PLEASE REVIEW Immediately for CASE # 2025-00177

To the Members of the Siting Board,

We are submitting this letter along with the enclosed documentation on behalf of a large group of residents, landowners, and community members directly impacted by the proposed solar facility in Wayne County.

This submission is not made lightly. It represents the voices, concerns, and lived realties of families who have built their lives in this community and now find themselves facing a project that was advanced without proper transparency or meaningful public awareness.

What is included in this packet:

- Documentation outlining the Siting Board process and public participation expectations
- Evidence showing lack of adequate notification to affected residents
- Supporting materials related to environmental oversight and permitting gaps
- Scientific literature regarding potential leaching and long-term environmental concerns
- Community observations and written concerns, including proximity, glare, and quality-of-life impacts
- Notes and firsthand accounts from public interactions and meetings

Failure of Public Notification

The materials included raise serious concerns regarding whether the public was properly notified as intended under the spirit of the process. Many directly affected residents were unaware of this project until late in the timeline. For a project this scale, impacting homes, roadways, and long-established community spaces, this lack of awareness is not a minor oversight – it undermines public trust and participation.

The Siting Board process itself emphasizes public involvement. That cannot occur if the public is not meaningfully informed.

Community Impact and Visual/Glare Concerns

While the solar facility has not yet been constructed, the applicant's own study identifies multiple locations where significant glare impact is expected. Specifically, three separate locations have been noted where a yellow glare may directly affect nearby homes and surrounding properties.

This is not speculation from the community – it is based on the projects submitted analysis.

The anticipated glare, often described as a yellow or intense reflective light, raises serious concerns about:

- Disruption to daily life and outdoor use of property
- Interference with visibility and surrounding landscape
- Long-term impact on mental well-being and quality of life

Residents in this area have spent years, and in many cases generations, building their lives in a quiet, rural environment centered around Lake Cumberland. The introduction of persistent reflective glare in close proximity to homes represents a fundamental change to that environment.

Once implemented, these impacts cannot easily be reversed.

Responsibility of the Citing Board

As outlined in your own materials, the role of the Siting Board is not only to review applications but to consider the broader impacts on communities, including visual effects, environmental concerns, and the voices of those affected.

We are here to ensure those voices are heard.

This submission represents not just individual opinions, but a collective concern from neighbors who feel overlooked in a process that should have included them from the beginning.

Position of the Community

The overwhelming sentiment from the residents we represent is clear:

This project, as proposed, is not supported by the community it will directly impact.

The concerns are not rooted in opposition to progress, but in the manner in which this project has been introduced, the proximity to homes and community spaces, and the long-term effects it may have on both environment and well=being.

Closing

We respectfully ask that the Board give full and careful consideration to the enclosed materials and the concerns raised within them. The decisions made here will have lasting consequences for families, land, and a community that has long called this place home.

We trust that this process will reflect not only regulatory compliance, but fairness, transparency, and genuine consideration of the people most affected.

This submission represents a unified voice from residents who are asking to be seen, to be heard, and to be fully considered before decisions that cannot be undone.

Thank you for your time and consideration.

Respectfully submitted,

Concerned residents of Wayne County

APPENDIX L
SOLAR GLARE HAZARD ANALYSIS

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Seville Solar Farm Complex: Solar Glare Hazard Analysis

Date: November 20, 2014
To: Dwight Carey
From: Josh Proudfoot, Aaron Toneys and Justin Overdevest

Key Findings

- **Fixed-tilt photovoltaic (PV)** arrays *do present glare issues to the residences due west of the project site* for short intervals (15-30 minutes) of potential after-image glare at sunrise in non-winter months (mid-March through October). The arrays *do not* present glare issues to other surrounding ground-level observation points.
- **Horizontal Single-axis tracking PV arrays** *do not* present glare issues to surrounding ground-level observation points.
- **Dual-axis tracking concentrated PV (CPV) arrays** *do not* present glare issues to surrounding ground-level observation points.

Project Description

Environmental Management Associates (EMA) contracted with Good Company to evaluate the potential for glare from the proposed Seville Solar Farm Complex to surrounding ground-level observation points. The observation points assessed include roads, residences and the Ocotillo Wells State Vehicular Recreation Area.

The proposed Seville Solar Farm Complex, if built, would be a ground-mounted photovoltaic (PV) array with a total capacity of approximately 135 MW. The final design and specifications for the PV array has not been selected as of this writing, but three design alternatives are being considered.

- Fixed-tilt PV array
- Horizontal single-axis tracking PV array that partially tracks the path of the sun from east to west
- Dual-axis tracking concentrated PV array that tracks and directly faces the sun at all times

The 1,181-acre site for the proposed Seville Solar Farm Complex is located on the 2,440-acre Allegretti Farms property in west-central Imperial County, California, approximately 8 miles west of the junction of State Highway 78 and State Highway 86, and approximately 3 miles east of the San Diego County line. The elevation of the site is at its highest in the northwest corner and slopes downward to the southeast by roughly 35 feet.

Methodology

The purpose of a glare analysis is to assess the potential impact of glare from PV modules and other components as a potential hazard or distraction for motorists and nearby residents. Glare is a common phenomenon that originates from the reflection of a light source (usually the sun) off any reflective service (e.g., windows, chrome automobile bumpers, water, solar panels, etc.).

The methodology for the analysis consists of 2 parts: 1) identifying the observational points of concern around the project site, and 2) conducting the calculations necessary to determine if the observational points of concern intersect with the angles of light reflection, resulting in glare.

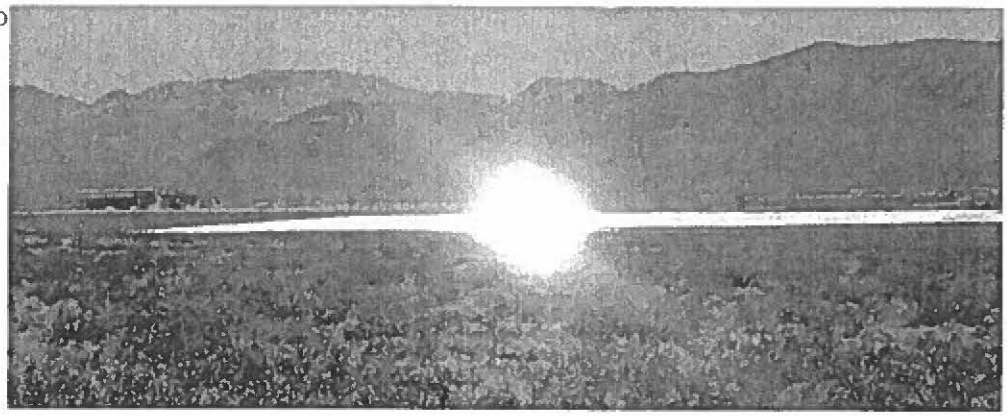
The points of concern for this glare analysis were identified through information provided by EMA and through the use of Google Earth and Google Maps. EMA identified the *Ocotillo Wells State Vehicular Recreation Area* as a site of particular concern. A radius of ~11 miles around the project site was reviewed for major traffic corridors, residential and commercial structures. The points identified are described in the *Analysis* section of this report in Figure 3.

Relieving a Glaring Problem

Proper design and siting of solar energy installations is probably the most effective way to mitigate potentially hazardous glare.

By CLIFFORD K. HO

April 20, 2013



With growing numbers of solar energy installations around the world, solar glare is becoming an increasing concern. Impacts of glare, whether from photovoltaic (PV) or concentrating solar power installations, can range from discomfort to disability.

solar glare seen from air traffic control Manchester-Boston regional airport

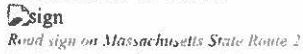
Glare viewed from the air traffic control tower at Manchester-Boston Regional Airport that impacted

In 2012, CNN and local media reported that modules in a $3.5 million PV array on a parking garage at the Manchester-Boston Regional Airport had to be covered to alleviate glare to air-traffic controllers in the nearby control tower [1].

controllers. Rows of PV panels, installed at a cost of $3.5 million, had to be covered with tarp. Photo courtesy of: Stephen B Barrett

Options for mitigating these effects range from anti-reflective coatings and glass texturing for PV modules to blinds and screens, in certain situations. Perhaps the most effective method is through proper design and siting of the solar energy system, with consideration of its size, orientation, optical properties and location relative to key observation points. To assist with proper design and siting systems, solar developers have a few models and tools they can tap to evaluate the potential glare and ocular hazards [2, 3, 4].

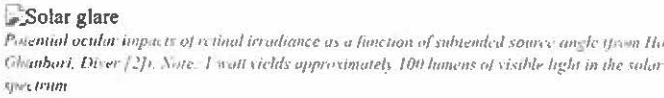
The Effects of Glare



Road sign on Massachusetts State Route 2 heading eastbound, warning of dangerous solar glare in the mornings.

Glare from direct sunlight has been recognized for many years as a potential hazard for motorists and pilots [5-7]. Reports citing National Highway Traffic Safety Administration data estimate that solar glare causes nearly 200 fatalities and thousands of accidents involving motor vehicles each year, and the Federal Aviation Administration (FAA) reported that glare from direct sunlight contributed to nearly a dozen aviation accidents on average each year during an 11-year study [7].

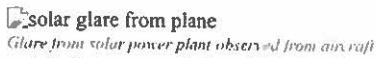
While glare from direct sunlight is predictable — most problems occur during the mornings and evenings when the sun is close to the horizon — solar glare caused by reflections from solar energy installations can occur at varying times in unexpected locations. Glint (a momentary flash of light) and glare (a more continuous source of excessive brightness relative to the ambient lighting) can occur from various solar energy components such as PV modules, concentrating solar collectors/ mirrors and receivers.



Potential ocular impacts of retinal irradiance as a function of subtended source angle (from Ho, Ghanbari, Diver [2]). Note: 1 watt yields approximately 100 lumens of visible light in the solar spectrum

Because of these risks, codes and regulations seek to prevent unwanted glare from solar energy installations [8]. In addition, the FAA recently announced that it will disallow any new solar installations near airports without a quantitative glare analysis, including an assessment of visual impacts.

Impacts of glint and glare on eyesight can include discomfort, disability, veiling effects, after-image and retinal burn [2, 5, 9-13]. Prolonged exposure to "discomfort glare" may lead to headaches and other physiological impacts, whereas "disability glare" immediately reduces visual performance. Disability glare can include after-image effects, flash blindness and veiling, such as that caused by solar glare on a windshield that might mask pedestrians or vehicles.



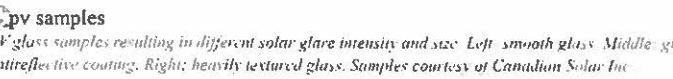
Glare from solar power plant observed from aircraft cockpit. Photo courtesy Air Force Flight Test Center 412 TW at Edwards AFB

For the purposes of evaluating glint and glare from solar energy systems, colleagues and I [2] summarized the potential impacts to eyesight as a function of retinal irradiance (the solar flux entering the eye and reaching the retina) and subtended source angle (size of glare source divided by distance). The figure above shows the resulting "Ocular Hazard Plot" with three regions: (1) potential for permanent eye damage (retinal burn), (2) potential for temporary after-image, and (3) low potential for temporary after-image.

If the retinal irradiance or subtended angle is sufficiently large, permanent eye damage from retinal burn may occur (e.g., from concentrating mirrors). Below the retinal burn threshold, a region exists where a sufficiently high retinal irradiance may cause a temporary after-image, which is caused by bleaching (oversaturation) of the retinal visual pigments. The size and impact of the after-image in the field of view depends on the size of the subtended source angle. For a given retinal irradiance, smaller source angles yield smaller after-images, and the potential impact is less. Sufficiently low retinal irradiances and/or sub-tended angles of the glare source have a low potential for after-image and ocular impacts.

Factors that Impact Glare

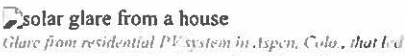
A number of factors can affect both the intensity and perceived impact of glare: direct normal irradiance (DNI), reflectance, distance, size and orientation of the reflecting surfaces, and human factors. The DNI is the amount of solar irradiance striking a surface perpendicular to the sun's rays. A typical clear sunny day may yield a DNI of ~1,000 watts per square meter at solar noon, with lower values in the mornings and evenings. The DNI provides the starting "strength" of the solar glare source, which can then be reduced by the reflectance of the PV module, mirror or receiver. The reflected light can be characterized as a combination of specular (mirror-like) and diffuse (scattered) reflections. Smooth surfaces such as mirrors and smooth glass produce more specular reflections with greater intensity and tighter beams (larger retinal irradiances and smaller subtended angles used in the figure above), while solar receivers, textured glass and anti- reflective coatings produce more diffuse reflections with lower solar intensities but greater subtended angles (see figure). The specular reflectance of mirrors can be greater than 90 percent, while the specular reflectance of PV glass can be as low 1 to 2 percent at near- normal incidence angles. However, at large (glancing) incidence angles (greater than 60 percent), the reflectance of PV glass can be 20 percent or more (even with texturing and anti-glare coatings).



PV glass samples resulting in different solar glare intensity and size. Left: smooth glass. Middle: glass with antireflective coating. Right: heavily textured glass. Samples courtesy of Canadian Solar Inc.

The distance between the observer and the glare source can impact both the retinal irradiance and subtended source angle used in the figure. Atmospheric attenuation caused by particulates or humidity in the air will reduce the retinal irradiance with increasing distance. In addition, for a fixed size of the glare source, larger distances will typically yield smaller sub-tended angles of the glare source.(1)

(1) For flat specular surfaces, the subtended angle of solar glare remains constant until the distance increases to a point that the reflected glare image overfills the available surface area.



Glare from residential PV system in Aspen, Colo., that led to new county regulations governing PV installations. Photo courtesy of Sherri Spiekerman

The size and orientation of reflective surfaces relative to the observer also impact the glare intensity and size. For example, a 3-kilowatt residential rooftop PV array will appear small relative to a 5-megawatt PV array at a given distance. The glare on the larger array can therefore grow to much larger sizes at longer distances than on the smaller array, yielding a greater potential for ocular hazards. Orientation of the array will also impact the effective viewable area, as well as the reflectance.

Finally, human factors such as ocular properties (pupil size, eye focal length, ocular transmittance) and light sensitivity will affect the retinal irradiance, subtended angle and perceived impact of the glare. Typical ocular properties for daylight adjusted eyes are provided in Ho, Ghanbari and Diver [2].

Mitigation Measures

Of the factors discussed above, those that can be controlled to mitigate the impacts of glare include reducing the specular reflectance and ensuring proper design and siting of solar energy installations. Textured glass and anti-reflective coatings can reduce the near-normal specular reflectance of PV modules to ~1 to 2 percent. The reduced reflectance and the increased scatter of the reflected beam can reduce the retinal irradiance and potential for ocular hazards.(2) However, reducing the reflectance is not always an option for some solar energy components, such as the mirrors for concentrating solar power collectors. Using screens and blinds to block glare is also possible, but it can be impractical or inconvenient for, say, air-traffic controllers needing to view the airport runways or for residents experiencing glare from a neighbor's PV system.

(2) Increased scattering increases the observable size (subtended angle) of the glare image, which increases the potential for ocular hazards. However, the reduction in glare intensity and retinal irradiance from increased scattering and a larger subtended angle has a larger-order impact on reducing the ocular hazard.

Sandia National Labs
Glare from heliostats (mirrors) and receiver at the National Solar Thermal Test Facility at Sandia National Laboratories in Albuquerque, N.M. Photo: Sandia National Laboratories

Proper siting of solar energy installations, taking into account the size of the solar energy system, distance, orientation, environmental conditions and key observation points, is perhaps the most effective way to mitigate the negative impacts of glare. Models can assist in determining the impacts of glare (retinal irradiance, subtended angle and potential ocular hazard) from a variety of solar technology components that consist of flat, curved, specular and/or diffuse surfaces [2, 3].

Sandia Labs
Photo: Sandia National Laboratories

In addition, Sandia National Laboratories has developed a web-based Solar Glare Hazard Analysis Tool (SGHAT) for PV systems that provides a quantified assessment of when and where glare will occur throughout the year, as well as potential effects on the human eye at locations where glare occurs [4].

SGHAT is free and available to the public at sandia.gov/glare.

The FAA has announced that it will disallow any new solar installations near airports without a quantitative glare analysis, including an assessment of visual impacts.

The SGHAT tool employs an interactive Google map where the user can quickly locate a site, draw an outline of the proposed PV array and specify observer locations or paths. Latitude, longitude and elevation are automatically recorded through the Google interface, providing necessary information for sun position and vector calculations. The user enters additional information regarding the orientation and tilt of the PV panels, reflectance, environment and ocular factors. If glare is found, the tool calculates the retinal irradiance and subtended angle of the glare source to predict potential ocular hazards shown in the figure. The results are presented in a plot that specifies when glare will occur throughout the year, with color codes indicating the potential ocular hazard. SGHAT also predicts relative energy production while evaluating alternative designs, layouts and locations to identify configurations that maximize energy production while mitigating the impacts of glare.

ABOUT THE AUTHOR
Clifford Ho (ckho@sandia.gov) is a distinguished member of the technical staff at Sandia National Laboratories, where he has worked since 1993 on problems involving energy, water and the environment. In the Concentrating Solar Technologies Department at Sandia, Ho has performed research on collector optics, solar glare, flux characterization, receiver design and modeling, and probabilistic systems analysis. He received his Ph.D. and master's in mechanical engineering from the University of California at Berkeley in 1993 and 1990, and his B.S. in mechanical engineering from the University of Wisconsin-Madison in 1989.

ACKNOWLEDGMENTS
Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corp., a wholly owned subsidiary of Lockheed Martin Corp., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

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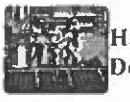

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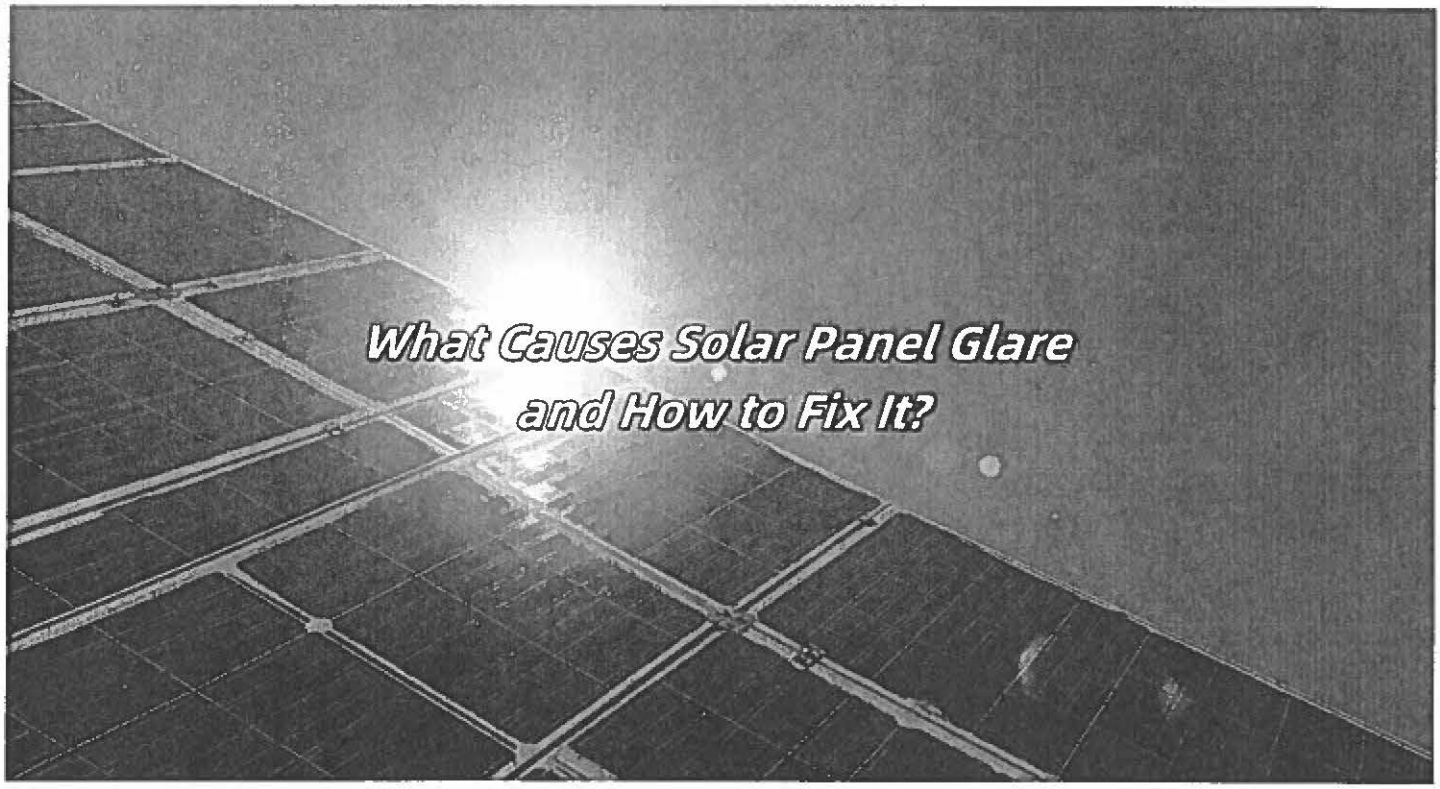
News

What Causes Solar Panel Glare and How to Fix It?

Views: 147 Author: Site Editor Publish Time: 2025-06-14 Origin: Site

Solar panel glare occurs when sunlight bounces off solar panels. This happens more in the morning or evening when the sun is low. You may see it as a bright and annoying light. Different glare types affect your eyes differently. Green glare can tire your eyes over time. Yellow glare makes you squint and see less clearly. Experts use special tools to measure how strong glare is. They also check how it affects nearby places each year. Knowing these effects helps you reduce glare and its problems.



Key Takeaways

- Solar panel glare happens when sunlight bounces off panels, especially in the morning or evening when the sun is low.
- Adding anti-reflective coatings to solar panels can cut glare and still keep them efficient.
- Changing the angle and direction of solar panels based on the season can help reduce glare.
- Planting trees or adding screens near solar panels can block glare and make the area look nicer.
- Checking for glare problems before putting up solar panels ensures safety rules are followed and lowers risks.

Reflection of Sunlight from Panel Surfaces

Solar panels take in sunlight to make energy. But not all sunlight is absorbed. Some bounces off, causing glare. This glare is easier to see when the sun is low, like in the morning or evening. Smooth, shiny panels make the glare stronger and brighter.

You might see this glare as a bright flash or steady shine. It can be uncomfortable to look at. Panels without special coatings reflect more light. When sunlight hits at just the right angle, the glare gets worse. This can bother people or places nearby.

Impact of Panel Materials and Design

The materials in solar panels affect how much glare they make. Panels with glass or shiny parts reflect more sunlight. To fix this, makers add anti-reflective coatings. These coatings spread light out instead of bouncing it back, cutting down glare but keeping energy production high.

Studies show that panel design is key to reducing glare. The angle of sunlight and its strength change how glare looks. For example, the most glare happens when sunlight hits at *about 40°*. New coatings using nanotechnology can lower glare even more by changing how light hits the panel.

Role of Mounting Angles and Sun Position

How panels are tilted changes how much glare they create. If panels are tilted wrong, they can reflect sunlight toward homes or roads. Adjusting the tilt to follow the sun's path helps reduce glare.

Glare is worse when sunlight hits panels at low angles. This is why checking glare is important near airports, highways, or homes. These checks help plan setups that avoid problems.

Weather also matters. Dust, dirt, or water on panels can scatter sunlight unevenly. This makes glare harder to predict. Cleaning panels often keeps them working well and reduces glare.

Environmental Factors That Affect Solar Panel Glare

The environment around solar panels changes how much glare they make. Things like weather, nearby places, and seasons can affect sunlight reflections. Knowing these factors helps you control glare better.

Weather Effects

Weather can make glare stronger or weaker. On sunny days, panels reflect more light because the sun shines directly. Cloudy skies scatter sunlight, which lowers glare. Rain leaves water drops on panels. These drops act like tiny mirrors, causing scattered reflections that might bother people.

Dust and dirt on panels also change glare. Dirty panels reflect light unevenly, creating strange glare patterns. Cleaning panels often keeps them working well and reduces glare.

Nearby Surroundings

The area around panels matters too. If panels are near water, like lakes or pools, water reflections mix with panel glare. This makes glare brighter and harder to ignore. Glass buildings nearby can bounce light between surfaces, making glare worse.

Plants can help block glare. Trees, bushes, or tall grass absorb or stop reflected light. Adding plants near panels reduces glare and makes the area look nicer.

Seasonal Effects

Seasons change how sunlight hits panels. In winter, the sun is lower, so glare reaches homes or roads more easily. In summer, the sun is higher, and glare is less noticeable. Adjusting panel angles for each season helps reduce glare all year.

Air Pollution

Air quality also affects glare. Dust, smog, or haze scatters sunlight before it hits panels. This lowers glare but can also reduce panel efficiency. Cleaner air means stronger sunlight and possibly more glare. Balancing these effects is important.

By watching these environmental factors, you can control glare and reduce problems for nearby areas.

Visual Discomfort and Safety Hazards

Solar panel glare can make your eyes feel tired. Bright sunlight bouncing off panels can hurt your vision. If you stare at it, you might see spots or lose sight for a moment. Tools like SGHAT measure how glare affects people. SGHAT checks glare all year and predicts its impact. It uses numbers to show if glare might harm eyes or just be annoying.

Glare can also cause safety problems. Drivers and pilots may struggle to see clearly. Reflections from panels near roads can hide signs or block views. At airports, glare can make it hard for pilots to land safely. Fixing these issues is important to keep everyone safe.

Risks in Sensitive Areas (Airports, Highways, Residential Zones)

Glare is worse in places like airports, highways, and neighborhoods. Pilots landing planes might have trouble seeing the runway because of glare. Groups like the FAA and Highways England study these risks. They suggest checking glare before putting up solar panels.

Authority/Organization	Concern About Glare
Planning authorities	Yes
Highways England	Yes
Network Rail	Yes
Airports	Yes
Federal Aviation Administration (USA)	Yes
Airport Operators Association (UK)	Yes
Ministry of Housing, Communities and Local Government (UK)	Yes

In homes, glare can bother people and even affect their health. Reflections coming inside can make daily life harder. Careful planning can help stop these problems.

Effects on Wildlife and Scenic Environments

Glare doesn't only bother people; it can confuse animals too. Birds might think reflections are water and fly toward them. This can lead to accidents or confusion for the birds.

In pretty places, glare can ruin the view. Bright flashes from panels can look out of place in nature. This is a big problem in parks or tourist spots where beauty matters. Fixing glare helps solar panels work well with the environment.

How to Reduce Solar Panel Glare?

Use of Anti-Reflective Coatings

A great way to cut down glare is using anti-reflective coatings. These coatings stop sunlight from bouncing off the panels. Instead, they help panels soak up more sunlight. This boosts energy production and lowers glare.

New coatings use special materials to spread light evenly. This keeps panels working well without bothering nearby people. Some companies even add anti-reflective paint for extra glare control. Picking panels with these coatings solves glare problems without hurting performance.

Tip: Ask your solar panel supplier about anti-reflective coatings. This small feature can greatly reduce glare issues.

Adjusting Panel Angles and Orientation

The way panels are tilted affects how much glare they make. If tilted wrong, they can reflect sunlight toward homes or roads. Fixing the tilt to match the sun's path helps reduce glare.

Think about seasons too. In winter, the sun is lower, making glare worse. Changing panel angles during the year keeps glare low and energy high.

Note: Use tools like solar pathfinders to find the best panel angles. These tools help balance energy production and glare control.

Implementing Screening and Shielding

Screens and shields can block glare when adjusting panels isn't enough. Fences or screens stop reflected light from reaching homes or roads. These

Tip: Plan your solar setup with the surroundings in mind. Adding plants or screens reduces glare and improves the area's look.

Adding Plants and Using Black Materials

Growing plants near solar panels can cut down glare a lot. Trees, bushes, or tall grass act like shields. They soak up sunlight and stop reflections from bothering nearby areas. Pick plants that grow fast and need little care. This not only reduces glare but also makes the area look nicer.

Black materials, like frames or backing, also lower glare. These parts take in light instead of bouncing it back. For instance, black panel frames match the surroundings and stop light from reflecting off edges. Black mounting parts make this even better.

Tip: Use both plants and black materials together. This combo reduces glare and looks good too.

Checking for Glare Problems

Before setting up solar panels, check for glare issues first. This test shows how sunlight bounces off panels and spots problem areas. It helps you see how glare might affect homes, roads, or airports nearby.

Special tools and software study sunlight angles all year long. They predict when and where glare could happen. With this info, you can change the panel setup to reduce glare.

Note: Doing this check ensures your panels follow rules and don't cause problems for others.

Rules and Planning to Reduce Solar Panel Glare

FAA and CASA Rules for Solar Near Airports

If you plan solar panels near airports, follow safety rules. The FAA in the U.S. and CASA in Australia have strict guidelines. These rules stop glare from distracting pilots during takeoff or landing.

The FAA uses a tool called SGHAT to check glare risks. If your panels are near an airport, you must submit a glare report. CASA also requires similar checks to keep flight paths safe. Following these rules ensures your solar panels don't cause problems for aviation.

Why Local Rules and Zoning Matter

Local governments set rules for where solar panels can go. These zoning laws balance clean energy with community concerns like glare.

Some places require a glare test before starting a project. Others limit panels near schools or hospitals. Knowing these rules helps you avoid legal trouble. Always check with local authorities before installing solar panels.

Developers' Role in Solving Glare Problems

Developers must plan ahead to reduce glare issues. Start by studying the site to find possible glare problems. Use tools to predict how sunlight will reflect off panels all year.

Talk to the community early to hear their concerns. Explain how you'll fix glare problems to build trust. Adding anti-glare coatings or planting trees shows you care about the area. These steps help make your solar project good for everyone.

You can handle solar panel glare with smart planning. Adding anti-reflective coatings helps cut glare and keeps energy strong. Planning the setup carefully also reduces glare problems. Checking for glare issues ensures panels help without causing trouble. Following rules and thinking about nature keeps things balanced. Good planning makes solar power clean and friendly for everyone.

FAQ

What is solar panel glare?

Solar panel glare happens when sunlight bounces off solar panels. This makes a bright light that can be hard to look at. It's easier to notice during sunrise or sunset when the sun is lower.

23. On September 27, 2022, DEQ granted coverage to Caden Energix under the General VPDES Permit for Discharges of Stormwater from Construction Activities, No. VAR10, promulgated at 9 VAC 25-880-70, which was issued under the State Water Control Law and VSMP Regulations, and the General Permit Regulation on July 1, 2019 and which expires on June 30, 2024 (2019 Permit). Caden Energix was assigned registration number VAR10R609.

24. The 2019 Permit allows Caden Energix to discharge stormwater associated with construction activities from Site 2 to Cascade Creek, Smith River, and Fall Creek, in strict compliance with the terms and conditions of the 2019 Permit.

25. The receiving waters are surface waters located wholly within the Commonwealth and are "state waters" under the State Water Control Law.

26. DEQ staff conducted inspections of Site 2 on May 12, 2023, June 22, 2023, July 18, 2023, December 14, 2023, February 20, 2024, and May 9, 2024.

27. During the inspections on June 22, 2023, July 18, 2023, and December 14, 2023 it was observed that sediment traps and basins had not been made functional in accordance with the approved erosion and sediment control plan prior to the occurrence of upslope land disturbing activities. See 9VAC25-870-54(B) and 9VAC25-840-40(4).

    a. On June 22, 2022, it was observed that construction of SBC12, SBC7, SBC 8 was not completed. On July 18, 2022, it was observed that construction of SBC11 was halted due to the presence of bedrock. Construction of SBE1, SBE2, and SBE4 was not complete. SBD3 and SBD6 were not constructed. Clearing, grubbing, and de-stumping had occurred upslope of the locations where the basins were to be installed.

    b. On December 14, 2023, the wooden baffles were not installed on SBC11, SBE02, STE03, and SBE04. The concrete risers of SBC11 were leaking which allowed intrusion of the more heavily sediment laden water of the wet storage of the sediment basin to enter the riser structure.

28. During the inspection on February 20, 2024, baffles were not installed on F03, F04, D02 and E02 even though the approved erosion and sediment control plan indicates baffles should be installed. Modified plans submitted by Energix indicate baffles should be installed on sediment traps STC 11 B and 11C and no baffles were installed. 9VAC25-870-54(B). Energix submitted photographs to DEQ documenting the installation of baffles in all the basins except F1 and F4. Energix stated it encountered rock when trying to install the posts. DEQ explained that a plan modification would need to be submitted for the two basins where the baffles cannot be installed. On April 18, 2024, Energix informed DEQ that it found a way to install the baffles and that the installation would be completed by the end of the week.

29. During the inspections on June 22, 2023, July 18, 2023, December 14, 2023 and February 20, 2024, it was observed that a vehicular stream crossing and dirt access road had been constructed across Cascade Creek outside the approved limits of disturbance within the existing overhead electrical transmission utility right of way. The vehicular stream crossing was not indicated on the approved erosion & sediment control plan nor the approved stormwater management plan and has not been approved by the VESCP or VSMP authorities. See 9VAC25-870-54(A)-(C) and Permit Part II.C(1)-(2). Energix submitted photographs demonstrating the removal of the stream crossing and DEQ confirmed the removal during the inspection on May 9, 2024.

30. During the inspection on June 22, 2023, and July 18, 2023, it was observed that operational stormwater conveyance channels had not been lined with erosion control blanket matting or a vegetative lining as indicated on the approved plan. On July 18, 2023, it was observed that the channel lining indicated on the approved plan for SCCE1 had not been installed, nor had it been directed to flow into sediment basin SBE1 as indicated on the approved ESC and stormwater management plans. As installed, the terminal end of SCCE1 discharged directly into a stream channel, there was no outlet protection at the terminal end of SCCE1, and the silt fence at the end of SCCE1 had failed and was not being maintained. There was evidence that SCCE1 was discharging sediment directly to a stream without adequate perimeter controls in place. See 9VAC25-840-40(11), 9VAC25-870-54(A)-(C) and Permit Part II.C(1)-(2). During the DEQ inspection on December 14, 2023, the SCCE1 was lined with riprap and a culvert had been installed under the access road to direct flows from SCCE1 to SBE1. DEQ verified that SCCE1 does discharge to basin SBE1, not the stream.

31. During the December 14, 2023 inspection, DEQ observed that SCCE4 had not been lined with riprap. There were multiple channels that did not have adequate lining and were eroding. During the inspection on February 20, 2024, stormwater conveyance channels SCCF5, SCCF6, SCCD3 and SCCD9 were not adequately stabilized with channel lining. See 9VAC25-840-40(11), 9VAC25-870-54(B). On April 2, 2024, Energix submitted photographs of corrective actions.

32. During the inspection on June 22, 2023, it was observed that rip-rap outlet protection installed at the ends of the discharge barrels of sediment basins was not installed in accordance with the approved ESC plans. See 9VAC25-840-40(11) and 9VAC25-870-54(B). During the inspection on December 14, 2023, DEQ observed that the rip-rap outlet protection was installed in accordance with the approved plans.

33. During the inspections on June 22, 2023, July 18, 2023, December 14, 2023 and February 20, 2024, it was observed that the earthen embankments of sediment traps and sediment basins had not been immediately stabilized on installation. See 9VAC25-840-40(5) and 9VAC25-870-54(B).

a. On June 22, 2023, the earthen embankments of sediment traps and basins had not been immediately stabilized on installation including SBC 12, SBC 7, and SBC 8.

b. During the inspection of Site 2 on July 18, 2023, it was observed that the earthen embankments of sediment traps and sediment basins had not been immediately stabilized on installation, including SBE1, SBE2, and SBE4. Temporary earthen "water bars" installed in the drainageways to the locations designated for SBD3 and SBD 6 were not immediately stabilized upon installation.

c. During the inspection on December 14, 2023, some of the basin embankments still required stabilization. The downstream faces of the earthen embankments of SB1 and SBE4 had been disturbed and required stabilization. Rills and erosion on the basin slopes were continuing due to concentrated flows at the top of the slopes going down poorly stabilized slope faces.

d. During the inspection on February 20, 2024, portions of the earthen embankments of sediment basins F03 and the downstream face of sediment basin F04, the earthen embankment of STD10, the repaired portion of the failed earthen embankment of STC11C and portions of the earthen embankment of sediment basin D02 required stabilization. Energix submitted photographs of corrective actions following the February 20, 2024 inspection.

34. During the inspections on June 22, 2023, evidence of concentrated stormwater flows being discharged down the face of the denuded faces of cut and fill slopes resulting in the presence of erosive rills and gullies was observed. During inspection of Site 2 on July 18, 2023, it was observed that the cut side slopes of several sediment basins were not stabilized with permanent, or temporary stabilization. During the inspection on December 14, 2023, DEQ observed the side slopes of SBC 12 were denuded and required stabilization. DEQ also observed erosion and gullies on the cut slopes of STC11A, SBE1 and SBE2. During the inspection on February 20, 2024, erosion gullies were observed on the cut slopes of sediment basins F03, F04, E01 and E02 indicating the concentrated stormwater runoff was being discharged down the face of the cut slopes. See 9VAC25-840-40(7), 9VAC25-840-40(8), and 9VAC25-870-54(B). Energix submitted photographs of corrective actions following the February 20, 2024 inspection.

35. During the inspections on June 22, 2023, July 18, 2023, and December 14, 2023, it was observed that there were large portions of the Site in a denuded, unstabilized condition. Portions of Site 2 had been disturbed and land disturbance ceased for a period of 14 days or more but had not been stabilized. During the inspection on February 20, 2024, DEQ observed that the overall site stabilization had improved but areas were still not adequately stabilized including portions of Area F, portions of the areas around basin D02, the area adjacent to the inverter in area E, the slope located between the diversion channel to the north of sediment basin STC 11C and the limits of disturbance on the eastern perimeter of the site. See 9VAC25-840-40(1), 9VAC25-870-54(B), and Permit

Part II.B.2.c(8).

36. During inspections on June 22, 2023, July 18, 2023, December 14, 2023, and February 20, 2024, erosion and sediment controls were not maintained to ensure continued performance of their intended function. See 9VAC25-870-54(B) and 9VAC25-840-60(A).

    a. During the inspection on June 22, 2023, sediment accumulations were observed in several sediment basins as a result of upslope erosion. Sediment accumulations on the upstream side of check dams required removal to ensure the check dams functioned correctly.

    b. On July 18, 2023, DEQ staff observed several locations where silt fence required maintenance.

    c. On December 14, 2023, DEQ staff observed sediment accumulations against the upstream face of the check dams which was exacerbating the sediment loading in the conveyance channels. DEQ also observed sediment accumulations in sediment traps, sediment basins, and stormwater conveyance channels that required removal. Erosion rills and gullies required repair.

    d. During the inspection on February 20, 2024, DEQ staff observed that the check dam accumulations were removed. DEQ also observed evidence of the end running of triangular silt dikes resulting in erosion of the bank of SCCD3. An erosion gulley was observed in the PV array area above sediment basin D02. Sediment had accumulated in sediment basin F03 and required removal. Sediment accumulations in the culvert receiving stormwater runoff from SCCE1 which directs stormwater into sediment basin E01 require removal to restore the culvert volume capacity. The area to the west of sediment trap 11C was impacted by sediment transport. A portion of the slope above sediment trap 11B had collapsed and needed to be repaired. An erosion gulley had formed at the eastern end of the permanent stream crossing at the entrance to area E. Energix submitted photographs of corrective actions following the February 20, 2024 inspection.

37. During the inspection on July 18, 2023, it was observed that soil stockpiles were not provided with sediment trapping measures. See 9VAC25-840-40(2) and 9VAC 25-870-54(B). During the DEQ inspection on December 14, 2023, DEQ observed that this item had been corrected.

38. During the inspection on July 18, 2023, DEQ staff observed sediment deposits in the natural channel at the northeast side of the permanent stream crossing, which was receiving stormwater runoff being contributed by SCCE1 instead of the stormwater being directed into the northern portion of SBE1. A method of intercepting sediment laden runoff from the southern dirt approach road at the unpermitted temporary vehicular stream crossing between areas D and F was not observed to prevent sediment from

entering the surface waters of the stream. See 9VAC28-870-54(B) and 9VAC840-40(12). During the DEQ inspection on December 14, 2023, DEQ observed that the contributing drainage from SSCE1 has been diverted to SBE1 via a culvert under the access road that crosses the permanent stream crossing.

39. Based on the results of the May 12, 2023, June 22, 2023, July 18, 2023, December 14, 2023, February 20, 2024, and May 9, 2024 inspections, the Department concludes that Caden Energix violated 9VAC25-870-54(A-C), 9VAC25-840-60(A), 9VAC25-840-40(1), (2), (4), (5), (7), (8), (11), (12) and 2019 Permit Parts II.C(1-2) and II.B.2.c(8), as described in paragraphs C (27) through (38) of this Order.

Site 3- Axton Solar Phase 3

40. Caden Energix Axton LLC (Caden Energix) is a business entity authorized to do business in Virginia and references to Caden Energix Axton LLC include its affiliates, partners, and subsidiaries. Caden Energix Axton LLC is a "person" within the meaning of Va. Code § 62.1-44.3.

41. Caden Energix owns operates the Axton Solar Phase 3 site located at latitude 36.6267 and longitude -79.7035 near 374 Centerville Rd in Axton, Virginia, located in Henry County (Site 3) from which stormwater associated with construction activity is discharged.

42. DEQ is the Virginia Stormwater Management Program (VSMP) authority for Site 3.

43. On February 16, 2023, DEQ granted coverage to Caden Energix under the General VPDES Permit for Discharges of Stormwater from Construction Activities, No. VAR10, promulgated at 9 VAC 25-880-70, which was issued under the State Water Control Law and VSMP Regulations, and the General Permit Regulation on July 1, 2019 and which expires on June 30, 2024 (2019 Permit). Caden Energix was assigned registration number VAR10S146.

44. The 2019 Permit allows Caden Energix to discharge stormwater associated with construction activities from Site 3 to Cascade Creek, Smith River, Fall Creek, in strict compliance with the terms and conditions of the 2019 Permit.

45. The receiving waters are surface waters located wholly within the Commonwealth and are "state waters" under the State Water Control Law.

46. DEQ staff conducted inspections of Site 3 on July 18, 2023, December 14, 2023, and February 20, 2024.

47. During the inspection on July 18, 2023, DEQ staff observed portions of the Site in a denuded and unstabilized condition, including lack of soil stabilization at stream crossings 1 and 2. During the inspection on December 14, 2023, DEQ staff observed that

the stream banks at crossings 1 and 2 located within the limits of disturbance required stabilization. The disturbed area behind the headwall but outside of the silt fence required stabilization. See 9VAC25-870-54(B), 9VAC25-840-40(1), 9VAC25-840-40(15) and Permit Part II.B.2.c(8). During an inspection on February 20, 2024, DEQ confirmed that this area had been stabilized.

48. During the inspection on July 18, 2023, DEQ staff observed a soil stockpile that was not provided with sediment trapping measures or stabilized upgradient of stream crossing 2. See 9VAC25-840-40(2) and 9VAC 25-870-54(B). During an inspection on December 14, 2023, DEQ observed that this had been corrected.

49. During the inspection on July 18, 2023, it was observed that there was a ruptured filter sock located near stream crossing 2 that required repair or replacement. See 9VAC25-870-54(B) and 9VAC25-840-60(A). During an inspection on December 14, 2023, DEQ observed that this had been corrected.

50. During the inspection on December 14, 2023, DEQ staff observed that sediment had accumulated on the rip-rap outlet protection at stream crossings 1 and 2 and required removal. An erosive head cut was forming on the bank of the stream upstream of the twin culverts at stream crossing 1. Silt fence at both stream crossings 1 and 2 required maintenance and repair. See 9VAC25-870-54(B) and 9VAC25-840-60(A). During an inspection on February 20, 2024, DEQ observed that this had been corrected.

51. Based on the results of the July 18, 2023, December 14, 2023, and February 20, 2024 inspections, the Department concludes that Caden Energix violated 9VAC25-870-54(B), 9VAC25-840-60(A), 9VAC25-840-40(1), (2), (15) and 2019 Permit Parts II.C(1-2), II.B.2.c(9), II.F.1, and II.B.2.c(8), as described in paragraphs C (47) through (50) of this Order.

Site 4- Waverly Solar Phase 2

52. Energix EPC US LLC (Energix) is a business entity authorized to do business in Virginia and references to Energix EPC US LLC include its affiliates, partners, and subsidiaries. Energix EPC US LLC is a "person" within the meaning of Va. Code § 62.1-44.3.

53. Energix owns operates the Waverly Solar Phase 2 site located at latitude 37.0351 and longitude -77.1486 off Beef Steak Road, in Waverly, Virginia (Site 4) from which stormwater associated with construction activity is discharged.

54. DEQ is the Virginia Stormwater Management Program (VSMP) authority for Site 4.

55. On March 29, 2023, DEQ granted coverage to Energix under the General VPDES Permit for Discharges of Stormwater from Construction Activities, No. VAR10, promulgated at 9 VAC 25-880-70, which was issued under the State Water Control Law and VSMP Regulations, and the General Permit Regulation on July 1, 2019 and which expires on

June 30, 2024 (2019 Permit). Energix was assigned registration number VAR10R839.

56. The 2019 Permit allows Energix to discharge stormwater associated with construction activities from Site 4 to Assamoosick Swamp and Pigeon Swamp, in strict compliance with the terms and conditions of the 2019 Permit.

57. The receiving waters are surface waters located wholly within the Commonwealth and are "state waters" under the State Water Control Law.

58. On December 9, 2022, DEQ issued Waverly Solar, LLC coverage under VWP General Permit WP2-22-1720 and authorized surface water impacts as depicted on impact maps and sheets received by DEQ. Energix received authorization from DEQ to modify the VWP permit on September 29, 2023. See VWP General Permit WP2-22-1720 and coverage letter.

59. DEQ staff conducted inspections of Site 4 on July 17, 2023, July 31, 2023, December 28, 2023, February 6, 2024, and May 2, 2024.

60. During the inspection on July 17, 2023, DEQ staff observed that Zone D had all clearing done within the limits of disturbance of the section inspected and perimeter controls were partially installed with no sediment basins or traps nor a construction entrance installed. Zone B had all clearing done, but did not have perimeter controls, a construction entrance, and installation of basins was still in progress. Zone A was in the process of being cleared and did not have a construction entrance or basins. The construction activity was not consistent with the sequence from the erosion and sediment control phase 1 construction sequence seen in the approved plan page C.7.03. See 9VAC25-870-54(B)-(C) and 9VAC25-840-40(4).

61. During the inspection on July 17, 2023, DEQ staff observed operational stormwater conveyance channels and sediment basin slopes in Zone B that lacked stabilization. See 9VAC25-870-54(B), 9VAC25-840-40(5) and 9VAC25-840-40(11). During the December 28, 2023 inspection, DEQ observed that this has been corrected.

62. The silt fence joints in Zone B and D were improperly joined together. See 9VAC25-870-54(B), 9VAC25-840-60(A) and Permit Part II.F(1). During the December 28, 2023 inspection, DEQ continued to observe silt fence joints that were not properly joined together. On January 12, 2024, Energix submitted photographs to DEQ documenting corrective actions.

63. On July 31, 2023, DEQ Virginia Water Protection (VWP) staff conducted a site inspection. DEQ staff observed approximately 0.19 acre of Palustrine Forested (PFO) Wetland impacted by the accumulation of 1-8" of sediment deposition in surface waters near Stormwater Basins 11, 20, 21, 22, and 24. This impact was not authorized by the VWP permit. See Va. Code §62.1-44.15:20(A), 9VAC25-210-50(A), and VWP General Permit WP2-22-1720 Part I.B.5. During the December 28, 2023 inspection, DEQ

observed that the sediment had been cleaned up and seed/straw was applied.

64. During the December 28, 2023 inspection, DEQ staff observed that the southern perimeter next to stormwater management facility PB24 was eroding. DEQ staff also observed rill erosion underneath panel arrays and through security fencing towards PB19 and rill erosion coming from panel arrays towards the stormwater conveyance channel near PB14. Rill erosion was also observed near the perimeter next to PB13 and uphill from and into the stormwater conveyance channel next to PB13. Multiple erosion rills were observed under panel arrays into the stormwater conveyance channel between PB15 and PB16. See 9VAC25-870-54(B), 9VAC25-840-40(1), and Permit Part II(F)(1). On January 12, 2024, Energix submitted photos documenting corrective actions for everything except the rill erosion underneath panel arrays and through the security fencing towards PB19 and the rills from panel arrays to the stormwater conveyance channel near PB14. On March 20, 2024, Energix submitted an email to DEQ stating that it expected to have the rills above PB19 fixed by March 27, 2024 and the rills above PB14 fixed by April 3, 2024. On April 3, 2024, Energix informed DEQ that the rills above PB14 would not be fixed until April 13, 2024. On April 30, Energix submitted an updated schedule to DEQ with an anticipated completed date of May 31, 2024.

65. During the December 28, 2023 inspection, DEQ staff observed the western slope of stormwater management facility PB24 was eroding under the matting and the northeastern slope of PB15 was also eroding. The stormwater conveyance channel near PB22 was filled with sediment between check dams and there was erosion and sediment build up between check dams in the stormwater conveyance channel leading to PB13. The stormwater conveyance channel between PB15 and PB16 was eroding. See 9VAC25-870-54(B), 9VAC25-840-40(1), 9VAC25-840-40(5), and Permit Part II.F. On January 12, 2024, Energix submitted photos to DEQ documenting corrective actions.

66. During the December 28, 2023 inspection, DEQ staff observed that the PB25 outfall pipe was filled with sediment and did not have flared end sections. The PB19 and PB14 outfall pipes were broken. See 9VAC25-870-54(B), Permit Part II.F and 9VAC25-840-40(11). On January 12, 2024, Energix submitted pictures of corrective actions.

67. During the December 28, 2023 inspection, DEQ staff observed that trash was strewn throughout the site including just outside the limits of disturbance. See Permit Part II.B.4.e(6) and 9VAC25-870-56. On January 12, 2024, Energix submitted photos documenting corrective actions.

68. The discharge of fill material to a wetland without a Permit is a violation of Va. Code § 62.1-44.15:20 and 9 VAC 25-210-50.

69. Based on the results of the July 17, 2023, December 28, 2023, and May 2, 2024 inspections, the Department concludes that Energix violated § 62.1-44.15:20(A), 9VAC25-210-50(A), 9VAC25-870-54(B) and (C), 9VAC25-870-56, 9VAC25-840-60(A), 9VAC25-840-40(1), (4), (5), and (11), VWP General Permit WP2-22-1720 Part

I.B.5 and 2019 Permit Parts II.F.1 and II.B.4.e(6), as described in paragraphs C (60) through (67) of this Order.

Site 5- Wytheville Solar

70. Energix EPC US LLC (Energix) is a business entity authorized to do business in Virginia and references to Energix EPC US LLC include its affiliates, partners, and subsidiaries. Energix EPC US LLC is a "person" within the meaning of Va. Code § 62.1-44.3.

71. Energix owns operates the Wytheville Solar site located at latitude 36.9637 and longitude -81.0489 off Lovers Ln, in Wytheville, located in Wythe County, Virginia (Site 5) from which stormwater associated with construction activity is discharged.

72. DEQ is the Virginia Stormwater Management Program (VSMP) authority for Site 5.

73. On October 8, 2021, DEQ granted coverage to Energix under the General VPDES Permit for Discharges of Stormwater from Construction Activities, No. VAR10, promulgated at 9 VAC 25-880-70, which was issued under the State Water Control Law and VSMP Regulations, and the General Permit Regulation on July 1, 2019 and which expires on June 30, 2024 (2019 Permit). Energix was assigned registration number VAR10O685.

74. The 2019 Permit allows Energix to discharge stormwater associated with construction activities from Site 5 to Reed Creek Muskrat Branch, in strict compliance with the terms and conditions of the 2019 Permit.

75. The receiving waters are surface waters located wholly within the Commonwealth and are "state waters" under the State Water Control Law.

76. DEQ staff conducted inspections of Site 5 on May 16, 2023, July 25, 2023, September 11, 2023, December 19, 2023, and March 19, 2024.

77. During DEQ inspections on May 16, 2023, July 25, 2023, and September 11, 2023, DEQ staff observed that sequencing of the project had not been implemented in accordance with the approved erosion and sediment control and stormwater management plans. Sediment traps and basins were not installed in accordance with 9VAC25-840-40(6) and the approved plan. The basins had not yet been lined to ensure the appropriate wet and dry storage volumes are maintained as required by the regulation. See 9VAC25-840-40(6), 9VAC25-870-54(B-C), and Item #3 of Appendix C of the Consent Order Effective May 1, 2023 and Va. Code § 62.1-44.31. During an inspection on December 19, 2023, DEQ observed that the construction at Site 5 has progressed to the point that temporary basins and traps are being incrementally removed. DEQ has discussed the removal and timeline with Energix as well as the need to submit plan modifications should Energix choose to leave basins in place.

78. During DEQ inspections on May 16, 2023, July 25, 2023, and September 11, 2023, DEQ staff observed concentrated runoff discharging over cut and fill slopes that were not contained in an adequate temporary or permanent slope conveyance structure. See 9VAC25-840-40(8), 9VAC25-870-54(B) and Permit Part II.B.2.c. During the December 19, 2023 inspection, DEQ staff observed that this item from the NOV had been corrected.

79. During DEQ inspections on May 16, 2023, July 25, 2023, September 11, 2023, and March 19, 2024, DEQ staff observed that sediment control measures were not being properly maintained in an effective operating condition. See 9VAC25-870-54(B), 9VAC25-840-60(A), and Permit Part II.F.1.

80. During the DEQ inspection on December 19, 2023, DEQ staff observed that the SWPPP had not been updated to document areas that have reached final stabilization and the approved modification to the SWM plan was not included in the SWPPP. See 9VAC25-870-54(C), 9VAC25-870-54(G), Permit Part II.B.3, and Permit Part II.C.4.c. On December 20, 2023, Energix submitted an email with corrective actions.

81. During the DEQ inspection on December 19, 2023 and March 19, 2024, DEQ staff observed that outlet protection and channel lining had not been installed in accordance with the approved plans. See 9VAC25-870-54(B), 9VAC25-840-40(11), and Permit Part II.B.2.c.

82. During the DEQ inspection on March 19, 2024, DEQ staff observed that compost amended soils were not incorporated in the installed vegetated filter strips in accordance with the approved stormwater management plan. Energy dissipators were not installed at the outlet of SCC8 and the outlet of Pipe 7-5 in accordance with the approved plans. DEQ staff also observed that rock check dams were not properly installed in ditches VFS 23-2 and VFS 22-1 and ditch 3-3 East required removal per the approved plans. The rock outlet of the ditch into VFS 23-2 and the culvert outlet to TSB 5-2 were not properly installed in accordance with the approved plan and the erosion and sediment control minimum standards. See 9VAC25-870-54(B) and (C), 9VAC25-840-40(11), 9VAC25-840-60.A.

83. Based on the results of the May 16, 2023, July 25, 2023, September 11, 2023, December 19, 2023, and March 19, 2024 inspections, the Department concludes that Energix violated the May 1, 2023 consent order, § 62.1-44.31, 9VAC25-870-54(B), (C), and (G), 9VAC25-840-60(A), 9VAC25-840-40(6), (8), and (11), and 2019 Permit Parts II.F.1, II.B.2.c, II.B.3 and II.C.4.c, as described in paragraphs C (77) through (82) of this Order.

Site 6- Buckingham II Solar

84. Energix EPC US LLC (Energix) is a business entity authorized to do business in Virginia and references to Energix EPC US LLC include its affiliates, partners, and subsidiaries. Energix EPC US LLC is a "person" within the meaning of Va. Code § 62.1-44.3.

85. Energix owns operates the Buckingham II Solar site located at latitude 37.5003 and longitude -78.3808 at 23 Highrock Rd in Buckingham, Virginia (Site 6) from which stormwater associated with construction activity is discharged.

86. DEQ is the Virginia Stormwater Management Program (VSMP) authority for Site 6.

87. On August 28, 2020, DEQ granted coverage to Energix under the General VPDES Permit for Discharges of Stormwater from Construction Activities, No. VAR10, promulgated at 9 VAC 25-880-70, which was issued under the State Water Control Law and VSMP Regulations, and the General Permit Regulation on July 1, 2019 and which expires on June 30, 2024 (2019 Permit). Energix was assigned registration number VAR10K840.

88. The 2019 Permit allows Energix to discharge stormwater associated with construction activities from Site 6 to Buffalo Creek and Payne Creek unnamed tributary, in strict compliance with the terms and conditions of the 2019 Permit.

89. The receiving waters are surface waters located wholly within the Commonwealth and are "state waters" under the State Water Control Law.

90. DEQ staff conducted inspections of Site 6 on May 30, 2023, July 31, 2023, and December 12, 2023.

91. During the DEQ inspections on May 30, 2023 and July 31, 2023, DEQ staff observed that Basin 28 was ponding and stabilization was lacking at the bottom of the basin. See 9VAC25-870-54(B), 9VAC25-840-40(1), 9VAC25-840-60(A), Item #1.a, 1.e, and 2.b of Appendix F of the Consent Order between DEQ and Energix effective May 1, 2023. During an inspection on December 12, 2023, DEQ confirmed that this had been corrected.

92. During the December 12, 2023 inspection, DEQ staff observed erosion occurring at a temporary access road next to Basins 8, 9 and 10. A portion of a slope on Basin 32 lacked stabilization. Basin 9 had rill erosion at its south end that connects to the temporary access road. See 9VAC25-870-54(B) and 9VAC25-840-40(1). On January 3, 2024, DEQ received photos from Energix documenting corrective actions.

93. During the December 12, 2023 inspection, DEQ staff observed that the trash racks for Basins 17, 18, and 21 required vegetative maintenance. Basin 13 required woody vegetation maintenance. The Basin 9 outfall was in need of vegetative and silt fence maintenance. Basin 18 was ponding, Basin 20 had rutting that was ponding, and the Basin 10 outfall was no longer flush to the ground. The stormwater conveyance channel leading towards Basin 28 had several downed trees in it that required removal. Channel lining was also lacking upslope from Basin 10. See 9VAC25-870-54(B), 9VAC25-840-40(11), 9VAC25-840-60(A), and Permit Part II.F.1. On January 3, 2024, DEQ received photos from Energix documenting corrective actions.

