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Photo: Solar Frontier

Markets & Trends

Japan: Drastic changes to the country's FIT set to drive the solar market's evolution. *Page 22*


Photo: Evonik

Industry & Suppliers

Recycling: Backsheet considerations are paramount when recycling the whole PV module. *Page 58*


Photo: Jonathan Gifford/Solarpraxis AG

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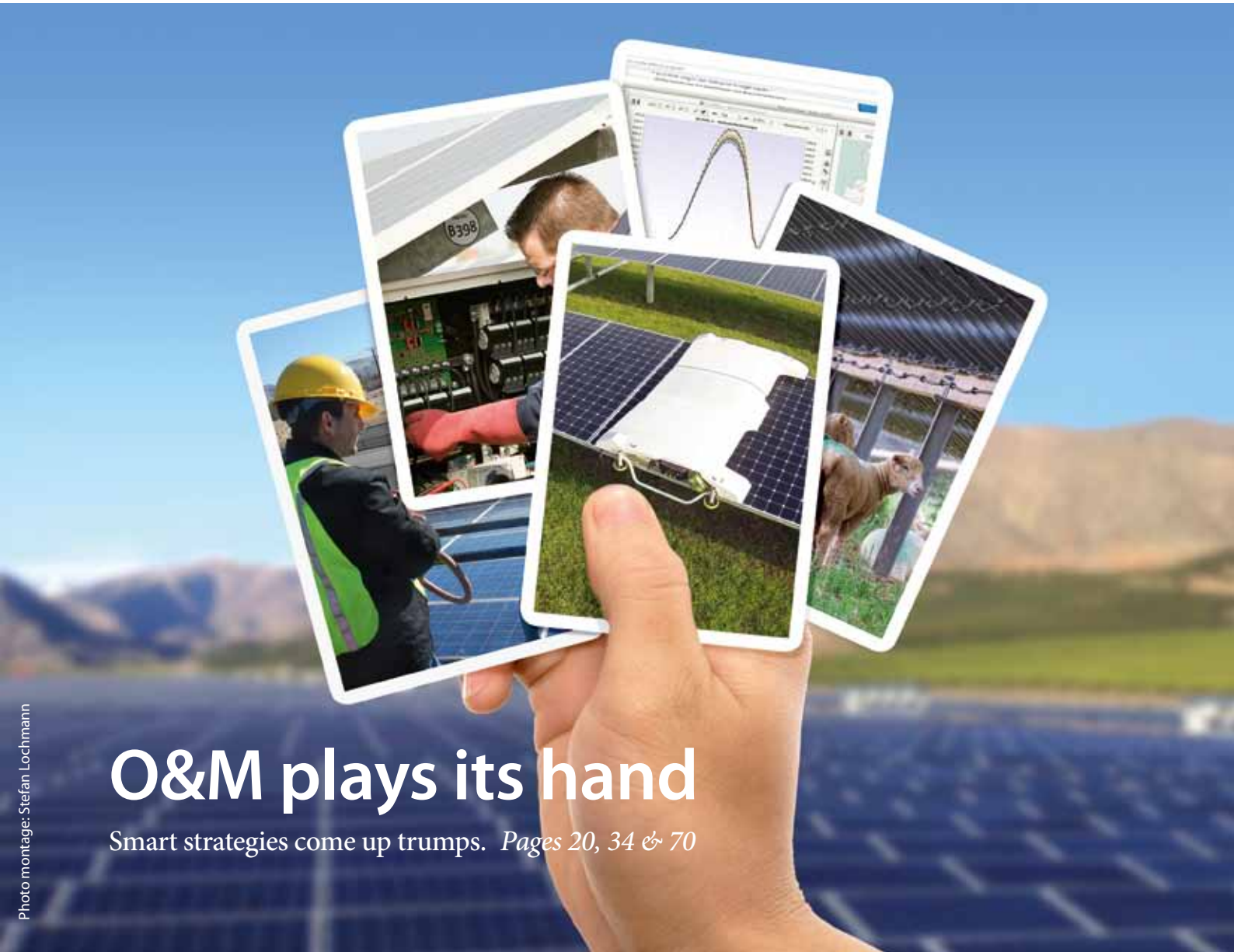
pv magazine

