PV Without Surprises: Avoid Mistakes and Maximize Your Investment

A Practical Guide to Choosing the Right Solar Panel for Every Need

If you're planning to invest in solar energy, making informed decisions is crucial—starting with the selection of the right solar modules. This article highlights a key but often overlooked factor: the mechanical resistance of photovoltaic panels.

Why Mechanical Resistance Matters

When evaluating solar panels, most people focus on electrical parameters like wattage. However, selecting a panel based solely on power output, without considering installation context, can lead to costly mistakes.

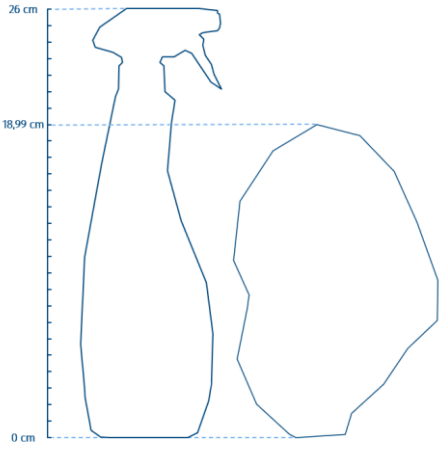
Key factors to consider include the installation site, local climate conditions, and potential mechanical stress on the panel. With extreme weather events on the rise—such as heavy hailstorms and strong winds—the mechanical resistance of solar panels is now more critical than ever, often outweighing pure energy efficiency.

In 2023, severe weather events caused significant damage to solar installations worldwide, including in Italy, France, Switzerland, and Texas. Record-sized hailstones and extreme winds exposed the vulnerability of many panels, proving that not all modules are built to withstand such conditions.

For this reason, the quality of materials, glass strength, and installation methods have become essential criteria when selecting solar panels. Choosing robust solutions tailored to the environment ensures greater system longevity and a higher return on investment over time.

Did You Know?

Italy recorded the largest hailstone ever seen in Europe—a massive 19 cm (7.5 inches) long chunk of ice, about the size of an A5 notebook but much heavier, falling from the sky at an incredible speed!



This record-breaking hailstone was documented in the province of Pordenone, in the Northeast of the country, in July 2023 – just days after a previous record was set just a few hundred kilometers away, in the province of Padua. The news quickly spread across Italian social media through a viral photo comparing the hailstone to

This Italian giant came close to the world record of 20.3 cm (8 inches), set in the United States in 2010. An astonishing event, but also a worrying sign of ongoing climate change.

The Crucial Role of Glass in Solar Panel Durability

The strength of the front glass plays a decisive role in a panel's mechanical resistance.

Tempered and laminated glass, designed for controlled fragmentation upon impact, provides increased safety. However, the industry's shift from thicker (4 mm) to thinner glass (3.2 mm or less) has reduced mechanical resistance, making panels more susceptible to extreme weather conditions.

Statistical analyses of thousands of installations reveal that newer panels with thinner glass suffer more damage than older models. This underscores a trade-off: materials designed for cost reduction and efficiency gains can compromise mechanical strength.

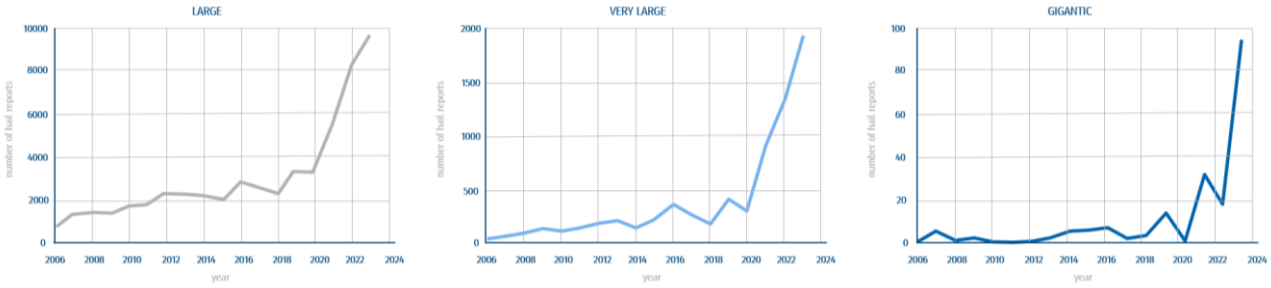
What the Data Says

According to reports from the European Severe Weather Database, between 2006 and 2023, there has been a significant increase in the number of days with intense hailstorms, classified into large, very large, and giant hailstones.

This concerning trend also impacts solar panel installations: between 2011 and 2021, the percentage of modules with glass damage due to hail rose from 8% to 20% in 2020. These figures highlight the urgent need to design and install more resilient panels to withstand an increasingly unstable and unpredictable climate.

