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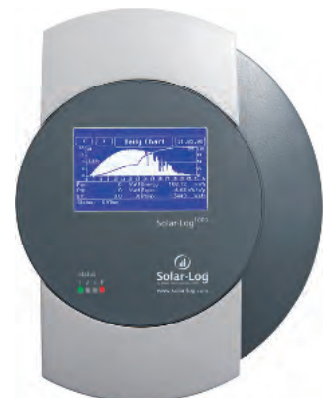


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David Ridsdale
Editor in Chief

Is the cure worse than the complaint?

Divide and conquer is a famous maxim of conflict but the divisions in the solar and PV industries lack an external foe to conquer so appears destined to only cause friction within. This friction can be seen locally with fierce political discussions on what is an appropriate level of subsidy for an emerging industry. It is most notably seen on the global stage with trade complaints against China adding to recent industry uncertainty.

No matter the motivations behind the companies and individuals involved in such actions the consequences are likely to be very different than the outcomes people are trying to achieve. China's extraordinary growth in the last decade has impacted almost every industry and completely changed the division of markets around the world. This has caused a sharp and sometimes envious eye from companies and countries previously holding larger margins than they find themselves with today. The scrutiny has led to accusations of trade manipulation against China from a number of sources across a number of industries.

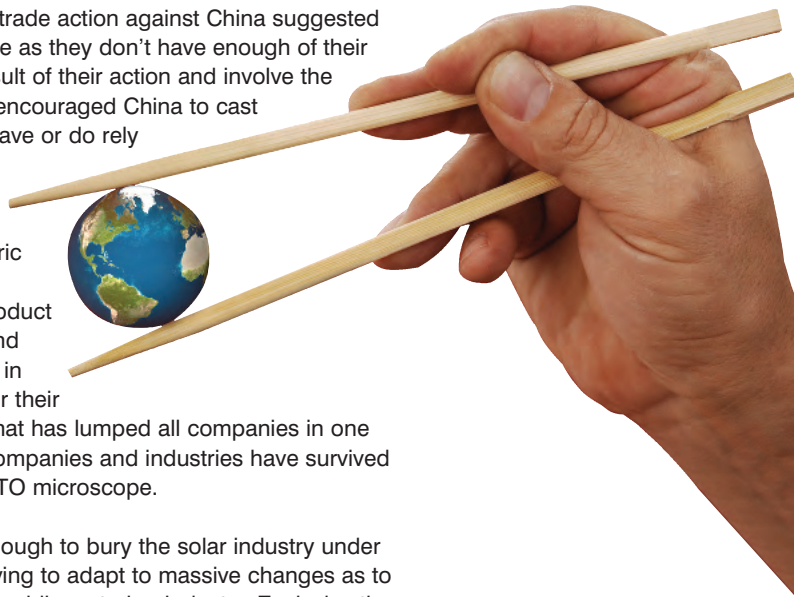
China is getting more annoyed at these actions and have started to retaliate with trade actions of their own. A recent comment by a European company official involved in the EU trade action against China suggested China would not retaliate as they still need to buy silicon from Europe as they don't have enough of their own. The gentleman is assuming that any actions will be a direct result of their action and involve the same industry. By challenging Chinese growth so bluntly they have encouraged China to cast their own sharp eye on a range of industries around the world that have or do rely on government support for their survival.

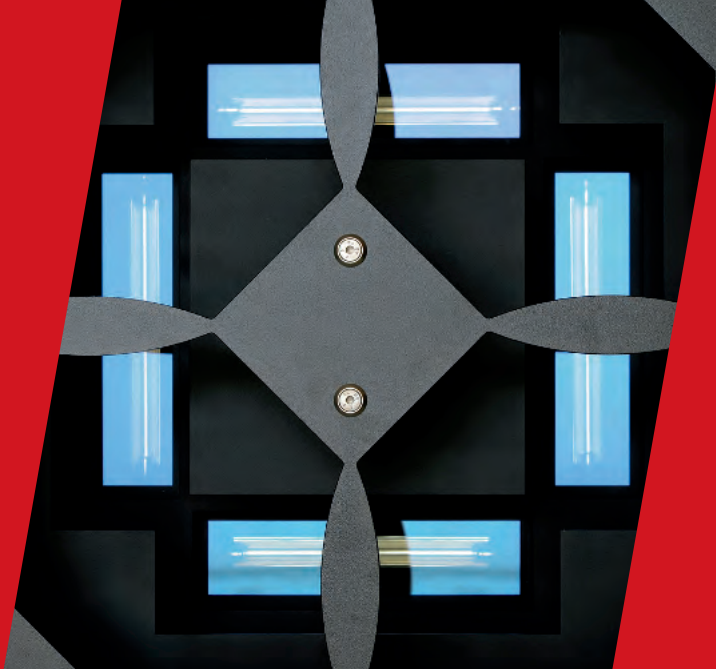
I am in no way suggesting all the actions of all Chinese companies fit into the world trade organisation (WTO) rules but the simple generic reaction of blaming a country as vast as China seems a little short sighted. Many of the problems in China in regards to the issue of product dumping have their origins in regional politics and competitiveness and some detractors may have done well to discover some of the issues in China which may well have led them to a more appropriate culprit for their concerns. Instead we have a reaction to the entire Chinese market that has lumped all companies in one derisory group. This is not clever business or politics as too many companies and industries have survived with government support which may not stand up under a similar WTO microscope.

The issues at hand are much larger than the solar industry. Large enough to bury the solar industry under larger concerns. This is all coming at a time when the industry is having to adapt to massive changes as to how the finances of the industry work and consolidation beckons a rapidly maturing industry. Each day there are more reports of companies in trouble and the uncertainty for prices, investment and even supply are only increasing with legal speculations.

The larger Chinese companies have already set up alternative manufacturing routes to circumvent US based tariffs and detractors are planning a new trade dispute due to this. The case highlights what a merry go round fiscal regulations and enforcement truly is. The only real winners seem to be the lawyers.

For the industry the dispute will probably see an increase on prices and a speeding up of the demise of many players. Only the long term will tell the true outcome and as usual those with big pockets and a long term view will survive regardless of their country of origin.





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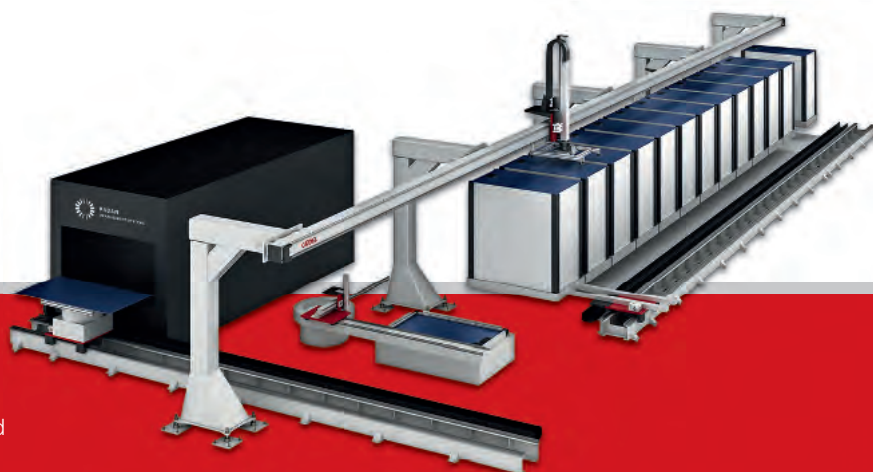
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Front cover designed by Mitch Gaynor

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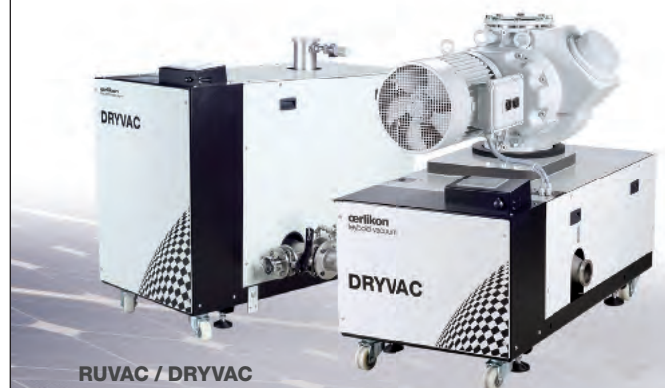
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Solar Junction claims record breaking 44% cell efficiency

SILICON VALLEY based solar energy company Solar Junction, a developer of high efficiency multi-junction solar energy cells for the concentrating photovoltaics (CPV) market, has set a world record for energy efficiency of a commercial-ready production solar cell.

“Breaking our own world record cements Solar Junction as an innovator and leader in the multi-junction cell space,” said Vijit Sabnis, VP Technology at Solar Junction. “We continue to push technological boundaries to further drive CPV costs down.”

The power conversion efficiency of Solar Junction’s cells was measured at 44 percent at 947 suns, beating the Silicon



Valley company’s record of 43.5 percent at 418 suns it set in April 2011. Both records were verified by the National Renewable Energy Laboratory (NREL). Solar Junction’s new record continues to demonstrate the value of its A-SLAM materials, which uniquely provides CPV

system manufacturers the foundation to deliver the most efficient conversion of solar to electrical energy. CPV panels work by concentrating sunlight onto small multi-junction cells, which Solar Junction manufactures at its San Jose facility.

Solar Junction’s announcement falls on the heels of a successful investment round, a 5-megawatt order, and several industry awards. Earlier this year, Solar Junction and IQE, the leading global supplier of epitaxial wafers, signed an investment and manufacturing agreement to ramp Solar Junction’s market-leading SJ3™ solar cell product to high volumes.

In addition, Solar Junction is commissioning a 6” production fabrication facility, partially funded by a U.S. Department of Energy SUNPATH contract, in Silicon Valley, with shipments beginning in the first quarter of 2013.

WTO ruling suggests Canadian subsidy not so fit

ACCORDING to an interim WTO dispute settlement report, a three-member panel has sided with the EU and Japan in their challenge of renewable energy support provided by the Canadian province of Ontario, sources told BioRes. The two countries had argued that the feed-in-tariff (FIT) system - put in place in 2009 - violates WTO rules because it requires participating electricity generators to source up to 60 percent of their equipment in Ontario.

The interim report, circulated to the parties by the panel on 20 September, now confirms the view that the scheme’s “local content requirement” violates the WTO’s non-discrimination principle enshrined in the General Agreement on Tariffs and Trade (GATT) and the WTO Agreement on Trade-Related Investment Measures (TRIMS).

However, based on what is currently known about the confidential document, assertions by Brussels and Tokyo that the programme also amounted to illegal subsidies - dependent on use of locally produced equipment - have been

rejected. At the time BioRes went to press, the ruling was not available. The case has been widely portrayed as an environmental dispute, concerning the extent to which authorities can favour domestic producers and suppliers in promoting green energy. At the earlier hearing, however, the arguments from the parties principally focused on the investment aspects of the FIT provisions.

Claimed by Ontarian officials to encourage clean energy production, the local initiative offers incentives to energy producers to use electricity from renewable sources. Provisions of the programme, however, also require that to be eligible for such incentives, renewable energy projects include a minimum quota of goods and services deriving from Ontario - in the case of wind, 25 percent, and for solar projects, 60 percent. Such a, “discriminatory measure,” said Japan in its statement before the panel in March this year, “is designed to promote the production of renewable energy generation equipment in Ontario rather than to promote the generation of renewable energy.”

Canada, on behalf of Ontario, instead portrayed the measure as government procurement necessary to facilitate a move toward green energy production. If the argument was accepted, the measure would not have been subject to WTO provisions on non-discrimination. In addition to their arguments that the measures were discriminatory, the EU and Japan also argued that the provisions constituted a prohibited subsidy inconsistent with the Agreement on Subsidies and Countervailing Measures (SCM Agreement). It is understood that both arguments have now failed, with the Panel ultimately condemning the Ontario rules on the grounds they are discriminatory against foreign suppliers of equipment and components for renewable energy generation facilities.

Both parties have now had an opportunity to submit comments on the interim report. Following the example of most WTO panels to date, however, the panel is not expected to substantially depart from its preliminary findings when it issues its final ruling in November.

Obama approves utility PV roadmap

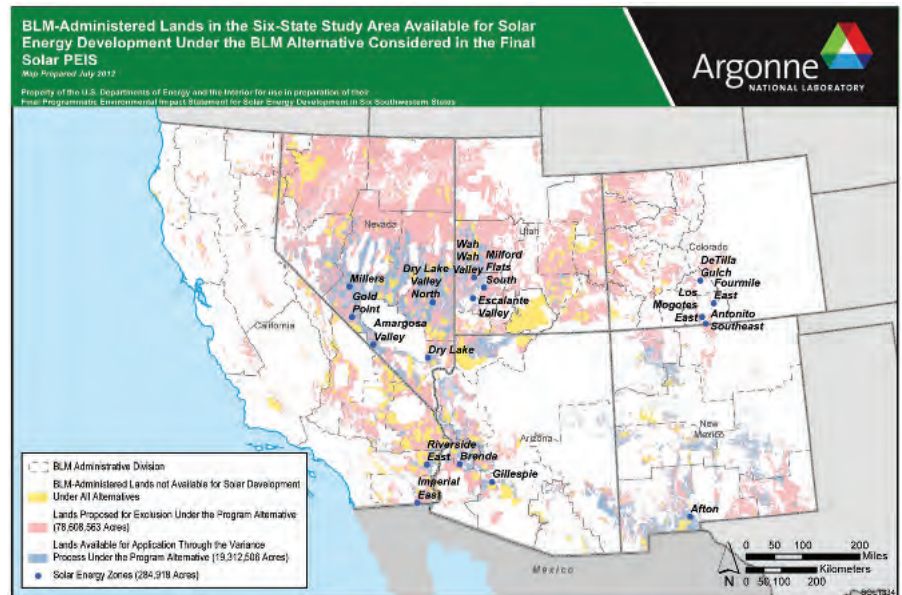
AS PART of President Obama's all-of-the-above energy strategy to expand domestic energy production, Secretary of the Interior Ken Salazar has finalized a program for spurring development of solar energy on public lands in six western states. The Programmatic Environmental Impact Statement (PEIS) for solar energy development provides a blueprint for utility-scale solar energy permitting in Arizona, California, Colorado, Nevada, New Mexico and Utah by establishing solar energy zones with access to existing or planned transmission, incentives for development within those zones, and a process through which to consider additional zones and solar projects.

Since 2009, Interior has authorized 33 renewable energy projects, including 18 utility-scale solar facilities, 7 wind farms and 8 geothermal plants, with associated transmission corridors and infrastructure. When built, these projects will provide enough electricity to power more than 3.5 million homes, and support 13,000 construction and operations jobs according to project developer estimates.

