

DAY AFTER DAY™



Photovoltaic Solutions

**Because
the world
can't wait.**



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 >10% over the next five years. China is installing >40GW a year, 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 as an 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.



DuPont™ Tedlar®

With the industry's new focus on bifacial modules – DuPont has answered with continuous innovation - new Clear DuPont™ Tedlar®. Compared to a double glass module structure, modules with a breathable transparent backsheet, enabled by Clear DuPont™ Tedlar® film are up to 30% lighter in weight, lowering manufacturing, transportation, and installation costs.

Clear DuPont™ Tedlar® protects against degradation from ultraviolet (UV) light, moisture, and abrasion and enables an optimal balance of barrier properties preventing corrosion. It provides easy cleaning, and chemical resistance in harsh environments. Clear DuPont™ Tedlar® is designed to transmit the maximum amount of solar energy through the backsheet, enabling the maximum energy returned from a bifacial photovoltaic module for increased LCOE.



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*



When continuous performance matters.

System lifetime is key to investment returns.

The more reliable a system is over its lifetime – means reliable power and more 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 add value for future sale.

30+ years of proven field performance.

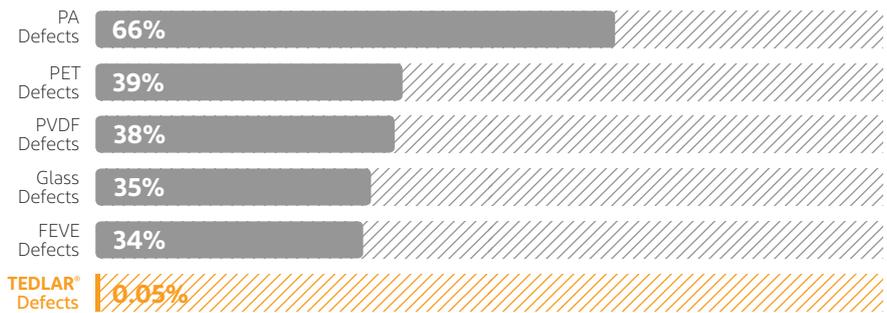
DuPont™ Tedlar® PVF film-based backsheets offer over 30 years of proven, protective performance and a history of reducing overall system cost.

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.

Defect Rate by Backsheet Type

Only 0.1% of the DuPont™ Tedlar based backsheets showed defects after 4+ years in service. From a global field-module survey of 355 installations (>6.5 million modules at 1.8 GW) in NA, EU and AP. *Survey available upon request*



When standing the test of time matters.

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.

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 people and 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, and all of the recommended final designs contained Tedlar® PVF film-based backsheets.

Failure Rates

As module development improved, failure rates dropped from 45% in early designs to 0.1% in final designs.



Designed to endure.

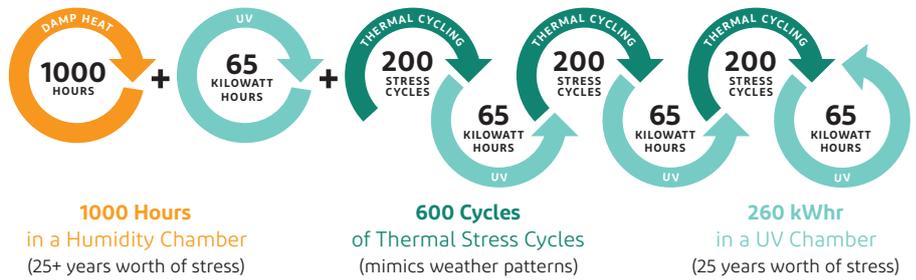
Our lab-testing practices.

Yesterday's 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.

Module Accelerated Sequential Testing (MAST)



Our field-testing practices.

Since 2011, in collaboration with field partners, customers, downstream developers, universities and national labs, DuPont has conducted worldwide field surveys to inspect, assess and understand the state of degradation of fielded PV modules.

Years of field-proven performance



We have looked at PV modules of varying ages and with different bills of materials in a variety of geographies and climates—from North America and Europe to the Middle East and Asia. To date DuPont's Field Module Program has evaluated over 6,500,000 panels from 355 global installations and 100 module manufacturers accounting for 1.8 GW of potential power production.

