Liberty Mutual INSURANCE

In this Liberty Mutual white paper, explore the opportunities and risks when selecting site locations for utility-scale commercial solar farm developments.

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Building renewable energy: **commercial solar panel location risks**

Introduction

Climate change is one of the Earth's most pressing concerns. While seemingly miniscule, a 1.5-degree Celsius global average temperature increase could cause catastrophic damage and loss of life.

Hoping to prevent such loss, much of the world is rallying around efforts to reduce carbon emissions. And while many strategies can help, shifting energy production from fossil fuels to renewable energy sources is one of our primary opportunities to address climate change.

The effort is gaining serious momentum. Global renewable energy growth is increasing exponentially. According to the International Energy Agency, renewables are forecast to account for more than 90 percent of global electricity capacity expansion from 2022 to 2027. In addition, the Inflation Reduction Act's incentives could reduce renewable energy costs for businesses, nonprofits, educational institutions, and state, local, and tribal organizations. This work is critical to lowering greenhouse gas emission footprints and accelerating the clean energy transition.

The role of solar in the great renewable buildout

Much of this renewable energy buildout will be in the form of solar photovoltaic (PV). As a lower-cost option for new electricity generation, PV should propel investment in the coming years.

In fact, the increased emphasis on renewables directly correlates to growth in new solar buildout. According to the U.S. Energy Information Administration (EIA):

- Developers plan to add 54.5 gigawatts (GW) of new utility-scale electric-generating capacity to the U.S. power grid in 2023; **more than half** of this capacity (29.1 GW) will be solar power (see Figure 1).
- If successful, this new capacity would be the most added solar capacity ever in a single year.

The largest new solar developments are planned for **Texas (7.7 GW)** and **California (4.2 GW)**, which account for

41%

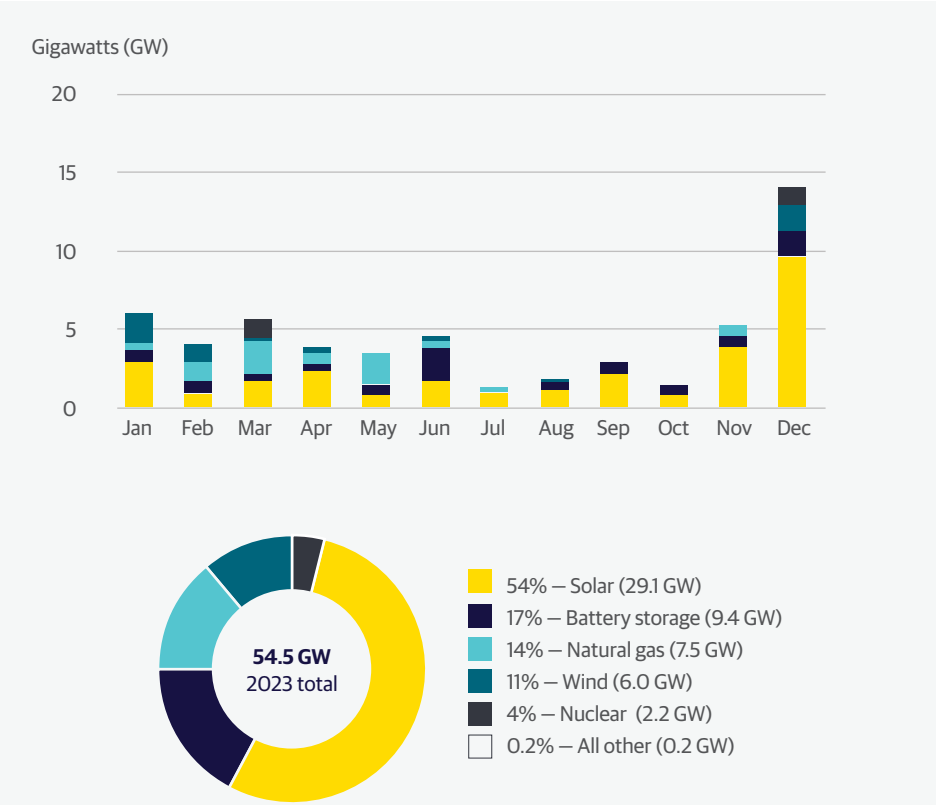
of new planned capacity.[1]

Utility-scale PV, which is more concentrated and larger-scale than rooftop solar, remains the most competitive source of PV generation in most parts of the world. However, building these types of installations can be challenging.

