

DAY AFTER DAY™

Photovoltaic Solutions



For over 40 years

our material innovations have led the photovoltaics industry forward, and helped our clients transform the power of the sun into power for us all. Today we offer a portfolio of solutions that deliver **proven power** and **lasting value** over the long term. Whatever your material needs, you can count on quality DuPont Photovoltaic Solutions to deliver the lifetime performance, efficiency and financial returns you require, day after day after day.





BECAUSE THE WORLD CAN'T WAIT

When Materials Matter™, you continuously innovate so that the power you are able to deliver keeps the world moving forward.

Today there is genuine urgency about reducing our dependence on fossil fuels, yet demand for energy continues to grow.

Global demand for solar energy is surging. Solar system installations are expected to grow at an average rate of 15% over the next five years. China is on an exceptionally ambitious track toward 110 gigawatts by 2020, and India is seeking 100 gigawatts by 2022. As populations and economies continue to expand, faster and broader adoption of solar will be required to meet our renewable energy needs.

But it's not enough to merely fill the increasing demand. The world needs dependable energy that's as reliable as the sun itself.

DuPont Photovoltaic Solutions stands alone as the industry leader, and our long-standing commitment to continuous innovation has transformed solar into a viable commercial energy source for the new energy economy. Our materials have been repeatedly verified by field-testing to perform over time—which means reliable investment returns for you, and a supply of clean energy the world can count on into the future.

OF THE
900M PANELS
INSTALLED

IN THE PAST
40 YEARS

MORE THAN
50% CONTAIN
OUR
MATERIALS

TEDLAR®

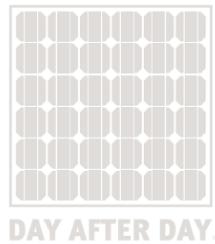
When Continuous Performance Matters: DuPont™ Tedlar®

System lifetime is key to investment returns.

The more reliable the system lifetime is—and the power provided over that lifetime—the more reliable and certain the investment. Pay careful attention to your system's bill of materials, component design and manufacturing practices. Materials that are proven to deliver longer-term performance can help mitigate your risk and improve your return on investment.

30 years of proven field performance.

DuPont™ Tedlar® PVF film-based backsheets offer more than 30 years of proven, protective performance and a history of reducing overall system cost.



The PV industry needs better testing standards for predicting the long-term reliability of solar panel materials.

As more and more materials come to market, yesterday's lab tests simply aren't good enough to model the prolonged, real-world stresses of UV rays, heat, humidity and thermal cycling.

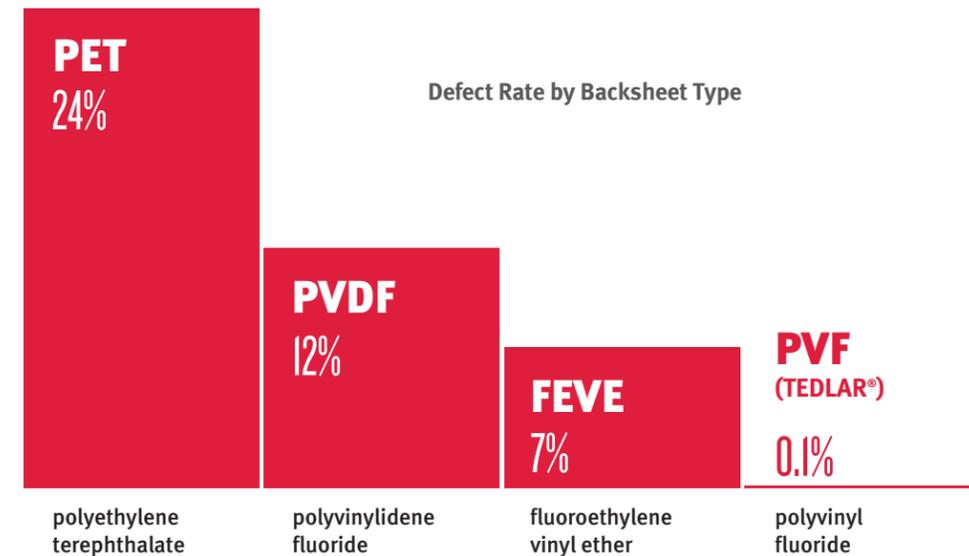
Why DuPont Photovoltaic Solutions materials deliver higher power outputs and financial returns over the course of a lifetime:

- Accumulated materials expertise that enables leading cell and module technology.
- Reliable backsheet and paste materials that minimize annual power degradation and help prevent early-onset catastrophic failure.



