



# Sacramento Electrical Power Utility Makes Solar History with Photovoltaic Solutions from DuPont

## Panels Provide Consistent Power Output for More Than a Quarter Century at World's First Utility-Scale Plant

### Background

The state of California has played a central role in developments in solar power. A combination of high levels of sunlight, pro-solar government initiatives and an emphasis on innovation has paved the way for a number of important breakthroughs in the history of solar energy.

The Sacramento Municipal Utility District (SMUD) was at the forefront back in 1984, when it built the world's first utility-scale solar array at Rancho Seco, California. The one-megawatt plant, named PV1, generated enough electricity to power 800 single-family homes. Built on a 10-acre site, PV1 was comprised of 28,672 solar cells assembled into 896 panels, each incorporating DuPont™ Tedlar® polyvinyl fluoride (PVF) film-based backsheets for protection from the elements and to provide safe and critical electrical insulation.

The PV1 array has since become one of the best examples of long-term solar power performance. The array maintained reliable power output for 27 years, despite the variable climate, which alternated from damp and wet in winter to hot and dry in summer.

Even after PV1 was retired, it continued to contribute toward advancing solar power. For DuPont researchers, a close examination of the retired panels provided critical information and insight into the durability and longevity of Tedlar® PVF film-based backsheets. And for SMUD, the condition of the panels after close to 30 years of operation was a validation of its initial decision to select panels made using Tedlar® film, made more than a quarter of a century before.

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### Challenges

For pioneers exploring a new land or entering a nascent industry, there are always challenges. For the engineering team at SMUD, leading the way in 1984 with the world's first utility-scale solar installation, material selections had to be made that would have implications many years into

the future. What type of solar panels? What type of system design? The wrong decision could have derailed the solar program, and prevented PV1 from achieving its expected lifespan. Another consideration was the weather variation in Rancho Seco.

While information on the durability and lifetime of different solar options was much scarcer back then, one early study was key: the 11-year, \$150 million research project completed by NASA's Jet Propulsion Laboratory (JPL). Commissioned by the U.S. Department of Energy in 1975, all of the recommended final designs cited in the JPL study contained PVF film-based backsheets and ethyl vinyl acetate (EVA) based encapsulants.

In planning PV1, SMUD's engineering team opted for a ground-mounted 896-panel system, aligned north-south, with a single-axis tracking configuration that followed the sun across the solar sky from three hours before solar noon to three hours after, making a three-degree movement every 12 minutes.

The team drew up strict criteria for the design and manufacture of the solar panels, in line with the JPL study recommendations for PVF film-based backsheets and EVA-based encapsulants. With the specifications in hand, they looked for a panel manufacturer that would meet their requirements, using the materials they'd determined would succeed.

### Solution

SMUD put the manufacture of the panels for PV1 out to tender. After reviewing three bids, the team chose ARCO Solar to manufacture the solar panels, using a triple-layer backsheet construction of Tedlar® film, polyester, and another layer of Tedlar® film (referred to as TPT).

Even 30 years ago, Tedlar® film-based backsheets were known for their durability, high UV resistance, and superior weatherability to enhance the effectiveness of solar panels. In addition, the TPT backsheet construction offered superior electrical insulation for the solar panels — essential to system safety.

## Results

In the decades following the initial installation, the performance of the panels demonstrated exceptional durability, well within a typical power-loss warranty performance range of less than 1% per year.

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—Alex Bradley, principal investigator,  
DuPont Photovoltaic Solutions

“We at SMUD are very proud of this endeavor, one of the first utility-scale solar arrays of its kind in the world,” said Eric Poff, SMUD superintendent of renewable generation assets. “SMUD was able to get considerable use out of the Rancho Seco array, going well beyond the pioneering aspect to be utilized as a practical generation source for many years,” said Poff.

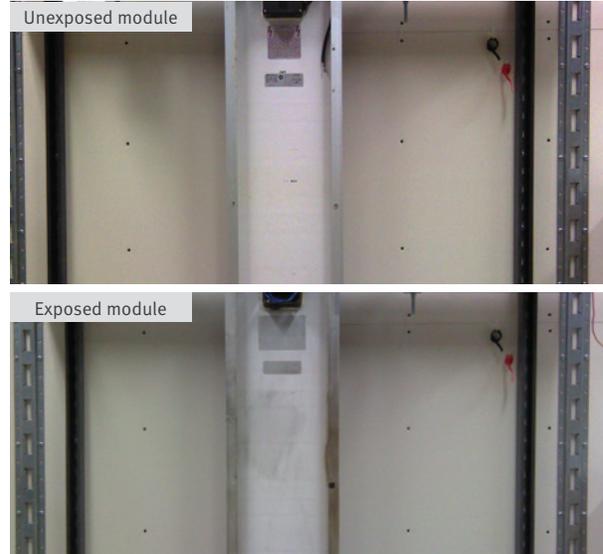
In 2011, plans were made to decommission the PV1 array. Over the 27 years of its lifetime, the plant operated consistently, safely generating about 37 gigawatt hours of electrical energy, offsetting 19 million pounds of carbon dioxide emissions, 5,900 pounds of sulfur dioxide emissions and 16,500 pounds of nitrogen oxide emissions.

Central to the quality of photovoltaic solutions from DuPont, then and now, is an intensive focus on research, at every step of the product development process. Testing doesn't end when a product is launched, but is ongoing. For DuPont, the decommissioning of PV1 offered a prime opportunity to examine the effects of 27 years on the Tedlar® film-based backsheets.

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Because SMUD had purchased extra panels, DuPont was able to compare exposed panels to unexposed panels. A visual inspection of the backsheets showed essentially no difference between them – no delamination, cracking or embrittlement. Some darkening of the EVA encapsulant was seen to have occurred early on in the life of the array, with no impact on performance.



Minimal changes observed on DuPont™ Tedlar® film-based backsheets after 27 years of exposure

“Accelerated aging tests do provide useful information on panel performance, but examining how panels perform in the real world gives us an even better view,” said Alex Bradley, principal investigator, DuPont Photovoltaic Solutions. “What the panels from PV1 show us, after close to three decades, is that Tedlar® PVF film is consistently able to strike the right balance to bring value and performance to the end user throughout the lifetime of the system.”

Over the years, SMUD has continued to set trends in solar power. Current initiatives include helping local homeowners put solar panels on their roofs, working with home builders to make solar power a feature on new homes, and offering customers “shares” in a solar farm.

DuPont is another pioneer when it comes to solar innovation. As a prominent participant in industry organizations that determine standards for materials and reliability, DuPont works to ensure high performance levels for solar installations around the globe. Research projects, such as the research into the panels from PV1, help the purchasers of solar panels make fully informed decisions on materials, and accurately calculate total cost of ownership. These initiatives, combined with the technological leadership for which DuPont is known, are serving to advance the solar energy industry worldwide.

**To learn more about DuPont Photovoltaic Solutions,  
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