And one of the most underappreciated challenges can be: *Where?*

1 Source: https://www.eia.gov/todayinenergy/detail.php?id=55419

Figure 1. 2023 planned U.S. utility-scale electric-generating capacity additions



Source: https://www.eia.gov/todayinenergy/detail.php?id=55419

Why geography matters

The location of a utility scale solar installation is not always front-of-mind, but it can present a variety of risks to a company's operations and finances. This paper drills down into three key geographical considerations, the risks they can pose, and how to mitigate them for successful renewable energy growth.

1. **Severe weather and property risk.** Wind and hail can damage or shut down commercial solar equipment, causing property losses.
2. **Wildfires and casualty risk.** Any electrical power generation, including solar, might present wildfire risks that can damage property and put people's health and lives at risk, with the company potentially at fault.
3. **Brightfields, panel disposal, and environmental risk.** Unless managed correctly, decommissioned solar panels and the repurposing of "brownfields" for solar generation can result in environmental claims and damage.

The future is bright for commercial solar. With the right expertise, widespread use of renewables, supported by ample solar power generation, can play a critical role in how the world generates and distributes energy.

Severe weather and property risk

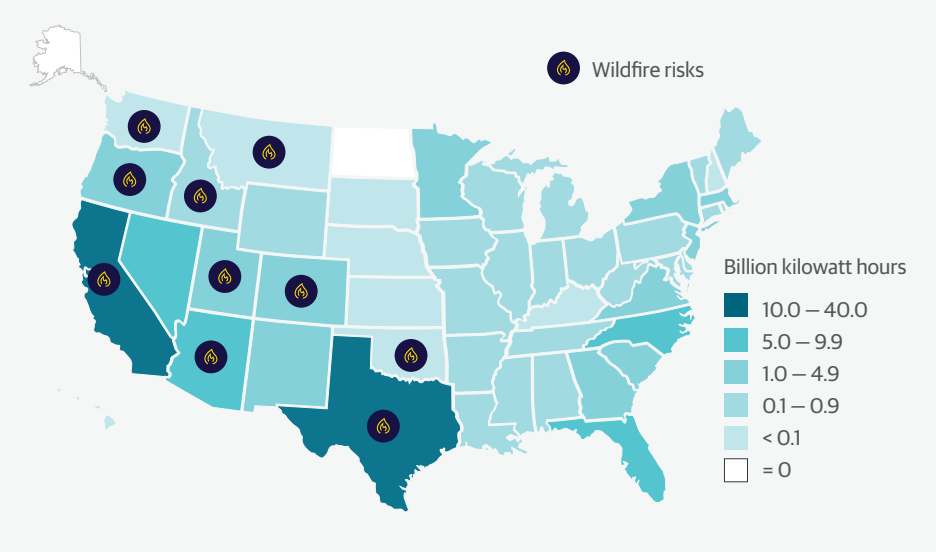
The force of wind or the impact of hail can cause microcracks in solar panels, resulting in suboptimal performance, or, worse, damage that renders panels inoperable. Severe weather events that bring wind and hail are on the rise. Those seeking to build renewable energy and solar should understand the risks of severe weather, the connections between weather and solar generation, and how to address these risks.

National Centers for Environmental Information (NCEI) data show increasing damage from more frequent severe weather, particularly the kind of weather likely to compromise or damage solar panels:

- From 2018 to 2022, the U.S. experienced 89 billion-dollar natural catastrophes that cost more than $600 billion.
  - In that same period, severe storms and tropical cyclones accounted for 70 of those events and more than $400 billion.
- In 2022, there were 18 separate billion-dollar natural catastrophes that cost the U.S. almost $176 billion.
  - In that same year, severe storms and tropical cyclones accounted for 14 of those events and more than $138 billion.

