

All solar panel manufacturers make promises about the power of their products. But how do you know your solar panel will really deliver what's promised?



# Out-of-the-Box Power

Knowing the answer to this question is all about making a sound investment in solar. You can't simply take a solar panel for a quick test drive. Nor can you tell how good a solar panel is just by the way it looks.

Evergreen Solar recognizes how difficult it is to know exactly what you're really buying. That's why we've worked hard to make sure every one of our solar panels delivers just what you expect.

## Three steps to superior quality

First, we control every step of making solar panels – from the silicon wafers used to make our solar cells to our completed solar panels. Not only do we control every step, but we do it all under one roof using state-of-the-art production technology. That means we really can guarantee the high quality of every solar panel we make.



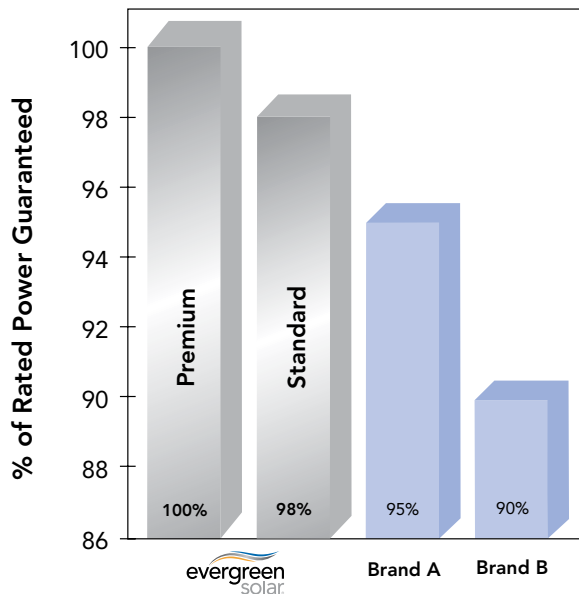
*Wafers, cells and completed solar panels made under one roof*

Second, we regularly calibrate all our power test equipment with the help of renowned independent laboratories such as TÜV in Germany and the National Renewable Energy Laboratory (NREL) in the United States. We even install calibrated solar panels right on top of our measuring equipment to ensure that every individual panel is tested against the same high quality benchmark. After all, the power of any solar panel is only as good as the equipment that measures it.



*Evergreen Solar power tester with a calibrated solar panel mounted on top*

Third, we classify our products with one of the tightest power tolerances in the industry. You're guaranteed at least 100% of the rated power for our premium products and 98% for our standard products. Many manufacturers guarantee only 95% or less of the rated power. That means at least 3% or more additional available power from Evergreen Solar panels. It might not sound like much, but that can be a lot of electricity over 25 years.



*Guaranteed power offered by different brands*

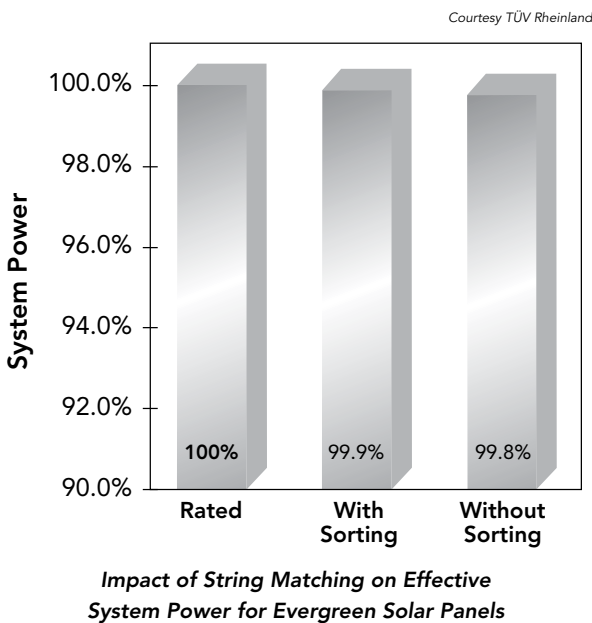
### Optimum performance at no extra cost

Slight variations in the manufacturing process of solar panels influence the final power of an individual panel. That means the power of one panel will never be exactly the same as the next.