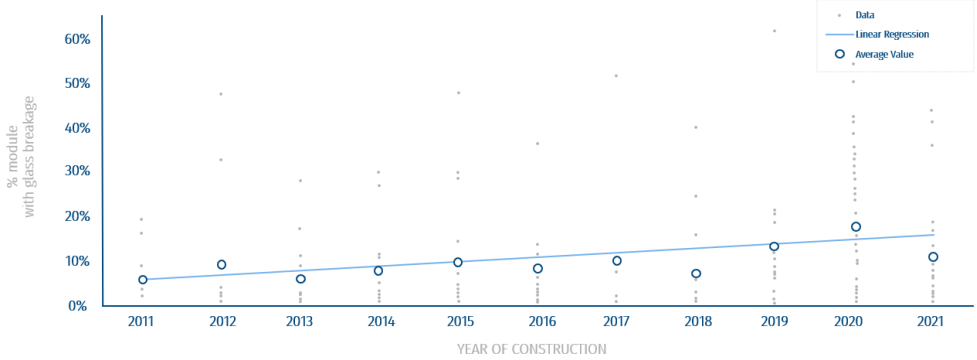
Hail Reports by Size: Large (1), Very Large (2), Gigantic (3)

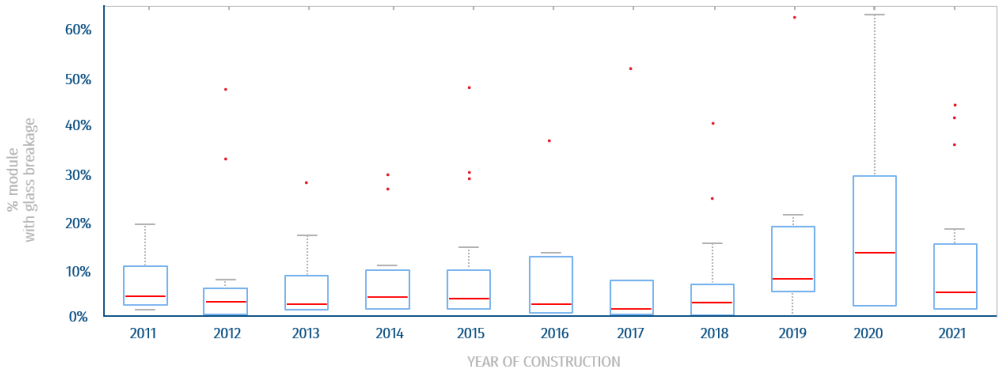
2006-2024



Broken Glass Reports in Solar Panels

2011-2021





Source: the European Severe Weather Database, SPF Institute for Solar Technology

The selection of glass for both the front and rear layers of a solar module is crucial in determining its resilience to impacts, particularly hail. Over the past decade, the solar industry has undergone a technological revolution, introducing increasingly innovative components that promise higher efficiency, energy yield, and long-term reliability. However, these advancements have also introduced new challenges in mechanical resistance and durability.

Tempered vs. Heat-Strengthened Glass: Enhancing Solar Panel Durability

In the early days of solar technology, most panels featured a single-glass, monofacial configuration. Today, bifacial double-glass modules dominate the market, offering increased efficiency and specific advantages in challenging climates. These benefits include resistance to saline fog, improved protection against sand abrasion in desert environments, and better resistance to moisture damage in humid areas. The double-glass design also enhances thermal stability, reducing hot spot formation and performance degradation over time.

However, the transition to double-glass has introduced new challenges, particularly related to impact resistance and mechanical stress.

To cut costs and reduce weight, manufacturers have moved from 4 mm glass to 3.2 mm in single-glass panels and as thin as 2 mm (or even 1.6 mm!) in double-glass panels. This shift has made specialized glass treatments, such as tempering and heat strengthening, essential.

- Tempered Glass: Heated to 620–650°C and rapidly cooled with forced air, tempered glass achieves a surface compression of ≥90 MPa, making it 4–5 times more impact-resistant than standard glass. If broken, it shatters into small, non-sharp pieces, enhancing safety during maintenance. This glass type is predominantly used in single-glass modules.
- Heat-Strengthened Glass: Heated similarly to tempered glass but cooled more slowly, this process results in a surface compression of 24–69 MPa, offering lower impact resistance. This glass type is more common in double-glass modules.

Since the front glass is the first line of defense against hail and other impacts, single-glass panels with thicker tempered glass are generally more reliable in extreme weather conditions.

Why Not Use Tempered Glass for All Modules?

The primary limitation is production complexity and cost. As glass becomes thinner, the tempering process becomes technically challenging. For glass under 2 mm thick, achieving a perfectly flat surface is difficult, leading to lower production yields and higher costs.

Currently, most double-glass modules use 2 mm heat-strengthened glass on both sides. While combining a thick tempered front glass with a thinner heat-strengthened rear glass would enhance durability, it would also increase costs and weight, making transportation and installation more difficult.

