PB #0406-24 to PB #0409-24
Sky Solar Commercial Drive Applications

Attachment to Abstract #29
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1. Conservation Considerations for Solar Farms
2. Solar Energy Development Environmental Concerns
3. Solar "farm" components are starting to fail after only 10 to 15 years
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Conservation Considerations for Solar Farms

NRCS Fact Sheet

Introduction

Ground-based, utility-scale solar panel installations used for electricity generation of 1 MW or greater are commonly referred to as 'solar farms' (US Energy Information Administration, 2020). The purpose of the solar farm is to generate and sell electricity, therefore it is key that the collection, generation, and distribution of energy is not hampered by factors that reduce capacity. Management of natural resources on a facility's footprint is beneficial to enable it to maintain capacity. Natural resource concerns, such as soil erosion, dust, runoff, and damage from wildlife or livestock, frequently occur during construction and operation of solar farms.

The Natural Resources Conservation Service (NRCS) and its partners provide financial and technical assistance for producers and landowners to restore, enhance, and preserve the Nation's productive landscapes and natural resources. Producers, landowners and developers should consider the following natural resource conservation concerns regarding solar farms.

Soil Conservation

Healthy soils are critical for proper function of the water cycle and for providing habitat for a diversity of organisms. Soil conservation concerns include soil erosion by water and wind, compaction, water ponding, pollutants, and loss of organic matter. Four principles that guide land management to support healthy soil are: (1) maximize soil cover, (2) minimize soil disturbance, (3) maximize living roots, and (4) maximize biodiversity. These principles can apply to solar farms during planning, construction, operation, and even decommissioning activities.

Soil erosion, by water or wind, is a key resource concern that is often a consequence of construction and infrastructure projects. Erosion generally occurs where soils have been heavily disturbed or left uncovered as bare ground. With solar farms, wind erosion can cause problems when wind-blown soil ends up on the surface of panels, reducing their electricity output and possibly leading to permanent damage. Water erosion from runoff and concentrated flows can damage infrastructure, equipment, and facilities, leading to increased maintenance and repair costs. It can also lead to detrimental offsite environmental effects including gullies and the transport of sediment.

Steps to take during the construction and operation to conserve soil include:

- Limiting disturbance and compaction from heavy machinery to only the most necessary areas such as access roads and other areas with frequent or intense use.
- Preserving on-site topsoil; covering and preventing soil movement by applying mulches and erosion control mats or socks.
- Designing sites for optimal runoff flow with diversions, terraces, basins, and other earthworks.
- Maintaining a healthy perennial vegetative cover on the soil under and between solar panel rows to encourage infiltration and prevent erosion. Ideally, the vegetated distance between the rows of panels should be no less than the maximum horizontal width of the panel rows.
- Planting windbreaks perpendicular to the prevailing wind direction to reduce wind erosion.
- Utilizing dust control measures on unpaved roads and surfaces.

More Information

This fact sheet provides conservation considerations regarding solar farms for a general audience. For producers and landowners, there may be program-specific rules or requirements that could affect potential participation in USDA programs which are not included in this document. NRCS encourages producers and landowners to utilize the complete NRCS conservation planning process to address natural resource concerns through the implementation of conservation practices.

The Farmland Protection Policy Act is intended to minimize the impact Federal programs have on the unnecessary and irreversible conversion of farmland to nonagricultural uses. If agricultural farmland (cropland, forest, pasture, or other land) will be converted to a non-agricultural use, producers, landowners, and developers should make every effort to minimize the impact and maintain the possibility for the land to be converted back to agricultural use. Limiting use of concrete and cement footing or pads; and if ground-mounted, considering use of driven-post structures to minimize use of concrete footings; will protect future agricultural suitability. Consider solar development using existing buildings, structures, idle or marginal lands, or water bodies such as irrigation ditches.

Vegetation Management

Establishment and maintenance of perennial vegetation is paramount for ensuring the health and function of both the land and the solar farm. Sites are typically cleared of all vegetation and subjected to substantial land manipulation during construction. The bare, disturbed soil creates an environment favorable for undesirable species, including noxious and invasive species. Perennial herbaceous vegetation should be reestablished immediately following initial site preparation. Also, many tree and brush species will resprout from the base following top removal. Unmanaged vegetation can grow over and into electrical equipment and infrastructure, potentially causing damage, reducing performance and efficiency, and increasing maintenance costs.

Select plants that are adapted to the area and require minimal maintenance. An ideal species will be low-growing (short stature) or which can easily be maintained by mowing or grazing. Sod-forming or rhizomatous grasses (such as those found in a typical yard) are preferred, as is a mix of warm and cool-season plants, if the site and climate allow. When practical, include native forbs that attract pollinators, promote soil health, and offer aesthetic value.

Vegetation management plans should:

- Identify commercially available, locally adapted species. Consider using plants with drought, moisture, and shade tolerance. Solar panels can significantly affect ecohydrology by redistributing moisture from precipitation and casting a significant amount of shade.
- Account for potential threats from noxious and invasive species, prioritize the prevention of their establishment, and ensure effective treatment if discovered.
- Anticipate encroachment from woody species common to the area and include treatment thresholds and plans for treating both resprouting and emerging plants.
- Where vegetation isn't growing, and the ground is covered instead by a community of bacteria, lichens, or mosses (collectively referred to as a microbiotic soil crust), minimize disturbance to the crust as much as possible since these beneficial communities take much longer to establish than vegetation.
- Identify target minimum and maximum vegetation heights and prescribe regular mowing, grazing, or other similar maintenance treatments to manage vegetation height and prevent vegetation from growing into the equipment, casting shade or dropping pollen, leaves, limbs, mast, or other debris onto the solar panels or causing other damage to equipment and facilities.

Wildlife Considerations

Wildlife can interfere with solar farm operations by causing damage to equipment or injuring themselves. Identify management strategies to reduce the attractiveness of the site for nuisance species. Establishing food, water, and favorable habitat in alternative locations can draw troublesome species away from the solar farm and maintain the current level of wildlife habitat. Physical deterrents can also be used to discourage nesting by birds and to otherwise dissuade unwanted wildlife from using the site. Some wildlife, like aquatic habitat birds, may perceive the reflected light from solar panels as bodies of water and be drawn to the facility. Consider selecting panels that have a white outline or white grid lines to reduce this effect. Ensure perimeter fencing is constructed to exclude problem wildlife species. When practical, design fences to facilitate the movement of migrating animals around facilities. Nuisance wildlife species will vary by site. Two common examples of invasive species include feral swine and the European Starling (*Sturnus vulgaris*). Both can greatly reduce the efficiency and/or destroy equipment.

Other types of wildlife, including many pollinator species, are relatively low-impact and can coexist on solar farms without confli[ct]. Incorporating locally adapted, pollinator-friendly forbs into seed mixes is an effective strategy for creating habitat for pollinator[s] and promoting the environmental benefits provided by these species.

NRCS Conservation Practice Standards to consider when planning on solar farms: Critical Area Planting (Code 342), Conservation Cover (Code 327), Herbaceous Weed Management (Code 315), Range Planting (Code 550), Brush Management (Code 314), Windbreak-Shelterbelt Establishment and Renovation (Code 380), Diversion (Code 362), Terrace (Code 600), Heavy Use Area Protection (Code 561), Access Road (Code 560), Water and Sediment Control Basin (Code 638), Fence (Code 382), Prescribed Grazing (Code 528).

Contingency Planning

Anticipating and planning for unexpected disturbances, such as severe weather, vandalism, and wildfire, is crucial for maintaining equipment and ensuring the continuity of operations. Access to the site should be controlled with secure perimeter fencing to provide critical security and protection of assets and prevent unauthorized human access. Plan roads to provide dedicated travel ways for heavy equipment and vehicles and to allow easy access to facilities and infrastructure for maintenance and repairs. Regularly mowing or grazing can reduce the risk of fire. Firebreaks constructed both along the perimeter and inside the facility can help contain potential internal fires and protect the facility from external wildfires. Plan heavy use area protection for sites frequently used by vehicles, equipment, and machinery and for stockpiling supplies and spare parts, or discarded components.