"Energy from sources like wind and solar have doubled since the President took office, and with this milestone, we are laying a sustainable foundation to keep expanding our nation's domestic energy resources," said Secretary Salazar, who signed the Record of Decision at an event in Las Vegas, Nevada with Senator Harry Reid. "This initiative provides a roadmap for landscape-level planning that will lead to faster, smarter utility-scale solar development on public lands and reflects President Obama's commitment to grow American made energy and create jobs."

The Solar PEIS establishes an initial set of 17 Solar Energy Zones (SEZs), totaling about 285,000 acres of public lands, that will serve as priority areas for commercial-scale solar development, with the potential for additional zones through ongoing and future regional planning processes. If fully built out, projects in the designated areas could produce as much as 23,700 megawatts of solar energy, enough to power approximately 7 million American homes.

The program also keeps the door open, on a case-by-case basis, for the possibility of carefully sited solar projects



outside SEZs on about 19 million acres in "variance" areas. The program includes a framework for regional mitigation plans, and to protect key natural and cultural resources the program excludes a little under 79 million acres that would be inappropriate for solar development based on currently available information.

"The Solar PEIS sets forth an enduring, flexible blueprint for developing utility-scale solar projects in the right way, and in the right places, on our public lands," said David J. Hayes, Deputy Secretary of the Interior. "Never before has the Interior Department worked so closely and collaboratively with the industry, conservationists and sportsmen alike to develop a sound, long-term plan for generating domestic energy from our nation's sun-drenched public lands."

The signing of the Record of Decision follows the release of the Final PEIS, an analysis done that identified locations on Bureau of Land Management (BLM) lands most suitable for solar energy development.

"We are proud to be a part of this initiative to cut through red tape and accelerate the future development of America's clean, renewable energy," said Secretary of Energy Steven Chu. "There is a global race to develop renewable energy technologies—and this effort will help us win this race by expanding solar energy production while reducing permitting costs."

The action is in line with the President's direction to continue to expand domestic energy production and infrastructure, safely and responsibly.

Since President Obama took office, domestic oil and gas production and costs have increased each year, with domestic oil production at an eight-year high, natural gas production at an all-time high, and foreign oil imports now accounting for less than 50 percent of the oil consumed in America – the lowest level since 1995.

"We thank the Department of the Interior and the Department of Energy for finalizing the process for solar energy development on public lands. We hope that this decision results in a permitting process that brings more solar online to serve the American people," said Rhone Resch, president and CEO of SEIA. "The U.S. Southwest is home to some of the best solar resources in the world. The Administration set a goal to permit 10 gigawatts of additional renewable energy projects on public lands by the end of this year."

"The PEIS identifies a process that has the potential to accommodate well-sited solar power plants outside of designated Solar Energy Zones and protects the rights of pending solar applications. The Bureau of Land Management must ensure pending projects do not get bogged down in more bureaucratic processes," added Resch.

Ontario leads Canadian PV consumption

SOLAR PHOTOVOLTAIC (PV) technology is growing at a fast rate in Canada, as the government employs various initiatives to support the rapid deployment of solar PV energy sources, states a new report by power experts GlobalData. The new report portrays Ontario as a leading beacon in the renewable energy industry, as the Canadian state sees tariffs, tax rebates and joint ventures encourage the rise of solar PV generation and the solar PV backsheet market.

Canada's ecoEnergy Retrofit program and tax credits provide support across the country, and the solar power industry in the Canadian states of Ontario, Quebec, British Columbia and Nova Scotia also benefit from net metering. However, provincial efforts, such as investment incentives offered by the Ontario government, show local power authorities wielding significant influence. The Ontario Green Power Tariff system program provides rules, tariffs and contracts for solar power producers, and also stipulates domestic content



requirements for solar power generation, strengthening the local solar equipment manufacturing base. The Renewable Energy Standard Offer Program (RESOP) and sales tax rebate initiative also support the development of the solar power market in Ontario.

Canada is an import-oriented market for solar backsheets, as there are no backsheet manufacturers currently located in Canada, with the local PV industry still in its early stages. As a result of the introduction of the Ontario Green Energy Act in 2009, solar PV backsheet installations increased from 4 Megawatts (MW) in 2006 to 240 MW in 2011, at a

Compound Annual Growth Rate (CAGR) of 131%. However, the local content requirement clause has boosted the market for domestic modules. Annual solar PV installations over the forecast period are expected to record consistent growth, with backsheet capacity expected to increase from 240 MW in 2011 to 937 MW by 2020.

Individual companies are also getting involved. Recently, producer and supplier of solar modules Canadian Solar, and Canada's leading developer of solar parks, SkyPower, joined forces to develop alternative energy in Ontario. The 50:50 international joint venture saw Canadian Solar agree to acquire a majority stake in 16 solar projects in Ontario from SkyPower, with an estimated total installed capacity of between 190 to 200 MW.

Cumulative solar PV installed capacity in Canada increased from 20 MW in 2006 to 500 MW in 2011, at a CAGR of 89%, and is forecast to reach 6,579 MW by 2020 at a CAGR of 33%.

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Australia's largest installation supplied by Kyocera

KYOCERA SOLAR, INC. a supplier of solar modules and renewable energy solutions, recently supplied 348 kilowatts (kW) of solar modules that now cover the roof of the Townsville RSL Stadium in North Queensland, Australia.

The photovoltaic installation, which will produce approximately 500 megawatt hours (MWh) of energy annually, is now the largest in North Queensland and will supply the equivalent of two-thirds of the stadium's yearly energy requirements by utilizing the clean, renewable energy of the sun.

More than 1,800 Kyocera solar modules provide two-thirds of Townsville RSL Stadium's power needs. Ergon Energy installed the solar system, which will generate about 1,400 kilowatt hours each day, equivalent to the daily energy requirements of 75 typical North Queensland homes.

That amount of clean energy equates to eliminating 460 tonnes of carbon pollution each year or removing approximately 100 cars from the road.



Federal Parliamentary Secretary for Climate Change and Energy Efficiency, Mark Dreyfus, opened the Townsville RSL Stadium solar array.

"These measures make the most of Australia's natural resources and help us make the gradual shift to a modern, clean energy economy," he stated.

The solar-powered stadium is a key component of the federally funded Townsville Solar City Program, which has already been responsible for installing more than 1MW of solar energy throughout the city.

The ongoing solar program will help achieve objectives to better manage rising electricity demand in Northern Queensland using environment-friendly resources.

Townsville Queensland Solar City is one of seven solar cities across Australia, and part of the Australian Government's Solar Cities program that works with all levels of government, industry and community to change the way we think about and use energy.

"Kyocera is proud to support Ergon, the leader of the Townsville Solar City Program, to help create renewable solar energy that will power the North Queensland region for decades to come," said Steve Hill, president of Kyocera Solar, Inc.

"Citizens attending basketball games and other events at Townsville RSL Stadium may enjoy themselves even more knowing that the stadium's commitment to environmentally friendly renewable energy helps to protect Australia's natural beauty."

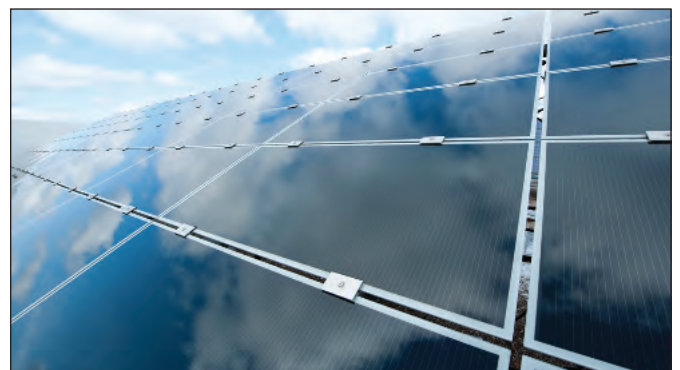
First Solar signs Indonesian MOU

FIRST SOLAR and PT. Pembangkitan Jawa Bali Services (PJB Services) of Indonesia has signed a memorandum of understanding (MOU) to collaborate on the delivery of 100 megawatts (MW) of utility-scale solar power plants in Indonesia in order to address the growing energy demand in the country.

"Indonesia has an increasingly urgent need for reliable, cost-effective energy resources. The agreement with PJB Services facilitates an ideal collaboration to provide Indonesia with the needed solution," said Won Park, First Solar's Senior Manager of Business Development and Sales in Southeast Asia. "This MOU underscores First Solar's belief that the Indonesian market has great potential as a sustainable market where solar power can be a meaningful part of the energy mix."

The MOU is the first for First Solar in Indonesia and one of several related to the company's strategy of forging strategic alliances in fast-growing, sustainable energy markets worldwide. The MOU also represents the first foray into the development of utility-scale solar photovoltaic power plants for PJB Services.

The MOU represents an initial step in the collaboration between the two companies toward the development, engineering, procurement, construction, operation and maintenance of an



approximately 100 MW pipeline for solar PV power plants, including PV hybrid solutions, using First Solar's advanced thin-film PV modules and related system services and components.

"We are excited by the opportunity to collaborate with a world leader in solar energy for the development of utility-scale PV power plants in Indonesia," said Bernadus Sudarmanta, President of PJB Services. "Solar PV electricity can help Indonesia meet its fast-growing power needs while reducing its dependence on fossil fuels."

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2012 China PV Market has slow start but a strong ending to come

CHINA'S domestic PV market made a slow start to the year, with just 720 MW installed in the first half, according to the latest research from IMS Research. Installations are forecast to surge in the 2nd half, with more than four gigawatts (GW) of PV installations to be completed, taking full year installations to five GW, according to the Q3'12 edition of the China PV Market report. In September, China announced its latest PV Five-Year-Plan which targets 20 GW of PV systems and one GW of solar thermal power to be completed by 2015. However, this plan did not bring the levels of financial stimulus that were expected.

"While old issues like grid-connection and power transmission have still not been solved, new issues emerged in the second quarter of 2012, such as worsening bankability, poor credit conditions and a general slowdown of the Chinese economy," remarked Frank Xie, IMS Research's senior PV analyst based in Shanghai. "Many projects are said to have completed the bidding process but they are not yet under construction. Integrators are prioritizing projects to be completed by year end, and there will be a huge surge in installations."

2012 has so far also bought difficult times for China's huge supplier base and



utilization rates remained low as a result of a strong focus on cost control and caution over the ongoing EU trade investigation into Chinese PV products. Average utilization levels for PV polysilicon, wafers, cells and module manufacturers all declined in the third quarter; all were lower than 60 percent. Despite wafer production capacity in China declining in the third quarter, average utilization fell to just 58 percent; as a growing number of manufacturers favored sourcing wafers from third parties at a lower cost than manufacturing them.

Utilization rates are forecast to recover slightly in the fourth quarter. Both inverter shipments and revenues declined in the second quarter of 2012 compared with the previous quarter as a result of weak demand. According to the report, the first half of 2012 saw inverter shipments of just 700 MW, less than half of the amount shipped in the second half of 2011.

Xie added, "The situation is set to improve, and China's inverter supplier base is forecast to ship more than 4GW of inverters in the second half of 2012."

Soitec delivers Italian system

SOITEC has completed delivery on a total of 5 MW of its Concentrix CPV systems to seven solar power plants in Italy. These system deliveries to multiple customers expand Soitec's solar system installations to more than 10 MW worldwide.

"Our proven CPV technology provides the highest power-generating efficiency, making it a perfect match for Italy's solar initiatives," said José Bériot, vice president Solar Projects Development of Soitec's Solar Energy division.

"With Soitec's high-quality modules being very well received in Italy and with our office in Rome providing direct customer support and developing new business opportunities, we are building momentum in the growing Italian market for renewable energy solutions."



"We are committed to have a competitive offering in Italy and we are currently looking into integrating more and more local content," Bériot added. "Soitec's industrial manufacturing capacity and supply chain in Europe, with its fully automated solar-module factory in Freiburg,

Germany, has proven to be a reliable and flexible infrastructure to ensure competitiveness and security of supply in Europe."

Each CPV system produces a high, constant power output curve to match peak-load demands – a key performance need for power utilities.

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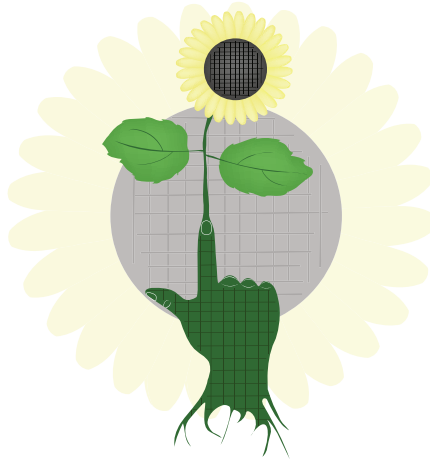
Solar PV Backsheet Market hit by recession

EUROPE currently leads the solar PV market, but the ongoing impact of the ongoing Euro zone crisis is expected to lead to a drastic decline, states a new report by energy experts GlobalData. The new report names Europe the largest solar PV backsheet market in the world, with the region accounting for 72.1% of global backsheet installed capacity. However, the maturing market and struggling national finances are expected to cause global solar backsheet revenues to fall in 2012.

Germany represents the largest market for PV backsheets in the world, registering revenues of around \$537.7m in 2011. The German company KREMPEL is currently the global leader in backsheet manufacturing, producing between 63 and 69 million square meters of backsheets in 2011. Historical market growth can be attributed to an increase in sales resulting from multi MW PV installations in the country.

However, reduced government support and a low investment scenario resulting from the Euro zone crisis will damage the German PV backsheet market, which is already maturing and perhaps reaching domestic saturation. Manufacturers are therefore looking to expand the export market for PV backsheets, and exponential growth in the Asia-Pacific region has created a sizable potential market. The market in Germany is expected to generate estimated revenues of \$65.1m in 2020.

Italy is the second largest PV market in the world, and has an export-oriented market for solar backsheets. The Feed-in Tariff (FIT) program supports the development of solar PV, and continued



revisions to the Conto Energia FIT scheme have so far molded to the development of the solar PV market itself.

However, financial instability is predicted to lead solar PV investments into a sharp decline, making project financing a major challenge for solar PV firms. A market recovery from 2013 onwards will be aided by the expiry of registration duties introduced by the government in 2011, and backsheet price reductions will keep market revenues constant. European PV backsheet installed capacity increased from 949 megawatts (MW) in 2006 to 15,491 MW in 2011 at a Compound Annual Growth Rate (CAGR) of 75%, but is expected to amount to 12,888 MW by 2020 at a negative CAGR of 2%.