94. Based on the results of the May 30, 2023, July 31, 2023, and December 12, 2023 inspections, the Department concludes that Energix violated the May 1, 2023 consent order, 9VAC25-870-54(B), 9VAC25-840-60(A), 9VAC25-840-40(1) and (11), and 2019 Permit Parts II.F.1, as described in paragraphs C (91) through (93) of this Order.

Site 7- Waverly Solar Phase 3

95. Energix EPC US LLC (Energix) is a business entity authorized to do business in Virginia and references to Energix EPC US LLC include its affiliates, partners, and subsidiaries. Energix EPC US LLC is a "person" within the meaning of Va. Code § 62.1-44.3.

96. Energix owns operates the Waverly Solar Phase 3 site located at latitude 37.0210 and longitude -77.1226 at 29665 Sussex Dr, in Waverly, Virginia (Site 7) from which stormwater associated with construction activity is discharged.

97. DEQ is the Virginia Stormwater Management Program (VSMP) authority for Site 7.

98. On March 28, 2023, DEQ granted coverage to Energix under the General VPDES Permit for Discharges of Stormwater from Construction Activities, No. VAR10, promulgated at 9 VAC 25-880-70, which was issued under the State Water Control Law and VSMP Regulations, and the General Permit Regulation on July 1, 2019 and which expires on June 30, 2024 (2019 Permit). Energix was assigned registration number VAR10R284.

99. The 2019 Permit allows Energix to discharge stormwater associated with construction activities from Site 7 to Blackwater River and Coppahaunk Swamp, in strict compliance with the terms and conditions of the 2019 Permit.

100. The receiving waters are surface waters located wholly within the Commonwealth and are "state waters" under the State Water Control Law.

101. On December 9, 2022, DEQ issued Waverly Solar, LLC coverage under VWP General Permit WP2-22-1720 and authorized surface water impacts as depicted on impact maps and sheets received by DEQ. Energix received authorization from DEQ to modify the VWP permit on September 29, 2023. See VWP General Permit WP2-22-1720 and coverage letter.

102. DEQ staff conducted inspections of Site 7 on July 17, 2023, December 28, 2023, and February 6, 2024.

103. During the inspection on July 17, 2023, DEQ staff observed silt fence joints that were improperly spliced together in Zone D. During this inspection, this area was incorrectly identified as belonging to Waverly Solar Phase II, which consists of Zones A and B only. See 9VAC25-870-54(B) and 9VAC25-840-60(A).

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Leaching of cadmium and tellurium from cadmium telluride (CdTe) thin-film solar panels under simulated landfill conditions

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Abstract

A crushed non-encapsulated CdTe thin-film solar cell was subjected to two standardized batch leaching tests (*i.e.*, Toxicity Characteristic Leaching Procedure (TCLP) and California Waste Extraction Test (WET)) and to a continuous-flow column test to assess cadmium (Cd) and tellurium (Te) dissolution under conditions simulating the acidic- and the methanogenic phases of municipal solid waste landfills. Low levels of Cd and Te were solubilized in both batch leaching tests (<8.2% and <3.6% of added Cd and Te, respectively). On the other hand, over the course of 30 days, 73% of the Cd and 21% of the Te were released to the synthetic leachate of a continuous-flow column simulating the acidic landfill phase. The dissolved Cd concentration was 3.24-fold higher than the TCLP limit (1 mg L^{-1}), and 650-fold higher than the maximum contaminant level established by the US-EPA for this metal in drinking water (0.005 mg L^{-1}). In contrast, the release of Cd and Te to the effluent of the continuous-flow column simulating the methanogenic phase of a landfill was negligible. The remarkable difference in the leaching behavior of CdTe in the columns is related to different aqueous pH and redox conditions promoted by the microbial communities in the columns, and is in agreement with thermodynamic predictions.

Keywords

CdTe thin-film solar panel; landfill; leaching; cadmium; tellurium

1. Introduction

In recent years, solar photovoltaic (PV) technology has advanced due to a growing interest in renewable energy sources. While crystalline silicon has remained the dominant PV technology, thin-film solar panels have become increasingly popular [1]. The leading thin-film technology, cadmium telluride (CdTe), had a module production of 1.8 GW_p in 2012, making it the second largest PV technology on the market [2]. Due to their efficiency and relatively low manufacturing energy requirements, CdTe solar cells had the shortest energy payback time among commercially relevant PV technologies [3].

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As their usage has increased, there has also been increased concern over the safety of CdTe solar cells because of the toxic compounds they contain. Cadmium is recognized as a toxic substance by the United States Environmental Protection Agency (EPA), which set a maximum contaminant level (MCL) for cadmium (Cd) of 0.005 mgL^{-1} in drinking water. Tellurium (Te), while not regulated by the EPA, has also been shown to have the potential to cause kidney, heart, skin, lung, and gastrointestinal system damage in rats and in humans [4, 5]. Furthermore, two individuals that were mistakenly injected with sodium tellurite died after 6 h of exposure [4]. The toxicity of CdTe itself is poorly characterized, but several studies have shown that CdTe [6, 7] and CdTe quantum dots are cytotoxic to mammalian cells [8-10]. CdTe can cause severe pulmonary inflammation and fibrosis [6]. Zayed and Philippe (2009) [11] studied the acute toxicity of CdTe to rats via nasal and oral routes. The median lethal concentration of aerosolized CdTe in the nasal exposure test was 2.7 mg CdTe L^{-1} atmosphere (particles were 2-3 μm in diameter). The acute toxicity was also evaluated with oral gavage administration together with carboxymethylcellulose. In the oral route the highest body weight dose of 2g kg^{-1} was below the lethal concentration in a 14-d observation period.

Electronic waste is often disposed in municipal mixed solid waste (MSW) landfills [12, 13]. For example, in Australia, 84% (by weight) of electronic waste generated in 2008 was landfilled [14]. In the United States, electronic waste has been reported to account for 70% of the Cd and lead (Pb) present in landfills [15]. Disposal of electronic waste into landfills raises concerns about the potential release of toxic compounds into the environment. The US EPA uses the Toxicity Characteristics Leaching Procedure (TCLP) to characterize the potential of a solid waste to leach when disposed in a landfill and determine whether a waste material should be classified as hazardous according to its toxic characteristic [16]. If the waste fails the TCLP test, it must be disposed of in a hazardous waste landfill. The TCLP limit for cadmium is 1 mgL^{-1}. While some TCLP leaching studies have reported concentrations of Cd lower than 1 mg L^{-1} [17], others have obtained Cd concentrations exceeding 9 mgL^{-1} for CdTe solar cells [18, 19].

Due to the presence of hazardous substances like Cd and lead (Pb) in PV technology, solar PV panels have been included in the European Union Waste Electrical and Electronic Equipment (WEEE) Directive [20] which is aimed at maximizing the collection, recycling and recovery of valuable and hazardous materials from electronic waste to optimize the use of natural resources, as well as, to prevent the entry of the toxicants into the environment. Despite the potential risks posed by PV technology, many other countries have not yet introduced regulations to prevent the disposal of CdTe solar cells in MSW landfills.

While some studies have assessed the chemical dissolution of Cd and Te from CdTe solar panels using different standardized tests simulating outdoor exposure and the landfill environment [17, 21-24], none have considered the potential impacts of the complex biogeochemical conditions commonly found in municipal MSW landfills on the mobility of these toxic contaminants. For instance, the pH of landfill leachates varies widely from highly acidic values typical of young landfills to circumneutral and slightly alkaline pH values characteristic of mature landfills [25, 26]. Such pH shifts could impact the dissolution of CdTe in the landfill leachate since both the corrosion of CdTe [27] and the aqueous

solubility of Cd and Te are strongly dependent on pH [28, 29]. Municipal waste landfills are generally rich in anaerobic microbial activity. Anaerobic microorganisms are capable of reducing and precipitating tellurium [30-33], and such microbial transformations could potentially impact the dissolution of CdTe in the landfill environment. Microbial processes have previously been shown to promote the mobilization of some metals and metalloids in MSW landfills. For example, several studies have demonstrated the microbially-mediated mobilization and biotransformation of arsenic under simulated landfill conditions [34-36]. A preliminary generic risk assessment for decommissioned thin-film CdTe panels disposed in a MSW landfill has been performed using a U.S. EPA software model based on TCLP data that concluded that under current production of PV panels there should be no risk to humans [24, 37].

The purpose of this study is to investigate the potential environmental risk posed by the disposal of CdTe solar cells in municipal waste landfills. For this purpose, crushed samples of CdTe cells were placed in continuous-flow columns simulating the chemical, physical, and biological environments at two of the different stages in the lifetime of a landfill (*i.e.* the acidic phase and the methanogenic phase) [25]. The release of both Cd and Te was then monitored to determine the potential hazards of this disposal method.

2. Materials and methods

2.1. Panel characteristics

A thin-film CdTe solar panel was obtained from Abound Solar (Loveland, CO, USA) with dimensions of 60 by 120 cm, and 14 kg in mass. The CdTe thin-film layer was deposited between two sheets of glass, one of the sheets served as a glass substrate; while, the other was used as a back cover. The Abound solar panel used did not contain a laminate layer (e.g. ethylvinylacetate) to encapsulate the Cd-containing film. Such layer is found in some CdTe PV modules commercially available [38]. Four fragments of the panels were separated in order to determine the film to glass mass ratio of the panel as follows: the films were manually separated from their corresponding glass cases and, the masses of both fractions were obtained with an analytical balance (Mettler Toledo AB304-s; Columbus, OH, USA); finally, the film to glass mass ratio was estimated to be 0.0053 ± 0.00042 w/w.

2.2. Cadmium and tellurium content determination

Film fragments were digested using 15 mL of concentrated HF (45% wt.) and 3 mL of concentrated HNO_3 (70% wt.) according to a modified EPA standard procedure [39]. Digested samples were then diluted in demineralized (DI) water and analyzed for Cd and Te. The samples were analyzed with an inductively coupled plasma–mass spectrometer (ICP-MS, Agilent model 7700x; Santa Clara, CA, USA) operated with He as collision gas to reduce Ar based interferences. The detection limits were 1.6 ng L^{-1} for Cd and 32.5 ng L^{-1} for Te. The panel was found to contain 7.31 ± 1.22 mg Cd and 7.68 ± 1.19 mg of Te per gram of film, respectively.

2.3. Panel preparation

The size of the panel was first reduced by breaking it with a hammer and the larger fragments were placed into a ball mill (Sepor, Wilmington, CA, USA). The milling process was carried out at 90 rpm. The CdTe-containing film is not brittle and was poorly fragmented during milling. Therefore, the film fragments were manually separated from the glass fragments and their size further reduced with scissors. The length of the longest side of the snipped film ranged between 3-8 mm and the thickness of the film was < 1 mm. The glass fragments were then sieved using a standard 3 1/2 mesh sieve (ASTM E11). The fragments that did not pass through were then sieved using a standard mesh no. 14 (ASTM E11), and the fragments that passed through were kept, resulting in glass fragments that ranged in size from 1.4–5.6 mm.

2.4. Microbial inoculum

A methanogenic anaerobic granular sludge obtained from a wastewater treatment plant at Mahou beer brewery (Guadalajara, Spain) was used to inoculate the columns. The inoculum contained 0.079 g of volatile suspended solids (VSS) g^{-1} wet wt. The maximum acetoclastic and hydrogenotrophic methanogenic activities of the sludge were 566 ± 64 mg methane as chemical oxygen demand (COD-CH_4) g VSS^{-1} day^{-1} and 571 ± 26 mg COD-CH_4 g VSS^{-1} day^{-1}, respectively.

2.5. Columns set up and operational conditions

Two continuous upflow columns (V= 280 mL) were prepared and operated in parallel to model different stages of a MSW landfill (Fig. 1). Each column was packed with 1.5 g of snipped CdTe film and 300 g crushed glass, corresponding to the same mass ratio as was present in the panels. Each column contained 11.0 mg of Cd and 11.56 mg Te. Column 1 (acidic column) and column 2 (methanogenic column) were used to study the effect of the leachate produced during the acidic phase (young landfill) and in the initial methanogenic phase (mature landfill, circumneutral pH) of a municipal landfill, respectively, on the dissolution and mobility of the Cd and Te species present in the solar panel. Both columns were inoculated with 9.80±0.03 g sludge-VSS L^{-1}. The sludge used to inoculate the acidic column was heat treated in a VWR convection oven (1370GM, Radnor, PA, USA) at 70°C for 60 min to pasteurize the methanogenic microbial communities and thereby prevent an increase of the pH of the synthetic leachate due to the volatile fatty acids(VFA) degradation.

The columns were fed a synthetic leachate solution composed of a mixture of VFA (please refer to the Supplementary Data (SD) section) with a final pH of 4.67 ± 0.06. The pH of the influent of the acidic column was kept at 4.67 ± 0.06. The pH values for landfill leachate in this stage have been reported to range between 4.5 and 7.5 [25]. The pH of the influent of the methanogenic column was adjusted to 6.71 ± 0.19 using 10 M NaOH since microbial methanogenesis occurs only within a narrow pH range (circumneutral).

The acidic and methanogenic columns were operated at 25°C for 30 days at an average hydraulic retention time (HRT) of 27.7 ± 1.9 h and 28.8 ± 2.2 h, respectively.

2.6. Column sampling and monitoring

Throughout the testing period, samples were taken of the influent and effluent of both columns to determine the pH, as well as, the concentration of soluble Cd, Te, and VFA using the analytical methods described in the SD section. The CH_4 content of the gas produced in the columns was measured by monitoring the volume of liquid displaced in an inverted bottle filled with NaOH (2%, v/v) to scrub CO_2.

2.7. Chemical oxygen demand mass balance

The chemical oxygen demand (COD) concentration in the inlet and outlet streams of the columns was estimated by adding the COD of all species in these streams (Eq. 1 and 2). The mass balance for the components in the synthetic leachate, expressed as total COD, is represented in Eq. 3.

$$\sum[\mathrm{COD}]_{\mathrm{infl}}=[\mathrm{COD}-C_2]_{\mathrm{infl}}+[\mathrm{COD}-C_3]_{\mathrm{infl}}+[\mathrm{COD}-C_4]_{\mathrm{infl}}+[\mathrm{COD}-C_5]_{\mathrm{infl}}+[\mathrm{COD}-C_6]_{\mathrm{infl}}$$

(1)

$$\sum[\mathrm{COD}]_{\mathrm{effl}}=[\mathrm{COD}-C_2]_{\mathrm{effl}}+[\mathrm{COD}-C_3]_{\mathrm{effl}}+[\mathrm{COD}-C_4]_{\mathrm{effl}}+[\mathrm{COD}-C_5]_{\mathrm{effl}}+[\mathrm{COD}-C_6]_{\mathrm{effl}}$$

(1)

$$\sum[\mathrm{COD}]_{\mathrm{infl}}=\sum[\mathrm{COD}]_{\mathrm{effl}}+[\mathrm{COD}]_{\mathrm{methane}}+[\mathrm{COD}]_{\mathrm{cells}} \quad (3)$$

Where: infl = influent, effl = effluent, C_2 = acetate, C_3 = propionate, C_4 = butyrate, C_5 = valerate, C_6 = caproate, $[\mathrm{COD}]_{\mathrm{cells}}$ = organic matter COD used to produce new cells, and $[\mathrm{COD}]_{\mathrm{methane}}$ = organic matter COD used to produce methane.

The last term in Eq. 3 ($[\mathrm{COD}]_{\mathrm{cells}}$) was not considered in the COD balances since the cell growth yield associated with the anaerobic conversion of volatile fatty acids to methane is very low, typically less than 2-5% of the COD utilized[40, 41].

2.8. Standardized leaching tests

The CdTe solar panel was subjected to the standardized TCLP [16] and the California Waste Extraction Test (WET) [42] leaching tests using the snipped film and crushed glass previously prepared for the continuous columns set up, at the appropriate film/glass mass ratio of ~ 0.005. These standardized tests are used to determine if a solid waste should be considered and handled as hazardous waste. If the waste fails the standardized leaching test it must be disposed of in a hazardous waste landfill instead of in a MSW landfill along with

non-hazardous waste. The experimental conditions used in this work are described in the SD section.

2.9. Redox potential *vs.* pH (Pourbaix) diagrams

In this work, the W32-STABCAL software (Stability calculation for aqueous and non-aqueous systems, Montana Tech, Butte, MT, USA) and thermodynamic information published by the National Bureau of Standards NBS (NIST, U.S. Department of Commerce, USA) were used to plot potential-pH (Pourbaix) diagrams for CdTe. These diagrams showed the thermodynamically stable species of Cd and Te in complex aqueous systems under different redox potentials and pH conditions.

3. Results

3.1. Leaching of soluble Cd and Te species from the solar panel

Two continuous-flow columns packed with a mixture of CdTe thin-film and crushed glass of solar panels were run in parallel to investigate the impact of two simulated landfill conditions on the potential release of soluble Cd and Te from the CdTe semiconductor film into the environment. The columns were set up to simulate the acidic phase (acidic column) and, the initial period of the anaerobic methanogenic phase (methanogenic column) of a MSW landfill.

Figure 2A shows the concentrations of Cd and Te in the effluent from the columns. In the acidic column, the concentrations increased during the first ten days, reaching maximum levels of 3.23 mg L^{-1} for Cd and 1.10 mg L^{-1} for Te, respectively. At this point of time, 47.7% and 12.6% of the total Cd and Te contained in the solar panel had been released to the effluent, respectively. The concentration of Cd in the effluent was found to be above the threshold limit established in the TCLP for this metal for approximately 50% of the full operation time. The concentration of both Cd and Te in the effluent then decreased over the remainder of the experiment. Figure 3A shows the cumulative release of Cd and Te in the acidic column. Over the course of 30 days, 73% of the Cd and 21% of the Te were released.

In the methanogenic column, only very low concentrations of Cd and Te were measured in the effluent during the first 8 days of the experiment, and afterwards these contaminants could no longer be detected in the effluent for the remainder of the experiment. The maximum levels of Cd and Te observed in the effluent were 0.01 mg Cd L^{-1} (on the third day of operation), and 0.02 mg Te L^{-1} (on the second day of operation), respectively. Only 0.03% and 0.05% of the total Cd and Te in the solar panel, respectively, had been released to the effluent when their maximum levels were observed. Figure 3B shows the cumulative release in the methanogenic column. In total, 0.05% of the Cd and 0.18% of the Te were released.

Figure 2B shows that the pH of the effluent of both columns remained stable and very close to the pH of the respective influents over the course of the experiment.

3.2. Chemical oxygen demand balance

The continuous columns used in this work were fed with a synthetic leachate solution composed of a VFA mixture with an initial concentration of approximately 1.5 g COD L^{-1}. To monitor the activity of the microbial communities in the anaerobic sludge, the concentration of the synthetic leachate of the influent and effluent, as well as, the production of methane in both columns were measured during the full time of operation. Equations 2 and 3 were used to estimate the total COD in the influent and effluent of the columns, respectively.

Figure 4A shows the time course of the COD concentration of the synthetic leachate in the influent and effluent of the methanogenic column. The COD concentration decreased progressively from its initial value in the influent until day 20, when the microorganisms in the anaerobic sludge were able to completely degrade the VFA mixture. Figure 4B shows the daily production of methane in the methanogenic column, as well as, the maximum expected production of CH_4 (0.367±0.036 g COD-CH_4 day^{-1}) based on the amount of COD added to the influent of the column. The daily methane production increased over time until it reached the maximum expected value at day 20 and remained stable until the last day of operation At that point of time, the mass balance in Eq. 3 can best be represented as $\Sigma[COD]_{infl} = [COD]_{methanc.}$

In the case of the acidic column, no degradation of the VFA in the synthetic leachate or methane production was observed in the full time of operation as can be observed in Figure S1A (in supplementary data SD). This is consistent with the fact that the inoculum of the acidic column was subjected to heat treatment to inhibit methanogenic microorganisms. The low pH values of the column contents of the acidic column ($pH_{effluent}$ = 4.74±0.10, Fig. 2B) were also below the optimal range for methanogenesis.

3.3. Standardized leaching test

In this study, fragments of the CdTe solar panel were subjected to the EPA TCLP test and to the California WET leaching test to assess the potential dissolution of the toxic compounds present in the semiconductor material.

Figure 5 shows the results for the TCLP and WET test performed with the CdTe solar panel. The concentration of soluble Cd determined in the TCLP and WET tests were 0.150±0.006 and 0.219±0.010 mg L^{-1}, respectively. The Cd concentration was 6.7-fold lower than the threshold limit established in the TCLP test and 4.6-fold lower than the one for the WET test. The concentration of soluble Te in the final solutions produced in the TCLP and WET tests were 0.069±0.008 and 0.074±0.011 mg L^{-1}, respectively.

4. Discussion

4.1. Main findings

4.1.1 Leaching of Cd and Te—The potential release of the toxic compounds from a CdTe thin-film solar panel under conditions simulating those prevailing in young- and a mature MSW landfills was assessed in this work. The most important effect was observed in

the acidic column in which a remarkable release of Cd was observed (ca. 73% of the Cd supplied as CdTe). The maximum concentration of Cd in the leachate was 3.24 mg L^{-1}, which is 3-fold higher that the TCLP limit for Cd, and 650-fold higher than the U.S. federal MCL in drinking water (0.005 mg L^{-1}). Comparison of Cd levels in the leachate with MCL values provides information on the required attenuation to ensure that MLC levels are not exceeded in drinking water resources impacted by landfill leachate. The maximum concentration of dissolved Te measured in this leachate was 1.1 mg L^{-1}. In contrast, the release of dissolved Cd and Te species was negligible in the methanogenic column. To the best of our knowledge, this study represents the first attempt to comparatively assess the leaching behavior of a CdTe solar panel by considering both simulated acidic and methanogenic landfill conditions in a continuous flow fashion.

Whereas the maximum flux of dissolved Cd detected in the acidic column was 0.246 mg Cd cm^{-2} cross section of the column hr^{-1}, it is important to mention that the solar panel used in this study contained low levels of Cd and Te compared to the amount reported for other CdTe panels in several other studies. The PV cell used in this work contained 0.843±0.187 g Cd, and 0.891±0.211 g Te per m^2 of intact panel representing a mass percentage of 0.004 ± 0.001% of each in the solar panel. Other works have reported contents of Cd and Te which are 7.4- fold to 74.6-fold higher than those used in this study [21, 22, 43]. The amount of Cd and Te in solar panels has been decreasing over time in an attempt to reduce production costs and comply with environmental restrictions [44, 45]. The large variability in Cd and Te content suggests that higher concentrations of soluble Cd and Te could be released if older CdTe solar cells are disposed in MSW landfills after they reach the end of their useful service life (25-35 years).

The findings of the present work correlate well with the results reported previously in chemical dissolution that used CdTe powder. Leaching tests conducted by Zeng et al. [27] demonstrated that CdTe has a high leaching potential, especially under acidic and aerobic conditions. Their study demonstrated that the concentrations of Cd released from CdTe powder when subjected to the TCLP and WET leaching tests were about 1500 and 260 times higher than the regulatory limit (1 mg L^{-1}). The concentrations of soluble Cd determined in the present study are markedly lower than those obtained in the leaching studies performed with pure CdTe because CdTe solar cells contain a very large mass fraction of inert glass and the CdTe is present in a film.

The potential dissolution and mobility of Cd and Te from CdTe solar panels due to physico-chemical factors have been previously assessed using standardized batch leaching tests, and in one case, a column set up was used assessing leaching by rain. The TCLP data determined previously for CdTe solar panels show a large variability and soluble Cd values ranging from less than 0.15 to over 9.5 mg Cd L^{-1} (*i.e.*, almost 10-fold higher than the TCLP threshold) have been reported [18, 19, 23, 46]. Two standardized leaching tests were conducted according to the European Union landfill directive and the U.S. TCLP on CdTe modules manufactured by the British Petroleum Company (BP) [46]. The concentrations of Cd in the produced leachates were lower than the thresholds limits established in the corresponding protocols. In a different study, a standardized batch leaching tests was performed according to the Norwegian Standard-European Norm Characterization of waste.

This test uses deionized water as the leaching solution. The concentration of Cd in final leachate was found to be below the threshold limit established for an MSW landfill (≤1 mg Cd kg^{-1} dw.) [22]. In a study performed to investigate the impact of rain conditions on the mobility and emissions of soluble Cd and Te species in the environment, the concentrations of dissolved Cd and Te released after one week of exposure were 1.0 and 0.3 mg L^{-1}, respectively[21].

4.1.2 Microbial communities and redox conditions—The degradation of solid waste in MSW landfills occurs through a series of complex chemical and biological reactions [25]. During the acid phase of a landfill, cellulose and hemicellulose are hydrolyzed by bacteria to form monosaccharides, which are fermented by fermentative bacteria to volatile fatty acids. In this stage, the lowest pH of the leachate was reported to be 4.5 [25]. The synthetic leachate used in this work was constituted by a mixture of carboxylic acids representative of those formed by fermentative bacteria during the acidic phase. The initial methanogenic phase starts when the pH of the leachate increases and a minimal growth of methanogenic microorganisms begins. Methanogenic microorganisms are highly sensitive to pH, and methanogenesis occurs only within a narrow pH range (circumneutral). In the methanogenic phase, acetogenic bacteria convert carboxylic acids to acetate, H_2 and CO_2 which in turn are converted to methane by methanogens.

In the methanogenic column, the VFAs in the synthetic leachate were assumed to be converted via acetate, H_2 and CO_2 by acetogenic bacteria in the sludge. Since the pH of the influent of this column (6.71±0.19) was favorable for the growth of methanogenic microorganisms, methane was progressively formed until a stable production of methane was observed. Due to the expected production of H_2 by the acetogenic bacteria, and to the fact that methanogens are highly sensitive to oxygen, it is acceptable to assume that strong reducing conditions prevailed in this column.

4.2. Mechanisms of CdTe dissolution

The different leaching behaviors observed for CdTe in the two columns operated in the present study might be explained by the different pH levels and by differences in the redox conditions promoted by the microbial communities present in the methanogenic inoculum. Figure 6 shows the Pourbaix diagram obtained for the CdTe-H_2O system. The diagram was generated using the highest concentration of each element observed in the effluent of the acidic column. The dashed lines represent the stability region of water and can be defined by the following equations:

$$\text{Upper stability line: } Eh = 1.23 - 0.059pH \quad (4)$$

$$\text{Lower stability line: } Eh = -0.059pH \quad (5)$$

In the region above the upper dashed line (Eq. 4) water releases oxygen. The region below the dashed lower line (Eq. 5) corresponds to the conditions at which water becomes unstable and releases hydrogen.

As mentioned before, there was no substantial evidence of microbial activity in the acidic column based on the lack of VFA consumption and methane production. The resazurin redox indicator dye in the column effluent was pink indicating microaerophilic conditions that may have resulted from the lack of microbial consumption of traces of dissolved oxygen. Under these conditions, the presence of an important fraction of soluble Cd and Te would be expected based on thermodynamic considerations, which is in agreement with the extensive dissolution of CdTe observed in the acidic column. According to the Pourbaix diagram, the redox potential for the lower water stability is -0.276 V and the one for the upper limit is 0.954 V. The thermodynamically stable species expected for Te are elemental Te, $HTeO_3^-$ (tellurite), and H_6TeO_6 (tellurate). The stable species for Cd are CdTe, and soluble Cd^{2+}. The results are in agreement with our previous study investigating the leaching behavior of CdTe under different pH and redox conditions. Those results confirmed a marked enhancement in the dissolution of CdTe powder both at acidic pH levels and under aerobic conditions [27].

Due to the methanogenic microbial activity, highly reducing conditions are expected in the methanogenic column. CdTe is thermodynamically stable in aqueous solution under those conditions and no soluble Cd or Te would be expected in the system. According to the Pourbaix diagram, the redox potential for the lower water stability is -0.396 V, and the one for the upper line is 0.834 V. The thermodynamically stable species for Te are elemental Te and CdTe, and for Cd, CdTe is the only stable species. The absence of dissolved Cd in the circumneutral leachate could also be due to some extent to the decreased solubility of Cd^{2+} with increasing pH.

4.3. Implications

The evidence found in this work indicates that the standardized TCLP and WET leaching tests might underestimate the leaching of Cd and Te from disposing decommissioned CdTe solar panels in landfills. Although some previous works have stated that CdTe is an insoluble form of Cd and that CdTe is expected to have low bioavailability in the environment [47], the results obtained in the present study as well as another related investigations [27] indicate that a high fraction of the Cd and Te in CdTe panels could be potentially released if non-encapsulated CdTe solar panels are discarded in municipal landfills. Leaching of Cd and Te is expected to occur mainly during the acidic phase of a landfill in which low pH values are dominant.

The leaching results reported in the current study were obtained in accelerated column tests simulating the conditions in the acidogenic and methanogenic phases of a MSW landfill. The actual Cd concentrations in a given landfill would depend on the amount of PV panels disposed, panel design, panel fragment size, climatic conditions, landfill management and design, etc. The risk that leachate impact groundwater is minimized in modern MSW landfills that are designed with daily cover of the waste, storm water management, use of liners at the bottom of the landfill, and a leachate collection system [48]. Releases into

groundwater are, thus, particularly a problem in landfills that were not originally designed to prevent migration of the leachate (unlined landfills). Elevated concentrations of metals and metalloids have been measured in samples of groundwater collected in locations close to landfills receiving electronic waste [49]. Furthermore, release of these highly toxic compounds into the landfill, could impact the microbial communities degrading organic waste and, thereby, the waste stabilization process. Our findings from a previous work indicated the methanogenic activity of anaerobic sludge are highly inhibited by the presence of Cd and Te soluble species [50].

The significant leaching of toxic Cd demonstrated in the present study under simulated, acidic landfill conditions indicates the need for further investigation of the leaching potential of decommissioned CdTe PV panels, and suggests the need for measures to minimize their disposal in MSW landfills. In this sense it is important to point out that, as previously mentioned, the European Union has recently adopted the WEEE Directive that aims to achieve a high degree of separation of PV panels and other electronic waste in order to minimize their disposal in MSW landfills, reduce the entry of toxicants into the environment, and ensure recycling and recovery of valuable and hazardous materials from these waste resources [20]. The U.S. Solar Energy Industries Association (SEIA) did also launch a solar PV recycling program in late 2016 to improve the environmental sustainability of the U.S. solar industry [51].

Conclusions

The biogeochemical conditions prevailing during the different stages of a landfill potentially affect the release of the toxic soluble compounds from decommissioned non-encapsulated CdTe PV cells. During the acidic phase of a young landfill, the highest release of Cd and Te will be expected as a result of the low pH prevailing in the landfill environment. In contrast, during the methanogenic phase of a mature landfill, low corrosion of CdTe caused by the highly reducing conditions in the landfill environment only allows for marginal release of soluble Cd and Te species. Given the high toxicity of Cd, these results suggest the need for measures to minimize the disposal of decommissioned CdTe PV panels in MSW landfills.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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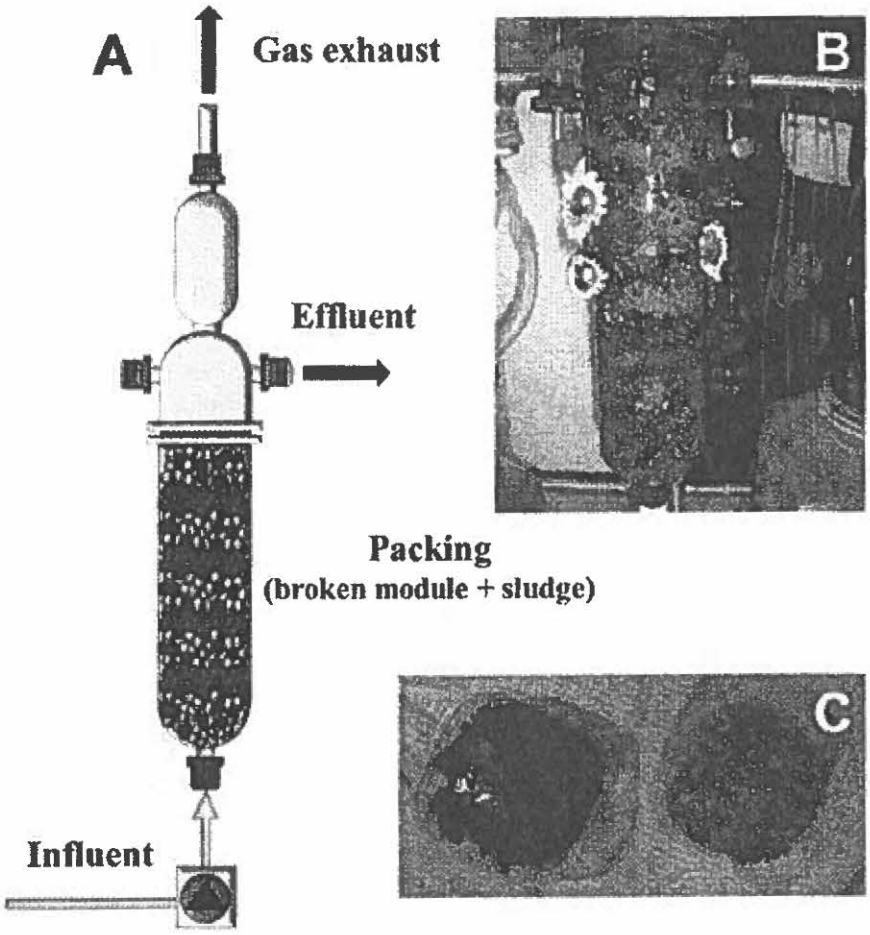


Figure 1.

Schematic of the continuous columns used in this work (**panel A**). Image of the layered packing of the columns (**panel B**). Snipped CdTe film and crushed glass fractions of solar panels used in the column packing (**panel C**).

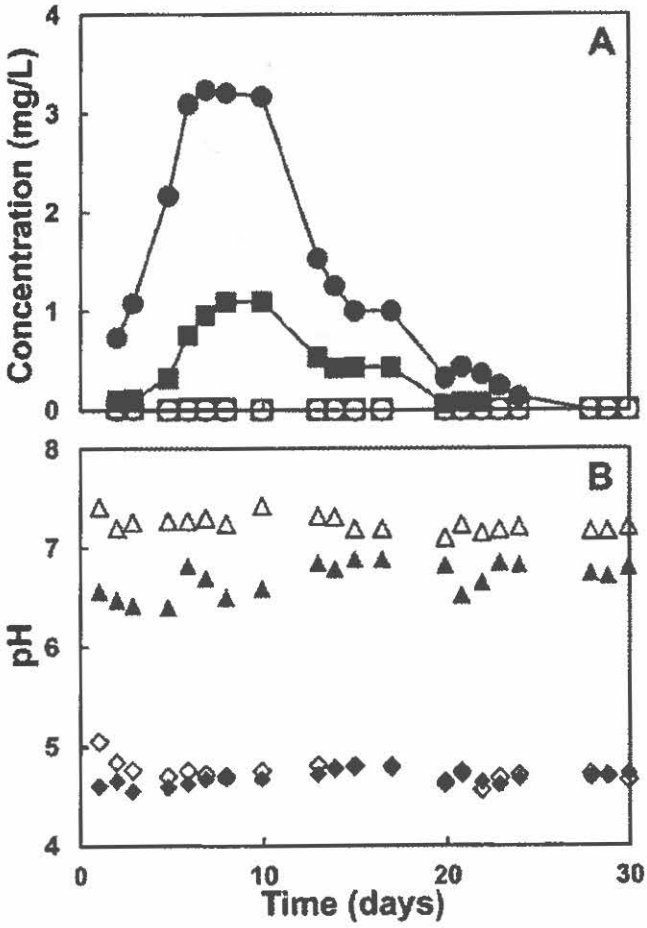


Figure 2.

Release of soluble cadmium (Cd) and tellurium (Te) from a CdTe solar panel and pH of the effluent of continuous flow columns operated under simulated landfill conditions as a function of time. **Panel A**: Concentrations (in mg L^{-1}) of Cd (●) and Te (■) in the effluent of the column simulating the conditions of a young, acidic landfill (pH 4.67 ± 0.06); and concentrations of Cd (○) and Te (●) in the effluent of the column simulating the conditions of a mature methanogenic landfill (pH 6.71 ± 0.19). **Panel B**: pH of influent (◆) and effluent (◊) of the column simulating an acidic landfill; pH of the influent (▲) and effluent (Δ) of the column simulating a methanogenic landfill.

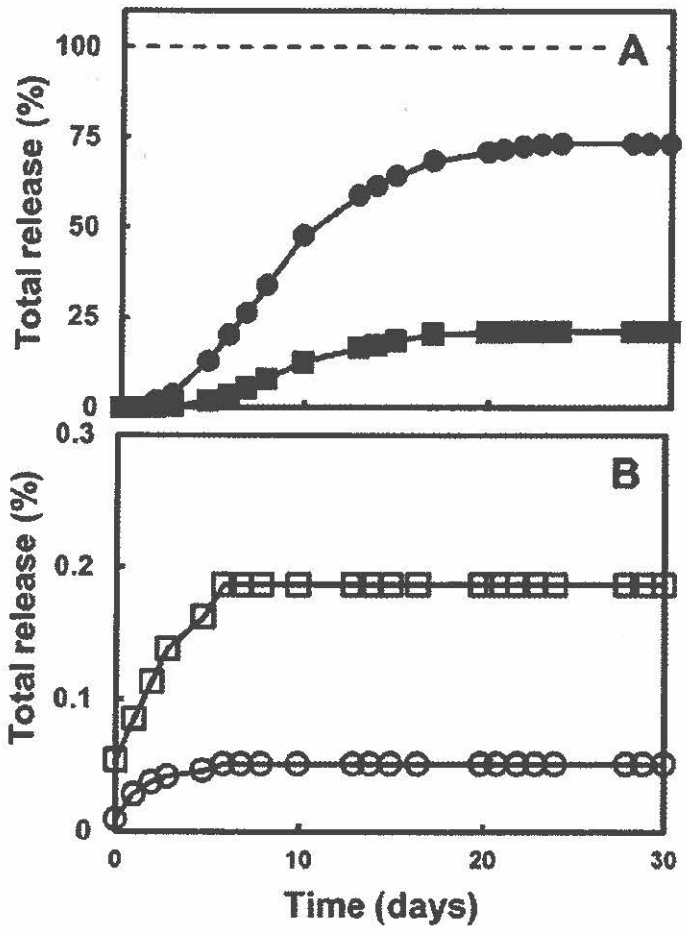


Figure 3.

Time course of the cumulative release of soluble cadmium (●, ○) and tellurium (■, □) from the solar panel in the continuous columns (as % of the total initial metal concentration supplied as CdTe). **Panel A**: Column simulating the conditions of an acidic landfill. **Panel B**: Column simulating the conditions of a methanogenic landfill.

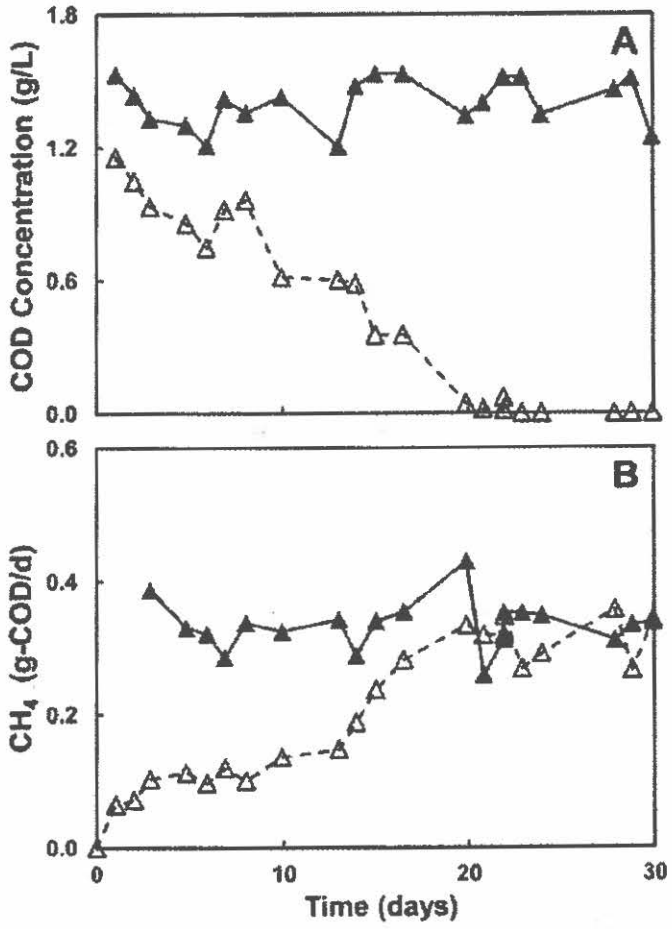


Figure 4.

(**Panel A**) COD concentration in the influent (▲) and effluent (Δ) of the methanogenic column (pH 6.71± 0.19). (**Panel B**) Daily production of methane as a function of the operation time: (▲), maximum expected concentration based on the amount of COD added to the influent; (Δ), daily measured production.

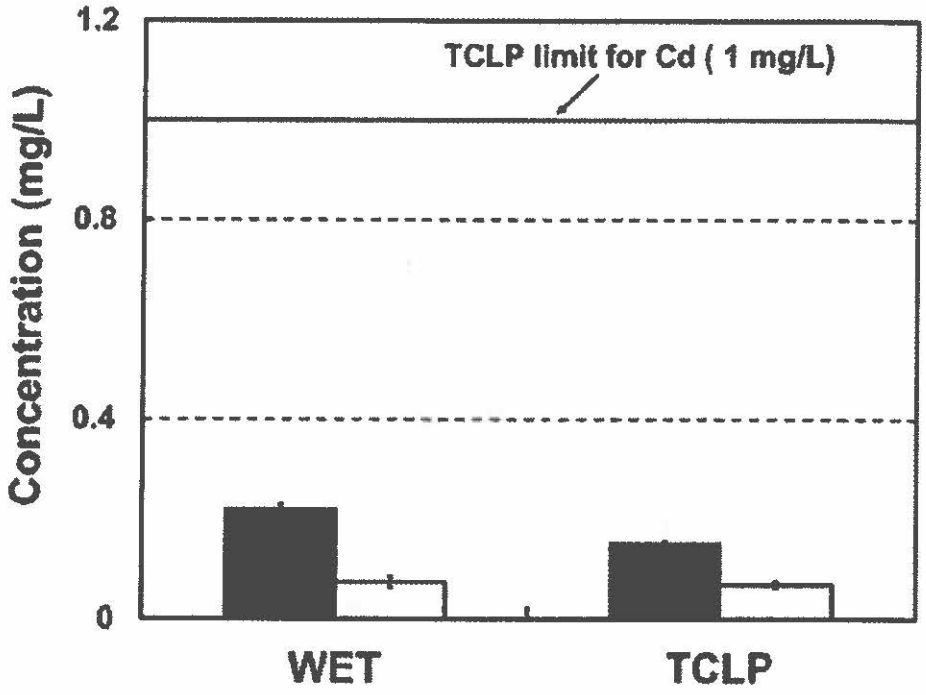


Figure 5.

Concentrations of soluble Cd (filled columns) and soluble Te (blank columns) released from the CdTe solar panel in the US-EPA Toxicity Characteristics Leaching Procedure (TCLP) and the California Waste Extraction Test (WET) leaching tests.

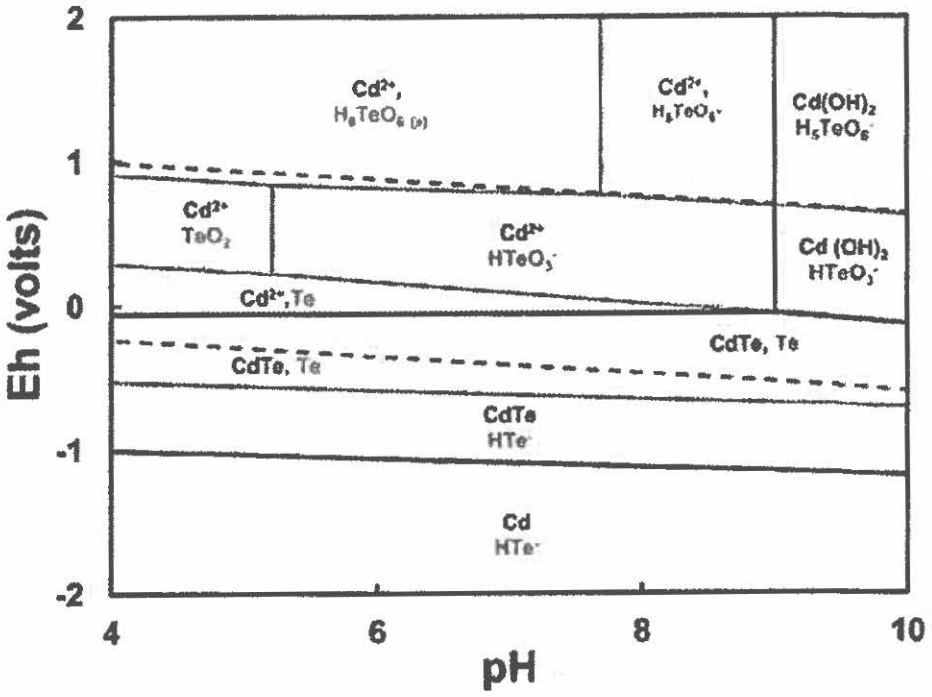


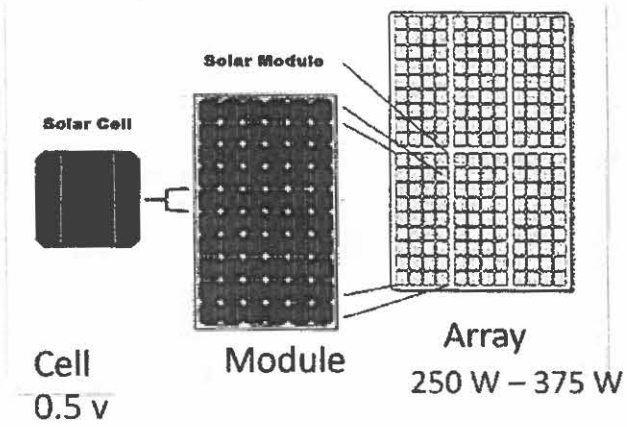
Figure 6.
Pourbaix diagram for the CdTe – H_2O system at 25°C. Pourbaix diagrams were constructed at activities of 2.9×10^{-2} mM Cd, and 8.6×10^{-3} mM Te.

Types of Photovoltaic (PV) Modules

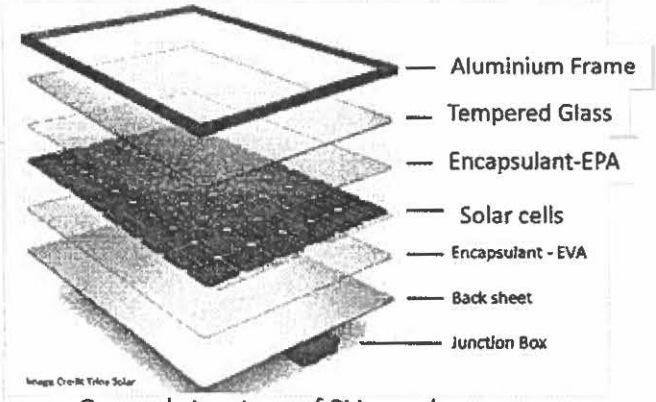
PV-Modules have evolved:

1. **First generation**: poly and mono crystalline silicon (c-Si)
   - Absorber layer is ~ 200 μm, low cost
   - 90 % of current modules
2. **Second generation**: thin-film technologies like cadmium telluride (CdTe), amorphous and copper-indium-selenide (CIS)
   - Absorber layer is ~ < 4 μm
   - Higher absorption 10 – 1000 nm
   - Less materials to make, flexible,
   - Energy pay back time = 5- 10 months
3. **Third generation**: includes technologies that are not available on a large scale (e.g., concentrator photovoltaic or organic solar cells)

Main Components of a typical c-SI PV Panel (Source Clean Energy Reviews, Trina Solar



Schematic of a PV Cell, Module, and Array (Infinite Power, n.d.)

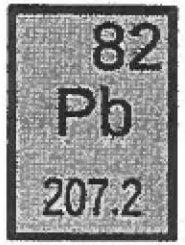


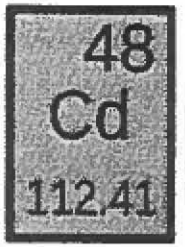
General structure of PV panel

EVA - ethyl vinyl acetate

Solar Panels can be Hazardous Waste

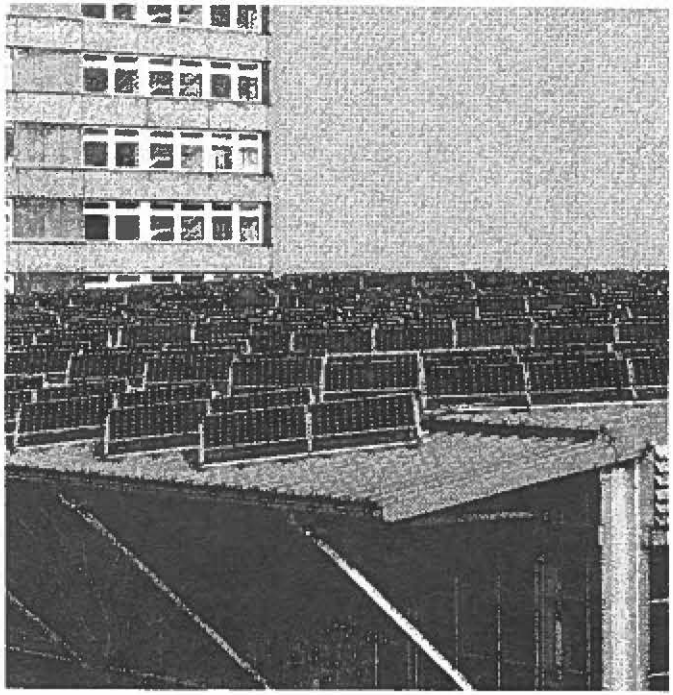
- Toxicity characteristics of PV-panel waste contains lead and cadmium
- The concentration of the toxic constituents in the specific panel, the aging or damage of the panel
- PV- panels become hazardous waste when since they exhibit the toxicity characteristic from Pb in the solder and/or cadmium in the panels
- Most of the structure of PV panel, such as Al-frame is not hazardous waste, and can be de-manufactured and recycled





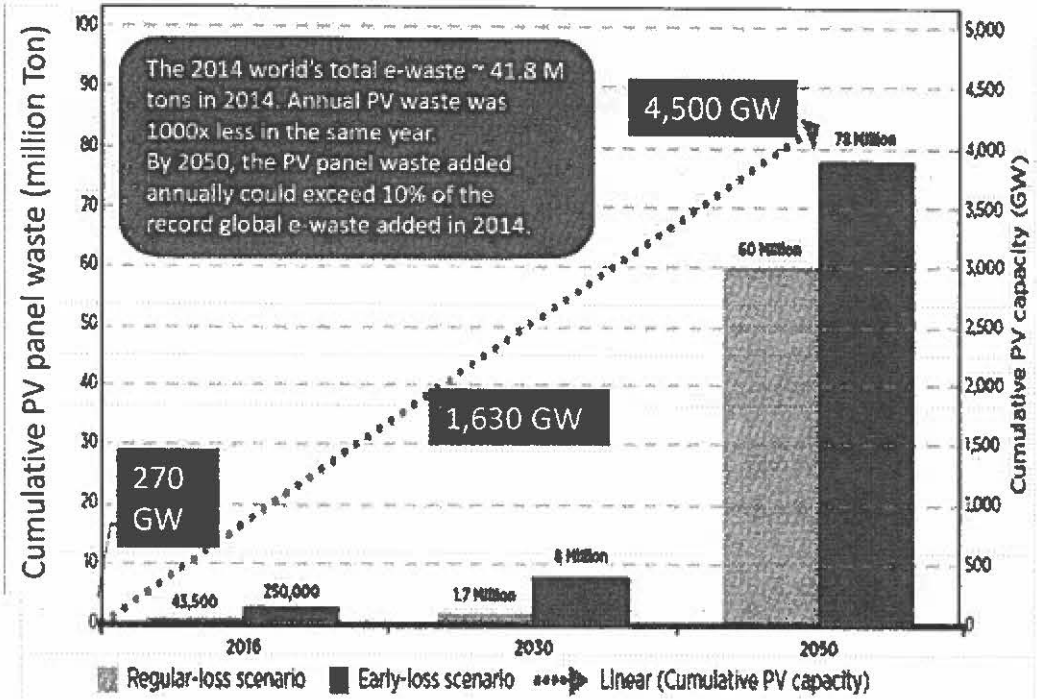
Outline

1. National Trends and Projection
2. Overview PV-Panels System
3. Projected Quantities of EoL Solar Panels
   - Forecasting tool
4. EoL PV Panel Management Practices
5. Management Practices and Regulations



Global PV Panel Waste Projection

Material	Quantity (kg)	% Weight of Module (wt/wt)
Glass, containing antimony (0.01-1%/kg of glass)	700	70%
Aluminum frame	180	18%
Copper connector	10	1%
Polymer-based adhesive (EVA) encapsulation layer	51	5.1%
Back-sheet layer (based on polyvinyl fluoride)	15	1.5%
Silicon metal solar cell	36.5	3.56%
Silver	0.53	0.053%
Aluminum, internal conductor	5.3	0.53%
Copper, internal conductor	1.14	0.114%
Various metals (tin, lead)	0.53	0.053%
Total	1,000	100%



Source: Latunussa et al., 2016

Overview of IRENA and IEA-PVPS (2016) Methodology

Determine PV capacity out to 2050 by country

- Existing IRENA report data for 2016 and 2030
- Interpolation between 2016 and 2030 using average growth in 5-year blocks
- Applied a conservative 2.5% escalation between 2030 and 2050

Converted PV capacity to mass

- Calculate an average ration of mass of PV per unit capacity (tons/MW) by averaging available data from leading manufacturers on panel weight and nominal power

Estimated the probability of PV panel losses

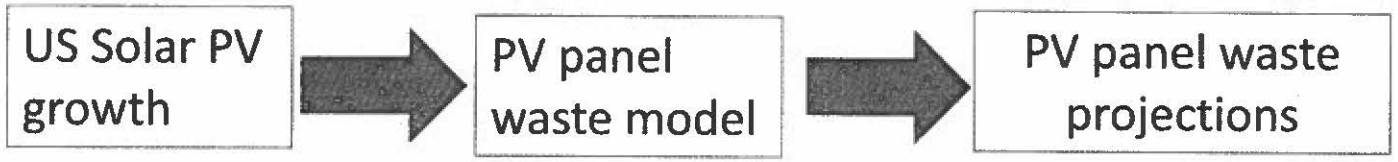
- Probability of failure for regular-loss and early-loss scenarios using the Weibull distribution function

Determined PV panel loss by estimated panel weight

- Results in annual tonnage of PV EoL panels

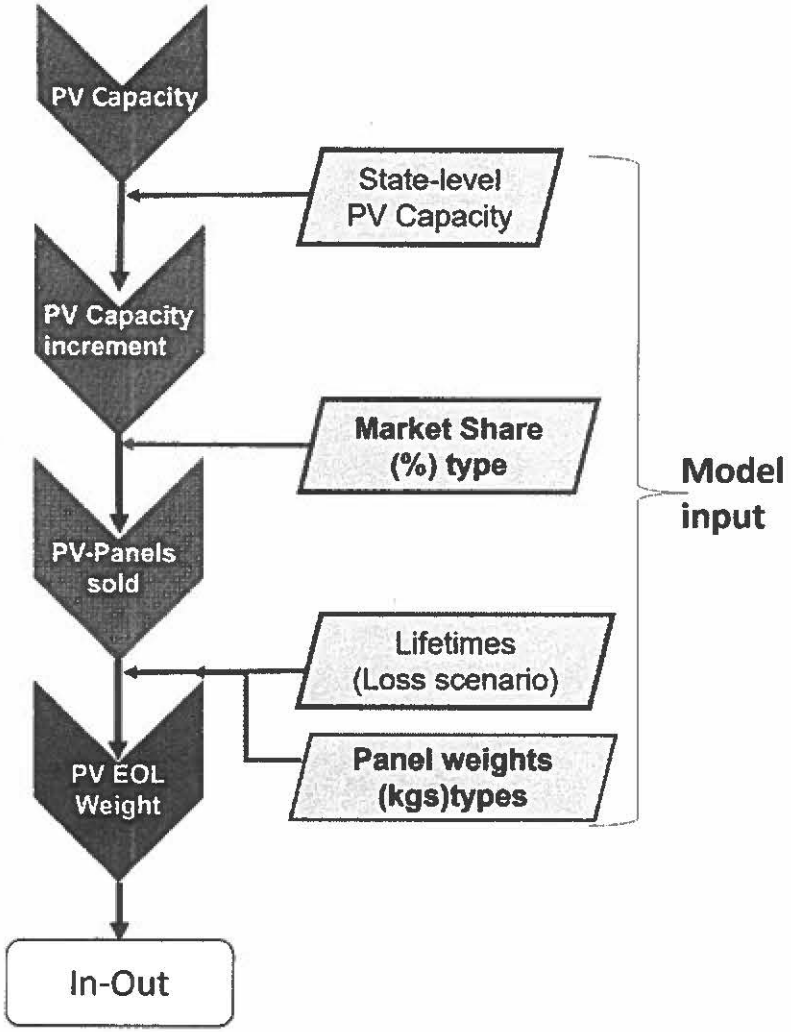
Solar PV Panel Waste Projection

At present PV market is young
2030: PV panel waste streams ~ 4 – 14 % of production
2050: PV panel waste ~ 80 % of installation



- Most waste is generated during four primary life cycle phases of PV panel.
  1) panel production,
  2) panel transportation
  3) panel installation and use, and
  4) end-of-life disposal of the panel.
- The following waste forecast model covers all life cycle stages except production.