To learn more about NRCS recommendations for conservation on solar farms and vegetation for a specific area, contact the local USDA Service Center at **farmers.gov/working-with-us/USDA-service-centers**.

Additional Resources:

1. Information on vegetation planting and establishment: **https://efotg.sc.egov.usda.gov/#/**
2. Controlling Soil Erosion: **Small Scale Solutions for your Farm**
3. **Introduction to Microbiotic Crusts**
4. **Web Soil Survey** soil interpretations are available for fencing and solar panels: **https://websoilsurvey.nrcs.usda.gov/app/**

Note the toxic African Rue (Peganum harmala) plants in the foregrour

Photo left. Side-view of an array of Photo-voltaic panels at a solar energy electricity generating station.
Photo right. Front-view of an array of Photo-voltaic panels at a solar energy electricity generating station.
These photos show sparse herbaceous vegetation under and around the photo-voltaic panels. This is not an ideal situation. A healthy cover of short-stature herbaceous grasses and forbs is preferred from both ecological and operational perspectives.

Argonne National Labs

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Solar Energy Development Environmental Considerations

Utility-scale solar energy environmental considerations include land disturbance/land use impacts; potential impacts to specially designated areas; impacts to soil, water and air resources; impacts to vegetation, wildlife, wildlife habitat, and sensitive species; visual, cultural, paleontological, socioeconomic, and environmental justice impacts, and potential impacts from hazardous materials.

Solar power facilities reduce the environmental impacts of combustion used in fossil fuel power generation, such as impacts from green house gases and other air pollution emissions. Unlike fossil fuel power generating facilities, solar facilities have very low air emissions of air pollutants such as sulfur dioxide, nitrogen oxides, carbon monoxide, volatile organic compounds, and the greenhouse gas carbon dioxide during operations. In addition to these benefits of solar development, construction and operation of solar facilities creates both direct and indirect employment and additional income in the regions where the development occurs. However, there are also some adverse impacts associated with solar power facilities that must be considered in BLM's process of granting solar right-of-way authorizations and DOE's process of developing environmental guidance for solar facilities. Potential adverse impacts to various resources associated with the construction, operation, and decommissioning of solar power plants are briefly outlined below. These impacts and mitigation measures for solar facilities are addressed in detail in the Solar Energy Development Programmatic EIS.

Land Disturbance/Land Use Impacts

All utility-scale solar energy facilities require relatively large areas for solar radiation collection when used to generate electricity at utility-scale (defined for the Solar PEIS as facilities with a generation capacity of 20 MW or greater). Solar facilities may interfere with existing land uses, such as grazing, wild horse and burro management, military uses, and minerals production. Solar facilities could impact the use of nearby specially designated areas such as wilderness areas, areas of critical environmental concern, or special recreation management areas. Proper siting decisions can help to avoid land disturbance and land use impacts.

Impacts to Soil, Water, and Air Resources

Construction of solar facilities on large areas of land requires clearing and grading, and results in soil compaction, potential alteration of drainage channels, and increased runoff and erosion. Engineering methods can be used to mitigate these impacts.

Parabolic trough and central tower systems typically use conventional steam plants to generate electricity, which commonly consume water for cooling. In arid settings, any increase in water demand can strain available water resources. Use of or spills of chemicals at solar facilities (for example, dust suppressants, dielectric fluids, herbicides) could result in contamination of surface or groundwater.

The construction and operation of solar facilities generates particulate matter, which can be a significant pollutant particularly in any nearby areas classified as Class I under Prevention of Significant Deterioration regulations (such as national parks and wilderness areas).

Ecological Impacts

The clearing and use of large areas of land for solar power facilities can adversely affect native vegetation and wildlife in many ways, including loss of habitat; interference with rainfall and drainage; or direct contact causing injury or death. The impacts are exacerbated when the species affected are classified as sensitive, rare, or threatened and endangered. 6-50

Other Impacts

Because they are generally large facilities with numerous highly geometric and sometimes highly reflective surfaces, solar energy facilities may create visual impacts; however, being visible is not necessarily the same as being intrusive. Aesthetic issues are by their nature highly subjective. Proper siting decisions can help to avoid aesthetic impacts to the landscape.

Cultural and paleontological artifacts and cultural landscapes may be disturbed by solar facilities. Additionally, socioeconomic impacts (both positive and negative) may be associated with solar facilities. For example, solar energy development could provide new employment opportunities, but an influx of workers could disrupt public services. These impacts may be disproportionately experienced by minority or low-income populations, thus resulting in environmental justice issues.

Photovoltaic panels may contain hazardous materials, and although they are sealed under normal operating conditions, there is the potential for environmental contamination if they were damaged or improperly disposed upon decommissioning. Concentrating solar power systems may employ materials such as oils or molten salts, hydraulic fluids, coolants, and lubricants, that may be hazardous and present spill risks. Proper planning and good maintenance practices can be used to minimize impacts from hazardous materials.

Concentrating Solar Power (CSP) systems could potentially cause interference with aircraft operations if reflected light beams become misdirected into aircraft pathways. Operation of solar facilities, and especially concentrating solar power facilities, involves high temperatures that may pose an environmental or safety risk. Like all electrical generating facilities, solar facilities produce electric and magnetic fields. Construction and decommissioning of utility-scale solar energy facilities would involve a variety of possible impacts normally encountered in construction/decommissioning of large-scale industrial facilities. If new electric transmission lines or related facilities were needed to service a new solar energy development, construction, operation, and decommissioning of the transmission facilities could also cause a variety of environmental impacts. 7-5

Solar 'farm' components are starting to fail after only 10 to 15 years

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A recent article in Utility Dive describes a growing problem at solar facilities reaching the middle of their useful 25-year lives: the inverters used to convert the current of electricity generated from the panels to be compatible with the greater grid are wearing out after only 10 to 15 years, and most of the manufacturers of these inverters, who were supposed to maintain and guarantee their performance over time, have gone out of business.

According to the article:

> *"These [solar] projects were designed for 20-25 year lifespans, and it's a well-known fact that the first and second generation inverters have a 15-year average lifespan," said Daniel Liu, who heads research on asset performance benchmarking, cost analysis and valuations at Wood Mackenzie. Like it or not, he said, "the market is going to have to repair a lot of inverters over the next ten years."*

Wood Mackenzie estimates that 23 gigawatts, or 37 percent of the solar installed in the United States as of 2021, will approach the 15-year mark within the next five years, meaning there will soon be a substantial need to retrofit solar facilities.

The article states replacing so many inverters, along with other equipment such as broken panels and fixing wiring, could tax a solar supply chain that has been taxed due to tariffs on China due to unfair business practices and the use of enslaved Muslim Uighurs in the factories that make polysilicon in Xinjiang province in Western China.

But this emergence of what could become the solar equivalent of repowering aging generating units could tax aspects of the industry's already strained supply chain, and experts at the tail end of that chain say it could be challenging to dispose of the panels that may be removed and replaced during these inverter-inspired upgrades. 9-5

It isn't just inverter failures driving the retrofitting of solar facilities halfway through their useful lifetimes. Repowering is also an increasingly popular option when existing modules are damaged by severe weather, which has grown more frequent, according to the Utility Dive article.

Replacing old panels with new panels raises another question: where do the old panels go? Some of them are still usable and are refurbished and reused at other sites, but the demand for used panels has fallen recently, resulting in more panels ending up in landfills because the cost of breaking panels into their component parts is greater than the value of the materials they contain.