Even in areas of historically low exposure, increasing severe weather trends can pose new risks. For PV solar, the risks extend not just to repair or replacement, but also downtime before a facility can come back online. Plus, with solar buildout happening on a large scale and global supply chains under strain, an unexpected repair or replacement might be costlier or take longer than expected. Companies should weigh this with other factors in their solar projects.

Figure 2. Utility-scale solar electricity generation by state, 2021[3]
Top 10 states — Properties at risk for wildfire[4]



> Many operational and planned developments are in western and southern states. These areas overlap significantly with areas of moderate to high wind and hail, specifically in Texas, Missouri, Arkansas, Tennessee, North Carolina, and Georgia[2]. (see Figure 2)

The connection between optimal solar output and severe weather risk

As with other risks, geography plays a role. Factors to consider when determining site location for solar installations for optimal performance, include:

- Irradiation
- Elevation
- Slope
- Distance to roads
- Distance to transmission grid
- Protected status area
- Type of land cover (agricultural versus forest)
- Cost of land

In short, utility-scale solar installations require large parcels of land and maximum sun for optimal performance. And while severe storms and hurricanes impact a very broad swath of the United States, areas with ample available land and sun are often at higher risk for hurricanes and convective storms that generate wind and hail.

While companies building significant PV solar may not be able to completely avoid property losses and downtime from repairing or replaced panels after severe weather events, they can proactively consider how weather events may affect their operations and develop plans to help reduce the overall impact.

2 Source: https://www.seia.org/research-resources/major-solar-projects-list
https://hazards.fema.gov/nri/strong-wind | https://hazards.fema.gov/nri/hail

3 Source: https://www.eia.gov/energyexplained/solar/where-solar-is-found.php

4 Source: https://hazards.fema.gov/nri/wildfire | https://www.iii.org/table-archive/74507

Severe weather and solar PV risk management

While the full destructive potential of hail on solar arrays has only been realized in the last few years, the industry is now more aware of the hazards of hail and wind. Companies looking to move forward with utility-scale solar installations should take these risk mitigation considerations into account:

- **Know the weather conditions.** Storm frequency and severity can differ materially across states and within a state. Actual historical weather experienced in a geography should be well understood during the planning phase of a utility scale solar facility, but also a recognition that climate change is resulting in changing weather patterns, frequency, and severity. Although the accuracy of modeling natural CAT activity is improving, it can help better understand relative geographic risk and develop estimates of potential loss.
- **Evaluate manufacturer's warranties.** It is critical to understand the manufacturer's warranty against wind and hail. Some panels are rated for significant wind upwards of 160 mph+, but not all. In addition, many panel types are only certified for up to 1" hailstones, which is considerably smaller than hail seen in some areas. This certification is also based on a test for visual damage, not microcracking that can affect the performance. Additionally, it is extremely important to understand any language that may protect the manufacturer from having to stand behind any damage.

Case study: a Texas hailstorm

In May 2019, the growing solar industry faced a new level of disaster when a massive hailstorm passed through West Texas. In the path of the storm sat a large solar project.

Once the storm had passed, it had left behind the largest weather-related single-project loss in its history. More than 400,000 of the 685,000 Hanwha Q cell modules were damaged or destroyed, resulting in insurance losses that totaled $70 million.

Since the 2019 hail event, there have been other large storms causing significant damage at utility scale solar facilities. As reported by Business Insurance, in 2022 the renewable energy industry suffered more than $300M in hail losses due to storms in Texas. With investment in utility scale solar being spurred by the Inflation Reduction Act, assets will only grow in number and increase the probability for future large-scale damage.

- **Use resilient equipment and technology.** Consider the functionality of the equipment and technology. For example:
  - Solar tracker equipment can help mitigate wind and hail damage by allowing for the panels to be stowed before adverse weather arrives.
  - Engage engineering and research experts on recommended stow direction and angle depending on the equipment and technology being used.
  - Understand how products such as monofacial versus bifacial solar panels can impact loss estimates and recommendations such as stow direction. Some panels, especially bifacial, use thinner glass to reduce the weight which are less resilient against hail.
  - The height of installed panels can affect wind flow patterns and potential damage from blowing debris.
  - Racks and supporting structure should be designed for corresponding wind loads.
- **Third party advisory firm.** Consider supplementing their own testing with a independent third-party advisory firm, not only to provide engineering services, but also for certifying a product and testing for durability and performance.
- **Understand your insurance coverage and needs.** In addition to the value of the installation itself, be sure to quantify other aspects, including installation costs and downtime. Also review your property policy for limits and waiting periods, any exclusions, and business interruption coverage. In the event of a claim, you will be more confident that your property coverage is adequate.