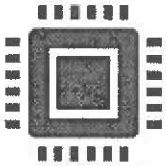
PV End-of-Life Model Process Flow Map



PV Panel Waste Stream Flow Model

- *Installed Solar PV capacity* (MW)
  - Predict future growth projection (source: Solar Energy Industries Associates (SEIA)
- *Market Share*: residential, commercial, industrial
  - Customer segment: residential versus commercial
  - Source: International Energy Agency
  - EIA-860 Non-Net Metering Distributed Capacity (MW), and Net Metering Capacity (MW).
  - EIA-860, Existing nameplate Capacity Energy Source, Producer Type and State
- Quantifies when and how much PV panels come to EoL
- What is the capacity – Increase
- The conversion & probability of loss during the PV panel life cycle

PV Panel Scope and Expected Lifetimes

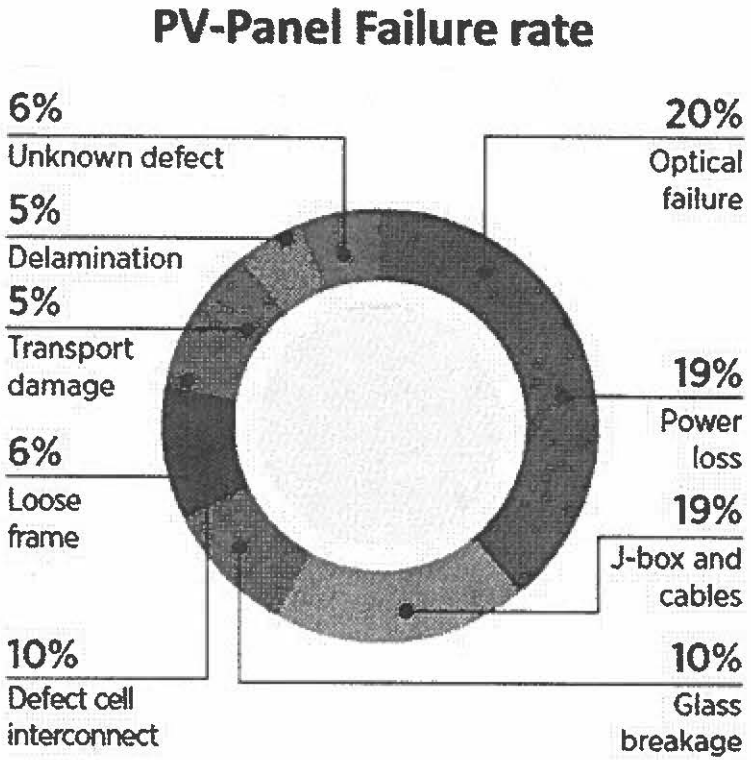


PV Panel Lifetime
25 to 30 years
Point at which panels may drop to 80% efficiency and tend to be upgraded or replaced
No comprehensive tracking of when PV panels enter the EoL stage

PV Market
2 market segments: residential and commercial
Commercially-available panels, no deviation in individual manufacturer performance
Not considering off-grid

Examples of EoL Situations

- Regular
  - End of expected panel life failure (i.e., 25 to 30 years)
  - Decommissioning (the end of the period or performance for a solar project)
- Early
  - Early failure
  - Identified safety issues
  - Weather damage (e.g., hail, extreme winds) and natural disasters (e.g., hurricanes, flooding, fires)
- Mid-Life (sometime between early and regular)
  - Homeowners who choose to uninstall an existing solar installation
  - Part replacement (e.g., inverters), panel refurbishment
  - Economic viability
- Other
  - Waste generated from solar panel manufacturing
  - A generator who decides to discard unused solar panels
  - Panels that were found (illegally dumped or abandoned)



Based on IEA-PVPS (2014a)

Model Assumptions

Model	Data input and references
Regular-loss scenario input assumptions • 30-year average panel lifetime • 99.99% loss after 40 years • extraction of Weibull model parameters from literature data Early-loss scenario input assumptions • 30-year average panel lifetime • 99.99% probability of loss after 40 years • Inclusion of supporting points for calculating nonlinear regression: • Installation/transport damages: • 0.05% of installed modules fail annually • 0.05% of modules fail before leaving manufacturer per year, and • 2% of modules are broken in production per year.	• The 30-year average panel lifetime assumption was taken from literature (Frischknecht et al., 2016). • A 99.99% probability of loss was assumed using the Weibull function. The 40-year technical lifetime assumption is based on depreciation times and durability data from the construction industry (Greenspec, 2016). • The early-loss input assumptions were derived from different literature sources (IEA-PVPS, 2014a; Padlewski, 2014; Vodermeyer, 2013; DeGraaff, 2011).

Weibull Probability Loss Function for PV Panels

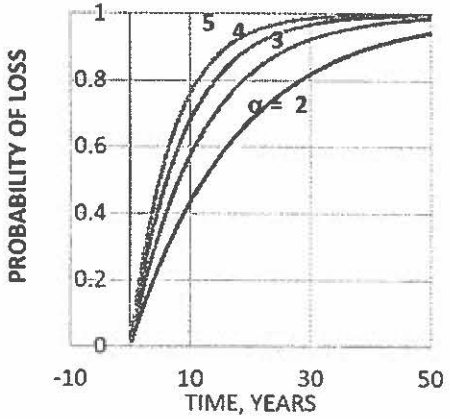
- Average panel lifetime = 30-year
- Both early-loss and regular-loss scenarios were modelled using the Weibull function based

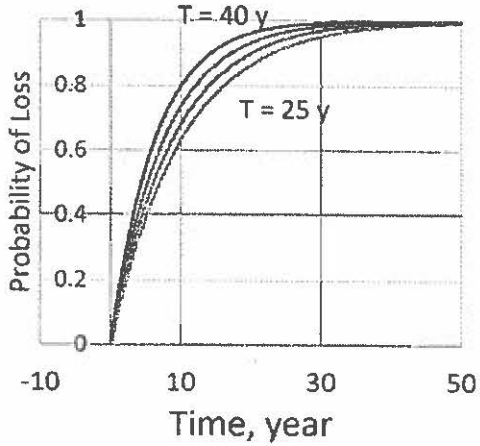
$$F(t) = 1 - e^{-\left(\frac{t}{T}\right)^{a}}$$

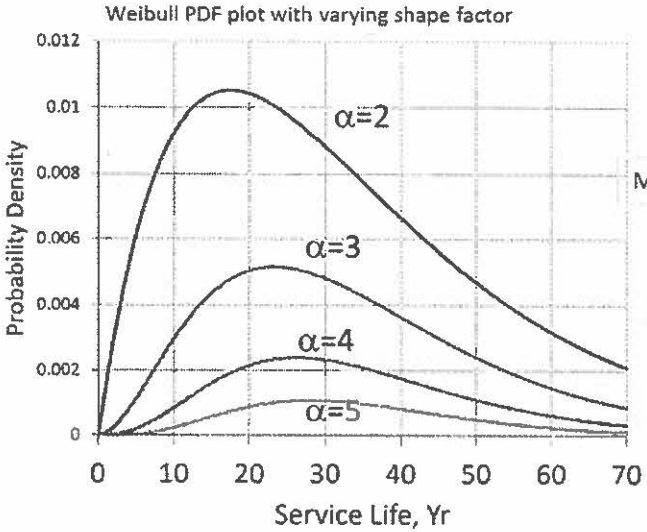
t = time in year
T = average life-time
α = shape factor

Scenarios	Weibull Parameters α (shape)	Weibull Parameters t (scale)
Regular Loss	5.3759	30
Early Loss	2.4928	30
Mid Loss	3.6	30

(Frischknecht, et al., 2016) and 5.3759 (Kuitsche, 2010; Zimmerman, 2013),



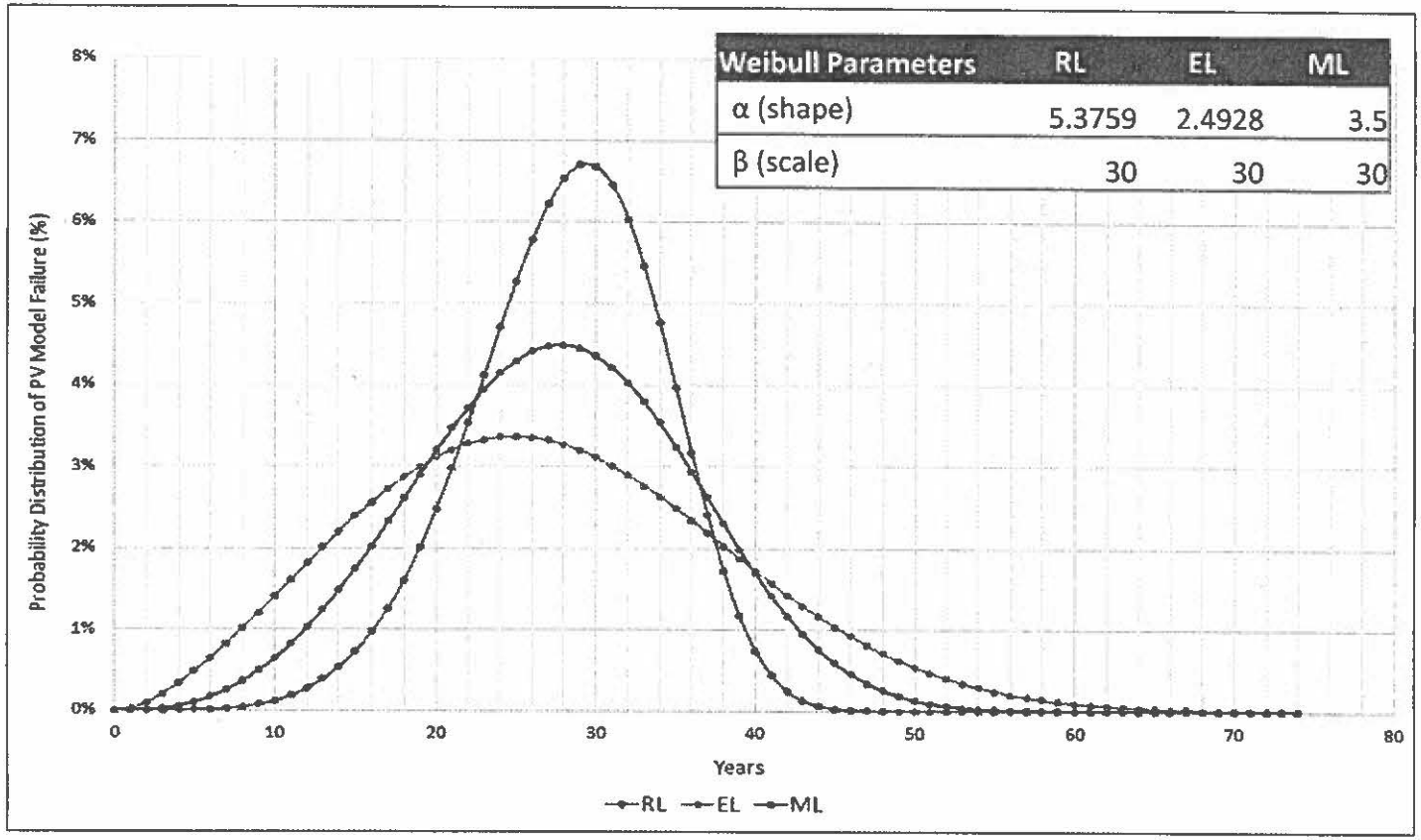




Median=T(ln2) $^{1/\alpha}$

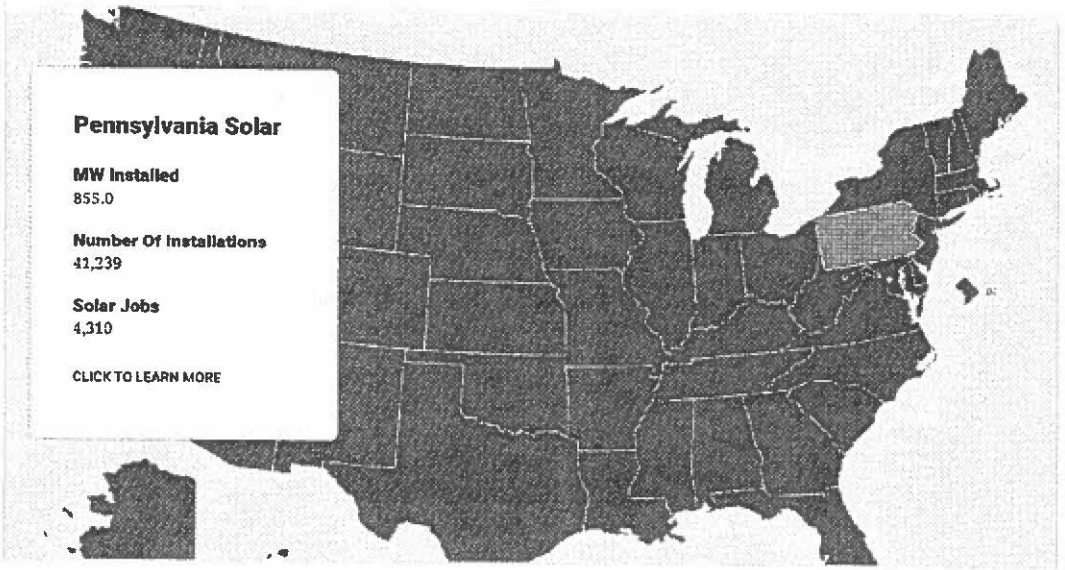
α	T
2	29
3	31
4	32
5	32.5

Weibull Probability Distributions



Installed State PV Capacity (MW)

- Solar Energy Industries Association (SEIA)
  - Installed capacity by state to Q4 2020
  - Projections by state between 2021 to 2024
- EIA 2020 Annual Energy Outlook (AEO)
  - Projections of solar PV capacity growth between 2025 and 2050



SEIA Solar State by State, https://www.seia.org/states-map

Market Share

- Done to separately estimate EoL mass from commercial vs. residential panels

- Percentage of total installed solar PV capacity in 2019 for residential and commercial segments
  - EIA-861, Non-Net Metering Distributed Capacity (MW)
  - EIA-861, Net Metering Capacity (MW)
  - EIA-860, Existing Nameplate Capacity Energy Source, Producer Type, and State

- Market share calculations
  - Summed residential capacity from both EIA-861 datasets
  - Assumed the commercial segment data included all non-residential installed PV capacity (commercial, industrial, and electric utilities)
  - Calculated the percentage of total installed solar PV capacity by state

Lifetimes and Scenario Runs

- Assumed PV panel lifetime of 30 years for commercial and residential
- Modeled 3 scenarios

Scenarios	Weibull Parameters α (shape)	Weibull Parameters t (scale)
Regular Loss	5.3759	30
Early Loss	2.4928	30
Mid Loss	3.5	30

α parameter sources: Kuitsche, 2010; Zimmermann, 2013; Frischknecht, 2016

Panel Generation Capacity and Weight

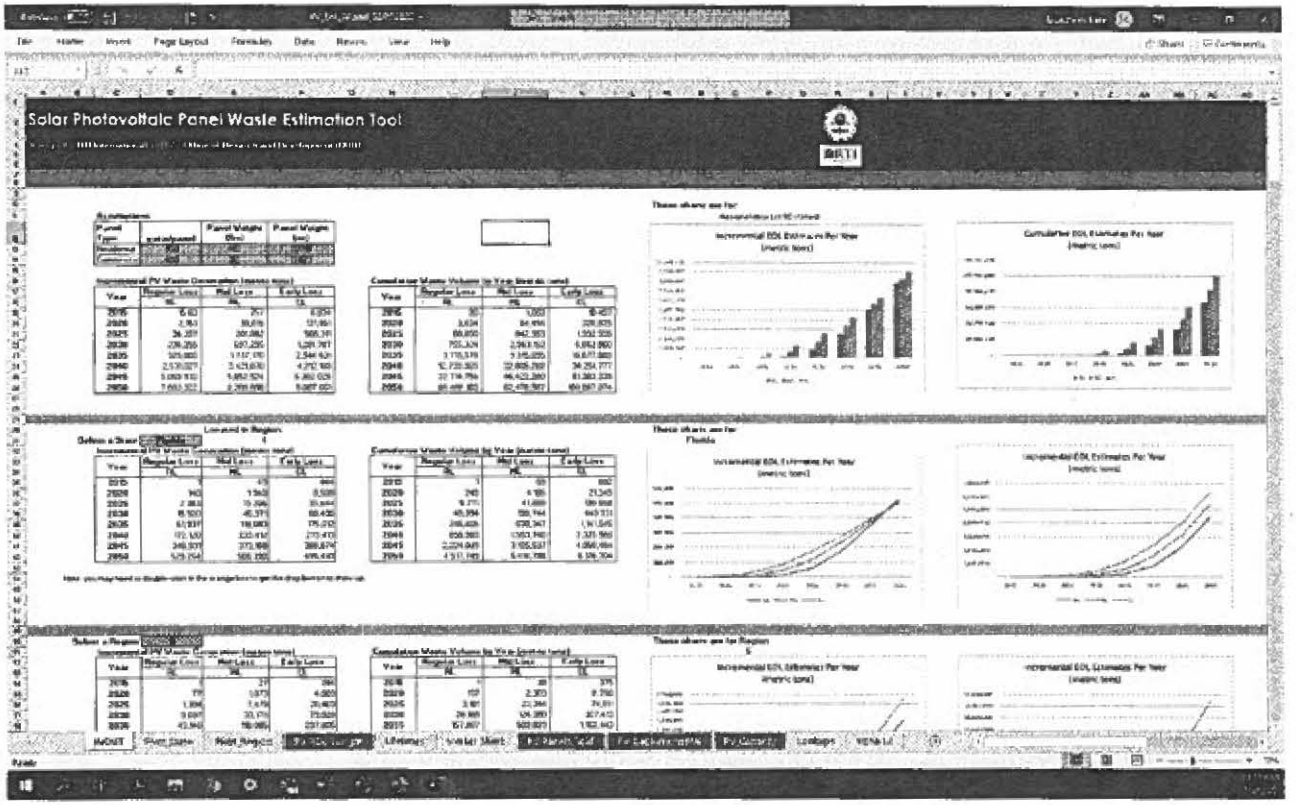
- Used to convert annual incremental installments of PV capacity (MW) to the number of PV panels installed each year.
- Multiplied by average panel weight to estimate the total installed weight.

Panel Type	Range of Size and Weight	Modeled Capacity (watts/panel)	Modeled Panel Weight (lbs)
Residential	65" x 39" 33 to 50 lbs	350	40
Commercial	78" x 39" 50+ lbs	400	50

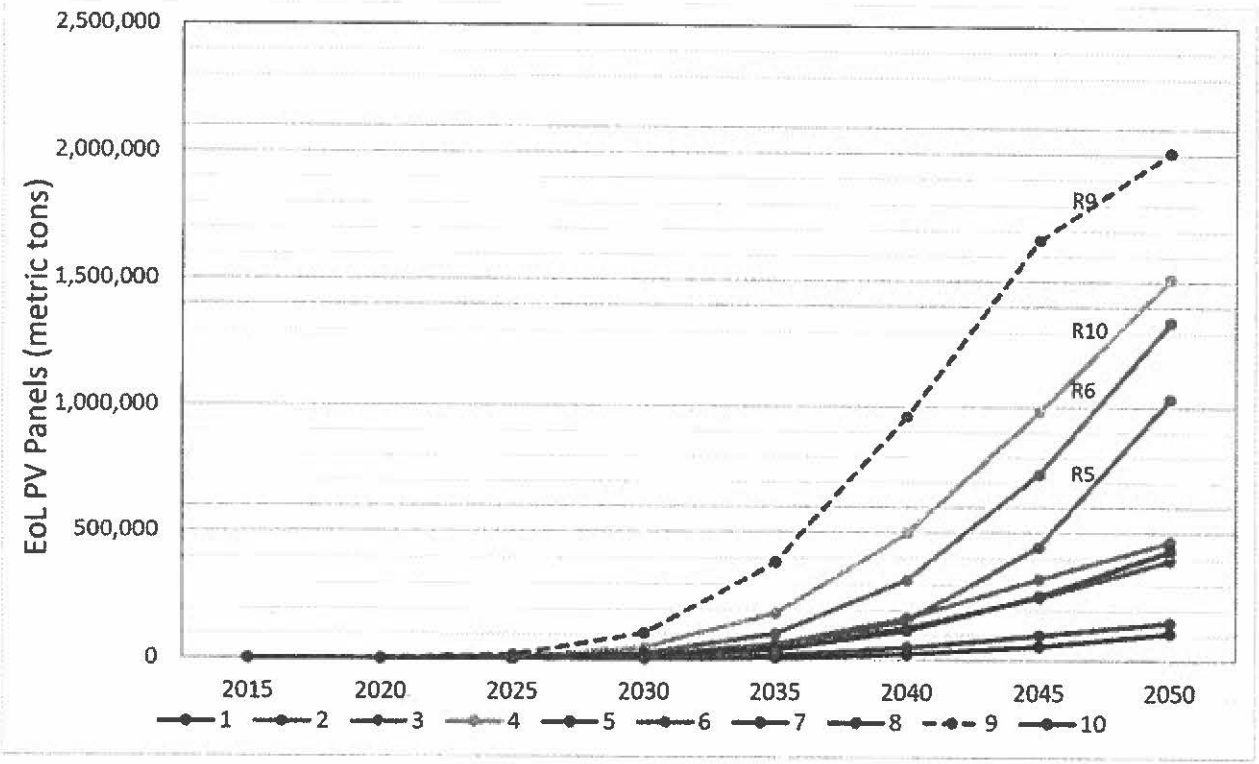
EoL PV Panel Loss (metric tons)

Year	Regular	Mid	Early
2015	16	757	6,834
2020	2,153	30,015	131,051
2025	36,357	201,882	506,311
2030	236,255	697,295	1,281,707
2035	925,865	1,737,170	2,544,631
2040	2,531,027	3,421,870	4,212,169
2045	5,059,933	5,652,524	6,302,028
2050	7,883,322	8,308,606	9,087,051
2050 IRENA	7.5 million	--	10 million

INOUT Worksheet – Main User Interface

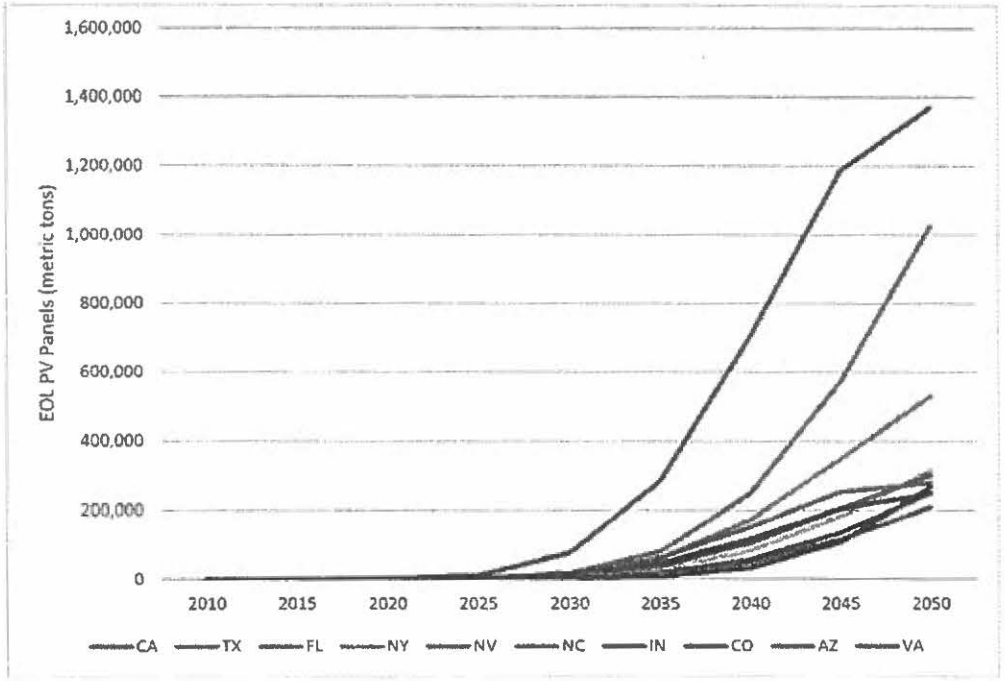


EoL PV Panel Projects by Region (RL, mt)

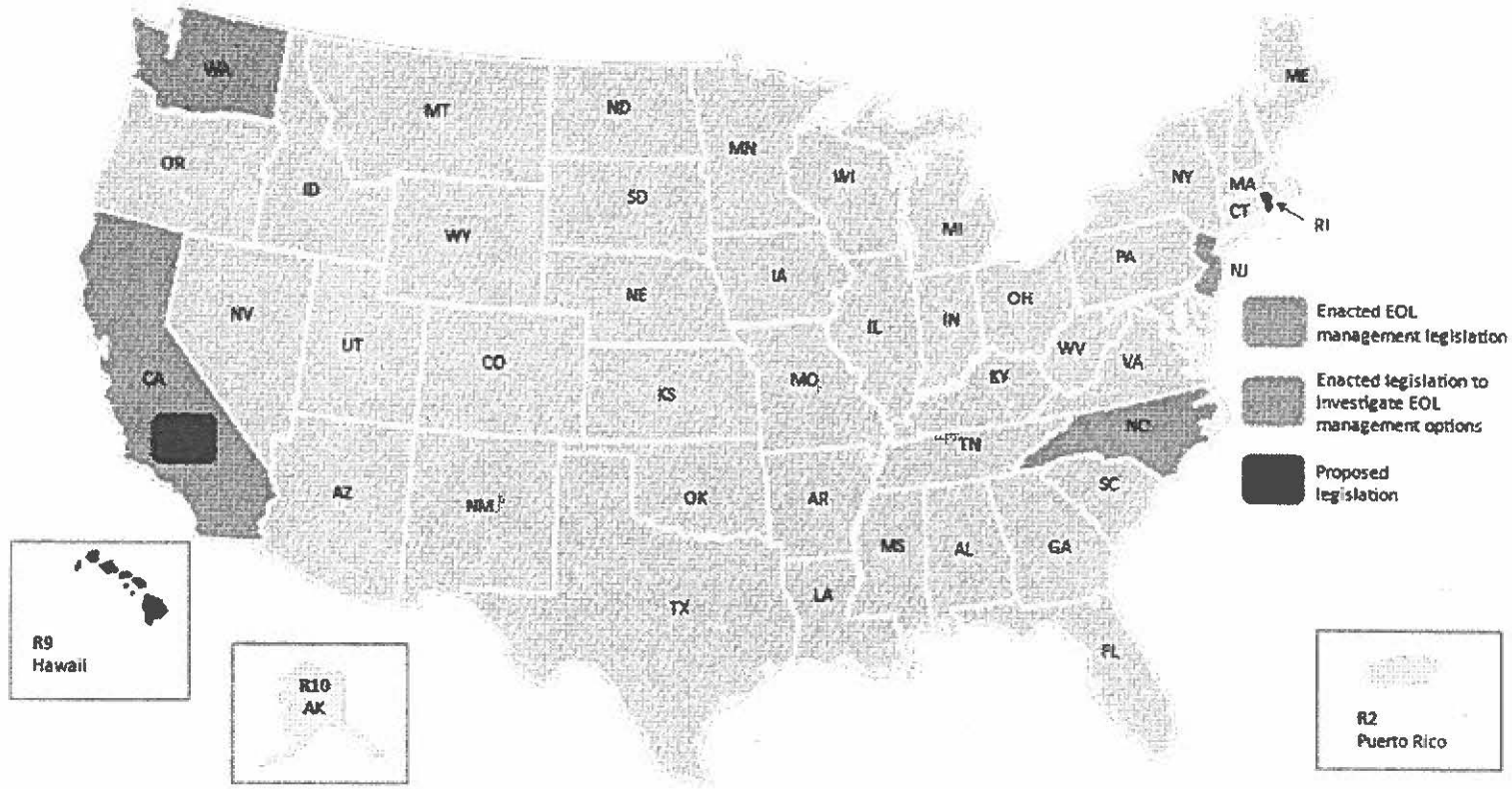


Top 10 States Under the Regular Loss Scenario by 2050

Highest Installed Capacity (2020)	Largest EoL Generators, RL (2050)
CA	CA
TX	TX
NC	FL
FL	NY
AZ	NV
NV	NC
NJ	IN
MA	CO
GA	AZ
NY	VA



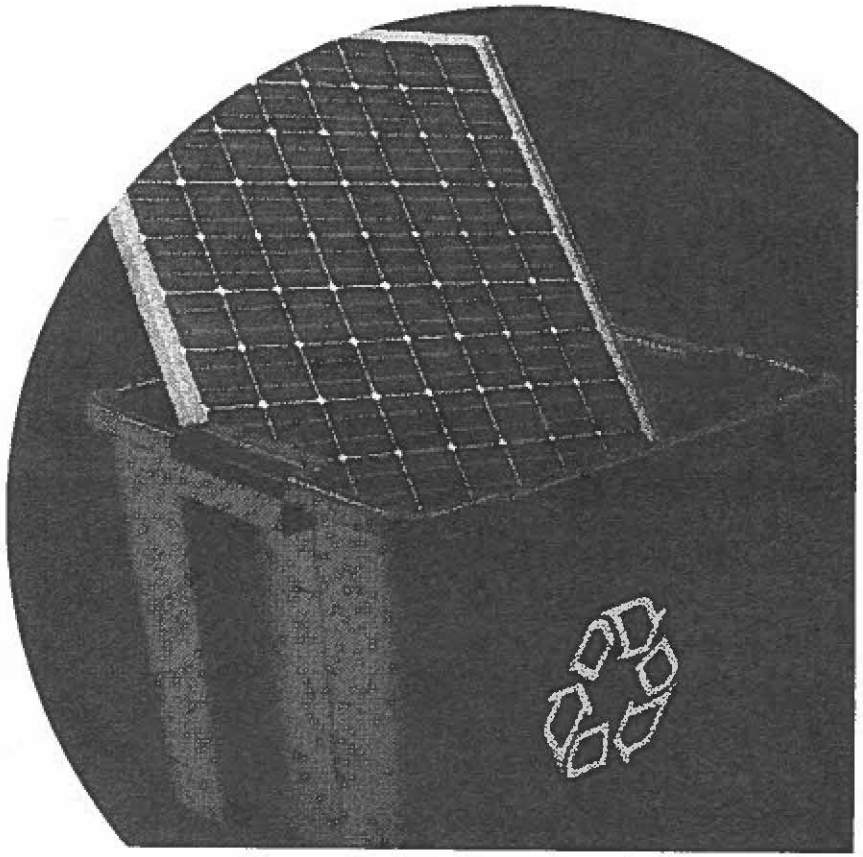
Current (as of 2020) PV Panel EoL Management Legislation



The Solar Panel Conundrum

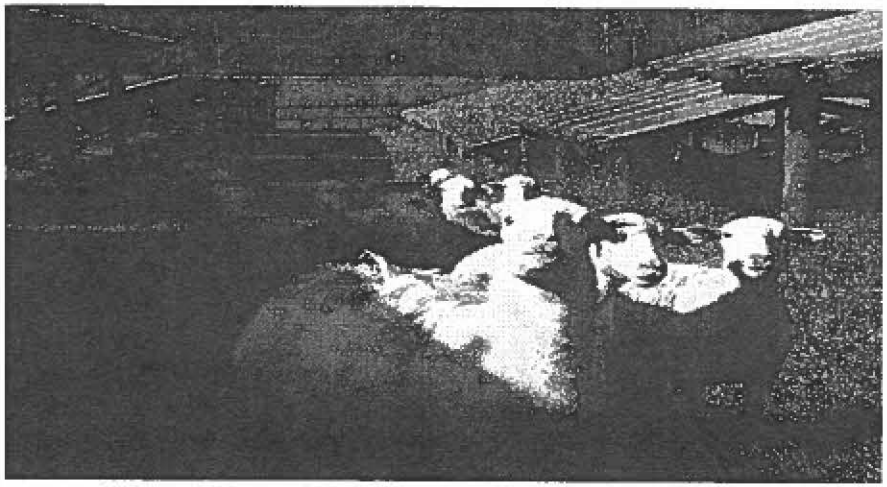
E. Sahle Demessie, John A. Glaser, Teri Richardson

U.S. Environmental Protection Agency,
Office of Research and Development
Center for Environmental Solution and Emergency Response
Cincinnati, Ohio



Disclaimer

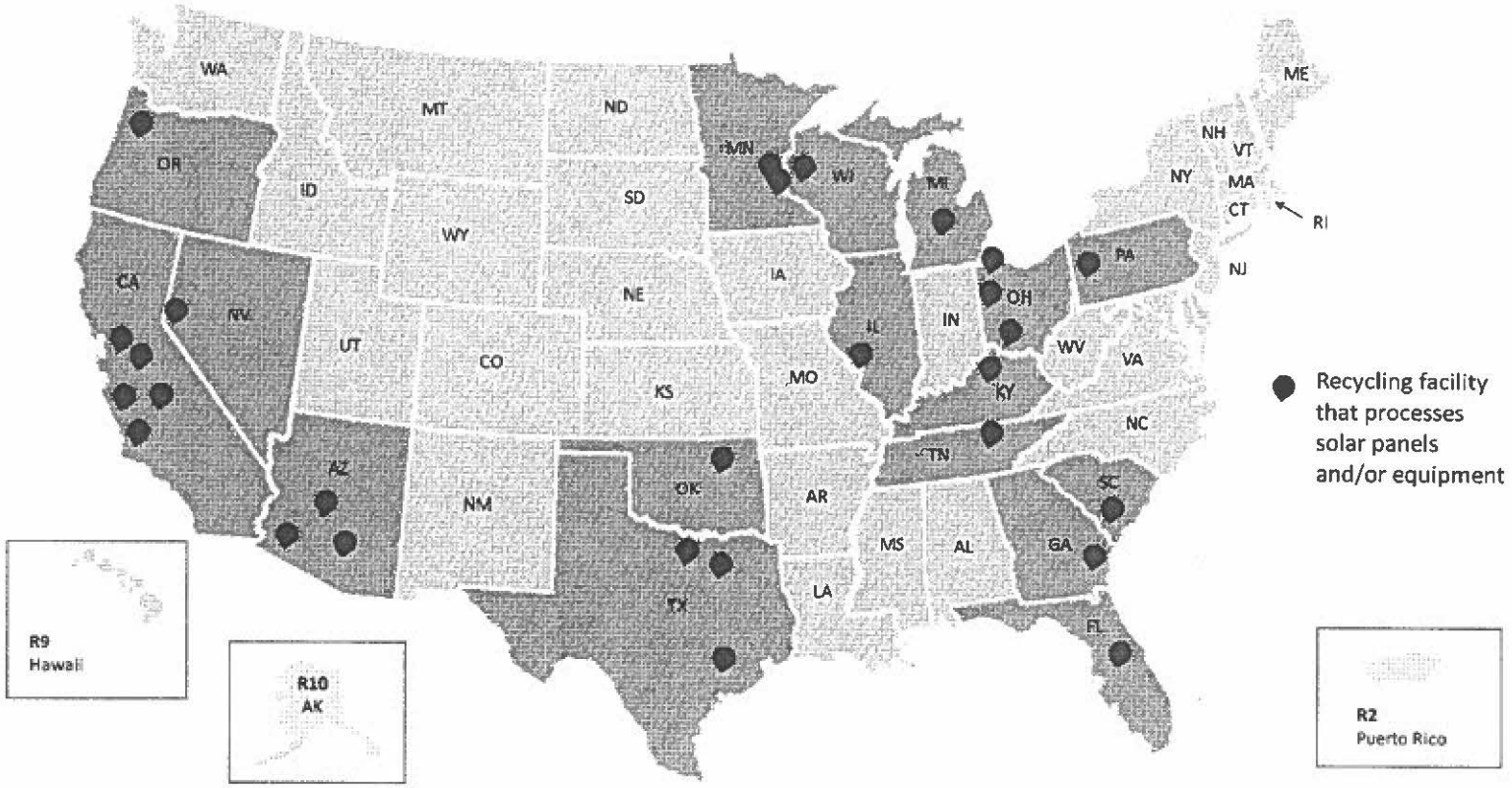
The views expressed in this presentation are those of the authors and do not necessarily represent the views or policies of the U.S. Environmental Protection Agency. Any mention of trade names or external references does not indicate endorsement by the EPA.



Planned EoL PV Panel Model Refinements

- Improving the static assumptions used in the calculations for market share over time
- Considering alternative loss scenarios that modulate the beta parameter (average panel lifetime) and alpha parameter in Weibull function
- Investigating solar installation and EoL projections in Puerto Rico and U.S. territories
- Making user improvements, such as automating the regional selection when selecting a state in the INOUT worksheet, adding a filterable results tab with sort by state, etc.
- Incorporating life cycle analysis results to estimate waste generated from landfill disposal and recycling
- Uncertainty assessments nationally, region, or state

Panel Recycling Facilities



Toxic constituents in Solar Panels

- Different components of solar panels have different toxic metals
- Crystalline-Silicon solar PV
  - Lead solder in junction box and in cell connections
  - Cadmium-telluride solar P
    - Cadmium in semiconductor
- Emerging Technology: Perovskite solar cells
  - Lead in semiconductor
- Solar panels exhibit the characteristic of toxicity if concentrations of toxic constituents are above RCRA thresholds found in 40 CFR Part 261.24.

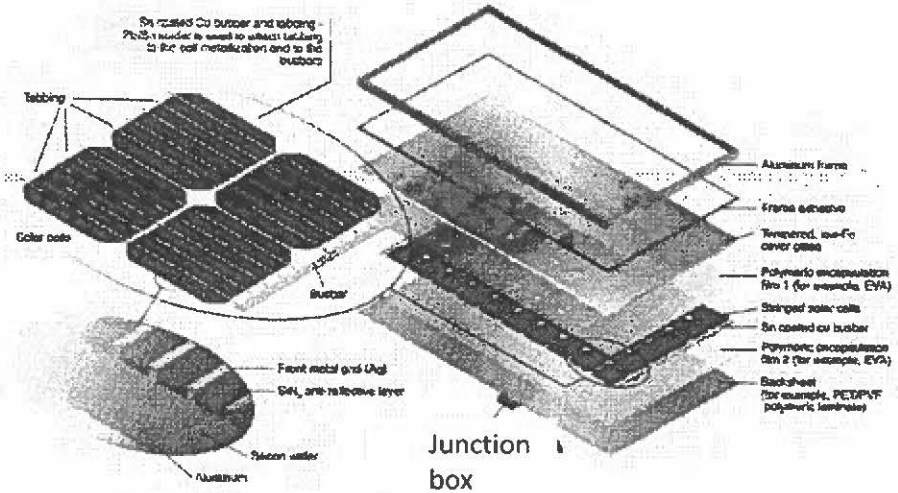


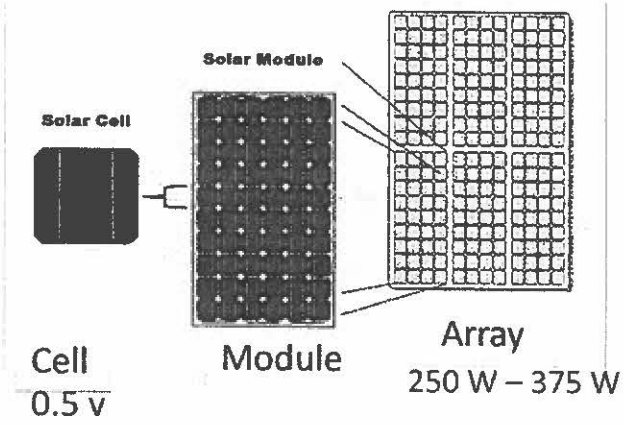
Diagram of a crystalline-silicon panel.
Source: https://www.nature.com/articles/s41560-020-0645-2.pdf

Types of Photovoltaic (PV) Modules

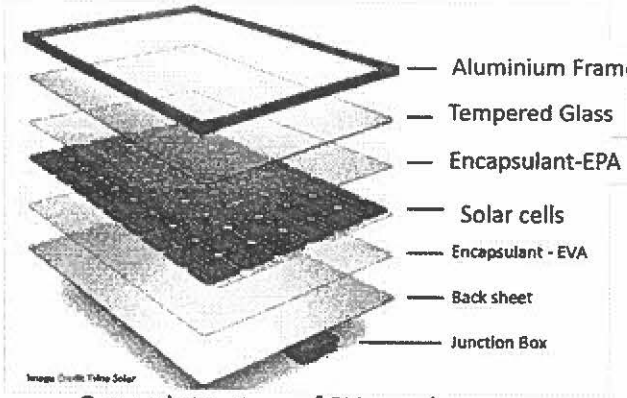
PV-Modules have evolved:

1. **First generation**: poly and mono crystalline silicon (c-Si)
   - Absorber layer is ~ 200 μm, low cost
   - 90 % of current modules
2. **Second generation**: thin-film technologies like cadmium telluride (CdTe), amorphous and copper-indium-selenide (CIS)
   - Absorber layer is ~ < 4 μm
   - Higher absorption 10 – 1000 nm
   - Less materials to make, flexible,
   - Energy pay back time = 5- 10 months
3. **Third generation**: includes technologies that are not available on a large scale (e.g., concentrator photovoltaic or organic solar cells)

Main Components of a typical c-SI PV Panel (Source Clean Energy Reviews, Trina Solar



Schematic of a PV Cell, Module, and Array (Infinite Power, n.d.)

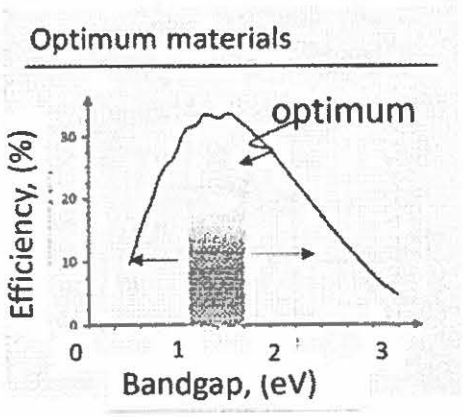


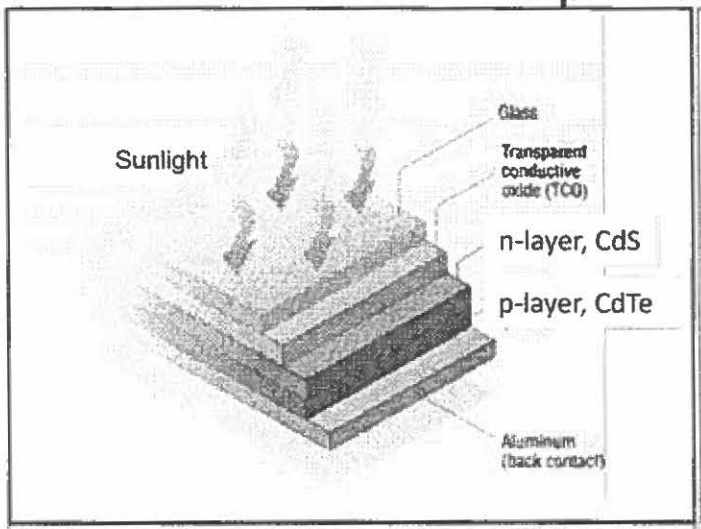
General structure of PV panel

EVA - ethyl vinyl acetate

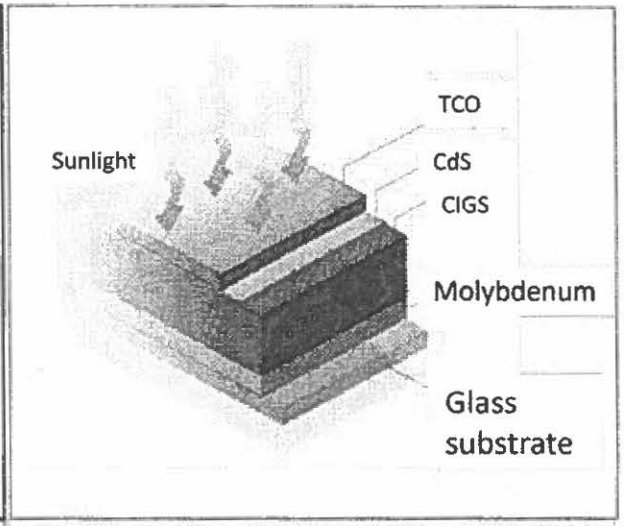
Thin Film Solar Cells- CdTe and CIGS thin-film PV panels

Energy gap= narrow
- Silicon: 1.1 eV
- CdTe, GaAs: 1.4
- CiGS: 1.1 -1.7





Thin Film – 30+yr
- Cadmium telluride, CdTe
- Efficiency = 22%
- Simple to produce – fragile
- Cd – heavy metal – toxic and scarce
- Tellurium is very rare
- May not play a major role for complete harvesting of solar energy

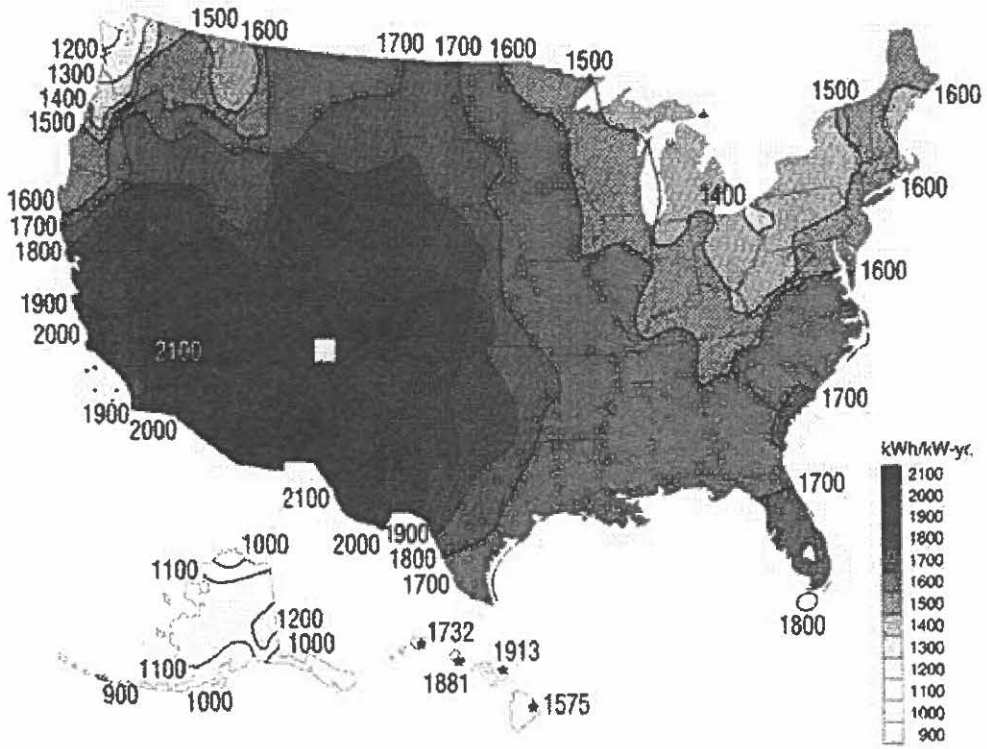


- Thin Film
- Copper indium gallium selenide (CIGS)
- 22% efficient
- Difficult to produce – four elements
- Gallium & Indium are rare
- In -used for cellphones and limited amount on earth crust

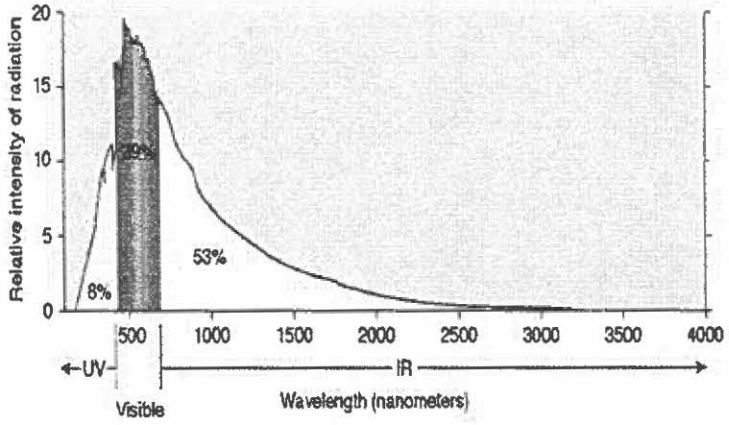
(U.S. DOE SETO,

TCO- Transparent conductive oxide layers n-ZnO, AZO

Solar Potential is High

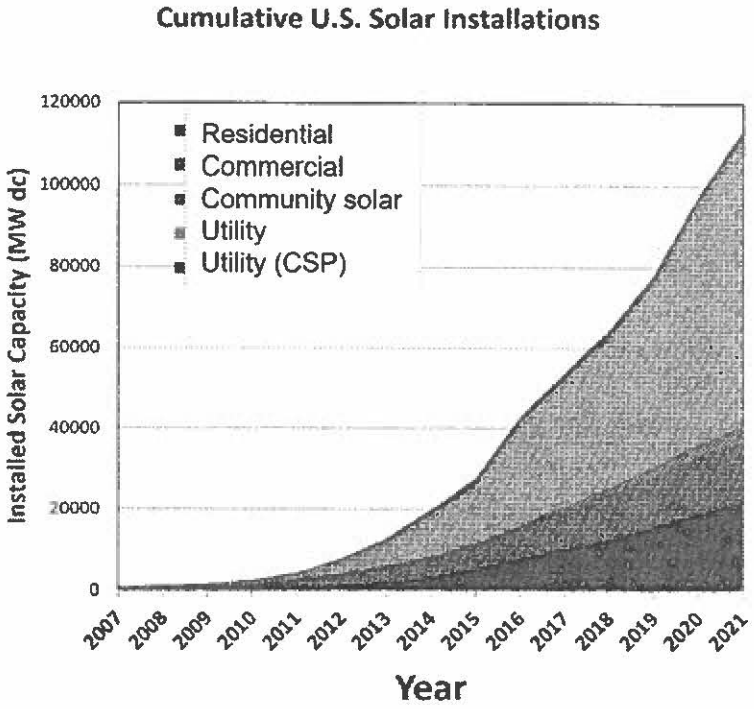


- Solar energy used = 400 EJ/yr
- Solar energy from sun= 10,800 EJ/day
- We are using = 0.01% of solar energy

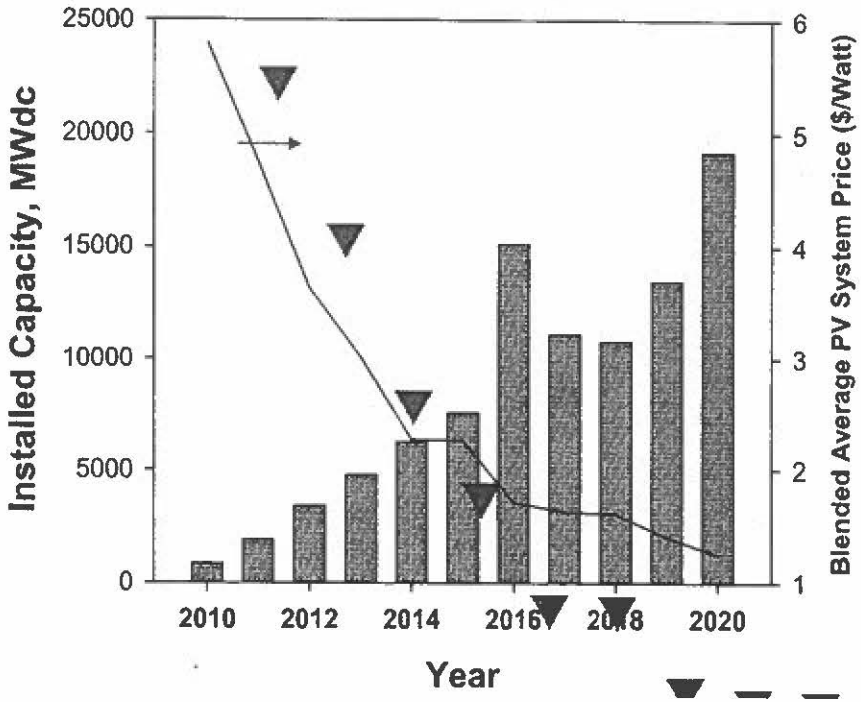


To Meet All Our Needs: Solar Area = 100x100 miles^2

Growth of Solar Energy



- In the last decade growth – 42%
- 2022-More than 100 GW→ 3%

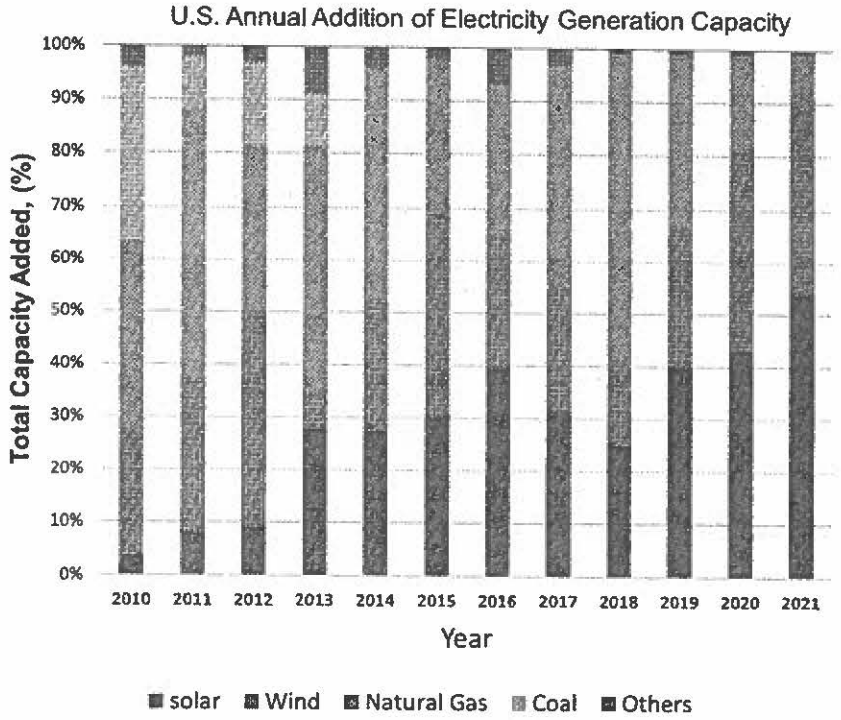


Installation price per household 50% down in 10 year
Utility-scale price =$16 – 35 /MWh

Solar Energy Industries Association, SEIA

National Solar Trends and Projections

- Solar power is the fastest growing energy source in the U.S.
- U.S. <u>new</u> electric generation capacity from solar
  - 2010 → 4%, and 2020 → 43% of solar contribution to electricity capacity added to the grid
  - Solar share: 2010 (0.1%), 2021 (4%)
- Growth at utility-scale
- Driver:
  - State, Federal policies
  - Consumer demand for clean energy



Feldman, D. and R. Margolis, 2021. H2 2020 Solar Industry Update. NREL. April 6, 2021.
SEIA/Wood Mackenzie, 2021. Solar Market Insight Report Q2 2021

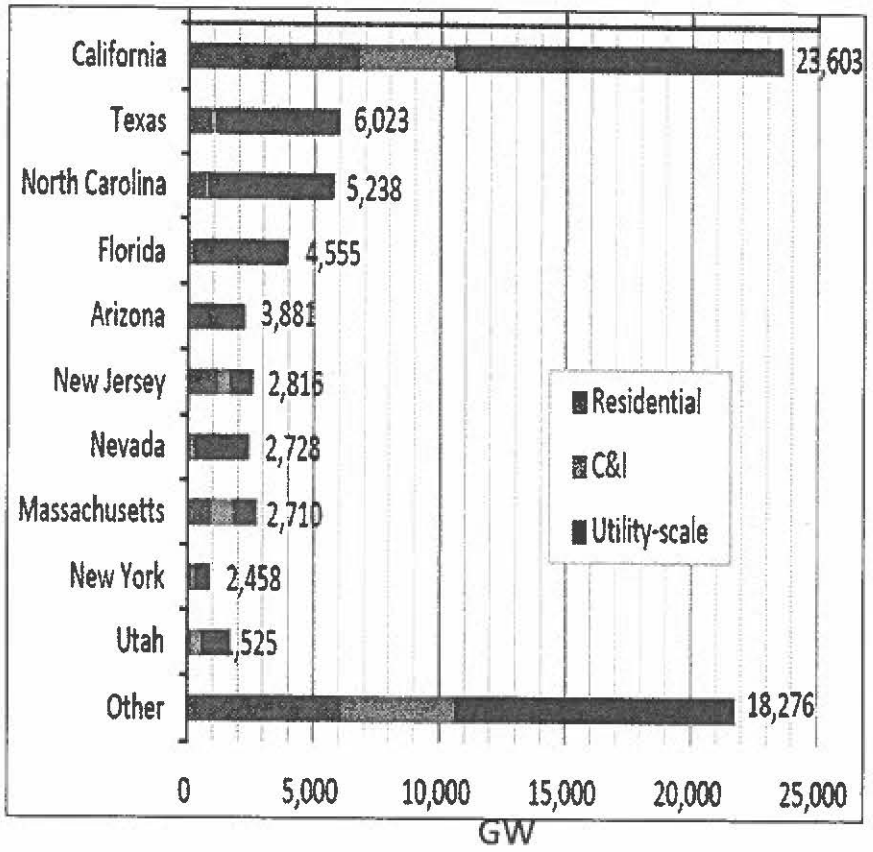
Project Objective

- To determine the end-of-life (EoL) management practice of photovoltaic panels and determine if existing recycling technologies and reuse pathways are sufficient to meet the projected panel waste generation in the next 20-30 years.

1. Project quantities of PV-panel waste generated in specific states or regions in the next 30 yrs.
2. Summarize the life cycle analysis of PV-panels, focusing on EoL management practices and waste by-products generated from the recycling process
3. Document existing EoL management options currently available and promising technologies
4. Identify viable panel reuse opportunities.

