



SOLAR PANEL TESTING

 **SOLARWATT®**

Confirmed quality

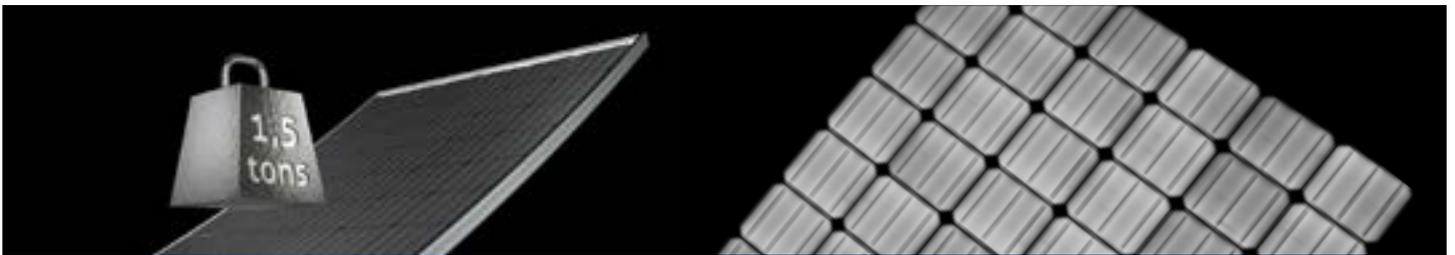
EXTENSIVE TESTING

SOLARWATT glass-glass solar panels provide 25% more energy within their 30-year warranty period and have a much longer lifespan than even high quality glass-foil solar panels. This is proven by exhaustive testing of our solar panels.

At SOLARWATT's test laboratory, accredited by VDE Renewables, our solar panels undergo extreme tests that demonstrate their superior quality and performance.

Without exception, all SOLARWATT solar panels are subjected to extensive testing before they are released to market.

By testing their resistance to both mechanical stress and weather simulations, we can prove the longer lifespan and better performance of SOLARWATT glass-glass panels as compared to glass-foil panels.



Mechanical load test (ML)

The mechanical load (ML) test simulates the physical pressure of snow and wind. The solar panel is clamped in place and held for 6 hours under varying pressure and suction loads of up to 5,400 Pa via a hydraulic system.

To meet stringent quality requirements, the solar panel must pass this test completely unscathed.

Electroluminescence test (EL)

Somewhat similar to an X-ray, the EL test reveals even the smallest damage (micro cracks) to a solar panel. Any such cracks would hinder the lifetime performance of a solar panel so these tests are crucial to understand the long-term effects of stress.

After each mechanical load test the solar panels must pass the electroluminescence test – even one micro crack is enough to reject the panel.

Tested up to 8,000 Pa

Our framed glass-glass panels can hold up to 4 times the weight of a regular panel that has been tested under the TÜV 61215 standard.

This standard requires that solar panels handle a pressure of 2400 Pa. SOLARWATT solar panels are tested up to 8000 Pa and still reveal zero micro cracks using electroluminescence measurements.

Higher mechanical strength

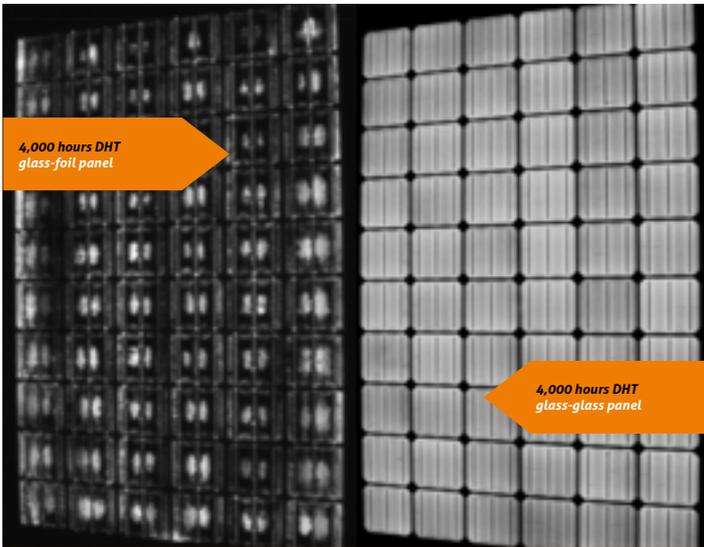
Glass-glass panels feature a higher mechanical resilience because the two solar glass panes are affixed to one another.