Every storm has different characteristics that could impact commercial solar panels differently. The industry also still has much to learn about performance during actual weather events. But with the increasing frequency and severity of natural catastrophes, conducting a cost/benefit analysis of investing in product and technologies that offer significant wind and hail mitigation should be an important part of risk management planning.

Resources

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Wildfires and casualty risk

Like any source of electricity, PV systems can present fire risks. If not addressed quickly, a few sparks in the wrong place can grow into large scale events, such as wildfires.

Wildfires, like other such catastrophes, can damage property and put people's lives and health at risk. As new residential developments and suburban sprawl encroach on natural areas, the risk of property damage due to wildfires caused by PV fires could increase.

If a utility company is found at fault for a wildfire, it could be liable for third-party property damage, failure to supply electricity, loss or destruction of wildlife habitat, bodily injury, and loss of life.

Meanwhile, per the EIA, there are over 5,000 utility-scale solar facilities operating in the United States, many in areas prone to wildfires. Although more solar facilities providing electricity will help reduce carbon emissions and mitigate risks associated with climate change, electrical arcs, system design mistakes, and overheated PV cells are unique risk exposures associated with solar facilities and the infrastructure to support electrical transmission.

Solar facilities in remote areas can also be affected by wildfires starting somewhere else that expand across a region. Plus, PV panels burn at a high temperature, which can increase property damage.

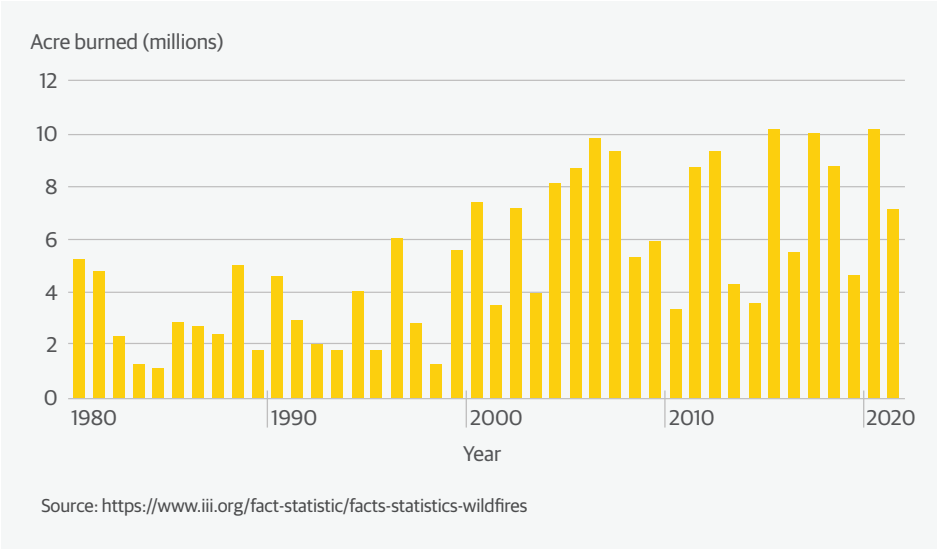
When planning, installing, operating, and maintaining solar power infrastructure at utility scale, companies should take the necessary steps to address wildfire-related hazards to help reduce the risk of these types of human, natural, and financial losses.

The frequency and severity of wildfires are increasing

According to the National Oceanic Atmospheric Administration (NOAA), the results of climate change, including increased heat, extended drought, and drier conditions, have been a key driver in increasing the risk and extent of wildfires in the western United States during the last two decades.
For example:

- There are 70,000 wildfires each year in the United States, on average.
- The extent of area burned by wildfires each year appears to have increased since the 1980s, with more than 7.1M acres burned in 2021. (See Figure 3).

