solar international

A PV Management Magazine

Changing dynamics

Maintaining position in a global market

A salute to excellence
Solar Industry Awards

Continued innovation
Research continues to push boundaries

An Angel Business Communications publication

Issue VII 2012
www.solar-international.net

MBJ

solutions to meet the needs

Electroluminescence imaging systems from MBJ ... just right for your production!

High resolution, high speed, fully automatic, reliable

- better product quality, less customer complains
- proven quality, higher profit
- fully automatic, fast payback

MBJ Solutions - leading electroluminescence inspection technologies
Phone +49 40 606 870 66
Email info@mbj-solutions.com
www.mbj-solutions.com

MBJ Solutions GmbH
Merkurring 82
22143 Hamburg
Germany

David Ridsdale
Editor in Chief

Screws of reality tighten

AS we have discussed on these pages before the contraction that the global industry is currently going through is expected and has been predicted for a number of years. This may not be great news for many companies struggling with an industry where the goal posts are continually changing. This is seen through rapidly changing subsidy and tariff offers around the world as well as price changes faster than anticipated. On top of this is the ongoing uncertainty of legal actions that are spreading around the world as regions try to maintain local impetus in the face of global change.

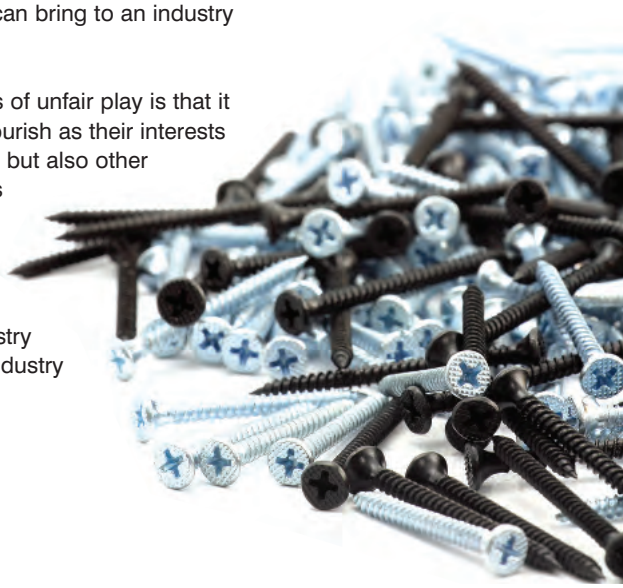
While much of the focus is on the rapid growth in China's role as a consumer and manufacturer of solar products it may be wise for people to begin to cast their view a little wider than their own industry. China is suffering its own concerns as it struggles to keep pace with the rapid and drastic change initiated in the country. The rapid growth of the last few years is slowing down and issues created from moving too fast too soon are starting to impact the Chinese economy and outlook.

The country has empty towns, newly built for a future that has not eventuated as planned. With such tight regulations on the yuan, local entrepreneurs have had little option but to invest in real estate. This has led to an overpriced market that is out of reach for most workers and those that do own property tend to own an average of three with a goal to rent for investment. Sadly the rental market has grown too quickly leaving many empty houses in many parts of the country. The solar industry has fared little better with unknown companies disappearing or going to the wall. Even their bigger branded companies are not immune with Suntech facing numerous headaches surrounding an alleged fraud involving German bonds. The Chancellor herself had a go at mediation on a recent trip to China.

Sadly for many companies in the industry will go under rather than continue the excited impetus felt when the financial community decided that solar was the next big thing. The long term potential was oversolad causing way too many players to rush into an industry they knew little about. The saddest part of such 'fiscal correction' is all the innovative products and concepts that can be lost in the shake out. The bottom line is the only thing on anyone's mind at such times of financial difficulty so we can only hope that the better ideas are noted by someone with the ability to maintain the potential benefits that such ideas can bring to an industry and community.