The use of a second pane ensures torsional rigidity and stability not present in conventional glass-foil panels. Result? The panels are ideal for installation in regions with high snow and wind loads and can withstand extreme weather such as heavy hailstorms.



Conclusion:

SOLARWATT glass-glass panels are extremely strong



4,000 hours DHT
glass-foil panel

4,000 hours DHT
glass-glass panel

Damp-Heat Test

The damp-heat test exposes a solar panel to a temperature of 85°C for 42 days, in a climate chamber with 85 % humidity – comparable to a tropical climate. This test assesses the combined effect of moisture and heat on the aging process of the solar panel.

Glass-foil panels are protected on the backside only by a sheet of plastic so as soon as the plastic degrades even a little – moisture can penetrate the panel and reach the solar cells.

Tests in the climate chamber show that moisture and heat have little influence on glass-glass panels because they are sealed more securely against outside elements.

The glass pane on the backside lets no moisture through and as such the cells do not age quickly from exposure to moisture, heat, or cold. SOLARWATT glass-glass solar panels have demonstrated a much longer lifespan and better performance in aggressive environments such as coastal areas (featuring salt) and Farm Outbuildings (with ammonia).

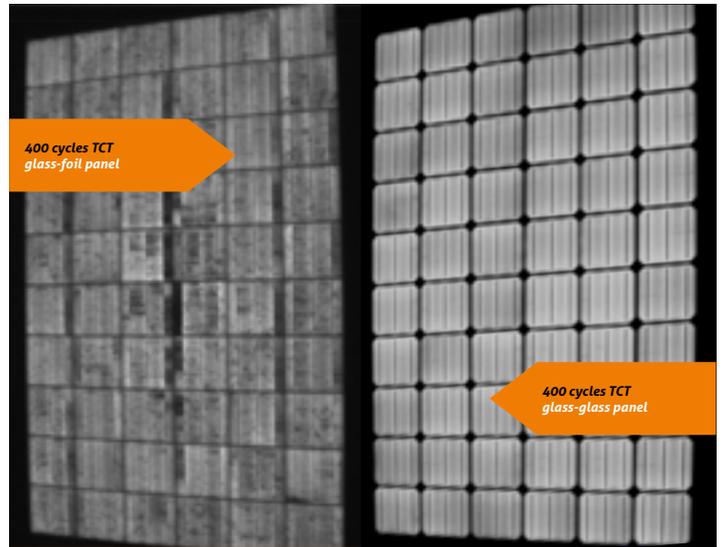
SOLARWATT glass-glass solar panels undergo a 5,000-hour damp heat test for tropical climate that is five times longer than prescribed (the IEC standard is 1,000 hours). Even this prolonged testing has resulted in zero deterioration in glass-glass panels.

Electroluminescence after Damp-Heat Test

The image above shows an electroluminescence test – light generated in response to an electric charge applied to the panel – after 4,000 hours of damp heat testing.

Almost the entire cell surface of the conventional glass-foil panel is inactive (black). Very few panes in the centre of the cell are still active (light). The glass-glass solar panel, in contrast, remains fully intact.

Conclusion:
testing reveals more than 50% power loss in the glass-foil panel against no power loss of the SOLARWATT glass-glass panel.



400 cycles TCT
glass-foil panel

400 cycles TCT
glass-glass panel

Thermal Cycling Test

Solar panels are constructed from a range of materials, each responding with a different rate of expansion under heat and radiation. Due to temperature and radiation changes, these components expand and shrink and if the materials aren't properly supported, this can cause damage and breakage.

Standard thermal cycling tests on solar panels involve 200 cycles, with temperature varying from -40°C to 85°C. SOLARWATT glass-glass panels, however, undergo as many as 600 cycles. Even with three times the testing stress, SOLARWATT panels still only show deterioration of about 1%.

Electroluminescence after Thermal Cycling Test

The figure below shows the electroluminescence at 400 Thermal Cycling Test (TCT) cycles. Due to the difference in thermal expansion and shrinkage of the glass layer and the back plastic of the glass-foil panel, the embedded cells are slowly destroyed by the repetitive bending and stretching.

Dead spots form (black areas in the picture) where solar power is no longer produced. The glass-glass solar panel, on the other hand, remains almost entirely intact.