Figure 3. Annual number of acres burned in wildland fires, 1980-2021



Source: https://www.iii.org/fact-statistic/facts-statistics-wildfires

A case study: California wildfires

The Dixie wildfire, the second-largest wildfire in California's history, was started when power lines owned by a major utility came into contact with a tree. That fire burned from July through October of 2021, destroying 963,309 acres and 1,329 structures across five counties in Northern California.

A smaller California wildfire that still spread to 1,127 acres in June of 2019 started when a bird flew into two transmission wires, creating a circuit, and $9 million in estimated losses.

- According to the NCEI, between 1980 and 2022 the United States had 21 wildfire events that caused more than $1 billion in damage each, for a total of more than $133B.

Utilities and wildfire risk

Wildfire risk and related damage is not new for the utility industry. Electric utility wildfires are well-known, especially those caused by electricity generation and transmission. A solar farm fire that might spread into a wildfire could be attributed to several causes, including:

- Poor system design
- A defect with a system component (such as the inverter)
- Faulty installation of the system or its connection to the grid (point of interconnection)
- Battery energy storage systems going into "thermal runaway," when they heat up uncontrollably
- Transmission lines bringing power to a substation or line tap

Specific to system components, the BRE National Solar Centre in the United Kingdom conducted a study of PV system-related fire incidents and found defective or faulty installation of DC isolators, DC connectors, and inverters as the top causes.

Currently, fires starting at solar facilities are difficult to quantify due to lack of data. A recent report by Firetrace International concluded that the solar industry is potentially underestimating the risk of fire at solar farms. Risk data can fail to capture cases where fires are resolved by a solar installer or maintenance engineer without fire department assistance. How solar-related wildfires are categorized in relation to other causes also makes it difficult to understand actual numbers and trends.

Again, geography becomes an important factor to consider. Many states with significant existing solar infrastructure also have higher wildfire activity, especially in the Western and Southern parts of the United States with hot and dry climates. Many of these same states also have a significant number of homes in hot, dry, sunny areas with both solar power and greater wildfire risk (Figures 2).

Scouting solar farm locations for wildfire risk

There are numerous considerations when picking the location of a utility scale solar farm as it relates to wildfire potential, including:

- **The environmental conditions.** Consider humidity levels, brush density, heat, average rainfall, and wind.
- **The proximity to populated areas.** The closer the operation is to where people live and work, the greater the liability risk.
- **Vegetation in surrounding area.** Heavy brush that is difficult to clear can present elevated exposure.
- **Power accessibility.** If transmission lines are used, who is responsible for their operation and maintenance? Downed transmission lines due to severe weather and fallen tree limbs are a main cause of wildfires. Having a third-party partner can help reduce your operation's risk.
- **Firefighting resources.** Response times, available manpower, and experience with solar fires should all be considered. Responding fire departments should be contacted to review site plans so they have the right equipment and firefighting foams to contain a fire.

Evaluating these areas can help inform decisions around budgeting, operational processes, and risk management planning for the solar farm.

Solar operations and wildfire risk management

Wildfire risk management planning should also cover two areas: the solar installation itself and the surrounding areas.

Solar installation:

- Consider using a supervisory control and data acquisition (SCADA) system to monitor and gather data from different components of solar farm equipment in real time.
- Regularly monitor component parts, such as inverters and junction boxes, to mitigate the risk of overheating, arcing, and short circuits. Confirm how components are housed and spaced in relation to each other follow manufacturers' specifications.
- Consider live feeds and regular field inspections with thermal imaging cameras.
- Install fire suppression systems around key pieces of equipment.
- Schedule regular preventative system maintenance with a licensed technician.
- Be prepared to replace or upgrade panels, parts, and other aspects of your system as it ages.