The program is one of the most thorough of its kind. It is guided by a multistep inspection protocol, and resulting data are analyzed using a variety of criteria, including component, material, mounting, time in service and climate.

Field studies conducted by DuPont clearly demonstrate that modules with different materials behave differently in the field. Low-quality, unproven materials degrade quickly when exposed to environmental stresses, which can negatively impact the modules' safety and power generation performance.

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™ Solamet®

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.

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.



When Materials Matter™, you never stop improving.

DuPont™ Solamet® paves the way to higher efficiency.

DuPont™ Solamet® PV22x 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 Single Print, Double Print and Dual Print, allowing for ultra-fine line design with excellent printability. The pastes are formulated to support the use of advanced screen for cell efficiency improvement, including Mesh-Cross-Free. New generation Solamet® PVD1x & PVD2x front side silver pastes are the leading solutions for Double Printing.

Promise vs. Proven.

Recently, the short-term decisions of some newer solar companies have resulted in lower-quality and unproven 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.

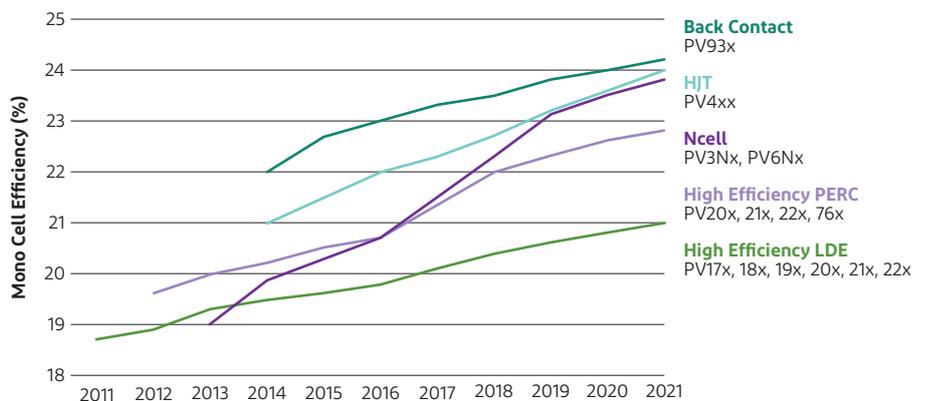
Increased Output: Same footprint, 30% more power.

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 and beyond.

DuPont Photovoltaic Solutions was 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.

Solar Cell Efficiency Evolution with DuPont™ Solamet®



NEW! PV22x: Further finer line, enabling new technologies, including aggressive diffusion profiles and finer texturing.

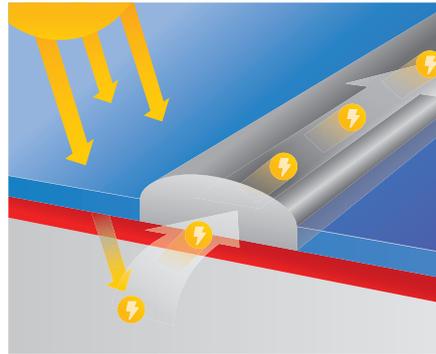
Reducing system cost-of-ownership.

Small efficiency gains can generate big cost reductions.

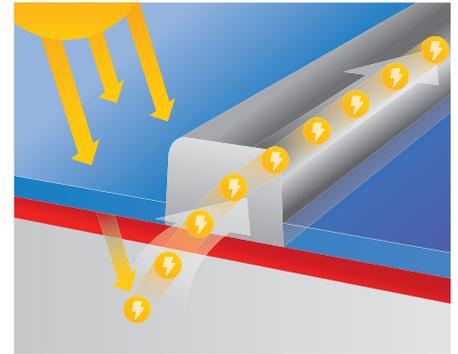
Increased efficiency reduces Balance of System (BoS) cost because less land is needed; installation and project costs are lower; and ongoing operating and maintenance costs are reduced.

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 are needed to generate the same amount of electricity.