The glass-foil panel produces about 3% less power while the glass-glass module shows a deterioration of only about 0.5%. These figures represent a stark difference especially when considering the lifetime yield of the panel.

Conclusion:
SOLARWATT glass-glass solar panels can withstand the most extreme weather conditions.

Extreme weather resistance

HAIL TEST

A summer evening on June 23, 2016, will go down in history as the date an unprecedented hailstorm caused at least 1 billion euros' damage in the Southeast Brabant area of The Netherlands. It was the first time Dutch solar energy users experienced large-scale damage to their PV panels caused by hailstones.

Extraordinary

One type of solar panel suffered far less damage – the glass-glass variety! Electroluminescence testing of 10 installations soon after the storm by the specialist firm, SolarTester, found that most standard glass-foil solar panels should be deinstalled and thrown away because they were completely broken. Even glass-foil panels without visible damage on the front side were also broken. That makes sense, as glass-foil solar panels are not designed to withstand this kind of hailstorm.

When a solar panel is tested for hail, ice balls 25 millimetres in diameter are used but the impact of a 50-millimetre hailstone has 20 to 30 times more force than this. When such a stone hits a solar panel, the impact is transmitted to the solar cells through the glass and the cells will shatter.

A Key Question

A question that often arises is what to do if one or two of five solar panels tested are found to be defective? Does the insurer reimburse all except one fifth or two fifths of the installation? That is, for the time being, a grey area. In addition, there are concerns about what happens if defects only become apparent a year or two after the hailstorm. Their product warranty may by then have expired. A hailstone of 50 millimetres may have an impact up to 30 times greater than allowed for in certification testing.

Even a solar panel which appears undamaged and intact may be found by electroluminescence testing to have sustained micro cracks or other damage. Although the micro cracks might not lead directly to a large loss of yield, they remain weaker zones in the panel which would be more quickly damaged later by temperature fluctuations, shrinkage, and expansion in the years following. After several years though, it is also difficult to satisfy an insurer that the hailstorm was the main cause.

The Neutral Zone

Glass-glass panels eliminate this problem because of the neutral centre zone which is created between the two glass plates. The tenth of a millimeter gap makes a big difference, as the solar cell sits perfectly in this point of least pressure, the "neutral zone".