From 2012 onward, the market is set to recover with the support of relevant government policies and incentives, with countries such as the Czech Republic, Portugal, Greece and Bulgaria increasing their presence in the PV market, but the economic crash in Europe will likely take its toll nonetheless.

REC announces reduced returns

Renewable Energy Corporation (REC) has announced third quarter results will be below analyst expectations. The company cited challenging market conditions leading to reduction in both sales volumes and ASPs for REC Solar and REC Silicon. REC expects revenues of NOK 1.5 billion and a negative EBITDA of about NOK 185 million for the quarter. REC Silicon is expected to break-even

while REC Solar expects a negative EBITDA of about NOK 175 million. Third quarter polysilicon sales amounted to about 4,800 MT, silane gas sales to about 360 MT and modules sales to 170 MW. ASPs were down 10 % for polysilicon, 4 % for silane gas and 10 % for modules. These effects, as well as inventory write downs negatively affected the results.

Centrotherm photovoltaics submits reorganization concept

CENTROTHERM PHOTOVOLTAICS AG has submitted its reorganization and future concept as planned to the District Court of Ulm. After being examined by the court, the insolvency plan will be presented to creditors who will then decide on whether to accept it in a separate voting meeting.

“Our aim is maintain centrotherm as an independent company based on this plan and to guide it towards a successful future. Ultimately this would benefit everyone involved in the process,” says the company’s administrator Tobias Hofer.

If the plan, which aims for the highest satisfaction of creditors, is accepted by creditors and confirmed by the court, the proceedings can be terminated in line with the regulations of the German Act Relating to the Further Simplification of the Reorganization of Companies (ESUG), and the German Insolvency Directive (InsO).

centrotherm photovoltaics AG could then operate again on a solid basis on the market as a reorganized company and on a fully independent basis. The same applies for the subsidiaries centrotherm thermal solutions GmbH & Co. KG and centrotherm SiTec GmbH, which are currently engaged in their own proceedings .

Insolvency creditors of the named companies are able to register their receivables to the court-appointed administrator by November 5 in order that to participate in the process and are can decide on the insolvency plans. The court has appointed the lawyer Prof. Dr. Martin Hörmann from the anchor Rechtsanwälte legal firm, Ulm, as centrotherm photovoltaics AG’s administrator. Alexander Reus, also from anchor Rechtsanwälte, has been appointed administrator for the subsidiaries centrotherm thermal solutions and centrotherm SiTec.

Managing the full energy potential

The German company Solare Datensysteme GmbH is a solar monitoring specialist and recent winner of a Solar Industry Award with the Solar-Log monitoring equipment and the WEB analysis platform. The company outlines recent experiences in the German market place to provide an outline of the capability of their tool and show that it is much more than simply an energy checker.

Malffunctions in a solar power plant are more than just annoying: they cost hard cash—especially if they go unnoticed for a long time. Modern monitoring equipment helps to prevent drops in yields, and offers a wide range of useful additional functions that make operating a solar power plant even more cost-effective.

A local PV installer named Michael Schneider was recently called to a plant that was offline due to a technical fault after three years of operations. The customer did not notice the breakdown for two months and had to call Schneider to repair the plant so that the PV power could be generated fault-free again. Due to the fault, the customer lost out on payments during prime summer months.

To prevent this from happening again, the customer followed Schneider's advice and installed a monitoring system so they are immediately notified about any malfunctions with the PV plant. The system is set up so that Mr. Schneider, as the plant installation supervisor, is also informed about any malfunctions.

"In this way, I can offer my customers a comprehensive service, so that when problems arise, I can immediately analyze them and carry out any necessary repairs or other measures," Schneider explained.

Ensuring yields and avoiding CO₂ emissions

More and more plant operators use the monitoring system for more than just detecting disturbances. They use monitoring devices, so-called data loggers, to calculate the current solar power yield, the total yield for a particular day, month or year, as well as the total yield for the plant's entire operating time. The reporting programs show how high the yields are in the currency for the country (euro, pounds, dollars etc.) and how many CO₂ emissions have been avoided with solar energy in comparison to conventionally produced electricity.

"Most of my customers operate a PV plant not only for the potential returns, but particularly because in doing so they can also make a contribution in reducing climate change," Schneider explains.

Shadows to rodent damage

How does a data logger actually function? Where does this information come from, and how does the device know that there is a fault in the system?

Jörg Karwath, Chief Technology Manager at the Data Logger manufacturer Solare Datensysteme explains: "The data logger is connected to the inverter by a data interface, from which it receives up-to-the-minute data such as the amount of electricity fed in, inverter error messages or the temperature of the inverter. This goes on continuously throughout the day."

The data logger compares the outputs between the inverters or individual strings. A separate irradiation sensor can also determine deviations between the potential and actual output. If those values differ over an extended period, Solar-Log reports a fault and sends an e-mail or text message to the operator or to the solar power support specialist. Unlike the monitoring devices that inverter manufacturers offer to complement their inverters, the Solar-Log appliances from the Swabian based company Solare Datensysteme are able to work with all commonly available makes and types of inverter.

"The underlying causes of faults can be many and varied," states Karwath from experience. "From shading caused by a fallen tree to rodent damage to cables, and even the complete failure of an inverter - we have seen it all."

Managing and utilizing self-produced power

"Our data logger can do much more than just saving, evaluating and processing data," Jörg Karwath points out.

The models are able to optimize the consumption of self-produced power. This is not only worthwhile for environmental reasons, but it increases the returns to the consumer in some countries and makes it possible to install larger plants. The German monitoring system monitors and controls power consumption in regard to the management of self-produced power. The only requirement for the measurements is an additional power meter that transmits power consumption to the data logger. The current power production and consumption are subsequently displayed in a clear graphic. With just a quick glance at this graphic, you can determine if enough power is



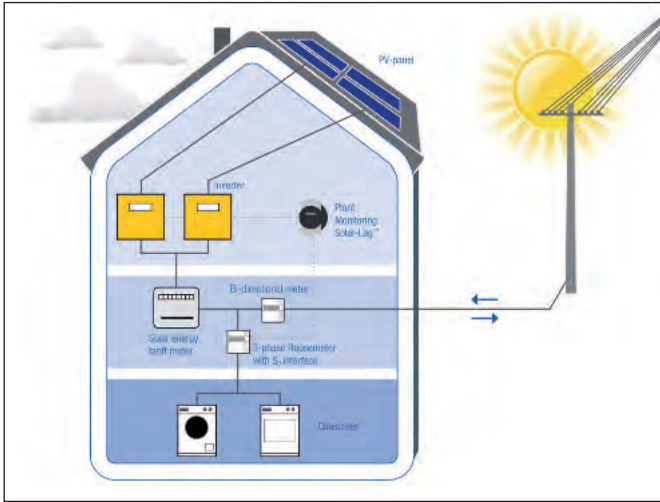
Easy to access and read is a key component of data logging tools to increase the ability to react to information

A 10 kWp PV plant can reduce CO₂ emissions by more than 6 tons per year by maintaining monitoring devices. There are various ways of viewing an analysis of yield values. A few data loggers have an on-board display that depicts all the key indicators in the form of simple graphics and tables. A greater level of convenience can be obtained by connecting the monitoring device to the internet via a DSL connection, modem or an optional wireless card. The ability to view the analysis in large-screen format allows easier recognition and reaction to concerns. Data can also be incorporated on your own homepage, or on an installer's website providing around the clock access to critical information from anywhere in the world .

Applications for mobile devices are available now. In addition to the yield in kilowatt hours and euro (or in any local currency), the savings in terms of CO₂ and the prevailing efficiency level of the inverter, the online view can also show the inverter temperature characteristics. These are fundamental to the efficiency rating of the plant. The characteristic curves of individual inverters can also be read out from plants with several inverters.

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winners

COVER STORY



Illustrating how solar log fits into a domestic installation enabling the consumer more control over their energy usage.

being generated to start additional electrical appliances. In addition to recording the amount of power generated and consumed, Solar-Log1000 offers the possibility to automatically turn on electrical appliances. Appliances can be switched on or off depending on the amount of energy being produced. For example, water heaters can be turned on when power is being produced and remain active throughout the day. If power production increases further, then additional appliances can be automatically turned on, for example air conditioners. You can determine if appliances are turned on for a minimum period of operation or if they are turned off again once a certain power production threshold is reached. It is also possible to configure the latest time by which the appliance is to be turned on even if there is not sufficient energy production.

Since the beginning of 2012, new regulations for feed-in power management in Germany have been in force. With the help of feed-in management technology, utility companies now have access to privately generated PV energy. They are able to establish how much energy can be delivered from decentralized power generation sources to the grid. To enforce these regulations, special control technology is usually employed. Solare Datensysteme GmbH has updated its monitoring systems accordingly and now offers extensive functions in the Solar-Log PM+ series to manage power generated by privately owned PV plants in the German region.

Solar-Log even makes it possible to control reactive power. It is especially important for grid stability to be able to adjust the reactive power. The inverter must support the possibility of controlling reactive power, but more and more inverters can react to this control through the Solar-Log power management system. Many utility companies require feedback of the actual power and reactive power of all connected PV plants.

Solar-Log has been one of the first monitoring systems that has been able to fulfil such

requirements by the utility companies. Specifically designed PM packages not only allow a universal connectivity of Solar-Log to the utility company, but also support the utility companies by helping to stabilize the grid.

Portioning the amount of PV energy that is used or fed into the grid

The Solar-Log PM+ was designed for feed-in power management but can also be configured so that a certain percentage of power is fed into the grid and the rest is available for industrial or household consumption. The option is particularly attractive in regions outside of Germany, where only a certain amount of PV power is allowed to be fed into the grid. This new Solar-Log control technology ensures that only part of the generated power is fed into the grid and that the rest is available only for self-consumption. You can set how much power is to be fed in.

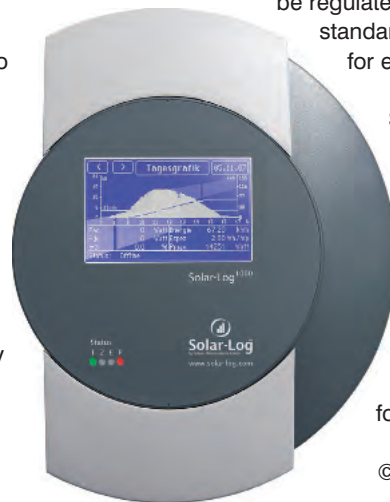
The example from Germany shows how PV control works. Jörg Karwath explains the function in regards to 70% fixed regulation for feed-in power:

If the amount of DC power from a PV plant is limited to 70%, it is possible with this technology to use the rest of the power for self-consumption. The 70% throttle only applies to the 'feeding point.' As a consequence, it is possible to generate more AC power at the inverter when it is warranted so the surplus power is used for residential or commercial use. A plant with 10 kWp then is limited to a maximum of 7 kWp with a 70% throttle. If a 600-watt appliance, such as a stove, is turned on, the inverter can convert 7.6 kWp to A.C. power. At the feed-in point, then only 7 kWp is delivered. For this practical form of utilizing self-produced power, the only requirement in addition to an appropriate monitoring system is a digital power meter.

Developments in feed-in power management

In Germany, the regulations for feed-in power management are still rather complex. PV plants are divided into various size classes, each with its own set of regulations. However, feed-in management is also becoming relevant in other countries as the amount of PV power installed continues to increase.

Standardized communication, according to IEC Standard 61850, between grid operators and decentralized generating plants will be regulated by law in the future in some countries. The standard specifies a general transmission protocol for electrical switching systems.



Starting this autumn, Solare Datensysteme GmbH is starting a pilot project for standardized communication according to IEC 61850 and IEC 60870. It will then be possible for the monitoring system to communicate directly with the grid operator's control center. This standardized communication between PV power generator and the respective grid company will then become more attractive for international PV markets.

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Trade wars threaten growth

The anti dumping claims against China have spread beyond the USA with SolarWorld spearheading both US and European complaints. India is talking about similar action and other regions are watching closely. At this early stage there can only be speculation as to the eventual fallout from the trade actions but at this stage the issue has divided the global industry and China is discussing retaliatory trade actions. With prices threatening to rise at a time government subsidies are reducing margins will be squeezed along the entire value chain.

The China trade cases that began when German based SolarWorld's USA operations instigated a US Commerce Department investigation into allegations that Chinese manufacturers had sold product below cost so as to garner market share. The US process has reached a key point as Washington announced punitive duties from the case against Chinese producers. Further bad news for the Chinese companies is the trade actions are spreading to other parts of the globe. The US Commerce Department has delivered its determination in response to the trade action instigated by SolarWorld. The department looked at anti-dumping and countervailing issues and decided to impose large and punitive tariffs on Chinese manufactures of solar cells.

The Commerce Department has determined that Chinese producers and exporters sold solar cells in the US at prices between 18 and 250 percent lower than what is considered their fair value. As the investigation used Taiwan as the benchmark for the determination the

suggestion is that Chinese manufacturers were selling product at these levels below what Taiwanese manufacturers are able to.

The frustration for detractors of the action is that even if such activities were occurring the end result was a vastly reduced PV cost enabling faster integration to a subsidy free business than anyone could have anticipated.

There are a number of reasons for the massive cost drop and oversupply with a primary cause being the number of players outnumbering the potential market space. The global market place has also proved more malleable than many would have anticipated and not everyone has had the size or flexibility to follow the market growth areas.

Companies whose growth has derived from a local base and local growth have found themselves short when the area they service slows down.

The larger companies tend to be able to sell products cheaper and many regional based operations are pushed out.

There is evidence that some companies were selling product below cost at times and one CEO of a Chinese manufacturer was bold enough to publically admit this although he is probably regretting his words in light of subsequent actions. The Commerce Department determined Chinese companies countervailable subsidies of 14.78 to 15.97 percent. This sort of subsidy is considered unfair with trade regulations.

The US government has declared its intention to retrospectively apply the new duties costing Chinese companies million of dollars in extra tariffs. With major Chinese companies already creating avenues of product through other countries and avoiding future trade duties the retrospective cost may be the bulk of what the US can pull back from the Chinese industry.

The results from the determination are considerably higher than the original March announcement, which said that Chinese producers received support at levels between 2.9 and 4.73 percent. The final range of countervailing duties that will impact



Chinese companies is between 14.78 to 15.97 percent. The final anti-dumping rates range from 18.32% to 31.73% for participating companies and 249.96% for non-participants. The coalition led by SolarWorld in the US has made it clear the goal is to ensure that PV companies are able to sell globally and on a fair playing field. The process seems to be achieving that but by raising the price of PV to the level of some US manufacturers instead of a collaborative effort of realistic prices combined with price reduction from all manufacturers.