DuPont™ Tedlar® – The Leader in Backsheet Durability over Time

Only 0.1% of the DuPont™ Tedlar® based backsheets showed defects.



From a global field-module survey of 71 installations (912,000 modules at 203 MW) in NA, EU and AP. Survey available upon request.



TEDLAR®

When Standing the Test of Time Matters: DuPont™ Tedlar®

DuPont™ Tedlar® PVF film-based backsheet designs have now been in the field for more than 30 years in all kinds of climates (desert, tropics, temperate, marine, mountain) and continue to provide critical, long-life protection to the solar panel, safeguarding the system and enabling long-term PV system returns. Tedlar® PVF film offers the optimal balance of properties for weatherability, adhesion and mechanical strength.



Tedlar® PVF film-based backsheets are critical to performance and long-term durability, protecting solar panels from:

	Ultraviolet Light		Extreme Temperatures		Moisture
	Corrosion		Electrical Damage		Physical Threats

Electrical Safety

Cracked and damaged backsheets can cause electrical insulation failure. In the field, electrical current leaking to the frame can become a safety hazard and a potential ground fault, putting your panels at risk.

Decades ago, the U.S. Department of Energy contracted NASA's Jet Propulsion Laboratory to develop a reliable, durable and safe 30-year PV module. Many different types of materials were tested throughout the 11-year program, but all of the recommended final designs contained Tedlar® PVF film-based backsheets.

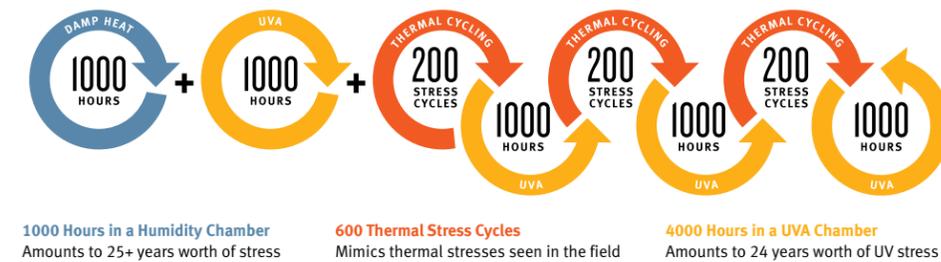
As module development improved, failure rates dropped:

FROM 45% IN EARLY DESIGNS **TO** 0.1% IN FINAL DESIGNS

Lab tested. Field tested. Designed to endure.

Our lab-testing practices

Yesterday's lab testing methods aren't demanding enough to measure the impacts of long-term aging on PV modules. That's why we've introduced MAST, Module Accelerated Sequential Testing.



The MAST program consists of a series of stress tests applied to a single module—exposure to damp heat, followed by repeated UVA exposure and thermal cycling—that more accurately predicts the long-term performance of PV module materials.

When it comes to testing PV modules for their ability to perform over the long haul, insist on MAST. It's the industry's most comprehensive testing program.

Our field-testing practices

The solar power industry is beginning to see higher failure rates as unproven, lesser-performing backsheet materials are introduced.

Long-term field exposure has been called "the ultimate test" for PV module materials. To date, DuPont™ Tedlar® PVF film-based backsheets are the only backsheets with more than 30 years of field-proven performance.

DuPont's Field Module Program has evaluated over 70 global installations consisting of 2 million modules from more than 30 module manufacturers. So, when you install new PV panels made with DuPont™ Tedlar®, you'll have confidence that they'll perform in the field. Day after day. Year after year.

DuPont™ Tedlar® PVF backsheets: **MORE THAN 30** YEARS OF FIELD-PROVEN PERFORMANCE

Other backsheets: **LESS THAN 15** YEARS OF FIELD-PROVEN PERFORMANCE

Long-term outdoor exposure is the ultimate test for all module components, material quality and manufacturing quality.

Artur Skoczek, Tony Sample, and Ewan D. Dunlop
The Results of Performance Measurements of Field-aged Crystalline Silicon Photovoltaic Modules, Wiley InterScience, 2008

SOLAMET®

When Materials Matter,™ you never stop improving them.