Capturing more energy from the sun



Conventional

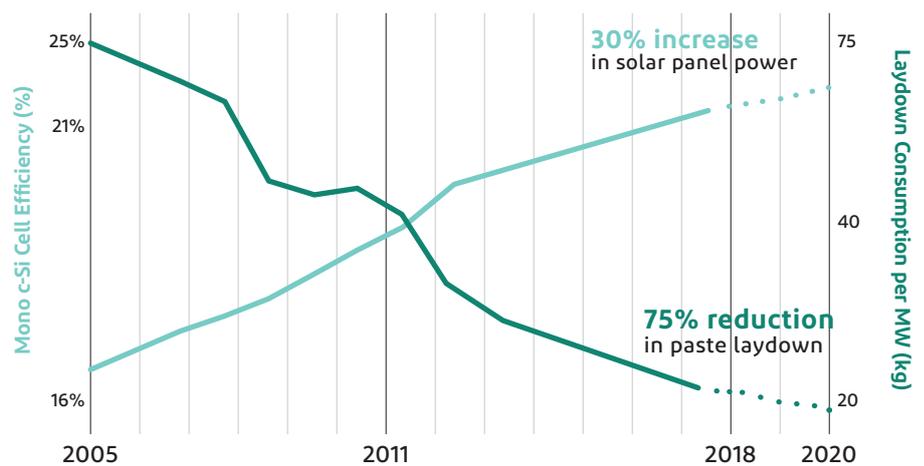


Latest Generation Solamet®

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 technology 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.



NEW!

DuPont™ Fortasun™

DuPont is proud to add a new brand to its flagship Tedlar® and Solamet® product lines, introducing DuPont™ Fortasun™ solar silicones.

Built on decades of experience from Dow Corning, our silicone based product line featuring sealants, adhesives and potting agents deliver the exceptional performance and proven reliability expected from DuPont Photovoltaic Solutions. These products have been used in PV applications for 30 years, now you will find them under a new brand name: Fortasun™.





Global solar demand grows daily.

Enhancing the power of solar energy through the chemistry of silicon.

We've transformed one of the most abundant elements in nature, silicon, into high quality silicone products that are successfully addressing critical needs of the global solar industry: reducing costs and increasing durability of photovoltaic modules and concentrators.

Not only do our silicone products bolster solar panel manufacturing efficiency, they boast decades of reliability in construction and electronic applications and have distinct advantages over competitors:

- Long-term elasticity, pliability and flexibility, ultra-transparency, and strong adhesive properties
- Resistance to rain, sleet, snow, ultraviolet radiation, and water repellency
- Resistance to damage and degradation from high or low temperature extremes, thermal shock, chemicals, delamination, oxidation and corrosion
- Resistance to aging - silicones do not harden, crack, peel, crumble, dry-out, rot or become brittle like many organics
- Excellent dielectric properties

Expanding manufacturing options.

Providing expertise in solar energy.

Be it glass or frames of varying origin, our sealants and adhesives will provide long-lasting bonds in solar modules where reliability is key. Compared to PV tapes, DuPont frame sealants offer:

- Long-term durability and adhesion
- Significantly better adhesion to glass and metal frames
- Sealing and protection in critical joints and areas difficult to tape

Silicone sealants and adhesives also outperform typical PV tapes in frame sealing and rail bonding application, and improve the durability of solar frame components by providing protection from moisture, debris, harsh temperatures, and environmental attack as well as mechanical and thermal shock, plus vibrations.

The most efficient and trustworthy way to build and install solar module systems is with the right materials – DuPont™ Fortasun™ Sealants & Adhesives, are ready to help protect your projects, and the world.

Materials Matter™

Sealants and Adhesives

Silicone sealants and adhesives are specifically designed to perform in frame sealing, rail bonding and junction box adhesion applications. Decades of field experience from Dow Corning ensure these products will last in all environments including extreme temperatures, high moisture and bright sunshine.

Potting Agents

Silicone potting agents possess unique properties and benefits that make them the materials of choice for solar industry applications and offer a desired combination of reliable performance and durability for photovoltaic junction box application and more.