Whatever the goal initially was the consequence has been to divide the US industry into two camps torn on the issue of Chinese trade and whether it has helped or hindered global growth. This has come at a time when the PV industry needs to be a collective voice and force for future energy needs.

Other solar trade bodies have been less committed to either side of the argument and have tended to counsel for a mutually benefitting outcome for all parties. Rhone Resch, president and CEO of the Solar Energy Industries Association (SEIA), had this to say, "While the decision rightly shows that the U.S. will protect its rights in the global trading system, trade litigation alone is not enough to solve the complex challenges that exist between the U.S. and China. What is immediately clear is that for solar to thrive globally, there is a need to build consensus on acceptable forms of government support for industry.

The concern spreads

China has been critical of the US process from the beginning and has threatened to return the favour in a number of areas and industries where the country feels the US has bent rules to suit its own needs. The potential consequences of such a trade war could have impacts beyond what can be currently seen. China has already instigated trade investigations against US polysilicon manufacturers accusing them of the same dumping concerns as China faces with PV cells.

Europe meanwhile has instigated a trade case of its own. Once again spearheaded by SolarWorld who are leading a European consortium to push through the same punitive trade restrictions as the US is developing. The consortium, EU ProSun initially went to the European Commission with an anti-dumping complaint against mainland Chinese products and was similar to the US complaint. Most of the 20 companies involved in ProSun have chosen to remain anonymous for fear of retributive actions.

The EU complaint differs from the US complaint in that it does not just target cell production but looks at a broader array of steps from the wafer to the module. This is due to Europe's early technological lead in the solar industry that has been challenged by the rapid growth from China. ProSun has since added another complaint with the European Commission over illegal subsidies to Chinese solar manufacturers. This new request is different from the first one and focuses on the level of support from the Chinese government.

Milan Nitzschke, President of EU ProSun, stated, "Chinese government subsidies are only available to Chinese companies. Massive subsidies and state intervention have stimulated overcapacity more than 20 times total Chinese consumption and close to double total global demand. Chinese subsidies shield manufacturers from insolvency, and are pumped into solar companies even if they are unprofitable."

The claim is that by supporting unprofitable companies longer than their capability led to the global glut and subsequent company dissolutions we are now seeing in Europe. The EU solar trade dispute with China is gearing up to be the most serious between the two areas in many a year. China has made it clear it finds the proceedings in both areas insulting and has promised a trade response. One solar CEO commented that China was bluffing as they need polysilicon but this is to underestimate the broader trade issues at hand between the regions. China does not need to retaliate towards the solar industry to hurt Europe and there are some industries, such as automobile that receives more support than PV and China has its eye on. Europe accounts for two thirds of the global solar industry and would be seriously impacted if the consequences were at the harsher end of potential.

The European case has taken on another similar note to the US with another trade consortium created in opposition to EU ProSun. The Alliance for Affordable Solar Energy (AFASE) is made up of companies who feel the EU process will ultimately harm the European solar industry and Europe in general. AFASE has called on the European Commission to uphold free trade in order to secure jobs in the European solar sector and support further industry growth and progress.

"Free trade was one of the factors that enabled the European solar industry to become a fast growing sector. At a time when

European governments are scaling back their subsidies for solar energy, trade barriers would push up costs and damage, possibly beyond repair, the competitiveness of solar power”, says Thorsten Preugschas, CEO of the German operating project development company and AFASE affiliate Soventix. “Therefore, we call on the EU Commission to bear in mind the severe damage punitive tariffs would bring to the whole European PV sector.”

AFASE also expressed its concern about the growing danger of a trade war between Europe and China. “Moves towards economic protectionism are short-sighted, not just in the solar sector but elsewhere, too”, says Preugschas. “They severely endanger the global business climate and economic growth. We therefore welcome German chancellor Angela Merkel’s call made on occasion of her state visit to China to deal with the dispute in the solar sector jointly through dialogue rather than legal procedures.”



Chinese response

The official line from the government of China is to condemn the trade cases going on. The Chinese see the wording of the complaints targeting the country rather than companies. The insistence on seeing China as a monolithic entity has meant that much of the rhetoric fails to understand the make up of China. Where problems with some branded PV companies may exist there is often a more regional or local situation that is supplying money. Especially in regions where there is pressure to improve national standing.

The Chinese Ministry of Commerce claimed the US decisions signals protectionism and will hinder innovation in solar and other clean energy sources. Government officials are using the situation to suggest the US is not actively progressing climate change and carbon emission issues. Many of the Chinese companies caught up in the dispute strongly deny wrongdoing and are spending much of their time positioning themselves as global companies rather than be perceived just as Chinese. Many of the Chinese companies have already developed manufacturing areas outside of China and intend to bypass the punitive duties. Canadian Solar is one of the companies caught in the dispute and are increasing the awareness of the Canadian connection. Dr. Shawn Qu, Chairman and Chief Executive Officer had this to say on the dispute.

“While we are disappointed with the DOC final determination, we will continue to defend our position with the ITC ahead of its final determination. We will also remain committed to the U.S. solar energy market, leveraging our global supply-chain to provide fairly priced solar energy solutions, to support our employees, partners and customer base.”

Gao Jifan, chairman and CEO of Trina Solar has said the company is considering whether to appeal the decision or just build better relations for the future. Many Chinese companies have expressed their gratitude for the support they have received from US and European allies and most of the industry hopes for a quiet resolution to reduce instability. Most observers are concerned at how the government in China will respond on a broader economic scale. Both Europe and the US would suffer greatly if China decided to tighten the trade screws. The biggest criticisms are left for SolarWorld, the company that began the process. There are suggestions that the company may come under scrutiny itself as its business growth was helped by German and US government support. Between 2003 and 2011 the company received more than 137 million Euros in support

Trouble continues

There is little chance the process will be quick as India has now suggested they will follow suit and more surprisingly is a recent court case from US manufacturer Solyndra. The company sadly became the poster boy for US energy failure and has now filed suit against Chinese companies claiming it was their dumping that caused their financial problems. The case will not be so simple with differing technologies and many more complex reasons besides dumping as to why poly silicon prices dropped from the ultra high levels when the Solyndra plan was born. Expect plenty of rhetorical pushing and shoving between companies and countries and no simple solution in sight.

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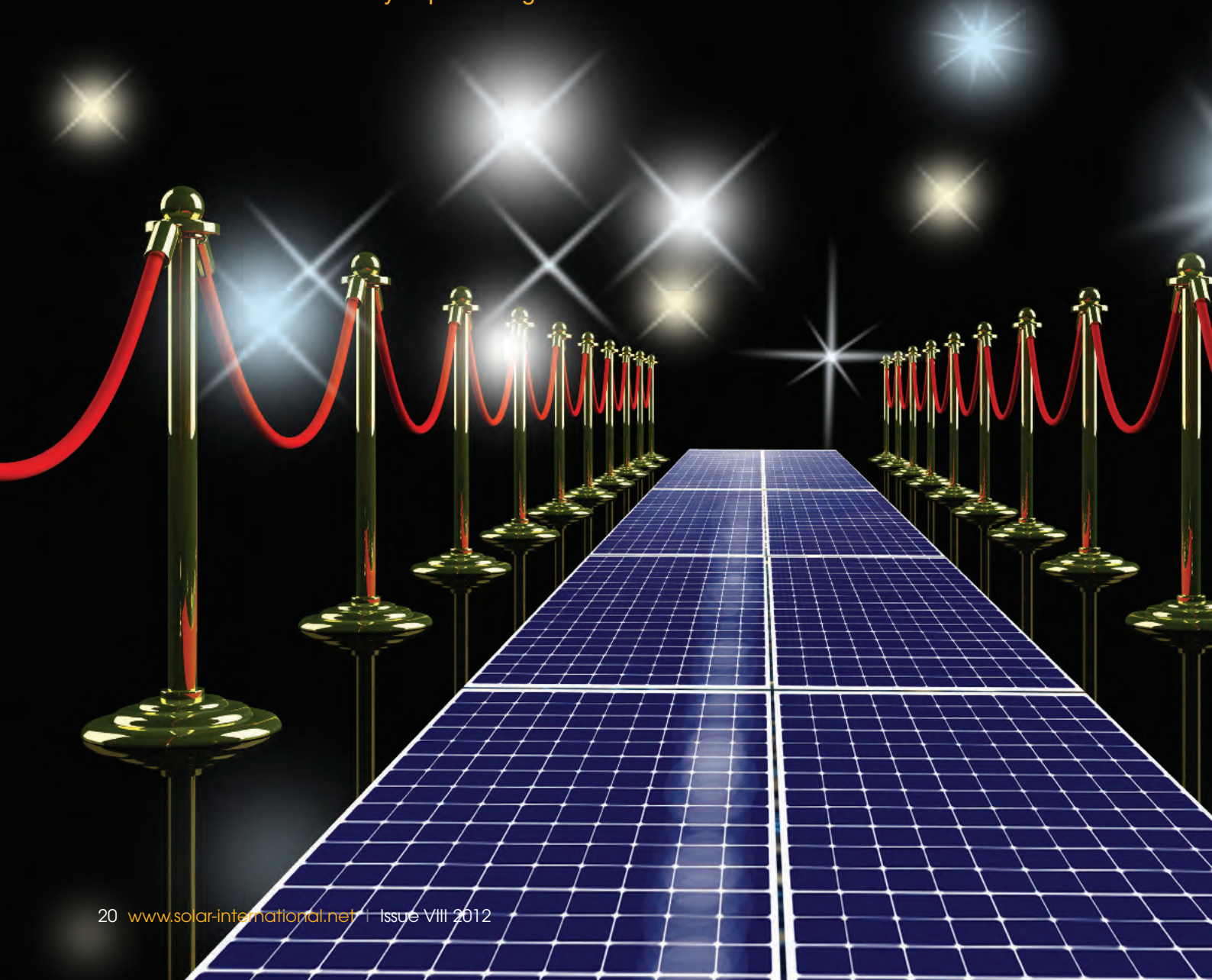
solar

awards 2012

w i n n e r s

The annual Solar Industry Awards were held in Frankfurt this year and the turn out of industry luminaries highlighted the stature of the awards as one of the industry's premier events that continues to applaud innovation and excellence the industry is producing.

The following pages showcase our first batch of winners with the remainder to follow next edition. The organisers of the Awards would like to thank all our readers for helping make this event such a success. Without your votes there would be no winners at all.



PV MATERIALS ENABLING AWARD

Heraeus

SOL200 Series

MODULE MANUFACTURING INNOVATION AWARD

Solar Junction
SJ 3 Cell

THIN FILM INNOVATION AWARD

SoloPower
CIGS Technology

RURAL ELECTRIFICATION DEVELOPMENT AWARD

Steca Elektronik GmbH
Solar refrigerator/freezer

SILICON INNOVATION AWARD



Aegis® Wafer for Silicon Photovoltaic Products

PROJECT DEVELOPMENT AWARD

Phaesun
Rural Electrification with Plan Ethiopia

SYSTEM INTEGRATION AWARD



Power Management for PV Plants

SOLAR AWARD FOR EXCELLENCE (PRODUCT)



Mobile Test Centre

PV TOOL AWARD



DragonBack™

SOLAR AWARD FOR EXCELLENCE (COMPANY)



Life Shines Brighter
(End User communication campaign on benefits of PV)

PV PROCESS AWARD



The Levitrack™ ALD system

SOLAR AWARD FOR EXCELLENCE (INNOVATION)

PV BALANCE OF SYSTEM



ArrayPower Sequenced Inverter™



Triex Solar Technology (hybrid module)

ENERGY USAGE ENABLING AWARD

SolarBridge Technologies
Pantheon II integrated microinverter

SOLAR AWARD FOR EXCELLENCE (INDIVIDUAL)

Jifan Gao, CEO of



INDUSTRY DEVELOPMENT AWARD



Upsolar Module Lifecycle Assessment

Industry Development Award

Upsolar Module Lifecycle Assessment



UPSOLAR'S lifecycle assessment meticulously examines the environmental impact of the company's mono- and polycrystalline modules over their entire lifetime. The company dedicated 10 months to data collection working alongside respected evaluation body Bureau Veritas CODDE to verify its methods and results. The analysis began with the raw materials used to create Upsolar's modules to ensure the company is working with environmentally conscious component providers.

Next Upsolar thoroughly assessed the practices of its primary manufacturing platforms monitoring gas emissions toxicity and waste levels throughout the production and packaging processes. The study then moves to installation and in-field operation analyses before taking a close look at end-of-life procedures on Upsolar modules. As a member of the PV Cycle, Upsolar is fully committed to enacting the most sustainable

disposal and recycling processes for its products. The resulting data from the LCA process will serve as a baseline and allow Upsolar to determine where it can improve its energy use material consumption and recyclability on an annual basis. The solar industry creates products that enable consumers to reduce their carbon footprints through renewable energy generation. However to cultivate a truly "green" industry clean technology providers must examine ways to optimize their processes and minimize environmental impact.

Upsolar is one of the first China-based module producers to perform an in-depth analysis of its environmental impact. This is especially significant as China currently manufactures more than 80 percent of the world's silicon-based PV products leaving the region to face the consequences of any environmentally harmful procedures.



Sebastian Prioux Project Development Director receiving the award from David Ridsdale, Editor-in-Chief of Solar International

winner

PV Balance of System Award

Sequenced Inverter



THE SOLAR inverter market is split into three primary categories each defined by size: Central inverters which connect hundreds of solar modules string inverters connecting 10-14 modules and micro-inverters which are connected to 1-2 modules. Central and string inverters are generally the cheapest option in terms of upfront cost but are also the most common point of failure in a solar system leading to costly replacements over the lifespan of a solar installation.

Micro-inverters are typically viewed as the most reliable of the three options and provide other system benefits like improved energy harvest ease of installation and module-level monitoring. This makes the technology attractive for commercial-scale installations but the high cost associated with micro-inverters makes the products impractical beyond the residential system level. Sequenced Inverters offer the benefits of other module-level inverters including Maximum Power Point Tracking (MPPT) anti-islanding protection and smart system monitoring through a communications gateway. However whereas competing technologies allocate the DC-AC conversion process to a single unit ArrayPower designed the Sequenced Inverter to distribute conversion across a system.

Each Sequenced Inverter converts DC power from the associated PV module to an output of high frequency pulses phase synchronized to the utility grid voltage. Each Sequenced Inverter operates at a deliberate phase offset relative to its neighbouring inverters and contributes a series of grid

synchronized current pulses to the branch circuit summing together and delivering high quality three-phase 208VLL power. This architecture results in reduction of required energy storage and eliminates complex low frequency grid-tracking output filters enabling the elimination of short lifetime components found in traditional inverter designs. The design of the Sequenced Inverter is such that it does away with liquid capacitors seen in other technologies enhancing reliability and ensuring the inverters will perform as long as the rest of the solar system. Additionally the Sequenced Inverter is compatible with grids that operate at either 50 Hz or 60 Hz which gives the technology a distinct advantage over other solar inverter products when entering non-North American or dual-grid markets such as Japan where grids operate at both 50 Hz and 60 Hz.

