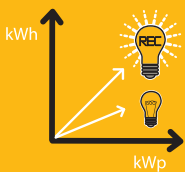


PROTECTING YOURSELF FROM SOLAR PANEL DEGRADATION

HOW CHOOSING REC PANELS CAN PROTECT YOU FROM POWER LOSS

- Earn more money through reduced degradation
- Choosing a quality panel with quality materials
- Trust only a quality manufacturer
- Use independently tested and proven panels



HIGHER ENERGY YIELDS



100% PID FREE

WHAT IS DEGRADATION?

The reduction in power production ability over time in solar panels is known as degradation. Because you invest in a solar installation with the aim of producing energy year after year, any reduction in production ability can impact on the system finances and profit.

There is a huge choice of solar panels, and to the untrained eye they all look similar. Beneath the visuals however, lie major differences in product quality – from the original silicon used to make the wafer (the building block of the solar cell) right through to the cell production process and the surrounding insulation materials, which protect the cells to the final panel. All of these influence the quality of the product and how much it degrades over time as better quality panels use better quality materials.

Degradation is a natural phenomenon caused by different factors and can be devastating to the customer's pocket. It stands to reason, better quality solar panels suffer less degradation and are therefore a better option for maximum income and savings.

★ The less degradation, the more money you earn!

There are three major forms of degradation that affect a panel - Light Induced Degradation, Potential Induced Degradation and the Annual Degradation Rate.

LIGHT INDUCED DEGRADATION

Light Induced Degradation (LID), is a small loss in power production ability that occurs on first exposure to sunlight and stabilizes after a few days. Affecting all silicon solar cells, LID is irreversible and permanent. It can be compared to the loss in value of a brand new car as soon as it is driven away from the showroom and is caused by the amount of impurities in the wafer material. So what is important is to know how much a chosen panel will degrade as soon as it is on the roof.

LID affects every solar panel to different extents depending on factors such as the intensity of sunlight and the inner structure of the cell. This means that making a poor choice of panel can leave with you with a significant amount less power than you paid for!

★ Ensure you get the power you pay for.

ANNUAL DEGRADATION RATES

A few days after installation, the panels will stabilize in power output and begin to age naturally over time at a more gradual rate. However, as an end-customer, you want your panels to age as slowly as possible, keeping output levels as high as possible throughout the lifetime of the panel.

★ Choose a quality panel with quality materials.

POTENTIAL INDUCED DEGRADATION

Potential Induced Degradation (PID) is often considered the most serious threat to solar installations today. It is an undesired leakage of current caused by a combination of high voltage, high humidity and high temperatures – making it a particular concern in tropical environments.

The industry journal Photon reported in December 2010, that PID can result in losses of 20% or more. Such a drastic reduction in system performance - even early on in a panel's life - can happen quickly and drag performance below expected returns. An occurrence of PID can lead to irreparable damage of cells, bringing the overall output down and a permanent reduction in power generation.

★ A quality panel offers you protection against degradation.

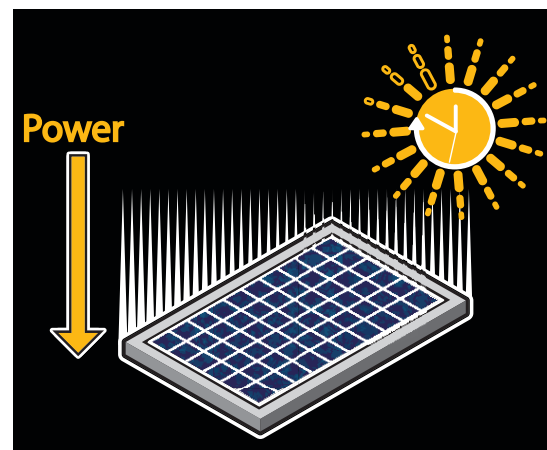
WHY DOES A PANEL DEGRADE?