We know that the power of a complete solar installation can be limited by the panel with the least power, making it important that solar panels are sorted and matched prior to installation.

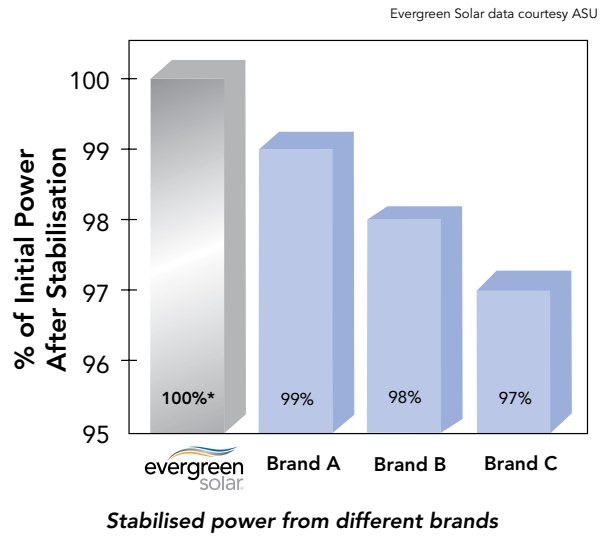
However, with our tight power tolerance and state-of-the-art manufacturing controls you are assured optimum system performance from the outset without the need for sorting and matching.

TÜV has shown that there is virtually no benefit to "sorting and matching" our solar panels to get best performance. You get practically optimum performance right out of the box while saving the extra costs associated with sorting and matching.



### Solar panels that like the sun

What happens when solar panels see the first few days of sunlight? Many panels lose power due to an effect called light-induced degradation or stabilisation. Some manufacturers don't account for this loss when they sell you a solar panel. That means any test data provided for individual panels becomes invalid immediately after the product is taken out of the box and used. At Evergreen Solar we firmly believe that the very thing enabling panels to produce electricity should not be the very thing that causes them to lose power.



Evergreen Solar has introduced new light stable materials to help eliminate light induced degradation from our solar panels. Competitor products can lose between 3% and 5% of their initial power as soon as they have seen the sun for a few days. Evergreen Solar panels lose none.

How do you capture these advantages in a real system? We are proud to be one of the few manufacturers conforming to the EN50380 norm – a standard defining the product information all customers should get to help them design an optimum and safe solar system. Check out our latest product datasheets for all the information you need to do just that.

\*within the tolerances of measurement accuracy

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Evergreen Solar panels are created in a strictly controlled manufacturing environment.

But what happens in the demanding and sometimes unpredictable conditions of the real world? There can be a marked difference in the power tested under ideal conditions in the factory versus the power you actually get in the field.



## In-Use Power

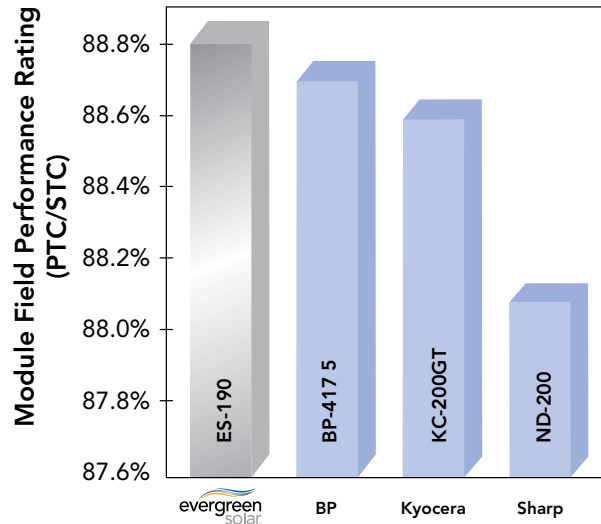
Solar panels get hot, they get dirty, and light doesn't always shine on them the way we'd prefer. We have therefore equipped our panels with the right tools to help them handle these field realities.

### Power that loses less in the heat

When solar panels get hot during the day they become less efficient. The trick is to minimize this loss in efficiency. At Evergreen Solar we have worked hard to deliver products with temperature-related performance better than some of the leading brands available today. Simply put, when our panels get hot they give you more than others do.