Cumulative Installed PV Capacity, as of Dec. 2020

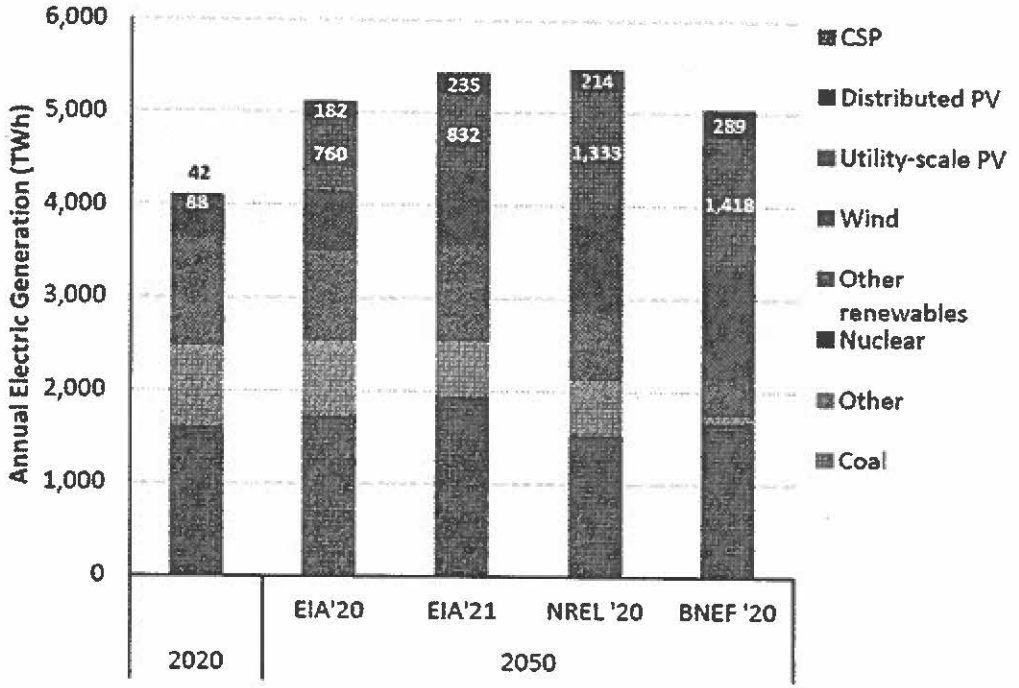
- California has traditionally dominant producing ~ 22 % of electricity from solar
- Other markets are expending Florida and Texas are rapidly growing
- The top 10 solar generating states produce more than 5% of their electricity from solar
- Cumulative solar power 73.8 GW



SEIA/Wood Mackenzie, 2021; Feldman & Margolis, 2021

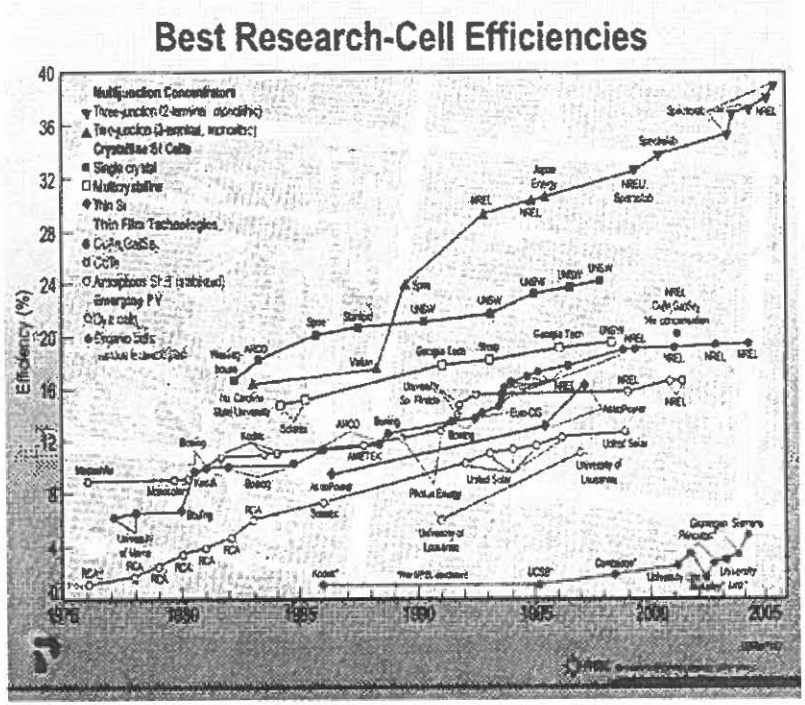
Projection of Electric Generation for 2050

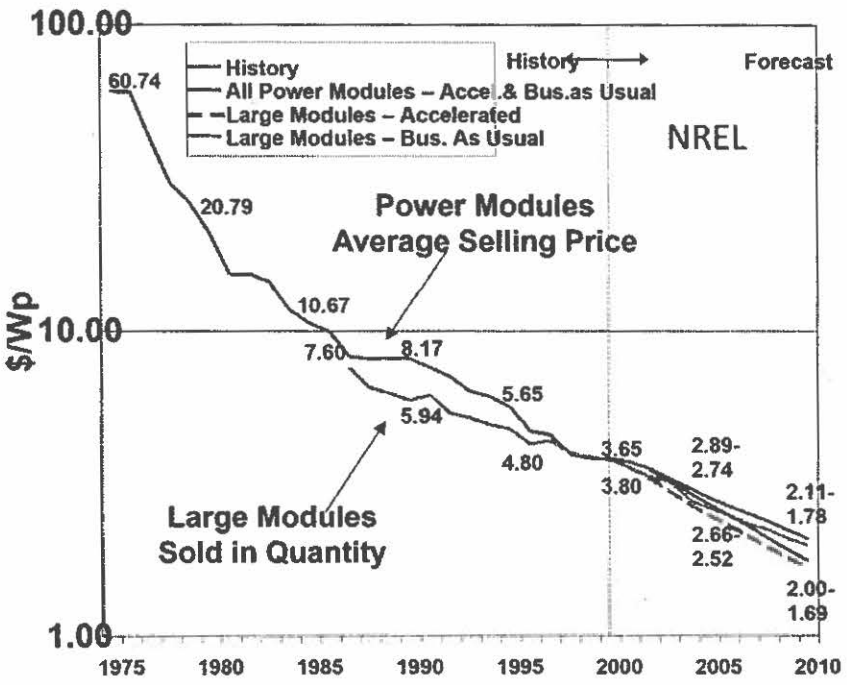
- EIA estimates of solar installation
  - 2020 15 GW-AC
  - 2021 21 GA-AC
  - 2022 19 GW-AC
- The projection of electricity generation for 2050 vary source and modeled scenario
- While the projections vary, solar will continue to expand as states continue to increase their renewable portfolio standards (RPS)



CSP- concentrated solar power

Trends – increasing cell efficiency, decreasing system cost, increasing demand





Challenge: large area, cost

Next generation Solar Cells

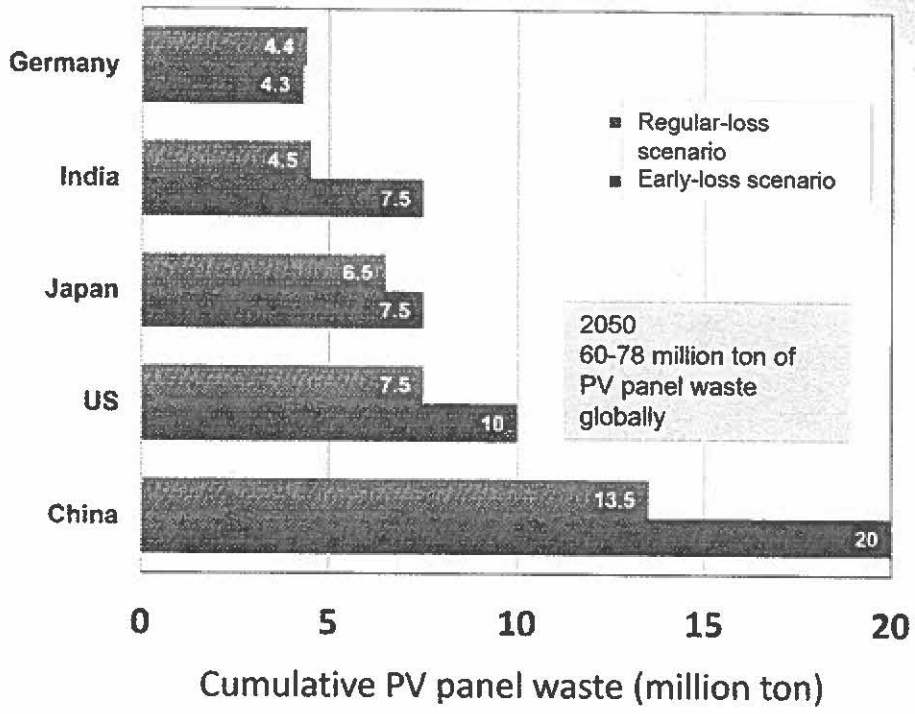
- Copper-Zn-Sn-sulfide, h = 9%, band gap -1.45 eV
- Perovskites – made from hybrid organic-inorganic materials
- Organic PV (OPV) – made from organic materials
- Quantum dots
- Concentrating PV - Use lenses and mirrors to reflect concentrated solar energy onto high-efficiency cells; require direct sunlight and tracking systems to be most effective; primarily located in the desert Southwest U.S.
- Building-integrated PV (BIPV) – Serve as both the outer layer of a structure and generate electricity for on-site use or export to the grid.

Cumulative Waste

- As the PV-panel market continues to grow, so will the quantity of decommissioned panels
- First installed panels are reaching their end of life (25 – 30 years),
- Most panels ~ 70% efficiency after 30 yr. (Curtis et al., https://www.nrel.gov.docs/fy21osti/74550
- Panels are replaced with by more efficient panels

- Goal: Reuse, refurbish and recycle

- PV modules can be reused or refurbished to have a "second life" generating electricity.
- Inverters can be recycled as e-Waste
- Racking equipment can be taken apart and re-utilized

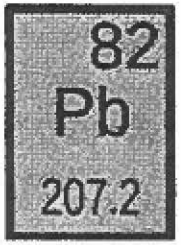


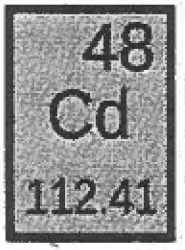
Composition of Solar Panels by weight

C-Si PV panels	CIGS Panels	CdTe Panels
• 76% glass (panel surface) • 10% polymer (encapsulant and back sheet foil) • 8% aluminum (mostly the frame) • 5% silicon (solar cells) • 1% copper (interconnectors) • < 1% Ag, Pb, Sn	• 89% of glass • 7% aluminum • 4% polymers • <1% of Cu, In, Ga, and Se	• 97% of glass • 3% polymers • <1% Ni, Zn, Cd, Te
Ref.: IRENA and IEA-PVPS, 2016; Sander et al., 2007	IRENA and IEA-PVPS, 2016; Sander et al., 2007 and Wambach and Schlenker, 2006	-

Solar Panels can be Hazardous Waste

- Toxicity characteristics of PV-panel waste contains lead and cadmium
- The concentration of the toxic constituents in the specific panel, the aging or damage of the panel
- PV- panels become hazardous waste when since they exhibit the toxicity characteristic from Pb in the solder and/or cadmium in the panels
- Most of the structure of PV panel, such as Al-frame is not hazardous waste, and can be de-manufactured and recycled

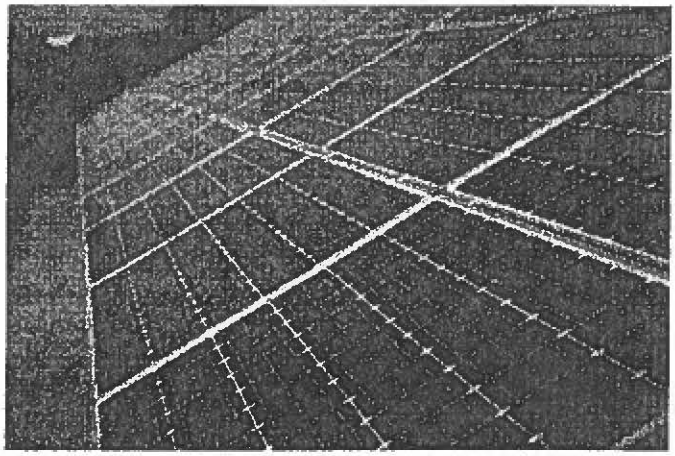




End-of-Life Solar Panels: Regulations and Management

Solar is a fast-growing energy source that is vital to the U.S. effort to reduce fossil fuel use. When solar panels, which typically have a lifespan of more than 25 years, reach the end of their lives and become a waste stream, they must be managed safely. Find information here about different types of solar panels and how they are regulated at end of life. If you are disposing of solar panels that are hazardous waste, then regulations under the Resource Conservation and Recovery Act (RCRA) must be followed to make sure the panels are safely recycled or disposed of.

On this page:



Background

Solar panels provide clean, renewable energy from the sun, and their prevalence as an energy source has been growing. In 2020, solar panels provided about 40 percent of new U.S. electric generation capacity, compared to just four percent in 2010. Overall, 3.3 percent of electricity in the United States was produced using solar technologies in 2020. For more information on these statistics and additional solar energy generation information, visit the U.S. Energy Information Administration Monthly Energy Review <https://www.eia.gov/totalenergy/data/monthly/pdf/mer.pdf> and the U.S. Department of Energy's Quarterly Solar Industry Update page <https://www.energy.gov/eere/solar/quarterly-solar-industry-update>.

While in use, solar panels safely generate electricity without creating any air emissions. However, like any source of energy, there are associated wastes that need to be properly recycled or disposed of when solar panels reach their end of life. As the solar photovoltaic (PV) market grows, so will the volume of end-of-life panels. By 2030, the United States is expected to have as much as one million total tons of solar panel waste. For comparison, the total generation of U.S. municipal solid waste (MSW) in 2018 was 292.4 million tons <https://epa.gov/facts-and-figures-about-materials-waste-and-recycling/national-overview-facts-and-figures-materials#generation>. By 2050, the United States is expected to have the second largest number of end-of-life panels in the world, with as many as an estimated 10 million total tons of panels. For more information on these and other solar panel waste projections, visit the International Renewable Energy Agency (IRENA) report on end-of-life solar panel management <https://www.irena.org/publications/2016/jun/end-of-life-management-solar-photovoltaic-panels>.

SECTION 1:
DEFINITIONS

A. **MERCHANT ELECTRIC GENERATING FACILITY** – an electricity generating facility or facilities (except for a qualifying facility as defined in KRS 278.700(7)) that, together with all associated structures and facilities:

1. Are capable of operating at an aggregate capacity of ten megawatts (10MW) or more; and

2. Sell the electricity they produce in the wholesale market, at rates and charges not regulated by the Public Service Commission.

B. **SOLAR ENERGY SYSTEM (SES)** – a device, including its components and subsystems, which collects solar energy for electricity generation, consumption, or transmission, or for thermal applications. SESs are in turn divided into three types depending on how the system is incorporated into existing land use:

1. **INTEGRATED SOLAR ENERGY SYSTEM (INTEGRATED SES)** – an SES where the solar materials are incorporated into the building materials, such that the building and solar system are reasonably indistinguishable, or where the solar materials are used in place of traditional building components, such that the SES is structurally and integral part of the house, building, or other structure. An Integrated SES may be incorporated into, among other things, a building facade, skylight shingles, canopy, light, or parking meter.

2. **ROOFTOP SOLAR ENERGY SYSTEM (ROOFTOP SES)** – an SES that is structurally mounted to the roof of a house, building, or other structure and does not qualify as an Integrated SES.

3. **GROUND MOUNTED SOLAR ENERGY SYSTEM, (GROUND MOUNTED SES)** – an SES that is structurally mounted to the ground and does not qualify as an Integrated SES. Ground Mounted SESs are further sub-categorized as follows:

   a. ***Small-Scale Ground Mounted Energy System (Small-Scale SES)*** – a Ground Mounted SES with a footprint of less than 2,500 square feet.

   b. ***Intermediate-Scale Ground Mounted Energy System (Intermediate-Scale SES)*** – a Ground Mounted SES with a footprint of between 2,501 square feet and forty (40) acres and which does not constitute a Merchant Electric Generating Facility as provided in KRS 278.700.

c. ***Large-Scale Ground Mounted Solar Energy System (Large-Scale SES)*** – a Ground Mounted SES with a footprint of more than forty (40) acres. This term also includes any non-exempt SES that, irrespective of footprint size or configuration, constitutes a Merchant Electric Generating Facility as defined by the terms of KRS 278.700 (2) and is otherwise subject to review and approval by the Kentucky State Board of Electric Generation and Transmission Siting.

4. **DECOMMISSIONING PLAN FOR GROUND MOUNTED SES** – a plan prepared by a licensed engineer that establishes the party responsible for the decommissioning, the anticipated life of the project, the estimated cost for removal of the SES facility, the costs for restoring the land to its original condition, and all other plan information required by this ordinance. **THE DECOMMISSIONING PLAN AT A MINIMUM SHALL MEET THE REQUIREMENTS OF KRS 278.706 IN ADDITIONAL TO OTHER REQUIREMENTS AS STATED IN THIS ORDINANCE.**

5. **ENLARGEMENT** – to increase the size of an SES footprint or relocate an SES footprint to an area of land not included as part of an original license's approval or any change which would exceed the scope (increased height or decreased setback or buffer) of the original license's approval. SES enlargement does not include the repair, modification, retrofitting, or enhancement of a licensed facility provided such repair, modification, retrofitting, or enhancement does not violate the terms of this ordinance or a condition of the license's approval.

6. **EXEMPT SOLAR ENERGY SYSTEM (EXEMPT SES)** – an SES that is a facility of a municipally owned electric system or public utility regulated by the Kentucky Public Service Commission or Federal Energy Regulatory Commission, which is exempt from planning and zoning requirements under KRS 100.324.

7. **PARTICIPATING PROPERTY** – a property on which a SES, as regulated by the terms of this ordinance, is to be constructed in whole or part. This includes any property for which the owner(s) has provided their signature(s) on a written and recorded agreement, explicitly consenting to be a party to the licensure application for the construction of an SES. Such signature(s) shall constitute prima facie evidence of the owner(s)' consent and/or agreement to any terms set forth in the licensure application, including the waiver of any setback requirements from non-participating properties as subsequently defined herein.

8. **PHYSICAL CONSTRUCTION (SES FACILITY)** – the excavation or movement of earth, erection of forms or structures, or similar activities undertaken in the construction of an SES Facility. This term does not include any activity or construction undertaken prior to the issuance of all required certificates, approvals

and permits, if any, as required under KRS Chapter 278 and other applicable state statutes.

9. **RESPONSIBLE ENTITY** – the owner of the SES and related improvements irrespective of land ownership by fee simple title, lease agreement, or other instrument. The responsible entity is the applicant under the terms of this ordinance.

10. **SES FOOTPRINT** – an area calculated by drawing a perimeter around the outermost SES panels and any equipment necessary for the equipment to function, such as transformers and inverters. The footprint does not include perimeter fencing or visual buffers, nor transmission lines or portions thereof that are required to connect the SES to a utility or customer outside the SES perimeter.

11. **SETBACK** – the minimum distance established by this ordinance measured from the property line of a non-participating property or boundary of a public roadway or rail-line to the nearest portion of an SES Footprint or other regulated SES feature. The setback distance required by this ordinance is to be contained within the boundary of a participating property and is the minimum distance from a non-participating property or public roadway or rail-line boundary that an SES Footprint or other regulated SES feature is allowed to be constructed.

12. **SITING BOARD REGULATED SES** – an SES that constitutes a "merchant electric generating facility" under KRS 278.700(2), the construction and sitting of which is subject to review and approval of the Kentucky State Board on Electric Generation and Transmission Siting.

SECTION 2:
APPLICABILITY OF ORDINANCE

A. **APPLICABILITY OF ORDINANCE.** This ordinance and its requirements for licensure shall apply to the siting, construction, installation, enlargement, operation, maintenance, and decommissioning of Intermediate-Scale SES and Large-Scale SES facilities in all unincorporated areas of Calloway County, Kentucky. The requirements of this ordinance shall not apply to the following:

1. Integrated SES;

2. Rooftop SES;

3. Small-Scale SES; and

4. Intermediate-Scale SES and Large-Scale SES where physical construction began prior to the effective date of this ordinance provided:

   a. Physical construction is completed within two (2) years of the effective date of this ordinance; and

   b. The Intermediate-Scale SES or Large-Scale SES footprint is not thereafter enlarged.

SECTION 3:
APPLICATION PROCESS FOR
INTERMEDIATE- AND LARGE-SCALE SES

A. LICENSE REQUIRED AND RENEWAL LICENSE. Prior to the commencement of physical construction or enlargement of an Intermediate-Scale SES or Large-Scale SES, the responsible entity (applicant) must obtain a Calloway County Solar Energy System License. Additionally, a renewal license shall be required concomitant with the updating of the decommissioning plan, as stipulated below. All applications and supporting documents for licensure shall be submitted by the applicant to the Calloway County Fiscal Court at the Judge/Executive's Office for a determination of conformance with the requirements of this ordinance. A request for licensure shall contain the following:

1. An application for licensure shall include:

   a. The name of the applicant and owner(s) of participating property (if different);

   b. The street address and tax map parcel number of the property for which a license is sought to include all participating property;

   c. The current mailing address and phone number of the applicant and the owner(s) of participating property;

   d. A copy of deeds and lease agreements for participating property;

   e. A listing of the names, mailing addresses, and property addresses (including tax map parcel number) of all adjoining non-participating property owners to include all owners within 2,500 feet of the proposed SES footprint;

   f. A written description of the proposed facility that includes a statement of conformance with the requirements of this ordinance; and

g. The signed statement of the applicant and all participating property owners attesting to the truthfulness and exactness of information supplied in the application.

2. Supplement documents and exhibits that include:

   a. Twenty-four copies (24) of a site plan, drawn to a scale of no greater than 1" to 100' which illustrates:

      i. A vicinity map denoting the location of the proposed facility;

      ii. Property lines of participating properties and adjacent nonparticipating properties, public rights-of-way, and rail-lines within 2,500 feet of the SES footprint (due to scale, this information may be provided on a separate sheet at a scale of not greater than 1' to 300');

      iii. Required setbacks with plan notes detailing the minimum distance to be provided from the SES Footprint to the boundary of non-participating properties and public streets and rail-lines;

      iv. Adjoining roads and points of proposed access to the facility;

      v. The proposed location of all building, panels, invertors, transformers, and other onsite supporting facilities with plan notes detailing the height of such features;

      vi. The proposed location of perimeter fencing with plan notes detailing type, height, and setback;

      vii. The proposed location of the vegetative buffer with plan notes detailing plant type, planting height and anticipated mature height, and capacity; and

      viii. Any additional site plan depictions or accompanying descriptions required to determine compliance with this ordinance.

   b. A decommissioning plan and surety instrument.

3. **State Approval.** A statement of the proposed Intermediate-Scale SES (if applicable) or Large-Scale SES's conformance (or pending conformance) with the

requirements of KRS 278.700 et seq. where the State Board of Electric Generation and Transmission Siting's approval is required.

4. **Fee Entitlement for Review and Application.** The Calloway County Fiscal Court is hereby authorized to impose a fee of $250.00 **$25,000** for the review and processing of licensure applications. This fee shall be payable upon submission of a licensure application and is non-refundable.

5. **Review Timeline.**

   a. Within sixty (60) days of its receipt of a complete licensure application, supplemental documents and exhibits, and fee, the Fiscal Court shall review and recommend that the application for licensure be 1) approved, 2) approved with conditions or required modifications, or 3) denied, with cause stated. Such recommendation shall be recorded in the minutes of the Fiscal Court. Notification of the Fiscal Court's recommendation shall be provided to the applicant and the Calloway County Judge Executive.

   b. Within thirty (30) days of receiving a recommendation from the Calloway County Fiscal Court regarding a licensure application, the County Judge Executive's Office shall:

      i. Issue the requested license with or without conditions or modifications as deemed appropriate,

      ii. Deny the license request, providing the cause for denial in writing, or

      iii. Remand the matter back to the Calloway County Fiscal Court for additional review and findings. In such cases, the County Judge Executive shall specify the reasons necessitating further review with particularity.

   c. Should the matter be remanded, the Fiscal Court is required to re-examine the application and submit a report to the County Judge Executive within forty-five (45) days of the remand receipt. This report should address the specified reasons for remand and provide additional findings as requested.

   d. When a license is issued, it shall remain in effect, unchanged, provided the applicant maintains compliance with the terms of this ordinance and the conditions of the original approval.

e. Upon the issuance of a Solar Energy System License by the Calloway County Judge Executive's Office, it shall be recorded with the Calloway County Clerk's Office to place notice upon all bona fide purchasers for value of the existence of said license.

f. In the event of a denial, the County Judge Executive will provide the decision in writing, which shall be sent via certified mail, with return receipt requested, to the applicant and all participating properties and any non-participating properties included within the application. Furthermore, the denial will be published in accordance with the provisions of Chapter 424 of the Kentucky Revised Statutes.

g. Any aggrieved party by either the issuance or denial of a license shall have a period of thirty (30) days from the date of the recording of the license or the publication of the denial of said license to file an action with the Calloway Circuit Court seeking judicial review.

SECTION 4:
SPECIFIC REQUIREMENTS

A. The following standards shall apply to the siting, construction, installation, enlargement, operation, maintenance, and decommissioning of Intermediate-Scale SES and Large-Scale SES:

1. **Setbacks.** The SES footprint shall be setback no less than 2,000 feet from any non-participating property line and any right-of-way for a publicly maintained roadway or rail-line.

2. **Perimeter Access and Screening.** Access to the site must be controlled by a fence of at least eight (8) feet in height with a vegetative landscape buffer provided between the fencing and the property line. The fence shall be equipped with screening to help shield the facilities and equipment from view. Screening shall consist of:

i. An eight (8) foot tall fence and a double row of staggered evergreen trees (minimum five (5) feet in height at planting and maturing to a minimum of fifteen (15) feet in height);

ii. Evergreen trees shall be planted exterior to the fence and shall be setback no less than fifteen (15) feet from any property line;

iii. Screening shall achieve an opacity of 90% to a height of no less than eight (8) feet within three (3) years of planting;

iv. Screening shall be installed within 180 days of the start of physical construction and shall be maintained until the decommissioning of the SES is completed; and

v. All unhealthy, dead, or noncompliant plantings shall be repaired or replaced within ninety (90) days of such occurrence.

3. **Lighting.** Lighting of a Ground Mounted SES shall be limited to the minimum necessary for safe operation, and shall be directed downward, incorporate full cut-off features, and incorporate motion sensors where feasible. Lighting shall be designed to avoid light trespass. Nothing in the section is intended to preclude installation of lighting required by the Federal Aviation Administration.

4. **Decommissioning Plan Required.** The applicant shall be responsible for a decommissioning plan, prepared by a registered professional engineer at the expense of the applicant, and updated not less than once every five (5) years, containing the following:

i. The anticipated life of the project and defined conditions upon which decommissioning will be initiated;

ii. The estimated decommissioning costs, including removal of the Solar Energy System and related foundations, pads, underground collector lines and roads, transmission lines, and the revegetation and restoration of the property, including soils, to its original condition and all calculations supporting the decommissioning estimate;

iii. The manner in which the project will be decommissioned, including provision and a timetable (such timetable not to exceed five years) for the removal of all structures and foundations, and for the revegetation and restoration of the property to its original condition;

iv. The manner of SES component disposal including the estimated recycled value of components; and

v. A copy of any contract containing specific agreements regarding decommissioning.

5. **Surety Instrument Required.** The applicant shall provide a surety instrument in an amount and form acceptable to the Calloway County Judge Executive, upon recommendation of the Fiscal Court, sufficient to cover the costs of decommissioning the SES in accordance with the approved plan in the event the

applicant defaults in its decommissioning obligations. The surety instrument shall be updated and revised in conjunction with a resubmitted decommissioning plan not less than once every five (5) years. A surety instrument shall be continuously maintained by applicant, their successors in interest and /or assigns, until such time as the Intermediate-Scale SES or Large-Scale SES is decommissioned and all disturbed areas are reclaimed, revegetated, and restored. The form and content of surety shall be in accordance with the requirements of KRS 278.706(2)(m)5 and shall name Calloway County Government as secondary beneficiary.

6. For projects with an SES Footprint located within an airport's approach zones or airport imaginary surfaces as defined by the United States Code of Federal Regulations or within one-thousand (1,000) feet of an Accident Potential Zone (APZ 1 or APZ 2), the applicant must complete and provide the results of a glare analysis through a qualitative analysis of potential impact, field test demonstration, or geometric analysis of ocular impact in consultation with the Federal Aviation Administration Office of Airports, the Kentucky Airport Zoning Commission, and the United States Army, Fort Campbell Directorate of Public Works.

7. **NO INTERMEDIATE-SCALE SES OR LARGE-SCALE SES PROJECT SHALL BE APPROVED IF LOCATED WITHIN A 100 YEAR FLOODPLAIN AS DETERMINED BY THE KENTUCKY ENERGY AND ENVIORNMENT CABINET OR THE FEDERAL EMERGENCY MANAGEMENT AGENCY.**

SECTION 5:
DECOMMISSION REQUIREMENT

A. TIMELINE OF DECOMMISSIONING. The applicant shall begin decommissioning no later than twelve (12) months after an Intermediate-Scale SES or Large-Scale SES has ceased to generate electricity or thermal energy. All structures and facilities associated with the SES shall be removed within six (6) months of the beginning of decommissioning. All materials shall be recycled or otherwise reused to the extent reasonably practicable and the disturbed areas shall be reclaimed, revegetated, and restored to like-kind soil quality and overall condition as the areas were prior to the installation of the Intermediate or Large-Scale SES.

B. FAILURE TO COMPLY. Failure of the applicant to decommission an Intermediate-Scale SES or Large-Scale SES in accordance with this ordinance and the approved decommissioning plan shall be grounds for the County to invoke the surety instrument. The County shall be entitled to recover from the surety instrument proceeds that are necessary to complete the decommissioning of the facility. Furthermore, should the costs of decommissioning exceed the value of the surety instrument, the County shall be entitled to recover the excess amount necessary to complete the decommissioning process.

C. **REMEDIES.** A failure to decommission an Intermediate-Scale SES Large-Scale SES as required herein is a violation of this ordinance and is subject to the enforcement and penalties as provided herein. In the event of a failure to perform, default, or failure to extend a surety instrument, the County reserves the right to take all available legal and administrative actions necessary to compel the completion of the decommissioning by the applicant. This includes securing all necessary easements and rights of entry, and/or to recoup any public funds expended by the County in the fulfillment of the applicant's obligation.

D. **LICENSE REVOCATION.** The Calloway County Judge Executive may revoke a license, subject to a 90-day written notice to the applicant, upon the occurrence of one (1) or more of the following:

1. The applicant has: 1) provided false or inaccurate information as part of the application for licensure; 2) the false or inaccurate information would result in the sitting, construction, or operation of an Intermediate-Scale SES or Large-Scale SES in violation of this ordinance; and 3) the applicant has failed to correct the violation through the resubmittal of an amended and approvable application and perform any necessary site modification within the 90-day notification period;

2. The applicant has: 1) failed to construct or maintain the Intermediate-Scale SES or Large-Scale SES in accordance with this ordinance and the approved plan; and 2) the applicant has failed to correct the violation within the 90-day notification period;

3. The applicant has: 1) failed to decommission the Intermediate-Scale SES or Large-Scale SES in accordance with this ordinance; and 2) the applicant has failed to correct the violation within the 90-day notification period;

4. The applicant has: 1) failed to submit an updated decommissioning plan and accompanying revised surety instrument within the five (5) year period as required; and 2) the applicant has failed to correct the violating within the 90-day notification period; or

5. The applicant has failed to transfer the license upon change of responsible entity in accordance with this ordinance.

E. **REVOCATION RECORDING.** Any license revocation issued under this section shall be recorded at the Calloway County Clerk's Office. Within 90 days of the recording of a revocation of a license, the Intermediate-Scale SES or Large-Scale SES shall cease operation and, within 12 months thereafter, be decommissioned in accordance with this ordinance.

SECTION 6:
CHANGE IN OWNERSHIP

A. LICENSE TRANSFER. A change in or transfer of the responsible entity's ownership, as contained on an Intermediate-Scale SES or a Large-Scale SES application and accompanying license, shall require the issuance of an amended license which shall be so recorded at the Calloway County Clerk's Office.

B. RECORDING. A change in or transfer of the responsible entity's ownership, as contained on an Intermediate-Scale SES or Large-Scale SES application and accompanying license, shall require the issuance of an amended license that shall be recorded at the Calloway County Clerk's Office. **THE CALLOWAY COUNTY FISCAL COURT IS HEREBY AUTHORIZED TO IMPOSE A CHANGE IN OWNERSHIP FEE OF $5,000.**

C. NOTICE AND EXHIBITS. No later than thirty (30) days following the sale or transfer of an Intermediate-Scale SES or Large-Scale SES, the responsible entity that has or is assuming ownership shall provide written notification to the Calloway County Judge Executive and shall submit the following information:

1. The name and mailing address of the current, licensed responsible entity and license number;

2. The name and mailing address of the responsible entity assuming ownership with proof of ownership;

3. A statement that lease agreements for participating property, if any, are transferable with accompanying documentation;

4. A statement of conformance with this ordinance. If SES enlargement or change to the conditions of the original application (other than ownership) is to occur, a new application as provided in Section 3 is required; and

5. A revised surety instrument bearing the name of the new responsible entity.

D. RESPONSE TO NOTICE AND EXHIBITS. Within sixty (60) days of receipt of notification, the Calloway County Fiscal Court shall: 1) approve the issuance of the amended license; or 2) deny the issuance of the amended license with cause stated.

SECTION 7:
MISCELLANEOUS

A. STATE LAWS AND REGULATIONS. All other state and regulatory laws that are not specifically addressed by this ordinance remain in effect. **KRS 278.700-278.718 SHALL**

SERVE AS MINIMUM REQUIREMENTS FOR INTERMEDIATE-SCALE SES OR LARGE-SCALE SES.

B. SEVERABILITY. If a provision of this act or its application to any person or circumstance is held invalid, the invalidity does not affect other provisions or applications of the act that can be given effect without the invalid provision or application, and to this end the provisions of this act are severable.

C. MISDEMEANOR PER DAY OF VIOLATION. Any person found in violation of this ordinance shall be guilty of a misdemeanor and shall be fined not less than One Hundred ($100.00) dollars and not more than Five Hundred ($500.00) dollars per violation. Each day of violation shall constitute a separate offense.

Date of First Reading: _____

Motion by: _____

Seconded by: _____

Vote: _____

This Ordinance was published not more than seven (7) days nor more than twenty-one (21) days prior to passage on:

Date of Publication: _____

Date of Second Reading and Passage: _____

Motion by: _____

Seconded by: _____

Vote: _____

APPROVED, RESOLVED, ADOPTED AND EXECUTED ON THIS 20th DAY OF MARCH, 2024.

_____ _____

KENNETH C. IMES, RICKY STEWART,

Calloway County Judge-Executive Magistrate, District 1

_____ _____

LARRY CRUTCHER,	DON CHERRY,
Magistrate, District 2	Magistrate, District 3
PAUL RISTER,	Attested to by: ANTONIA D. FAULKNER,
Magistrate, District 4	Clerk of Calloway County

Letter to the Editor: Overwhelming majority against industrial solar farmland at 3rd Ohio Power Siting Board hearing

LETTER TO THE EDITOR

Knox County Commission candidate Drenda Keesee | Facebook / Drenda Keesee

By Drenda Keesee, GOP candidate for Knox County Commission
May 31, 2024

I attended all three Ohio Power Siting Board hearings on the Frasier Solar project, and as the Republican nominee for Knox County Commissioner and a citizen opposing this hidden agenda in the works for many years, this case by sheer numbers is landmark, and the 3rd meeting was the most telling of all!

Local residents whose lives will be forever impacted finally had opportunity to speak (now that college students and lobbyists have gone home for break). The percentage of Knox County residents who signed in opposition at the first hearing was approximately 73.6% against and 26.4% for the project (and many "for" were not residents). But at this hearing real residents shared their stories of devastation by solar farm-field agendas that were hidden from them by officials and even neighbors prodded by Open Roads' "hush money" contracts of up to 15,000!

What was most prominent in their testimonies was the pain and sorrow the Open Roads Frasier solar project has created. Some of these residents are fifth-generation farmers. Many shed tears telling their story of waking up "last to hear" about this nightmare but the most impacted. Don't tell any of them Open Roads cares about our community or its residents. Other young families purchased homes to live next to grandparents only to learn their children will be playing 100 yds. from large-scale industrial developments if this project is approved.

Residents bordering the project are known as Intervenor's and their attorney could not be present. Taking advantage of this, the pro-solar attorney cross examined almost every intervenor after they spoke. Hopefully, Frasier's apparent bullying of locals was noted by the OPSB. Regardless, residents emphatically made it clear, we don't want this project here. Only one testimony (a union worker outside of Knox) spoke for the project.

All three Miller township trustees spoke too, and added their arguments against solar fields along with reading an unanimous resolution against the Frasier solar project. All together 18 Knox townships have made resolutions against industrial solar fields, along with the Mount Vernon City Council whose members only recently discovered that 100 acres in the proposed site are in the city limits (going contrary to proposed city developmental plans).

Authorities and residents expressed their concern for the wildlife, environment, safety, revenue loss, road damage, construction issues, loss of fertile farm ground, drainage and flooding issues, inability to screen views, loss of tranquility, lawsuits, liens, and decline in home values. The sense of betrayal by both state and local government, neighbors, and especially Open Roads Renewables was real.

The battle is not finished. Another hearing occurs in Columbus, August 19th. Current Knox County Commissioners (Collier, Bemiller, Purcell) should make a resolution against large-scale solar facilities in Knox County which would likely kill the Frasier project, and the Ohio Power Siting Board is still receiving your comments on their website, case number 23-0796-EL-BGN.

Keep fighting!

I am.

Best Regards,

ORGANIZATIONS IN THIS STORY

Knox County Commission

TRENDING

1. Knox County reported 42 missing children in 2023
2. Letter to the Editor: Overwhelming majority against industrial solar farmland at 3rd Ohio Power Siting Board hearing
3. Mount Vernon Municipal Court: 163 cases on docket, June 3-7, 2024
4. Letter to the Editor: Edgewood Road Improvement Project to be placed on November ballot
5. Local filmmaker wraps production with help from Kenyon College

MORE NEWS

LETTER TO THE EDITOR

Letter to the Editor: Ohio needs renewable energy

LETTER TO THE EDITOR

Letter to the Editor: Overwhelming majority against industrial solar farmland at 3rd Ohio Power Siting Board hearing

LETTER TO THE EDITOR

Letter to the Editor: Edgewood Road Improvement Project to be placed on November ballot

LETTER TO THE EDITOR

Letter to the Editor: Banners honoring 14 young men killed in Vietnam

LETTER TO THE EDITOR

OPINION: Open Letter to Rep. Seitz regarding Frasier Solar Project

COMMONWEALTH OF KENTUCKY
COUNTY OF CALLOWAY
SOLAR ENERGY SYSTEM INSTALLATION REQUIREMENTS
ORDINANCE NO. _____

AN ORDINANCE ESTABLISHING LICENSURE REQUIREMENTS FOR SOLAR ENERGY SYSTEMS IN CALLOWAY COUNTY, KENTUCKY

WHEREAS, pursuant to KRS 67.083, the Calloway County Fiscal Court is granted the authority to undertake all necessary governmental actions for the welfare of the county, and specifically is endowed pursuant to KRS 67.083(3)(h) and KRS 67.083(3)(m) for the regulation of commerce for the protection and convenience of the public, and with the power to protect and conserve the county's natural resources, including but not limited to soil and wildlife, to safeguard the livelihoods and well-being of its residents; and

WHEREAS, KRS 278.718 became effective June 29, 2023, and further provides that an ordinance, permit, or license issued by a local government and enacted under the provisions of home rule under KRS Chapter 67.080, 67.083, 67.850, 67.922, 67A.060, 67C.101, and 82.082, shall have primacy over the state provisions, including setback requirements, set forth in KRS 278.700, 278.704, 278.706, 278.708, and any conflict between an order of the board and a local ordinance, permit, or license shall be resolved in favor of the local government's ordinance, permit, or license; and

WHEREAS, the Calloway County Fiscal Court finds it necessary and appropriate to provide reasonable safeguards which mitigate potential nuisances such as soil erosion, water runoff, and other environmental impacts to agricultural land and local flora and fauna, among others, created by Intermediate-Scale and Large-Scale Ground Mounted Solar Energy Systems as defined herein in order to protect adjoining properties and public rights-of-way;

NOW THEREFORE BE IT ORDAINED BY THE FISCAL COURT OF CALLOWAY COUNTY, COMMONWEALTH OF KENTUCKY:

CHAPTER 140

(HB 4)

AN ACT relating to merchant electric generating facilities and making an appropriation therefor.

Be it enacted by the General Assembly of the Commonwealth of Kentucky:

➔Section 1. KRS 278.702 is amended to read as follows:

(1) There is hereby established the Kentucky State Board on Electric Generation and Transmission Siting. The board shall be composed of seven (7) members as follows:

(a) The three (3) members of the Kentucky Public Service Commission;

(b) The secretary of the Energy and Environment Cabinet or the secretary's designee;

(c) The secretary of the Cabinet for Economic Development or the secretary's designee;

(d) 1. If the facility subject to board approval is proposed to be located in one (1) county, two (2) ad hoc public members to be appointed by the Governor from a county where a facility subject to board approval is proposed to be located:

a. One (1) of the ad hoc public members shall be the chairman of the planning commission with jurisdiction over an area in which a facility subject to board approval is proposed to be located. If the proposed location is not within a jurisdiction with a planning commission, then the Governor shall appoint either the county judge/executive of a county that contains the proposed location of the facility or the mayor of a city, if the facility is proposed to be within a city; and

b. One (1) of the ad hoc public members shall be appointed by the Governor and shall be a resident of the county in which the facility is proposed to be located.

2. If the facility subject to board approval is proposed to be located in more than one (1) county, two (2) ad hoc public members to be chosen as follows:

a. One (1) ad hoc public member shall be the county judge/executive of a county in which the facility is proposed to be located, to be chosen by majority vote of the county judge/executives of the counties in which the facility is proposed to be located; and

b. One (1) ad hoc public member shall be a resident of a county in which the facility is proposed to be located, and shall be appointed by the Governor.

If a member has not been chosen by majority vote, as provided in subdivision a. of this subparagraph, by thirty (30) days after the filing of the application, the Governor shall directly appoint the member.

3. Ad hoc public members appointed to the board shall have no direct financial interest in the facility proposed to be constructed.

(2) The term of service for the ad hoc members of the board shall continue until the ***merchant electric generating facility***~~[board issues a final determination in the proceeding]~~ for which they were appointed ***has been constructed and begins generating electricity for sale or the construction certificate expires***. The remaining members of the board shall be permanent members.

(3) The board shall be attached to the Public Service Commission for administrative purposes. The commission staff shall serve as permanent administrative staff for the board. The members of the board identified in subsection (1)(a) to (d) of this section shall promulgate administrative regulations in accordance with KRS Chapter 13A to implement KRS 278.700 to 278.716.

(4) No member of the board shall receive any salary or fee for service on the board or shall have any financial interest in any facility the application for which comes before the board, but each member shall be reimbursed for actual travel and expenses directly related to service on the board.

(5) The chairman of the Public Service Commission shall be the chairman of the board. The chairman shall designate one (1) member of the board as vice chairman. A majority of the members of the board shall

constitute a quorum for the transaction of business. No vacancy on the board shall impair the right of the remaining members to exercise all of the powers of the board. The board shall convene upon the call of the chairman.

➔Section 2. KRS 278.704 is amended to read as follows:

(1) No person shall commence to construct a merchant electric generating facility until that person has applied for and obtained a construction certificate for the facility from the board. The construction certificate shall be valid for a period of ***three (3)***~~[two (2)]~~ years after the issuance date of the last permit required to be obtained from the Energy and Environment Cabinet after which the certificate shall be void. The certificate shall be conditioned upon the applicant obtaining necessary air, water, and waste permits. If an applicant has not obtained all necessary permits and has not commenced to construct prior to the expiration date of the certificate, the applicant shall be required to obtain a ***new*** valid certificate from the board.

(2) Except as provided in subsections (3), (4), and (5) of this section, no construction certificate shall be issued to construct a merchant electric generating facility unless the exhaust stack of the proposed facility and any wind turbine is at least one thousand (1,000) feet from the property boundary of any adjoining property owner and all proposed structures or facilities used for generation of electricity are two thousand (2,000) feet from any residential neighborhood, school, hospital, or nursing home facility. For purposes of applications for site compatibility certificates pursuant to KRS 278.216, only the exhaust stack of the proposed facility to be actually used for coal or gas-fired generation or, beginning with applications for site compatibility certificates filed on or after January 1, 2015, the proposed structure or facility to be actually used for solar or wind generation shall be required to be at least one thousand (1,000) feet from the property boundary of any adjoining property owner and two thousand (2,000) feet from any residential neighborhood, school, hospital, or nursing home facility.

(3) If the merchant electric generating facility is proposed to be located in a county or a municipality with planning and zoning, then ***decommissioning and*** setback requirements from a property boundary, residential neighborhood, school, hospital, or nursing home facility may be established by the planning and zoning commission. Any ***decommissioning requirement or*** setback established by a planning and zoning commission for a facility in an area over which it has jurisdiction shall:

(a) Have primacy over the ***decommissioning requirements in subsection (2)(m) of Section 3 of this Act and the*** setback requirement in subsections (2) and (5) of this section; and

(b) Not be subject to modification or waiver by the board through a request for deviation by the applicant, as provided in subsection (4) of this section ***or otherwise***.

(4) The board may grant a deviation from the requirements of subsection (2) of this section on a finding that the proposed facility is designed to and, as located, would meet the goals of KRS 224.10-280, 278.010, 278.212, 278.214, 278.216, 278.218, and 278.700 to 278.716 at a distance closer than those provided in subsection (2) of this section.

(5) If the merchant electric generating facility is proposed to be located on a site of a former coal processing plant in the Commonwealth where the electric generating facility will utilize on-site waste coal as a fuel source, then the one thousand (1,000) foot property boundary requirement in subsection (2) of this section shall not be applicable; however, the applicant shall be required to meet any other setback requirements contained in subsection (2) of this section.

(6) If requested, a merchant electric generating entity considering construction of a facility for the generation of electricity or a person acting on behalf of such an entity shall hold a public meeting in any county where acquisition of real estate or any interest in real estate is being considered for the facility. A request for such a meeting may be made by the commission, or by any city or county governmental entity, including a board of commissioners, planning and zoning, fiscal court, mayor, or county judge/executive. The meeting shall be held not more than thirty (30) days from the date of the request.

(7) The purpose of the meeting under subsection (6) of this section is to fully inform landowners and other interested parties of the full extent of the project being considered, including the project time line. One (1) or more representatives of the entity with full knowledge of all aspects of the project shall be present and shall answer questions from the public.

(8) Notice of the time, subject, and location of the meeting under subsection (6) of this section shall be posted in both a local newspaper, if any, and a newspaper of general circulation in the county. Notice shall also be placed on the ***websites***~~[Web sites]~~ of the unregulated entity, and any local governmental unit. Owners of real

estate known to be included in the project and any person whose property adjoins at any point any property to be included in the project shall be notified personally by mail. All notices must be mailed or posted at least two (2) weeks prior to the meeting.

(9) The merchant electric generating entity or a person acting on behalf of a merchant electric generating entity shall, on or before the date of the public meeting held under subsection (6) of this section, provide notice of all research, testing, or any other activities being planned or considered to:

(a) The Energy and Environment Cabinet;

(b) The Public Service Commission;

(c) The Transportation Cabinet;

(d) The Attorney General; and

(e) The Office of the Governor.

(10) ~~[A person that, on or before April 10, 2014, has started acquiring interests in real estate for a project as described in subsection (6) of this section shall hold a meeting that complies with this section within thirty (30) days of April 10, 2014.~~

~~(11)]~~ Subsections (6) to *(9)*[~~(10)~~] of this section shall not apply to any facility or project that has already received a certificate of construction from the board.

➔Section 3. KRS 278.706 is amended to read as follows:

(1) Any person seeking to obtain a construction certificate from the board to construct a merchant electric generating facility shall file an application at the office of the Public Service Commission.

(2) A completed application shall include the following:

(a) The name, address, and telephone number of the person proposing to construct and own the merchant electric generating facility;

(b) A full description of the proposed site, including a map showing the distance of the proposed site from residential neighborhoods, the nearest residential structures, schools, and public and private parks that are located within a two (2) mile radius of the proposed facility;

(c) Evidence of public notice that shall include the location of the proposed site and a general description of the project, state that the proposed construction is subject to approval by the board, and provide the telephone number and address of the Public Service Commission. Public notice shall be given within thirty (30) days immediately preceding the application filing to:

1. Landowners whose property borders the proposed site; and

2. The general public in a newspaper of general circulation in the county or municipality in which the facility is proposed to be located;

(d) A statement certifying that the proposed plant will be in compliance with all local ordinances and regulations concerning noise control and with any local planning and zoning ordinances. The statement shall also disclose setback requirements established by the planning and zoning commission as provided under KRS 278.704(3);

(e) If the facility is not proposed to be located on a site of a former coal processing plant and the facility will use on-site waste coal as a fuel source or in an area where a planning and zoning commission has established a setback requirement pursuant to KRS 278.704(3), a statement that the exhaust stack of the proposed facility and any wind turbine is at least one thousand (1,000) feet from the property boundary of any adjoining property owner and all proposed structures or facilities used for generation of electricity are two thousand (2,000) feet from any residential neighborhood, school, hospital, or nursing home facility, unless facilities capable of generating ten megawatts (10MW) or more currently exist on the site. If the facility is proposed to be located on a site of a former coal processing plant and the facility will use on-site waste coal as a fuel source, a statement that the proposed site is compatible with the setback requirements provided under KRS 278.704(5). If the facility is proposed to be located in a jurisdiction that has established setback requirements pursuant to KRS 278.704(3), a statement that the proposed site is in compliance with those established setback requirements;

(f) A complete report of the applicant's public involvement program activities undertaken prior to the filing of the application, including:

1. The scheduling and conducting of a public meeting in the county or counties in which the proposed facility will be constructed at least ninety (90) days prior to the filing of an application, for the purpose of informing the public of the project being considered and receiving comment on it;

2. Evidence that notice of the time, subject, and location of the meeting was published in the newspaper of general circulation in the county, and that individual notice was mailed to all owners of property adjoining the proposed project at least two (2) weeks prior to the meeting; and

3. Any use of media coverage, direct mailing, fliers, newsletters, additional public meetings, establishment of a community advisory group, and any other efforts to obtain local involvement in the siting process;

(g) A summary of the efforts made by the applicant to locate the proposed facility on a site where existing electric generating facilities are located;

(h) Proof of service of a copy of the application upon the chief executive officer of each county and municipal corporation in which the proposed facility is to be located, and upon the chief officer of each public agency charged with the duty of planning land use in the jurisdiction in which the facility is proposed to be located;

(i) An analysis of the proposed facility's projected effect on the electricity transmission system in Kentucky;

(j) An analysis of the proposed facility's economic impact on the affected region and the state;

(k) A detailed listing of all violations by it, or any person with an ownership interest, of federal or state environmental laws, rules, or administrative regulations, whether judicial or administrative, where violations have resulted in criminal convictions or civil or administrative fines exceeding five thousand dollars ($5,000). The status of any pending action, whether judicial or administrative, shall also be submitted;~~[and]~~

(l) A site assessment report as specified in KRS 278.708. The applicant may submit and the board may accept documentation of compliance with the National Environmental Policy Act (NEPA) rather than a site assessment report; ***and***

(m) A decommissioning plan that shall describe how the merchant electric generating facility will be decommissioned and dismantled following the end of its useful life. The decommissioning plan shall, at a minimum, include plans to:

1. Unless otherwise requested by the landowner, remove all above-ground facilities;

2. Unless otherwise requested by the landowner, remove any underground components and foundations of above-ground facilities. Facilities removed under this subparagraph shall be removed to a depth of three (3) feet below the surface grade of the land in or on which the component was installed, unless the landowner and the applicant otherwise agree to a different depth;

3. Return the land to a substantially similar state as it was prior to the commencement of construction;

4. Unless otherwise requested by the landowner, leave any interconnection or other facilities in place for future use at the completion of the decommissioning process;

5. Secure a bond or other similar security for the project to assure financial performance of the decommissioning obligation, provided that:

a. The amount of the proposed bond or similar security shall be determined by an independent, licensed engineer who is experienced in the decommissioning of solar electric generating facilities and has no financial interest in either the merchant electric generating facility or any parcel of land upon which the merchant electric generating facility is located. The proposed amount of the bond or similar security shall be either:

i. The net present value of the total estimated cost of completing the decommissioning plan, less the current net salvage value of the merchant electric generating facility's components; or

ii. The bond amount required by a county or municipal government that has established a decommissioning bond requirement or similar security obligation in the county or municipality where the merchant electric generating facility will be located. If the facility will be located in more than one (1) county or municipality that has established a decommissioning bond or similar security obligation, then the higher amount shall be required for the facility;

b. The bond or other similar security names:

i. For property that is leased by the applicant, each landowner from whom the applicant leases land and the Energy and Environment Cabinet as the primary co-beneficiaries; or

ii. For property that is owned by the applicant, the Energy and Environment Cabinet as the primary beneficiary;

c. If the merchant electric generating facility is to be located in a county or municipality that has not established a decommissioning bond or other similar security obligation, the bond or other similar security shall name the county or municipality as a secondary beneficiary with the county's or municipality's consent;

d. The bond or other similar security shall be provided by an insurance company or surety that shall at all times maintain at least an "Excellent" rating as measured by the AM Best rating agency or an investment grade credit rating by any national credit rating agency and, if available, shall be noncancelable by the provider or the customer until completion of the decommissioning plan or until a replacement bond is secured; and

e. The bond or other similar security shall provide that at least thirty (30) days prior to its cancellation or lapse, the surety shall notify the applicant, its successor or assign, each landowner, the Energy and Environment Cabinet, and the county or city in which the facility is located of the impending cancellation or lapse. The notice shall specify the reason for the cancellation or lapse and provide any of the parties, either jointly or separately, the opportunity to cure the cancellation or lapse prior to it becoming effective. The applicant, its successor, or its assign, shall be responsible for all costs incurred by all parties to cure the cancellation or lapse of the bond. Each landowner, or the Energy and Environment Cabinet with the prior approval of each landowner, may make a demand on the bond and initiate and complete the decommissioning plan.

6. Communicate with each affected landowner at the end of the merchant electric generating facility's useful life so that any requests of the landowner that are in addition to the minimum requirements set forth in this paragraph and in addition to any other requirements specified in the lease with the landowner may, in the sole discretion of the applicant or its successor or assign, be accommodated; and

7. Incorporate the requirements of paragraph (m)1. to 6. of this subsection into the applicant's leases with landowners.

(3) Application fees for a construction certificate shall be set by the board and deposited into a trust and agency account to the credit of the commission.

(4) Replacement of a merchant electric generating facility with a like facility, or the repair, modification, retrofitting, enhancement, or reconfiguration of a merchant electric generating facility shall not, for the purposes of this section and KRS 224.10-280, 278.704, 278.708, 278.710, and 278.712, constitute construction of a merchant electric generating facility.

(5) The board shall promulgate administrative regulations prescribing fees to pay expenses associated with its review of applications filed with it pursuant to KRS 278.700 to 278.716. All application fees collected by the board shall be deposited in a trust and agency account to the credit of the Public Service Commission. If a majority of the members of the board find that an applicant's initial fees are insufficient to pay the board's expenses associated with the application, including the board's expenses associated with legal review thereof,

the board shall assess a supplemental application fee to cover the additional expenses. An applicant's failure to pay a fee assessed pursuant to this subsection shall be grounds for denial of the application.

➔Section 4. KRS 278.708 is amended to read as follows:

(1) Any person proposing to construct a merchant electric generating facility shall file a site assessment report with the board as required under KRS 278.706(2)(l).

(2) A site assessment report shall be prepared by the applicant or its designee.

(3) A completed site assessment report shall include:

(a) A description of the proposed facility that shall include a proposed site development plan that describes:

1. Surrounding land uses for residential, commercial, agricultural, and recreational purposes;
2. The legal boundaries of the proposed site;
3. Proposed access control to the site;
4. The location of facility buildings, transmission lines, and other structures;
5. Location and use of access ways, internal roads, and railways;
6. Existing or proposed utilities to service the facility;
7. Compliance with applicable setback requirements as provided under KRS 278.704(2), (3), (4), or (5); and
8. Evaluation of the noise levels expected to be produced by the facility;

(b) An evaluation of the compatibility of the facility with scenic surroundings;

(c) The potential changes in property values and land use resulting from the siting, construction, and operation of the proposed facility for property owners adjacent to the facility;

(d) Evaluation of anticipated peak and average noise levels associated with the facility's construction and operation at the property boundary; and

(e) The impact of the facility's operation on road and rail traffic to and within the facility, including anticipated levels of fugitive dust created by the traffic and any anticipated degradation of roads and lands in the vicinity of the facility.

(4) The site assessment report shall also suggest any mitigating measures to be implemented by the applicant to minimize or avoid adverse effects identified in the site assessment report.

(5) The board shall have the authority to hire a consultant to review the site assessment report and provide recommendations concerning the adequacy of the report and proposed mitigation measures. The board may direct the consultant to prepare a separate site assessment report. Any expenses or fees incurred by the board's hiring of a consultant shall be borne by the applicant.

(6) The applicant shall be given the opportunity to present evidence to the board regarding any mitigation measures. As a condition of approval for an application to obtain a construction certificate, the board may require the implementation of any mitigation measures that the board deems appropriate. ***Ongoing compliance with any mitigation measures that were conditions of construction certificate application approval shall be enforced by the Energy and Environment Cabinet pursuant to subsection (9) of Section 5 of this Act.***

➔Section 5. KRS 278.710 is amended to read as follows:

(1) Within one hundred twenty (120) days of receipt of an administratively complete application, or within one hundred eighty (180) days of receipt of an administratively complete application if a hearing is requested, the board shall, by majority vote, grant or deny a construction certificate, either in whole or in part, based upon the following criteria:

(a) Impact of the facility on scenic surroundings, property values, the pattern and type of development of adjacent property, and surrounding roads;

(b) Anticipated noise levels expected as a result of construction and operation of the proposed facility;

(c) The economic impact of the facility upon the affected region and the state;

(d) Whether the facility is proposed for a site upon which existing generating facilities, capable of generating ten megawatts (10MW) or more of electricity, are currently located;

(e) Whether the proposed facility will meet all local planning and zoning requirements that existed on the date the application was filed;

(f) Whether the additional load imposed upon the electricity transmission system by use of the merchant electric generating facility will adversely affect the reliability of service for retail customers of electric utilities regulated by the Public Service Commission;

(g) Except where the facility is subject to a statewide setback established by a planning and zoning commission as provided in KRS 278.704(3) and except for a facility proposed to be located on a site of a former coal processing plant and the facility will use on-site waste coal as a fuel source, whether the exhaust stack of the proposed merchant electric generating facility and any wind turbine is at least one thousand (1,000) feet from the property boundary of any adjoining property owner and all proposed structures or facilities used for generation of electricity are two thousand (2,000) feet from any residential neighborhood, school, hospital, or nursing home facility, unless a different setback has been requested and approved under KRS 278.704(4). If a planning and zoning commission has established setback requirements that differ from those under KRS 278.704(2), the applicant shall provide evidence of compliance. If the facility is proposed to be located on site of a former coal processing plant and the facility will use on-site waste coal as a fuel source, the applicant shall provide evidence of compliance with the setback requirements provided in KRS 278.704(5);

(h) The efficacy of any proposed measures to mitigate adverse impacts that are identified pursuant to paragraph (a), (b), (e), or (f) of this subsection from the construction or operation of the proposed facility;~~[and]~~

(i) Whether the applicant has a good environmental compliance history*; and*

(j) Whether the decommissioning plan is complete and complies with the requirements of subsection (2)(m) of Section 3 of this Act and any other local requirements that may apply.