Another aspect of such a slow down, made messy with court cases and accusations of unfair play is that it plays directly into the hands of those who may not want to see the solar industries flourish as their interests are vested elsewhere. Solar is not only in competition with traditional energy sources but also other renewable industries and the overall pattern of the industry for the last 18 months has been divisive with no clear path of future technology directions or long term goals.

The battle for the mind of the end consumer is a bigger part of the industry picture than many seem to realise. I still have people ask me if PV works. Not if it works well but if it works at all. It would seem that ensuring potential customers believe the industry potential is just as important as traversing the many difficulties in surviving a global industry that is constantly on the move seeking new markets and opportunities.

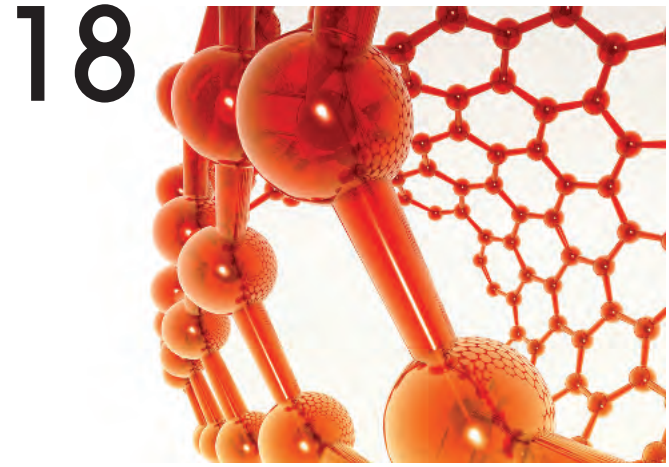


David Ridsdale
Editor-in-Chief

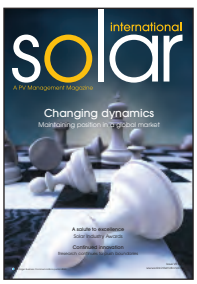
contents

Issue VII 2012 www.solar-international.net

international solar
A PV Management Magazine



Features



Front cover designed by Mitch Gaynor

When footprint matters

The Complete Solution

Apollo the integrated cell manufacturing metallization platform

What do you get when you combine ±10 micron accuracy @ 2 Cpk capability, reliability and high performance? A low footprint, single line configuration that helps manufacturers meet the future challenges of the solar industry today. Featuring specifically designed systems incorporating next-generation technology, Apollo platform sets the standard in throughput and flexibility.

Solar Awards Winner 2011

Solar Awards Winner 2010

Solar Awards Winner 2009

2009 IPC Innovative Technology Centre Honours - PVP1200

EM Asia Innovation Award 2009 - PVP1200

For more information:
www.deksolar.com

DEK® SOLAR
A DOVER COMPANY

Think beyond equipment.

Q-Cells sold to Hanwha

DESPITE Isofoton's late bid to acquire Q-Cells creditors have agreed to an offer from South Korean business giant Hanwha in a move that will see Hanwha develop their solar sector within a downturn. The acquisition will see overall job losses but mainly from the Q-Cells administrative end. There was no reason given why the Hanwha offer was chosen over the late arriving Isofoton deal from Spain but with multiple partners and investors in the Spanish offer the larger South Korean company provided stability with a strong international presence and clout.

At the creditor meeting in Dessau-Rosslau, the creditors of Q-Cells SE approved by a large majority the sale of the business operations to South Korean conglomerate Hanwha. Insolvency administrator Henning Schorisch had signed the contract. As part of a "transferred restructuring process", Hanwha Group takes over 1,250 employees out of a total headcount of roughly 1,550 as well as most parts of the total Q.CELLS Group: in Germany, this pertains to the site in Bitterfeld-Wolfen with solar cell and solar module research, development and production as well as the administration site in Berlin; abroad, to the production site in Malaysia with an unchanged number of about 500 employees as well as some international sales companies. The integration will mainly lead to job cuts in Q.CELLS' administration division, as there is overlap with the organisational structure of the Hanwha Group.