This advantage is captured in our so-called PTC/STC field performance rating. This rating measures the difference in power between real field conditions (PTC) and controlled factory test conditions (STC). The higher the percentage, the better suited the panel is for real field conditions.

For example, if all the solar panels shown in the chart to the right were tested in the factory at 100W, Evergreen Solar panels would deliver 88.8W in the field. That's nearly 1% more power than other leading brands measured under the same conditions. It might not sound much, but the extra power can add up to a lot of electricity over 25 years.

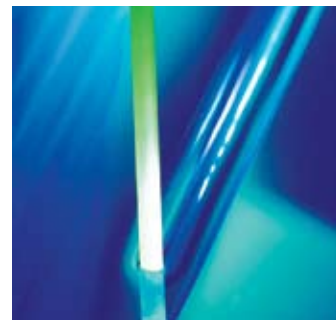


**Performance ratings of different brands**

PTC – PV USA Test Conditions; STC – Standard Test Conditions  
CEC Listing of Eligible Photovoltaic Modules, May 2007

### Power that catches more light

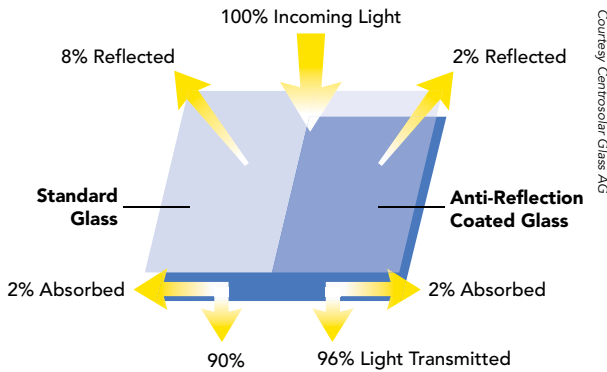
The primary job of our solar panels is to capture light and convert it to useful electricity. We take advantage of an innovative anti-reflection (AR) coating applied to the glass cover of our solar panels to help catch more light. The new coating was developed with the help of the renowned Fraunhofer Institute in Germany.



Courtesy Centrosolar Glass AG

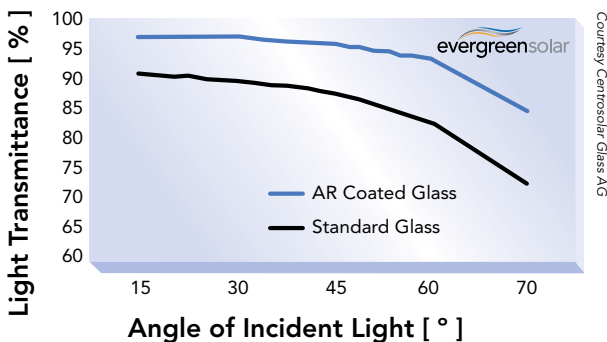
**Anti-reflective coating being applied to Evergreen Solar Glass**

Normally a portion of the light that lands on a solar panel will get reflected and lost forever. The AR-coating helps capture more light by reducing the amount of reflection from the glass surface by up to 6%. That means more light to make electricity.



**More light captured with anti-reflection coated glass**

The shallower the angle at which the light hits the panel the more light is lost. But with cutting-edge AR-coating technology we are able to trap up to 16% more light during the early morning and late afternoon hours, when the sun hits the panel at a shallow angle.



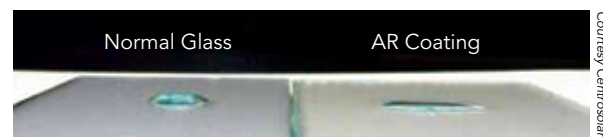
**More light captured when light hits the panels at shallower angles**

Not only does the AR-coating work better at capturing direct sunlight, it is also better at capturing diffuse light typical of cloudy conditions. When combining all these effects, the total annual gain in power is typically between 3 and 5% when comparing solar panels with and without an AR-coating on the glass.