Surrounding areas:

- Keep a close eye on transmission lines. Even if ownership belongs to a third party, confirm that lines are inspected (via drones, line sensors, or other method), and maintenance occurs on a regular basis.
- Have a vegetation management plan. Trimming tree limbs around lines and managing brush and other vegetation with grazing livestock and/or herbicides can help reduce available "fuel" for fires.
- Create firebreaks. Firebreaks, areas cleared of all flammable material, can help prevent fires from spreading.
- Have a plan for fire water runoff. If a fire does occur, the runoff from the water used to extinguish the blaze could be contaminated. Without a proper drainage plan, this runoff could pollute nearby soil and bodies of water and creating environmental hazards.
- Stay in touch with the fire department. As a business, you'll want fire personnel to review your system and become familiar with its layout and location.
- Make it easy to report incidents. Consider setting up a hotline so that members of community can report a fire or other issues.
- As you work with third parties to install, maintain, and operate your solar facility, it's important to engage legal counsel to review vendor contracts to ensure they clearly define responsibilities, outline risks each party is assuming, and assign liability appropriately. It's also important to review each party's insurance to help mitigate the risk of coverage gaps in the event of an incident.

While climate change is exacerbating wildfire dangers, it is incumbent on solar farm companies to do all they can before, during, and after installation to help ensure that their facilities are not the culprit.

Brightfields, panel disposal, and environmental risk

Growth in solar energy is likely to exceed all other renewable energy sources, providing numerous benefits to combat climate change. While the "green" benefits are significant, the upside comes at a cost. It still involves equipment, waste, and potential contaminants that companies installing and maintaining solar farms need to understand, anticipate, and manage to help mitigate environmental hazards and related claims.

The decommissioning and disposal of solar panels

When solar panels reach their end of life — typically in 25 to 30 years — or are damaged by severe weather, fire, or other incidents, they need to be decommissioned properly. Solar panel waste can contain heavy metals such as silver, lead, cadmium, or arsenic, which can be harmful to human health and the environment.

As the utility-scale solar PV market grows, so will the volume of panels that required proper disposal, and more progress is necessary:

- The International Renewable Energy Agency forecasts that about 80 million tons of decommissioned solar panels could accumulate globally by 2050.
- According to the EPA, some panels are considered hazardous waste and others are not, and the generators of the solar panel waste are themselves responsible for testing to determine if their specific panels are hazardous and present an environmental risk or not.

> 80 million tons of decommissioned solar panels could accumulate globally by 2050.

Significant damage to solar panels can exacerbate the potential exposure. As an example, if a wildfire or electrical fire destroys a solar farm, those melted panels can leak toxic chemicals into the soil and potentially contaminate groundwater.

Solar panel recycling challenges

Compounding the disposal challenges, the U.S. National Renewable Energy Agency estimates only approximately 10% of solar panels in the country are recycled.

A report by the National Renewable Energy Laboratory (NREL) highlights key barriers to solar panel recycling:

- There are no federal regulations to mandate PV recycling, and only a few states have such mandates.
- There is a lack of research to understand the value of recovered materials, the current volume and composition of PV modules, the technology and infrastructure needs, and the costs and liabilities associated with PV recycling.
- Current technology, infrastructure, and processes for recycling panels are not as cost-effective or accessible as other disposal options.

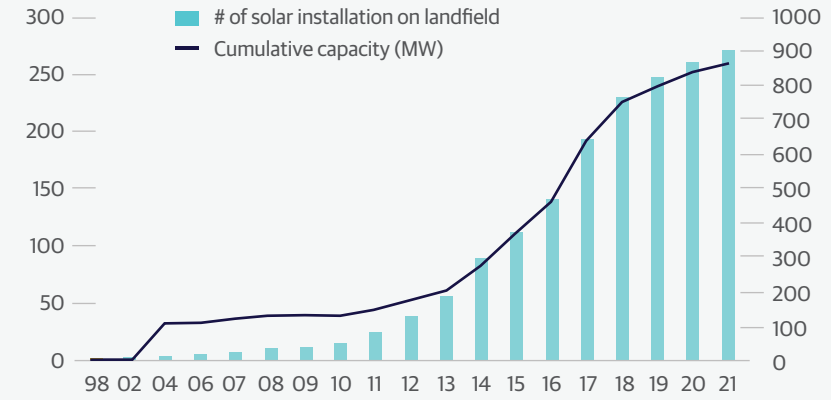
Without addressing these areas, PV panel recycling is likely to continue to be an expensive and lengthy endeavor.

Giving brownfields a brighter outlook

Solar panels have another, useful relationship with "green" benefits that requires careful management. There's a remarkable transformation taking place within the solar industry that involves safely reclaiming "brownfields" into "brightfields."