The purchase price is composed of the takeover of operational liabilities in the lower triple-digit millions as well as a cash component in the mid double-digit millions, while the cash component depends on the volume of additional liabilities that will have to be taken over. The purchase agreement is still subject to the approval of the relevant anti-trust authorities. The transaction is being managed by Deloitte & Touche Corporate Finance GmbH as the exclusive M&A consultant for both, the insolvency administrator and the company.

With this deal, Hanwha Group is to obtain Q-Cells' headquarter office, cell and module production facilities (200MW/120MW) in Germany, cell production facility (800MW) in Malaysia and sales offices in US, Australia and Japan. The total cell production capacity acquired from this transaction is equivalent to 1GW.

The total acquisition value is EUR 40 million (around KRW 55.5 billion) with possibility of further negotiations until closing.Hanwha has effectively renegotiated to buy in the existing loan agreement (MYR 850 million / around KRW 300 billion) signed between Q-Cells Malaysia and the Malaysian government. With a strong support shown by the Malaysian government, the loan has been structured in such ways that Hanwha can use the profits generated from Malaysian operations to pay back in the long-term.

"In the current macroeconomic and political environment, which is extremely difficult for Q.CELLS, it is a great success that we managed to maintain not only research and development, but also the production capacities at the Bitterfeld-Wolfen site," Schorisch emphasised today at the Q.CELLS headquarters in Bitterfeld-Wolfen. "While I regret the fact that there are certain job losses, I am very happy that Q.CELLS has found a strong partner in Hanwha, who has the necessary means to provide company, brand and staff with long-term perspectives again."

Through the takeover of Q.CELLS, Hanwha plans to expand its position as one of the globally leading players in the photovoltaic industry. Hanwha is one of the largest South Korean corporations with sales of USD 31.6bn in 2011. The company operates in various sectors, such as the chemical industry, insurances, banking, engineering, pharmaceuticals and construction. With its Chinese subsidiary Hanwha SolarOne, for example, the group is already active in the field of photovoltaics.

Schorisch praised again the enormous commitment of Q.CELLS' employees. "The value of the company and of the Q.CELLS brand is based on the expertise and loyalty of its employees," he said. "The successful sale would not have been possible, if people would have abandoned the company during these difficult times. I naturally regret all the more that it was not possible to take over everyone."

Schorisch also thanked the management and stressed that the Q.CELLS management board acted professionally at all times, showed great loyalty to the company and contributed with all their strength towards maintaining the company until the very end.

Schorisch has already started negotiations with the works council on reconciliation of interests and a social plan because of the required staff adjustments. Moreover, the insolvency administrator has already raised the prospect of funds to establish a re-employment and training company where those employees affected will be able to receive training and support with finding new jobs.

Q-Cells SE had filed for insolvency on 3 April 2012. In the months prior to this date, the legal basis for the planned financial restructuring fell away due to a decision made by the Oberlandesgericht Frankfurt (Higher Regional Court, Frankfurt/Main).

The insolvency administrator Henning Schorisch, from the law firm hww wienberg wilhelm, had managed very quickly to stabilise business operations to an extent that no redundancies were necessary during the insolvency proceedings. Moreover, he had immediately started to look for investors.

German Chancellor Merkel to intervene in anti dumping case

According to media reports German Chancellor Angela Merkel is planning to intervene in the potential anti-dumping case brought against Chinese solar manufacturers led by German manufacturer Solarworld who instigated a similar proceeding in the USA. Merkel has made it clear she believes there is a diplomatic solution and plans to involve the European Commission and Chinese authorities to seek a mediated way out of the potentially damaging legal process. Merkel is in China for an official visit and has been involved in a number of deals in China including a 3.5 Billion euro deal with European based Airbus.