PHOTOVOLTAIC MARKETS & TECHNOLOGY



O&M plays its hand

Smart strategies come up trumps. *Pages 20, 34 & 70*

Photo montage: Stefan Lochmann

Photo: Eckhart Gouras/Solarpraxis AG

Photo: ABB

pv magazine editor in chief Jonathan Gifford with the Solar Impulse Si2 aircraft at a launch event, and (right) with ABB's global head of power conversions Otto Preiss at the 8th World Future Energy Summit, Abu Dhabi.

A maturing market and the rise of O&M

PV is all grown up. In its 2014 clean energy investment analysis released last month, Bloomberg New Energy Finance found that global investment in solar reached almost $150 billion for the year, its largest-ever slice of the clean energy pie. BNEF noted that some large solar investments, such as Japan's $1.1 billion 250 MW Setouchi Mega PV plant, were significant contributors to the total. It was the year that distributed solar truly shone.

After big investments in the grouping of the splendidly-named "mega" solar, large scale solar thermal, and large wind installations, investments in distributed solar were the second largest category of investment. $73.5 billion was invested in sub-1 MW solar arrays, predominantly rooftop, an increase of 34% on the previous year. Some would argue that, despite the ongoing role utility scale solar is set to play (see p. 86) this indicates solar is growing strongly and is directly where its competitive advantage lies: distributed installations close to consumption.

This poses something of a quandary for the fast-growing O&M market. **pv magazine** has taken a comprehensive look this month at this topic. When solar installations become distributed, fine tuning O&M provision, from monitoring (see p. 68), to maintenance (see p. 20) and the supply of replacement components (see p. 72 & 78) becomes an important financial equation and logistical challenge.

The cleaning of solar modules is a key part of O&M, although its importance in some markets is far greater than in others. In Germany (see p. 34), frequent rain and snow means dust build-up is not a major factor, whereas in Chile and the MENA markets it is crucial. **pv magazine** has tracked the development of cleaning solutions for some years and it seems now that the importance of the service, whether provided by robots such as SunPower's or companies such as SolarMaid (both of which are pictured on the cover) is an aspect of our maturing industry that must too be fine-tuned.

There are signs the MENA region may begin to deliver serious demand for PV, with tenders in Jordan resulting in real orders and projects on the ground and the signs in Egypt looking most promising. Dubai, at the heart of the United Arab Emirates (UAE), is also looking good, and the recent DEWA auction for a 200 MW power plant captured global cleantech headlines.

Winning bidder ACWA's price of around $0.06/kWh over 25 years is currently a subject of debate, but it has set off a train of thought that solar is now cheaper than gas-fired generation in the region. The UAE was the center of solar attention last month as it hosted the 8th World Future Energy Summit in Abu Dhabi (see p. 44). The **pv magazine** team was there as was the world-record-attempting solar plane from Solar Impulse (see p. 46). The Si2 plane will take off on its round-the-world journey from the city next month.

The Solar Impulse project and team represents the embodiment of technical innovation and perseverance in the face of adversity, and will carry with it a powerful message of hope as world leaders meet later this year for climate negotiations in Paris. Most importantly, PV will keep the wind beneath its wings.

Jonathan Gifford
Editor in chief

Photo: Skytron

Photo: Kyocera

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Markets & Trends

Markets & Trends

Photo: Jolywood

Photo: Sonnenbatterie

Photo: Filmcutter

Italy's Filmcutter supplies its Filmback MLP monolayer PET backsheet, which it produces on a flexible, lean, efficient, and productive production process.