Encapsulants

Silicone encapsulants protect solar components against corrosion and delamination, prolonging life of a module and ensuring better power output and improved performance results in terms of increased power generation.

Increase performance of solar modules.

Adhesives and Sealants for PV Junction Box Bonding

DuPont™ Fortasun™ sealants expand manufacturing options with competitive features and a range of product properties. With room-temperature cure and low VOC options available, manufacturers can find the sealant to meet all of their solar adhesive needs.

Unlike other solutions, our silicone sealants have proven long life spans, providing reliable sealing in addition to effective adhesion. They outperform organic alternatives, improving durability of solar module components by providing protection from moisture and environmental attack, and mechanical and thermal shock and vibration

PV Rail and Bonding Pad Adhesives

Our silicone adhesives possess unique properties and benefits with competitive features that make them the materials of choice for solar industry applications. Specifically designed and tested for structural applications, our proprietary silicone rail bonding technology can:

- Enhance the mounting process, enabling a lower installed cost per watt
- Enable on-site ease of installation compared to mechanical mounting hardware, such as brackets, clips and screws
- Reduce material and installation costs
- Reduce module damage from stress points caused by the mounting hardware

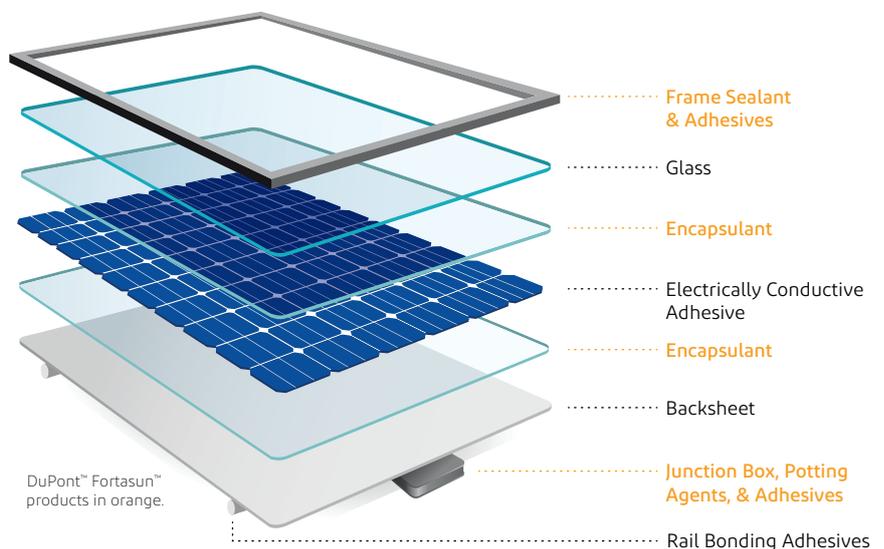
Electrically Conductive Adhesives

Leveraging decades of experience in silicone technology, our new electrically conductive adhesives, provide for high-performance electrical and mechanical bonding. They also enable the emerging automated back-contact module assembly process –permitting automation, high throughput, and high yield.

Our metal-filled, silicone-based adhesives can help create a reliable interconnection of advanced solar cells - delivering high conductivity and flexibility, while also potentially reducing material costs. Increased durability and flexibility help improve the overall stability of the PV module under thermal stress. The silicone adhesives use lower silver content - for greater affordability while providing high conductivity.

DuPont™ Fortasun™ Solar Silicone Solutions

Dow Corning® brand solar silicones are now Fortasun™ brand, same great performance in new name.



The importance of lasting value.

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.



Levelized Cost of Electricity: A better measure of value.

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

$$\text{Total System Cost} / \text{Lifetime Power Output} = \$/\text{kWh}$$

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.



Count on our leadership.

Since presenting our first technical paper on the use of Tedlar® PVF film in PV applications nearly 50 years ago, we have cemented our place as a leader in PV materials. 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.



40 years of driving the photovoltaics industry, and our world, forward.

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

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.

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.

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.



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.**

Of the 900+ million panels installed in **the past 40 years**



more than 50% contain our materials.



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