This article has important implications for both the economic and environmental costs of solar facilities. If the inverters only last for 10 or 15 years, then the cost of the solar facilities increases, and so does their environmental impact.

10-5

The Complete List of Solar Bankruptcies and Business Closures

The solar industry experienced exponential growth over the last decade as costs fell and favorable policies helped drive mass adoption.

However, 2023 has brought immense challenges, with higher interest rates, tighter financing, and adverse policy shifts in key states contributing to over 100 solar bankruptcies based on our industry data, a number unseen before in our almost 20 years in the solar sector.

California was particularly hard hit due to new net metering rules under NEM 3.0 that radically reduced system economics.

These adverse state policy impacts exacerbated financing shifts, triggering plummeting demand and an 80% decrease in rooftop solar installation volume. The California Solar & Storage Association reports that the fallout includes thousands of stalled projects, over 17,000 industry layoffs, and a wave of high-profile bankruptcies.

While stronger players demonstrate some resilience, impacted homeowners and solar employees face prolonged uncertainty. The outright collapse of many once fast-growing solar firms provides a sobering case study on the potential unintended consequences of incentive transitions.

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Major Solar Contractors That Went Out of Business in 2023 & 2024

Major Solar Bankruptcies as of July 2024 Include:

- SunPower – Multiple States
- Pink Energy – Multiple States
- MC Solar – Modern Concepts – Florida
- Harness Power – California
- NM Solar Group – New Mexico
- ASA – American Solar Advantage – California
- Kuubix Energy – California
- Erus Energy – Arizona
- Infinity Energy – California
- Suntuity Renewables – Per Sunova – NJ, CA , TX
- ADT Solar – Multiple States
- Vision Solar – Multiple States
- Solcius – CA, NM, AZ, NV
- Sunworks, Inc. – CA
- Kayo Energy – AZ, CA, TX, FL
- iSun – CT
- Titan Solar Power – Multiple States

California Company Closures:

- ASA – American Solar Advantage
- Canapoy Energy – CA
- Charged Up Energy – CA

- Enver Solar – CA
- Harness Power – CA
- GCI Solar – CA
- Green Nrg – CA
- Kuubix Energy – CA
- Peak Power USA – CA
- Penguin Home- CA
- Polar Solar – CA
- Professional Roofing and Solar – CA
- Sigora Home Solar – CA
- Solsun USA – CA
- Solar Advantage – CA
- Sullivan Solar Power – CA
- Sungrade Solar – CA
- SunPower – CA
- Sunstor Solar – CA
- RGS Energy – CA
- Solar Spectrum – CA
- Sunworks, Inc. – CA
- United Solar Inc. – CA

Texas Company Closures:

- American Sun
- Daybreak Solar Power
- Cosmo Solaris – DBA WNK Associates , Under Investigation
- Envirosolar
- Hitech Solar
- Integrity Solar
- Next Energy
- Speir Innovations
- TES Home Solar
- Texas Solar Broker LLC

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- Verisolar
- Vulcan Solar

Other States:

- 3D Solar – Florida
- AAA Certified Solar – Nevada
- Accept Solar – MA
- ACE Solar Systems – AZ
- Arizona Solar Concepts – AZ
- Code Green Solar – NJ
- EcoMark Solar – CO
- Elan Solar – UT
- Electriq Power – FL
- Encor Solar – UT
- Gulf South Solar – LA
- Moxie Solar – IA
- Refresh Energy Group – CO
- Saveco Solar – UT
- Solar Is Freedom – OH
- SolarDot – FL
- Solarworks – AZ
- Solular, LLC – NJ
- Utah Solar Group – UT
- Voltage Solar Power – FL
- Zenernet – AZ

Why Solar Companies Go Out Of Business

In 2023, the solar industry witnessed a significant number of contractors going out of business, a trend fueled by a confluence of economic and policy-driven factors.

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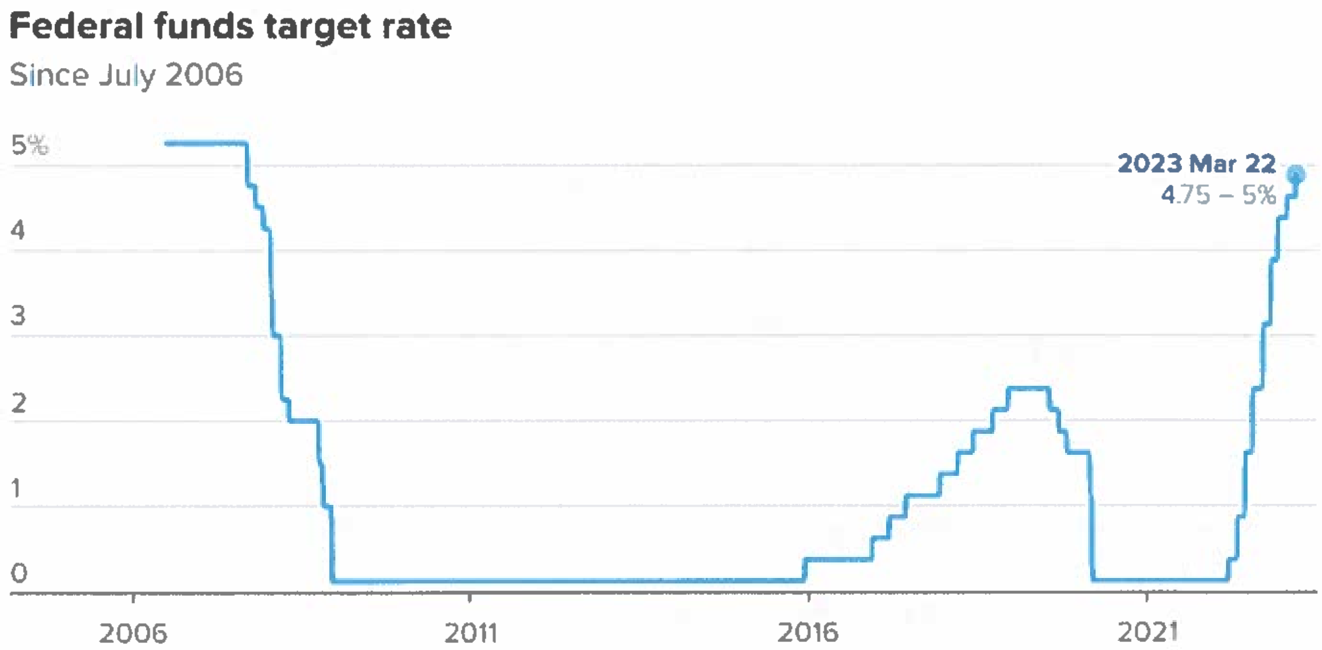
Higher Interest Rates



Federal Reserve's Rate Hike: The Federal Reserve raised interest rates to combat inflation, inadvertently affecting the solar sector. Higher interest rates have made borrowing more expensive, discouraging consumers from investing in solar energy systems. This drop in consumer demand hit solar contractors hard, as their business model relies heavily on a steady flow of new installations.

Consumer Sentiment and Solar Investments: With increased borrowing costs, the allure of solar energy as a cost-saving investment diminished. Potential customers became more hesitant to undertake large expenditures, especially for systems perceived as long-term investments.

Escalating Working Capital Costs

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Borrowing Challenges for Solar Companies: Solar contractors typically rely on borrowed capital to finance their operations and projects. The rise in interest rates significantly increased their cost of capital. This surge in working capital costs strained their financial resources, leading to cash flow issues and, for some, insolvency.

Impact on Small and Medium Contractors: Smaller contractors, in particular, struggled to absorb these increased costs, lacking the financial buffers of larger firms. This disparity led to a disproportionate impact on these smaller players, many of whom were forced to close their doors.