With the Sequenced Inverter ArrayPower for the first time offers a module-level inverter technology that encompasses all the system benefits of micro-inverters but is priced at the level of string inverters. The Sequenced Inverter is also the first module-level inverter to create three-phase output. Whereas residential and utility-scale solar systems utilize single-phase power three-phase power is required for commercial-scale solar installations.

To implement a single-phase product on a commercial-scale system would require additional equipment and consequently additional cost to the end-user. Sequenced Inverters are designed for integration into a solar module during the module manufacturing process. While micro-inverters can be affixed to the frame of a module ArrayPower works closely with module manufacturers to optimize the two technologies and allow for product combination in the form of a grid-ready AC module. This integration eliminates the need for previously standard components including the junction box facilitating cost reduction during the production process. ArrayPower also teamed with Phoenix Contact to design a simple cable harness and three-pronged plug to connect each module resulting in a "plug and play" AC module.

Not only does this method of connection increase worker safety by eliminating exposed wiring it also reduces the amount of time and capital required for system installation. Units can be easily replaced if needed equalling cost savings during any maintenance routines over the lifetime of a solar electric system.





Nick Cravalho VP Business Development & CTO Sorin Spanoche receive their award from David Ridsdale, Editor-in-Chief of Solar International

winner

PV Materials Enabling Award

SOL200 Series

Heraeus

SILVER METALLIZATION pastes have become one of highest material cost parameters in c-Si solar cell fabrication due to the dependence on the core market price of silver (Ag). The need for both high-performance silver-based pastes for improved cell performance and cost-effective conducting materials is a critical requirement for PV manufacturers.

Heraeus develops front-side and backside pastes that lower the silver content per cell. Heraeus addresses the need to reduce that cost by producing silver pastes that allow for up to 40% reduction in silver usage. Heraeus SOL205S, the current product for the back-side, is produced using 52% silver content.

Heraeus' line of back-side pastes are especially formulated to provide high coverage for reduced usage on wafers. Heraeus

continue to reduce the silver content of back-side pastes, while also maintaining excellent adhesion to the silicon cell.

With Pb- and Cd-free material options, Heraeus' back-side pastes offer excellent solderability in both leaded and lead-free solders. All back-side pastes are co-fireable with back-side Al and front-side Ag pastes.

Silver bullion prices have eased over the last nine months, as increased silver bullion production has resulted in an oversupply. Whether this is a permanent situation or not, Heraeus will continue in the direction of reducing the silver usage in cells.

The low laydown of the SOL200 series helps customers save money while maintaining good cell performance.



Andy London, Global Manager for the Photovoltaics Business Unit, receiving the award from David Ridsdale, Editor-in-Chief of Solar International

winner

PV Process Improvement Award

The Levitrack™ ALD system



THE LEVITRACK™ ALD system is based on the novel concept of precursor separation in space, instead of by time, in combination with the unique floating wafer and conductive heating technology used in the Levitor RTP products.

Recently scientific studies by institutes and Si-based cell makers demonstrated that Aluminum Oxide ALD films have excellent passivation potential for both P-type and N-type solar cells partially because of the negative charges that are present in these films.

However the cyclical nature of traditional ALD systems have relatively low growth rates and high gas usage which makes it



difficult to achieve the throughput numbers and cost-of-ownership requirements required by solar cell manufacturing environments.

Conventional technologies use time to separate the reactive gasses (a.k.a. precursors) in the chamber the Levitrack(tm) uses separation in space. In the Levitrack(tm) the solar wafers will travel at high speed through repeating series of gas zones -ALD cells.

These cells are designed such that in the no reaction of precursors takes place inside the system other than on the wafer surface. Other contributing factors are operation under atmospheric conditions (no vacuum chambers load locks or pumps easy automation (no carriers the lack of moving parts (except wafers and the ability to operate without deposition on the walls eliminating the need for periodic cleaning.

With this unique "space separation" ALD technology the Levitrack(tm) closes the gap between the low deposition rates of traditional "time separation" ALD processes and the demands for high throughput and low cost-of-ownership in solar cell manufacturing. The Levitrack(tm) can deposit films efficiently and effectively.

This is crucial for integration of Aluminium Oxide films in solar cell designs and enabling cells with higher efficiency to become available for the mass and to clear the way to and beyond grid parity.



Robin Schiermann, Sales Manager and the Levitech team with the Solar Industry Award

winner

PV Tool Award

DragonBack™



TODAY'S major challenge in PV is to reach grid parity. In order to achieve that goal efforts are made on the cell/module efficiency on one hand and on the TCO (total cost of ownership) on the other hand. New-generation PV materials exhibiting higher efficiencies jointly reveals highly capacitive effect that disturbs their performance measurement by conventional method.

Such solar cells/modules require new solution for accurately determining their electrical performance in production environments. The DragonBack method introduced by Pasan is the solution for efficiently determining the performance of highly efficient modules with economical and high quality pulsed light source.

The DragonBack measurement method is the solution for the final power measurement of production of highly-efficient

modules. It is used in conjunction with standard Pasan HighLIGHT pulsed solar simulator enabling accurate measurement within one flash at high tact-time while keeping low TCO. Technically the DragonBack measurement method is a dynamic sweeping methodology.

Instead of applying a continuously increasing voltage ramp the DragonBack works by steps during which the module response is stabilized thanks to an adapted overshoot. It consequently diminishes the stabilization time and accurate values forming the current-voltage curve can be measured during a short illumination period (10 ms)

The DragonBack measurement method gives an answer to modules producer looking for reliable accurate and cost-effective solution for the measurement of advanced PV technologies. The noteworthy aspect of the DragonBack method is the combination of a highly accurate and highly repeatable measurement process for HiCap modules with industry requirements including tact-time low TCO and easiness of use.

Up to now the various proposed approaches for testing such material never includes and solved both aspects of measurement accuracy and cost of the solution.

From a technical point of view such dynamic sweeping method was never applied to solar cells or modules before Pasan developed it together with the Swiss university and PV reference laboratory SUPSI within a research project funded by Swiss Confederation. It is the only approach which solves the dynamic problem induced by the new high performance technologies through an adapted measurement process.





Andreas Von Kaenel CEO, Corinne Droz Product Manager, receiving their award from David Ridsdale, Editor-in-Chief of Solar International

winner

Silicon Innovation Award

Aegis Wafer for Silicon Photovoltaic Products



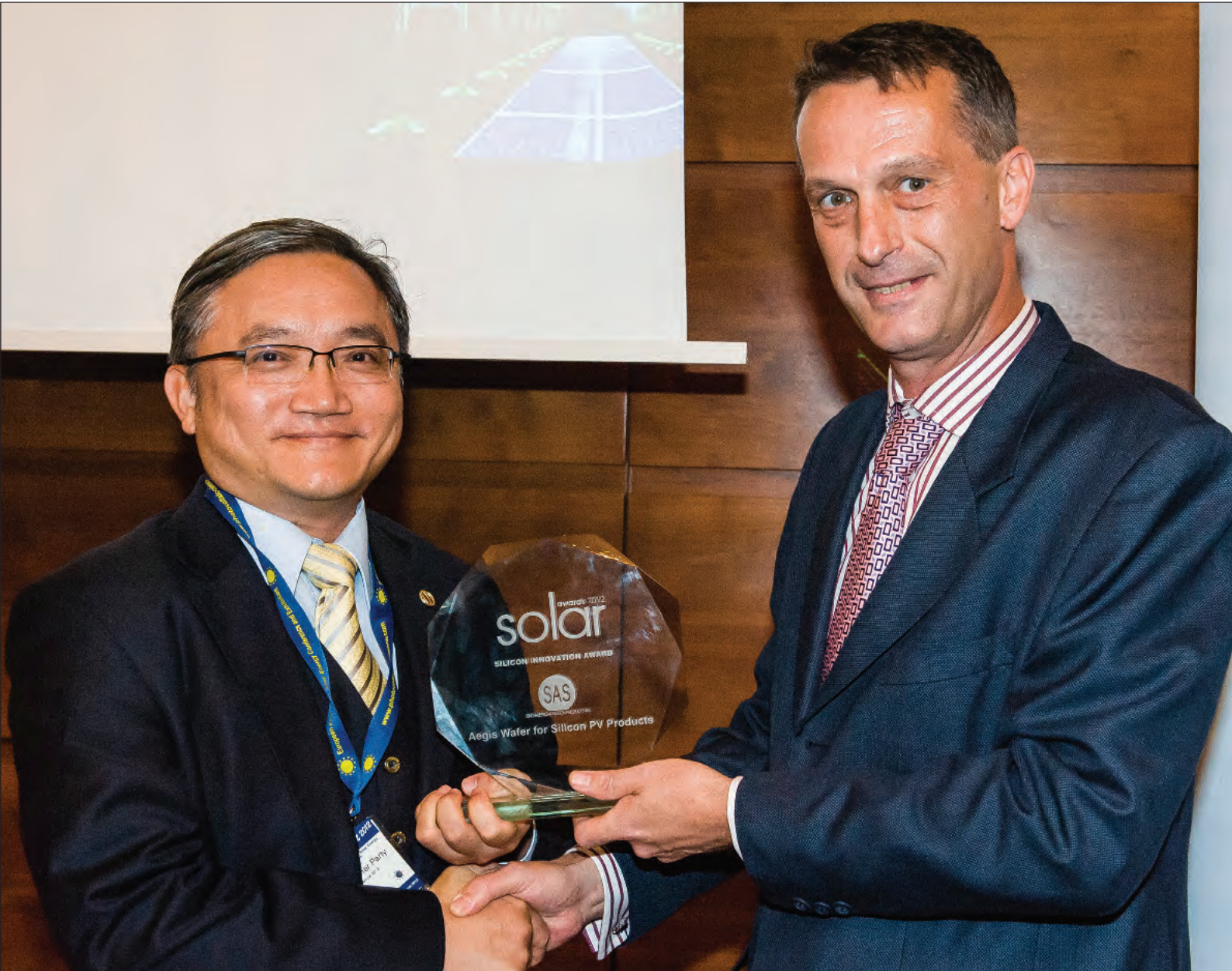
AEGIS WAFER is designed to meet the strong desire of a cost-effective solution at the solar cell industry simultaneously driving high performance and low cost (e.g. loss. In particular ultra-high fracture strength for low loss without hampering the conversion efficiency has topped the desired technology list of the PV community.

SAS invented nano-texturing technology to extensively enhance the fracture strength on the fourth generation of SAS high efficiency A-series wafers. High PV conversion efficiency is achieved by ultra-low bulk defect density while ultra-high fracture strength is enabled using nano-texturing shielding surface defects from crack propagation. The Aegis Wafer perfectly arranges both surface and bulk effects of silicon for the best interest of customers.

The SAS Aegis Wafer is designed for highly strengthening multi-crystalline silicon substrates combined with impressive efficiency improvement. The Aegis Wafer technology platform is combined with SAS A-series silicon growth technology of high cell

conversion efficiency and nano-texturing technology. By nano-texturing technology the Aegis Wafer is enhanced dramatically by over 200 % than conventional multi-crystalline wafer. Accordingly the greatest reduction of in-line fracture loss by over 75 % is undoubtedly instrumental in manufacture loss and provides customer user-friendly thinner wafer solution. Furthermore the Aegis Wafer possesses cost-effective high throughput and its feasibility of batch production to achieve lower manufacturing cost with more than 80 % and energy consumption reduction with more than 50 %.

The SAS Aegis Wafer has excellent efficiency performance on a global scale to advance two-steps ahead on the dramatic high efficiency photovoltaic market by SAS A-series silicon growth technology. The Aegis Wafer achieves over 18 % median PV conversion efficiency by more than 1 % enhancement and raises product value premium by more than 20 %. The Aegis Wafer meets customer's requirements by the greatest gains in efficiency of solar power and cost-effective solution making it more competitive with other means of electricity generation.



Dr. Chung-wen Lan, professor at National Taiwan University, receiving the award from David Ridsdale, Editor-in-Chief of Solar International

winner

System Integration Award

Power Management for PV Plants



IN GERMANY there are over 600 grid companies and each grid company uses a different technology to control the pv-plant. Solar-Log has to offer a universal method to fulfil nearly all requirements. Another important thing is that at some location the grid is on the limit and no additional PV plants can be connected. Solar-Log is able to limit the power that is fed in with consideration of self consumption. So the plant owner can build a larger plant than allowed and still feed in the maximum allowed power.

Solar-Log has implemented different interfaces to get the commands of the grid company and can control the inverters of which protocols for power management has been implemented. By measuring the voltage e.g. on the 20.000 V side solar-log can control the reactive power based on characteristic curve of the grid company. Finally for self consumption solar-log is measuring the power consumption and reduces this from the produce power, based on the difference, Solar-Log is permanently in control of the power of the inverter.

A standard monitoring device has changed to a complete control unit. We are the only company that can fulfil even the most complicated requirements of grid companies. No other monitoring company is able to considering self consumption.

Solar-Log has added some standard interfaces to be able to receive the commands of a ripple control receiver or a more complicated receiver. By this the grid company can give commands to the pv plants via the Solar-Log to reduce the power. Some grid companies also require a feedback of the actual power. This can be also realized with Solar-Log. By using provided characteristic curves for reactive power based on voltage in the grid Solar-Log can also control reactive power. Finally Solar-Log can measure the self consumption and limit the power that is fed in at the grid side.

The new thing is that a PV monitoring device has changed to a complete control device including feedback control system and control based on self consumption.

winner



Jochen Laun Product Marketing Manager and the Solar-Log team with the Solar Industry Award

winner

Thin Film Innovation Award

CIGS Technology

SoloPower has re-imagined solar. Their lightweight and flexible solar technology provides design versatility that makes integration with a variety of applications conceivable — offering a powerful and aesthetic solution to meet the challenges of growing market demand.

In developing next-generation solar alternatives, a thinner profile is paramount. Here's why: the majority of solar cells in existence today are made from rigid multi- or single-crystalline silicon (Si) wafers. Typically 150 μm thick, the wafers demand multiple processing steps before they can be integrated into a module.

On the contrary, thin-film solar cells utilize only a 1-4 μm -thick layer of semiconducting material to produce electricity, thus requiring less processing and fewer materials.



These cost-saving alternatives also offer another important advantage as compared to wafer-based modules in that they can be used in a wide range of applications.