DuPont continues to set the pace of innovation in the solar industry by continuously introducing leading performance pastes that work to deliver greater solar panel efficiency and power.

SOLAMET®
130+ NEW PRODUCTS
IN JUST OVER
9 YEARS



Every gain in efficiency matters.

As planned system lifetimes increase, everything becomes magnified. At DuPont, we continuously improve our Solamet® photovoltaic metallization pastes, because even minor gains in solar cell efficiency can add significant value, especially if they can be maintained over today's longer lifetimes.

To date, Solamet® pastes:

HAVE HELPED ACHIEVE
23% SOLAR CELL EFFICIENCY

One innovation after another, DuPont™ Solamet® paves the way to higher efficiency

DuPont™ Solamet® PV20A is the latest generation front side silver paste designed for P-type solar cells, LDE (Lightly Doped Emitters) and PERC (Passive Emitter Rear Cell) which provides aspect ratio improvement and superior contact. These advancements are aimed at increasing cell efficiency by more than 0.1 percent.

DuPont™ Solamet® photovoltaic metallization pastes enable advanced screen printing such as Double Printing and Mesh-Cross-Free (MCF) screen for cell efficiency improvement. New generation Solamet® PVD1x & PVD2x front side silver pastes are the leading solutions for Double Printing, and Solamet® PVM1x front side silver paste is specially designed for MCF screen printing. Both can help to achieve more than 0.1% efficiency gain.

Promise vs. Proven.

Recently, the short-term decisions of some newer companies have resulted in lower-quality and lower-performing materials being used in modules. This shifts more risk to PV system owners. **Today you need to be aware of what materials are in your system—and what materials to ask for.**

Efficiency Improvements That Add Up Over Time

Increased Output | Same footprint, 30% more power.

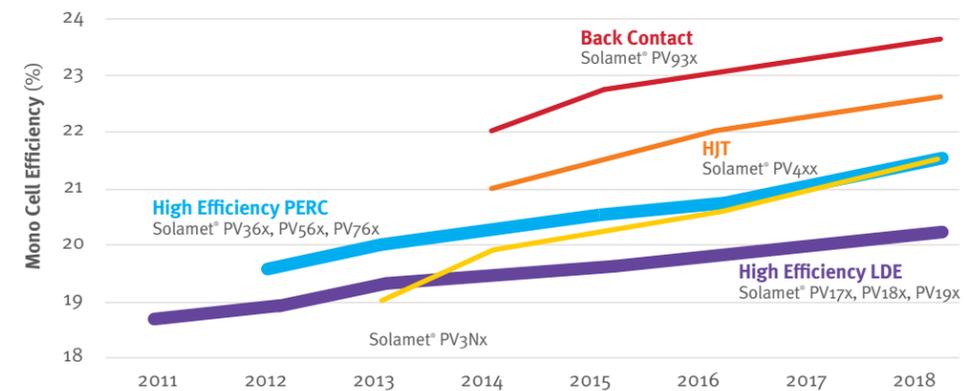
In the past 12 years, DuPont™ Solamet® metallization pastes have helped enable solar cell improvements that have yielded 30% higher cell efficiencies. Which means today you can generate the same power with fewer panels and less panel space.

Innovation Efficiencies | Enabling PERC technology.

DuPont Photovoltaic Solutions is the first supplier to offer a complete portfolio of pastes designed to enable PERC technology. PERC allows solar panels to absorb more light resulting in more efficient conversion to electricity.

As our pipeline grows, improvements to our products (such as PERC, MCF, Double Printing and IBC) deliver increased efficiency gains.

Solar Cell Efficiency Evolution



NEW
PV20A
EXCELLENT FINE LINE AND CONTACT CAPABILITY FOR PERC AND LDE.



SOLAMET®

Reducing System Cost-of-Ownership: DuPont™ Solamet®

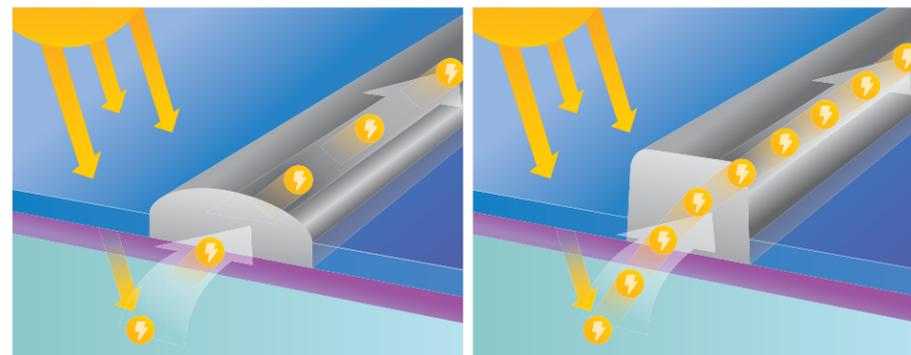
Small efficiency gains can generate big cost reductions.