Recycling the whole module

Sustainable PV: In part two of **pv magazine**'s investigation of module recycling, the attention remains on the backsheet and how, in a cost-competitive environment, fluoropolymers continue to pose a largely hidden challenge.

It has been called the solar industry's "dirty little secret": the inclusion of potentially toxic materials in solar modules. A very public discussion about the presence of cadmium in First Solar's modules captured headlines towards the end of 2010, particularly in Germany, which was a booming market at the time.

The debate raged for months, through much of 2011, often polarizing the industry, bloodying noses and damaging the environmental reputation of solar to outsiders.

While this debate has receded, a new discussion is growing in momentum regarding the presence of fluoropolymers in backsheets and potential impacts when modules come to end of life. Fluoropolymer backsheets, in various guises, is proving popular among many module manufacturers, reports IHS analyst Karl Melkonyan.

"Backsheet manufacturer Arkema offers a fluoropolymer called Kynar (polyvinylidene fluoride) that equals the performance of Tedlar, yet without supply constraints. Its availability rapidly established it as a highly-popular alternative to Tedlar, both in single and double fluoropolymer constructions," says Melkonyan.

Why fluoropolymer matters

The standard technique during module recycling for the c-Si modules is to degrade the backsheet in order to separate it from the silicon and glass. This is according to Alessandro Anderlini, photovoltaic division manager with Italian backsheet supplier Coveme.

"Today, conventional recycling methods are unable to degrade the fluoropolymer backsheet as the fluorocarbons can not be degraded because of their chemical structure," Anderlini explains. "If fluoropolymers are burned, then they are highly toxic."

Martin Wielpuetz, director of business management solar of Performance Materials Group at global specialty chemical supplier Evonik, concurs.

"Thermal recycling of fluoropolymers is really, really toxic," says Wielpuetz. "Talking about the hydrogen fluorides, it is one of the most toxic substances you

can find." Evonik supplies its Vestamid PA12 product to the PV industry, where it can be used to form a water, UV, and abrasion-resistant barrier to the electrical insulation part of the backsheet stack.

Fluoropolymers, despite their toxicity, have become more prominent in backsheets due to a perception that they provide the most robust protection to the electrically insulating layer. Evonik's Wielpuetz believes that perception should be turned on its head, particularly given potentially toxic end-of-life issues.

"There is no awareness of recycling and the consequences of this," says Wielpuetz. "There are backsheets available that do not contain any fluoropolymers with our materials and those based only on PET materials that do not include any fluoropolymers. The performance of the backsheet is significant depending on where you are going to install the modules afterwards."

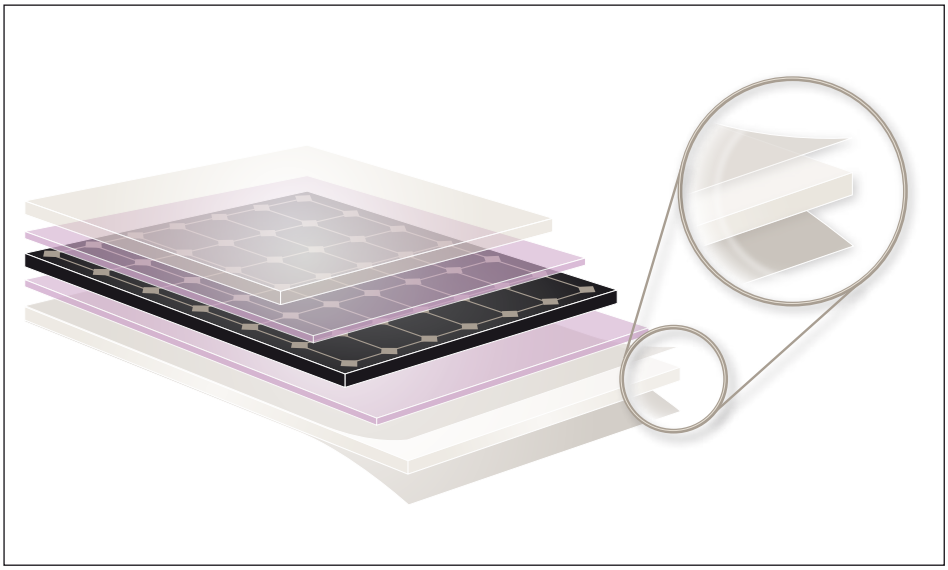
Wielpuetz says that in cooler areas, such as northern Europe, PET backsheets are preferred. Data is currently being collected in support of PET and technologies such as coextruded backsheets for applications in humid and sunbelt countries. Evonik says it has collected extensive data on the performance of its Vestamid PA12 solution across a range of conditions in its in-house labs.