Thin-film solar cells employ lightweight, flexible substrates, making them ideal for advanced applications such as building-integrated photovoltaics. What's more, because of the lightweight form factor, the costs of balance-of-system (BOS) components (such as mounting hardware, wiring, inverters and other electronic hardware) are comparatively lower than other PV devices.

Dedicated to delivering the most competitive solar cell solutions, SoloPower targets the critical challenges of producing CIGS-based devices, which have the highest conversion efficiency among the family of thin-film PVs. Our proprietary approach embodies critical technology, manufacturing and cost advantages to enable large-scale, "fab-style" production.

SoloPower is advancing the work of "thin-film" photovoltaic pioneers, thereby enabling increased affordability and widespread product integration, integrating lightweight thin-film photovoltaic devices into buildings that have never before been able to utilize solar energy due to the considerable weight of traditional glass panels. Integrating solar modules into less predictable applications are becoming increasingly possible.



Bart van Ouytsel Head of Sales EMEA, receiving the award from David Ridsdale, Editor-in-Chief of Solar International

winner

Turnkey Supplier Award

Manz CIGSfab – World Record with 14.6% module efficiency



Manz's own innovation line in Schwäbisch Hall is the incubator of the Manz CIGSfab, a fully integrated production line for manufacturing CIGS thin-film solar panels. Manz acquired the location in Schwäbisch Hall from Würth Solar at the beginning of 2012. As a result, the high-tech engineering firm has the ability to test and implement new materials and production processes under mass production conditions.

Manz offers the only turn-key production line for CIGS thin-film solar panels currently available under the name CIGSfab. In doing so, the company draws on its wide-ranging expertise in six different fields of technology: automation, laser processes, vacuum coating, metrology, and wet chemical processes. In this process, Manz uses synergies that result from making advancements to these technologies in its three strategic areas of business: Solar, Display, and Battery.

In September 2012 the German high-tech engineering firm has achieved a technological breakthrough: the Manz CIGSfab can

be used to manufacture solar panels that, in the future, will supply power costing between 4 euro cents (Spain) and 8 euro cents (Germany) per kilowatt hour, depending on the location.

This means the cost of solar power is now at similar level as electricity from fossil power plants and is significantly less expensive than electricity from offshore wind parks. According to Dieter Manz, founder and CEO of Manz AG, "our technology has the potential to revolutionize the solar industry."

Manz's CIGS solar panel was manufactured on a mass production line, the CIGSinnoline, and with a total panel efficiency of 14.6% and an aperture efficiency of 15.9%, sets a world record for thin-film solar panels. This panel impressively surpassed both the world record for total panel efficiency held by the former cost leader for thin-film panels, First Solar, as well as the record for aperture efficiency held by MiaSolé. In addition, when it comes to efficiency, thin-film solar panels have now pulled even with polycrystalline solar panels.



Axel Bartmann, Head of Corporate Communication, Bernhard Dimmler, Senior Consultant CIGS Technology, receiving their award from David Ridsdale, Editor-in-Chief of Solar International

winner

Energy Usage Enabling Award

SolarBridge Pantheon II integrated microinverter

The SolarBridge Pantheon microinverter addresses a critical problem in distributed PV: the cost of solar adoption is still too high. A key targeted area for potential efficiency gains is the central inverter typically the weakest link in terms of system reliability.

SolarBridge Technologies has developed a microinverter and PV management system that is changing the economics of solar. The SolarBridge Pantheon microinverter is factory-installed and mounted directly on the solar panel to create a “roof-ready” AC module. Power conversion takes place directly on each module rather than through the central or string inverter.

Designed for reliability SolarBridge microinverters are backed by the industry’s first 25-year warranty enabling module manufacturers to offer the maximum end-to-end warranty on their modules. This directly reduces operating costs and system downtime by eliminating the need to replace inverters.

SolarBridge Technologies has changed the game for solar module manufacturers and installers with its innovative revenue-enhancing solution that makes solar more cost-efficient more reliable and easier to install than ever before. The SolarBridge AC Module System enables virtually any homeowner or business to go solar.



winner

Seeking a singular voice

Frankfurt was the host for the industry's largest conference/exhibition, EUPVSEC and with the industry divided by political, economic and legal processes the search was on for an industry voice leading the way. David Ridsdale discovered that the conference still delivers on the best range of innovative ideas but that the industry is dangerously divided at a key tipping point for the global PV and solar industries.



EU PVSEC 2012 was held in Frankfurt this year and unsurprisingly the event was dominated by changing local dynamics, oversupply and on going accusations of Chinese dumping. With the consequences of these issues being felt more each day there was a huge sense of concern on the exhibition floor as to the industry uncertainty. Most are aware that not all the companies at the show will survive the coming twelve months so any conversation was tinged with these issues.

Luckily the EUPVSEC is a much broader event and at the conference side the boffins were more excited about the innovative idea presented. A cursory glance through the sessions showed that there continues to be research in all facets of the PV and solar value chains as well as new ideas in how the technology can be used.

One key area of research is the move towards building integrated PV that becomes part of the structure. One boffin commented to me that he

looks forward to the day when PV is invisible as it is part of the building and not an add on like some satellite dish.

The show organisers had to make late changes to the halls they were using and the space that eventuated unfortunately only highlighted the gap between research and manufacturing. Initially the plan was to use two halls at the Frankfurt Messe for the exhibition but the realities of industry economics had seen a decline in numbers so the entire manufacturing exhibition was put into one hall.

The technical meetings were left in the other hall and the conference was held in the Congress Hall. Sadly the distance between all three sites meant that the conference delegates rarely ventured into the manufacturing exhibition reducing the numbers on the show floor. With such a physical gap between the three areas it only outlined the current gaps in industry thinking and interaction. While many of the sessions in the conference highlighted



Key note speaker and previous Solar Industry Award winner Professor Martin Green from Australia. Known as the father of solar to many.

the range of innovation being developed through research the truth is that the manufacturing industry is unlikely to take on board most of the ideas being discussed. The main reason for this is that the industry has matured at a much faster rate than could have been anticipated and like similar industries, manufacturers are becoming risk adverse with their margins shrinking and therefore less likely to take on any new ideas that do not fit directly into their current manufacturing practices. Although this is a fairly common occurrence in industry it seems that many in the solar industry do not feel that this has occurred. By presenting the elements of the event in such geographically isolated sectors, the organisers accidentally provided a microcosm of the main challenges facing the PV and solar industry today.

Figuring the future

Despite the above mentioned issues the overall conference remains the most attended in the world and the conference in particular was full of optimism and ideas. In fact the poster areas often looked the busiest with a constant flow of people seeking new ideas in an industry facing economic restrictions at a key moment of research and development. The conference saw more than 1,600 contributions and delegates enjoyed a rich programme strong in research, industry and policy-making. Frankfurt did provide a place to take the pulse of emerging global policy and industry trends in a sector that has grown 500 fold since 1990, and now employs over 300,000 in the European Union alone

Companies were intent of showcasing their strengths and products

The new Europe – Asia PV Forum, was well attended and received with a large number of Asian delegates present. The European



Commission's Joint Research Centre (JRC), launched its PV Status Report 2012. Now in its 12th edition, this compendium presented a detailed snapshot of the latest developments in all EU member states. The exhibition organisers said there were over 650 international groups took part to promote their innovations.

Speaking at the Forum, Dr. Giovanni De Santi, Director of the European Commission's Institute for Energy and Transport highlighted key policy developments: "We all accept that energy supply is a global problem demanding global solutions but I assure you that it is amongst the highest priorities of the European Union. We are leaving no stone unturned to address those obstacles that are holding this necessary technology back. From issues around skills training, access to the grid and long waiting times for connection, to proper methods for recycling and addressing a lack of public awareness, we are playing our part and will continue to support the industry in doing so".

Future directions

A common plea in Frankfurt was that roadmaps and objectives should be revisited because PV now offers a generation of technology which is ready to deliver energy solutions around the globe. A common issue that remains is the need to explore best practices and pitfalls for integration into energy systems. This is an issue that affects the entire value chain as well as policy-makers. This is an area that the industry needs to promote its long term goals and needs so policy makers are able to make informed choices.

"Roadmaps and objectives should be revisited because PV offers a generation of technology ready to deliver," said Dr. Winfried Hoffmann, President of the EPIA and Recipient of the 2012 European Becquerel Prize. "The challenge remains how to bring about a swift deployment on a large scale. While techno-economic barriers continue to fall in terms of performance, reliability and cost, the main barriers to large-scale deployment are unquestionably of an administrative and regulatory nature. We must stay together, act with one voice and we will succeed".

The call for one voice was reiterated throughout the event but this is an area where PV and solar has failed to capitalise on both on a global and local level. The best example is the China anti-dumping accusations that are spreading across the globe. The most telling part of the whole process is the dramatic split to the industry that has occurred with a number of competing groups all claiming to speak on behalf of the industry.

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Hoffmann is accurate when he says the industry needs to act with once voice but the reality is a divided industry becoming more isolated from its long term goals as economics takes over innovation in key decision making. Whatever the opinion of the massive growth of China as a solar player, the truth is they changed the nature of the market and sped up the globalisation of the industry faster then had been predicted. The current fall out to this is not helping the perception of the industry.

Tipping point of success

Speaking at the closing session, Chairman of the Conference and of the International Energy Agency (IEA) Photovoltaic Programme, Dr. Stefan Nowak declared: "I reiterate the strong message



The conference was standing room only



Frankfurt's industrial past beckoned participants to the 2012 EUPVSEC

received from keynote speakers and grassroots participants coming together this week in Frankfurt. Photovoltaic solar energy is here to stay but is now at a tipping point. Electricity business leaders, investors, innovators, regulators and especially policy-makers must join forces and push ahead with an inevitable paradigm shift in the way electricity is produced, sold, transported and distributed".

The organisers announced that the 2013 host will be Paris in France. The actual venue has not been named but the congress and exhibition centre is a much cosier affair in Paris and hopefully will lead towards a more integrated and intimate exhibition and conference highlighting the need for industry to develop long term goals, define realistic industry roadmaps that do not isolate manufacturers and most of all find a community voice that actually speaks on behalf of an industry currently divided by short term economic fears that are distracting attention from long term goals that formed this fast growing industry.

Dr. Winfried Hoffmann, President of the EPIA and Recipient of the 2012 European Becquerel Prize



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Hybrid technology opportunity

The solar industry can no longer rely on government subsidies to further technology and market capacity. With this in mind companies are seeking improvements that provide an edge to competition. Chris Beitel, VP of Business Development at Silevo discusses harnessing hybrid technology to reach new advancements in solar based on the recent Solar Industry Award winning technology.



Evidenced by steadily rising photovoltaic (PV) installation rates, the solar industry has shown tremendous growth over the past five years. However, this growth is largely attributable to government subsidies, which help to drastically lower the cost barriers to financing solar power. Grid parity must be the ultimate goal; to achieve self-sufficiency; the solar industry will need to transform this subsidy-based system by developing high performance solar power at a viable cost of production and implementation.

Current PV technologies have competed with one another on two fronts: the drive to lower costs and the drive to produce high efficiency panels. Until now, the solar industry has not had a module that optimizes both performance and cost at a ratio that creates optimal levelized cost of electricity (LCOE). While thin-film modules offer good cost and energy harvest, their low efficiency leads to a high balance-of-system (BOS) cost.

Conversely, high-efficiency crystalline silicon can drive lower BOS costs; however, high manufacturing costs and poor energy harvest negate these efficiency advantages.

Silevo, a PV solar module manufacturer based out of Silicon Valley, has developed a proprietary solar cell technology called Triex, a hybrid solar module that goes beyond traditional silicon-based PV to deliver high efficiency and low temperature coefficients at a previously unattainable cost of production.

Triex's design fuses together proven technology from the semiconductor industry with the latest in solar advancements. Triex evolves silicon-based PV as the first hybrid solar solution to combine high-performance crystalline silicon n-type substrates, thin-film passivation layers and a unique tunneling oxide layer—all in a single solar module. A unique metallization scheme was also developed utilizing industry-proven electrochemical plating (ECP) of copper. The resistivity of copper lines is five to 10 times lower than that of screen-printed silver paste. By utilizing a low resistivity copper-based metallization scheme instead, Silevo is immune to silver's increasing cost issue in the marketplace, while capturing the performance advantages of copper.

Tunnelling technology

Triex cells utilize high quality, ultra-thin silicon oxide layers on the front and back surfaces of a mono-crystalline n-type silicon substrate for passivation and quantum tunneling. The device boasts extremely low interface trap densities (Dit) of $\sim 4E10/cm^2$, enabling high open circuit voltage (Voc), which is the foundation for low temperature coefficients.

Atomic layer silicon oxide is well-regarded as the best surface passivation layer for complementary metal-oxide-semiconductor (CMOS) technology with the surface trap density reaching as low as $1E10/cm^2$ level. Graded doped silicon-based thin films were therefore deposited on the Triex oxide layers to form tunneling junctions. In this way, Triex cells can achieve high Voc without compromising the carrier collection efficiency. In addition, the thin tunnel oxide layers allow for a wider range of modulation of the graded-doping thin film layers and serve as better dopant diffusion barriers, while also maintaining high mono-crystalline silicon interface quality.

Figure 1 shows the schematic of a Triex solar cell. Figure 2 is a band diagram of a Triex solar cell, which shows the excellent passivation quality of the silicon oxide while it allows excess carriers to be collected at the emitter via quantum tunneling.

Metal grids on TCO layers formed on the front and back surfaces of the cells are used for current collection. In order to maintain good passivation on front and back surfaces, the metallization temperature needs to be kept lower than 200°C. A proprietary Cu metallization scheme that utilizes industry-proven ECP copper is used. A critical copper barrier and adhesion layer reliably implements copper metallization in Triex to enable adhesion to TCO and a low contact resistance below $3m\Omega cm^2$. Moreover, the copper grids are fully covered by a layer of tin, both for protection of copper from environmental corrosion and for subsequent soldering of ribbons on busbars.