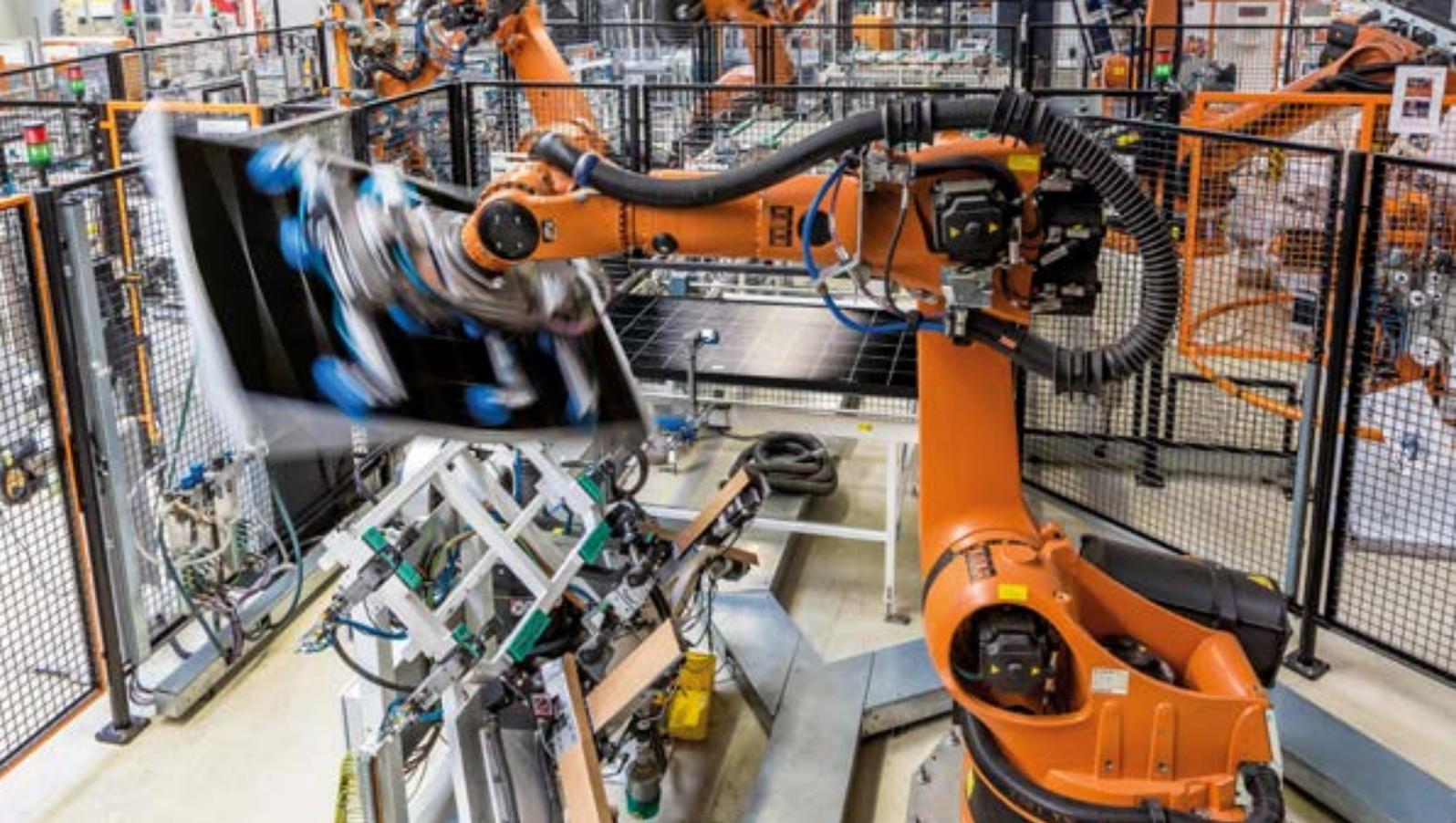
Solar panels last several decades and it is impossible accurately to predict what extreme weather conditions they will be exposed to in practice. We know that extreme weather is expected to be a major result of climate change and SOLARWATT glass-glass panels will be able to withstand those events.

Industry-leading strength

The IEC (International Electrotechnical Commission) standard prescribes a hail test with 25mm stones and a speed of 23m/second. But glass-glass solar panels from SOLARWATT are tested with 45mm hailstones (almost six times standard mass).

SOLARWATT is the first and only supplier that meets the requirements of 'hail class 4' with its 2mm thick, thermally hardened glass, making SOLARWATT glass-glass solar panels resistant to hail and other extreme weather conditions.





SOLARWATT glass-glass panels

THE ADVANTAGES

Here are some of the advantages of SOLARWATT glass-glass solar panels:

- ✓ More than 27 years experience in the field of glass-glass. The laminating process has been continuously developed by SOLARWATT
- ✓ Guaranteed 25% average extra yield over the product lifetime
- ✓ 'Best tested' according to CLEAR. SOLARWATT solar panels were rated best in a study by CLEAR, an EU project to help end customers make the right decisions regarding decentralised energy supply
- ✓ Maximum load capacity of mechanical external influences possible
- ✓ Fire Safety Class A (best rating) according to IEC
- ✓ 30-year warranty on the product and 30-year linear performance guarantee
- ✓ 100% protection against performance degradation (both PID and LeTID safe)
- ✓ Glass-glass panels are exceptionally robust
- ✓ Glass-glass panels prevent microcracks because there is no tensile and push load on the solar cells
- ✓ Glass-glass panels are resistant to extreme weather conditions, tested in Australia against cyclones
- ✓ Extreme environmental influences are no problem: ammonia (farms), aggressive gasses and acid rain (industrial), salt (coastal areas), & abrasion (sandstorms)
- ✓ Resistant to heat-cold cycles: the symmetrical construction of glass-glass panels allows expansion and shrinkage to occur evenly, resulting in considerably less aging (than with glass-foil)
- ✓ IP67 socket for optimum watertightness
- ✓ Compared to a good glass-foil module, the glass-glass module produces 25% more guaranteed power within the warranty period of 30 years
- ✓ 'State of the art' glass-glass helps the installer to situate themselves as a leader in their market

**PROFITABLE.
DEPENDABLE.
INDESTRUCTIBLE.**

www.solarwatt.com