Increased efficiency reduces Balance of System (BoS) cost because less land is needed; installation and structure costs are lower; and operating and maintenance costs are reduced.

Every 1% improvement in sunlight conversion efficiency could result in a 5% reduction in the cost of the overall solar power generation system because fewer panels/less panel space would be needed to generate the same amount of electricity.



Capturing more energy from the Sun



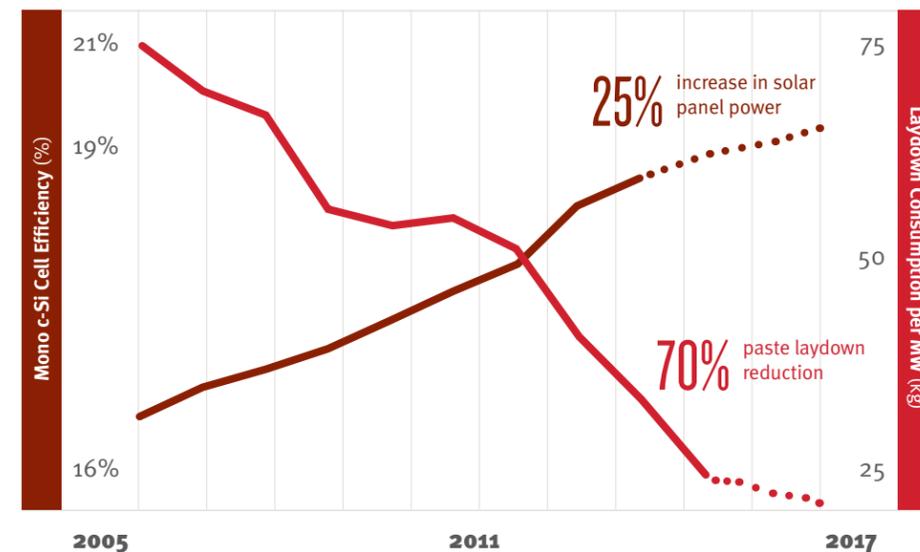
Conventional

Latest Generation Solamet®

Latest generation Solamet® pastes allow narrower and taller current collector “fingers”, which significantly improve solar cell efficiency. This improvement is amplified on the latest solar cell types such as PERC.

Raising Efficiency while Reducing Laydown

Since 2005, improvements to DuPont™ Solamet® paste have reduced costs by raising efficiency while reducing laydown significantly—all without compromising reliability.



LASTING VALUE

The Value of Taking a Longer View

When Materials Matter, you obsess over quality because true value is ultimately revealed over time.

THINK

BEYOND
INITIAL COST:
FROM **\$/WATT**
TO **\$/KWH**

Today, cost-per-watt (or \$/watt) is widely used in the industry to express the cost of a PV system. Unfortunately, this only describes the purchase price for the initial power capacity for a solar panel—it does not adequately express the overall cost of system ownership.

Focusing only on cost-per-watt is short-term thinking—it overlooks system quality and field failures that can seriously degrade investor returns.

Stay focused on what will ensure the best long-term investment returns from your system.

LCOE

REDUCING
THE EFFECTIVE
SYSTEM LIFETIME
BY 5 YEARS CAN
INCREASE THE LCOE
BY OVER **20%**.

Levelized Cost of Electricity (LCOE): A better measure of value

Many experts advocate the use of LCOE as a much better performance metric.

Total System Cost / Lifetime Power Output = \$/kWh

LCOE (\$/kWh) provides a more accurate measure of costs and cash flows that better reflects true system performance and, therefore, true investment returns. LCOE enables smarter cost/performance decisions.

You may see initial savings through changes to a component's design, bill of materials and/or manufacturing practices, but it can mean higher LCOE (\$/kWh) if it results in decreased lifetime, faster power degradation and/or increased performance risk and the need to replace modules.