(2) When considering an application for a construction certificate for a merchant electric generating facility, the board may consider the policy of the General Assembly to encourage the use of coal as a principal fuel for electricity generation as set forth in KRS 152.210, provided that any facility, regardless of fuel choice, shall comply fully with KRS 224.10-280, 278.212, 278.216, and 278.700 to 278.716.

(3) A person that has received a construction certificate for a merchant electric generating facility shall*:*

(a) File with the Energy and Environment Cabinet the copy of the bond or other similar security that, pursuant to subsection (2)(m)5. of Section 3 of this Act, is required by a county or a municipal government or as part of a decommissioning plan, no later than the date upon which the construction of the merchant generating facility commences, and refile an updated copy at least once every five (5) years thereafter;

(b) Not transfer rights and obligation under the certificate without having first applied for and received a board determination that:

1.~~[(a)]~~ The acquirer has a good environmental compliance history; and

2.~~[(b)]~~ The acquirer has the financial, technical, and managerial capacity to meet the obligations imposed by the terms of the approval or has the ability to contract to meet these obligations*;*

(c) File with the Energy and Environment Cabinet a notice of the date that construction is complete and the merchant electric generating facility begins producing electricity for sale; and

(d) Following the date the merchant electric generating facility begins producing electricity for sale, file a notice of any transaction involving the transfer or sale of ownership, control, or the right to control the merchant electric generating facility, with lessors of property where the merchant electric generating facility is located, the Energy and Environment Cabinet, the county judge/executive of a county and, if applicable, the mayor of a municipality in which the merchant electric generating facility is located, within ten (10) days of completing the transaction. The notice shall include the name, street address, telephone number, and e-mail address of the person acquiring ownership, control, or the right to control the merchant electric generating facility.

(4) A person that has acquired ownership, control, or the right to control a merchant electric generating facility from the applicant or its successor or assign shall file with the Energy and Environment Cabinet within ten (10) days of completing the acquisition:

(a) A written consent to assume the obligations set forth in the decommissioning plan as of the date the acquisition occurred; and

(b) A notice of adoption of an existing bond or other similar security previously filed pursuant to subsection (3)(a) of this section or a replacement bond or other similar security that complies with subsection (2)(m)5. of Section 3 of this Act. An existing bond or other similar security shall be adopted, or a replacement bond or other similar security shall be in place, as of the date the acquisition occurs so that there is no lapse in coverage of the decommissioning bond or other similar security. A person making a filing pursuant to this subsection shall file an updated bond or other similar security that complies with subsection (2)(m)5. of Section 3 of this Act at least once every five (5) years.

(5) Any person who transfers or sells ownership, control, or the right to control a merchant electric generating facility shall remain liable for all existing decommissioning obligations and bond requirements until the person who acquires ownership, control, or the right to control the merchant electric generating facility files with the Energy and Environment Cabinet the documents required by subsection (4) of this section and they are accepted as complete by the secretary.

(6) Any application approval condition that requires the approval of the transfer of control of a merchant electric generating facility after construction is complete shall be void and unenforceable, but any transfer of control of a merchant electric generating facility shall be subject to compliance with the requirements of subsections (3)(d), (4), and (5) of this section.

(7) Notwithstanding any provision of law to the contrary, including any order issued by the board prior to the effective date of this Act, after the board has approved an application for a construction certificate for a merchant electric generating facility under this section, the approved applicant has posted the bond or similar security required under subsection (2)(m)5. of Section 3 of this Act, and the facility is constructed and begins generating electricity for sale, the board's authority to enforce any conditions of the construction certificate, including bonding and decommissioning requirements, shall end and the secretary of the Energy and Environment Cabinet shall monitor and enforce the construction certificate holder's compliance with the requirements of KRS 278.700 to 278.716 and the conditions of its construction certificate application approval.

(8) In addition to all compliance monitoring and enforcement performed by the secretary of the Energy and Environment Cabinet, and notwithstanding any provision of law to the contrary, the secretary shall also review the decommissioning plan required by subsection (2)(m) of Section 3 of this Act or by local ordinance, license, or permit and the bond or similar security amount required by subsection (2)(m)5. of Section 3 of this Act or by local ordinance, license, or permit as needed, including any time a transfer determination is made under subsection (5) of this section, but in any event at least once every five (5) years. Upon review, the secretary of the Energy and Environment Cabinet shall require the decommissioning plan to be updated and the bond amount to be changed to match any significant change in circumstances or change to the estimated cost of effectuating the decommissioning plan or to the salvage value of the facility or its components.

(9) After the facility for which an application for a construction certificate has been approved is constructed and begins generating electricity for sale, the secretary of the Energy and Environment Cabinet shall ensure ongoing compliance with the mitigation measures that were conditions of the application approval under subsection (6) of Section 4 of this Act and any enforcement by the board of the mitigation measures shall cease.

(10) During the period that the merchant electric generating facility is operational, if solar panels are replaced and discarded, the facility owner-operator shall remove discarded solar panels from the site within ninety (90) days of completion of the work. Upon request of the facility owner-operator, the secretary of the Energy and Environment Cabinet may extend the time period under this subsection for removing discarded solar panels.

➔Section 6. KRS 278.718 is amended to read as follows:

The provisions of KRS 278.700, 278.704, 278.706, 278.708, and 278.710 shall~~[be in addition to, and shall]~~ not supplant, any other state or federal law, including the powers available to local governments under the provisions of

home rule under KRS 67.080, 67.083, 67.850, 67.922, 67A.060, 67C.101, and 82.082. ***An ordinance, permit, or license issued by a local government shall have primacy over the provisions and requirements of KRS 278.700 and Sections 2, 3, and 4 of this Act, and any conflict between an order of the board and a local ordinance, permit, or license shall be resolved in favor of the local government's ordinance, permit, or license.***

➔Section 7. KRS 224.10-100 is amended to read as follows:

In addition to any other powers and duties vested in it by law, the cabinet shall have the authority, power, and duty to:

(1) Exercise general supervision of the administration and enforcement of this chapter, and all rules, regulations, and orders promulgated thereunder;

(2) Prepare and develop a comprehensive plan or plans related to the environment of the Commonwealth;

(3) Encourage industrial, commercial, residential, and community development which provides the best usage of land areas, maximizes environmental benefits, and minimizes the effects of less desirable environmental conditions;

(4) Develop and conduct a comprehensive program for the management of water, land, and air resources to assure their protection and balance utilization consistent with the environmental policy of the Commonwealth;

(5) Provide for the prevention, abatement, and control of all water, land, and air pollution, including but not limited to that related to particulates, pesticides, gases, dust, vapors, noise, radiation, odor, nutrients, heated liquid, or other contaminants;

(6) Provide for the control and regulation of surface coal mining and reclamation in a manner to accomplish the purposes of KRS Chapter 350;

(7) Secure necessary scientific, technical, administrative, and operational services, including laboratory facilities, by contract or otherwise;

(8) Collect and disseminate information and conduct educational and training programs relating to the protection of the environment;

(9) Appear and participate in proceedings before any federal regulatory agency involving or affecting the purposes of the cabinet;

(10) Enter and inspect any property or premises for the purpose of investigating either actual or suspected sources of pollution or contamination or for the purpose of ascertaining compliance or noncompliance with this chapter, or any regulation which may be promulgated thereunder;

(11) Conduct investigations and hold hearings and compel the attendance of witnesses and the production of accounts, books, and records by the issuance of subpoenas;

(12) Accept, receive, and administer grants or other funds or gifts from public and private agencies including the federal government for the purpose of carrying out any of the functions of the cabinet. The funds received by the cabinet shall be deposited in the State Treasury to the account of the cabinet;

(13) Request and receive the assistance of any state or municipal educational institution, experiment station, laboratory, or other agency when it is deemed necessary or beneficial by the cabinet in the performance of its duties;

(14) Advise, consult, and cooperate with other agencies of the Commonwealth, other states, the federal government, and interstate and interlocal agencies, and affected persons, groups, and industries;

(15) Formulate guides for measuring presently unidentified environmental values and relationships so they can be given appropriate consideration along with social, economic, and technical considerations in decision making;

(16) Monitor the environment to afford more effective and efficient control practices, to identify changes and conditions in ecological systems, and to warn of emergency conditions;

(17) Adopt, modify, or repeal with the recommendation of the commission any standard, regulation, or plan;

(18) Issue, after hearing, orders abating activities in violation of this chapter, or the provisions of this chapter, or the regulations promulgated pursuant thereto and requiring the adoption of the remedial measures the cabinet deems necessary;

(19) Issue, continue in effect, revoke, modify, suspend, or deny under such conditions as the cabinet may prescribe and require that applications be accompanied by plans, specifications, and other information the cabinet deems necessary for the following permits:

(a) Permits to discharge into any waters of the Commonwealth, and for the installation, alteration, expansion, or operation of any sewage system; however, the cabinet may refuse to issue the permits to any person, or any partnership, corporation, etc., of which the person owns more than ten percent (10%) interest, who has improperly constructed, operated, or maintained a sewage system willfully, through negligence, or because of lack of proper knowledge or qualifications until the time that person demonstrates proper qualifications to the cabinet and provides the cabinet with a performance bond;

(b) Permits for the installation, alteration, or use of any machine, equipment, device, or other article that may cause or contribute to air pollution or is intended primarily to prevent or control the emission of air pollution; or

(c) Permits for the establishment or construction and the operation or maintenance of waste disposal sites and facilities;

(20) May establish, by regulation, a fee or schedule of fees for the cost of processing applications for permits authorized by this chapter, and for the cost of processing applications for exemptions or partial exemptions which may include but not be limited to the administrative costs of a hearing held as a result of the exemption application, except that applicants for existing or proposed publicly owned facilities shall be exempt from any charge, other than emissions fees assessed pursuant to KRS 224.20-050, and that certain nonprofit organizations shall be charged lower fees to process water discharge permits under KRS 224.16-050(5);

(21) May require for persons discharging into the waters or onto the land of the Commonwealth, by regulation, order, or permit, technological levels of treatment and effluent limitations;

(22) Require, by regulation, that any person engaged in any operation regulated pursuant to this chapter install, maintain, and use at such locations and intervals as the cabinet may prescribe any equipment, device, or test and the methodologies and procedures for the use of the equipment, device, or test to monitor the nature and amount of any substance emitted or discharged into the ambient air or waters or land of the Commonwealth and to provide any information concerning the monitoring to the cabinet in accordance with the provisions of subsection (23) of this section;

(23) Require by regulation that any person engaged in any operation regulated pursuant to this chapter file with the cabinet reports containing information as to location, size, height, rate of emission or discharge, and composition of any substance discharged or emitted into the ambient air or into the waters or onto the land of the Commonwealth, and such other information the cabinet may require;

(24) Promulgate regulations, guidelines, and standards for waste planning and management activities, approve waste management facilities, develop and publish a comprehensive statewide plan for nonhazardous waste management which shall contain but not be limited to the provisions set forth in KRS 224.43-345, and develop and publish a comprehensive statewide plan for hazardous waste management which shall contain but not be limited to the following:

(a) A description of current hazardous waste management practices and costs, including treatment and disposal, within the Commonwealth;

(b) An inventory and description of all existing facilities where hazardous waste is being generated, treated, recycled, stored, or disposed of, including an inventory of the deficiencies of present facilities in meeting current hazardous waste management needs and a statement of the ability of present hazardous waste management facilities to comply with state and federal laws relating to hazardous waste;

(c) A description of the sources of hazardous waste affecting the Commonwealth including the types and quantities of hazardous waste currently being generated and a projection of such activities as can be expected to continue for not less than twenty (20) years into the future; and

(d) An identification and continuing evaluation of those locations within the Commonwealth which are naturally or may be engineered to be suitable for the establishment of hazardous waste management facilities, and an identification of those general characteristics, values, and attributes which would render a particular location unsuitable, consistent with the policy of minimizing land disposal and encouraging the treatment and recycling of the wastes.

The statewide waste management plans shall be developed consistent with state and federal laws relating to waste;

(25) Perform other acts necessary to carry out the duties and responsibilities described in this section;

(26) Preserve existing clean air resources while ensuring economic growth by issuing regulations, which shall be no more stringent than federal requirements, setting maximum allowable increases from stationary sources over baseline concentrations of air contaminants to prevent significant deterioration in areas meeting the state and national ambient air quality standards;

(27) Promulgate regulations concerning the bonding provisions of subsection (19)(a) of this section, setting forth bonding requirements, including but not limited to requirements for the amount, duration, release, and forfeiture of the bonds. All funds from the forfeiture of bonds required pursuant to this section shall be placed in the State Treasury and credited to a special trust and agency account which shall not lapse. The account shall be known as the "sewage treatment system rehabilitation fund" and all moneys placed in the fund shall be used for the elimination of nuisances and hazards created by sewage systems which were improperly built, operated, or maintained, and insofar as practicable be used to correct the problems at the same site for which the bond or other sureties were originally provided;

(28) Promulgate administrative regulations not inconsistent with the provisions of law administered by the cabinet;[~~and~~]

(29) Through the secretary or designee of the secretary, enter into, execute, and enforce reciprocal agreements with responsible officers of other states relating to compliance with the requirements of KRS Chapters 350, 351, and 352 and the administrative regulations promulgated under those chapters;

(30) Monitor and enforce the compliance of a merchant electric generating entity to which a construction certificate has been issued pursuant to Section 5 of this Act with respect to its obligations under subsections (3), (4), (5), (7), (8), (9) and (10) of Section 5 of this Act; and

(31) Draw upon a decommissioning bond or similar security for which it is named as a beneficiary and decommission and dismantle a merchant electric generating facility in accordance with its approved decommissioning plan.

➔Section 8. KRS 224.99-010 is amended to read as follows:

(1) Any person who violates KRS 224.10-110(2) or (3), 224.70-110, 224.73-120, 224.20-050, 224.20-110, 224.46-580, 224.1-400, or who fails to perform any duties imposed by these sections, or who violates any determination, permit, administrative regulation, or order of the cabinet promulgated pursuant thereto shall be liable for a civil penalty not to exceed the sum of twenty-five thousand dollars ($25,000) for each day during which such violation continues, and in addition, may be concurrently enjoined from any violations as hereinafter provided in this section and KRS 224.99-020.

(2) Any person who violates KRS 224.10-110(4) or (5), or KRS 224.40-100, 224.40-305, or any provision of this chapter relating to noise, or who fails to perform any determination, permit, administrative regulation, or order of the cabinet promulgated pursuant thereto shall be liable for a civil penalty not to exceed the sum of five thousand dollars ($5,000) for said violation and an additional civil penalty not to exceed five thousand dollars ($5,000) for each day during which such violation continues, and in addition, may be concurrently enjoined from any violations as hereinafter provided in this section and KRS 224.99-020.

(3) (a) Any person who shall knowingly violate any of the provisions of this chapter relating to noise or any determination or order of the cabinet promulgated pursuant to those sections which have become final shall be guilty of a Class A misdemeanor. Each day upon which the violation occurs shall constitute a separate violation.

(b) For offenses by motor vehicles, a person shall be guilty of a violation.

(4) Any person who knowingly violates KRS 224.70-110, 224.73-120, 224.40-100, 224.20-110, 224.20-050, 224.40-305, or 224.10-110(2) or (3), or any determination, permit, administrative regulation, or order of the cabinet promulgated pursuant to those sections which have become final, or who knowingly provides false information in any document filed or required to be maintained under this chapter, or who knowingly renders inaccurate any monitoring device or method, or who tampers with a water supply, water purification plant, or water distribution system so as to knowingly endanger human life, shall be guilty of a Class D felony, and upon conviction thereof, shall be punished by a fine not to exceed twenty-five thousand dollars ($25,000), or

by imprisonment for a term of not less than one (1) year and not more than five (5) years, or by both fine and imprisonment, for each separate violation. Each day upon which a violation occurs shall constitute a separate violation.

(5) If any person engages in generation, treatment, storage, transportation, or disposal of hazardous waste in violation of the hazardous waste management provisions of this chapter or contrary to a permit, order, or rule issued or promulgated under this chapter, or fails to provide information or to meet reporting requirements required by terms and conditions of a permit or administrative regulations promulgated pursuant to this chapter, the secretary may issue an order requiring compliance within a specified time period or may commence a civil action in a court of appropriate jurisdiction. The violator shall be liable for a civil penalty not to exceed the sum of twenty-five thousand dollars ($25,000) for each day during which the violation continues, and in addition, may be enjoined from any violations in a court of appropriate jurisdiction.

(6) Any person who knowingly is engaged in generation, treatment, storage, transportation, or disposal of hazardous waste in violation of this chapter or contrary to a permit, order, or administrative regulation issued or promulgated under this chapter, or knowingly makes a false statement, representation, or certification in an application for or form pertaining to a permit or in a notice or report required by the terms and conditions of an issued permit, shall be guilty of a Class D felony, and upon conviction thereof, shall be punished by a fine not to exceed twenty-five thousand dollars ($25,000) for each day of violation, or by imprisonment for a term of not less than one (1) year and not more than five (5) years, or by both fine and imprisonment, for each separate violation. Each day upon which a violation occurs shall constitute a separate violation.

(7) Nothing contained in subsections (4) or (5) of this section shall abridge the right of any person to recover actual compensatory damages resulting from any violation.

(8) Any person who violates any provision of this chapter to which no express penalty provision applies, except as provided in KRS 211.995, or who fails to perform any duties imposed by those sections, or who violates any determination or order of the cabinet promulgated pursuant thereto shall be liable for a civil penalty not to exceed the sum of one thousand dollars ($1,000) for said violation and an additional civil penalty not to exceed one thousand dollars ($1,000) for each day during which the violation continues, and in addition, may be concurrently enjoined from any violations as hereinafter provided in this section and KRS 224.99-020.

(9) The Franklin Circuit Court shall hold concurrent jurisdiction and venue of all civil, criminal, and injunctive actions instituted by the cabinet or by the Attorney General on its behalf for the enforcement of the provisions of this chapter or the orders and administrative regulations of the cabinet promulgated pursuant thereto, ***except for any actions arising from or related to subsections (3), (4), or (5) of Section 5 of this Act or subsection (16) of this section, which shall be brought in the Circuit Court in any county in which the merchant electric generating facility is located***.

(10) Any person who deposits leaves, clippings, prunings, garden refuse, or household waste materials in any litter receptacle, except with permission of the owner of the receptacle, or who places litter into a receptacle in such a manner that the litter may be carried away or deposited by the elements upon any property or water not owned by him ***or her*** is guilty of a Class B misdemeanor. Penalties imposed under this subsection shall be, when collected, transferred to the county treasurer where the offense occurred and placed into a fund for solid waste cleanup. This subsection shall not be construed to divert any other fines assessed and collected by the cabinet or funds available to the cabinet for the purpose of remediation of open dumps.

(11) In addition to or in lieu of the penalties set forth in this section or in KRS Chapters 532 and 534, any person found guilty of a second or subsequent offense related to littering may be ordered by the court to pick up litter for not less than four (4) hours.

(12) Any person who violates KRS 224.20-300, 224.20-310, any other provision of this chapter, or any determination, permit, administrative regulation, or order of the cabinet relating to the Asbestos Hazard Emergency Response Act of 1986 (AHERA), Public Law 99-519, as amended, shall be liable to the Commonwealth of Kentucky for a civil penalty in an amount not to exceed twenty-five thousand dollars ($25,000) for each violation. Each day a violation continues shall, for purposes of this subsection, constitute a separate violation of provisions of this chapter relating to AHERA.

(13) A violation of KRS 224.50-413 shall be subject to a fifty dollar ($50) fine for each day the violation continues.

(14) Any person who removes a methamphetamine contamination notice posted under KRS 224.1-410(9) contrary to the administrative regulations governing methamphetamine contamination notice removal shall be guilty of a Class A misdemeanor.

(15) Any person who leases, rents, or sells a property that has been determined to be contaminated property under KRS 224.1-410(4) to a lessee, renter, or buyer without giving written notice that the property is a contaminated property pursuant to KRS 224.1-410(10) shall be guilty of a Class D felony.

(16) Any person who violates subsection (3), (4), or (5) of Section 5 of this Act may be subject to civil penalties not to exceed two thousand five hundred dollars ($2,500) per day. In determining the civil penalty to be imposed under this subsection, the cabinet shall consider all relevant circumstances including but not limited to the extent of harm or potential harm caused by the violation, the nature and duration of the violation, the number of past violations, and any corrective action taken by the merchant electric generating facility owner. If a merchant electric generating facility fails to pay any civil penalty for noncompliance under this subsection for a period of three hundred sixty-five (365) days after a final determination of the assessment of the civil penalty, or fails to post a bond or replacement bond in compliance with subsections (3), (4), or (5) of Section 5 of this Act within ninety (90) days of a final determination that the bond or replacement bond is required, the cabinet may order suspension of its operations until it is brought back into compliance and all civil penalties have been paid or the bond or replacement bond is posted. If after a final determination that the cabinet's order suspending operations of the facility is valid, and the merchant electric generating facility fails to bring the facility back into compliance by paying all outstanding civil penalties or posting the bond or replacement bond within ninety (90) days of that final determination, the cabinet may order the decommissioning of the facility to commence.

➔SECTION 9. A NEW SECTION OF SUBCHAPTER 10 OF KRS CHAPTER 224 IS CREATED TO READ AS FOLLOWS:

(1) If the owner of a merchant electric generating facility fails to complete the decommissioning plan within eighteen (18) months of the date that the facility ceases to produce electricity for sale and the secretary has not extended the deadline, the cabinet shall draw upon the decommissioning bond and implement the decommissioning plan.

(2) Within ninety (90) days of the effective date of this Act, the cabinet shall promulgate administrative regulations pursuant to KRS Chapter 13A to establish the monitoring and enforcement requirements for the obligations set forth in subsections (3), (4), (5), (7), (8), (9) and (10) of Section 5 of this Act and subsections (30) and (31) of Section 7 of this Act. The cabinet shall establish a fee structure covering the entire useful life of a merchant electric generating facility to be charged to each facility for which the cabinet has monitoring and enforcement responsibilities. The fees collected shall be deposited in the restricted fund established in subsection (3) of this section.

(3) (a) There is hereby established in the State Treasury a restricted fund to be known as the merchant electric generating facility monitoring and enforcement fund, which shall be administered by the cabinet and shall consist of the fees collected under subsection (2) of this section and any moneys collected pursuant to enforcement actions taken by the cabinet in the course of performing its monitoring and enforcement responsibilities for merchant electric generating facilities.

(b) Amounts deposited in the fund shall only be used to defray the costs of the cabinet's monitoring and enforcement responsibilities for merchant electric generating facilities and for no other purpose.

(c) Notwithstanding KRS 45.229, fund amounts not expended at the close of the fiscal year shall not lapse, but shall be carried forward into the next fiscal year.

(d) Any interest earnings of the fund shall become part of the fund and shall not lapse.

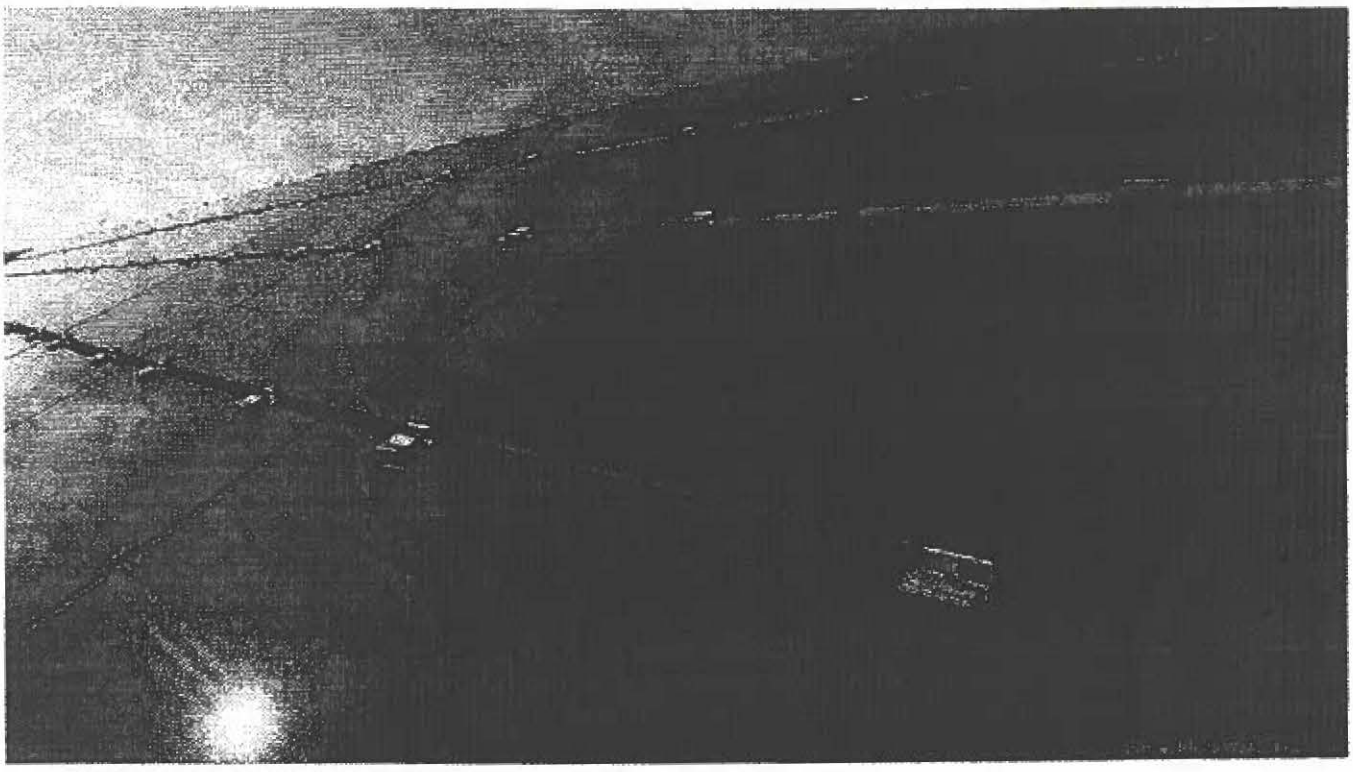
(e) Moneys deposited in the fund are hereby appropriated for the purposes set forth in this subsection and shall not be appropriated or transferred by the General Assembly for any other purposes.

(4) In carrying out its decommissioning plan and bond adequacy review under subsection (8) of Section 5 of this Act, the cabinet shall have the authority to hire a consulting independent licensed engineer to review the secured decommissioning bond or similar security instrument and decommissioning plan and provide recommendations concerning the adequacy of the security instrument to cover actual costs. The cabinet may direct the independent licensed engineer to prepare an assessment report. Any expenses or fees incurred by the cabinet's hiring of the independent licensed engineer shall be paid by the owner-operator of the merchant electric generating facility.

Veto Overridden March 30, 2023.

Energy

First Solar to pay $350M in investor class-action lawsuit settlement



First Solar's advanced thin-film Cadmium Telluride solar modules

PROVIDED BY FIRST SOLAR

By Patrick O'Grady – Managing Editor, Phoenix Business Journal
Jan 7, 2020

First Solar Inc. has agreed to settle a class-action lawsuit alleging it mislead investors during a boom period for the company, with the bill coming in at $350 million.

The case, initially brought by investor Mark Smilovits and eventually certified as a class action, was initially filed in 2012 and came after several years of Tempe-based First Solar (Nasdaq: FSLR) landing multiple deals to land massive solar power plant projects.

The lawsuit alleged First Solar officials mislead investors about the challenges the company faced in regards to replacing defective panels at those power plants. It was filed after the company reported it was paying more than $164 million in warranty claims on it panels during the fourth-quarter 2011.

The company at the time said between 4% and 8% of its panels were affected by a manufacturing problem.

First Solar announced the settlement Jan. 6 in an announcement and filings with the U.S. Securities and Exchange Commission. Company CEO Mark Widmar said in a statement the move was to get beyond the lawsuit and not face the uncertainties of going to trial.

"While we are confident in the facts and the merits of our position, we believe it is prudent to end this protracted and uncertain class action litigation process, and focus on driving the business forward," he said. "We remain in a strong financial position, are pleased with our progress with Series 6 and our contracted customer pipeline, and are focused on executing our global strategy and serving our customers."

The company's stock fell as much as $2.50 per share in trading Jan. 6 following the announcement, but gained much of that back on Tuesday, closing at $56.67. Click here to follow the stock.

While the move settles one lawsuit, two others – Maverick Fund LDC v. First Solar in U.S. District Court of Arizona and Bargar, et al V. Ahearn, et al in Maricopa County Superior Court – remain pending.

solubility of Cd and Te are strongly dependent on pH [28, 29]. Municipal waste landfills are generally rich in anaerobic microbial activity. Anaerobic microorganisms are capable of reducing and precipitating tellurium [30-33], and such microbial transformations could potentially impact the dissolution of CdTe in the landfill environment. Microbial processes have previously been shown to promote the mobilization of some metals and metalloids in MSW landfills. For example, several studies have demonstrated the microbially-mediated mobilization and biotransformation of arsenic under simulated landfill conditions [34-36]. A preliminary generic risk assessment for decommissioned thin-film CdTe panels disposed in a MSW landfill has been performed using a U.S. EPA software model based on TCLP data that concluded that under current production of PV panels there should be no risk to humans [24, 37].

The purpose of this study is to investigate the potential environmental risk posed by the disposal of CdTe solar cells in municipal waste landfills. For this purpose, crushed samples of CdTe cells were placed in continuous-flow columns simulating the chemical, physical, and biological environments at two of the different stages in the lifetime of a landfill (*i.e.* the acidic phase and the methanogenic phase) [25]. The release of both Cd and Te was then monitored to determine the potential hazards of this disposal method.

2. Materials and methods

2.1. Panel characteristics

A thin-film CdTe solar panel was obtained from Abound Solar (Loveland, CO, USA) with dimensions of 60 by 120 cm, and 14 kg in mass. The CdTe thin-film layer was deposited between two sheets of glass, one of the sheets served as a glass substrate; while, the other was used as a back cover. The Abound solar panel used did not contain a laminate layer (e.g. ethylvinylacetate) to encapsulate the Cd-containing film. Such layer is found in some CdTe PV modules commercially available [38]. Four fragments of the panels were separated in order to determine the film to glass mass ratio of the panel as follows: the films were manually separated from their corresponding glass cases and, the masses of both fractions were obtained with an analytical balance (Mettler Toledo AB304-s; Columbus, OH, USA); finally, the film to glass mass ratio was estimated to be 0.0053 ± 0.00042 w/w.

2.2. Cadmium and tellurium content determination

Film fragments were digested using 15 mL of concentrated HF (45% wt.) and 3 mL of concentrated HNO_3 (70% wt.) according to a modified EPA standard procedure [39]. Digested samples were then diluted in demineralized (DI) water and analyzed for Cd and Te. The samples were analyzed with an inductively coupled plasma–mass spectrometer (ICP-MS, Agilent model 7700x; Santa Clara, CA, USA) operated with He as collision gas to reduce Ar based interferences. The detection limits were 1.6 ng L^{-1} for Cd and 32.5 ng L^{-1} for Te. The panel was found to contain 7.31 ± 1.22 mg Cd and 7.68 ± 1.19 mg of Te per gram of film, respectively.

2.3. Panel preparation

The size of the panel was first reduced by breaking it with a hammer and the larger fragments were placed into a ball mill (Sepor, Wilmington, CA, USA). The milling process was carried out at 90 rpm. The CdTe-containing film is not brittle and was poorly fragmented during milling. Therefore, the film fragments were manually separated from the glass fragments and their size further reduced with scissors. The length of the longest side of the snipped film ranged between 3-8 mm and the thickness of the film was < 1 mm. The glass fragments were then sieved using a standard 3 1/2 mesh sieve (ASTM E11). The fragments that did not pass through were then sieved using a standard mesh no. 14 (ASTM E11), and the fragments that passed through were kept, resulting in glass fragments that ranged in size from 1.4–5.6 mm.

2.4. Microbial inoculum

A methanogenic anaerobic granular sludge obtained from a wastewater treatment plant at Mahou beer brewery (Guadalajara, Spain) was used to inoculate the columns. The inoculum contained 0.079 g of volatile suspended solids (VSS) g^{-1} wet wt. The maximum acetoclastic and hydrogenotrophic methanogenic activities of the sludge were 566 ± 64 mg methane as chemical oxygen demand (COD-CH_4) g VSS^{-1} day^{-1} and 571 ± 26 mg COD-CH_4 g VSS^{-1} day^{-1}, respectively.

2.5. Columns set up and operational conditions

Two continuous upflow columns (V= 280 mL) were prepared and operated in parallel to model different stages of a MSW landfill (Fig. 1). Each column was packed with 1.5 g of snipped CdTe film and 300 g crushed glass, corresponding to the same mass ratio as was present in the panels. Each column contained 11.0 mg of Cd and 11.56 mg Te. Column 1 (acidic column) and column 2 (methanogenic column) were used to study the effect of the leachate produced during the acidic phase (young landfill) and in the initial methanogenic phase (mature landfill, circumneutral pH) of a municipal landfill, respectively, on the dissolution and mobility of the Cd and Te species present in the solar panel. Both columns were inoculated with 9.80±0.03 g sludge-VSS L^{-1}. The sludge used to inoculate the acidic column was heat treated in a VWR convection oven (1370GM, Radnor, PA, USA) at 70°C for 60 min to pasteurize the methanogenic microbial communities and thereby prevent an increase of the pH of the synthetic leachate due to the volatile fatty acids(VFA) degradation.

The columns were fed a synthetic leachate solution composed of a mixture of VFA (please refer to the Supplementary Data (SD) section) with a final pH of 4.67 ± 0.06. The pH of the influent of the acidic column was kept at 4.67 ± 0.06. The pH values for landfill leachate in this stage have been reported to range between 4.5 and 7.5 [25]. The pH of the influent of the methanogenic column was adjusted to 6.71 ± 0.19 using 10 M NaOH since microbial methanogenesis occurs only within a narrow pH range (circumneutral).

The acidic and methanogenic columns were operated at 25°C for 30 days at an average hydraulic retention time (HRT) of 27.7 ± 1.9 h and 28.8 ± 2.2 h, respectively.

2.6. Column sampling and monitoring

Throughout the testing period, samples were taken of the influent and effluent of both columns to determine the pH, as well as, the concentration of soluble Cd, Te, and VFA using the analytical methods described in the SD section. The CH_4 content of the gas produced in the columns was measured by monitoring the volume of liquid displaced in an inverted bottle filled with NaOH (2%, v/v) to scrub CO_2.

2.7. Chemical oxygen demand mass balance

The chemical oxygen demand (COD) concentration in the inlet and outlet streams of the columns was estimated by adding the COD of all species in these streams (Eq. 1 and 2). The mass balance for the components in the synthetic leachate, expressed as total COD, is represented in Eq. 3.

$$\sum[\mathrm{COD}]_{\mathrm{infl}}=[\mathrm{COD}-C_2]_{\mathrm{infl}}+[\mathrm{COD}-C_3]_{\mathrm{infl}}+[\mathrm{COD}-C_4]_{\mathrm{infl}}+[\mathrm{COD}-C_5]_{\mathrm{infl}}+[\mathrm{COD}-C_6]_{\mathrm{infl}}$$

(1)

$$\sum[\mathrm{COD}]_{\mathrm{effl}}=[\mathrm{COD}-C_2]_{\mathrm{effl}}+[\mathrm{COD}-C_3]_{\mathrm{effl}}+[\mathrm{COD}-C_4]_{\mathrm{effl}}+[\mathrm{COD}-C_5]_{\mathrm{effl}}+[\mathrm{COD}-C_6]_{\mathrm{effl}}$$

(1)

$$\sum[\mathrm{COD}]_{\mathrm{infl}}=\sum[\mathrm{COD}]_{\mathrm{effl}}+[\mathrm{COD}]_{\mathrm{methane}}+[\mathrm{COD}]_{\mathrm{cells}} \quad (3)$$

Where: infl = influent, effl = effluent, C_2 = acetate, C_3 = propionate, C_4 = butyrate, C_5 = valerate, C_6 = caproate, $[\mathrm{COD}]_{\mathrm{cells}}$ = organic matter COD used to produce new cells, and $[\mathrm{COD}]_{\mathrm{methane}}$ = organic matter COD used to produce methane.

The last term in Eq. 3 ($[\mathrm{COD}]_{\mathrm{cells}}$) was not considered in the COD balances since the cell growth yield associated with the anaerobic conversion of volatile fatty acids to methane is very low, typically less than 2-5% of the COD utilized[40, 41].

2.8. Standardized leaching tests

The CdTe solar panel was subjected to the standardized TCLP [16] and the California Waste Extraction Test (WET) [42] leaching tests using the snipped film and crushed glass previously prepared for the continuous columns set up, at the appropriate film/glass mass ratio of ~ 0.005. These standardized tests are used to determine if a solid waste should be considered and handled as hazardous waste. If the waste fails the standardized leaching test it must be disposed of in a hazardous waste landfill instead of in a MSW landfill along with

non-hazardous waste. The experimental conditions used in this work are described in the SD section.

2.9. Redox potential *vs.* pH (Pourbaix) diagrams

In this work, the W32-STABCAL software (Stability calculation for aqueous and non-aqueous systems, Montana Tech, Butte, MT, USA) and thermodynamic information published by the National Bureau of Standards NBS (NIST, U.S. Department of Commerce, USA) were used to plot potential-pH (Pourbaix) diagrams for CdTe. These diagrams showed the thermodynamically stable species of Cd and Te in complex aqueous systems under different redox potentials and pH conditions.

3. Results

3.1. Leaching of soluble Cd and Te species from the solar panel

Two continuous-flow columns packed with a mixture of CdTe thin-film and crushed glass of solar panels were run in parallel to investigate the impact of two simulated landfill conditions on the potential release of soluble Cd and Te from the CdTe semiconductor film into the environment. The columns were set up to simulate the acidic phase (acidic column) and, the initial period of the anaerobic methanogenic phase (methanogenic column) of a MSW landfill.

Figure 2A shows the concentrations of Cd and Te in the effluent from the columns. In the acidic column, the concentrations increased during the first ten days, reaching maximum levels of 3.23 mg L^{-1} for Cd and 1.10 mg L^{-1} for Te, respectively. At this point of time, 47.7% and 12.6% of the total Cd and Te contained in the solar panel had been released to the effluent, respectively. The concentration of Cd in the effluent was found to be above the threshold limit established in the TCLP for this metal for approximately 50% of the full operation time. The concentration of both Cd and Te in the effluent then decreased over the remainder of the experiment. Figure 3A shows the cumulative release of Cd and Te in the acidic column. Over the course of 30 days, 73% of the Cd and 21% of the Te were released.

In the methanogenic column, only very low concentrations of Cd and Te were measured in the effluent during the first 8 days of the experiment, and afterwards these contaminants could no longer be detected in the effluent for the remainder of the experiment. The maximum levels of Cd and Te observed in the effluent were 0.01 mg Cd L^{-1} (on the third day of operation), and 0.02 mg Te L^{-1} (on the second day of operation), respectively. Only 0.03% and 0.05% of the total Cd and Te in the solar panel, respectively, had been released to the effluent when their maximum levels were observed. Figure 3B shows the cumulative release in the methanogenic column. In total, 0.05% of the Cd and 0.18% of the Te were released.

Figure 2B shows that the pH of the effluent of both columns remained stable and very close to the pH of the respective influents over the course of the experiment.

3.2. Chemical oxygen demand balance

The continuous columns used in this work were fed with a synthetic leachate solution composed of a VFA mixture with an initial concentration of approximately 1.5 g COD L^{-1}. To monitor the activity of the microbial communities in the anaerobic sludge, the concentration of the synthetic leachate of the influent and effluent, as well as, the production of methane in both columns were measured during the full time of operation. Equations 2 and 3 were used to estimate the total COD in the influent and effluent of the columns, respectively.

Figure 4A shows the time course of the COD concentration of the synthetic leachate in the influent and effluent of the methanogenic column. The COD concentration decreased progressively from its initial value in the influent until day 20, when the microorganisms in the anaerobic sludge were able to completely degrade the VFA mixture. Figure 4B shows the daily production of methane in the methanogenic column, as well as, the maximum expected production of CH_4 (0.367±0.036 g COD-CH_4 day^{-1}) based on the amount of COD added to the influent of the column. The daily methane production increased over time until it reached the maximum expected value at day 20 and remained stable until the last day of operation At that point of time, the mass balance in Eq. 3 can best be represented as $\Sigma[COD]_{infl} = [COD]_{methane}$.

In the case of the acidic column, no degradation of the VFA in the synthetic leachate or methane production was observed in the full time of operation as can be observed in Figure S1A (in supplementary data SD). This is consistent with the fact that the inoculum of the acidic column was subjected to heat treatment to inhibit methanogenic microorganisms. The low pH values of the column contents of the acidic column ($pH_{effluent}$ = 4.74±0.10, Fig. 2B) were also below the optimal range for methanogenesis.

3.3. Standardized leaching test

In this study, fragments of the CdTe solar panel were subjected to the EPA TCLP test and to the California WET leaching test to assess the potential dissolution of the toxic compounds present in the semiconductor material.

Figure 5 shows the results for the TCLP and WET test performed with the CdTe solar panel. The concentration of soluble Cd determined in the TCLP and WET tests were 0.150±0.006 and 0.219±0.010 mg L^{-1}, respectively. The Cd concentration was 6.7-fold lower than the threshold limit established in the TCLP test and 4.6-fold lower than the one for the WET test. The concentration of soluble Te in the final solutions produced in the TCLP and WET tests were 0.069±0.008 and 0.074±0.011 mg L^{-1}, respectively.

4. Discussion

4.1. Main findings

4.1.1 Leaching of Cd and Te—The potential release of the toxic compounds from a CdTe thin-film solar panel under conditions simulating those prevailing in young- and a mature MSW landfills was assessed in this work. The most important effect was observed in

the acidic column in which a remarkable release of Cd was observed (ca. 73% of the Cd supplied as CdTe). The maximum concentration of Cd in the leachate was 3.24 mg L^{-1}, which is 3-fold higher that the TCLP limit for Cd, and 650-fold higher than the U.S. federal MCL in drinking water (0.005 mg L^{-1}). Comparison of Cd levels in the leachate with MCL values provides information on the required attenuation to ensure that MLC levels are not exceeded in drinking water resources impacted by landfill leachate. The maximum concentration of dissolved Te measured in this leachate was 1.1 mg L^{-1}. In contrast, the release of dissolved Cd and Te species was negligible in the methanogenic column. To the best of our knowledge, this study represents the first attempt to comparatively assess the leaching behavior of a CdTe solar panel by considering both simulated acidic and methanogenic landfill conditions in a continuous flow fashion.

Whereas the maximum flux of dissolved Cd detected in the acidic column was 0.246 mg Cd cm^{-2} cross section of the column hr^{-1}, it is important to mention that the solar panel used in this study contained low levels of Cd and Te compared to the amount reported for other CdTe panels in several other studies. The PV cell used in this work contained 0.843±0.187 g Cd, and 0.891±0.211 g Te per m^2 of intact panel representing a mass percentage of 0.004 ± 0.001% of each in the solar panel. Other works have reported contents of Cd and Te which are 7.4- fold to 74.6-fold higher than those used in this study [21, 22, 43]. The amount of Cd and Te in solar panels has been decreasing over time in an attempt to reduce production costs and comply with environmental restrictions [44, 45]. The large variability in Cd and Te content suggests that higher concentrations of soluble Cd and Te could be released if older CdTe solar cells are disposed in MSW landfills after they reach the end of their useful service life (25-35 years).

The findings of the present work correlate well with the results reported previously in chemical dissolution that used CdTe powder. Leaching tests conducted by Zeng et al. [27] demonstrated that CdTe has a high leaching potential, especially under acidic and aerobic conditions. Their study demonstrated that the concentrations of Cd released from CdTe powder when subjected to the TCLP and WET leaching tests were about 1500 and 260 times higher than the regulatory limit (1 mg L^{-1}). The concentrations of soluble Cd determined in the present study are markedly lower than those obtained in the leaching studies performed with pure CdTe because CdTe solar cells contain a very large mass fraction of inert glass and the CdTe is present in a film.

The potential dissolution and mobility of Cd and Te from CdTe solar panels due to physico-chemical factors have been previously assessed using standardized batch leaching tests, and in one case, a column set up was used assessing leaching by rain. The TCLP data determined previously for CdTe solar panels show a large variability and soluble Cd values ranging from less than 0.15 to over 9.5 mg Cd L^{-1} (*i.e.*, almost 10-fold higher than the TCLP threshold) have been reported [18, 19, 23, 46]. Two standardized leaching tests were conducted according to the European Union landfill directive and the U.S. TCLP on CdTe modules manufactured by the British Petroleum Company (BP) [46]. The concentrations of Cd in the produced leachates were lower than the thresholds limits established in the corresponding protocols. In a different study, a standardized batch leaching tests was performed according to the Norwegian Standard-European Norm Characterization of waste.

This test uses deionized water as the leaching solution. The concentration of Cd in final leachate was found to be below the threshold limit established for an MSW landfill (≤1 mg Cd kg^{-1} dw.) [22]. In a study performed to investigate the impact of rain conditions on the mobility and emissions of soluble Cd and Te species in the environment, the concentrations of dissolved Cd and Te released after one week of exposure were 1.0 and 0.3 mg L^{-1}, respectively[21].

4.1.2 Microbial communities and redox conditions—The degradation of solid waste in MSW landfills occurs through a series of complex chemical and biological reactions [25]. During the acid phase of a landfill, cellulose and hemicellulose are hydrolyzed by bacteria to form monosaccharides, which are fermented by fermentative bacteria to volatile fatty acids. In this stage, the lowest pH of the leachate was reported to be 4.5 [25]. The synthetic leachate used in this work was constituted by a mixture of carboxylic acids representative of those formed by fermentative bacteria during the acidic phase. The initial methanogenic phase starts when the pH of the leachate increases and a minimal growth of methanogenic microorganisms begins. Methanogenic microorganisms are highly sensitive to pH, and methanogenesis occurs only within a narrow pH range (circumneutral). In the methanogenic phase, acetogenic bacteria convert carboxylic acids to acetate, H_2 and CO_2 which in turn are converted to methane by methanogens.

In the methanogenic column, the VFAs in the synthetic leachate were assumed to be converted via acetate, H_2 and CO_2 by acetogenic bacteria in the sludge. Since the pH of the influent of this column (6.71±0.19) was favorable for the growth of methanogenic microorganisms, methane was progressively formed until a stable production of methane was observed. Due to the expected production of H_2 by the acetogenic bacteria, and to the fact that methanogens are highly sensitive to oxygen, it is acceptable to assume that strong reducing conditions prevailed in this column.

4.2. Mechanisms of CdTe dissolution

The different leaching behaviors observed for CdTe in the two columns operated in the present study might be explained by the different pH levels and by differences in the redox conditions promoted by the microbial communities present in the methanogenic inoculum. Figure 6 shows the Pourbaix diagram obtained for the CdTe-H_2O system. The diagram was generated using the highest concentration of each element observed in the effluent of the acidic column. The dashed lines represent the stability region of water and can be defined by the following equations:

$$\text{Upper stability line: } Eh = 1.23 - 0.059pH \quad (4)$$

$$\text{Lower stability line: } Eh = -0.059pH \quad (5)$$

In the region above the upper dashed line (Eq. 4) water releases oxygen. The region below the dashed lower line (Eq. 5) corresponds to the conditions at which water becomes unstable and releases hydrogen.

As mentioned before, there was no substantial evidence of microbial activity in the acidic column based on the lack of VFA consumption and methane production. The resazurin redox indicator dye in the column effluent was pink indicating microaerophilic conditions that may have resulted from the lack of microbial consumption of traces of dissolved oxygen. Under these conditions, the presence of an important fraction of soluble Cd and Te would be expected based on thermodynamic considerations, which is in agreement with the extensive dissolution of CdTe observed in the acidic column. According to the Pourbaix diagram, the redox potential for the lower water stability is -0.276 V and the one for the upper limit is 0.954 V. The thermodynamically stable species expected for Te are elemental Te, $HTeO_3^-$ (tellurite), and H_6TeO_6 (tellurate). The stable species for Cd are CdTe, and soluble Cd^{2+}. The results are in agreement with our previous study investigating the leaching behavior of CdTe under different pH and redox conditions. Those results confirmed a marked enhancement in the dissolution of CdTe powder both at acidic pH levels and under aerobic conditions [27].

Due to the methanogenic microbial activity, highly reducing conditions are expected in the methanogenic column. CdTe is thermodynamically stable in aqueous solution under those conditions and no soluble Cd or Te would be expected in the system. According to the Pourbaix diagram, the redox potential for the lower water stability is -0.396 V, and the one for the upper line is 0.834 V. The thermodynamically stable species for Te are elemental Te and CdTe, and for Cd, CdTe is the only stable species. The absence of dissolved Cd in the circumneutral leachate could also be due to some extent to the decreased solubility of Cd^{2+} with increasing pH.

4.3. Implications

The evidence found in this work indicates that the standardized TCLP and WET leaching tests might underestimate the leaching of Cd and Te from disposing decommissioned CdTe solar panels in landfills. Although some previous works have stated that CdTe is an insoluble form of Cd and that CdTe is expected to have low bioavailability in the environment [47], the results obtained in the present study as well as another related investigations [27] indicate that a high fraction of the Cd and Te in CdTe panels could be potentially released if non-encapsulated CdTe solar panels are discarded in municipal landfills. Leaching of Cd and Te is expected to occur mainly during the acidic phase of a landfill in which low pH values are dominant.

The leaching results reported in the current study were obtained in accelerated column tests simulating the conditions in the acidogenic and methanogenic phases of a MSW landfill. The actual Cd concentrations in a given landfill would depend on the amount of PV panels disposed, panel design, panel fragment size, climatic conditions, landfill management and design, etc. The risk that leachate impact groundwater is minimized in modern MSW landfills that are designed with daily cover of the waste, storm water management, use of liners at the bottom of the landfill, and a leachate collection system [48]. Releases into

groundwater are, thus, particularly a problem in landfills that were not originally designed to prevent migration of the leachate (unlined landfills). Elevated concentrations of metals and metalloids have been measured in samples of groundwater collected in locations close to landfills receiving electronic waste [49]. Furthermore, release of these highly toxic compounds into the landfill, could impact the microbial communities degrading organic waste and, thereby, the waste stabilization process. Our findings from a previous work indicated the methanogenic activity of anaerobic sludge are highly inhibited by the presence of Cd and Te soluble species [50].

The significant leaching of toxic Cd demonstrated in the present study under simulated, acidic landfill conditions indicates the need for further investigation of the leaching potential of decommissioned CdTe PV panels, and suggests the need for measures to minimize their disposal in MSW landfills. In this sense it is important to point out that, as previously mentioned, the European Union has recently adopted the WEEE Directive that aims to achieve a high degree of separation of PV panels and other electronic waste in order to minimize their disposal in MSW landfills, reduce the entry of toxicants into the environment, and ensure recycling and recovery of valuable and hazardous materials from these waste resources [20]. The U.S. Solar Energy Industries Association (SEIA) did also launch a solar PV recycling program in late 2016 to improve the environmental sustainability of the U.S. solar industry [51].

Conclusions

The biogeochemical conditions prevailing during the different stages of a landfill potentially affect the release of the toxic soluble compounds from decommissioned non-encapsulated CdTe PV cells. During the acidic phase of a young landfill, the highest release of Cd and Te will be expected as a result of the low pH prevailing in the landfill environment. In contrast, during the methanogenic phase of a mature landfill, low corrosion of CdTe caused by the highly reducing conditions in the landfill environment only allows for marginal release of soluble Cd and Te species. Given the high toxicity of Cd, these results suggest the need for measures to minimize the disposal of decommissioned CdTe PV panels in MSW landfills.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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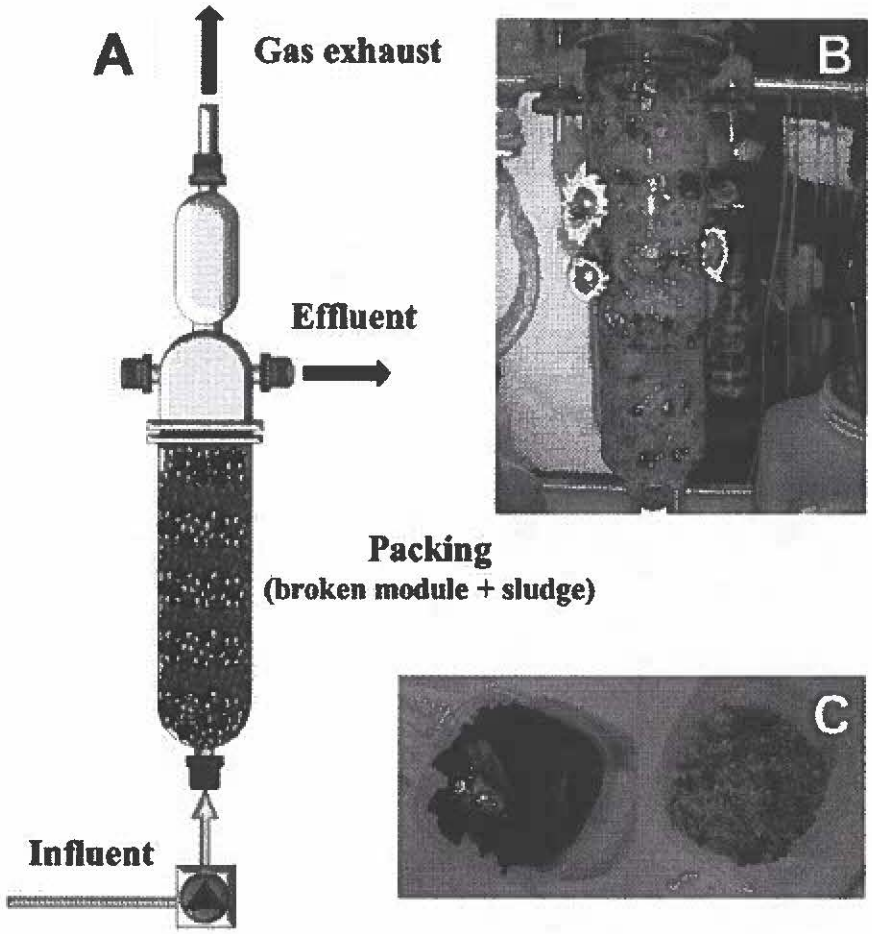

Figure 1.

Schematic of the continuous columns used in this work (**panel A**). Image of the layered packing of the columns (**panel B**). Snipped CdTe film and crushed glass fractions of solar panels used in the column packing (**panel C**).

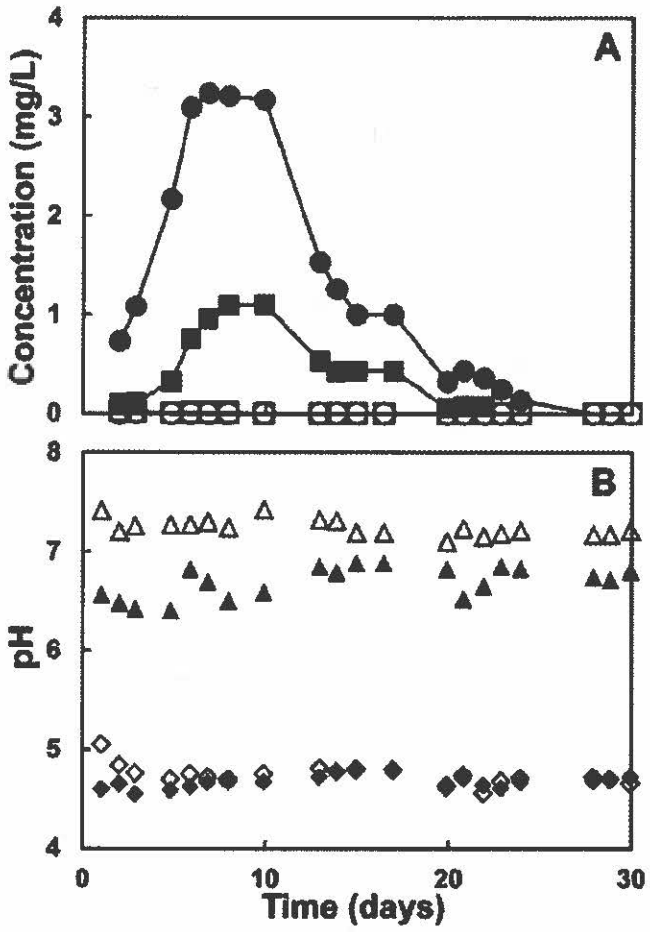

Figure 2.

Release of soluble cadmium (Cd) and tellurium (Te) from a CdTe solar panel and pH of the effluent of continuous flow columns operated under simulated landfill conditions as a function of time. **Panel A**: Concentrations (in mg L^{-1}) of Cd (●) and Te (■) in the effluent of the column simulating the conditions of a young, acidic landfill (pH 4.67 ± 0.06); and concentrations of Cd (○) and Te (●) in the effluent of the column simulating the conditions of a mature methanogenic landfill (pH 6.71 ± 0.19). **Panel B**: pH of influent (◆) and effluent (◊) of the column simulating an acidic landfill; pH of the influent (▲) and effluent (Δ) of the column simulating a methanogenic landfill.