Figure3(a) shows that the Triex cell does not undergo any light induced degradation (LID) after about 60 hours of soaking under 1sun STC condition, which can be attributed to the usage of

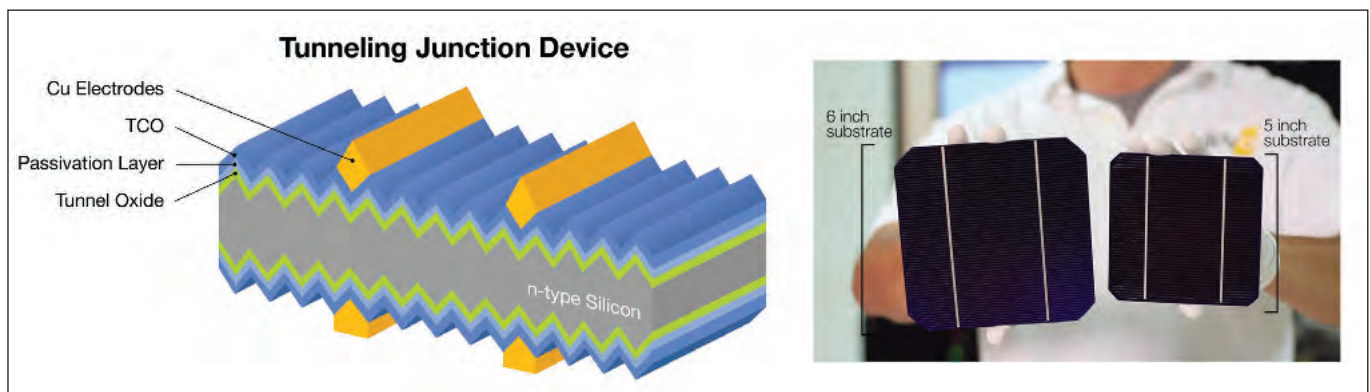


Figure 1: Schematic Diagram of a Triex Solar Cell

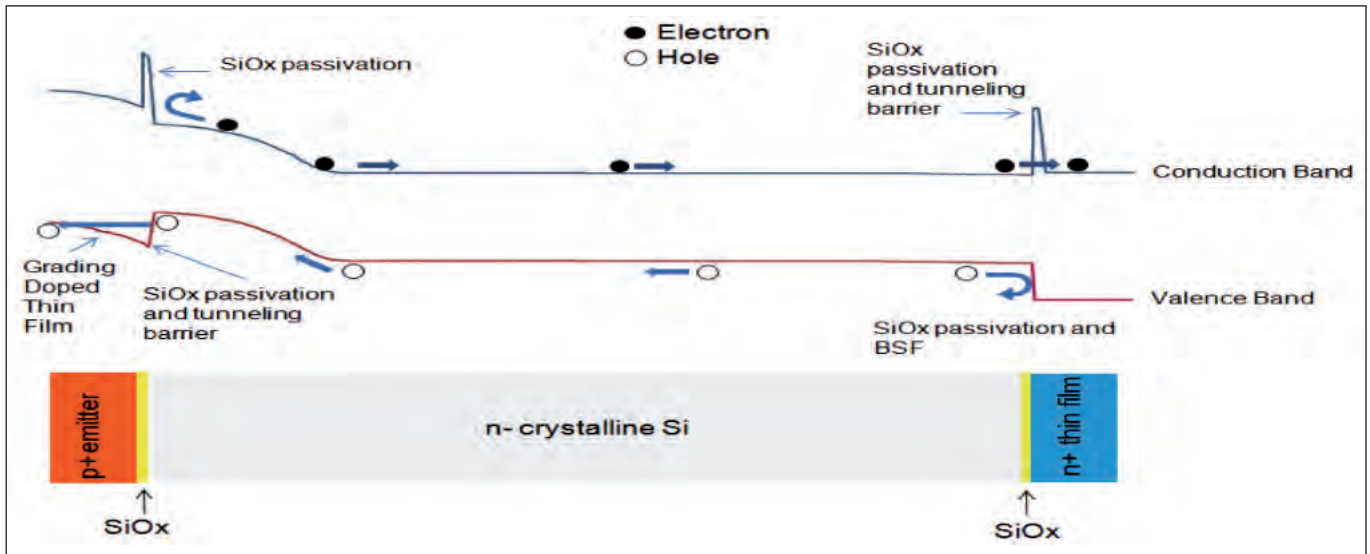


Figure 2: Band Diagram of a Triex Solar Cell

n-type mono-silicon substrate as well as the high passivation quality. Figure 3(b) shows the dependence of interface trap densities (Dit) with Triex cell Voc, where the strong surface passivation enables continual Voc improvement. The highest Voc demonstrated is 735mV. Note that Dit levels from 4E9-1E10/cm2 were achieved, enabling a greater than 755mV Voc Triex cell.

Powered by its breakthrough “tunneling junction” architecture and hybrid design, Triex technology is able to reach exciting new milestones. Silevo’s Triex technology has already achieved efficiency rates of approximately 22 percent and temperature coefficients below -0.25 percent/C. Per solar panel, this provides an added benefit of five to 12 percent additional energy harvested.

The solar PV industry has already made strong advancements in its own sustainability, but more technology advancements are in store. For example, Silevo is currently developing bifacial modules with double glass, which produce up to 10 percent more power when mounted on a highly reflective surface. As solar innovation continues to evolve, the industry needs to keep in mind the leveled cost of efficiency and its central role in achieving grid parity.

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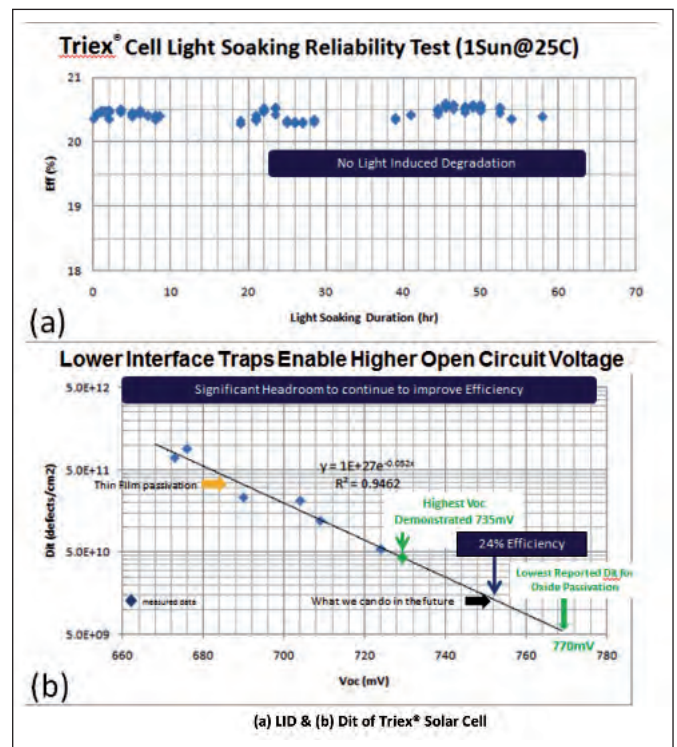


Figure 3a Triex cell does not undergo light induced degradation
Figure 3b. Shows the dependence of interface trap densities

Silevo, a PV solar module manufacturer based out of Silicon Valley, has developed a proprietary solar cell technology called Triex, a hybrid solar module that goes beyond traditional silicon-based PV to deliver high efficiency and low temperature coefficients at a previously unattainable cost of production

Transforming energy potential

As manufacturers seek to maximise their product in a changing market much attention has turned to effective improvements to existing products and the balance of system impacts. Stéphane Rollier and Bernard Richard of LEM discuss how control and protection in device usage rests on measurement precision.

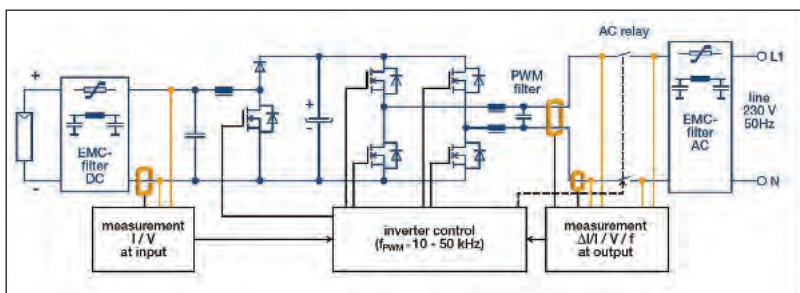
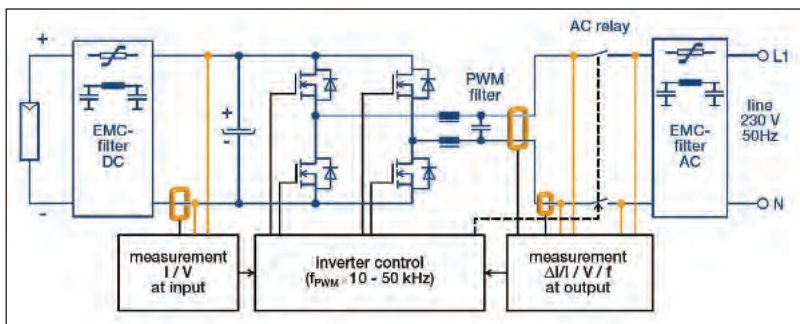
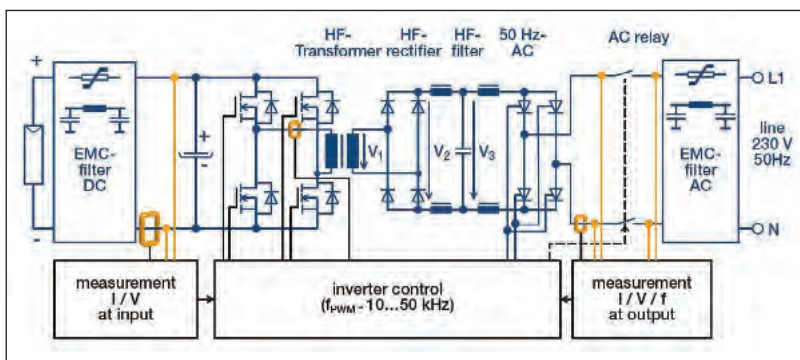
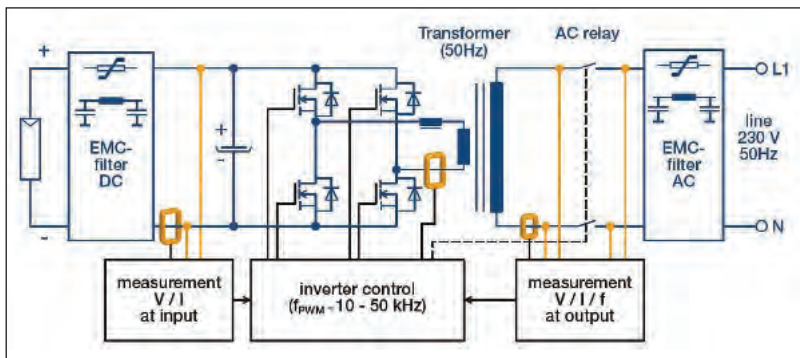


Designers of solar power, photovoltaic (PV), generating systems face some of the same problems as their counterparts in any other power-related technology; the need to constantly improve performance, reliability, longevity and above all, efficiency. As with any engineering endeavour, improved performance requires with higher-quality and more accurate measurements.

Of the installations worldwide that are actively feeding power into national and trans-national power grids, around 40% of the total installed capacity is located in Europe: and of that, the largest national installed base is in Germany. In 2011, Germany's cumulative PV generating capacity was just under 25 GW, and in that year its PV power stations generated some 18 TWh (tera-Watt-hours) for the German grid.

The rapid ramp-up in PV installations can be judged from the fact that, although connection of solar generating capacity to the grid dates back to the early 1990s, the "first GW" figure in Germany was reached only in 2004, and installed capacity grew by 7.5 GW from 2010 to 2011 alone. Other countries have seen PV installations grow at a similar rate.

This almost-exponential growth has been partly driven by generous feed-in tariffs available to those who contracted to provide solar power to the grid, early in the adoption of the technology. In many territories, those initial attractive terms are no longer available, increasing the pressure on



Figures 1a) b) c) d): Four main inverter designs commonly encountered with their current measurements (with transformer and transformerless)

system designers to deliver more and more power to the grid from each unit of incident solar radiation and, as systems become more powerful, to do so safely. PV system efficiency comes from a number of sources; semiconductor technologists strive to further increase the conversion efficiency of the basic silicon cells, but much attention focuses on inverter architecture and control.

Maximising inverter performance is based on accurate measurements of current and voltage and

precision measurements of basic parameters underpin several functions of the solar inverter. The most obvious is fiscal; metering exactly how much billable energy has been generated and transferred to the grid in a given period. Next, there is the need to maximise power conversion; and finally, there is a need to monitor possible leakage current paths to ensure that the solar arrays and their inverters are safe for those working on and around them.

Isolated measurement technology

At all points in the power conversion chain, it is advantageous to carry out current measurements with non-intrusive technologies, that is, with sensors that are not directly connected into the circuit being measured. This provides galvanic isolation from the – possibly very high – potentials of the power-generation path; and it also eliminates I²R losses associated with inserting resistive sensing elements into power paths.

Key to conversion efficiency is maintaining the maximum peak power transfer point. Power output from the PV array is the product (VxI) of the terminal voltage and the DC current delivered. As with any DC supply that has a source impedance, the voltage drops as the current increases. In solar cells, the relationship is not linear, and also varies with the level of light energy reaching cells.

The algorithms that control the inverter must constantly adjust the operating point to maintain operation at MPPT. The DC values that determine MPPT change relatively slowly, and moderate measurement precision is sufficient to determine the optimum operating point, and therefore these DC current measurements can be made with current transducers that use open- or closed-loop Hall-effect technology.

A number of inverter designs are used in PV installations. Commercial and large PV arrays on industrial or agricultural sites usually series-connect solar panels to deliver a high DC voltage to a high-power inverter with a single feed to the grid. In smaller, typically domestic or commercial installations, work continues to optimise the micro-inverter concept in which conversion to mains voltage is done at each panel. Today micro-inverters are not cost-effective in comparison with traditional technology. Monitoring the aggregate AC fed to the grid in this arrangement presents a separate measurement challenge.

Connection of the solar array through an inverter to the grid can be made either by using a transformer or directly without transformer. Transformerless installations have no galvanic isolation, with a consequent risk of leakage to earth: Both configurations may also be used with

or without energy storage in a battery. Four main inverter designs are commonly encountered. Two designs use a transformer (at low or high frequency) and two designs are transformer-less; with or without a DC chopper or step-up converter. The low-frequency transformer design switches the DC from the PV array at the 50-Hz mains frequency, and the transformer (depending on the DC potential available) steps it up to the grid voltage. This provides isolation, eliminates the possibility of DC injection into the grid but implies a large transformer, and is not maximally efficient.

It requires measurements at the output of the solar panel and at the AC output to the grid. An alternative is to switch the DC at a higher frequency (tens of kHz) into a step-up transformer, rectify that to an intermediate DC at grid potential, and then use a further switch to generate AC synchronised to the grid. This is more complex, and depending on the accuracy of the output switch, may inject DC into the grid.