DuPont PV materials impact LCOE in four ways:

1. They increase system lifetime.
2. They maintain higher system power over time.
3. They deliver more power with fewer solar panels.
4. They reduce Balance of System (BoS) cost.

Reduced Risk, Greater Peace-of-Mind

The longer a PV system runs, the lower the cost of electricity. And the greater the potential to increase investment returns. But there's also a lot to be concerned about. Power degradation over time. Early-onset catastrophic failure. Injury to people or physical assets. Which is why quality materials are so important.

The right materials can make all the difference.

By selecting DuPont Photovoltaic Solutions materials, you can extend system life while reducing the risk of loss due to solar panel durability issues. Think of it as improving your potential return on investment while minimizing investment risk.

For example, using proven industry-standard materials in your backsheet will increase your initial system cost by less than 1% vs. unproven materials. The lifetime gains and resulting financial benefit greatly outweigh the incremental cost of higher-quality materials.

DuPont Photovoltaic Solutions materials put banks and insurance companies at ease. They are proven to perform consistently over the long term.





MAKING A DIFFERENCE DAY AFTER DAY

Durbuk Village, India

In the remote region of Leh and Ladakh, where people believe the sun is everything, diesel power is not only costly but also dangerous to bring in. The region was sometimes left powerless for months at a time. DuPont Photovoltaic Solutions changed everything. Because the materials can stand up to the harsh climate, the people of Durbuk Village can now rely on their sun for the electrical power they need to be truly independent, all year round.



Golmud, China

Choosing the right materials, and the right materials provider, can be key to providing sustainable solar power. DuPont works closely with State Power Investment Corporation (SPIC) in order to help them meet their boldly ambitious expansion goals. In addition to providing SPIC with superior materials on a massive scale, DuPont collaborates on everything from field research to performance analysis and optimization. They also align precisely with SPIC's supply chain requirements for a seamless process.



Masdar City, Abu Dhabi

In Abu Dhabi lies Masdar City, an entirely sustainable, carbon-neutral city, complete with its own solar farm. The city consumes 40% of the energy it produces. The talented young researchers who work here say they're creating what they want the world to be in the future. Recently they worked with Suntech and DuPont to develop the next generation of solar panels here. The hope is that in just a few years, the cost of solar power will be lower than the cost of fossil fuels.



Tokyo, Japan

In Japan, where the culture places a high priority on coexisting with nature, it's not surprising to find people like Nobuyuki Morioka from SHARP Corporation, who for over 40 years made solar energy his life's work. Today, even as Nobuyuki retires, his work lives on—in the panels he's installed, and also in the form of New Single Crystalline Solar Cells. The result of a recent collaboration between SHARP and DuPont, these innovative cells are setting a new world standard for energy conversion.

COUNT ON OUR LEADERSHIP

You can count on our materials to deliver proven power and lasting value because of our deep commitment to four areas:

IT'S MORE

than just 40 years of ongoing investment. It's 40 years of driving the photovoltaics industry, and our world, forward.

Lifetime Performance

DuPont™ Tedlar® is the long-standing benchmark for the industry. Newer materials have since emerged, but none demonstrate the durability and longevity Tedlar® has over its more-than-30-year history in the field. As the industry seeks to maximize returns by extending system lifetimes, Tedlar® continues to be the clear choice for backsheets.

Lifetime Efficiency

DuPont™ Solamet® continues to set new standards for efficiency. Solamet® is the first choice for customers who seek to continually improve solar cell and panel efficiencies, to ultimately reduce LCOE.

Financial Returns

We focus on not only delivering higher power output over the course of a lifetime, but also greater safety, peace-of-mind and lower risk, which add up to lifetime returns that are both higher and more predictable.

Field-Testing

Recent history has shown there is no substitute for field-testing, and no one else even comes close to us in this area. We have vigorously evaluated our field-proven materials in extreme environments for over 30 years, and we continue to do so today.

Day After Day

Since presenting our first technical paper on the use of Tedlar® PVF film in PV applications nearly 50 years ago, we have become the leading PV material expert. Today, our capabilities extend from materials to modules, including fundamental PV materials science and cell and module processing, architecture and testing. We are also a PV system owner and PV electricity user, with PV systems at DuPont sites around the world. As we look to the future, our commitment only grows.



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