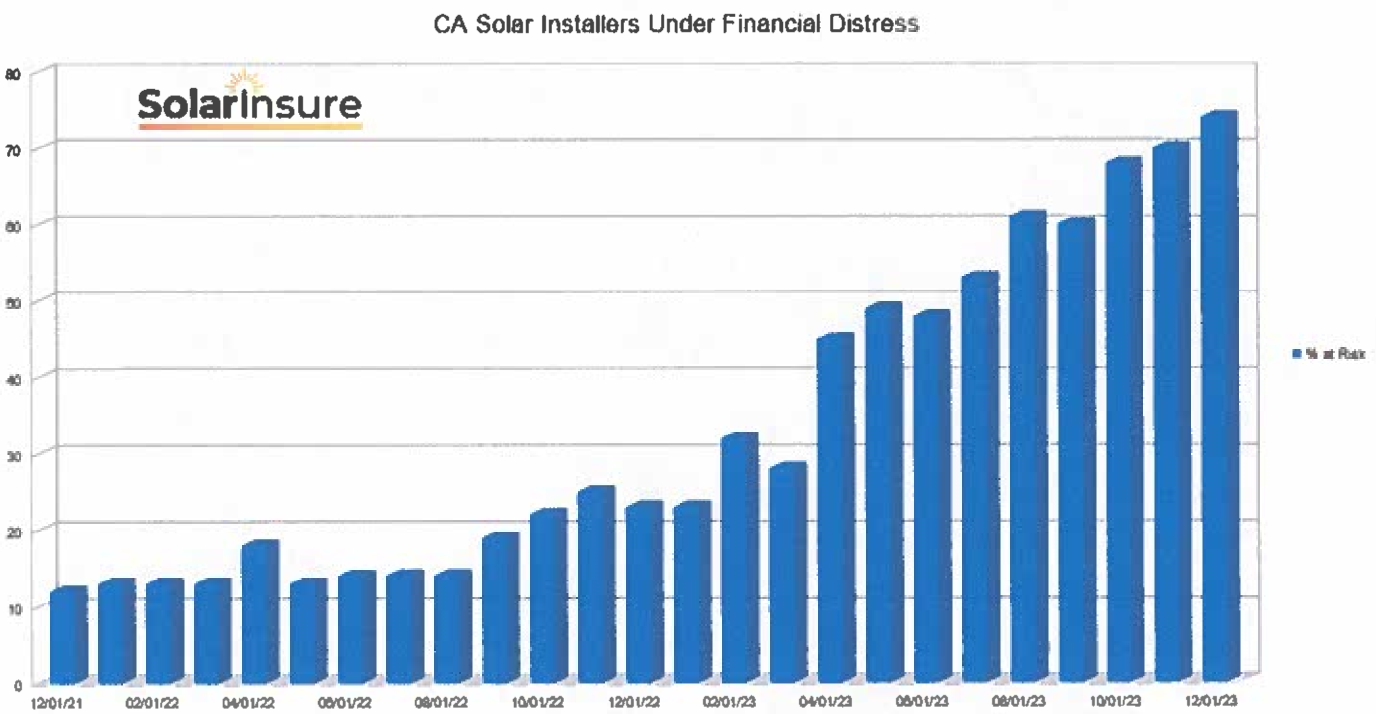
Changes in Solar Lending Practices

A shift in Milestone Payments: Solar lenders, responding to the riskier financial environment, altered their payment structures. Previously, contractors received payments at various project milestones M1, M2. M3, depending on the state of the solar installation. Generally, full payment was obtained from the lenders during M1 and M2 which was after the installation was complete. Now, lenders typically delay full payment to M3, which is PTO.

The new structures delayed these payments, exacerbating cash flow challenges for contractors.

Balance Sheet Stress: These changes placed additional pressure on the balance sheets of solar contractors. The delayed cash inflows hindered their ability to manage operational expenses and invest in new projects, leading to a vicious cycle of financial stress.

Policy Shifts and Their Consequences



Case Study: NEM 3 in California: California's Net Energy Metering (NEM) 3 policy is a prime example of policy impact. This policy revision reduced the net metering rates paid to solar consumers, extending the payback period of solar investments.

Effect on Consumer Decisions: The reduced financial attractiveness of solar investments under NEM 3 made consumers reconsider solar installations. This policy change directly impacted contractors' business, as California is one of the largest solar markets in the U.S.

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Understanding the Impact of Solar Bankruptcies

The closure of numerous solar contractors in 2023 has sent ripples through various facets of the solar market, affecting customers, ongoing projects, and the industry.

Impact on Customers and Projects:

- Homeowners with ongoing installations face uncertainty and potential delays.
- Customers amid warranty or service agreements may find themselves without support.
- The reduction in active contractors could lead to less competition, potentially impacting pricing and service quality in the short term.

Solar Market Dynamics:

- These closures could temporarily slow down the rate of new solar installations.
- The supply chain for solar components might experience fluctuations due to altered demand patterns.
- Industry consolidation might occur, with larger players absorbing defunct companies' client base and assets.

Homeowner Concerns:

- Homeowners may worry about the longevity and maintenance of their solar systems.
- Questions around warranty claims and service continuation are prevalent among those whose contractor is on the closure list.

What Homeowners Can Do About Solar Bankruptcies

For homeowners affected by these closures, there are several steps to mitigate the situation: 18-50

- Warranty Claims and Service Continuations:
  - Review your contract for warranty details and any clauses about service disruptions.
  - Contact the manufacturer of your solar panels or system components for warranty support.
  - Seek alternative local contractors who might take over service agreements.
- Utilizing Solar Insure's Extended Warranty Product:
  - Solar Insure offers an extended warranty product that includes monitoring and service for unsupported homeowners.
  - This warranty can be a safety net, providing peace of mind and ensuring system upkeep.

Industry Resilience and Looking Forward

Despite these challenges, the solar industry demonstrates remarkable resilience and offers significant long-term benefits.

Resilience Factors:

- Technological advancements continue to make solar energy more efficient and cost-effective.
- Growing environmental consciousness and government incentives support the industry's growth.
- Diversification in services and business models within the industry enhances its adaptability.

Conclusion

In conclusion, while the closure of several solar contractors in 2023 poses immediate challenges, the underlying strength and potential of the solar industry remain intact. Homeowners affected by these closures have avenues for support, and the long-term outlook for solar energy continues to be bright and promising.

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Pros and Cons of Solar Energy

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1. Renewable and abundant source of energy

As long as the sun exists (barring a very unexpected supernova explosion or the untimely arrival of an alien species from another galaxy with technology to absorb our sun's gases), solar energy is a 100% renewable and inexhaustible resource to fuel the generation of electricity. Luckily, the sun is not yet old enough to go through a supernova and the arrival of alien species seems rather unlikely.

2. Environmentally friendly

The use of solar power to generate electricity produces minimal environmental pollution compared to fossil fuels. This helps reduce the production of greenhouse gases and combat climate change.

3. Low operating costs

After solar panels are installed, the cost to operate and maintain them is very low. There are fewer expenses related to their operation and maintenance compared to fossil fuel generation plants.

4. The solar industry creates many jobs

There are over 250,000 workers employed in the solar power industry in the United States. As the market for solar continues to grow, so will job creation.

5. Reduced impact to the local environment

In comparison to traditional power plants, solar farm installations have a lower impact to their surroundings. The land can serve multiple purposes – some solar farms are also used for agriculture.

6. Relatively quick installation

Compared to other types of power plants, such as nuclear or fossil fuel plants, solar farms can be implemented rather quickly. The construction is not as involved and there are fewer regulations and hoops to jump through.

Disadvantages of solar energy

1. Intermittency, variability, and weather dependence

Solar power generation is dependent on sunlight, which is intermittent and variable. Cloudy days, nighttime, and seasonal changes can affect energy production, requiring backup or storage solutions. Extreme weather conditions, such as hailstorms, can damage solar panels, affecting their performance and lifespan.