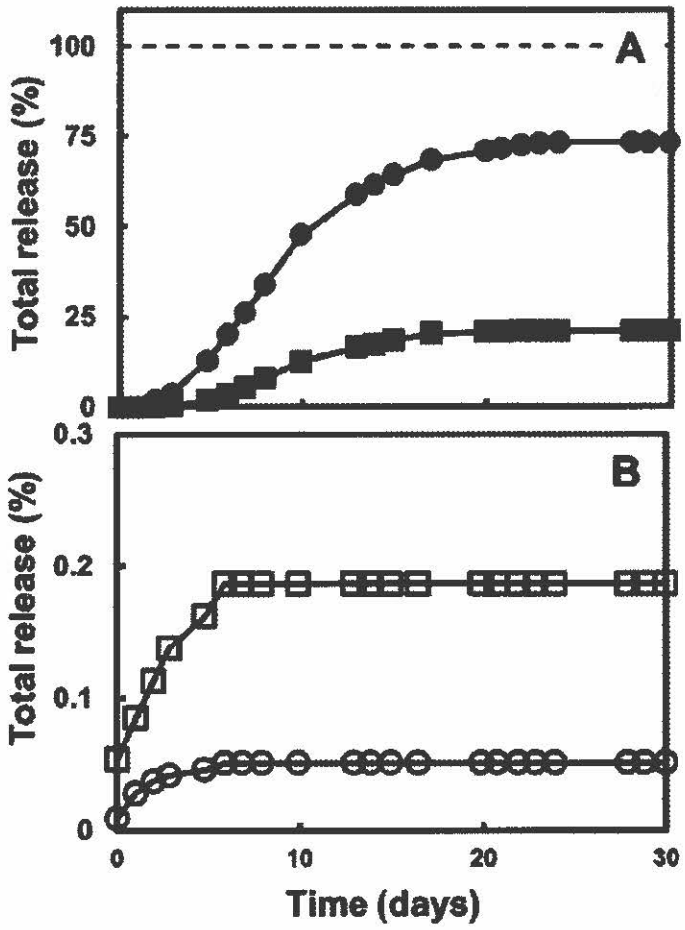

Figure 3.

Time course of the cumulative release of soluble cadmium (●, ○) and tellurium (■, □) from the solar panel in the continuous columns (as % of the total initial metal concentration supplied as CdTe). **Panel A**: Column simulating the conditions of an acidic landfill. **Panel B**: Column simulating the conditions of a methanogenic landfill.

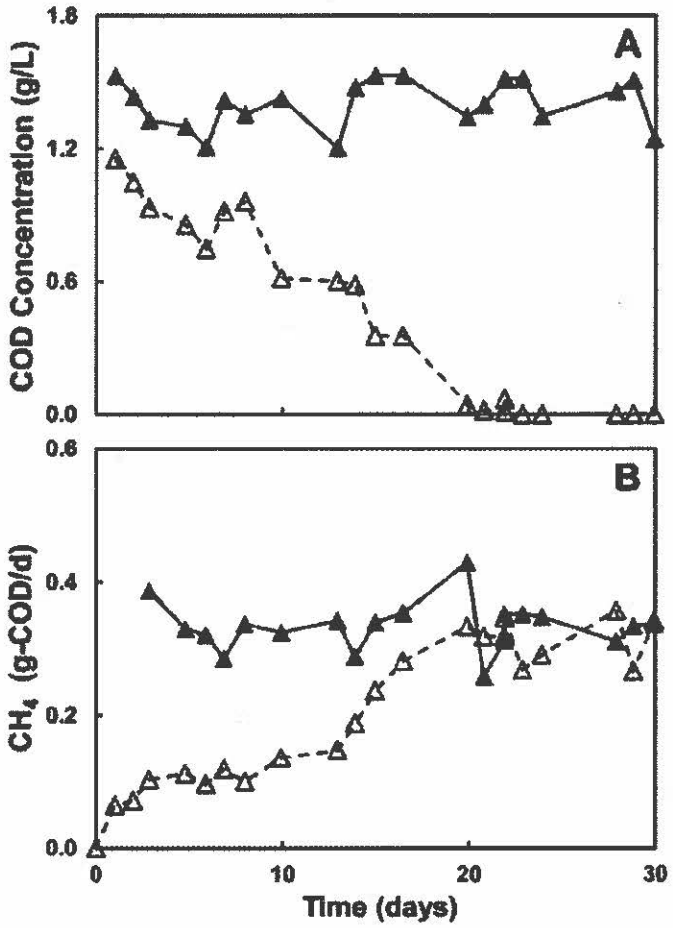

Figure 4.

(**Panel A**) COD concentration in the influent (▲) and effluent (Δ) of the methanogenic column (pH 6.71± 0.19). (**Panel B**) Daily production of methane as a function of the operation time: (▲), maximum expected concentration based on the amount of COD added to the influent; (Δ), daily measured production.

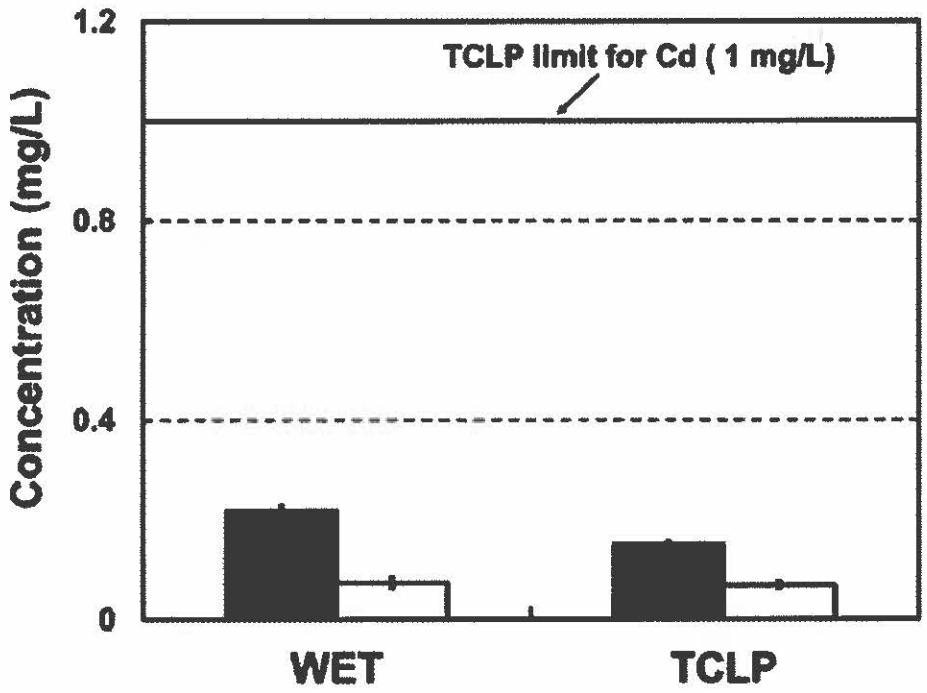

Figure 5.

Concentrations of soluble Cd (filled columns) and soluble Te (blank columns) released from the CdTe solar panel in the US-EPA Toxicity Characteristics Leaching Procedure (TCLP) and the California Waste Extraction Test (WET) leaching tests.

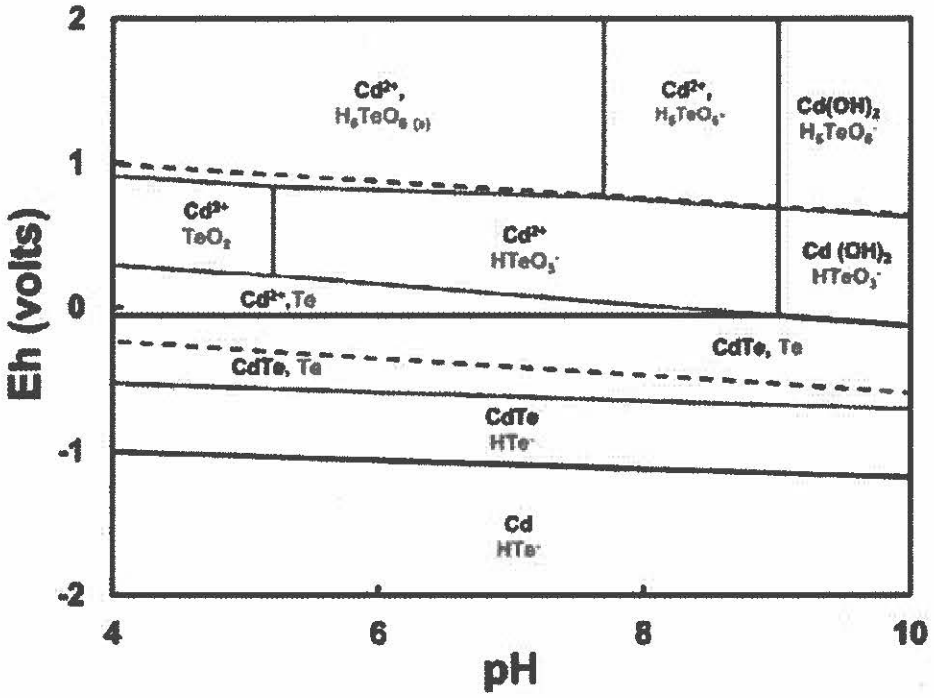

Figure 6.

Pourbaix diagram for the CdTe – H_2O system at 25°C. Pourbaix diagrams were constructed at activities of 2.9×10^{-2} mM Cd, and 8.6×10^{-3} mM Te.

Kentucky
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House Bill 4

Actions ↓ | Amendments ↓

Last Action	03/30/23: delivered to Secretary of State (Acts Ch. 140)
Title	AN ACT relating to merchant electric generating facilities and making an appropriation therefor.
Bill Documents	Acts Chapter 140 Current/Final Introduced
Fiscal Impact Statement	Fiscal Note
Bill Request Number	900
Sponsors	J. Branscum, S. Baker, J. Bray, J. Decker, J. Dixon, M. Dossett, R. Duvall, D. Fister, D. Frazier Gordon, C. Freeland, R. Heath, S. Heavrin, M. Imes, K. King, M. Koch, W. Lawrence, D. Lewis, S. Lewis, B. McCool, D. Meade , M. Meredith, A. Neighbors, M. Pollock, P. Pratt, R. Raymer, B. Reed, S. Riley, S. Rudy, K. Timoney, K. Upchurch, W. Williams

Summary of Original Version	Amend KRS 278.702 to provide that the terms of service for the ad hoc members of the Kentucky State Board on Electric Generation and Transmission Siting end when the merchant electric generating facility for which they were appointed has been constructed and has begun generating electricity for sale or its construction certificate expires; amend KRS 278.704 to lengthen the period of time that a construction certificate for a merchant electric generating facility is valid from 2 years to 3 years; include decommissioning requirements within the requirements over which local planning and zoning requirements shall have primacy; remove outdated language; amend KRS 278.706 to require that a decommissioning plan be included in an application for construction of a merchant electric generating facility; establish minimum requirements for a decommissioning plan; require as part of a decommission plan that a bond or similar security be secured to assure that the decommissioning plan is accomplished; establish requirements for how the bond is set and how the beneficiaries of the bond are to be determined; require that certain components of the decommissioning plan be incorporated into the construction certificate applicant's leases with landowners; amend KRS 278.708 to reference the transfer of the enforcement authority for mitigation measures that are conditions of application approval from the board to the Energy and Environment Cabinet; amend KRS 278.710 to include whether the decommissioning plan is complete and complies with the requirements of the Act in the criteria for approval of a construction certificate for a merchant electric generating facility; require a person that has received a construction certificate for a merchant electric generating facility file with the Energy and Environment Cabinet the copy of the bond or similar security no later than the date that construction commences for the facility; require that an updated copy of the bond or similar security be refiled at least once every 5 years thereafter; require notice to be filed with the Energy and Environment Cabinet when the construction of the merchant electric generating facility is complete and has begun producing electricity for sale; require that notice be given of any transaction involving the sale or transfer of ownership of the facility to the Energy and Environment Cabinet and local officials within 10 days of finalizing the transaction; require a person who has acquired a merchant electric generating facility to file with the Energy and Environment Cabinet written consent to assume the obligations in the decommissioning plan for the facility and to adopt or replace the required decommissioning bond; provide that the transferor of control of a merchant electric generating facility remain liable for its decommissioning obligations until the transferee completes the documentation required by the Act and the secretary of the Energy and Environment cabinet accepts it as complete; provide that application approval conditions that require approval of transfer of control shall be void and unenforceable, subject to the requirements of the section; provide that after the application for a construction certificate for a

merchant electric generating facility has been approved, the bond required by the Act has been posted, the facility has been constructed, and it has begun generating electricity for sale, the secretary of the Energy and Environment Cabinet shall ensure the facility's ongoing compliance with the requirements of KRS 278.700 to 278.716 and the conditions of its construction certificate approval, including updating its decommissioning plan and bond amounts at least once every 5 years; transfer the enforcement authority for mitigation measures that are conditions of application approval from the board to the Energy and Environment Cabinet once the facility is constructed and begins generating electricity for sale; require that while the electric merchant generating facility is operational, if solar panels are removed and discarded, the discarded solar panels be removed from the site within 90 days of the completion of the work; amend KRS 278.718 to provide that an ordinance, permit, or license issued by a local government shall have primacy over the requirements of KRS 278.700 and Sections 2, 3, and 4 of this Act; amend KRS 224.10-100 to authorize the Energy and Environment Cabinet to monitor and enforce compliance of merchant electric generating entities with the requirements of the Act; authorize the Energy and Environment Cabinet to draw upon a decommissioning bond or other similar security for which it is named a beneficiary to complete an approved decommissioning plan; amend KRS 224.99-010 to give jurisdiction to the Circuit Court in any county where a merchant electric generating facility is located for actions arising from or related to certain provisions of the Act; allow for a civil penalty not to exceed $2,500 per day to be imposed for violation of the bonding and bond transfer requirements in the Act; allow for the suspension of a merchant electric generating facility's operations for failing to pay civil penalties or complying with the bonding transfer requirements of the Act; allow for the decommissioning of the facility if it is still noncompliant after 90 days of suspension of its operation; create a new section of Subchapter 10 of KRS Chapter 224 to require that if a merchant electric facility fails to complete its decommissioning plan within 18 months of ceasing to produce electricity for sale, then the cabinet shall draw upon the decommissioning bond and implement the decommissioning plan; require the Energy and Environment Cabinet within 90 days of the effective date of the Act to promulgate administrative regulations to establish the monitoring and enforcement of the bonding and bond transfer requirements of the Act; allow the Energy and Environment Cabinet to establish a fee structure to cover the costs of its enforcement responsibilities; establish the merchant electric generating facility monitoring and enforcement fund to receive the fees and penalties collected by the Energy and Environment Cabinet pursuant to their monitoring and enforcement responsibilities under the Act; require that the funds collected only be used to defray the Energy and Environment Cabinet's costs related to their monitoring and enforcement responsibilities under the Act;

	require that all expenses for the determination of the bond amount and for the procurement of decommissioning services by the Energy and Environment be paid by the owner of the merchant electric generating facility; APPROPRIATION.
Index Headings of Original Version	Energy - Merchant electric generating facilities, siting Environment and Conservation - Merchant electric generating facilities, siting Home Rule - Merchant electric generating facilities, decommissioning, bonding, local primacy Land Use - Merchant electric generating facilities, siting Local Government - Merchant electric generating facilities, decommissioning, bonding, local primacy Notices - Merchant electric generating facilities, transfer of control, notice Property - Merchant electric generating facilities, siting Public Utilities - Merchant electric generating facilities, siting Administrative Regulations and Proceedings - Energy and Environment Cabinet, merchant electric generating facilities, monitoring and enforcement Bonds of Surety - Merchant electric generating facilities, decommissioning bonds, requirement Appropriations - Merchant electric generating facility monitoring and enforcement fund Fiscal Note - Merchant electric generating facility monitoring and enforcement fund
Jump to Proposed Amendments	Senate Committee Substitute 1 ↓ Senate Floor Amendment 1 ↓
Votes	Vote History
Governor's Veto Message	Veto

Actions

Top ↑ | Amendments ↓

02/10/23	introduced in House to Committee on Committees (H)
02/15/23	to Appropriations & Revenue (H)

02/21/23	reported favorably, 1st reading, to Calendar
02/22/23	2nd reading, to Rules posted for passage in the Regular Orders of the Day for Thursday, February 23, 2023
02/23/23	**3rd reading, passed 99-0**
02/24/23	received in Senate to Committee on Committees (S)
03/01/23	to Agriculture (S)
03/07/23	taken from Agriculture (S) 1st reading returned to Agriculture (S)
03/08/23	taken from Agriculture (S) 2nd reading returned to Agriculture (S)
03/14/23	reported favorably, to Rules with Committee Substitute (1) floor amendment (1) filed to Committee Substitute
03/15/23	posted for passage in the Regular Orders of the Day for Wednesday, March 15, 2023 **3rd reading, passed 25 -10 -1 with Committee Substitute (1) and Floor Amendment (1)** received in House to Rules (H) taken from Rules posted for passage for concurrence in Senate Committee Substitute (1) and Floor Amendment (1) **House concurred in Senate Committee Substitute (1) and Floor Amendment (1)** **passed 83-14**

03/16/23	enrolled, signed by Speaker of the House enrolled, signed by President of the Senate **delivered to Governor**
03/24/23	**Vetoed**
03/29/23	received in House to Rules (H) taken from Rules posted for passage for consideration of Governor's veto **veto overridden** **passed 81-17** received in Senate to Rules (S) posted for passage for consideration of Governor's veto **veto overridden** **passed 29 -6** received in House enrolled, signed by Speaker of the House
03/30/23	enrolled, signed by President of the Senate **delivered to Secretary of State (Acts Ch. 140)**

Proposed Amendments

Top ↑ | Actions ↑

Amendment	Senate Committee Substitute 1

Summary	Retain original provisions; require that a merchant electric generating facility decommissioning plan include removal of above-ground and below-ground facilities to a depth of three feet and to leave interconnection facilities unless otherwise requested by the landowner; require noncancelable bonds to ensure decommissioning only if they are available; require notice by the surety if a bond will be lapsing or canceled and allow for an opportunity for the stakeholders to cure the lapse or cancellation; clarify that lease terms with the landowner are not discretionarily accommodated by the applicant; specify that the secretary of the Energy and Environment Cabinet shall review decommissioning plans and bonds once every five years, including those required by local ordinance, permit, or license; authorize the Secretary of the Energy and Environment Cabinet to extend the time period for removing discarded solar panels upon request of the facility owner-operator.
Index Headings	Environment and Conservation - Energy and Environment Cabinet, local decommissioning plan and bond requirements, review Land Use - Energy and Environment Cabinet, local decommissioning plan and bond requirements, review Local Government - Energy and Environment Cabinet, local decommissioning plan and bond requirements, review Notices - Merchant electric generating facilities, decommissioning bonds, lapse, notice State Agencies - Energy and Environment Cabinet, local decommissioning plan and bond requirements, review Bonds of Surety - Merchant electric generating facilities, decommissioning bonds, lapse, notice

Amendment	Senate Floor Amendment 1
Sponsor	J. Howell
Summary	Specify that decommissioning plans provide for the removal of underground components and foundations for above-ground components of merchant electric generating facilities to a depth of three feet unless otherwise agreed to by the parties; specify that additional lease terms agreed to by the parties are not discretionarily accommodated.

Index Headings	Energy - Merchant electric generating facilities, decommissioning plans, underground facility removal Environment and Conservation - Merchant electric generating facilities, decommissioning, additional lease terms, accommodation Environment and Conservation - Merchant electric generating facilities, decommissioning plans, underground facility removal Land Use - Merchant electric generating facilities, decommissioning plans, underground facility removal Property - Merchant electric generating facilities, decommissioning plans, underground facility removal

Last updated: 11/9/2023 3:03 PM (EST)

BLUEGRASS TOMORROW

news & updates

May | 2021

Bluegrass Tomorrow Issues Paper on Solar Siting as Several Counties Consider Large Scale Solar Array Facilities

LEXINGTON, Kentucky-- Bluegrass Tomorrow has issued a resource paper on the siting of large utility scale solar farms, intended to help communities, elected officials, economic development organizations, and planning commissions to make wise decisions on where large utility scale solar facilities could be located.

The paper was issued by Bluegrass Tomorrow with input from its 55-member Board of Directors and partners in the Regional Land Use Partnership Council (Bluegrass Area Development District, Fayette Alliance, Woodford Forward, Bluegrass Land Conservancy, and Farm Bureau) and the committee has also gathered examples of sample ordinances, wording in Comprehensive Plans, and resources for planning directors, planning commissions, and regional governments to make effective, transparent solar siting decisions.

Several of our Bluegrass counties are currently considering plans for siting large solar facilities that will collectively consume thousands of acres of Bluegrass farmland. At stake is some of the most productive agricultural land that lies in the Commonwealth's Bluegrass physiographic region. The most productive agricultural soils of the Inner Bluegrass are found from Clark to Franklin Counties (east to west) and from Harrison to Mercer Counties (northeast to southwest). The land that encompasses Woodford, Jessamine, Fayette, and Bourbon Counties are almost entirely classified as "best soils."

Bluegrass Tomorrow has a long-standing policy that it will never insert itself into the decision making of local Planning Commissions or local governments. However, we will always promote what is best for our overall region as agreed upon by our diverse Board of Directors, 53 percent of whom are from outside Fayette County. The Bluegrass Tomorrow Board of Directors

includes business leaders, educators, farmers, equine and sustainability members, utility representatives and more, representing our 18-county footprint.

Bluegrass Tomorrow also promotes conservation, preservation and sustainability through the work of its Bluegrass Forever Green Division. We believe that renewable, clean solar energy is an important element of the current and future energy grid and is vital in addressing global warming and a resilient, more sustainable environment for the next generation. As such, Bluegrass Tomorrow supports solar energy as a part of our total energy portfolio, now and into the future.

At Bluegrass Tomorrow's *Conversation with the Region on Energy Innovations* two years ago, one of the first solar farms in the state developed by the East Kentucky Power Cooperative (EKPC) off I-64 in Clark County was discussed and highly lauded as an example of the types of energy innovations needed in our region. EKPC has set a goal of generating 15 percent of its energy from renewable sources by 2035. However, all agreed that solar is only one part of a complicated energy grid in the Bluegrass that also includes coal, natural gas and fossil fuels which keep energy costs lower and ensures the 24/7/365 reliability of energy in Kentucky, critical to economic development.

Solar is one of the fastest-growing energy sources in the world due to the decreasing cost per kilowatt hour, promotional government policies, growing consumer demand for renewable energy--especially in the business sector--and the solar industry's comparative speed in constructing facilities. Recently, University of Oxford researchers estimated solar could increase to 20 percent of global electricity by 2027. Federal and state tax incentives have accelerated the energy industry's efforts to bring facilities online as quickly as possible.

While solar energy aligns with national, state, and local sustainability goals, including Bluegrass Tomorrow, solar industries must bring an overall value to the locality beyond the clean energy label and the temporary jobs created during construction of the facilities. Our Bluegrass governments must consider other uses of sustainability and economic development for the land and make deliberate, transparent decisions regarding impacts and benefits to the social fabric, natural environment, scenic viewsheds, the local economy, agricultural production, and local government.

Some Planning Commissions have already created language in their Comprehensive Plans and/or ordinances and subdivision regulations to regulate large solar developments, which would require a text amendment to change; but in many other cases, there are no ordinances nor regulations, nor Comprehensive Plan language to address these new solar land use issues. There are two tools available: the existing Comprehensive Plan itself and the zoning ordinances and subdivision regulations which codify the implementation of the Plan.

Bluegrass Tomorrow recommends that our region's city and county Planning Directors and Commissions must take the reins to see that these documents are amended to bring some structure, consistency, and transparency to the evaluation process for utility-scale solar facilities. Unlike many other land uses, large solar installations will occupy vast tracts of land for one or more generations. This is not a decision to be taken lightly and requires the utmost due diligence.

Bluegrass Tomorrow further recommends that our communities consider the following when making decisions about solar siting and solar farms on Bluegrass farmland:

- Prioritize solar development, taking all available state and local guidance into consideration, on such siting as brownfields, rooftops, land zoned for industrial use, empty big box developments. It is understood that some of these sitings could be more expensive for the solar developer. The question becomes--how

much revenue the potential solar development can create, compared to revenue for the landowner and/or government while also considering keeping the land as an agriculture use and associated revenue generated. Consider methods to provide incentives to develop these non-agriculture zoned sites.

- Preserve the abilities of individual home and business owners to implement solar energy production for their own use on their own property.

- Avoid siting large utility-scale solar development on productive farmland in any location or in such a way that it displaces agriculture from the land, if feasible, and understanding that every county and community is different, and solar is one key to our sustainable energy future.

- In ordinances and comprehensive planning, primary farmland and most productive agricultural land should be defined and prioritized. Size limitations for large utility scale solar developments should be considered and should require project design to minimize other land use impacts such as access roads, excessive concrete pads, run-off considerations et. al.

- If farm entities and local governments have invited solar development proposals, consider incentivizing dual-use to support continued agricultural activity and farming. Dual use, also known as agrivoltaics, is the practice of co-locating solar panels on farmland in such a manner that primary agriculture activities including animal grazing, and crop production can continue simultaneously on that farmland. In this case, please consider the natural beauty and idyllic scenic viewsheds of our region.

- Work with communities outside of our regional footprint to encourage siting of alternative energy facilities. For example, our Eastern counties' coalfields may present opportunities for solar installations, if feasible. It is understood that some of these sitings could also be more expensive for the solar developer.

Through our Bluegrass Tomorrow Regional Land Use Partnership Council, we have learned that within our region there are many disagreements about the uses of the ordinance or the comprehensive planning process to regulate rapidly evolving solar development. Ordinances may be the most effective and time efficient tool to address this. But if a city or county is currently in review of the Comprehensive Plan (reviewed every five years), this could be the best avenue. In either case, wording on solar siting and complete definitions needs to be added to ordinances and all our region's city, county, and combined Comprehensive Plans in the future.

Link to Solar Siting Document & Resources

Contact: Rob Rumpke, and we'll work this together!
rob@bluegrasstomorrow.org |859.351.2447.

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BLUEGRASS TOMORROW
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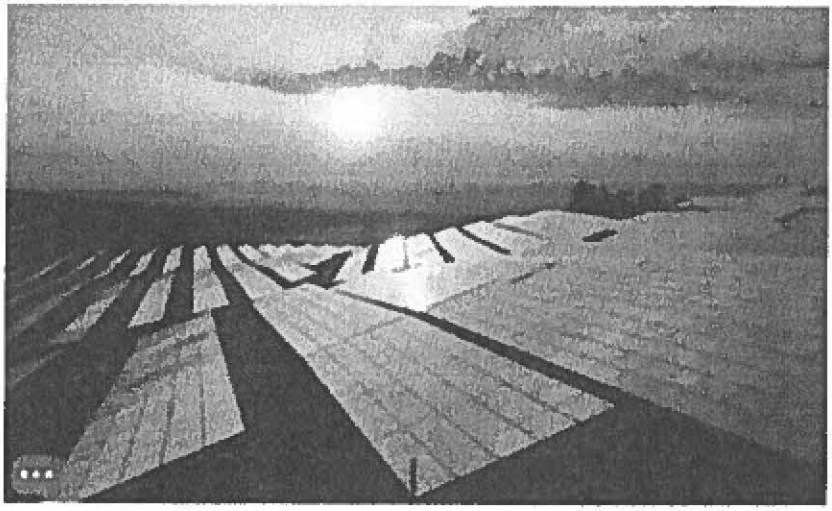
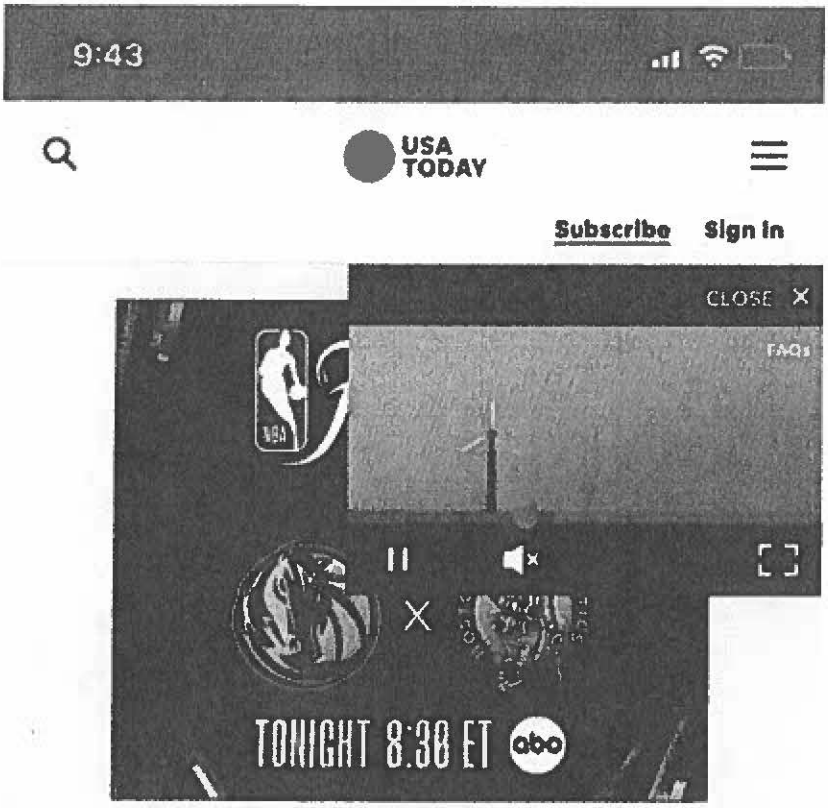
Toxic Chemicals in Solar Panels



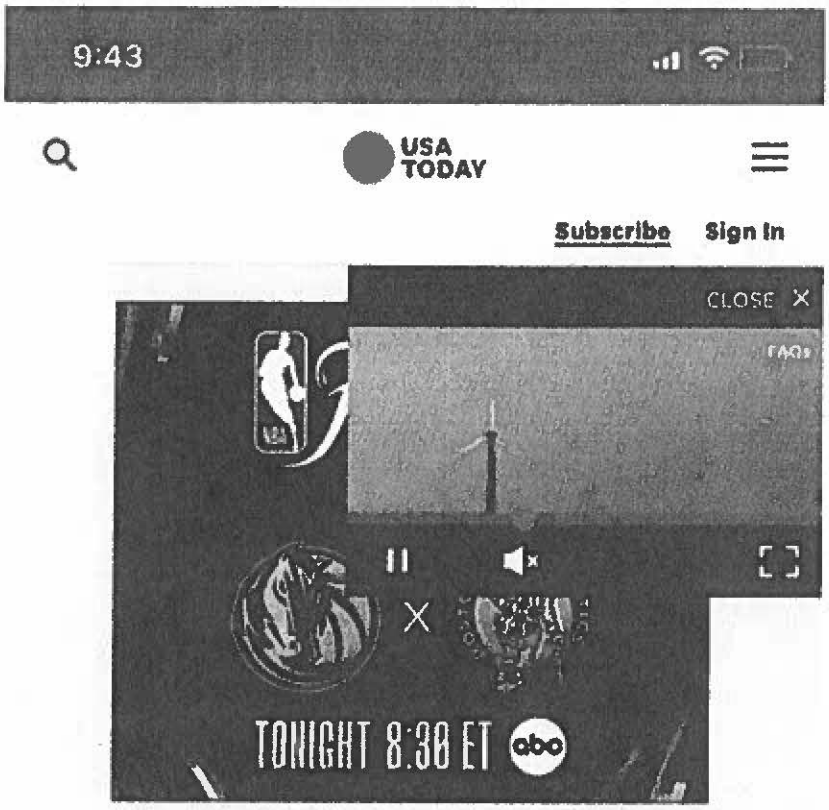
Updated April 30, 2018
By David H. Nguyen, Ph.D.

Solar panels may be an appealing choice for clean energy, but they harbor their share of toxic chemicals. The toxic chemicals are a problem at the beginning of a solar panel's life -- during its construction -- and at the end of its life when it is disposed of. These two intervals are times when the toxic



That hasn't stopped this argument from taking root. In Horry County, South Carolina, in 2020, in response to a proposed 138 megawatt solar project, community members raised concerns about the leaching of cadmium telluride, questioning what would happen if the solar panels were damaged in a hurricane. County council members also raised concerns about decommissioning and whether landfills would accept solar panels. Although the developer agreed not to use solar panels that include cadmium telluride, the project was never built.

The issue: Will wind turbines hurt nearby property values?



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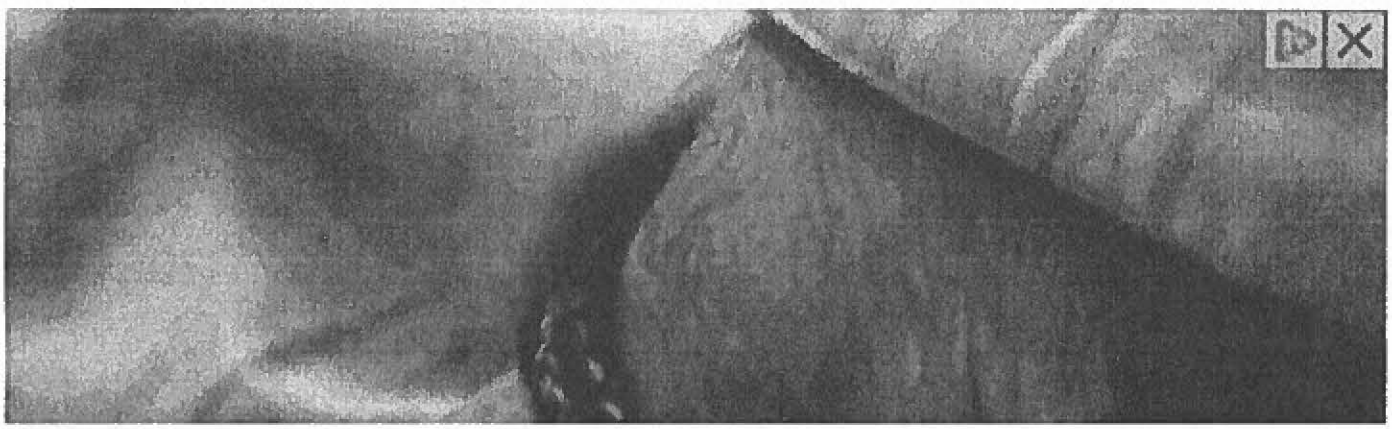
The issue: Will wind turbines hurt nearby property values?

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.



Nguyen, PhD, 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. Silicon tetrachloride, a byproduct of producing crystalline silicon, is also highly toxic.

The pro-solar website EnergySage writes:

There are some chemicals used in the manufacturing process to prepare silicon and make the wafers for monocrystalline and polycrystalline panels. One of the most toxic chemicals created as a byproduct of this process is silicon tetrachloride. This chemical, if not handled and disposed of properly, can lead to burns on your skin, harmful air pollutants that increase lung disease, and if exposed to water can release hydrochloric acid, which is a corrosive substance bad for

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Biden's Solar Power Scam | The Heritage Foundation

6 AM

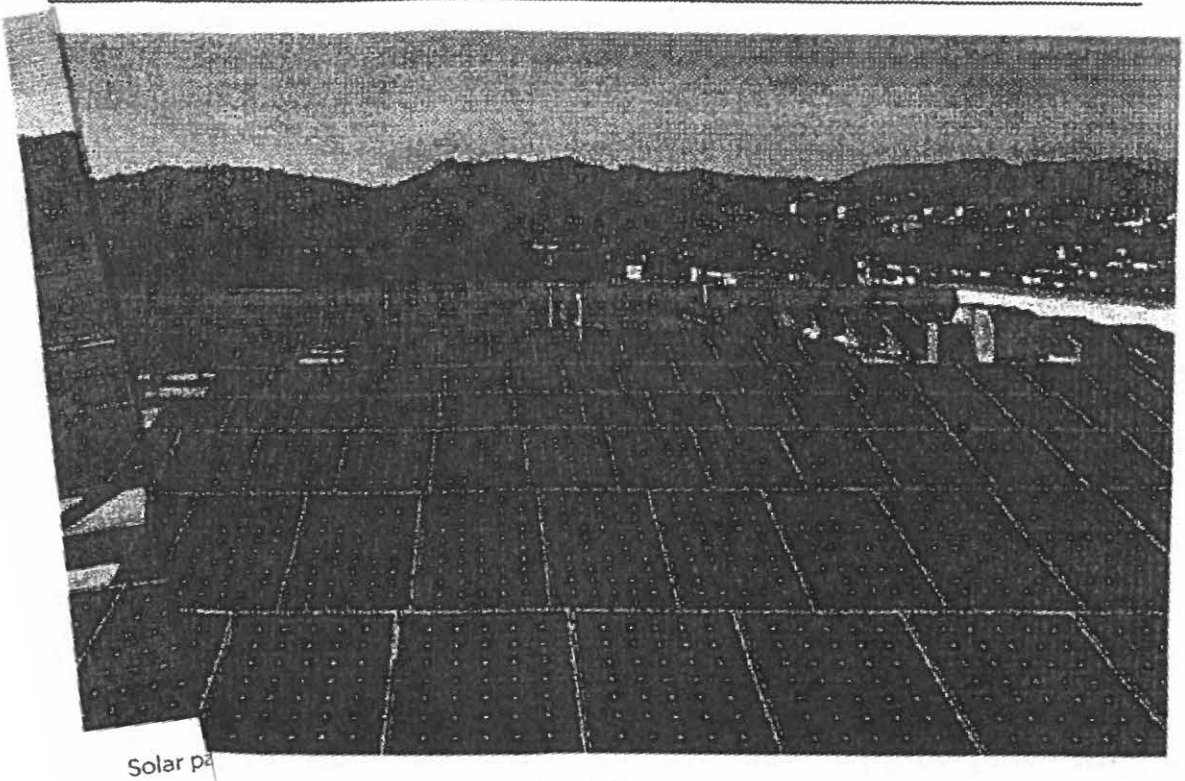
COMMENTARY Renewable Energy

15, 2022
3 min read

mmentary By

Roger Severino
Vice President, Domestic Policy

James Jay Carafano
Senior Counselor to the President and E.W. Richardson Fellow



Solar pa
DANIEL oof of a building in Los Angeles, California, on June 18 2022.
ages

because U.S. companies won't be able to keep up with the wholly artificial demand for panels created by his decree.

Tariffs were implemented 10 years ago to protect Americans from China's malicious efforts to undercut the U.S. solar power industry by flooding the market with cheap products. The Commerce Department is currently investigating complaints that Chinese solar panel producers have evaded the tariffs by shipping effectively completed versions of their panels to third countries where they are trivially assembled and shipped to America tariff-free—a ruse known as "transshipping." But with Biden's tariff moratorium, even if violations of U.S. trade laws are proved, China won't have to pay any of the unpaid tariffs.

>>> An Action Plan for America's Energy Security

While being able to shop for goods from companies around the globe can lead to increased consumer options, economic efficiency cannot be the only consideration. There is no question, for example, that Chinese goods made with slave labor, should have no avenue into American markets. There is also a fairness issue. If the Chinese are dumping goods on the U.S. market in violation of law and wiping out swaths of U.S. industry in the process, they should be held to account, not given the equivalent of a presidential pardon.

Moreover, if solar panel supply is as big a national security risk as Mr. Biden says it is, the last country we should be seeking to partner with for our energy needs is our chief global rival and adversary, China.

The administration is trying to frame these initiatives as a way to address high energy prices and the rising risk of blackouts, but it will do nothing to alleviate those problems. Rather, it will unnecessarily restrict access to reliable energy sources, increase the costs of energy, strain the U.S. electrical grid and potentially leave our nation more vulnerable to China.

Mr. Biden may think his moves make for good liberal politics, but the reality is he is squeezing American families, fueling price increases, impoverishing the middle

class and, most ironically, risking our national security. By refusing to change course on energy policy, he seems intent on burning the village to save it.

This piece originally appeared in The Washington Times

Office of
ENERGY EFFICIENCY & RENEWABLE ENERGY

SOLAR ENERGY TECHNOLOGIES OFFICE

Solar Photovoltaic Cell Basics

Solar Energy Technologies Office

When light shines on a photovoltaic (PV) cell – also called a solar cell – that light may be reflected, absorbed, or pass right through the cell. The PV cell is composed of semiconductor material; the "semi" means that it can conduct electricity better than an insulator but not as well as a good conductor like a metal. There are several different semiconductor materials used in PV cells.

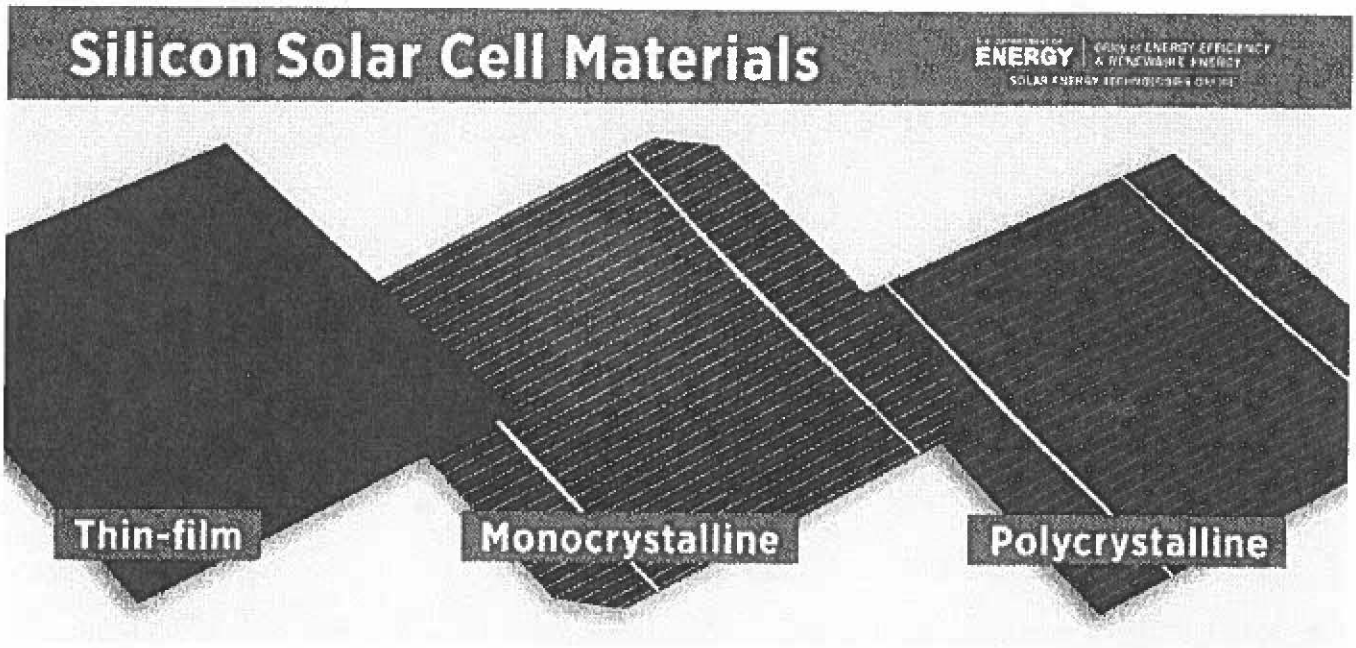
When the semiconductor is exposed to light, it absorbs the light's energy and transfers it to negatively charged particles in the material called electrons. This extra energy allows the electrons to flow through the material as an electrical current. This current is extracted through conductive metal contacts – the grid-like lines on a solar cells – and can then be used to power your home and the rest of the electric grid.

The **efficiency** of a PV cell is simply the amount of electrical power coming out of the cell compared to the energy from the light shining on it, which indicates how effective the cell is at converting energy from one form to the other. The amount of

electricity produced from PV cells depends on the characteristics (such as intensity and wavelengths) of the light available and multiple performance attributes of the cell.

An important property of PV semiconductors is the bandgap, which indicates what wavelengths of light the material can absorb and convert to electrical energy. If the semiconductor's bandgap matches the wavelengths of light shining on the PV cell, then that cell can efficiently make use of all the available energy.

Learn more below about the most commonly-used semiconductor materials for PV cells.



SILICON

Silicon is, by far, the most common semiconductor material used in solar cells, representing approximately **95% of the modules sold** today. It is also the second most abundant material on Earth (after oxygen) and the most common semiconductor used in computer chips. Crystalline silicon cells are made of silicon atoms connected to one another to form a crystal lattice. This lattice provides an organized structure that makes conversion of light into electricity more efficient.

Solar cells made out of silicon currently provide a combination of high efficiency, low cost, and long lifetime. Modules are expected to last for 25 years or more, still producing more than 80% of their original power after this time.

THIN-FILM PHOTOVOLTAICS

A thin-film solar cell is made by depositing one or more thin layers of PV material on a supporting material such as glass, plastic, or metal. There are two main types of thin-film PV semiconductors on the market today: **cadmium telluride** (CdTe) and **copper indium gallium diselenide** (CIGS). Both materials can be deposited directly onto either the front or back of the module surface.

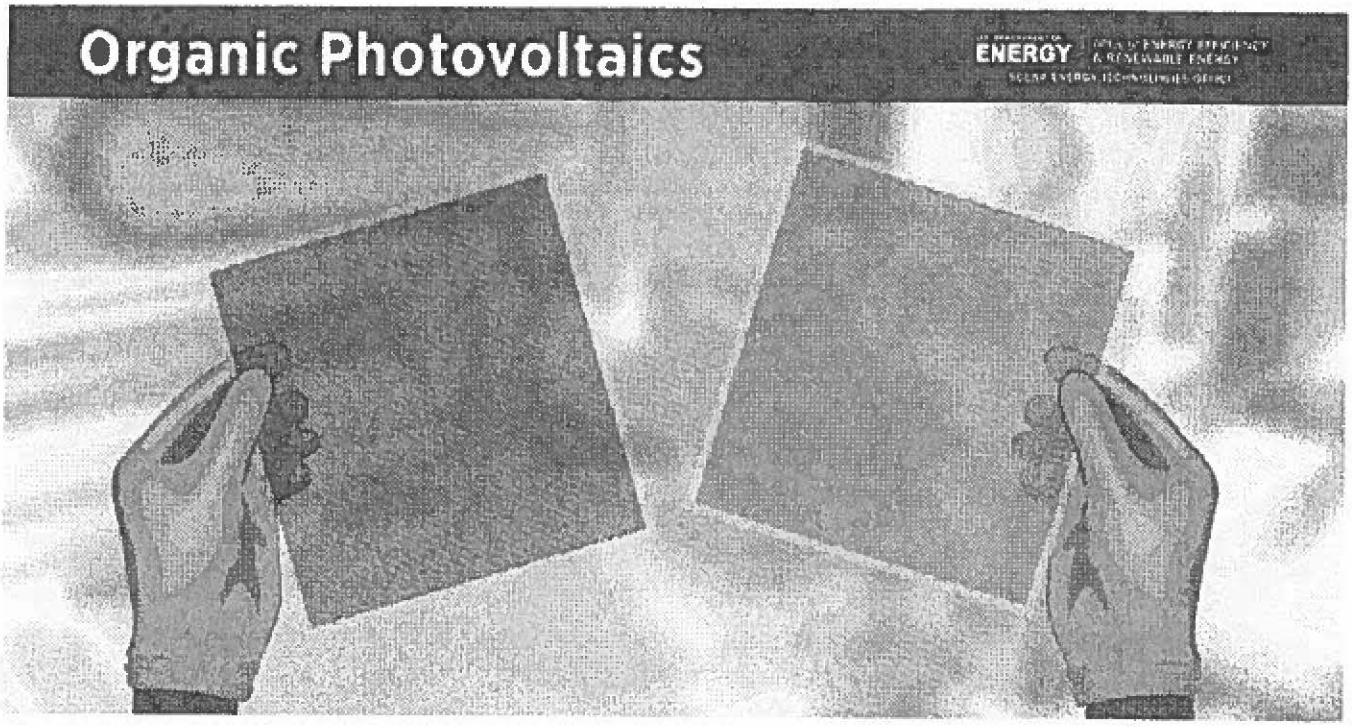
CdTe is the second-most common PV material after silicon, and CdTe cells can be made using low-cost manufacturing processes. While this makes them a cost-effective alternative, their efficiencies still aren't quite as high as silicon. CIGS cells have optimal properties for a PV material and high efficiencies in the lab, but the complexity involved in combining four elements makes the transition from lab to manufacturing more challenging. Both CdTe and CIGS require more protection than silicon to enable long-lasting operation outdoors.

PEROVSKITE PHOTOVOLTAICS

Perovskite solar cells are a type of thin-film cell and are named after their characteristic crystal structure. Perovskite cells are built with layers of materials that are printed, coated, or vacuum-deposited onto an underlying support layer, known as the **substrate.** They are typically easy to assemble and can reach efficiencies similar to crystalline silicon. In the lab, perovskite solar cell efficiencies have improved faster than any other PV material, from 3% in 2009 to over 25% in 2020. To be commercially viable, perovskite PV cells have to become stable enough to survive 20 years outdoors, so researchers are working on making them more durable and developing large-scale, low-cost manufacturing techniques.

ORGANIC PHOTOVOLTAICS

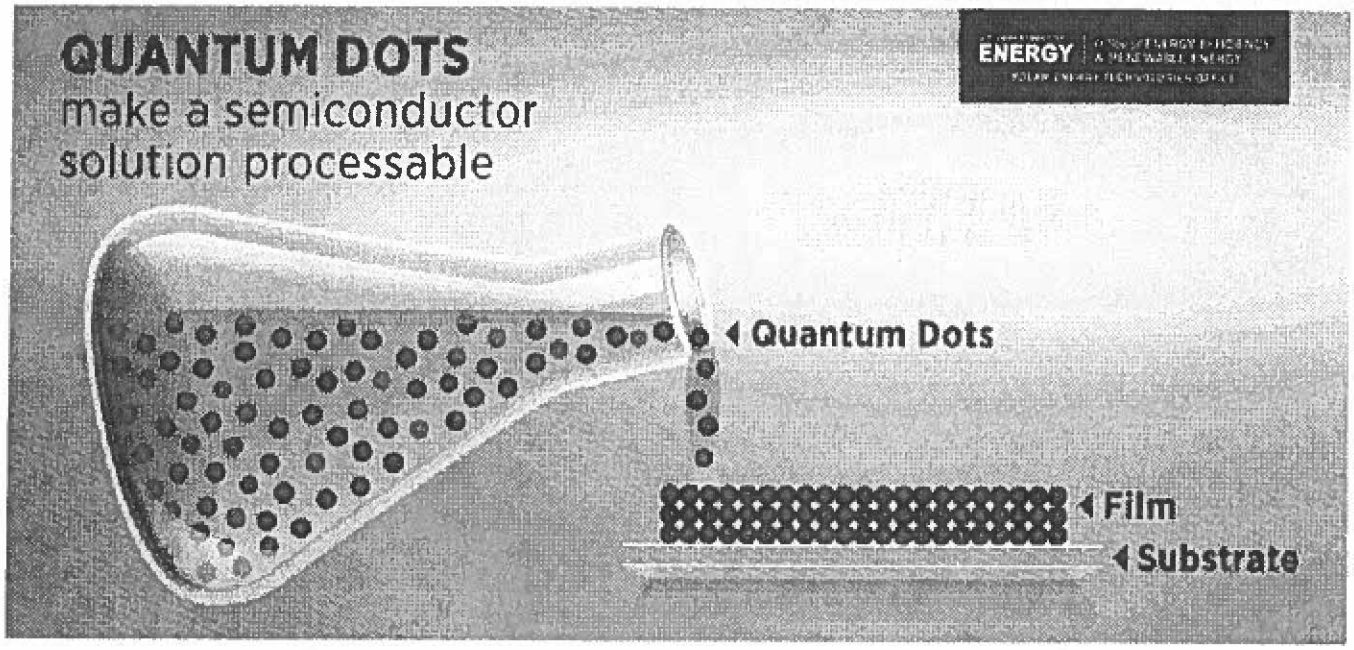
Organic PV, or OPV, cells are composed of carbon-rich (organic) compounds and can be tailored to enhance a specific function of the PV cell, such as bandgap, transparency, or color. OPV cells are currently only about half as efficient as crystalline silicon cells and have shorter operating lifetimes, but could be less expensive to manufacture in high volumes. They can also be applied to a variety of supporting materials, such as flexible plastic, making OPV able to serve a wide variety of uses.PV



QUANTUM DOTS

Quantum dot solar cells conduct electricity through tiny particles of different semiconductor materials just a few nanometers wide, called quantum dots. Quantum dots provide a new way to process semiconductor materials, but it is difficult to create an electrical connection between them, so they're currently not very efficient. However, they are easy to make into solar cells. They can be deposited onto a **substrate** using a spin-coat method, a spray, or roll-to-roll printers like the ones used to print newspapers.

Quantum dots come in various sizes and their bandgap is customizable, enabling them to collect light that's difficult to capture and to be paired with other semiconductors, like perovskites, to optimize the performance of a multijunction solar cell (more on those below).



MULTIJUNCTION PHOTOVOLTAICS

Another strategy to improve PV cell efficiency is layering multiple semiconductors to make **multijunction solar cells**. These cells are essentially stacks of different semiconductor materials, as opposed to single-junction cells, which have only one semiconductor. Each layer has a different bandgap, so they each absorb a different part of the solar spectrum, making greater use of sunlight than single-junction cells. Multijunction solar cells can reach record efficiency levels because the light that doesn't get absorbed by the first semiconductor layer is captured by a layer beneath it.

While all solar cells with more than one bandgap are multijunction solar cells, a solar cell with exactly two bandgaps is called a tandem solar cell. Multijunction solar cells that combine semiconductors from columns III and V in the **periodic table** are called multijunction III-V solar cells.

Multijunction solar cells have demonstrated efficiencies higher than 45%, but they're costly and difficult to manufacture, so they're reserved for space exploration. The military is using III-V solar cells in drones, and researchers are exploring other uses for them where high efficiency is key.

CONCENTRATION PHOTOVOLTAICS

Concentration PV, also known as CPV, focuses sunlight onto a solar cell by using a mirror or lens. By focusing sunlight onto a small area, less PV material is required. PV materials become more efficient as the light becomes more concentrated, so the highest overall efficiencies are obtained with CPV cells and modules. However, more expensive materials, manufacturing techniques, and ability to track the movement of the sun are required, so demonstrating the necessary cost advantage over today's high-volume silicon modules has become challenging.

Learn more about **photovoltaics** research in the Solar Energy Technologies Office, check out these **solar energy information resources**, and find out more about **how solar works.**

Office of
Energy Efficiency & Renewable Energy

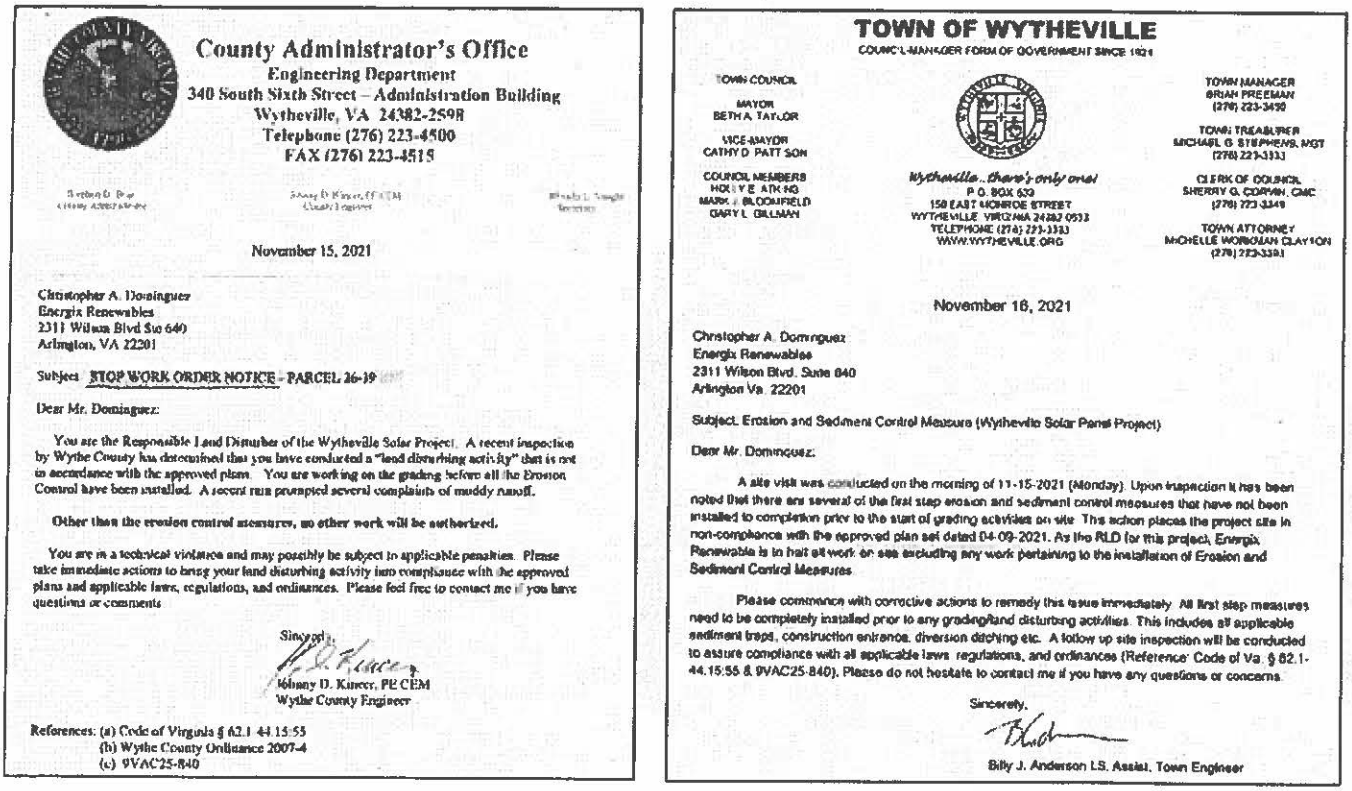
Office of Energy Efficiency & Renewable Energy
Forrestal Building
1000 Independence Avenue, SW
Washington, DC 20585

FOREIGN GOVERNMENT INTERFERENCE?

ISRAELI COMPANY AND UN HUMAN RIGHTS VIOLATOR ENERGIX UNDER SCRUTINY FOR ENVIRONMENTAL VIOLATIONS IN US

Israeli renewable energy firm and UN-designated human rights violator, Energix is under scrutiny from government agencies and activists alike for environmental violations stemming from its solar panel projects in Virginia. The company has been fined over $90,000 by ten counties and two state agencies for causing environmental damage and has faced pushback in implementing its solar projects.

According to data collected by the Virginia Coalition for Human Rights (VCHR), the Virginia Department of Environmental Quality (DEQ) and the State Water Control Board fined Energix about $92,000 on June 8 for environmental violations at its solar sites in Wythe and Buckingham counties. The violations are mainly attributed to sediment contamination, lack of proper sediment control measures, and erosion and stormwater runoff causing "land disturbing activities."



County Administrator's Office
Engineering Department
340 South Sixth Street – Administration Building
Wytheville, VA 24382-2598
Telephone (276) 223-4500
FAX (276) 223-4515

November 15, 2021

Christopher A. Dominguez
Energix Renewables
2311 Wilson Blvd Ste 640
Arlington, VA 22201

Subject: STOP WORK ORDER NOTICE - PARCEL 26-19

Dear Mr. Dominguez:

You are the Responsible Land Disturber of the Wytheville Solar Project. A recent inspection by Wythe County has determined that you have conducted a "land disturbing activity" that is not in accordance with the approved plans. You are working on the grading before all the Erosion Control have been installed. A recent rain prompted several complaints of muddy runoff.