But the magic of the AR-coating doesn't just stop there. The coating itself is actually made of the same material glass is made of. That means it's extremely durable and will last at least as long as the solar panel itself.

**Powering through dirt**

Dirt, dust and falling leaves are another reality which can pose a challenge for solar panels. Another high-tech feature of our glass is its self-cleaning ability. Drops of water normally bead on glass and trap dirt. The AR-coating ensures that water doesn't bead on the glass, but instead makes water droplets sheet across the surface of the solar panel. This sheeting helps to rinse away loosened dirt and allows for quick evaporation.



**Water doesn't bead on AR-glass**

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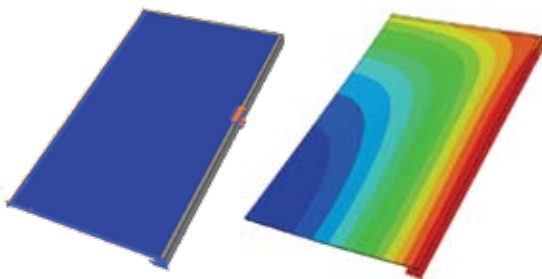
We know installation costs make up an important part of overall system costs and that some mounting methods are more cost effective than others. We recognize that not all roofs are the same and that some systems benefit from certain electrical configurations more than others.

## Versatile Power

In short, solar panels must be versatile enough to install how you want and where you want. So we created a solar panel with extraordinary versatility.

### State of the art product design

Our solar panels may not look vastly different from many others you can buy today. But pay attention to the details. Using sophisticated design and analysis tools borrowed from the aerospace industry, we have developed a specialized double-walled frame that allows our solar panels to be mounted virtually anywhere.



*Sophisticated tools are used to evaluate Evergreen Solar panel design*

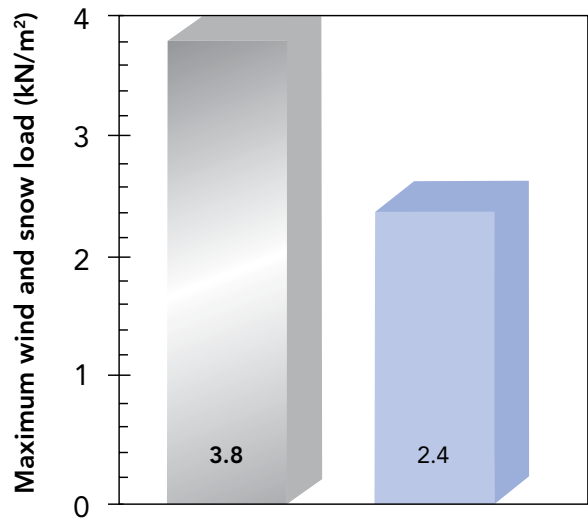
We have also carried out many hours of simulated wind and snow loading at third party test institutes who are experts in testing solar panels. These tests verify that our solar panels really do perform the way our models predict.



*Snow load testing of Evergreen Solar panels at Arizona State University, USA*

### Installable virtually anywhere

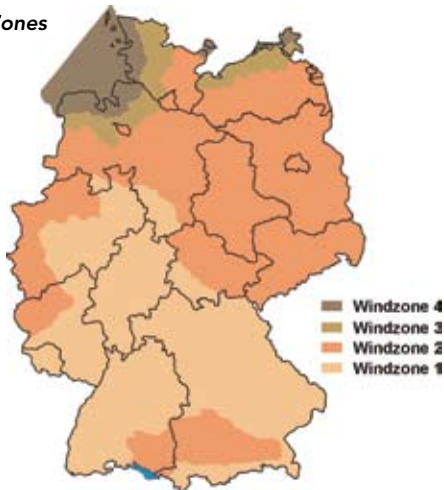
Most solar panels are certified by the IEC 61215 standard to a maximum wind and snow loading of 2.4kN/m<sup>2</sup>. But in reality loadings in the field can often exceed this maximum, especially in areas prone to high winds or heavy snow.