During a snowstorm, extra maintenance may be required to keep the panels clean. If they are covered in snow, they cannot generate power.

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2. High initial costs

The upfront costs of purchasing and installing solar panels and associated equipment can be relatively high. While prices have been decreasing, the initial investment can remain a significant barrier.

3. Energy storage challenges

To address the intermittent nature of solar power, energy storage solutions like batteries are often needed. Current energy storage technologies have limitations in terms of capacity, efficiency, and cost.

4. Land use concerns

Large-scale solar installations may require significant land area, potentially leading to concerns about land use, habitat disruption, and conflicts with agricultural activities. Although as mentioned above, some solar farms have found a solution to this issue by using the land for agriculture at the same time.

5. Resource-intensive manufacturing

The production of solar panels involves the use of rare materials and can be energy-intensive, raising environmental concerns. Improvements in manufacturing processes are needed to mitigate these impacts.

6. Aesthetic impact

Some people find solar panels unattractive, especially on residential properties. This can lead to aesthetic concerns and, in some cases, regulatory challenges.

7. Geographic limitations on installation

Solar energy production is more effective in regions with high sunlight exposure, limiting its effectiveness as a power generation solution in some

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geographic locations where sunlight is scarce or inconsistent.

8. Limited energy conversion efficiency

Solar panels have a conversion efficiency that varies, and it may not be as high as some other forms of energy generation. Advances in technology are needed to improve efficiency.

9. Difficult to dispose of

While efforts are made to minimize environmental impact, proper disposal and recycling practices are crucial. The manufacturing and disposal of solar panels can involve the use of toxic materials.

8. Grid integration challenges

Integrating solar power into existing electricity grids can pose challenges due to its intermittent nature. Upgrading and modifying grids to handle distributed generation can be costly.

9. Limited lifetime of solar panels

While solar panels have a relatively long lifespan, they do degrade over time, and their efficiency decreases. Proper disposal and recycling practices are essential to manage end-of-life environmental impacts.

At the same time, solar panel technology is improving rapidly. That means by the time you complete an installation, there's already a newer more efficient model out there.

Written by Graham Lumley

Graham Lumley, Digital Marketing Manager at BKV Energy, leads digital and traditional marketing strategies, focusing on educating Texans about the state's deregulated energy market. With over 8 years of marketing experience, he creates content to help consumers understand and save on

If you are concerned about your exposure to electromagnetic sources around you (including power lines), you can measure the field strength with a device called a gaussmeter.

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Written by Additional resources References

American Cancer Society

The American Cancer Society medical and editorial content team

Our team is made up of doctors and oncology certified nurses with deep knowledge of cancer care as well as editors and translators with extensive experience in medical writing.

Along with the American Cancer Society, other sources of information and support include:

Environmental Protection Agency (EPA)
Website: www.epa.gov
Radiation Basics: www.epa.gov/radiation/radiation-basics

National Cancer Institute (NCI)
Toll-free number: 1-800-422-6237 (1-800-4-CANCER)
Website: www.cancer.gov
Electromagnetic Fields and Cancer: www.cancer.gov/about-cancer/causes-prevention/risk/radiation/electromagnetic-fields-fact-sheet

National Institute of Environmental Health Sciences
Website: www.niehs.nih.gov
Electric & Magnetic Fields: www.niehs.nih.gov/health/topics/agents/emf/index.cfm

World Health Organization
Website: www.who.int
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**Inclusion on this list does not imply endorsement by the American Cancer Society.*

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Power Lines, Electrical Devices, and Extremely Low Frequency Radiation

On this page [show]

What is extremely low frequency (ELF) radiation?

Radiation is the emission or sending out of energy from any source. X-rays are one example of radiation, but so is the light that comes from the sun and the heat that constantly comes off our bodies.

When talking about radiation and cancer, many people think of specific kinds of radiation such as x-rays or the radiation in nuclear reactors. But these are not the only types of radiation that concern us when we think about radiation risks to human health.

Radiation exists across a spectrum, from very high-energy (also referred to as high-frequency) radiation to very low-energy (or low-frequency) radiation. This is sometimes referred to as the **electromagnetic spectrum**.

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Examples of high-energy radiation include x-rays and gamma rays. They, as well as some higher energy ultraviolet (UV) rays, are classified as **ionizing radiation**, which means that they have enough energy to remove an electron from (ionize) an atom. This can damage the DNA inside cells, which can sometimes lead to cancer.

Extremely low frequency (ELF) radiation is at the low-energy end of the electromagnetic spectrum and is a type of **non-ionizing radiation**. Non-ionizing radiation does not have enough energy to directly damage DNA. ELF radiation has even lower energy than other types of non-ionizing radiation like radiofrequency radiation and infrared and visible light.

Although ELF radiation doesn't damage the DNA in cells the way ionizing radiation does and is generally thought to be safe, researchers are studying if there might be other ways that ELF radiation could somehow affect cancer risk.

Electric and magnetic fields

Electromagnetic radiation is made of 2 parts: the electric field and the magnetic field.

- **Electric fields** are the forces acting on charged particles (parts of atoms), like electrons or protons, which cause them to move. Electric current is simply the flow of electrons produced by an electric field.
- A **magnetic field** is created when charged particles are in motion.

With most types of radiation, the electric and magnetic fields are coupled. Because they act as one, they are considered together as an electromagnetic field (EMF). But with ELF radiation, the magnetic field and the electric field can exist and act independently, so they are often studied separately.

The possible link between electromagnetic fields and cancer has been a subject of controversy for several decades. It's not clear exactly how electromagnetic fields, a form of low-energy, non-ionizing radiation, could increase cancer risk. Plus, because we are all exposed to different amounts of these fields at different times, the issue has been hard to study.

How are people exposed to ELF radiation?

Generating, transmitting, distributing, and using electricity all expose people to ELF radiation. Power lines, household wiring, and any device that uses electricity can generate ELF radiation. This can include anything from refrigerators and vacuum cleaners to televisions and computer monitors (when they are on). Even electric blankets expose people to ELF radiation.

How much electromagnetic radiation you are exposed to depends on the strength of the electromagnetic field, your distance from the source of the field, and the length of time you are exposed. The highest exposure occurs when a person is very close to a source putting out a strong field and stays there for a long time.

Does ELF radiation cause cancer?

Researchers use 2 main types of studies to try to figure out if something causes cancer.

- **Lab studies:** (studies done using lab animals or cells in lab dishes)
- **Studies in people** (epidemiologic studies)

Often neither type of study provides enough evidence on its own, so researchers usually look at both lab-based and human studies when trying to figure out if something can cause cancer.

Studies in the lab

Several large studies have looked at the possible effects of ELF magnetic fields (ELF-MF) on cancer in rats and mice. These studies exposed the animals to magnetic fields much stronger than what people are normally exposed to at home. Most of these studies have found no increase in the risk of any type of cancer. In fact, the risk of some types of cancer was actually lower in the animals exposed to the ELF radiation.

One study did show an increased risk of tumors that start in thyroid cells, called C-cells, in male rats at some exposures. This increased risk was not seen in female rats or in mice, and was not seen at the highest field strength. These inconsistencies, and the fact that these findings were not seen in the other studies, make it hard for scientists to conclude that the observed increased risk of tumors is from the ELF radiation.

Other studies in mice and rats have looked specifically for increases in leukemia and lymphoma as a result of exposure to ELF radiation, but these studies have also not found a link.

Although there is no clear link between ELF-MF and cancer in animal studies, there is some evidence from animal and cell-based research that ELF-MF may affect living organisms in some ways. For example:

- Some studies suggest that at certain levels of exposure, ELF-MF may affect how information from genes is used for cellular processes.
- Some studies have suggested that ELF-MF might stress cells, which could lead to the creation of reactive oxygen species inside the cells.