Other than the erosion control measures, no other work will be authorized.

You are in a technical violation and may possibly be subject to applicable penalties. Please take immediate actions to bring your land disturbing activity into compliance with the approved plans and applicable laws, regulations, and ordinances. Please feel free to contact me if you have questions or comments.

Sincerely,

Johnny D. Kinser, PE CEM
Wythe County Engineer

References: (a) Code of Virginia § 62.1-44.15:55
(b) Wythe County Ordinance 2007-4
(c) 9VAC25-840

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COUNCIL-MANAGER FORM OF GOVERNMENT SINCE 1924

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VICE-MAYOR
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WWW.WYTHEVILLE.ORG

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CLERK OF COUNCIL
SHERRY G. COPPAN, CMC
(276) 223-3349
TOWN ATTORNEY
MICHELLE MORGAN CLAYTON
(276) 223-3381

November 16, 2021

Christopher A. Dominguez
Energix Renewables
2311 Wilson Blvd. Suite 640
Arlington Va. 22201

Subject: Erosion and Sediment Control Measure (Wytheville Solar Panel Project)

Dear Mr. Dominguez:

A site visit was conducted on the morning of 11-15-2021 (Monday). Upon inspection it has been noted that there are several of the first step erosion and sediment control measures that have not been installed to completion prior to the start of grading activities on site. This action places the project site in non-compliance with the approved plan set dated 04-09-2021. As the RLD for this project, Energix Renewable is to halt all work on site excluding any work pertaining to the installation of Erosion and Sediment Control Measures.

Please commence with corrective actions to remedy this issue immediately. All first step measures need to be completely installed prior to any grading/land disturbing activities. This includes all applicable sediment traps, construction entrance, diversion ditching etc. A follow up site inspection will be conducted to assure compliance with all applicable laws, regulations, and ordinances (Reference: Code of Va. § 62.1-44.15:55 & 9VAC25-840). Please do not hesitate to contact me if you have any questions or concerns.

Sincerely,

Billy J. Anderson LS, Assist. Town Engineer

Stop Work Order Notices issued November 2021 by Wythe County and Town of Wytheville.

Courtesy | © Virginia Coalition for Human Rights

According to the Environmental Protection Agency (EPA), sediment is sand, clay, and other soil particles that stormwater carries into nearby bodies of water. The EPA classifies sediment as the most common pollutant in rivers, streams, and lakes; and downgrades the quality of drinking water, damages wildlife habitats, and can cause toxic algae blooms.

VCHR activist Jeanne Trabulsi explained that the fines are part of draft enforcement orders, so any actions and fines related to them are only proposed and not official yet.

As reported by local press outlet, *The Farmville Herald*, the consent orders must undergo a public comment period, ending Aug. 3, before decisions are finalized. VCHR has submitted a public comment regarding Energix's environmental and human rights concerns and requesting that the DEQ revoke its permit.

Energix did not respond to press inquiries regarding the fines and environmental concerns. However, Energix did admit to the violations in the consent orders.

The hefty fines are not the only obstacle Energix is facing in Virginia. In Rockingham County, landowners sued the Board of Supervisors (BoS), government officials overseeing county operations, and Energix over the planned Caden Endless Energix Caverns site because the project violated newly-passed solar zoning guidelines. The BoS in Dinwiddie County voted down Energix's bid to build an 80 megawatt "Lily Pond" utility due to environmental concerns.

In Franklin County, Energix was forced to withdraw its application for a proposed 20-megawatt solar project due to property owners' concerns over toxic runoff from its Cadmium Telluride (CdTe) solar panels. And in Buckingham, Caroline, Chesterfield, Madison, Prince George, and Spotsylvania counties, officials banned or prohibited Energix's installation of CdTe solar panels, which contain toxic heavy metals.

Energix only installs CdTe solar panels, which just 5% of the solar industry uses. CdTe is listed on the EPA's Toxic Substances List and the National Institute of Health's (NIH) hazard identification list. The NIH warns CdTe is harmful if swallowed, inhaled, or comes into contact with skin and is dangerous to aquatic life. CdTe is also considered hazardous by the U.S. Department of Labor's Occupational Safety and Health Administration.

In total, at least six of Energix's solar projects have been withdrawn, not permitted, or have not been submitted to county planning departments.

While Energix faces regulatory hurdles in Virginia, that has not stopped the company from engaging in energy projects in other states. In May, Energix took over the development, construction, and ownership of the Adams Solar project, which will provide 22% of Philadelphia's municipal electricity use. Philadelphia Energy Authority did not respond to media inquiries on whether it's aware of Energix's environmental and human rights violations.

Energix job posts on LinkedIn mention the company is involved in solar projects in West Virginia and Kentucky as well. The job description lists possible travel to these states. However, project details in Kentucky and West Virginia are not disclosed on Energix's website. The company also operates a wind farm in Poland.

FOREIGN GOVERNMENT INTERFERENCE?

In 2001, the Virginia Israel Advisory Board (VIAB) was established as a state agency under the General Assembly of Virginia. VIAB's charter states its mission is to "advise the Governor on ways to improve economic and cultural links between the Commonwealth and the State of Israel, with a focus on the areas of commerce and trade, art and education, and general government." However, using Virginia taxpayer money, VIAB operates similarly to an Israel lobbying organization.

VIAB promoted Energix's business activities in the U.S. "VIAB should be a chamber of commerce, which is separate from the government," Trabulsi told *MintPress News*. "But because they are so closely enmeshed and have offices within the General Assembly, they are very active and very close to people who have power and make policy."

At a March 2022 conference on the Israel lobby jointly hosted by the *Washington Report on Middle East Affairs* and the Institute for Research: Middle Eastern Policy, Trabulsi outlined Energix's strong governmental influences.

This included the fact that, in 2019, former Virginia Governor Ralph Northam and state Secretary of Commerce Brian Ball went on a VIAB-sponsored trade trip to Israel. Aviva Frye, Energix's director of governmental and public relations, served as the head of Energix's U.S. subsidiary while simultaneously serving on VIAB's board. In an email seeking a private meeting with former Virginia first lady Pamela Northam to discuss Energix, Frye signed it as "VIAB board." Recently, VIAB's budget was increased from $200,000 annually to $250,000 per year.

During the conference, Trabulsi said:

> *"Energix credits VIAB with connecting it with senior leaders in the commonwealth, and credits VIAB with introduction to private and public entities and assisting in the identification of new projects. We [VCHR] believe that this gives Energix an unfair advantage over other Virginia solar companies."*

Additionally, Energix — like other solar companies — receives a 30% federal investment tax credit. Through loopholes, the company has also obtained state and federal subsidies. In 2020, Energix applied for a Virginia Jobs Investment Program subsidy as well as federal Payroll Protection Program loans — receiving one-third of all PPP loans for the Virginia utility scale solar sector.

ENERGIX, HUMAN RIGHTS AND THE ENVIRONMENT

In 2020, the Office of the UN High Commissioner for Human Rights designated Energix as violating human rights for conducting business in the occupied territories, specifically labeling it as a category G company for using natural resources, particularly water and land, for business purposes.

Energix seized land from Palestinians living in Masafer Yatta in the occupied West Bank in order to build the Meitarim solar facility in an illegal settlement industrial zone in 2014.

(5) Energix South Har Hevron, Limited Partnership (hereinafter: "Energix Har Hevron")

Commencing in 2013, the Company consolidates in its financial statements Energix Har Hevron, in which the Company holds 50.1%.
The partnership was established for the purpose of the initiation, construction and operation of a project for the generation of electricity using photovoltaic energy at the Meitarim industrial zone in the Judea & Samaria region with a capacity of 5MWp (the Company's share - about 2.5MWp).
The balance of non-controlling interest as at the date of the report is approximately NIS 4.4 million, resulting primarily from the infusion by the minority of capital in the amount of NIS 4.6 million for the purpose of meeting regulatory requirements that are necessary for the financial closing of the project.
For information on the project, see Note 16a(6) below.

Energix's 2014 financial report refers to the Meitariam project in Judea and Samaria, a colloquial Israeli reference to occupied Palestinian territory

In December 2021, the Israeli Defense Ministry signed an agreement with Energix to build a massive wind farm in the occupied Golan Heights, consisting of 41 wind turbines standing at 656 feet tall. Energix's wind turbine project in the Golan has prompted significant backlash from local residents who say it will harm their health, housing, livelihoods, and the environment. The wind farm will be built on occupied Syrian agricultural land — disrupting local cultivation practices and preventing villages' expansion.

Experts also indicate that wind farms may cause health problems to the surrounding populations, such as infrasound and low-frequency sound waves measured below the audible threshold, which may lead to headaches, dizziness, and nausea. It is also suggested that wind turbines can harm wildlife, particularly by killing migratory birds.

With these violations in mind, VCHR is planning to notify Philadelphia officials of Energix's practices in hopes of stopping its takeover of the Adams Solar Project. Yet as Energix continues expanding in the U.S., the recent governmental opposition it has faced may signal it will have a harder time than expected in cementing itself in the American energy industry.

Feature photo | Graphic by MintPress News

Jessica Buxbaum *is a Jerusalem-based journalist covering Palestine, Israel and Syria. Her work has been featured in Middle East Eye, The New Arab and Gulf News.*

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AS ANTI-BDS BILLS BECOME THE NORM, ACLU TAKES FREE SPEECH FIGHT TO THE SUPREME COURT

Commonwealth of Virginia

VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY

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Secretary of Natural and Historic Resources

Michael S. Rolband, PE, PWD, PWS Emeritus
Director
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VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY ENFORCEMENT ACTION - ORDER BY CONSENT ISSUED TO ENERGIX EPC US LLC, WAVERLY SOLAR, LLC and CADEN ENERGIX AXTON LLC FOR AXTON SOLAR PHASE 1, AXTON SOLAR PHASE 2, AXTON SOLAR PHASE 3, WAVERLY SOLAR PHASE 2, WYTHEVILLE SOLAR, BUCKINGHAM II SOLAR, and WAVERLY SOLAR PHASE 3

Virginia Pollutant Discharge Elimination System Permit Nos. VAR10P781, VAR10R609, VAR10S146, VAR10R839, VAR10O685, VAR10K840, VAR10R284

Virginia Water Protection General Permit No. WP2-22-1720

SECTION A: Purpose

This is a Consent Order issued under the authority of Va. Code §§ 62.1-44.15, 62.1-44.15:25, and 62.1-44.15:48, between the Virginia Department of Environmental Quality and Energix EPC US LLC ("Energix EPC"), on behalf of Caden Energix Axton LLC and Waverly Solar, LLC (together with Energix EPC, collectively, "the parties" or "Energix"), regarding Axton Solar Phase 1, Axton Solar Phase 2, Axton Solar Phase 3, Waverly Solar Phase 2, Waverly Solar Phase 3, Wytheville Solar, and Buckingham II Solar (Sites), for the purpose of resolving certain violations of the State Water Control Law and the applicable permit and regulations. Because the Parties are under common management and control and Energix EPC has operational responsibility for the construction of the Sites for and on behalf of the Parties, this Order is being executed by Energix EPC. This Order supersedes and terminates the Order issued by the Department to Energix EPC on May 1, 2023 for Axton Solar Phase 2, Pamplin Solar, Sol Leatherwood Solar, Wytheville Solar, Hollyfield II Solar, Rives Road Solar and Buckingham II Solar.

SECTION B: Definitions

Unless the context clearly indicates otherwise, the terms have the meanings assigned to them in Va. Code § 62.1-44.2 *et seq.*, § 62.1-44.15:24 *et seq.*, the Virginia Stormwater Management Program (VSMP) Regulation at 9 VAC 25-870-10., the General VPDES Permit for Discharges of Stormwater from Construction Activities at 9 VAC 25-880-1, and the Virginia Water Protection Permit Program Regulation at 9VAC25-210-10.

SECTION C: Findings of Fact and Conclusions of Law

Site 1- Axton Solar Phase 1

1. Caden Energix Axton LLC (Caden Energix) is a business entity authorized to do business in Virginia and references to Caden Energix Axton LLC include its affiliates, partners, and subsidiaries. Caden Energix Axton LLC is a "person" within the meaning of Va. Code § 62.1-44.3.

2. Caden Energix owns operates the Axton Solar Phase 1 site located at latitude 36.6482 and longitude -79.7049 near 374 Centerville Rd in Axton, Virginia, located in Henry County (Site 1) from which stormwater associated with construction activity is discharged.

3. DEQ is the Virginia Stormwater Management Program (VSMP) authority for Site 1.

4. On October 28, 2022, DEQ granted coverage to Caden Energix under the General VPDES Permit for Discharges of Stormwater from Construction Activities, No. VAR10, promulgated at 9 VAC 25-880-70, which was issued under the State Water Control Law and VSMP Regulations, and the General Permit Regulation on July 1, 2019 and which expires on June 30, 2024 (2019 Permit). Caden Energix was assigned registration number VAR10P781.

5. The 2019 Permit allows Caden Energix to discharge stormwater associated with construction activities from Site 1 to Cascade Creek, Smith River, Fall Creek, and Upper Sandy River unnamed tributary, in strict compliance with the terms and conditions of the 2019 Permit.

6. The receiving waters are surface waters located wholly within the Commonwealth and are "state waters" under the State Water Control Law.

7. DEQ staff conducted inspections of Site 1 on March 8, 2023, June 21, 2023, July 19, 2023, August 22, 2023, December 6, 2023, February 23, 2024, and May 8, 2024.

8. During the inspection on March 8, 2023, it was observed that the banks of the stream crossing between Zones B & C were not stabilized immediately in accordance with

Minimum Standard 15. See 9VAC25-870-54(B) and 9VAC25-840-40(15). DEQ confirmed corrective actions were completed during the June 21, 2023 inspection.

9. During the inspection on July 19, 2023, the contractor stated that the grading plan was revised to flatten out steep grades, eliminating the need for one or more stormwater conveyance channels (SCC). During the inspection of Site 1 on August 22, 2023, the Operator stated that a plan modification was being prepared but was unaware of the scope of the changes to be included in the modified stormwater management plan. The approved erosion and sediment control and stormwater plans had not been adjusted to document the change in grading, elimination of SCCs, or re-analyze the effect of these changes on stormwater runoff. See 9VAC25-870-54(A)-(C) and Permit Part II.C(1)-(2). Energix submitted a plan modification on November 30, 2023. On December 26, 2023, DEQ completed its review and sent comments to Energix. On February 14, 2024, Energix submitted revisions to DEQ. On February 16, 2024 and March 13, 2024, DEQ issued additional comments on the plan modification. DEQ approved the stormwater plan modification on May 8, 2024.

10. During the March 8, 2023, June 21, 2023, July 19, 2023, and August 22, 2023, December 6, 2023, and February 23, 2024 inspections of Site 1 it was observed that sediment trapping measures had not been made functional in accordance with the approved erosion and sediment control plan prior to the occurrence of upslope land disturbing activities. See 9VAC25-840-40(4), 9VAC25-840-40(7), 9VAC25-870-54(B), and Permit Part II.B.2.c(9).

    a. Sediment traps and basins were not properly installed.

        i. During the March 8, 2023 inspection, the dewatering structure was not installed properly on SBA1 and SBA 3 resulting in no wet storage volume for the basins.

        ii. During the June 21, 2023 inspection, SBA1, SBA3, SBA4, SBA5, SBA6, SBA7, SBA10 and SBA11 did not have dewatering structures in accordance with the approved plan and lacked the design wet storage component. Sediment basin riser structures were installed with the permanent riser trash rack instead of the temporary riser, which includes an anti-vortex plate. During the inspection of Site 1 on June 21, 2023, the sediment traps were not properly constructed. STA2, STA8, and STA9 did not include smaller stone on the inside face of the outlet weir.

        iii. During the July 19, 2023 inspection, the contractor had attempted to create a watertight seal between dewatering HDPE pipes and concrete riser pipes with tape. It was observed that the tape had not provided a watertight seal on basins SBA1, SBA3, SBA4, SBA5, SBA6, SBA10, and SBA11 and dewatering structures were not installed in accordance with the approved erosion and sediment control (ESC) plans. The dewatering structure of

SBA7 had not been modified and was still installed incorrectly.

iv. During the August 22, 2023 inspection, it was observed that sealant had been applied between the HDPE plate and the concrete riser to improve the watertightness of the dewatering structures of sediment basins SBA1, SBA3, SBA4, SBA5, SBA6, SBA10, and SBA11. Sediment basin SBA7 was holding a permanent pool, but others were not. The principal spillway of SBA5 was set higher or at the same elevation as the emergency spillway of SBA5; the plan indicates the emergency spillway should be set 1.0 feet higher than the top of the riser pipe. During an inspection on December 6, 2023, DEQ confirmed that the height of the principal spillway was correct.

v. During the December 6, 2023 inspection, DEQ observed that all sediment basins in Phase 1, Zone A (SBA1, SBA3, SBA4, SBA5, SBA6, SBA10, and SBA11) had sealant applied to the HDPE plate at the junction with the concrete riser. Energix explained that some of the basins were holding water but others were not water-tight where corrugated sections of the dewatering structured had been taped to cover perforations and pipe joints. Sediment basins in Phase 1, Zones B and C, had not been sealed and five basins had the original dewatering structures. Energix further explained that it was planning to change all dewatering structures to PVC if approved by Henry County, the Virginia Erosion and Sediment Control Program (VESCP).

vi. During the February 23, 2024 inspection, DEQ staff observed basins with new dewatering structures. However, DEQ staff observed that baffles were not installed in basins SBA10, SBA11, SBB1, SBB2, SBB5, SBB6, SBC3 and SBC4. Following the February 23, 2024 inspection, Energix submitted photos to DEQ of the basins with baffles installed.

b. During the June 21, 2023 inspection, silt fence had been installed along the limits of disturbance prior to the completion of sediment traps and basins. The discharge from the installed traps and basins went to the perimeter fence in several locations causing the silt fence to fail. In addition, several conveyance channels (SCCA8, SCCA9) did not have check dams that were on the approved ESC plan. Stormwater conveyance channel SCCA6 was not constructed, which allowed concentrated flow to bypass sediment basin SBA5. Energix informed DEQ that it received VESCP approval to use alternate check dams and DEQ verified this with the County.

c. During the February 23, 2024 inspection, DEQ observed silt fence at the stream crossing in Zone B was not installed in a manner that allows capture of sediment without end-run of stormwater runoff. Runoff from the construction road approaches to the culvert crossing was not diverted to properly installed control

measures. DEQ and Energix discussed installing filter socks as a means of diversion along the top of the road embankment to direct runoff to the silt fence. During DEQ's inspection on May 8, 2024, DEQ observed that the silt fence had been repaired and the filter socks had been installed but required maintenance.

11. During the inspections on June 21, 2023, it was observed that operational stormwater conveyance channels (SCC) SCCA9 and SCCA14 had not been lined with erosion control blanket matting or a vegetative lining as indicated in the approved ESC and stormwater management plan. During the inspection on August 22, 2023, it was observed that the upper end of SCCA14, the channel entering sediment basin SBA10, had been recently regraded in preparation for re-seeding and additional check dams installed, but the lower section of SCCA14 is eroding. It was explained by the Operator that a flexible concrete lining product was being considered for trial application in the lower section of this conveyance. During the inspection on December 6, 2023, channels SCCA9 and SCCA14 had been re-graded but were not stabilized. Following the inspection, Energix sent DEQ pictures of SCCA14 and SCCA9 and stated they had been re-worked and were lined. During a DEQ inspection on February 23, 2024, SCCA14 was not lined with riprap in accordance with the plan modification submitted by Energix and was not otherwise stabilized with channel lining. In addition, roadside ditches along the gravel access road lacked stable channel lining and were eroding. See 9VAC25-870-54(B) and 9VAC25-840-40(11). Following the February 23, 2024 inspection, Energix submitted photos to DEQ documenting corrective actions in the roadside ditches. During DEQ's inspection on May 8, 2024, DEQ confirmed that the roadside ditches were stabilized. During the inspection, DEQ also observed that SCCA14 had been stabilized with channel lining; however, approximately 100 feet at the upper end of the channel was eroding beneath the fabric.

12. During the June 21, 2023, July 19, 2023, August 22, 2023 and December 6, 2023 inspections, the "engineered stormwater ditch", Detail 8 on Sheet C2-203 was not installed per Note 5 on the Site Grading and Drainage Plan Sheets. During the inspection on August 22, 2023, it was observed that the Stormwater Pollution Prevention Plan (SWPPP) contained the approval by the VESCP authority for the use of proprietary fiber stabilization in lieu of the "EC-2" type erosion and sediment control blanket matting. Stormwater conveyance channels directing flow to SBA10 and SBA11 are constructed on the Site but are not included in the approved plans, so it is unknown what type of channel lining is required in these channels. See 9VAC25-870-54(B) and 9VAC25-840-40(11). Energix explained that grading of the site was changed during construction to flatten out steep grades and the installation of the engineered ditch is now impractical. Energix addressed the identification of channel lining materials in the plan modification approved May 8, 2024. Energix did not address the removal of the "engineered stormwater ditch", Detail 8 on Sheet C2-203 per Note 5 on the Site Grading and Drainage Plan Sheets.

13. During the inspection on June 21, 2022, July 19, 2023, August 22, 2023, and December 6, 2023, it was observed that the earthen embankments of sediment traps and sediment

basins had not been immediately stabilized on installation. See 9VAC25-870-54(B) and 9VAC25-840-40(5).

a. On August 22, 2023, the embankment of STA2 had been recently disturbed by security fence installation and the embankment of SBA5 had been recently disturbed by repair and re-orientation of the riprap outlet protection stone. The cut slope of SBA7 had been regraded and stabilized with EC-2 fabric. On August 22, 2023, it was observed that rill erosion was occurring on the cut slope of SBA10 where it had been observed stabilized on July 19, 2023.

b. On December 6, 2023, DEQ observed that temporary slope drains had been added and riprap outlet protection was removed from the base of each slope drain entering SBA10, and the length of pipe extended. Additional pipe was needed to reach the wet storage elevation. The slopes above traps and basins STA2, SBA3, SBA4, SBA5, SBA6, SBA7, STA9, and SBA10 were being re-worked and stabilized. Energix submitted photographs of corrective actions and during the February 23, 2024 inspection, DEQ observed that the slopes were stabilized.

14. During the inspection on June 21, 2023, and July 19, 2023, it was observed that culvert inlet protection had not been installed on SCCA14. During the inspection on August 22, 2023, it was observed that culvert discharging into SCCA14 had been cleaned out, the channel recently re-graded, and check dams installed. Culvert inlet protection had not been installed. See 9VAC25-870-54(B) and 9VAC25-840-40(10). During the December 6, 2023 inspection, DEQ observed that the inlet protected had been installed at SCCA14. However, during the February 23, 2024 inspection, DEQ observed that culvert inlet protection was not installed at four culverts: two culverts crossing the main access road, a culvert crossing between Zone B and Zone C, the culvert at the access road intersection that drains to SBA11. Following the February 23, 2024 inspection, Energix submitted photographs to DEQ of the installation of culvert inlet protection.

15. During the February 23, 2024 inspection, DEQ observed that culvert inlet protection along the gravel access road in Phase 1 had not been maintained and check dams along the gravel access road had not been maintained. See 9VAC25-870-54(B), 9VAC25-840-60(A), and Permit Part II.F.1. Energix submitted photographs to DEQ following the February 23, 2024 inspection documenting corrective actions.

16. During the inspections on June 21, 2023, July 19, 2023, August 22, 2023, and December 6, 2023, it was observed that there were large portions of the Site in a denuded and not stabilized condition. During the inspection on February 23, 2024, there was significant progress in stabilization but areas remained denuded including rills and the slope above basin SBA5, rills and the area around basin SBB1, laydown areas that did not have adequate cover above basins SBC2, SBC3 and SBC4, and the areas beneath the arrays above basin SBA10, sediment trap STC1, and basin SBC4. See 9VAC25-870-54(B), 9VAC25-840-40(1) and Permit Part II.B.2.c(8). During DEQ's inspection on May 8,

2024, DEQ observed that the site was temporarily stabilized.

17. During the inspections on June 21, 2023 and July 19, 2023, discharges from installed traps and basins were to the perimeter silt fence, which caused the silt fence to fail. Since June 21, 2023, an attempt was made to separate the discharge from the completed basins but concentrated runoff still flowed to the perimeter silt fence during the July 19, 2023 inspection. The silt fence installed to separate the flow paths was incorrectly installed-not entrenched and not spliced with a watertight connection. During the July 19, 2023 and August 22, 2023 inspections, it was observed that sections of silt fence that had been repaired were not made with watertight splices. See 9VAC25-840-60(A) and 9VAC25-870-54(B). During the December 6, 2023 inspection, DEQ observed that the silt fence that was previously identified as improperly spliced had been repaired and replaced with sections of silt fence that were properly spliced.

18. During the inspections on July 19, 2023, and August 22, 2023, it was observed that there were temporary slope drains (TSD) installed in SBA4 and SBA10. The TSD in SBA10 did not extend to the toe of the basin slope. The TSDs practices are not identified on the approved erosion and sediment control plan. In addition, concentrated runoff was flowing down basin slopes creating erosion in SBA3, SBA4, SBA5, SBA6, SBA7, STA9, SBA10, and SBA11. See 9VAC25-840-40(7), 9VAC25-840-60, 9VAC25-870-54(B) and Permit Part II.C(1)-(2). During the inspection on December 6, 2023, the temporary slope drains were extended to the toe of the basin slope. Energix indicated it plans to address areas of concentrated discharges in a plan modification.

19. Based on the results of the March 8, 2023, June 21, 2023, July 19, 2023, August 22, 2023, December 6, 2023, February 23, 2024, and May 8, 2024 inspections, the Department concludes that Caden Energix violated 9VAC25-870-54(A-C), 9VAC25-840-60(A), 9VAC25-840-40(1), (4), (5), (7), (10), (11), and (15), and 2019 Permit Parts II.C(1-2), II.B.2.c(9), II.F.1, and II.B.2.c(8), as described in paragraphs C (8) through (18) of this Order.

<u>Site 2- Axton Solar Phase 2</u>

20. Caden Energix Axton LLC (Caden Energix) is a business entity authorized to do business in Virginia and references to Caden Energix Axton LLC include its affiliates, partners, and subsidiaries. Caden Energix Axton LLC is a "person" within the meaning of Va. Code § 62.1-44.3.

21. Caden Energix owns operates the Axton Solar Phase 2 site located at latitude 36.6268 and longitude -79.7035 near 374 Centerville Rd in Axton, Virginia, located in Henry County (Site 2) from which stormwater associated with construction activity is discharged.

22. DEQ is the Virginia Stormwater Management Program (VSMP) authority for Site 2.

104. During the inspection on December 28, 2023, DEQ staff observed denuded areas that required temporary or permanent stabilization including the area just past the outfall of stormwater management facility PD11 and a recently installed underground cable in the northern section of E12 that was exposed in multiple locations. During the inspection on February 6, 2024, DEQ staff observed stabilization was lacking under panel arrays near the entrance to E2. See 9VAC25-870-54(B) and 9VAC25-840-40(1) and (16). On March 20, 2024, Energix submitted photos documenting corrective actions to DEQ.

105. During the inspection on December 28, 2023 and February 6, 2024, DEQ staff observed earthen structures and conveyance channels that were eroding and lacked stabilization. During the December 28, 2023 inspection, there was erosion and lack of stabilization on cut and fill slopes. The erosion of cut slopes indicated that concentrated flow was not contained in an adequate permanent or temporary structure. The slope of stormwater management facility PD09, where the stormwater conveyance channel connects, was eroding. DEQ re-inspected the site on May 2, 2024 and observed the erosion at the stormwater conveyance channel connection to PD09 is still present under the matting. See 9VAC25-870-54(B), 9VAC25-840-40(1), (5), (7), (8), and (11).

106. During the inspection on December 28, 2023, DEQ staff observed the ground around the PD03 outfall was eroding and the pipe was not flush to the ground. During the DEQ inspection on February 6, 2024, outfalls were not installed at zero grade for stormwater management facilities E2: SB17 and E3: ST29 and ST30. See 9VAC25-870-54(B) and 9VAC25-840-40(11). On January 12, 2024 and March 20, 2024, Energix submitted photos to DEQ documenting corrective actions.

107. During the inspection on December 28, 2023, DEQ staff observed sediment tracking from the construction entrance to Sussex Drive and control measures that were not properly installed and maintained in effective operating condition. The laydown area in Zone D E12 did not have the stone called out in the plan. Silt fence required maintenance and was improperly joined together. DEQ staff also observed tree protection fencing down at the perimeter and trash throughout the site. See 9VAC25-870-54(B), 9VAC25-870-56, 9VAC25-840-40(17), 9VAC25-840-60(A), and Permit Parts II.B.4.e.(6) and II.F. On March 20, 2024 and March 29, 2024, Energix submitted photos to DEQ documenting corrective actions. The photos showed the laydown area in better condition but it still appeared to be only partially stoned with VDOT gravel aggregate 21A on the approved plan, page detail 7.01.

108. During the inspection on February 6, 2024, DEQ staff observed a culvert near the entrance to section E2 that is not on the approved plan and needed maintenance. DEQ staff also observed outlets with sediment in riprap, silt fence that was not keyed in well, silt fence with a pile of trash and in need of maintenance, an access road in need of maintenance, and riser trash racks in need of cleanup. Trash was observed near the panel arrays at the entrance to and northern perimeter of E2 and in the laydown area. Stand-alone discarded dewatering bags were observed outside of the limits of disturbance. See 9VAC25-870-54(B), 9VAC25-870-56, 9VAC25-840-60(A), and Permit Parts II.B.4.e.(6)

and II.F. On March 20, 2024 and March 29, 2024, Energix submitted photos to DEQ documenting corrective actions for everything except the culvert that is not on the approved plan.

109. During the DEQ inspection on February 6, 2024, DEQ staff discovered unauthorized discharges outside the limits of disturbance. The SWPPP did not identify any prohibited discharges. See 9VAC25-870-54(G) and Permit Part II.C.4.

110. During the inspection on February 6, 2024, DEQ staff observed sediment traps without covers over the basin inlet end of the outfall pipe and covers that were not installed in accordance with the approved plan. See 9VAC25-870-54(B). On March 26, 2024, Energix submitted photos documenting corrective actions to DEQ.

111. On February 6, 2024, DEQ VWP staff conducted a site inspection. DEQ staff observed approximately 0.46 acres of wetlands impacted by the accumulation of fill material with depositions ranging from 2-12 inches. This impact was not authorized by the VWP permit. See Va. Code §62.1-44.15:20(A) and 9VAC25-210-50(A),

112. Based on the results of the May 30, 2023, July 31, 2023, December 12, 2023, and May 2, 2024 inspections, the Department concludes that Energix violated the May 1, 2023 consent order, Va. Code §62.1-44.15:20(A), 9VAC25-210-50(A), 9VAC25-870-54(B), 9VAC25-840-60(A), 9VAC25-840-40(1) and (11), and 2019 Permit Parts II.F.1, as described in paragraphs C (103) through (111) of this Order.

All Sites

113. On October 18, 2023, DEQ issued Notice of Violation No. 2023-SWRO-0002 to Energix for violations at Sites 1-6.

114. On October 26, 2023, Energix confirmed it received the NOV. Energix provided an initial response to the NOV on November 1, 2023.

115. On March 28, 2024, DEQ issued Notice of Violation No. 2024-PRO-0001 to Energix for the violations listed in C(103) to (110) above.

116. On April 2, 2024, DEQ issued Notice of Violation No. 2404-002523 to Energix for the violation listed in C(111) above.

117. DEQ staff and Energix personnel participated on conference calls on January 19, 2024, January 29, 2024, February 12, 2024, March 11, 2024, April 3, 2024, May 7, 2024 and May 10, 2024 to discuss corrective actions and the status of the sites.

118. In order for the Parties to complete their return to compliance, DEQ staff and the Parties have agreed to the Schedule of Compliance, which is incorporated as Appendix A of this Order.

Legal Requirements

119. 9VAC25-210-50(A) states that "Except in compliance with a VWP permit, no person shall dredge, fill or discharge any pollutant into, or adjacent to surface waters, withdraw surface water, otherwise alter the physical, chemical or biological properties of surface waters and make them detrimental to the public health, or to animal or aquatic life, or to the uses of such waters for domestic or industrial consumption, or for recreation, or for other uses; excavate in wetlands or on or after October 1, 2001, conduct the following activities in a wetland: 1. New activities to cause draining that significantly alters or degrades existing wetland acreage or functions; 2. Filling or dumping; 3. Permanent flooding or impounding; or 4. New activities that cause significant alteration or degradation of existing wetland acreage or functions."

120. 9VAC25-840-40(1) states: "Permanent or temporary soil stabilization shall be applied to denuded areas within seven days after final grade is reached on any portion of the site. Temporary soil stabilization shall be applied within seven days to denuded areas that may not be at final grade but will remain dormant for longer than 14 days. Permanent stabilization shall be applied to areas that are to be left dormant for more than one year."

121. 9VAC25-840-40 (2) states: "During construction of the project, soil stock piles and borrow areas shall be stabilized or protected with sediment trapping measures. The applicant is responsible for the temporary protection and permanent stabilization of all soil stockpiles on site as well as borrow areas and soil intentionally transported from the project site."

122. 9VAC25-840-40(4) states: "Sediment basins and traps, perimeter dikes, sediment barriers and other measures intended to trap sediment shall be constructed as a first step in any land-disturbing activity and shall be made functional before upslope land disturbance takes place."

123. 9VAC25-840-40(5) states: "Stabilization measures shall be applied to earthen structures such as dams, dikes and diversions immediately after installation."

124. 9VAC25-840-40 (7) states: "7. Cut and fill slopes shall be designed and constructed in a manner that will minimize erosion. Slopes that are found to be eroding excessively within one year of permanent stabilization shall be provided with additional slope stabilizing measures until the problem is corrected."

125. 9VAC25-840-40 (8) states: "Concentrated runoff shall not flow down cut or fill slopes unless contained within an adequate temporary or permanent channel, flume or

slope drain structure."

126. 9VAC25-840-40 (10) states: "All storm sewer inlets that are made operable during construction shall be protected so that sediment-laden water cannot enter the conveyance system without first being filtered or otherwise treated to remove sediment."

127. 9VAC25-840-40(11) states: "Before newly constructed stormwater conveyance channels or pipes are made operational, adequate outlet protection and any required temporary or permanent channel lining shall be installed in both the conveyance channel and receiving channel."

128. 9VAC25-840-40(12) states: "When work in a live watercourse is performed, precautions shall be taken to minimize encroachment, control sediment transport and stabilize the work area to the greatest extent possible during construction. Nonerodible material shall be used for the construction of causeways and cofferdams. Earthen fill may be used for these structures if armored by nonerodable cover materials."

129. 9VAC25-840-40(14) states: "All applicable federal, state and local requirements pertaining to working in or crossing live watercourses shall be met."

130. 9VAC25-840-40(15) states: "The bed and banks of a watercourse shall be stabilized immediately after work in the watercourse is completed."

131. 9VAC25-840-60. Maintenance and inspections, states, "A. All erosion and sediment control structures and systems shall be maintained, inspected and repaired as needed to insure continued performance of their intended function. A statement describing the maintenance responsibilities of the permittee shall be included in the approved erosion and sediment control plan."

132. 9VAC25-870-54, Stormwater pollution prevention plan requirements, states, "A. A stormwater pollution prevention plan shall include, but not be limited to, an approved erosion and sediment control plan, an approved stormwater management plan, a pollution prevention plan for regulated land-disturbing activities, and a description of any additional control measures necessary to address a TMDL pursuant to subsection E of this section.

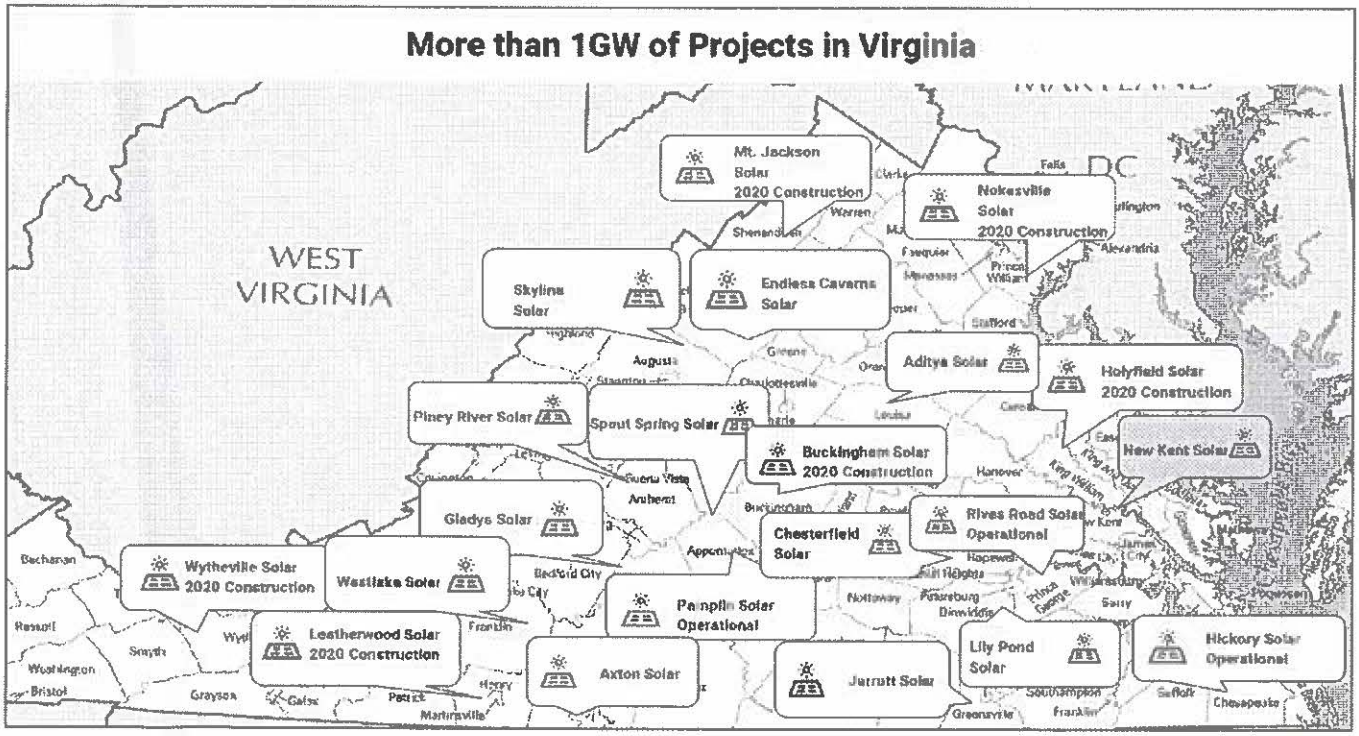
B. An erosion and sediment control plan consistent with the requirements of the Virginia Erosion and Sediment Control Law and regulations must be designed and implemented during construction activities. Prior to land disturbance, this plan must be approved by either the VESCP authority or the department in accordance with the Virginia Erosion and Sediment Control Law and attendant regulations.

C. A stormwater management plan consistent with the requirements of the Virginia Stormwater Management Act and regulations must be designed and implemented during

Virginia Coalition for Human Rights

Energix Campaign

The Virginia Coalition for Human Rights (VCHR) supports responsible solar energy, but it opposes the construction of solar energy projects by **Energix** in Virginia. The map below shows the status of Energix solar projects as of July 2021.



VCHR opposes Energix because it is an LLC incorporated under **Energix Group, Ltd.**, an Israeli-based company that has been cited by the United Nations for its violations of human rights in the West Bank and the Golan Heights.

Cited as #32 on a United Nations list for constructing renewable energy projects on occupied land in Palestine and in Syria, Energix has brought its worst practices to Virginia that has resulted in almost $200,000 of fines imposed by the state Department of Environmental Quality. In addition, Energix exclusively utilizes solar panels that consist of the toxic metal alloy Cadmium Telluride (CdTe), which has the potential to leach into soil and water.

As of May 2024, Virginia communities in 6 counties have successfully opposed 10 Energix solar energy project applications:

- May 2024 - Dinwiddie County: Permit denied to Lily Pond Solar
- Feb 2024 - Amherst County: Permit denied to Piney River Solar
- May 2023 - Dinwiddie County: Energix withdrawal of Lily Pond Solar
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- Nov 2022 - New Kent County: Energix withdrawal of New Kent Solar
- Oct 2022 - Pulaski County: Permit denied to Helios Solar
- Sept 2022 - Caroline County: Permit denied to Racehorse Solar
- Oct 2021 - Dinwiddie County: Permit denied to Lily Pond Solar
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VCHR Presentation on Energix in Virginia

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The slide deck of VCHR's presentation at this conference can be found **here**.

What can *you* do?

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CdTe Test Reports

01/12/2021 - Size- and Surface-Dependent Solubility of Cadmium Telluride

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Press Releases and Statements

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Newspaper Articles

05/29/2024 - Southwest Virginia Sun: Solar dreams turned into nightmare for Wythe farmer

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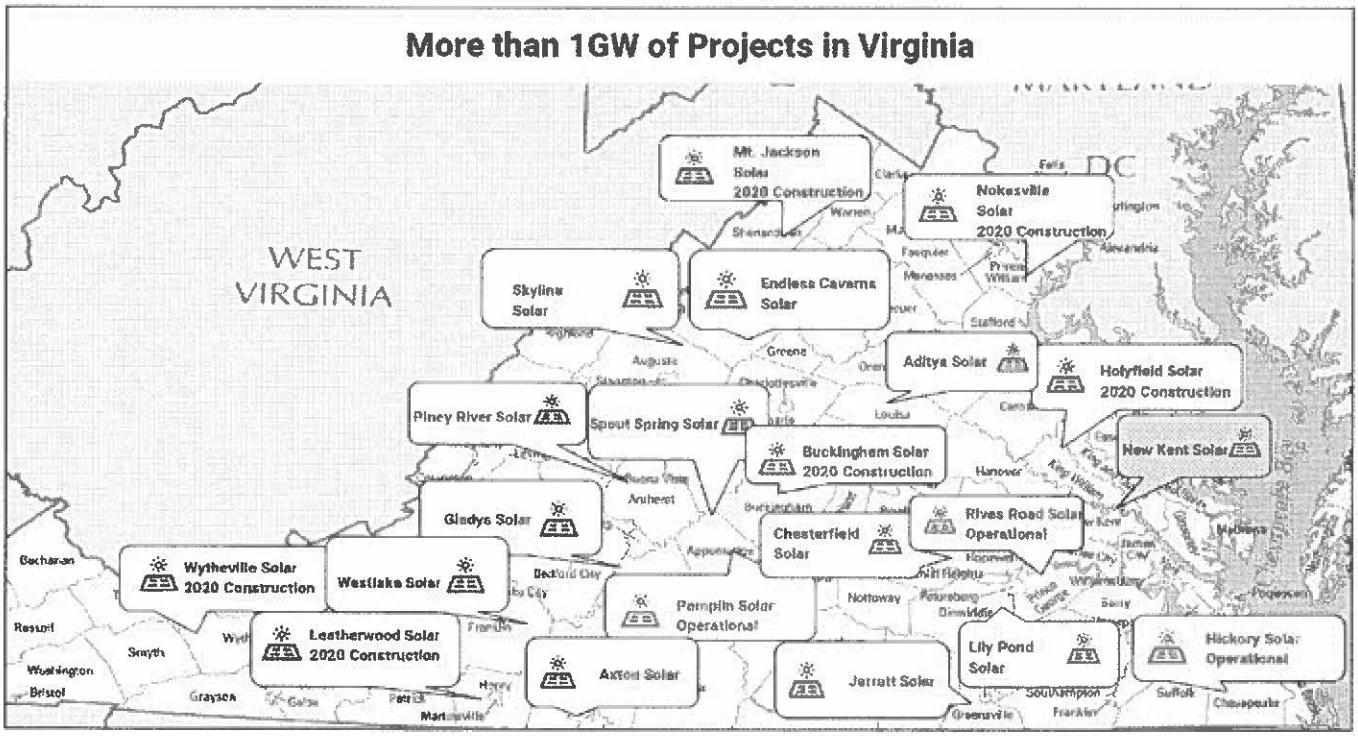

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Solar Power Depletes Farmlands of Rich Soil

BY IER (HTTPS://WWW.INSTITUTEFORENERGYRESEARCH.ORG/ABOUT/IER-SITE-MANAGER/ARTICLES) (ARTICLES)

MAY 29, 2024

CONTACT THE EXPERT

Key Takeaways

1

Driven by subsidies, mandates and federal and state policies compelling the use of more renewable energy, solar energy facilities are now displacing farmland at an increasing rate.

2

While land leases generally offer protection for landowners so that farms can be reclaimed from the solar installations, in practice damage is already being done with remediation as long as 50 years in the future.

3

The target for solar operations is increasingly in the Midwest, where government handouts to solar allow them to pay more to rent land than the farmers providing food for the nation.

4

Farmland preservation groups believe 83 percent of new solar installations will come from farm and ranch lands with half of these installations on the richest land for food and crops.

Solar energy is depleting farmlands (https://www.reuters.com/world/us/solar-capacity-grows-some-americas-most-productive-farmland-is-risk-2024-04-27/?utm_source=Sailthru&utm_medium=Newsletter&utm_campaign=Weekend-Briefing&utm_term=042724&user_email=b1f33c724f72e6ae81530a646d129e79a9988a48c9ad389eee85b1a662118 of their rich soils in the U.S. Midwest. The solar industry is moving into the U.S. Midwest, drawn by cheaper land rents, access to electric transmission, massive federal and state incentives, and the region's wide-open fields. But Biden's renewable energy boom risks damaging some of America's richest soils in key farming states like Indiana. Reuters based the finding (https://www.reuters.com/world/us/solar-capacity-grows-some-americas-most-productive-farmland-is-risk-2024-04-27/?utm_source=Sailthru&utm_medium=Newsletter&utm_campaign=Weekend-Briefing&utm_term=042724&user_email=b1f33c724f72e6ae81530a646d129e79a9988a48c9ad389eee85b1a662118 on an analysis of federal, state and local data, hundreds of pages of court records; and interviews with more than 100 energy and soil scientists, agricultural economists, farmers and farmland owners, and local, state and federal lawmakers.

According to some agricultural economists and agronomists (https://www.reuters.com/world/us/solar-capacity-grows-some-americas-most-productive-farmland-is-risk-2024-04-27/?utm_source=Sailthru&utm_medium=Newsletter&utm_campaign=Weekend-Briefing&utm_term=042724&user_email=b1f33c724f72e6ae81530a646d129e79a9988a48c9ad389eee85b1a662118 taking even small amounts of the best cropland out of production for solar development and damaging valuable topsoil impacts future crop potential in the United States. According to the U.S. Environmental Protection Agency and the Justice Department (https://www.reuters.com/world/us/solar-capacity-grows-some-americas-most-productive-farmland-is-risk-2024-04-27/?utm_source=Sailthru&utm_medium=Newsletter&utm_campaign=Weekend-Briefing&utm_term=042724&user_email=b1f33c724f72e6ae81530a646d129e79a9988a48c9ad389eee85b1a662118 common solar farm construction practices, including clearing and grading large sections of land, can lead to significant erosion and major runoff of sediment into waterways without proper remediation.

Solar leases in Indiana and surrounding states can offer $900 to $1,500 an acre per year in land rents (https://www.reuters.com/world/us/solar-capacity-grows-some-americas-most-productive-farmland-is-risk-2024-04-27/?utm_source=Sailthru&utm_medium=Newsletter&utm_campaign=Weekend-Briefing&utm_term=042724&user_email=b1f33c724f72e6ae81530a646d129e79a9988a48c9ad389eee85b1a662118 with annual rate increases. In comparison, farmland rent for top corn and soybean producers in Indiana, Illinois and Iowa averaged about $251 per acre in 2023 (https://www.reuters.com/world/us/solar-capacity-grows-some-americas-most-productive-farmland-is-risk-2024-04-27/?

utm_source=Sailthru&utm_medium=Newsletter&utm_campaign=Weekend-Briefing&utm_term=042724&user_email=b1f33c724f72e6ae81530a646d129e79a9988a48c9ad389eee85b1a662118 according to USDA data. Farmland Partners Inc, a publicly traded farmland real estate investment trust (REIT) leased about 9,000 acres (https://www.reuters.com/world/us/solar-capacity-grows-some-americas-most-productive-farmland-is-risk-2024-04-27/?utm_source=Sailthru&utm_medium=Newsletter&utm_campaign=Weekend-Briefing&utm_term=042724&user_email=b1f33c724f72e6ae81530a646d129e79a9988a48c9ad389eee85b1a662118 nationwide to solar firms to obtain profits for its investors; much of that ground was highly productive for farm use.

Some solar project leases are being designed (https://www.reuters.com/world/us/solar-capacity-grows-some-americas-most-productive-farmland-is-risk-2024-04-27/?utm_source=Sailthru&utm_medium=Newsletter&utm_campaign=Weekend-Briefing&utm_term=042724&user_email=b1f33c724f72e6ae81530a646d129e79a9988a48c9ad389eee85b1a662118 to make it possible to grow crops between panels, while others, like Doral Renewables LLC, are allowing livestock to graze around the panels as part of their land management. Some solar developers argue that in the Midwest, where more than one-third of the U.S. corn crop is used for ethanol production, solar energy is key for powering future electric vehicles.

Solar development comes amid increasing competition for land: In 2023, there were 76.2 million (https://www.reuters.com/world/us/solar-capacity-grows-some-americas-most-productive-farmland-is-risk-2024-04-27/?utm_source=Sailthru&utm_medium=Newsletter&utm_campaign=Weekend-Briefing&utm_term=042724&user_email=b1f33c724f72e6ae81530a646d129e79a9988a48c9ad389eee85b1a662118 – or nearly 8 percent – fewer acres in farms than in 1997, USDA data shows, as farmland is converted for residential, commercial and industrial use. According to USDA (https://www.reuters.com/world/us/solar-capacity-grows-some-americas-most-productive-farmland-is-risk-2024-04-27/?utm_source=Sailthru&utm_medium=Newsletter&utm_campaign=Weekend-Briefing&utm_term=042724&user_email=b1f33c724f72e6ae81530a646d129e79a9988a48c9ad389eee85b1a662118 urban sprawl and development are currently bigger contributors to farmland loss than solar power, citing reports from the Department of Energy and agency-funded research. However, with Biden's rush towards deploying solar energy and enormous subsidies under the Inflation Reduction Act and other laws, land losses to solar power are certain to grow.

Example of Damages to Cropland

In 2019, one Indiana farmer leased about 445 acres (https://www.reuters.com/world/us/solar-capacity-grows-some-americas-most-productive-farmland-is-risk-2024-04-27/?utm_source=Sailthru&utm_medium=Newsletter&utm_campaign=Weekend-Briefing&utm_term=042724&user_email=b1f33c724f72e6ae81530a646d129e79a9988a48c9ad389eee85b1a662118 of his 1200 acre farm near Whitfield to Dunns Bridge Solar LLC for one of the largest solar developments in the Midwest. According to the solar lease

(https://www.reuters.com/world/us/solar-capacity-grows-some-americas-most-productive-farmland-is-risk-2024-04-27/?utm_source=Sailthru&utm_medium=Newsletter&utm_campaign=Weekend-Briefing&utm_term=042724&user_email=b1f33c724f72e6ae81530a646d129e79a9988a48c9ad389eee85b1a662118) Dunns Bridge would use "commercially reasonable efforts to minimize any damage to and disturbance of growing crops and crop land caused by its construction activities" outside the project site and "not remove topsoil" from the property itself. Sub-contractors, however, graded the fields to assist in the building of roads and installation of posts and panels, despite warnings that it could make the land more vulnerable to erosion. The crews spread fine sand across large stretches of rich topsoil. Much of the land beneath the panels is now covered in yellow-brown sand, where no plants grow. The Dunns Bridge Solar project is a subsidiary of NextEra Energy Resources LLC, the world's largest generator of renewable energy from wind and solar. According to the company (https://www.reuters.com/world/us/solar-capacity-grows-some-americas-most-productive-farmland-is-risk-2024-04-27/?utm_source=Sailthru&utm_medium=Newsletter&utm_campaign=Weekend-Briefing&utm_term=042724&user_email=b1f33c724f72e6ae81530a646d129e79a9988a48c9ad389eee85b1a662118) it would review any remedial work needed to the land at the end of its contract in 2073, as per the terms of the lease agreement.

Land Needed for Solar Development

Because land deals are typically private transactions, the amount of cropland currently under solar panels or leased for possible future development is unknown (https://www.reuters.com/world/us/solar-capacity-grows-some-americas-most-productive-farmland-is-risk-2024-04-27/?utm_source=Sailthru&utm_medium=Newsletter&utm_campaign=Weekend-Briefing&utm_term=042724&user_email=b1f33c724f72e6ae81530a646d129e79a9988a48c9ad389eee85b1a662118) The United States Geological Survey and the U.S. Department of Energy's Lawrence Berkeley National Laboratory are compiling a database of existing solar facilities across the country. Work on the U.S. Large-Scale Solar Photovoltaic Database (https://eerscmap.usgs.gov/uspvdb/) began in 2020 and includes data on 3,699 facilities (https://www.nature.com/articles/s41597-023-02644-8) in 47 states and the District of Columbia. As of 2021, around 0.02 percent (https://www.reuters.com/world/us/solar-capacity-grows-some-americas-most-productive-farmland-is-risk-2024-04-27/?utm_source=Sailthru&utm_medium=Newsletter&utm_campaign=Weekend-Briefing&utm_term=042724&user_email=b1f33c724f72e6ae81530a646d129e79a9988a48c9ad389eee85b1a662118) of all cropland in the continental U.S. intersected in some way with large-scale, ground-based solar panel sites. The total power capacity of the solar operations in the data set represents over 60 gigawatts (https://www.reuters.com/world/us/solar-capacity-grows-some-americas-most-productive-farmland-is-risk-2024-04-27/?utm_source=Sailthru&utm_medium=Newsletter&utm_campaign=Weekend-Briefing&utm_term=042724&user_email=b1f33c724f72e6ae81530a646d129e79a9988a48c9ad389eee85b1a662118) of electric power capacity. But, between 2021 and 2023, solar capacity had nearly tripled (https://www.reuters.com/world/us/solar-capacity-grows-some-americas-

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Reuters reviewed (https://www.reuters.com/world/us/solar-capacity-grows-some-americas-most-productive-farmland-is-risk-2024-04-27/?utm_source=Sailthru&utm_medium=Newsletter&utm_campaign=Weekend-Briefing&utm_term=042724&user_email=b1f33c724f72e6ae81530a646d129e79a9988a48c9ad389eee85b1a662118 land use in four Midwestern counties – Pulaski, Starke and Jasper counties in Indiana, and Columbia County in Wisconsin—and found far larger percentages. The counties, representing an area of land slightly bigger than the state of Delaware, are where some of the nation's largest solar projects are being developed or built. Reuters found the percentage (https://www.reuters.com/world/us/solar-capacity-grows-some-americas-most-productive-farmland-is-risk-2024-04-27/?utm_source=Sailthru&utm_medium=Newsletter&utm_campaign=Weekend-Briefing&utm_term=042724&user_email=b1f33c724f72e6ae81530a646d129e79a9988a48c9ad389eee85b1a662118 of these counties' most productive cropland secured by solar and energy companies as of end of 2022 was: 12 percent in Pulaski, 9 percent in Starke, 4 percent in Jasper and 5 percent in Columbia. Doral Renewables, the developer behind the $1.5 billion Mammoth Solar project in Pulaski and Starke counties, does not consider (https://www.reuters.com/world/us/solar-capacity-grows-some-americas-most-productive-farmland-is-risk-2024-04-27/?utm_source=Sailthru&utm_medium=Newsletter&utm_campaign=Weekend-Briefing&utm_term=042724&user_email=b1f33c724f72e6ae81530a646d129e79a9988a48c9ad389eee85b1a662118 corn or soybean yields in its siting decisions. The company looks at the land's topography, zoning and closeness to an electrical grid or substation – and tries to avoid wooded areas, ditches and environmentally sensitive areas. These are also areas typically avoided by farmers.

By 2050, to meet the Biden Administration's decarbonization targets, the U.S. will need up to 1,570 gigawatts of capacity from solar (https://www.reuters.com/world/us/solar-capacity-grows-some-americas-most-productive-farmland-is-risk-2024-04-27/?utm_source=Sailthru&utm_medium=Newsletter&utm_campaign=Weekend-Briefing&utm_term=042724&user_email=b1f33c724f72e6ae81530a646d129e79a9988a48c9ad389eee85b1a662118 According to the Energy Department's Solar Futures Study, published in 2021, the land needed is not expected to exceed 5 percent (https://www.reuters.com/world/us/solar-capacity-grows-some-americas-most-productive-farmland-is-risk-2024-04-27/?utm_source=Sailthru&utm_medium=Newsletter&utm_campaign=Weekend-Briefing&utm_term=042724&user_email=b1f33c724f72e6ae81530a646d129e79a9988a48c9ad389eee85b1a662118 of any state's land area, except the smallest state of Rhode Island, where it could reach 6.5 percent by 2050.

Researchers at American Farmland Trust, a non-profit farmland protection organization, however, found that 83 percent (https://www.reuters.com/world/us/solar-capacity-grows-some-americas-most-productive-farmland-is-risk-2024-04-27/?

utm_source=Sailthru&utm_medium=Newsletter&utm_campaign=Weekend-Briefing&utm_term=042724&user_email=b1f33c724f72e6ae81530a646d129e79a9988a48c9ad389eee85b1a662118 of new solar energy development in the United States will be on farm and ranchland, unless current government policies change. Nearly half (https://www.reuters.com/world/us/solar-capacity-grows-some-americas-most-productive-farmland-is-risk-2024-04-27/?utm_source=Sailthru&utm_medium=Newsletter&utm_campaign=Weekend-Briefing&utm_term=042724&user_email=b1f33c724f72e6ae81530a646d129e79a9988a48c9ad389eee85b1a662118 would be on the nation's best land for producing food, fiber, and other crops.