Hail Resistance Standards: The Need for Higher Benchmarks

Existing standards require solar panels to withstand hailstones of 25 mm in diameter, frozen for one hour at -4°C, and launched at 23 m/s (83 km/h). However, with extreme weather becoming more frequent, these thresholds are proving insufficient in many regions.

Fortunately, advanced testing protocols are now being developed, such as the Swiss VKF standard. These protocols classify panels based on mechanical resistance, subjecting them to harsher conditions—such as 40 mm hailstones frozen for 48 hours at -20°C and shot at 99 km/h. Panels like the Silk Nova Rhino undergo such rigorous testing to ensure resilience in extreme environments.

These protocols provide a stricter evaluation of a module's ability to withstand extreme weather conditions.

Glass-Glass vs. Glass-Backsheet: Choosing the Right Solar Module

The decision between double-glass and single-glass modules depends on multiple factors, including installation type, local climate conditions, and project goals. Each configuration has distinct advantages and limitations.

Here is a final comparison to help you identify the ideal applications of both types of modules.

Double-Glass Modules: The Power of Bifaciality

1. Agrivoltaic Systems with Vertical Panels

- Bifacial double-glass modules excel in photovoltaic and agrivoltaic installations where panels are mounted vertically. This setup takes full advantage of bifaciality, capturing both direct and reflected light on both sides of the module, thereby maximizing energy production.
- The vertical position significantly reduces the risk of hail damage, as the glass is not directly exposed to impacts.

2. Large Ground-Mounted Systems with Trackers

- In ground-mounted systems with solar trackers that follow the sun's movement, bifacial double-glass modules optimize the use of both direct sunlight and reflected light from the ground. However, it is crucial to ensure proper distribution of mounting points on the tracker to avoid excessive mechanical stress.

3. Installations in Challenging Climates and High-Reflection Environments

- In projects located in humid, high-salinity, or high-temperature environments, as well as desert areas, double-glass modules provide an ideal solution for maximizing performance and ensuring resilience against harsh climatic conditions.
- High-albedo environments, such as flat rooftops with white reflective surfaces, create an optimal setting for bifacial double-glass modules. The reflected light boosts energy output, fully leveraging the module's bifacial properties.

Single-Glass Modules: Reliability and Practicality for Rooftops and Standard Installations

1. Residential and Commercial Rooftop Installations

- Single-glass modules are the optimal choice for sloped or flat rooftops, where bifaciality is either marginal or irrelevant due to limited reflected light beneath the panel.
- The thicker 3.2 mm tempered glass front (that goes up to 4 mm for the Silk Nova Rhino) provides excellent protection against wind loads, snow, and hail, reducing the risk of damage.

2. Rooftops with Limited Space or Difficult Access

- Unlike double-glass panels, single-glass modules are lighter and easier to handle, making installation more convenient in tight spaces or rooftops with challenging access. This reduces labor costs and enhances installer safety.

3. Regions with Extreme Weather Events

- In areas prone to storms, frequent hail, and heavy snowfall, single-glass modules offer superior mechanical resistance, ensuring greater reliability against extreme weather conditions.

Final Comparison: What, When, and Why to Choose

	Single-glass (vetro-backsheet)	Double-glass (vetro-vetro)
Configuration	Monofacial: tempered front glass + polymer backsheet (with additional rear support bars for Silk Nova Rhino)	Bifacial: heat-strengthened reinforced glass on both sides
Glass Type & Thickness	- Tempered front glass, 3.2 mm thick (or 4 mm for Silk Nova Rhino) - Polymer backsheet	- Heat-strengthened reinforced glass on both sides - Reduced thickness (2 mm, some manufacturers go as low as 1.6 mm!)
Advantages	- Higher resistance to mechanical stress and impacts - Lighter and easier to install - Greater protection against extreme weather events	- Increased energy yield due to bifaciality - Resistant to humidity, salt fog, and high temperatures - Improved thermal stability, reducing performance degradation over time
Disadvantages	- Does not utilize reflected light (no bifaciality) - Lower resistance to specific climatic conditions (e.g., salt fog, high humidity)	- Lower mechanical resistance (thinner glass) - Heavier and more complex to install
Mechanical Resistance	High: tempered glass (≥90 MPa) provides better protection against hail, wind, and snow loads, especially with increased thickness (>3.2 mm), as seen in "hail-resistant" photovoltaic modules	Moderate: heat-strengthened glass (24-69 MPa) is less resistant and more vulnerable to mechanical stress
Ideal Applications	- Residential or commercial rooftop installations where module positioning makes reflected light insignificant to overall system efficiency - Areas prone to storms, snowfall, or frequent hail	- Installations with vertically mounted or ground-based tracker modules - High-reflection environments (e.g., snow or desert) - Humid, saline, or high-temperature conditions
Ease of Installation & Maintenance	Easy: lighter and more manageable, ideal for rooftops with limited access or tight spaces	More complex: heavier weight and mechanically more fragile glass make installation and maintenance more challenging and costly