Results from different studies looking at these ideas have been inconsistent, and many studies have not found that ELF has any biological impact.

Studies in people

Studying the effects of ELF radiation in people can be hard, for many reasons.

Exposure to ELF radiation is very common, so it's not possible to compare people who are exposed with people who aren't exposed. Instead, studies try to compare people exposed at **higher levels** with people exposed at **lower levels**.

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It is very hard to determine how much ELF radiation a person has been exposed to, especially over a long period. As far as we know, the effects of ELF radiation do not add up over time, and there is no test that can measure how much exposure a person has had.

Researchers can get a snapshot of ELF exposures in different ways, but none of these are perfect:

- They can have a person wear a device that records their exposure levels over hours or days.
- They can measure the magnetic or electrical field strength in a person's home or workplace settings.
- They can estimate exposure based on the wiring configuration of someone's workplace/home or on its distance from power lines.

But all of these methods result in exposure estimates that have a lot of uncertainty. They typically don't account for a person's ELF exposures while in other places, and they don't measure ELF exposures in every location that person has ever lived or worked over their lifetime. As a result, there is no good way to accurately estimate someone's long-term exposure, which is what matters most when looking for possible effects on cancer risk.

In children

A number of studies have looked at a possible link between ELF radiation from **magnetic fields** in the home and the risk of childhood leukemia, and have had mixed results. Still, when the findings from these studies are combined, a small increase in risk is seen for children at the highest exposure levels compared to those with the lowest exposure levels. Studies looking at the effect of ELF **electric fields** on childhood leukemia risk have not found a link.

Studies have generally not found any strong links between ELF electric or magnetic fields and other types of childhood cancers.

In adults

Several studies have looked at possible links between ELF exposures in adults and cancer. Most have not found a link, although a small number have suggested a possible link.

What expert agencies say

Several national and international agencies study different exposures in the environment to determine if they can cause cancer. Something that causes cancer or helps cancer grow is called a **carcinogen**. **The American Cancer Society looks to these organizations to evaluate the risks based on evidence from laboratory, animal, and human research studies.**

Based on animal and human evidence like the examples above, some expert agencies have evaluated the potential cancer-causing nature of ELF radiation.

The **International Agency for Research on Cancer (IARC)** is part of the World Health Organization (WHO). One of its major goals is to identify causes of cancer. In 2002, IARC considered the evidence for ELF magnetic and electric fields separately:

- It found "limited evidence" in humans for the carcinogenicity of ELF **magnetic fields** in relation to childhood leukemia, with "inadequate evidence" in relation to all other cancers. It found "inadequate evidence" for the carcinogenicity of ELF magnetic fields based on studies in lab animals.
- It found "inadequate evidence" for the carcinogenicity of ELF **electric fields** in humans.

Based on this assessment, IARC has classified ELF magnetic fields as "possibly carcinogenic to humans." It has classified ELF electric fields as "not classifiable as to their carcinogenicity to humans."

In 1999, the US **National Institute of Environmental Health Sciences (NIEHS)** described the scientific evidence suggesting that ELF exposure poses a health risk as "weak," but noted that it cannot be recognized as entirely safe, and considered it to be a "possible" human carcinogen.

Between 2011 and 2015, the European research group **ARIMMORA (Advanced Research on Interaction Mechanisms of electroMagnetic exposures with Organisms for Risk Assessment)** did several studies to look for possible links between ELF-MF and cancer, especially childhood leukemia. The project concluded that their studies were consistent with the previously established IARC classification of ELF-MF as "possibly carcinogenic."

Can I avoid or limit my exposure to ELF radiation?

It's not clear that exposure to ELF radiation is harmful, and it's not possible to avoid all exposure to electromagnetic fields. But there are things you can do to lower your exposure if you are concerned. Your exposure is based on the strength of the ELF radiation coming from each source, how close you are to each, and how long you spend in the field.

The NIEHS recommends that people concerned about their exposure to EMF (and ELF radiation) find out where their major EMF sources are and move away from them or limit the time spent near them. For example, moving even an arm's length away from a source can dramatically lower exposure to its field.

Power lines

People who are concerned about ELF radiation exposure from high-power electrical lines should keep in mind that the intensity of any exposure goes down significantly as you get farther away from the source. On the ground, the strength of the electromagnetic field is highest directly under the power line. As you get farther away, you are exposed to less and less, with the level eventually matching normal home background levels. The electromagnetic field directly under a power line is typically in the range of what you could be exposed to when using certain household appliances.

Top five risks of solar energy 29-51

Released On 13th Mar 2024

The use of green energy is crucial in the fight against climate change and it's clear that renewable energy sources will gain prominence over the coming years as technology improves. This is a very good thing.

Solar panel systems are now an increasingly popular choice. According to the Microgeneration Certification Scheme, there were 130,596 solar systems mounted on UK rooftops in 2022. This is around double the number installed the previous year.

Below are the top five risks of solar energy, highlighting why there's a need for stronger industry standards in the renewables field and signposting you to extra resources and more information.

1. **Severe weather**
It's sadly ironic that the solar farms which have been introduced as a way to mitigate the effects of climate change are now falling victim to the same severe weather conditions that they are designed to alleviate.

There is an increase in the number of extreme weather events across the globe and these can spell disaster for solar farms. In 2021, Storm Arwen wreaked havoc at a solar farm near Wolviston, smashing hundreds of glass solar panels and damaging rows and rows of photovoltaics.

In extreme weather, solar panels can operate as lifting surfaces, making the panels vulnerable to being blown away, so it's important that these are securely tethered. Panels are in danger of being smashed by falling debris that's carried by the wind. If solar farms are struck by lightning it can result in damage to modules, cables and electrical equipment which can cost many thousands of pounds to repair or replace.

2. Maintenance problems

Micro-cracking, or micro-fractures, can occur in solar panels when panels are subject to strong wind forces. The silicon used is very thin and when it expands and contracts, or when it's damaged by wind or falling debris, it can crack, making the panel less efficient at absorbing light and storing energy. Dust and water may also travel into the cracks, further harming the effectiveness of the panels.

There is also an issue with the longevity of solar panels. Solar power installations should be lasting 40-50 years, but due to weather damage and issues with materials and construction, they are currently only lasting for 20. It's clear that unless these issues are resolved, it's going to be difficult for solar farms to reach their energy producing potential.

3. Theft

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Theft is also an issue for solar farms as they are often located in remote, rural areas where police response times are slow, so a robust approach to security is essential. Panels and cables offer a relatively easy, and high value target for thieves, and in 2019, £900,000 worth of solar panels were stolen from sites in Wales, resulting in serious financial losses for the companies operating them.

4. Planning issues

As with all new potential developments, solar farms are subject to planning regulations and these can be difficult to navigate. Ground mounted solar PV projects over 50kw should ideally be located on brownfield sites, or on agricultural or industrial land, avoiding cropland where possible. It's also important that solar farms do not adversely impact the visual aspect of landscapes and so should be flat and well-screened. They should not negatively affect domestic properties or road access either.

This means that planning applications for solar farms can take a long time to be approved, and construction times can be longer due to the location and terrain. These delays can incur additional business costs and could involve higher insurance premiums given the type of land that is being utilised for the development.

It's also important that due diligence is observed when processing planning applications for solar farms. Building on flood plains for example could mean that the solar farm is at risk of flooding or water damage. Building near archaeological sites also presents risks which would be reflected in higher insurance premiums.

5. New floating solar panels

Floating solar panels are solar panels that are mounted on a structure that floats on water and, in the main, are a great innovation as they don't take up valuable land space and can be up to 15% more efficient than terrestrial farms.