**evergreen solar** Typical Solar Panels  
*Maximum guaranteed loading capability of Evergreen Solar panels versus typical competitors*

Due to our specialized module framing technology, Evergreen Solar is able to guarantee combined wind and snow loading up to 3.8kN/m<sup>2</sup>. This is over 50% more guaranteed loading capability than many of our competitors. It also means our products can be installed virtually anywhere in Germany up to and including the most severe wind and snow load zones in the country.

**Wind Zones**



**Snow Zones**



Maximum Guaranteed*	Wind Zone	Snow Zone
Spruce Line™ Modules	Up to 4 (>100km/h)	1 – anywhere 2 to 900 m 3 to 700 m

Courtesy: Störfix

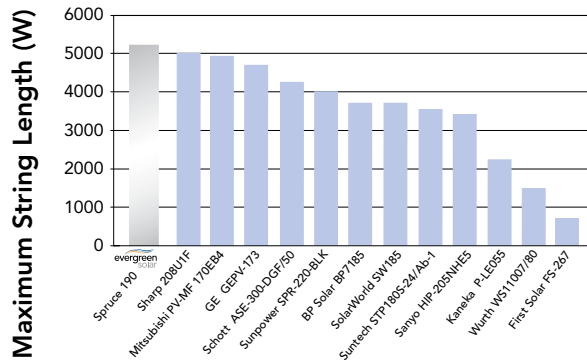
**Wind and snow load zones in Germany according to DIN 1055 (2007) and corresponding limits for Evergreen Solar panels**

\* Assumes snow and wind loads are not combined and Modules are mounted at the 1/5 points according Method A as defined in the Evergreen Solar Mounting Design Guide. Wind pressure is based on DIN 1055-4, Appendix A, using reference wind speeds with no correction for height, exposure, gusts, building shape or location. Snow pressure is based on ground snow loads in DIN 1055-5, Figures 1 & 2. Local variations in ground snow loads may occur, and snow loads on panels may exceed ground loads under certain circumstances. Consult your local authorities for wind and snow load requirements and stricter regulations which may apply in your particular area.

**Installable virtually any way**

Evergreen Solar panels are the first in the industry to be certified and guaranteed for mounting using virtually any location on the frame – from mounting on the short sides only to mounting at the centre and many variations in between. The maximum guaranteed load depends on how the product is mounted. To help you better understand exactly what we mean, see our exclusive **Mounting Design Guide** for more details.

Another way to reduce the cost of larger systems is to electrically install more solar panels in series. However, the maximum length of strings is often limited by the voltage of the solar panel. Due to the relatively low voltage of Evergreen Solar panels they can be installed in strings with over 5000W of capacity – that’s up to 8 times the maximum string length of some of our competitors.



**Maximum string lengths for a variety of solar panels**  
Based on a maximum DC open circuit inverter input voltage of 900V

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Concern for the environment is a fundamental reason we're in the solar business. That's why it's doubly important for us to be a leader in the business of supplying clean energy. Did you know that some solar panels supply cleaner electricity than others? Let us explain why.



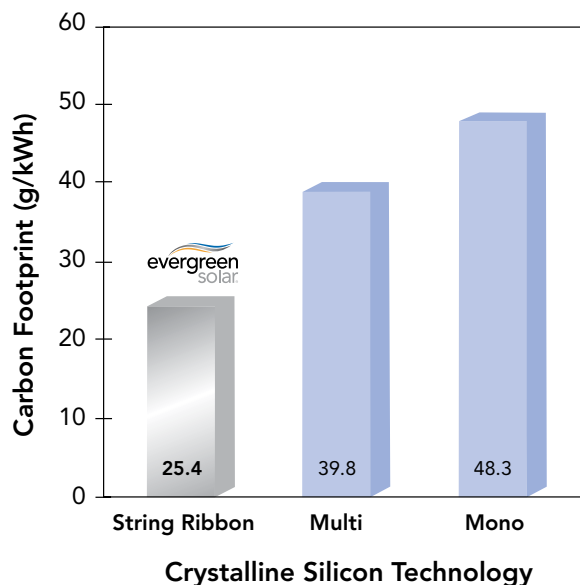
# Clean Power

## Fighting global warming

There's a lot of talk about why we need to invest in alternative energies to help fight global warming. The culprit is carbon dioxide (CO<sub>2</sub>) the ubiquitous greenhouse gas that results from the burning of fossil fuels in power stations, cars and airplanes. The expression "a carbon footprint" has become the buzzword used to describe how much of an impact our activities have on global warming. Your own carbon footprint is a measure of how much CO<sub>2</sub> is generated by everything you do or use.