Degradation is a natural phenomenon, which can be likened to aging over time. As it has no moving parts, a solar panel's operating life is determined by its stability and resistance to corrosion of the materials from which it is constructed and these can be influenced by factors such as:

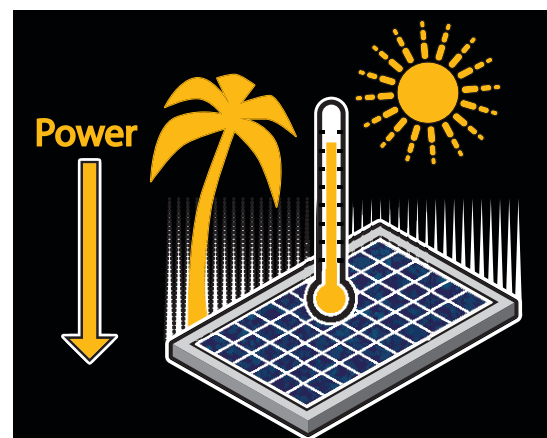
- Temperature
- UV exposure
- Mechanical damage

In solar panels, degradation can be identified by the following signs:

- Change of color
 - Poor quality materials can be seen by a yellowing of the backsheets caused by UV light
- Corrosion:
 - Including the decreased adherence of contacts caused by water vapor
- Delamination
 - Where the insulation materials weaken and allow humidity in and leakage of current



LID: All solar panels see a loss in power after a few days of exposure to light.



PID: In environments with high temperatures and high humidity such as tropical regions, solar panels can see a loss in power.

WHAT IS REC DOING TO PROTECT YOU FROM LID?

As LID is caused by impurities, it is critical that REC uses the highest quality and purest silicon to make its products. In building and improving its modern and integrated factory in Singapore, REC has consistently invested in industry-leading automated production processes, which reduce variation and make high quality panels consistently possible while keeping LID as low as possible. Included in this are production advances such as:

- An exclusive coating technology on REC's crucibles protect the molten silicon from contamination
- A unique mix of two different types of silicon – chunk and granules to ensure there is as little air in the melt as possible, meaning a purer wafer product
- Development of a special furnace technology to minimize air and impurity content in the silicon melt

The impact of this is proven by independent tests. The Solar Energy Research Institute of Singapore (SERIS) recently carried out a comparative performance test of the leading manufacturers and the results showed that REC panels were the only ones to lose less than 2%.

★ **REC panels had the least power loss of all test participants.**

WHAT IS REC DOING TO LIMIT ANNUAL DEGRADATION?

Degradation is a natural process and all solar panels will lose some power as time goes on. By using only the highest quality materials that pass our demanding qualification criteria (double that expected by international standards), REC reduces the degradation seen in its panels.

REC carries out an annual degradation study of panels of different ages and from climates from real-world installations in order to track power loss over time. The most recent study, completed in 2013, compared real installations across different climates and showed that of the sites in the test, all were performing above expectations, even when maximum measurement tolerances were applied to the results, confirming the quality of the design and manufacturing process at REC.

★ **Only trust panels from a quality manufacturer.**

WHAT IS REC DOING TO PROTECT YOU FROM PID?

Any look through solar magazines will see advertising for PID-free panels from different manufacturers. However, upon closer investigation, some of these claims are only valid for a select range of products, which are often sold at higher prices or allocated to specific regions, meaning customers are rarely sure whether their panels can resist PID or not.

SERIS also tested panel performance of the same manufacturers under PID conditions* and found that REC panels remained unaffected by PID, whereas the majority of the competition suffer power loss, even up to 50%!

★ **REC panels show zero power loss due to PID.**

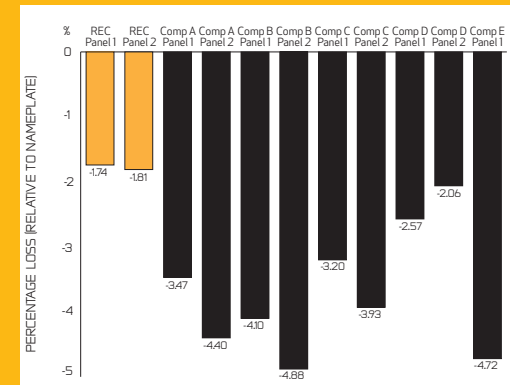
This justifies REC's declaration that 100% of its panels are PID-free. This has been achieved through introducing unique treatments at cell and panel level which protect against PID conditions, ensuring that a measurable and sustainable energy yield advantage is provided to all customers, in all climates. REC ensures the same treatment is given to 100% of its production, meaning that every REC panel can withstand the PID test, no matter where it is installed. As the test results clearly show, this is not always true of the competition.

*IEC/NREL PID test protocol of 96 hours at 60°C and 85% humidity with a negative voltage of -1000 V.

