only recently has been a surge in interest in Kentucky (Figure 3 next page). The topic is one of significant national, state, and local interest particularly since so many of the affected counties didn't have any plans in place to address this new competition for land. In an effort to allow time for careful planning, dozens of communities across the country have imposed 6- and 12-month moratoriums on new large-scale solar projects. For example: Porter, NY, Riverhead NY, La Sueur County, MN, San Bernardino County, CA, Marshall County, IN, Duanesburg, NY and Northampton County, NC have all recently voted to impose short-term moratoriums.

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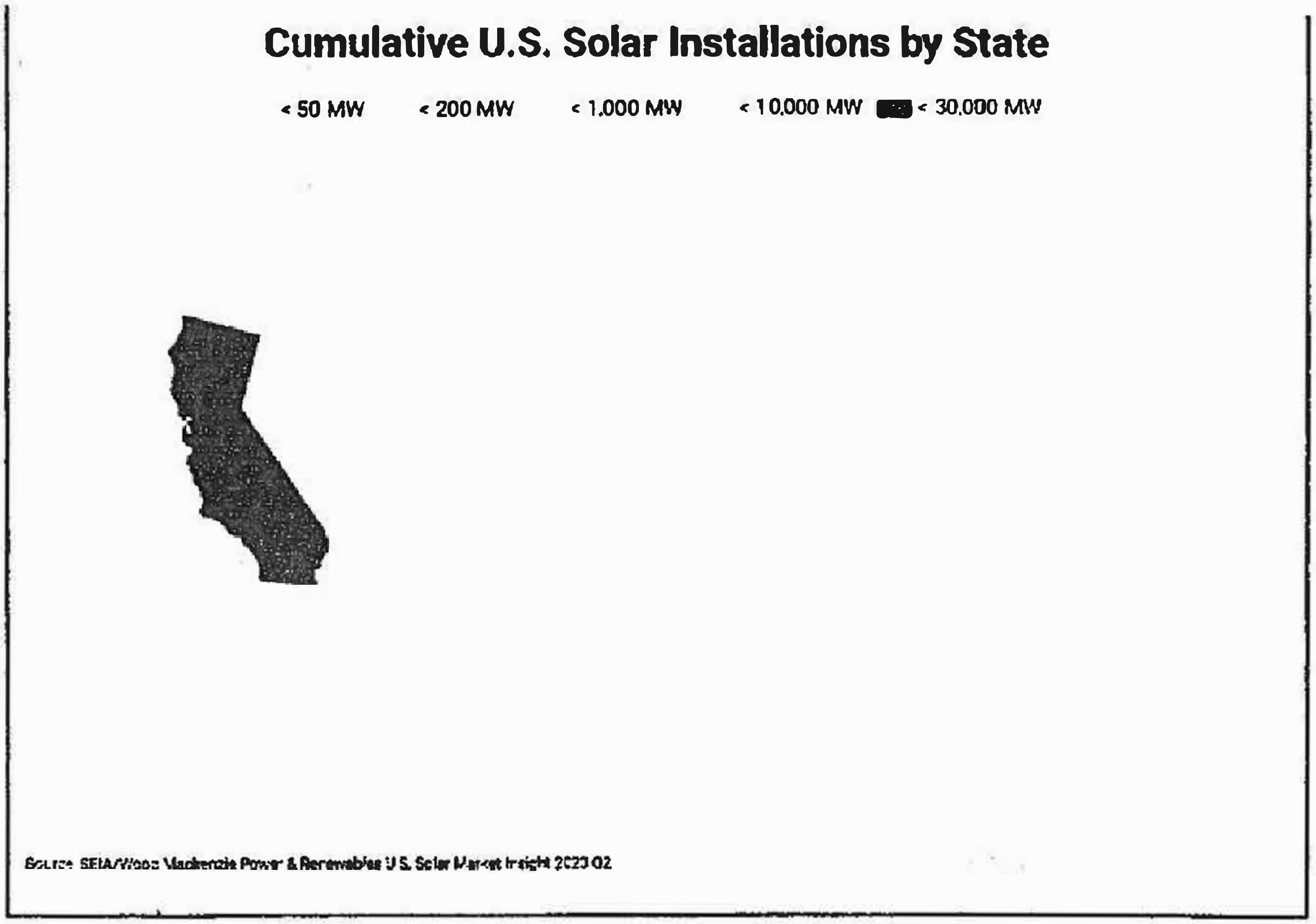

Figure 3. Solar Installations by State, 2020

The large-scale solar farming trend is not unique to the United States. In England, farmers have lost their right to claim subsidies for fields filled with solar panels under recent plans (2015) to ensure more agricultural land is dedicated to growing crops and food. Britain has some of the most productive farmland in the world and British leaders passed this law to incentivize land dedicated for agriculture production to boost the food and farming industry.

The local community should proactively adopt policies within its planning and zoning ordinances. The policies should complement the community's existing comprehensive plan. It is important to not make fragmented decisions and instead identify areas of the community, if any, best suited for utility-scale development. The community should also clearly articulate its values and priorities to ensure all contracts meet the minimum standards.

Stakeholder engagement is a key component of large-scale solar development. The majority of the proposed projects will require a zoning change which means the community will have an opportunity to voice their concerns in a public setting. The more community leadership and developers understands local values and policies, the easier it will be to develop a project that is acceptable to the community. Utility-scale solar projects frequently require local approval and permits. Recent conflicts have arisen after contracts have already been negotiated between the developer and land owner and the community is unaware. Providing advanced public notice of planned activities pertaining to the solar project and engaging with stakeholders will allow developers to address local concerns as early as possible.

Consider requiring an environmental assessment before approving contracts. Solar farm development must comply with federal and state environmental laws. If federal funding is at all involved in the development of the solar farm, then an environmental assessment is typically required and paid for by the developer.

From Denise Miller

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Sciencing.com/toxic-chemicals-solar-panels-18393.html

By David H. Nguyan PhD, Tumor Biologist. Cancer Biology B.A. U. of California, Berkely, currently Visiting Schlor in the Dept. of Radiology at Stanford University

Toxic materials are a problem in solar panels, during their construction, transportation, damage, and at the end of their life.

These toxic chemicals are cadmium telluride, copper indium selenide, cadmium gallium (di) selenide, copper indium gallium (di) selenide, hexafluroethane, lead, and polyvinyl fluride. Additionally silicon tetrachloride, a byproduct of producing crystalline silicon is highly toxic.

From "Considerations For Future Utility Scale Solar Farm Developments"
Dept. of Agricultural Economicex. U of K. Sept. 2020
By Allison F. Davis PhD on Line

Large Scale Solar Projects should not be built on Prime farmland, but rather marginal land.
"Particles of damaged panels will fall to soil creating contamination from heavy metals and rare earth elements used in solar panels"
"Birds do crash into panels thinking they are water causing some of the panels to be damage.

The Argonne Lab in Illinois was awarded a 1.3 million dollar contract to find out why so many birds die on solar panels. Duke Energy: 140,000 birds die each year on solar panels google.com.acc/amp/s/www.nyti