



Tackling dirt with Anti-Soiling coating

Panel soiling has been a running concern for solar park owners since the birth of the solar/PV industry. With many parks located in dry soiling environments, dirt accumulating on solar panels can be a major drain on efficiency, limiting power output and driving up cleaning and maintenance costs. DSM's new Anti-Soiling coating offers a compelling answer to this widespread industry problem.

Powering up output, panel by panel

A multidisciplinary team of scientists and application technologists from DSM spent three years developing the Anti-Soiling coating solution before it was ready to be brought to market. The coating is an offspring of the company's patented Anti-Reflective (AR) coating, which has been available on the market for seven years and is now in use at more than 50GW of installations globally.

A series of indoor and outdoor validation tests were carried out as part of the R&D process. These included a controlled, climate-representative test, which was undertaken at a TÜV SÜD solar park in the Gobi Desert, in Dunhuang, China. During the

assessment, modules coated with DSM's Anti-Soiling coating were benchmarked against panels coated with DSM's Anti-Reflective (AR) coating, as well as non-coated modules, over an 18-month period.

During this time, the DSM team spent 12 months actively measuring the power output of each set of modules to gauge any differences in performance. Each of the panels was manually cleaned a total of 17 times over the course of the testing period, using the exact same cleaning method at precisely the same time on each occasion. The team then tested for module performance using highly accurate monitoring equipment at string level.

The positive results of the assessments

were plain to see: under these tightly controlled and representative test conditions, the panels coated with the Anti-Soiling coating delivered 1.1% more power on average compared to panels that integrated DSM's Anti-Reflective coating [see figure]. On an annual basis, this is more than 17 kWh/kWp more energy gained. This clear outcome underlines both the reliability and added value of the Anti-Soiling coating to solar park owners.

Meaner clean, leaner costs

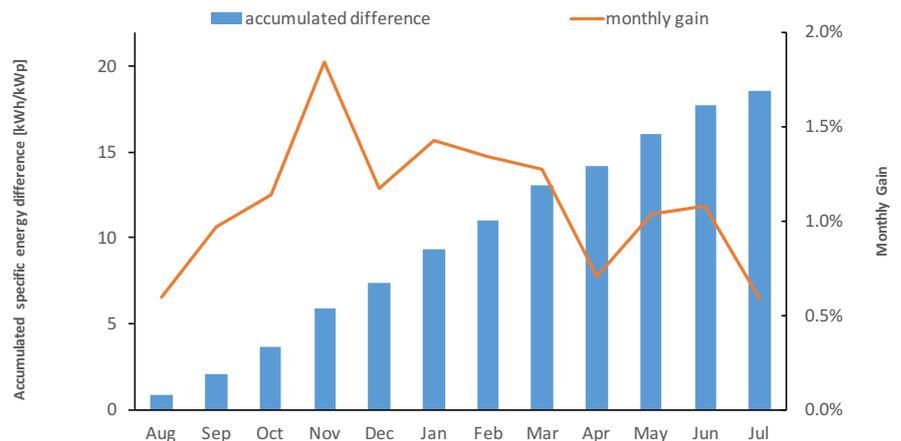
The cleaning of solar modules represents a major investment by solar park operators, particularly in larger parks where tens of thousands of panels may be in use. In the desert and other challenging environments

Key benefits of DSM Anti-Soiling coating:

- Significantly better anti-soiling properties compared to AR coated or uncoated glass
- Excellent anti-reflective properties: Average transmission gain is ~3%, which is competitive with other commercial anti-reflective coatings on the market
- Strong performance in various durability tests (acc. to IEC 61215), comparable to DSM Anti-Reflective coating
- Fewer cleaning cycles needed, so saving O&M costs
- Easier and faster cleaning, and reduced use of consumables
- Lower residual soiling level after cleaning
- Robot-cleaning capabilities were tested and approved by two equipment producers
- Excellent UV resistance, essential in areas with high sun loads
- It is applied at the glass producer prior to module manufacturing, as with DSM Anti-Reflective coating

with dust and dirt, the number of manhours used in manually cleaning modules can be considerable, with numerous intensive cleaning cycles typically required over the course of a year. As well as time, a huge amount of (scarce) water, cleaning products and other consumables typically feed into the process, increasing the overall cost to park owners.

Therefore, as well as reducing the dirt



Performance at Dunhuang test location

accumulation tendencies of the panels through its coating, a key objective of DSM was to deliver a coating that enabled better cleanability of PV panels. This would mean an easier, faster and less consumable-intensive clean for every cycle.

Again, the validation process at Dunhuang for the Anti-Soiling coating revealed the clear advantages, showing that the Anti-Soiling solution enables easier and faster cleaning of each module and allows reduced use of water and other consumables. The residual soiling level after cleaning is also noticeably reduced. What's more, as part of the assessment process, robot-cleaning capabilities were tested on Anti-Soiling-coated panels and were approved by two independent equipment producers.

Tangible gains for multiple beneficiaries

When combining the measured electricity output and efficiency benefits of DSM's Anti-Soiling coating with the associated reduction in cleaning and maintenance

costs, it's clear that the solution can positively impact the Internal Rate of Return (IRR) of solar projects in dry environments. As an example, if the potential exhibited in the test is extrapolated to a 50 MW solar park in Dunhuang, a solar park owner would benefit from an annual EBITDA increase of 1.3%.