Transformerless architectures switch a DC potential, either direct from the PV array, or via a step-up “chopper” stage into synchronised AC that is fed directly (via a filter) to the grid. As there is no galvanic isolation between PV panel and grid, fault and leakage paths can potentially expose personnel working on and around the panels to dangerous or lethal voltages.

All of these inverter configurations require current and voltage measurements both at the output of the PV array, and at the AC output of the inverter, both for control of the inverter and to detect fault conditions. Again, open- and closed-loop Hall-effect transducers can provide the necessary accuracy, with fast-response modes providing short-circuit protection.

Addressing exactly this class of application, LEM recently introduced the HO series of open-loop Hall-effect-based transducers that measure up to 25A DC, AC or pulsed currents, with accuracy as good as 1% at +25°C. The HO series provides designers with great flexibility as the devices are highly programmable and configurable so that one part can perform multiple roles. A separate over-current-detection function also adds an extra level of safety and circuit protection.

DC-to-grid, and leakage detection

In transformerless designs and in high-frequency transformer configurations, the DC current injected into the grid must be limited to a maximum value of between 10 mA and 1 A, according to different standards that apply in different countries (relevant standards include IEC 61727, IEEE 1547, UL 1741, and VDE 0126-1, IEC 62109-2). This necessitates

use of transducers with very high accuracy and very low offset and gain drifts; an ideal technology is the closed loop Fluxgate transducer.

Transformerless inverters without galvanic isolation have a potential for leakage currents to occur and it is a requirement to monitor leakage current. Any AC, 50/60 Hz, leakage currents will be small, and must be lower than 300 mA, depending on the capacitance due to the solar panel-roof configuration and is measured as the residual component remaining from a differential measurement of currents in several conductors. A person contacting a panel in a fault condition will generate a sudden current leakage variation, and this condition must be recognised. In current transducer terms, this requires accuracy and, especially, low offset and gain drifts, to ensure resolution of these small measured currents; physically, it means the ability to accommodate several conductors, to cater for single or three phase system within the transducer aperture.

Similar demands apply to earth fault current detection, arising from an insulation defect. The transducer used to measure the earth fault current must be able to measure AC and DC signals as the earth fault current could be AC or DC, depending where the fault (for example, a short circuit) occurs; and depending on whether the PV panel is grounded or not.

To achieve the targets in terms of accuracy with small currents, LEM applied its Closed Loop Fluxgate technology and created the LEM “CTSR” current transducer range.

Closed Loop current transducers measure current over wide frequency ranges, including DC. They provide contact-free coupling to the current that needs to be measured, in addition to safe galvanic isolation, and high reliability. Their closed-loop operating principle, together with sophisticated internal signal processing, yields a transducer that achieves accurate measurement of very small residual DC or AC currents with very low offset and gain drifts over a wide operating temperature range from -40°C to +105°C.

The residual-current capability measures the sum of the instantaneous currents flowing through the transducer aperture, in single- or three-phase configurations, with a high overload potential up to 3300 A for a pulse duration of 100µsec, and with a rise time of 500 A/µsec: conductors may be carrying currents of up to 30A/wire, AC or DC.

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HO user-programmable current transducers



CAS/CASR/CKSR current transducer series using Closed Loop Fluxgate technology

CTSR current transducer series using Closed Loop Fluxgate technology (available with test winding integrated)



India looks to solar success

India is seen as one of the future economic power houses but has struggled to replicate its IT sector success in other industries or sectors. Recent moves in the country suggest that solar and PV could be an area that the country may make a global mark.

Bhupesh Trivedi, CEO of Mumbai-based solar energy consulting firm REECODE Energy Solutions provides context and details of the upcoming changes.



India is set to replicate its information technology (IT) sector success in solar energy. With every known business entity exploring its own agenda in the solar energy sector, the country is already at the starting point of an energy revolution.

All prominent Indian companies have either set up their wholly-owned solar energy subsidiaries or have gone in for joint ventures or have set up solar energy divisions within their existing operations. The predominant business model being pursued by them currently is of grid-tied project development.

However, as more avenues open up for captive and REC-driven solar power projects, business entities are seeing more value in getting ready for the next wave. (RECs are renewable energy

certificates that have become tradable commodities on India's different power exchanges.). The private business sector is gearing up for solar energy even though there is an almost policy paralysis with the central government, while different state governments have slowed down or postponed their policy initiatives. Most companies have set up small teams, seeking to explore opportunities in off-grid, micro-grid and roof-top applications to serve the larger private consumer market.

These opportunities are small in terms of ticket-size, but these are enabling all new entrants to test technologies, processes and their people. Gaining experience through pilot projects seems to be the underlying thought.

And, it is not only in the PV space that this below-the-surface activity is happening. Companies are finding solar thermal, particularly heat and steam applications, to be exciting opportunities. Roof-top solar water heaters, one of the oldest available solar solutions, are now increasingly becoming a USP for residential property developers to offer to their prospective customers. The property developers for their part are forming joint ventures with technologists to gain a share in a market that will surely see exponential growth in the years to come.



Among the predominant and already-known entrants are the Reliance business groups, Lanco Infratech, Moser-Baer, Tatas and BHEL. Other corporate houses like that of automobile major Mahindra, finance major Welspun, finance major Kotak and the Birla group too have taken long bets on the solar energy sector and invested accordingly.

International majors like First Solar, juwi, abakus Solar, Bosch Solar, DeSolar, EMMVEE and SCHOTT are also among those who are investing on the long term Indian market. Some players, who are largely equipment manufacturers or suppliers in other markets, are keen to become project developers in a country whose over 30 per cent population is still without any grid-supplied power. Solar companies including Azure Power, Waaree, GreenBrilliance, Vikram Solar and Indosolar are seeking market share. A listing of newly established regional players suggests that the market is already over-crowded and all waiting for the solar energy wave to come in.

The above phenomenon largely reminds one of the early part of 1990s when almost all business entities in India stepped into the information technology (IT), or more specifically software services, arena. The dotcom boom of the late 90s and parallel offshoring of various service jobs placed Indian's IT sector among the world majors.

The current euphoria, however, is not without its own set of challenges and risks. Lesser-than-expected business is visible in the number of marketing and sales CVs that have started getting shared through emails. These CVs are not only of those professionals who are wishing to enter the solar sector, but also of professionals who claim to have a minimum of couple of years of experience in India's solar project development space.

Nevertheless, as awareness rises, as conventional power becomes costlier and as power shortage increases, the demand for solar power will rise. And, this day is certainly not far off.

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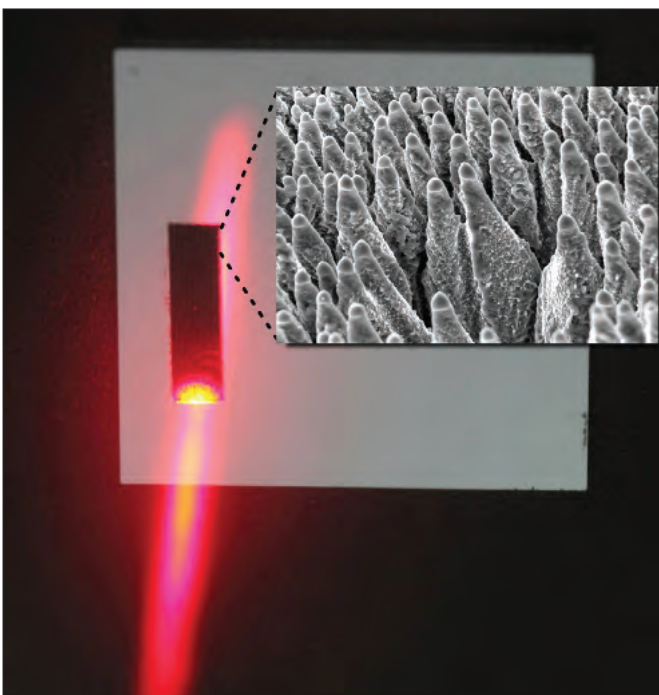
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Back to black

Extracting maximum sunlight for conversion to the maximum energy is the goal of any solar module manufacturer. The focus has mainly been on visible light but any optics student will tell you that light comes in a broad range of spectra. Researchers at Fraunhofer in Germany have announced that they have doubled the capacity of their light absorbing solar cells made from black silicon.

Solar cells convert three-quarters of the energy contained in the Sun's spectrum into electricity, yet the infrared spectrum is entirely lost in standard solar cells. In contrast, black silicon solar cells are specifically designed to absorb this part of the Sun's spectrum, and researchers have recently succeeded in doubling their overall efficiency.

The Sun blazes down from a deep blue sky, and rooftop solar cells convert this solar energy into electricity. Not all of it, however: Around a quarter of the Sun's spectrum is made up of infrared radiation which cannot be converted by standard solar cells, so this heat radiation is lost. One way to overcome this is to use black silicon, a material that absorbs nearly all of the sunlight that hits it, including infrared radiation, and converts it into electricity. But how is this material produced?



"Black silicon is produced by irradiating standard silicon with femtosecond laser pulses under a sulfur containing atmosphere," explains Dr. Stefan Kontermann. "This structures the surface and integrates sulphur atoms into the silicon lattice, making the treated material appear black."

Kontermann heads the Research group "Nanomaterials for Energy Conversion" within the Fraunhofer Project Group for Fibre Optical Sensor Systems at the Fraunhofer Institute for Telecommunications, Heinrich-Hertz-Institut, HHI.

If manufacturers were to equip their solar cells with this black silicon, it would significantly boost the cells' efficiency by enabling them to utilize the full Sun spectrum.

Researchers at HHI have now managed to double the efficiency of black silicon solar cells – in other words, they have created cells that can produce more electricity from the infrared spectrum.

"We achieved that by modifying the shape of the laser pulse we use to irradiate the silicon," says Kontermann.

This enabled the scientists to solve a key problem of black silicon: In normal silicon, infrared light does not have enough energy to excite the electrons into the conduction band and convert them into electricity, but the sulphur incorporated in black silicon forms a kind of intermediate level. You can compare this to climbing a wall: The first time you fail because the wall is too high, but the second time you succeed in two steps by using an intermediate level.

However, in sulphur this intermediate level not only enables electrons to climb the 'wall', it also works in reverse, enabling electrons from the conduction band to jump back via this intermediate level, which causes electricity to be lost once again. By modifying the laser pulse that drives the sulphur atoms into the atomic lattice, researchers can change the positions that these atoms adopt in the lattice and change the height of their 'levels', in other words their energy level.

We hope to be able to increase the efficiency of commercial solar cells – which currently stands at approximately 17 percent, by one percent by combining them with black silicon

“We used the laser pulses to alter the embedded sulphur in order to maximize the number of electrons that can climb up while minimizing the number that can go back down,” Kontermann sums up.

Prize-winning project

In the first stage of the project, the scientists modified the laser pulses and investigated how this changed the properties of black silicon and the efficiency of solar cells made from this material. Now they are working on using different shapes of laser pulses and analysing how this changes the energy level of the sulphur. In the future, they hope that a system of algorithms will automatically identify how the laser pulse should be modified in order to achieve optimum efficiency.

The ‘Customized light pulses’ project was one of this year’s winners in the ‘365 Places in the Land of Ideas’ competition. The researchers have already successfully built prototypes of black

silicon solar cells and their next step will be to try and merge these cells with commercial technology.

“We hope to be able to increase the efficiency of commercial solar cells – which currently stands at approximately 17 percent, by one percent by combining them with black silicon,” says Kontermann. Their starting point is a standard commercial solar cell: The experts simply remove the back cover and incorporate black silicon in part of the cell, thereby creating a tandem solar cell that contains both normal and black silicon. The researchers are also planning a spin off. This will be used to market the laser system that manufacturers will be able to acquire to expand their existing solar cell production lines. Manufacturers would then be able to produce the black silicon themselves and include it in the cells as standard.

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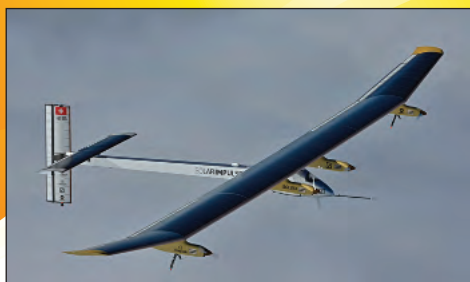
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New materials for around the world solar flight

BAYER MATERIALSCIENCE is expanding its contribution to the Solar Impulse project - an around-the-world flight powered solely by solar energy scheduled for take off in 2015. The materials company is responsible for the design of the cockpit shell of the second, improved model. Among its contributions will be an high-performance insulating material. Solar Impulse and Bayer Material Science announced that the new solar aircraft is expected to be completed in late 2013 and will conduct test flights the following year.

The first model will remain available for additional missions. "We are studying several possibilities and it could perhaps be making its first flights around the United States next year," announced Bertrand Piccard, the initiator and Chairman of the Swiss project that proves clean technologies are fully reliable allowing to drastically reduce energy consumption. So far the solar aircraft has completed flights in Europe and most recently to North Africa, in each case with materials from Bayer MaterialScience on board.

System leader for the cockpit

"We are now deepening our involvement as we go from materials supplier to system leader for the new cockpit," said Patrick Thomas, CEO of Bayer MaterialScience. "The Bayer Cross will be displayed on the aircraft in the future as a visible symbol of our commitment to this excellent partnership."

Bayer MaterialScience is contributing a variety of products and solutions to ensure that the second, larger model of the futuristic aircraft will be lightweight, yet retain its rigidity. For example,

because the cockpit cowl will be hinged for the first time, a section of it is being supported with a carbon fiber-reinforced plastic. The polyurethane foam Baytherm Microcell will be used as insulation in places. It is being developed together with the chemical company Solvay for use in the new plane. The material's improved comes from shrinking the pores in the foam 40 percent. Insulation is particularly important for the aircraft because it must withstand large temperature fluctuations.

"The larger size of the new cockpit shell and Solar Impulse's tight weight budget meant that we had to optimize the weight through design measures and targeted choice of materials," explained Martin Kreuter, Solar Impulse project manager at Bayer MaterialScience. Another innovation announced was the use of Baytubes carbon nanotubes in carbon fiber-reinforced structural components.

"This allow us to significantly enlarge the wings of the new aircraft and increase the number of solar cells mounted on them," Kreuter said.

The current model, which has the wingspan of an Airbus and weighs as much as a mid-size car, has 12,000 solar cells on its wings. The first manned around-the-world flight in a fuel-less aircraft is scheduled for take off in early 2015. The flight is expected to take 20 flight-days, with five to six needed just to cross the Pacific and two to three for the Atlantic crossing, according to Borschberg. Including the necessary breaks, the solar-powered aircraft's journey from west to east will take a total of three to four months.

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