However, as it's a new technology, these types of solar farms require specialist equipment and therefore cost more to construct and install than similar sized farms that are located on solid ground. They can also have issues with moisture and water droplets collecting inside the cables which reduces the amount of sunlight hitting the panels, making them less efficient. Water ingress is also problematic as it can lead to major power losses and potential safety hazards, again increasing the risks associated with this type of renewable.

Looking to the future and more information

As solar power gains prominence over the coming years it's important that the standardisation of testing, energy conversion, use of materials, and health and safety practices are applied consistently across the sector to reduce the risks involved in the harvesting of green energy, and see these installations achieve their full potential. 33-50

For more information there are two risk management guides from the Fire Protection Association which you can access below.

The rooftop mounted solar systems guide highlights the hazards associated with PV solar panel installations and provides risk control recommendations.

Recommendations for fire safety with PV solar panel installations is a joint code of practice for fire safety with photovoltaic panel installations, with a focus on commercial rooftop mounted systems, but it has lots of guidance for solar panel systems in general too.

We are here to help

If you are concerned about how this affects you and your business and would like support in assessing your needs, we are here to help. Please do get in touch for confidential advice and guidance.

This article was adapted from an article by Allianz which can be found here.

Emerging Hazards of Battery Energy Storage System Fires

34-5

Grant Number: EMW-2016-FP-00833
Principle Investigator: Ofodike Ezekoye Ph.D., P.E.
University of Texas at Austin

In April 2019, an unexpected explosion of batteries on fire in an Arizona energy storage facility injured eight firefighters. More than a year before that fire, FEMA awarded a Fire Prevention and Safety (FP&S), Research and Development (R&D) grant to the University of Texas at Austin to address firefighter concerns about safety when responding to fires in battery energy storage systems of all sizes. Professor O.A. ('DK') Ezekoye is working with other engineers, firefighters, and industry partners to develop a better understanding of the magnitude of the fire hazards.

There has been a dramatic increase in the use of battery energy storage systems (BESS) in the United States. These systems are used in residential, commercial, and utility scale applications. Most of these systems consist of multiple lithium-ion battery cells. A single battery cell (7 x 5 x 2 inches) can store 350 Whr of energy. Unfortunately, these lithium cells can experience thermal runaway which causes them to release very hot flammable, toxic gases. In large storage systems, failure of one lithium cell can cascade to include hundreds of individual cells. The hot flammable gases can result in an explosion, or a very difficult to extinguish fire.

Although the fire service routinely responds to explosive scenarios, such as those associated with natural gas leaks, standard operating procedures do not exist for scenarios like a battery energy storage system for which there is no way to cut off the gas supply. The fire service is unaware and inexperienced with the fire and explosion hazards of BESS.

The FP&S R&D study started with a laboratory test in which a single cell failed in one commercial storage module containing a total of 14 cells. In one of the early tests, when a single cell failed, smoke and gases were released that ignited and burned intensely for 12 seconds. Toxic smoke and gases filled the test space.

The research team has subsequently connected small-scale battery failure test results to large scale fire and explosion consequences associated with these systems. Through this research, one of the biggest lessons learned for the fire service is that the utilities and commercial entities that own large battery systems are equally unfamiliar with the potential fire hazards. As well, there remain many questions about the toxicity of the battery vent gas.

From 2014 to 2018, residential BESS installations have increased by 200% annually. Further research into residential BESS hazards is essential as BESS hazards could eventually become a regular part of dwelling fires.

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According to Professor Ezekoye, the results of this study will lead to wider awareness of the BESS hazards, a greater understanding of the underlying fire behavior of these systems, and eventually the development of safe standard operating guidelines and procedures for firefighters.

Link: www.UTFireResearch.com

For more information on Fire Prevention & Safety Grants including how to apply, please visit https://www.fema.gov/fire-prevention-safety-grants.

What Is A Safe Distance To Live From A Solar Farm

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Wondering what is a safe distance to live from a solar farm? Living near a solar farm raises questions about safety and comfort, especially concerning the distance that should be for residential areas.

While solar farms are inherently less harmful than many other industrial facilities, there are considerations like glare, aesthetics, and minimal electromagnetic fields.

It's not just about the technical specifications but also the quality of life and the perceptions of those in proximity. Balancing the utility of clean green energy production with ensuring nearby residents' peace of mind is crucial.

How Do Solar Farms Work?

Solar farms, also known as solar parks or solar power plants, are large-scale installations of solar panels that can capture sunlight and convert it into electricity. Here's a basic overview of how they work:

- **Solar Panels**: The primary components of solar farms are solar panels, often arranged in long rows, to maximize the capture of sunlight. Each panel consists of photovoltaic (PV) cells, typically made from silicon.
- **Photovoltaic Effect**: When sunlight hits a PV cell, it stimulates electrons within the cell. This phenomenon is called the photovoltaic effect. Electrons are knocked loose from their atoms and flow through the cell, generating electricity.

- **Inverters**: The electricity generated by solar panels is in direct current (DC) form. However, most power grids and appliances require alternating current (AC). Therefore, inverters help to convert the DC electricity from the solar panels into AC electricity.
- **Transformers**: After converting the DC to AC, the voltage might still need adjustment to match the grid requirements. Transformers help to step up or step down the voltage as required.
- **Grid Connection**: Once the electricity is in the appropriate AC form and at the correct voltage, it goes into the power grid. From there, it goes to homes, businesses, and other consumers.
- **Monitoring & Maintenance**: Solar farms typically include monitoring systems to track the solar system's performance, inverters, and other components. Again, this helps ensure they operate efficiently and alerts operators to potential issues.
- **Storage (optional)**: Some solar farms have battery storage systems. These batteries can store excess electricity produced during sunny periods, which can be released during cloudy days or nighttime when the panels aren't producing power. Besides, this helps smooth out the electricity supply and can make solar energy more reliable.
- **Land and Environmental Considerations**: Solar farms require a significant amount of land. They are often in

areas with high solar irradiance. While they have an environmental footprint (e.g., land use, panel production), they produce clean and renewable energy. They can do that without emitting greenhouse gases during operation.

- **Decommissioning**: Solar panels reduce efficiency after a few decades (typically 20-30 years). At the end of their lifecycle, panels and other components must be decommissioned and, ideally, recycled or repurposed.

What Are the Health Risks Living Near Solar Farms?

Living near a solar farm is generally considered safe, especially compared to other energy production facilities, such as coal or natural gas plants. However, there are some concerns and potential health risks, even if they are relatively minor or speculative in comparison. Here are some of the potential health risks and considerations associated with living near a solar farm:

Electromagnetic Fields (EMF)

All electrical devices and infrastructure, including solar panels and their associated equipment, emit some electromagnetic radiation. However, the EMF levels emitted by solar installations are typically low and are comparable to those emitted by household appliances. There's no conclusive evidence linking low-level EMF exposure to adverse health outcomes.

Glare and Reflection

Some solar panels can produce glare, which could be a nuisance to nearby residents or drivers, potentially posing a hazard. However, modern solar panels can absorb as much sunlight as possible, minimizing reflection. Still, proper placement and orientation can mitigate this concern.

Chemical Exposure

The production of solar panels involves chemicals, some of which are hazardous. However, once the panels are manufactured and installed, the risk of chemical exposure to nearby residents is negligible. The more significant concern is during the manufacturing process and at the end of the panel's life during disposal or recycling. One must manage these processes responsibly to prevent chemical release.

Noise

Inverters and transformers at solar farms can produce low humming noise. If homes are very close to the equipment for large-scale installations, there might be some noise concerns. These are generally minor and can be mitigated with proper placement and barriers.

Land Use and Habitat Disruption

While not a direct health risk, large solar farms can disrupt local ecosystems and habitats. It can indirectly affect human health if, for instance, it involves local water sources or land use changes leading to increased interactions between wildlife and humans.