How big is the carbon footprint of solar panels, and just how far do they go in helping us tackle global warming? Electricity is used to make solar panels. That electricity is usually generated in power stations which emit a lot of CO<sub>2</sub>. A solar panel itself generates electricity without emitting CO<sub>2</sub>. We divide the CO<sub>2</sub> generated in the making of the solar panel by the amount of CO<sub>2</sub>-free electricity it produces over its lifetime to give us an indicator of the carbon-footprint of solar panels measured in grams of CO<sub>2</sub> per kWh of electricity generated.

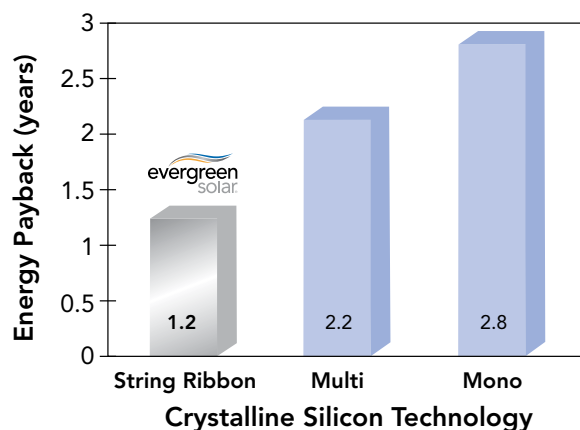
Evergreen Solar products have the smallest carbon footprint of any crystalline silicon product, nearly 50% smaller than typical mono-crystalline based solar panels. And we continue to reduce our carbon footprint through new innovations. So if you're choosing to go on a low carbon diet there's only one obvious choice.



*Carbon footprint of PV systems for different technologies*  
Based on a southern European climate with 1700 kWh/m<sup>2</sup>/yr irradiance

## Conserving our planet's resources

Carbon dioxide is not the only concern for our environment. With an ever growing population, careful use of our planet's resources is increasingly just as important. The less energy we use to create our solar panels, the more we conserve the earth's precious resources. How do we quantify the impact solar panels have on our planet's resources? We divide the energy used to make a solar panel by the amount of clean energy it produces over its lifetime – the so called "energy payback time" which is typically measured in years.



*Energy payback time for PV systems based on different technologies*  
Based on a southern European climate with 1700kWh/m<sup>2</sup>/yr irradiance

Evergreen Solar products have an energy payback time as fast as 15 months - the fastest payback time of any crystalline silicon product available today. Not only does it mean that you're making the best choice in helping to conserve our planet's resources, but also that you're generating real clean electricity for a longer period of time.

### Minimizing packaging waste

One of the reasons we invest in solar power is to do our part to protect the environment. It's important to Evergreen Solar that helping to protect tomorrow's environment does not cost the earth today. What have we done to minimize our impact on the environment?



***"Cardboard-free" product packaging solution used by Evergreen Solar***

We have eliminated cardboard from our product packaging materials which means less packaging waste on-site. We have optimized our packaging to minimize the number of truck shipments. We have initiated a pilot program for the return and re-use of the plastic corner pieces used to support and protect our products during shipment. Many small ideas, but they add up to a product which is truly "greener than green".

### Using clean materials

There's also a lot of talk about solar panel recycling. We, however, believe it's more important to make a clean product in the first place. So, in 2006, we eliminated lead from all the soldered inter-connections between the solar cells in our module. In 2007 we are looking at ways to completely eliminate lead from the cells themselves.

### Making solar panels using clean power

As a solar company we should set a good example to our customers and neighbors. That's why we've built a 86 kW solar system on our largest factory making Evergreen Solar panels. The system will generate more than 72,000 kWh of clean electricity every year. That's enough to relieve the environment of more than 43,000 kg of CO<sub>2</sub> ever year.



***Solar power system installed on the factory roof in Thalheim, Germany***

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