Brownfields are former industrial or commercial sites where future use is affected by real or perceived environmental contamination. The EPA reports there are more than 450,000 of these sites in the United States. Because the ground beneath a brownfield is physically unstable and contaminated, the land typically isn't suitable for housing, schools, or other structures.

Figure 4. Solar projects on landfills, 1998-2021



Source: https://www.freethink.com/cities/brownfields-brightfields

Brightfields are solar developments on brownfields. Solar energy technologies, especially PV systems, can be well-suited to brownfield sites, as they require less maintenance and can be installed without penetrating the surface or disturbing any existing contamination.

The growing interest in brightfields

Interest in brightfields is starting to grow. As of 2021, there were 271 solar projects installed on landfills. (Figure 4). Although the current number of brightfield solar projects is low at approximately 271, this trend is expected to continue due to numerous benefits, but there are also myriad risks that should be considered.

Brownfield sites are attractive as utility-scale solar locations because they:

- Provide large parcels of land
- Lack vegetation, making them generally unshaded with ample sunlight
- Already have access to critical infrastructure such as roads and electricity

In addition, there are many ways that brightfields can contribute to local communities and the environment, including:

- Reusing already developed land instead of building on undeveloped land, farms, and other agricultural areas.
- Reinvesting in sites that often lack other redevelopment options.
- Helping to create local jobs by co-locating the brightfield with manufacturing and other energy-intensive facilities.

> As of 2021, there were 271 solar projects installed on landfills.

As part of the Inflation Reduction Act, which offers incentives to accelerate the transition to a clean energy economy, developers could also receive tax credits when repurposing brownfields into brightfields.

Brightfields done right: know the risks

Still, challenges can arise from reclaiming a brownfield. Solar companies should know the significant risks of working in areas of environmental contamination to help protect their employees and the community from exposure to contaminants from the previous use. Some of the risks or drawbacks to developing on a brownfield site include the following:

- Greater uncertainty
- Missteps in the development or construction could result in additional ground contamination
- Development timelines may take longer
- Permitting process can be extensive
- Costs associated with development could run considerably higher due to the need for environmental consultants and engineers

Brightfields represent a major opportunity for America's solar industry. However, they're intrinsically challenging projects that require careful and conscientious development. Diligence and pragmatism, coupled with a proper mitigation strategy are key to successful execution.

Solar operations and environmental risk management

Companies can reduce their environmental risk by taking these considerations into account.

- Know the chemical makeup of your solar panels.
- Understand solar panel waste disposal requirements in your state.
- Take precautions to help protect your solar facility from natural catastrophes.
- Schedule regular maintenance to ensure equipment is in good condition and functioning properly.
- Develop a detailed clean up and waste removal plan for damaged solar panels.

And additional considerations for brownfield site developments:

- Budget additional expenses and project time to comply with state laws and EPA requirements.
- Hire contractors and engineers that have specific expertise with solar development on brownfield sites.

Solar technology creates great potential to help the environment, but it requires skill and care to manage. With the risks in mind and the right expertise, it can provide multiple "green" benefits without missteps that harming the environment it seeks to support.

Conclusion

Building the energy transition

Whether they are long-time players or new arrivals to renewables, the companies building the energy transition will need the industry-defining expertise to carry it forward. Thankfully there is also help available.

The right insurer can help you connect with further expertise committed to protecting your company from these losses and helping you recover.

Keep in mind that, with the rapid growth of solar power as the anticipated leader in renewable energy, the insurance coverage needs and valuations of solar energy projects and firms will need room to grow as well.

Expansion to a geography with different weather or fire risk might require greater property or general liability risk management and coverage. A new brightfield project may require a new specialty environmental coverage with build-in event response. Risk control and risk engineering services can help prevent losses before they happen.

Before your next big solar project, consult with your insurance broker and carrier to make sure you understand how can help protect your business against potential risks. This exploration into the opportunities and risks inherent in choosing a location for solar array development is just one example of Liberty Mutual's commitment to partner with you.

> Thank you for building the energy transition. We'll be with you at every step toward a brighter tomorrow.

Liberty is here for you.
Today. Tomorrow. Together.

For more information, please visit: **lmi.co/business.**

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