But the financial and operational advantages of the solution are not limited to park owners alone. From a manufacturing perspective, the Anti-Soiling coating means that PV module makers are able to produce specialised, solar modules, for environments with a high soiling impact, instead of the standard module. Thus, providing added value to their customers.

In addition, the coating has passed all relevant IEC durability tests. The anti-reflective properties of the coating are not affected and with the consistent average flash-test gains of up to 3% over uncoated glass, it's competitive with other commercial anti-reflective coatings on the market. So, module manufacturers do not lose power output in production. Finally, with the coating being applied by the glass manufacturer, the sourcing and processing of Anti-Soiling coated glass is done in the usual manner, without any need for additional steps or further uncertainties.

In order to drive the solar industry forward and deliver meaningful innovation, DSM collaborates closely with partners throughout the value chain. From project developers and investors to module makers and solar park owners, they help a wide range of stakeholders to implement their solutions and understand how their products can contribute to increase profit margins and reduce overall carbon footprints. Technical advice is available wherever and whenever needed. Understanding the customers' requirements will ensure continued research and development in the quest for sustained improvement.



Dunhuang site: (from left to right) panels coated with DSM Anti-Soiling coating, DSM Anti-Reflective coating and uncoated panels

From the experts mouth...

Vivek Chaturvedi, Regional Business Director IMEA, DSM Advanced Solar

PES: We are very interested in hearing about your Anti-Soiling coating for solar glass and to know what prompted you to develop this?

Vivek: Our Anti-Soiling coating is aligned with our 'Same sun. More power.™' promise. Historically, soiling was not an issue in regions such as Europe, Japan and the US, which is where the majority of PV modules have been installed in the last 20 years. But in the next 20 to 30 years, PV installations will become much more common in regions such as India, the Middle East, Africa and Latin America. Here, soiling is a major issue. DSM's Anti-Soiling coating will mitigate the soiling losses and help generate additional power, making solar energy more affordable in developing countries. This is in line with the UN Sustainable Development Goal #7, which aims to make energy affordable and clean for everybody. DSM's Anti-Soiling coating also works differently than other solutions that have been tried up till now.

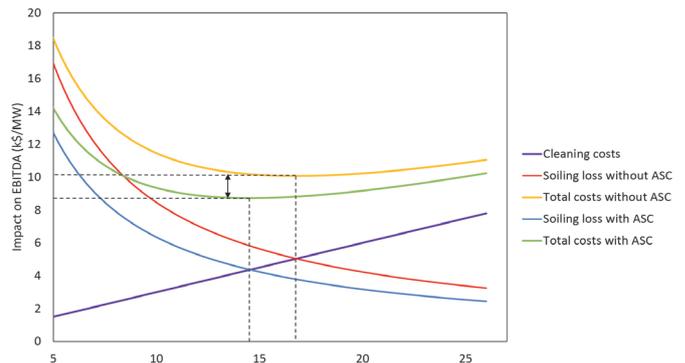


Example of soil-Performance difference between AR, AS and uncoated glass.

PES: We were wondering why you chose the Gobi Desert to test the results of your research?

Vivek: The Gobi Desert offered us very representative conditions of other locations where the Anti-Soiling coating could be put to work. In particular, the Gobi Desert typically has high dry conditions. Set up almost two years ago, this was also one of the first outdoor sites, and availability of key resources was also

Influence of AS coatings on financial performance per MW of PV plants as a function of the number of cleaning cycles



Assumptions

Location:	Dunhuang, China
Size:	50 MWp
Soiling rate:	0.4% per day
Soiling- rate reduction via AS:	25%
Cleaning cost:	300 \$/MW/cycle
Electricity price:	0.065 \$/kWh

Benefits of AS-coating vs. AR-coating:

Reduction of cleaning cycles	-2 per year
EBITDA gain	67,000 \$ per year
EBITDA gain	1.3% per year

Influence of AS coatings on financial performance per MW of PV plants as a function of the number of cleaning cycles

important, which we had in Europe and China. Europe is not as affected by soiling, so China became the first choice. In the next few months, in addition to our current outdoor tests, we will start up another 10-15 sites across the world, spread across different relevant regions, which will generate even more data in real-life conditions.

PES: Please explain what you found out and how it benefits the end user?

Vivek: I'm pleased to say that our Gobi Desert pilot project, which was monitored by TÜV SÜD, was successful in demonstrating delivery of an average increased energy yield of 1.1%, compared to our Anti-Reflective coating, over the course of 12 months. The additional bottom line would accrue to a PV investor, as the DSM Anti-Soiling coating enables less frequent cleaning cycles, saving operators' time and reducing the cost of consumables. In particular, it helps to conserve a precious and fast-depleting resource: water.

While the exact performance of the Anti-Soiling coating can differ according to the circumstances and location of its use, it is clear this technology can offer some very real advantages to solar-park owners. We invite our customers to model their projects and assess the potential benefits of the DSM Anti-Soiling coating together with our team.

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