Fire Risk

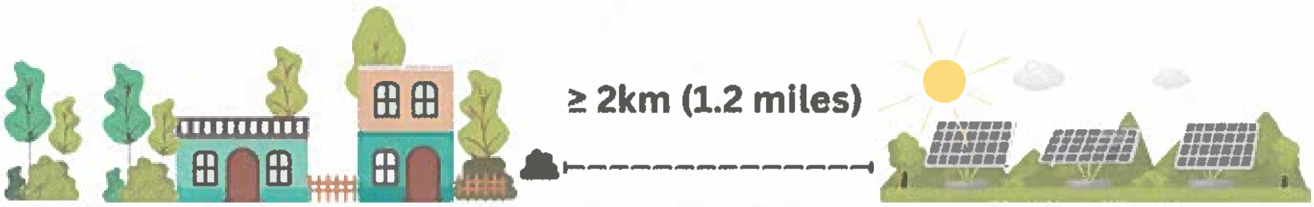
There's a minimal risk of fires originating from solar installations due to equipment malfunction or external factors. Proper maintenance, equipment checks, and adherence to safety guidelines can significantly minimize this risk.

Visual Impact

Large-scale solar farms can significantly alter the visual landscape. While this isn't a "health risk" in the traditional sense, it can affect the well-being and satisfaction of individuals who value the original aesthetic of the landscape.

What Is a Safe Distance to Live From a Solar Farm?

43-50



According to the World Health Organization (WHO), despite extensive research, there's no evidence that low-level electromagnetic field exposure from facilities like solar farms harms human health. Nevertheless, for those who may still have concerns, authorities recommend maintaining a distance of at least 2 kilometers, roughly 1.2 miles, from a solar field.

Do Solar Farms Leak Toxic Chemicals?

Solar farms, in their operational phase, do not leak toxic chemicals. However, the manufacturing process of solar panels involves certain chemicals, some of which can be hazardous. It's important to note that these chemicals are within the panels, and under normal conditions, they do not leak out during the operational life of the panel. Proper disposal or recycling at the end of the panel's lifecycle is crucial to prevent any release of these chemicals.

Do Solar Farms Pollute Water?

Solar farms, by design, do not pollute water. Unlike other energy production forms, solar farms do not produce wastewater or other pollutants that can contaminate water sources. However, during the construction phase of a solar farm, there could be potential for sediment runoff if proper erosion controls are not in place. Good site management can mitigate such risks.

Do Solar Panels Poison Soil?

Under normal conditions, solar panels do not poison or contaminate the soil. There can be sealing of the panels, preventing any leaching of materials. However, if panels were to break, there's a small risk of materials entering the soil, though this would be localized and minimal.

It's more important to consider the end-of-life treatment of solar panels, ensuring they are properly recycled or disposed of, preventing potential long-term soil contamination.

Solar Farm Land Requirements

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1. **Land Area**: The area required for a solar farm varies depending on the installation's capacity. On average, for utility-scale solar farms, approximately 5-10 acres are needed to generate 1 megawatt (MW) of electricity.
2. **Solar Insolation**: One of the primary considerations is the amount of sunlight the area receives, often measured in terms of "solar insolation." Regions with higher solar insolation values are more suitable for solar farms as they generate electricity for the same panel area.
3. **Land Topography**: Flat or gently sloping lands are preferable. Steep terrains can increase the installation cost and may reduce the efficiency of panel orientation towards the sun.

4. **Soil Type**: The soil should be stable enough to support the infrastructure, including the solar panels and mounting structures. Soil tests may be required to ensure that the land can bear the weight and that the installation will not be prone to erosion or subsidence.
5. **Accessibility**: Proximity to roads and infrastructure is essential for transporting materials, machinery, and maintenance. Additionally, access to the electrical grid is crucial unless the solar farm is for off-grid use.
6. **Water Drainage**: Proper drainage is vital to prevent waterlogging, which could damage the infrastructure or reduce the operational efficiency of solar panels.
7. **Vegetation:** The land should ideally be free from tall vegetation, which might cast shadows on the panels. In some cases, one might remove vegetation, but developers should also consider the environmental impact of such actions.
8. **Environmental Concerns**: The land chosen should not be in protected areas, habitats of endangered species, or areas of high biodiversity. Ecological impact assessments might be necessary to ensure the solar farm does not adversely affect local ecosystems.
9. **Local Regulations**: Before developing a solar farm, it's essential to understand local regulations, zoning laws, and any other restrictions. Some areas have restrictions on land use for large solar farms or require specific permits for large-scale solar installations.

10. **Future Expansion**: When choosing a site, solar farm developers often consider the potential for future expansion. As technology improves or demand increases, there might be a desire to add more panels to the existing infrastructure.
11. **Long-Term Lease Agreements**: Since solar farms have 20-30 years or more lifespan, developers often secure long-term lease agreements with landowners to ensure stability and return on investment.

Pros and Cons of Solar Energy

Pros of Solar Energy

- **Renewable Energy Source**: Solar energy is renewable, meaning we won't run out of it as long as the sun is shining, which can be several billion more years.
- **Reduces Electricity Bills**: Installing solar panels on your property can lead to substantial savings on your electricity bills. You can also earn money by selling unused electricity back to the grid in some locations.
- **Diverse Applications**: Solar energy can help for various purposes, such as generating electricity (photovoltaics) or heat (solar thermal). It can also produce electricity in areas without access to the energy grid or distill water in regions with limited clean water supplies.
- **Low Maintenance Costs**: Solar power systems

generally require minimal maintenance. Once installed, yearly cleaning and periodic inspections are typically sufficient, and many manufacturers offer warranties that last 20-25 years.

- **Technology Development**: With ongoing research and development, solar technology continuously improves, decreasing costs and increasing efficiency.
- **Environmentally Friendly**: Solar power reduces the reliance on fossil fuels, reducing greenhouse gas emissions and pollution. It also has a smaller carbon footprint during production than other forms of electricity generation.
- **Job Creation**: The solar industry has been a significant source of employment. In addition, there is an increase in jobs as the industry grows from manufacturing to installation.

Cons of Solar Energy

- **High Initial Costs**: The initial investment necessary for solar panels, including installation, can be increased. However, prices have been dropping steadily, and government incentives and rebates are often available to reduce costs.
- **Weather-Dependent**: Solar panels require sunlight to generate electricity, affecting their efficiency on cloudy or rainy days. While they can still produce power in

diffused light, there is still a reduction in output. 49-5

- **Space Requirements**: Large solar panels require significant space, which can be a limitation, especially in urban settings. Some areas may need more roof space or land to produce sufficient power.
- **Energy Storage Is Expensive**: While it's beneficial to store extra solar power for nighttime or cloudy days, the current solutions, like batteries, can be expensive.
- **Associated Pollution**: While solar energy production is clean, the manufacturing, transportation, and installation of solar panels have environmental impacts. Such ecological effects include greenhouse gas emissions. However, this is considerably lower than most other energy sources.
- **Long Payback Period**: Depending on the installation costs, energy prices, and incentives, it might take years before the savings on electricity bills surpass the initial costs.
- **Aesthetics**: Some people find solar panels unattractive, which can concern homeowners or areas with strict architectural guidelines.

Conclusion

Solar farms are increasingly prominent in Ireland's journey towards a sustainable future.

Drawing from global research, including insights from reputable entities such as the World Health Organization, the risks associated with living near these installations appear minimal. 50-5

Yet, individual preferences and perceived comfort are equally vital. While there isn't a prescribed "safe distance" universally applied in Ireland, it's paramount for residents to be informed and consider their comfort thresholds.

Ultimately, as Ireland continues to harness the sun, the intersection of safety, technology, and personal choice will define the ideal proximity for each individual.