Interestingly, while Italy's Coveme is eager to engage the industry in the debate regarding fluoropolymers, it still supplies both fluoronated and non-fluoronated backsheets. Coveme, which claims to supply around 15% of the global backsheet market, says that the PET backsheet market is growing rapidly and that its fluoropolymer range is primarily for Chinese manufacturers that are yet to make the switch.

"We still have a portfolio of Tedlar-based backsheets together with our best selling [fluoropolymer-free] dyMat PYE, special PET based backsheets."

Filmcutter & Jolywood

Last month, China's Jolywood and Italy's Filmcutter announced that the two companies will join forces to form what has been labeled as the "biggest backsheet company worldwide," according to the head of Filmcutter's PV Division, and soon-to-be CEO of the new Filmcutter incarnation Cesar Campos. The move will also bring together the companies' complementary product portfolios, meaning both a non-fluoropolymer and fluoropolymer backsheet range.



Graphic: Evonik

Evonik's Vestamid PA12 solution can be used to form a water, UV, and abrasion-resistant barrier to the electrical insulation part of the backsheet stack.

"The ambition is to continue establishing Jolywood as a leading Chinese fluoropolymer-based backsheet player, and expanding its international footprint," says Campos. "At the same time to guide Filmcutter to become a leading PET-based backsheet player worldwide."

Together, Filmcutter and Jolywood target 30% of the global backsheet market. Jolywood was the first pure-play backsheet company to go to IPO in China, in September of last year.

"At present, the fluoropolymer-based backsheet is the mainstream of the market in China. But outside of China, the PET-based backsheet is reaching a decisive leading position," says Jianwei Lin, Jolywood Chairman. "We believe that market share of both fluoro-coating type backsheet and modified PET based backsheet will continue rising."

PV remains safe

An understanding of the potential end-of-life impact of fluropolymers is undoubtedly growing, however Europe's solar industry recycling scheme PV Cycle is keen to emphasize that all PV technologies have been proven safe "for man and nature," both during their productive lifetime and for recycling.

"Most importantly … no commercially available PV module technology meets the criteria of hazardous waste today," reports PV Cycle's Olmina Della Monica, the organisation's operations and treatment manager. Della Monica says that the biggest operational and financial challenge to module recycling remains the collection of discarded modules. PV Cycle partners with established recycling partners in various countries throughout Europe, with methodologies for recycling varying between nations.

Synergies with the flat glass recycling industry have been leveraged in establishing operations. The three stages for c-Si module recycling include the preparation phase, when the frame and junction box are removed, the shredding and fine-processing to separate materials, and then the recovery and recycling.

"General output fractions of this flat-glass-oriented process are ferrous and non-ferrous metals, glass, silicon flakes, and plastics with an average recycling quota of approximately 85% (input weight)," says Della Monica. This high proportion of the module weight able to be recycled is a positive sign and there are efforts to establish recycling programs and standards in China, Japan, and the U.S. ◆

Jonathan Gifford

Photo: Jolywood

Jolywood completed a successful IPO in September. Acquiring Filmcutter, it now has a full fluoropolymer and MLP/PET backsheet range.