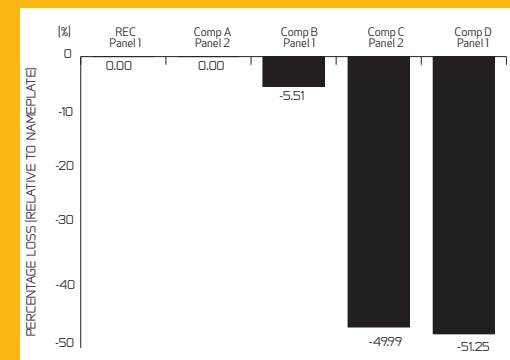
INDEPENDENT TESTING OF PANELS

The Solar Energy Research Institute of Singapore (SERIS) recently carried out a series of comparative performance tests on panels from the leading manufacturers globally and the results showed that REC panels perform better than the rest of the Tier 1 manufacturers.

LID test of 40 kWh:



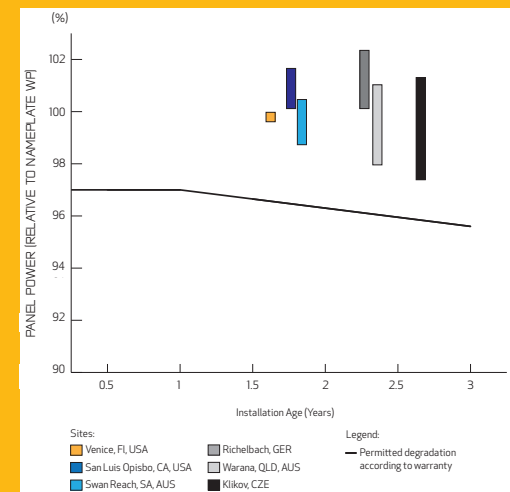
PID test (96 hrs, 60°C, 85% R.H., -1000 V)



MONITORING OF ANNUAL DEGRADATION

REC's annual study into the degradation rate of its panels of different ages and from climates from around the world shows that of the sites in the test, all were performing above the expected level as provided for by the warranty.

Degradation rates over time



CHOOSE A RELIABLE SUPPLIER FOR A SECURE INVESTMENT



REC – A GLOBAL LEADER

REC is a leading global provider of solar energy solutions with more than 15 years of experience, demonstrating that REC is a long-term player in the solar industry.

Founded in 1996, REC is headquartered in Norway and employs more than 1,600 people worldwide with offices, representatives and partnerships in place to help meet the world's growing energy needs.

REC's high-quality solar panels are installed for various applications in Europe, USA, Australia, Thailand, Japan, India, and locations in between. At the end of 2014, REC had produced more than 15 million solar panels, amounting to 4 GW of clean, green energy.

LOW CLAIMS, HIGH SECURITY

The high quality of REC solar panels is further supported by the very low claims rate. REC's automated production is state of the art, comparable to automotive industry standards. The high level of automation ensures consistent high quality output.

To put this in perspective, out of approximately 3 million solar panels manufactured on a yearly basis, less than 300 return to REC from the field.

In perspective:

Fewer than 300 from approximately 3 million REC solar panels manufactured each year come back from the field with claims.

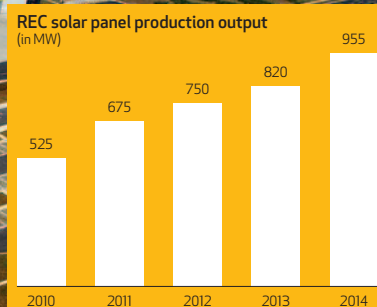
REC's solar panel production in Singapore received a Solar Industry Award for Module Manufacturing Innovation.

AWARD-WINNING PRODUCTION

In today's competitive solar market with import duties on some products, it's important to know where solar panels come from. REC solar panels are produced at a world-class facility in Singapore, which is certified to the highest health, safety, and environmental standards. Output steadily increases to meet the growing demand for REC solar panels.



REC's state-of-the-art manufacturing facility in Tuas, Singapore.



REC is the largest European brand of solar panels, with more than 15 million high-quality panels produced at the end of 2014. With integrated manufacturing from polysilicon to wafers, cells, panels and turnkey solar solutions, REC strives to help meet the world's growing energy needs. In partnership with a sales channel of distributors, installers, and EPCs, REC panels are installed globally. Founded in 1996, REC is a Bluestar Elkem company with headquarters in Norway and operational headquarters in Singapore. REC's 1,800 employees worldwide generated revenues of USD 680 million in 2014.



www.recgroup.com