Conclusion

Farmers are leasing land in the Midwest for solar development as the industry moves there due to the government's massive subsidies, and the area's cheap rents, access to transmission and wide-open spaces. While the leases provide for damage control, the land is being depleted of its rich top soil as the solar developers build their roads and other infrastructure. Solar power is just one more industry that is removing important farmland from production by offering much higher rents for the land than farmers can afford to pay. Unless government policy lavishing benefits on solar power changes, a large amount of farmland will be converted to solar power to meet Biden's climate goals, removing it from crop production. Despite the growing number of acres being converted to solar power use, the real issue is the quality of the land coming out of production, and what that means for local economies, state economies and the country's future abilities to provide food for Americans.

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Solar Power Depletes Farmlands of Rich Soil

BY IER (HTTPS://WWW.INSTITUTEFORENERGYRESEARCH.ORG/ABOUT/IER-SITE-MANAGER/ARTICLES) (ARTICLES)

MAY 29, 2024

CONTACT THE EXPERT

Key Takeaways

1

Driven by subsidies, mandates and federal and state policies compelling the use of more renewable energy, solar energy facilities are now displacing farmland at an increasing rate.

2

While land leases generally offer protection for landowners so that farms can be reclaimed from the solar installations, in practice damage is already being done with remediation as long as 50 years in the future.

3

The target for solar operations is increasingly in the Midwest, where government handouts to solar allow them to pay more to rent land than the farmers providing food for the nation.

4

Farmland preservation groups believe 83 percent of new solar installations will come from farm and ranch lands with half of these installations on the richest land for food and crops.

Solar energy is depleting farmlands (https://www.reuters.com/world/us/solar-capacity-grows-some-americas-most-productive-farmland-is-risk-2024-04-27/?utm_source=Sailthru&utm_medium=Newsletter&utm_campaign=Weekend-Briefing&utm_term=042724&user_email=b1f33c724f72e6ae81530a646d129e79a9988a48c9ad389eee85b1a662118) of their rich soils in the U.S. Midwest. The solar industry is moving into the U.S. Midwest, drawn by cheaper land rents, access to electric transmission, massive federal and state incentives, and the region's wide-open fields. But Biden's renewable energy boom risks damaging some of America's richest soils in key farming states like Indiana. Reuters based the finding (https://www.reuters.com/world/us/solar-capacity-grows-some-americas-most-productive-farmland-is-risk-2024-04-27/?utm_source=Sailthru&utm_medium=Newsletter&utm_campaign=Weekend-Briefing&utm_term=042724&user_email=b1f33c724f72e6ae81530a646d129e79a9988a48c9ad389eee85b1a662118) on an analysis of federal, state and local data, hundreds of pages of court records; and interviews with more than 100 energy and soil scientists, agricultural economists, farmers and farmland owners, and local, state and federal lawmakers.

According to some agricultural economists and agronomists (https://www.reuters.com/world/us/solar-capacity-grows-some-americas-most-productive-farmland-is-risk-2024-04-27/?utm_source=Sailthru&utm_medium=Newsletter&utm_campaign=Weekend-Briefing&utm_term=042724&user_email=b1f33c724f72e6ae81530a646d129e79a9988a48c9ad389eee85b1a662118) taking even small amounts of the best cropland out of production for solar development and damaging valuable topsoil impacts future crop potential in the United States. According to the U.S. Environmental Protection Agency and the Justice Department (https://www.reuters.com/world/us/solar-capacity-grows-some-americas-most-productive-farmland-is-risk-2024-04-27/?utm_source=Sailthru&utm_medium=Newsletter&utm_campaign=Weekend-Briefing&utm_term=042724&user_email=b1f33c724f72e6ae81530a646d129e79a9988a48c9ad389eee85b1a662118) common solar farm construction practices, including clearing and grading large sections of land, can lead to significant erosion and major runoff of sediment into waterways without proper remediation.

Solar leases in Indiana and surrounding states can offer $900 to $1,500 an acre per year in land rents (https://www.reuters.com/world/us/solar-capacity-grows-some-americas-most-productive-farmland-is-risk-2024-04-27/?utm_source=Sailthru&utm_medium=Newsletter&utm_campaign=Weekend-Briefing&utm_term=042724&user_email=b1f33c724f72e6ae81530a646d129e79a9988a48c9ad389eee85b1a662118) with annual rate increases. In comparison, farmland rent for top corn and soybean producers in Indiana, Illinois and Iowa averaged about $251 per acre in 2023 (https://www.reuters.com/world/us/solar-capacity-grows-some-americas-most-productive-farmland-is-risk-2024-04-27/?

utm_source=Sailthru&utm_medium=Newsletter&utm_campaign=Weekend-Briefing&utm_term=042724&user_email=b1f33c724f72e6ae81530a646d129e79a9988a48c9ad389eee85b1a662118 according to USDA data. Farmland Partners Inc, a publicly traded farmland real estate investment trust (REIT) leased about 9,000 acres (https://www.reuters.com/world/us/solar-capacity-grows-some-americas-most-productive-farmland-is-risk-2024-04-27/?utm_source=Sailthru&utm_medium=Newsletter&utm_campaign=Weekend-Briefing&utm_term=042724&user_email=b1f33c724f72e6ae81530a646d129e79a9988a48c9ad389eee85b1a662118 nationwide to solar firms to obtain profits for its investors; much of that ground was highly productive for farm use.

Some solar project leases are being designed (https://www.reuters.com/world/us/solar-capacity-grows-some-americas-most-productive-farmland-is-risk-2024-04-27/?utm_source=Sailthru&utm_medium=Newsletter&utm_campaign=Weekend-Briefing&utm_term=042724&user_email=b1f33c724f72e6ae81530a646d129e79a9988a48c9ad389eee85b1a662118 to make it possible to grow crops between panels, while others, like Doral Renewables LLC, are allowing livestock to graze around the panels as part of their land management. Some solar developers argue that in the Midwest, where more than one-third of the U.S. corn crop is used for ethanol production, solar energy is key for powering future electric vehicles.

Solar development comes amid increasing competition for land: In 2023, there were 76.2 million (https://www.reuters.com/world/us/solar-capacity-grows-some-americas-most-productive-farmland-is-risk-2024-04-27/?utm_source=Sailthru&utm_medium=Newsletter&utm_campaign=Weekend-Briefing&utm_term=042724&user_email=b1f33c724f72e6ae81530a646d129e79a9988a48c9ad389eee85b1a662118 – or nearly 8 percent – fewer acres in farms than in 1997, USDA data shows, as farmland is converted for residential, commercial and industrial use. According to USDA (https://www.reuters.com/world/us/solar-capacity-grows-some-americas-most-productive-farmland-is-risk-2024-04-27/?utm_source=Sailthru&utm_medium=Newsletter&utm_campaign=Weekend-Briefing&utm_term=042724&user_email=b1f33c724f72e6ae81530a646d129e79a9988a48c9ad389eee85b1a662118 urban sprawl and development are currently bigger contributors to farmland loss than solar power, citing reports from the Department of Energy and agency-funded research. However, with Biden's rush towards deploying solar energy and enormous subsidies under the Inflation Reduction Act and other laws, land losses to solar power are certain to grow.

Example of Damages to Cropland

In 2019, one Indiana farmer leased about 445 acres (https://www.reuters.com/world/us/solar-capacity-grows-some-americas-most-productive-farmland-is-risk-2024-04-27/?utm_source=Sailthru&utm_medium=Newsletter&utm_campaign=Weekend-Briefing&utm_term=042724&user_email=b1f33c724f72e6ae81530a646d129e79a9988a48c9ad389eee85b1a662118 of his 1200 acre farm near Whitfield to Dunns Bridge Solar LLC for one of the largest solar developments in the Midwest. According to the solar lease

(https://www.reuters.com/world/us/solar-capacity-grows-some-americas-most-productive-farmland-is-risk-2024-04-27/?utm_source=Sailthru&utm_medium=Newsletter&utm_campaign=Weekend-Briefing&utm_term=042724&user_email=b1f33c724f72e6ae81530a646d129e79a9988a48c9ad389eee85b1a662118) Dunns Bridge would use "commercially reasonable efforts to minimize any damage to and disturbance of growing crops and crop land caused by its construction activities" outside the project site and "not remove topsoil" from the property itself. Sub-contractors, however, graded the fields to assist in the building of roads and installation of posts and panels, despite warnings that it could make the land more vulnerable to erosion. The crews spread fine sand across large stretches of rich topsoil. Much of the land beneath the panels is now covered in yellow-brown sand, where no plants grow. The Dunns Bridge Solar project is a subsidiary of NextEra Energy Resources LLC, the world's largest generator of renewable energy from wind and solar. According to the company (https://www.reuters.com/world/us/solar-capacity-grows-some-americas-most-productive-farmland-is-risk-2024-04-27/?utm_source=Sailthru&utm_medium=Newsletter&utm_campaign=Weekend-Briefing&utm_term=042724&user_email=b1f33c724f72e6ae81530a646d129e79a9988a48c9ad389eee85b1a662118) it would review any remedial work needed to the land at the end of its contract in 2073, as per the terms of the lease agreement.

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Reuters reviewed (https://www.reuters.com/world/us/solar-capacity-grows-some-americas-most-productive-farmland-is-risk-2024-04-27/?utm_source=Sailthru&utm_medium=Newsletter&utm_campaign=Weekend-Briefing&utm_term=042724&user_email=b1f33c724f72e6ae81530a646d129e79a9988a48c9ad389eee85b1a662118 land use in four Midwestern counties – Pulaski, Starke and Jasper counties in Indiana, and Columbia County in Wisconsin—and found far larger percentages. The counties, representing an area of land slightly bigger than the state of Delaware, are where some of the nation's largest solar projects are being developed or built. Reuters found the percentage (https://www.reuters.com/world/us/solar-capacity-grows-some-americas-most-productive-farmland-is-risk-2024-04-27/?utm_source=Sailthru&utm_medium=Newsletter&utm_campaign=Weekend-Briefing&utm_term=042724&user_email=b1f33c724f72e6ae81530a646d129e79a9988a48c9ad389eee85b1a662118 of these counties' most productive cropland secured by solar and energy companies as of end of 2022 was: 12 percent in Pulaski, 9 percent in Starke, 4 percent in Jasper and 5 percent in Columbia. Doral Renewables, the developer behind the $1.5 billion Mammoth Solar project in Pulaski and Starke counties, does not consider (https://www.reuters.com/world/us/solar-capacity-grows-some-americas-most-productive-farmland-is-risk-2024-04-27/?utm_source=Sailthru&utm_medium=Newsletter&utm_campaign=Weekend-Briefing&utm_term=042724&user_email=b1f33c724f72e6ae81530a646d129e79a9988a48c9ad389eee85b1a662118 corn or soybean yields in its siting decisions. The company looks at the land's topography, zoning and closeness to an electrical grid or substation – and tries to avoid wooded areas, ditches and environmentally sensitive areas. These are also areas typically avoided by farmers.

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Conclusion

Farmers are leasing land in the Midwest for solar development as the industry moves there due to the government's massive subsidies, and the area's cheap rents, access to transmission and wide-open spaces. While the leases provide for damage control, the land is being depleted of its rich top soil as the solar developers build their roads and other infrastructure. Solar power is just one more industry that is removing important farmland from production by offering much higher rents for the land than farmers can afford to pay. Unless government policy lavishing benefits on solar power changes, a large amount of farmland will be converted to solar power to meet Biden's climate goals, removing it from crop production. Despite the growing number of acres being converted to solar power use, the real issue is the quality of the land coming out of production, and what that means for local economies, state economies and the country's future abilities to provide food for Americans.

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P301 + P312 + P330	IF SWALLOWED: Call a POISON CENTER/doctor if you feel unwell. Rinse mouth.
P302 + P352 + P312	IF ON SKIN: Wash with plenty of water.Call a POISON CENTER/doctor if you feel unwell.
P304 + P340 + P312	IF INHALED: Remove person to fresh air and keep comfortable for breathing. Call a POISON CENTER/doctor if you feel unwell.
P363	Wash contaminated clothing before reuse.
P391	Collect spillage.
P501	Dispose of contents/ container to an approved waste disposal plant.

2.3 Hazards not otherwise classified (HNOC) or not covered by GHS - none

3. COMPOSITION/INFORMATION ON INGREDIENTS

3.1 Substances

Formula	:	CdTe
Molecular weight	:	240.01 g/mol
CAS-No.	:	1306-25-8
EC-No.	:	215-149-9
Index-No.	:	048-001-00-5

Hazardous components

Component	Classification	Concentration
Cadmium telluride		
	Acute Tox. 4; Aquatic Acute 1; Aquatic Chronic 1; H302 + H312 + H332, H410	90 - 100 %

For the full text of the H-Statements mentioned in this Section, see Section 16.

4. FIRST AID MEASURES

4.1 Description of first aid measures

General advice
Consult a physician. Show this safety data sheet to the doctor in attendance.Move out of dangerous area.

If inhaled
If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

In case of skin contact
Wash off with soap and plenty of water. Consult a physician.

In case of eye contact
Flush eyes with water as a precaution.

If swallowed
Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

4.2 Most important symptoms and effects, both acute and delayed
The most important known symptoms and effects are described in the labelling (see section 2.2) and/or in section 11

4.3 Indication of any immediate medical attention and special treatment needed
No data available

5. FIREFIGHTING MEASURES

5.1 Extinguishing media

Suitable extinguishing media
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

5.2 Special hazards arising from the substance or mixture
No data available

A Focus on Heavy Metal, EDC, and Pesticide Exposures

Depending on concentration and length of exposure, the toxicity of prevalent heavy metals such as mercury, lead, chromium, cadmium, and barium may inflict a range of harmful consequences on children's health, including neurocognitive, behavioral, and congenital disorders as well as respiratory problems, cancer, and cardiometabolic diseases.[10] As an example, a 2017 *JAMA* study linked higher childhood lead exposure with lower IQ scores and downward social mobility in adulthood,[11] and a population-based case-controlled study found that higher concentrations of cadmium and lead in placental tissues were associated with increased risks for orofacial clefts in newborns.[12] In addition, a recent analysis from a large cohort study (n=1,751 women) indicated that prenatal mercury exposure in mothers with low prenatal folate levels adversely affected infant neurodevelopment.[13] The exposure was also associated with rapid catch-up growth in the first three years of life,[13] which has been shown to have both obvious short-term benefits and potential long-term metabolic risks such as childhood obesity and insulin resistance.[14-16]

Endocrine dysfunction related to EDC exposures may lead to systemic imbalances that increase the risk of adverse health effects, and developing fetuses are especially vulnerable. Both animal models and human cohort studies have suggested that such exposures have the potential to alter fetal growth and metabolism, potentially promoting metabolic disorders in adulthood such as obesity, type 2 diabetes, and metabolic syndrome.[17] In addition, a 2020 systematic review and meta-analysis examined the association between *postnatal* exposure to EDCs and obesity.[18] Of the included 73 mostly cross-sectional studies, 16 were conducted among children or adolescent participants. Pediatric results from qualitative and meta-analysis indicated:[18]

- BPA and phthalate exposures were associated with general and abdominal obesity in children.
- A significant association was noted between exposure to the organic compound 2,5-dichlorophenol and obesity in children.

Specific to chronic, low-level pesticide exposure during childhood, epidemiological, animal, and clinical studies suggest an association with alterations in growth, impaired neurobehavioral development, cancer, and increased vulnerability to infection.[19,20] Most recently, a 2021 study reviewed the epidemiological evidence regarding pyrethroid pesticides (chemicals also used in commercial and household insecticides) and health impacts among agricultural workers and their children.[21] Limited US studies were included in the review; however, investigators reported that in 66.6% of the reviewed studies (8 of 12), workers or their children exposed to pyrethroid pesticides had a higher risk of impairment to neurocognitive, neuromotor, or neurobehavioral performance, mainly associated with attention, processing speed, and motor coordination.[21]

Clinical Applications

The prenatal period and the first years of life are a critical period for prosperous pediatric development and wellness throughout life. Acute or long-term exposures to environmental contaminants may

		varies		
		TWA	0.1 mg/m3	USA. ACGIH Threshold Limit Values (TLV)
		Halitosis		
		PEL	0.005 mg/m3	OSHA Specifically Regulated Chemicals/Carcinogens
		1910.1027 This standard applies to all occupational exposures to cadmium and cadmium compounds, in all forms, and in all industries covered by the Occupational Safety and Health Act, except the construction-related industries, which are covered under 29 CFR 1926.63. OSHA specifically regulated carcinogen		
		Potential Occupational Carcinogen See Appendix A		
		TWA	0.1 mg/m3	USA. NIOSH Recommended Exposure Limits
		PEL	0.1 mg/m3	California permissible exposure limits for chemical contaminants (Title 8, Article 107)

Biological occupational exposure limits

Component	CAS-No.	Parameters	Value	Biological specimen	Basis
	-	cadmium	5 µg/l	In blood	ACGIH - Biological Exposure Indices (BEI)
	Remarks	Not critical			
		cadmium	5µg/g creatinine	Urine	ACGIH - Biological Exposure Indices (BEI)
		Not critical			

8.2 Exposure controls

Appropriate engineering controls
Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

Personal protective equipment

Eye/face protection
Safety glasses with side-shields conforming to EN166 Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin protection
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Body Protection
Complete suit protecting against chemicals, The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Respiratory protection
For nuisance exposures use type P95 (US) or type P1 (EU EN 143) particle respirator.For higher level protection use type OV/AG/P99 (US) or type ABEK-P2 (EU EN 143) respirator cartridges. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Control of environmental exposure
Prevent further leakage or spillage if safe to do so. Do not let product enter drains. Discharge into the environment must be avoided.

9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

a)	Appearance	Form: powder Colour: white
b)	Odour	No data available
c)	Odour Threshold	No data available
d)	pH	No data available
e)	Melting point/freezing point	Melting point/range: 1,092 °C (1,998 °F)
f)	Initial boiling point and boiling range	1,130 °C (2,066 °F)
g)	Flash point	No data available
h)	Evaporation rate	No data available
i)	Flammability (solid, gas)	No data available
j)	Upper/lower flammability or explosive limits	No data available
k)	Vapour pressure	No data available
l)	Vapour density	No data available
m)	Relative density	6.2 g/cm3 at 25 °C (77 °F)
n)	Water solubility	No data available
o)	Partition coefficient: n-octanol/water	No data available
p)	Auto-ignition temperature	No data available
q)	Decomposition temperature	No data available
r)	Viscosity	No data available
s)	Explosive properties	No data available
t)	Oxidizing properties	No data available

9.2 Other safety information
No data available

10. STABILITY AND REACTIVITY

10.1 Reactivity
No data available

10.2 Chemical stability
Stable under recommended storage conditions.

10.3 Possibility of hazardous reactions
No data available

10.4 Conditions to avoid
No data available

10.5 Incompatible materials
Strong oxidizing agents, Strong acids

10.6 Hazardous decomposition products
Hazardous decomposition products formed under fire conditions. - Cadmium/cadmium oxides, Tellurium oxides
Other decomposition products - No data available

In the event of fire: see section 5

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity
No data available

Inhalation: No data available

Dermal: No data available

No data available

Skin corrosion/irritation
No data available

Serious eye damage/eye irritation
No data available

Respiratory or skin sensitisation
No data available

Germ cell mutagenicity
No data available

Carcinogenicity

This is or contains a component that has been reported to be carcinogenic based on its IARC, OSHA, ACGIH, NTP, or EPA classification. Chronic exposure to cadmium may cause lung and prostate cancer.

IARC:	1 - Group 1: Carcinogenic to humans (Cadmium telluride)
NTP:	Known - Known to be human carcinogenThe reference note has been added by TD based on the background information of the NTP. (Cadmium telluride)
OSHA:	OSHA specifically regulated carcinogen (Cadmium telluride)

Reproductive toxicity
No data available

Overexposure may cause reproductive disorder(s) based on tests with laboratory animals.

Specific target organ toxicity - single exposure
No data available

Specific target organ toxicity - repeated exposure
No data available

Aspiration hazard
No data available

Additional Information
RTECS: EV3330000

Acute inhalation exposure to cadmium fumes may cause "metal fume fever" with flu-like symptoms of weakness, fever, headache, chills, nausea, vomiting, dizziness, sweating, muscular pain, cough and difficulty breathing. Acute pulmonary edema may develop within 24 hours and reaches a maximum by three days.The first chronic effect of exposure to cadmium is generally kidney damage, manifested by excretion of excessive protein in the urine, followed by anemia, teeth discoloration and loss of smell. Cadmium also is believed to cause pulmonary emphysema and bone disease.

12. ECOLOGICAL INFORMATION

12.1 Toxicity
No data available

12.2 Persistence and degradability
No data available

12.3 Bioaccumulative potential
No data available

12.4 Mobility in soil
No data available

12.5 Results of PBT and vPvB assessment
PBT/vPvB assessment not available as chemical safety assessment not required/not conducted

12.6 Other adverse effects
An environmental hazard cannot be excluded in the event of unprofessional handling or disposal.
Very toxic to aquatic life with long lasting effects.

No data available

13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Product
Offer surplus and non-recyclable solutions to a licensed disposal company. Contact a licensed professional waste disposal service to dispose of this material. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber.

Contaminated packaging
Dispose of as unused product.

14. TRANSPORT INFORMATION

DOT (US)
UN number: 2570 Class: 6.1 Packing group: III
Proper shipping name: Cadmium compounds (Cadmium telluride)
Reportable Quantity (RQ):
Poison Inhalation Hazard: No

IMDG
UN number: 2570 Class: 6.1 Packing group: III EMS-No: F-A, S-A
Proper shipping name: CADMIUM COMPOUND (Cadmium telluride)

IATA
UN number: 2570 Class: 6.1 Packing group: III
Proper shipping name: Cadmium compound (Cadmium telluride)

15. REGULATORY INFORMATION

SARA 302 Components
This material does not contain any components with a section 302 EHS TPQ.

SARA 313 Components
The following components are subject to reporting levels established by SARA Title III, Section 313:

	CAS-No.	Revision Date
Cadmium telluride	1306-25-8	2015-07-08

SARA 311/312 Hazards
Acute Health Hazard, Chronic Health Hazard

Massachusetts Right To Know Components
No components are subject to the Massachusetts Right to Know Act.

Pennsylvania Right To Know Components

	CAS-No.	Revision Date
Cadmium telluride	1306-25-8	2015-07-08

California Prop. 65 Components

, which is/are known to the State of California to cause cancer.	CAS-No.	Revision Date
For more information go to www.P65Warnings.ca.gov.	1306-25-8	2007-09-28
Cadmium telluride		

16. OTHER INFORMATION

Full text of H-Statements referred to under sections 2 and 3.

Acute Tox.	Acute toxicity
Aquatic Acute	Acute aquatic toxicity
Aquatic Chronic	Chronic aquatic toxicity
H302	Harmful if swallowed.
H302 + H312 + H332	Harmful if swallowed, in contact with skin or if inhaled.
H312	Harmful in contact with skin.

Further information

The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling or from contact with the above product. See www.sigma-aldrich.com and/or the reverse side of invoice or packing slip for additional terms and conditions of sale.

Preparation Information
Sigma-Aldrich Corporation
Product Safety – Americas Region
1-800-521-8956

Version: 4.9 Revision Date: 08/31/2018 Print Date: 10/01/2019

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.

Water quality criteria are based solely on data and scientific judgments about the relationship between pollutant concentrations and potential environmental and human health effects. EPA's recommended water quality criteria are not rules, nor do they automatically become part of a state's water quality standards. States must adopt into their standards water quality criteria that protect the designated uses of the water bodies within their area. These can include scientifically defensible site-specific criteria that are different from EPA's national recommended criteria, as long as the site-specific criteria are protective of the designated use. Water quality criteria are not effective under the Clean Water Act until they have been adopted into state water quality standards and approved by EPA.

What Are the 2016 Recommended Water Quality Criteria for Cadmium?

EPA recommends the:

- One-hour freshwater acute criterion maximum concentration not exceed 1.8 µg/L at a total hardness of 100 mg/L as $CaCO_3$.
- Four-day average freshwater chronic criterion concentration not exceed 0.72 µg/L at a total hardness of 100 mg/L as $CaCO_3$.
- One-hour estuarine/marine acute criterion maximum concentration not exceed 33 µg/L.
- Four-day average estuarine/marine chronic criterion concentration not exceed 7.9 µg/L.

The recommended frequency of exceedance for the above is no more than once every three years.

How Do the 2016 Criteria Compare to the Previously Recommended 2001 Criteria?

The 2016 criteria reflect data for 75 new species and 49 new genera. The 2016 freshwater acute criterion (1.8 micrograms per liter) for dissolved cadmium is slightly lower than the 2001 acute criterion (2.0 micrograms per liter). The 2016 freshwater chronic criterion (0.72 micrograms per liter) for dissolved cadmium is slightly higher (less stringent) compared to the 2001 criterion (0.25 micrograms per liter). These modest changes are primarily due to the inclusion of new toxicity studies. As in the 2001 criteria, the 2016 freshwater acute criterion was derived to be protective of aquatic species and was lowered further to protect the commercially and recreationally important rainbow trout. In addition, the duration of the 2016 acute criterion was changed to one-hour. Both changes are consistent with EPA's current aquatic life criteria guidelines.

The 2016 estuarine/marine acute criterion for dissolved cadmium (33 micrograms per liter) is lower (more stringent) than the 2001 acute criterion (40 micrograms per liter), which is primarily due to the addition of new toxicity studies for sensitive genera. The 2016 estuarine/marine chronic criterion (7.9 micrograms per liter) is also slightly more stringent than the 2001 chronic criterion (8.8 micrograms per liter), due the consideration of more species in the chronic criterion development. The 2016 criteria for dissolved cadmium can be found in Table 1.

Table 1. Summary of 2016 Draft Aquatic Life AWQC for Cadmium.

	2016 AWQC Update	
	Acute (1-hour, dissolved Cd)[c]	Chronic (4-day, dissolved Cd)
Freshwater (Total Hardness = 100 mg/L as $CaCO_3$)[a]	1.8 µg/L[b]	0.72 µg/L
Estuarine/marine	33 µg/L	7.9 µg/L

[a] Freshwater acute and chronic criteria are hardness-dependent and were normalized to a hardness of 100 mg/L as $CaCO_3$ to allow the presentation of representative criteria values.

[b] Lowered to protect a commercially and recreationally important species (rainbow trout), as per the 1985 Guidelines, Stephen et al. (1985).

[c] The duration of the 2016 acute criteria was changed to 1-hour to reflect the 1985 Guidelines-based recommended acute duration.

How to View the Criteria Document and Supporting Information:

EPA has established an official public docket for this action under Docket ID No. EPA-HQ-OW-2015-0753, accessed at www.regulations.gov. You may also download the document and supporting information from EPA's aquatic life criteria website at: http://www.epa.gov/wqc/aquatic-life-criteria-cadmium

Where can I find more information?

Please contact Mike Elias by email at elias.mike@epa.gov.

interfere with a child's health trajectory, depending on chemical concentrations and duration. To understand a patient's complete story, highlighting potential sources of low-level or excess toxicant exposure is a crucial component of a clinical assessment. From prenatal to postnatal, this assessment may include various considerations including:

- Eating and lifestyle habits during pregnancy
- Neighborhood location and health
- Ambient air pollution exposure
- Indoor toxicant exposures such as in cleaning products, molds, carpets, and toys
- Water quality and intake of non-organic foods more likely to contain pesticide residues

While many toxic chemicals are ubiquitous and difficult to avoid completely, reducing contact with potential sources is an important goal. Identifying those contaminants specific to a patient's daily life is a first step; improving biotransformation and elimination processes by supporting liver and gut health can be the next. This may include increasing intake of phytonutrient-dense foods, quality proteins, and healthy fats as well as sufficient water intake and pediatric-designed probiotics. It may also include avoiding those foods that are difficult for a patient to digest and excrete such as fried foods or ultra-processed meals. Functional medicine's patient-centered approach helps parents and practitioners co-develop a personalized health plan for pediatric patients. Learn more about the health impacts of pollutant exposures and treatment strategies at IFM's Environmental Health Advanced Practice Module (APM).

Related Podcasts and Articles

THE PEDIATRIC MICROBIOME AND BUILDING HEALTHY ADULTS WITH LIZ MUMPER, MD, FAAP >

AIR POLLUTION AND AUTOIMMUNE DISEASE: ADVERSE HEALTH OUTCOMES >

TOXICANT EXPOSURES AT HOME >

LOW-LEVEL LEAD EXPOSURE & IMPLICATIONS FOR HUMAN HEALTH >

PEDIATRIC ALLERGIES, ATOPY, & AUTOIMMUNITY WITH JULIE BUCKLEY, MD, IFMCP >

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Related Insights

INSIGHTS

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Were you able to find what you were looking for?

YES NO

278.702 Kentucky State Board on Electric Generation and Transmission Siting.

(1) There is hereby established the Kentucky State Board on Electric Generation and Transmission Siting. The board shall be composed of seven (7) members as follows:

(a) The three (3) members of the Kentucky Public Service Commission;

(b) The secretary of the Energy and Environment Cabinet or the secretary's designee;

(c) The secretary of the Cabinet for Economic Development or the secretary's designee;

(d) 1. If the facility subject to board approval is proposed to be located in one (1) county, two (2) ad hoc public members to be appointed by the Governor from a county where a facility subject to board approval is proposed to be located:

a. One (1) of the ad hoc public members shall be the chairman of the planning commission with jurisdiction over an area in which a facility subject to board approval is proposed to be located. If the proposed location is not within a jurisdiction with a planning commission, then the Governor shall appoint either the county judge/executive of a county that contains the proposed location of the facility or the mayor of a city, if the facility is proposed to be within a city; and

b. One (1) of the ad hoc public members shall be appointed by the Governor and shall be a resident of the county in which the facility is proposed to be located.

2. If the facility subject to board approval is proposed to be located in more than one (1) county, two (2) ad hoc public members to be chosen as follows:

a. One (1) ad hoc public member shall be the county judge/executive of a county in which the facility is proposed to be located, to be chosen by majority vote of the county judge/executives of the counties in which the facility is proposed to be located; and

b. One (1) ad hoc public member shall be a resident of a county in which the facility is proposed to be located, and shall be appointed by the Governor.

If a member has not been chosen by majority vote, as provided in subdivision a. of this subparagraph, by thirty (30) days after the filing of the application, the Governor shall directly appoint the member.

3. Ad hoc public members appointed to the board shall have no direct financial interest in the facility proposed to be constructed.

(2) The term of service for the ad hoc members of the board shall continue until the merchant electric generating facility for which they were appointed has been constructed and begins generating electricity for sale or the construction certificate expires. The remaining members of the board shall be permanent members.

(3) The board shall be attached to the Public Service Commission for administrative purposes. The commission staff shall serve as permanent administrative staff for the board. The members of the board identified in subsection (1)(a) to (d) of this section shall promulgate administrative regulations in accordance with KRS Chapter 13A to implement KRS 278.700 to 278.716.

(4) No member of the board shall receive any salary or fee for service on the board or shall have any financial interest in any facility the application for which comes before the board, but each member shall be reimbursed for actual travel and expenses directly related to service on the board.

(5) The chairman of the Public Service Commission shall be the chairman of the board. The chairman shall designate one (1) member of the board as vice chairman. A majority of the members of the board shall constitute a quorum for the transaction of business. No vacancy on the board shall impair the right of the remaining members to exercise all of the powers of the board. The board shall convene upon the call of the chairman.

Effective: June 29, 2023

History: Amended 2023 Ky. Acts ch. 140, sec. 1, effective June 29, 2023. -- Amended 2010 Ky. Acts ch. 24, sec. 605, effective July 15, 2010. -- Created 2002 Ky. Acts ch. 365, sec. 2, effective April 24, 2002.

Summary of Original Version	Amend KRS 278.702 to provide that the terms of service for the ad hoc members of the Kentucky State Board on Electric Generation and Transmission Siting end when the merchant electric generating facility for which they were appointed has been constructed and has begun generating electricity for sale or its construction certificate expires; amend KRS 278.704 to lengthen the period of time that a construction certificate for a merchant electric generating facility is valid from 2 years to 3 years; include decommissioning requirements within the requirements over which local planning and zoning requirements shall have primacy; remove outdated language; amend KRS 278.706 to require that a decommissioning plan be included in an application for construction of a merchant electric generating facility; establish minimum requirements for a decommissioning plan; require as part of a decommission plan that a bond or similar security be secured to assure that the decommissioning plan is accomplished; establish requirements for how the bond is set and how the beneficiaries of the bond are to be determined; require that certain components of the decommissioning plan be incorporated into the construction certificate applicant's leases with landowners; amend KRS 278.708 to reference the transfer of the enforcement authority for mitigation measures that are conditions of application approval from the board to the Energy and Environment Cabinet; amend KRS 278.710 to include whether the decommissioning plan is complete and complies with the requirements of the Act in the criteria for approval of a construction certificate for a merchant electric generating facility; require a person that has received a construction certificate for a merchant electric generating facility file with the Energy and Environment Cabinet the copy of the bond or similar security no later than the date that construction commences for the facility; require that an updated copy of the bond or similar security be refiled at least once every 5 years thereafter; require notice to be filed with the Energy and Environment Cabinet when the construction of the merchant electric generating facility is complete and has begun producing electricity for sale; require that notice be given of any transaction involving the sale or transfer of ownership of the facility to the Energy and Environment Cabinet and local officials within 10 days of finalizing the transaction; require a person who has acquired a merchant electric generating facility to file with the Energy and Environment Cabinet written consent to assume the obligations in the decommissioning plan for the facility and to adopt or replace the required decommissioning bond; provide that the transferor of control of a merchant electric generating facility remain liable for its decommissioning obligations until the transferee completes the documentation required by the Act and the secretary of the Energy and Environment cabinet accepts it as complete; provide that application approval conditions that require approval of transfer of control shall be void and unenforceable, subject to the requirements of the section; provide that after the application for a construction certificate for a

merchant electric generating facility has been approved, the bond required by the Act has been posted, the facility has been constructed, and it has begun generating electricity for sale, the secretary of the Energy and Environment Cabinet shall ensure the facility's ongoing compliance with the requirements of KRS 278.700 to 278.716 and the conditions of its construction certificate approval, including updating its decommissioning plan and bond amounts at least once every 5 years; transfer the enforcement authority for mitigation measures that are conditions of application approval from the board to the Energy and Environment Cabinet once the facility is constructed and begins generating electricity for sale; require that while the electric merchant generating facility is operational, if solar panels are removed and discarded, the discarded solar panels be removed from the site within 90 days of the completion of the work; amend KRS 278.718 to provide that an ordinance, permit, or license issued by a local government shall have primacy over the requirements of KRS 278.700 and Sections 2, 3, and 4 of this Act; amend KRS 224.10-100 to authorize the Energy and Environment Cabinet to monitor and enforce compliance of merchant electric generating entities with the requirements of the Act; authorize the Energy and Environment Cabinet to draw upon a decommissioning bond or other similar security for which it is named a beneficiary to complete an approved decommissioning plan; amend KRS 224.99-010 to give jurisdiction to the Circuit Court in any county where a merchant electric generating facility is located for actions arising from or related to certain provisions of the Act; allow for a civil penalty not to exceed $2,500 per day to be imposed for violation of the bonding and bond transfer requirements in the Act; allow for the suspension of a merchant electric generating facility's operations for failing to pay civil penalties or complying with the bonding transfer requirements of the Act; allow for the decommissioning of the facility if it is still noncompliant after 90 days of suspension of its operation; create a new section of Subchapter 10 of KRS Chapter 224 to require that if a merchant electric facility fails to complete its decommissioning plan within 18 months of ceasing to produce electricity for sale, then the cabinet shall draw upon the decommissioning bond and implement the decommissioning plan; require the Energy and Environment Cabinet within 90 days of the effective date of the Act to promulgate administrative regulations to establish the monitoring and enforcement of the bonding and bond transfer requirements of the Act; allow the Energy and Environment Cabinet to establish a fee structure to cover the costs of its enforcement responsibilities; establish the merchant electric generating facility monitoring and enforcement fund to receive the fees and penalties collected by the Energy and Environment Cabinet pursuant to their monitoring and enforcement responsibilities under the Act; require that the funds collected only be used to defray the Energy and Environment Cabinet's costs related to their monitoring and enforcement responsibilities under the Act;

	require that all expenses for the determination of the bond amount and for the procurement of decommissioning services by the Energy and Environment be paid by the owner of the merchant electric generating facility; APPROPRIATION.
Index Headings of Original Version	Energy - Merchant electric generating facilities, siting Environment and Conservation - Merchant electric generating facilities, siting Home Rule - Merchant electric generating facilities, decommissioning, bonding, local primacy Land Use - Merchant electric generating facilities, siting Local Government - Merchant electric generating facilities, decommissioning, bonding, local primacy Notices - Merchant electric generating facilities, transfer of control, notice Property - Merchant electric generating facilities, siting Public Utilities - Merchant electric generating facilities, siting Administrative Regulations and Proceedings - Energy and Environment Cabinet, merchant electric generating facilities, monitoring and enforcement Bonds of Surety - Merchant electric generating facilities, decommissioning bonds, requirement Appropriations - Merchant electric generating facility monitoring and enforcement fund Fiscal Note - Merchant electric generating facility monitoring and enforcement fund
Jump to Proposed Amendments	Senate Committee Substitute 1 ↓ Senate Floor Amendment 1 ↓
Votes	Vote History
Governor's Veto Message	Veto

Actions

Top ↑ | Amendments ↓

02/10/23	introduced in House to Committee on Committees (H)
02/15/23	to Appropriations & Revenue (H)

02/21/23	reported favorably, 1st reading, to Calendar
02/22/23	2nd reading, to Rules posted for passage in the Regular Orders of the Day for Thursday, February 23, 2023
02/23/23	**3rd reading, passed 99-0**
02/24/23	received in Senate to Committee on Committees (S)
03/01/23	to Agriculture (S)
03/07/23	taken from Agriculture (S) 1st reading returned to Agriculture (S)
03/08/23	taken from Agriculture (S) 2nd reading returned to Agriculture (S)
03/14/23	reported favorably, to Rules with Committee Substitute (1) floor amendment (1) filed to Committee Substitute
03/15/23	posted for passage in the Regular Orders of the Day for Wednesday, March 15, 2023 **3rd reading, passed 25 -10 -1 with Committee Substitute (1) and Floor Amendment (1)** received in House to Rules (H) taken from Rules posted for passage for concurrence in Senate Committee Substitute (1) and Floor Amendment (1) **House concurred in Senate Committee Substitute (1) and Floor Amendment (1)** **passed 83-14**

03/16/23	enrolled, signed by Speaker of the House enrolled, signed by President of the Senate **delivered to Governor**
03/24/23	**Vetoed**
03/29/23	received in House to Rules (H) taken from Rules posted for passage for consideration of Governor's veto **veto overridden** **passed 81-17** received in Senate to Rules (S) posted for passage for consideration of Governor's veto **veto overridden** **passed 29 -6** received in House enrolled, signed by Speaker of the House
03/30/23	enrolled, signed by President of the Senate **delivered to Secretary of State (Acts Ch. 140)**

Proposed Amendments

Top ↑ | Actions ↑

Amendment	Senate Committee Substitute 1

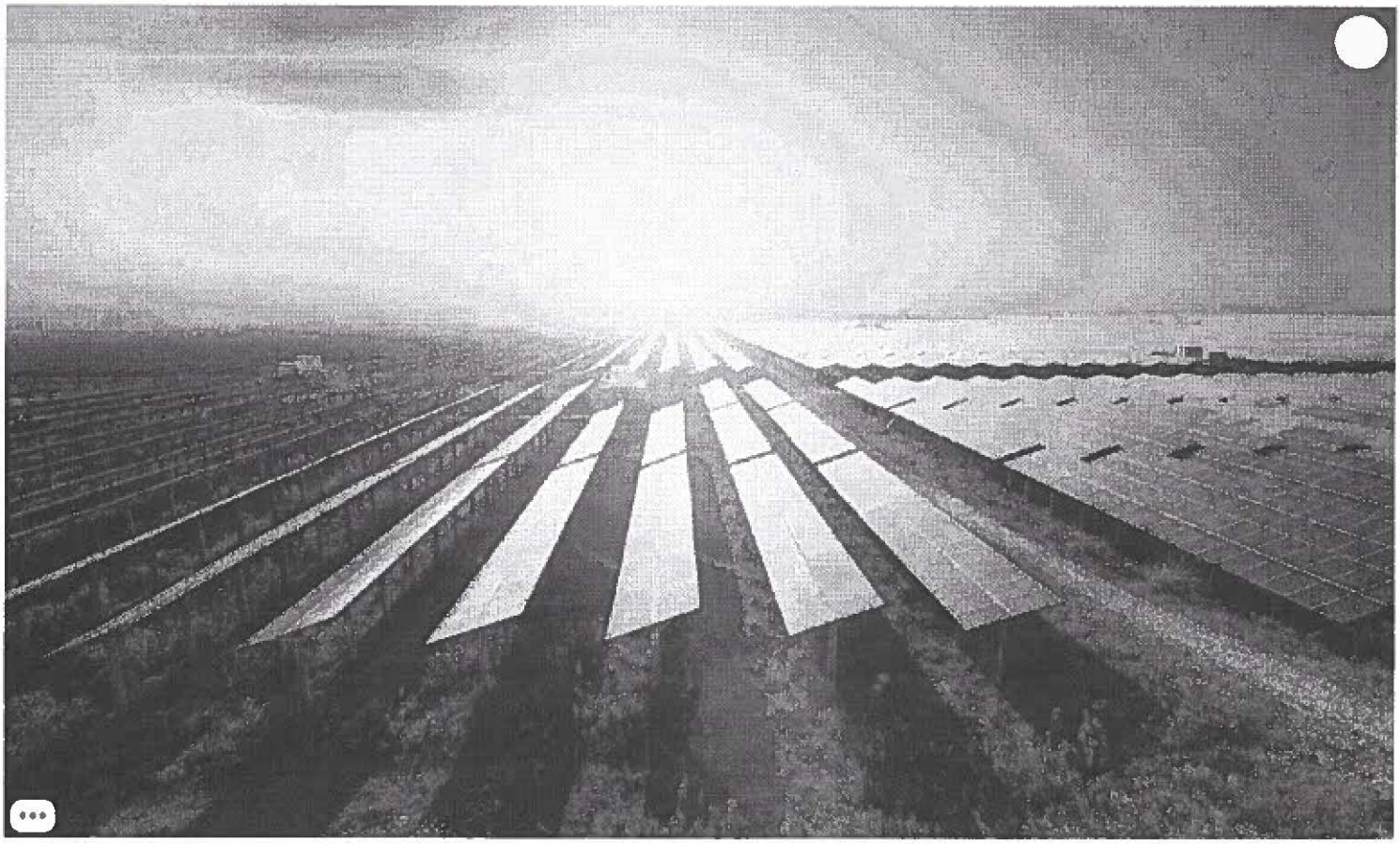
Summary	Retain original provisions; require that a merchant electric generating facility decommissioning plan include removal of above-ground and below-ground facilities to a depth of three feet and to leave interconnection facilities unless otherwise requested by the landowner; require noncancelable bonds to ensure decommissioning only if they are available; require notice by the surety if a bond will be lapsing or canceled and allow for an opportunity for the stakeholders to cure the lapse or cancellation; clarify that lease terms with the landowner are not discretionarily accommodated by the applicant; specify that the secretary of the Energy and Environment Cabinet shall review decommissioning plans and bonds once every five years, including those required by local ordinance, permit, or license; authorize the Secretary of the Energy and Environment Cabinet to extend the time period for removing discarded solar panels upon request of the facility owner-operator.
Index Headings	Environment and Conservation - Energy and Environment Cabinet, local decommissioning plan and bond requirements, review Land Use - Energy and Environment Cabinet, local decommissioning plan and bond requirements, review Local Government - Energy and Environment Cabinet, local decommissioning plan and bond requirements, review Notices - Merchant electric generating facilities, decommissioning bonds, lapse, notice State Agencies - Energy and Environment Cabinet, local decommissioning plan and bond requirements, review Bonds of Surety - Merchant electric generating facilities, decommissioning bonds, lapse, notice

Amendment	Senate Floor Amendment 1
Sponsor	J. Howell
Summary	Specify that decommissioning plans provide for the removal of underground components and foundations for above-ground components of merchant electric generating facilities to a depth of three feet unless otherwise agreed to by the parties; specify that additional lease terms agreed to by the parties are not discretionarily accommodated.

Index Headings	Energy - Merchant electric generating facilities, decommissioning plans, underground facility removal Environment and Conservation - Merchant electric generating facilities, decommissioning, additional lease terms, accommodation Environment and Conservation - Merchant electric generating facilities, decommissioning plans, underground facility removal Land Use - Merchant electric generating facilities, decommissioning plans, underground facility removal Property - Merchant electric generating facilities, decommissioning plans, underground facility removal

Last updated: 11/9/2023 3:03 PM (EST)

Negative Effects of Solar Energy



Updated July 26, 2019 *By Didem Tali*

While there is no doubt solar energy can be an important solution for many of the world's energy problems, it's not a magic pill. Some studies show solar energy to have considerable environmental drawbacks.

Land Use

Large utility-scale solar panels take up a lot of space, which can result in environmental degradation and habitat loss. Solar farms that cover a large amount of land are likely to have an impact on the local fauna and flora, particularly on birds. Solar farms can also inhibit local vegetation growth and damage agriculture. Unlike wind energy, solar panels aren't able to share the land they occupy for other uses.

Water Use

Creating energy with solar photovoltaic panels is a water-intensive process. Even though the solar cells themselves don't use water to generate electricity, the manufacturing process requires some water. So the energy production process doesn't use water, but the production of the solar panels themselves does use water.

In the United States, electricity production accounts for more than 40 percent of all daily freshwater withdrawals. Even though some of this water can be reused, an abundance of solar panels being manufactured in an area could put a strain on local water resources.

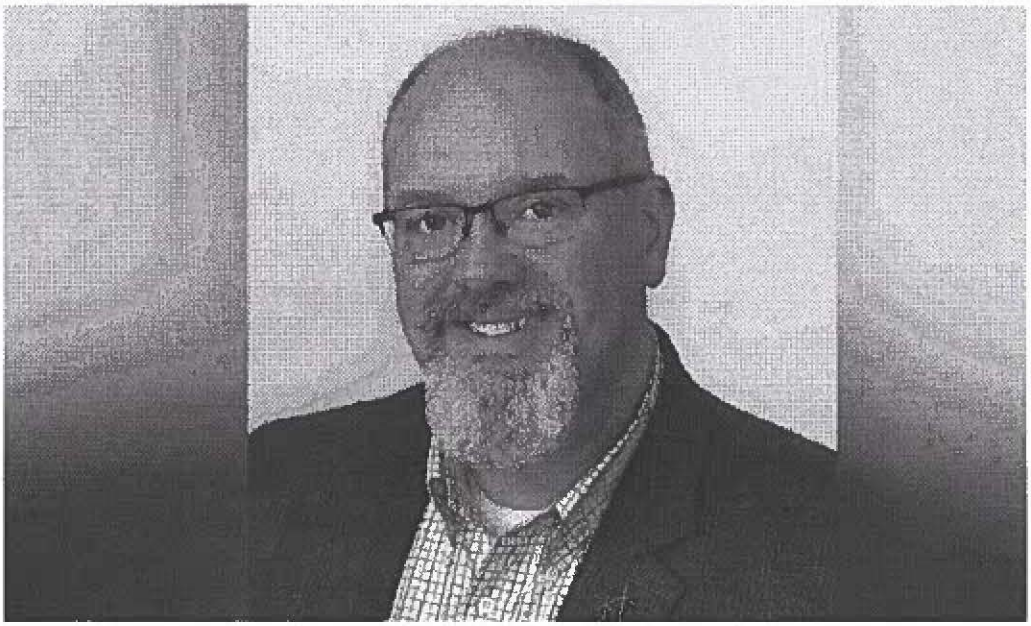
Toxic Chemicals

The photovoltaic manufacturing process employs toxic chemicals such as:

- hydrochloric acid
- sulfuric acid
- nitric acid
- hydrogen fluoride
- 1,1,1-trichloroethane
- acetone

Fire a major hidden danger for solar farms

Renewable energy providers underestimate this critical risk, expert says



Risk Management News

By Gabriel Olano

Sep 08, 2022 / Share

Fire is one of the oldest and most omnipresent risks businesses face and is potentially one of the most devastating. Any business worth its salt has adequate fire safety measures and insurance in place.

However, in many emerging industries, risks are often harder to measure, leading to exposures and losses. One such industry is solar energy, which has been growing

A recent report by Firetrace International found that the solar industry is potentially underestimating the risk of fire at solar farms, partly due to a shortage of data on solar farm fires. The report also said that research into the issue has given rise to suspicions that fires at solar farms have been under-reported.

"To be clear, fire risk is present across all utility scale, high voltage, renewable energy from wind to solar to battery storage systems," Ross Paznokas (pictured above), global business development manager, clean energy at Firetrace International, told Corporate Risk and Insurance. "Fire risks cannot be totally engineered out.

"With the expected exponential growth of renewable energy as well as aging infrastructure, the number of fire occurrences will only increase. One thing that operators tend to overlook is addressing these fire risks with fire mitigation strategies. Often, owners will simply rely on their insurance provider to cover a loss, if that does occur, rather than implementing the likes of fire suppression technology."

According to Paznokas, solar asset owners and major OEMs are reluctant to discuss or publicly acknowledge a loss attributable to fire. This means that there is a lack of data and definitive case studies to draw insights from.

With regard to data that is actually available, Paznokas said that the US Department of Energy's Solar Energy Technologies Office cited a study conducted by European testing and certification company TÜV Rheinland, titled Assessing Fire Risks in Photovoltaic Systems and Developing Safety Concepts for Risk Minimization. The study found that in approximately half of 430 cases of fire or heat damage in photovoltaic (PV) systems, the PV system itself was considered the "cause or probable cause."

Meanwhile, a study conducted by the BRE National Solar Centre found that more than a quarter of fires involving solar power systems were caused by the photovoltaics and those fires were all "serious fires,"meaning fires that were "difficult to extinguish and spread beyond the area of origin."

"Unfortunately, solar farm infrastructure is not just sitting in a warehouse and can have long lead times, which can result in degradation as parts move through the supply chain," Paznokas said. "There have been numerous solar farm fires ranging from Argentina to the USA and in Europe. In each of these cases, the affected companies have found themselves with hundreds of thousands worth of losses. Accumulated losses come from destroyed equipment anywhere near the fire and lost production for extended periods due to waiting for replacement parts, construction, and recommissioning. In our work, we have seen solar farm fires result in losses which encompass the entire solar farm with the potential to spread and endanger surrounding communities."

The Firetrace study highlighted three major causes of solar farm fires. These are an error in the system design, a faulty product (a design or quality issue), and poor installation practices. Among components, DC isolators pose the highest fire risk, being involved in the outbreak of around 30% of studied fires. Other components that are likely to cause a fire are DC connectors and inverters.

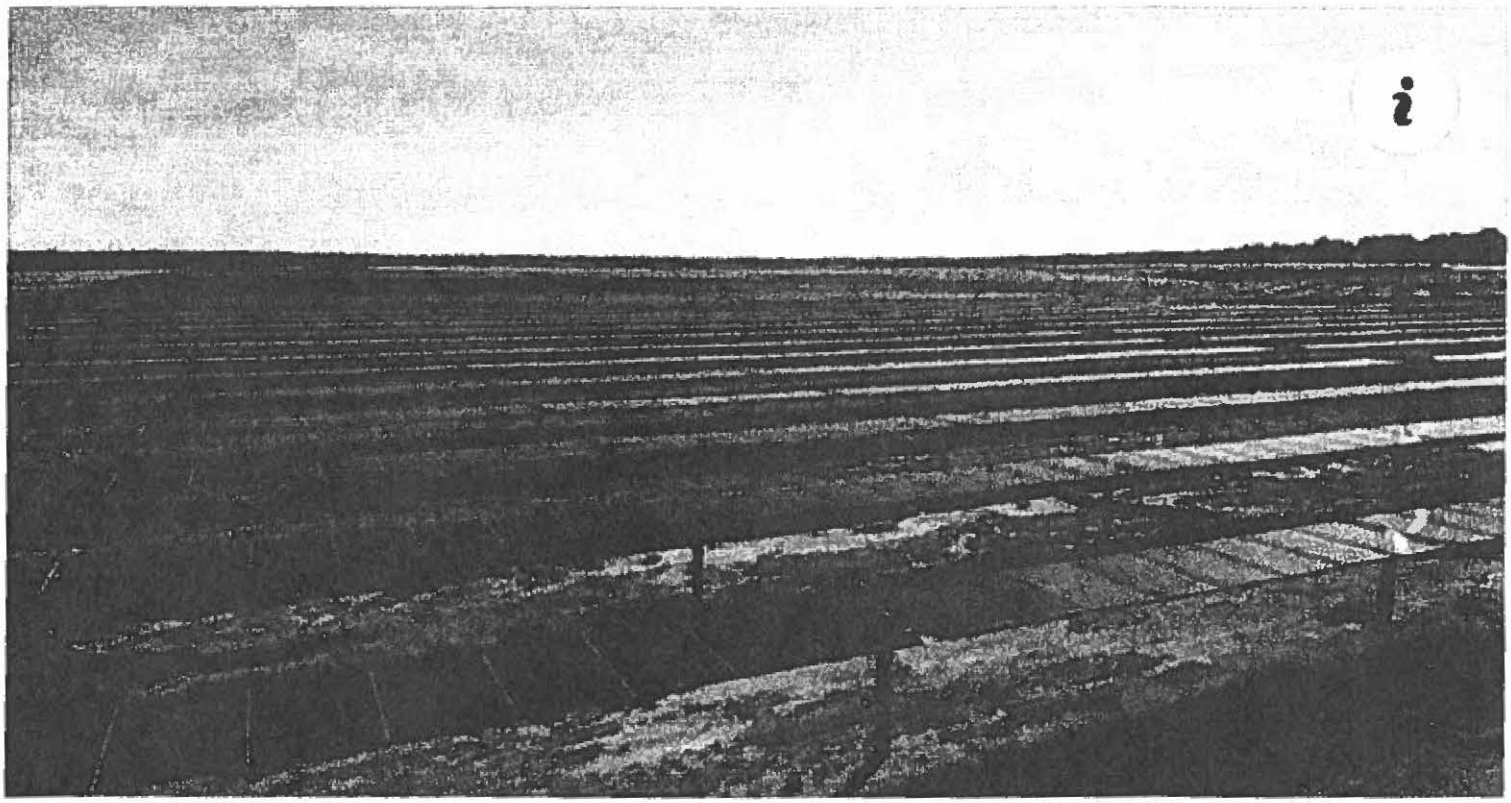
To minimize the risk of solar farm fires, Firetrace and TÜV Rheinland recommended the following steps:

- Ensure solar systems are regularly tested by independent third parties
- Incorporate additional safety components everywhere possible
- Create standardized quality assurance measures
- Ensure defective or prematurely aged components are promptly replaced

In the future, as the risk of fire becomes clearer for operators of solar energy facilities, Paznokas predicts that the industry will become more proactive in managing fire risks.

"As is the case with all maturing industries, we feel as though the solar farm industry will embrace the installation of fire suppression systems in the areas of the modules which can be protected," he said. "Additionally, we will begin to see original equipment manufacturers of these key components offering fire suppression fully integrated into their systems from the factory. This will not only address owner and investor concerns, but also help communities understand how safe and affordable systems can benefit the entire area through their provision of cheap, reliable energy."

Solar farm developer in Georgia ordered to pay 135 million dollars for damages to neighboring landowners property.



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Silicon Ranch plans to appeal ruling in 100 MW solar property...

construct a solar farm in the Wirtz area of Franklin County following significant negative feedback from the community.

The 20 megawatt solar farm, known as Mountain Brook Solar, was first proposed to the public earlier this year. Plans were for 92 acres of solar panels to be located on three parcels of property totaling 258 acres located at the intersections of Brooks Mill and Burnt Chimney roads.

Elianna Ginis, project developer, sent a letter to Franklin County on May 2 to announce Energix Renewables would be withdrawing its application for the solar farm. "Mountain Brook Solar has taken feedback from the Franklin County Planning Commission and the community and will resubmit a special use permit application for the project that aligns

The project could have provided clean energy for every home in Wytheville.

It turned into an unimaginable nightmare from which Eric Crowgey cannot wake.

The fourth-generation farmer bought property away from his own farm after an American company offered to place solar panels on the property.

Crowgey agreed on the conditions that his land remain in agriculture and that he would be able to raise sheep under the panels.

During the long permitting stage that accompanies the acquisition of any solar farm, the project was sold to another American company, which was later bought out by an Israeli company.

Thus began the never-ending headache for Crowgey.

Disregarding Department of Environmental

"We started the project in order to have clean energy and agriculture," Crowgey explained. "Now we will end up with a piece of property that won't grow anything, all because the solar array is owned by a foreign company with no Virginia values."

Although the company is under DEQ review with more than $100,000 in accumulated fines, this is of no consequence to the multimillion-dollar conglomerate inundated with a wealth of attorneys ready to pummel any small town farmer.

"It's easier for them to pay the fines than to do the right thing," Crowgey stated glumly. "These companies need to be held accountable."

As stipulated in the contract, the company was to lease the land from Crowgey, pay him royalties from energy profits and allow him to raise sheep under the panels.

Crowgey says he got along great with the first American company based out of Virginia simply because they followed the rules. His assumption that all subsequent companies would follow suit was incorrect.

Still, he was given no choice in the matter of a foreign takeover with the company handling his project. Had he known what would ensue, Crowgey says he would have never considered the project unless he could be guaranteed that each of the clauses within the mutual agreement could be honestly upheld.

Unfortunately, he was never given that option.

He also noted that this particular company has a half-dozen other projects in the state of Virginia alone, which have similarly become victims to such wrongdoings and are under review for numerous fines by the DEQ.

"They are trying to hold their feet to the fire," Crowgey said. "But they keep lying, saying

clean energy, but they harbor their share of toxic chemicals. The toxic chemicals are a problem at the beginning of a solar panel's life -- during its construction -- and at the end of its life when it is disposed of. These two intervals are times when the toxic chemicals can enter into the environment.

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.

Energix, operating under the name "Clinton Solar, LLC" here, is the company referenced in... See more

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Energix withdraws second solar farm proposal in Franklin Coun...

Energix Renewables announced earlier this week it is withdrawing plans to construct a solar farm in the Wirtz area of Franklin County following significant negative feedback from the community.

The 20 megawatt solar farm, known as Mountain Brook Solar, was first proposed to the public earlier this year. Plans were for 92 acres of solar panels to be located on three parcels of property totaling 258 acres located at the intersections of Brooks Mill and Burnt Chimney roads.

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