The Solarworld complaint is on behalf of around 25 European companies and claims China deliberately sold cells and panels below cost price to gain market chare at the expense of other companies. The Chinese response to Merkel's visit has been very positive with solar companies in particular hoping that Merkel's power base in Europe will help avoid legal processes.

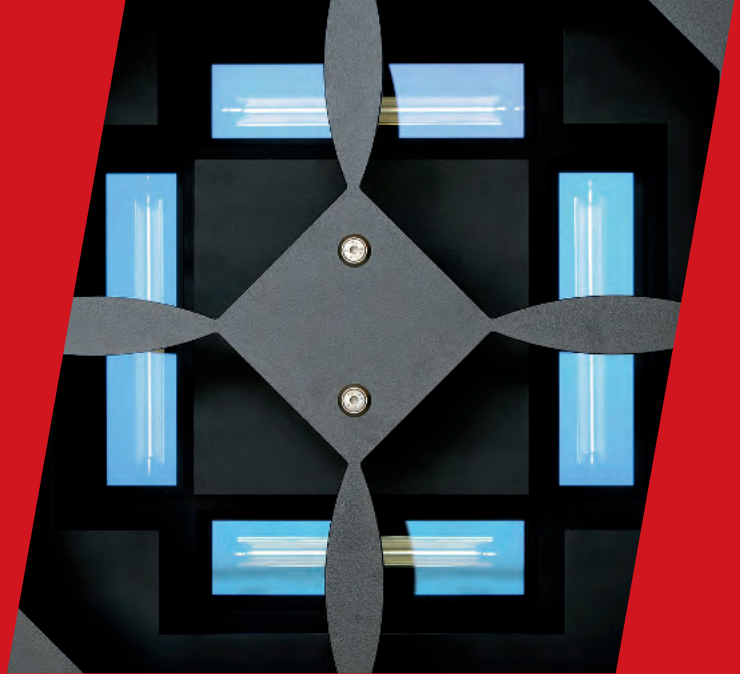
Westinghouse and CBD Energy enter Italian market

Westinghouse Solar and CBD Energy announced a joint venture to design, engineer, procure and construct (EPC) commercial projects in Italy.

Westinghouse Solar CEO Margaret Randazzo commented, "This agreement is a continuation of our companies' collaborative efforts as we move towards our merger. As with our previously announced Harvey Norman agreement and the 1.4 MW EPC project in New Jersey, we continue to look for collaboration opportunities that benefit both entities. We believe our investment in this venture further diversifies our business, and will provide incremental earnings."

CBD Managing Director, Gerry McGowan, stated, "As we work toward completion of our merger, we are committed to help improve the financial performance of Westinghouse Solar. In doing so, our teams continue to look for opportunities where both parties can bring something to the table. By partnering with Westinghouse Solar, we are able to diversify their business and provide them an attractive earnings source through their investment and participation in our Italy project pipeline. Following merger closing, we intend to pursue additional EPC opportunities in Europe and the U.S." Mr. McGowan said.

Westinghouse Solar will obtain a 25% stake (with the option to take up to a 50% stake) in the profits from CBD's commercial project pipeline in Italy, in exchange for an investment of $1.5 million (with option to invest up to a further $1.5 million). In May 2012, CBD announced it had obtained a $25 million credit facility to support development and sale of the Italy projects, which covers up to 75% of the development and construction cost of each project. In June 2012, CBD completed the first of several planned 5MW projects in Italy, and has negotiated the sale of that first project to a third party off-taker (closing is subject to verification due diligence by the off-taker) for €12.5 million. CBD expects to deliver five additional 5MW projects (another 25MW total) starting in October of this year, to be sold under a framework agreement being negotiated with the same project off-taker. Westinghouse Solar would receive its share of earnings from the joint venture, which is estimated at $5 million (based on a 50% participation stake in the joint venture) for the total 30MW. Earnings from project sales are projected to begin in the third quarter of 2012. Westinghouse Solar is pursuing an at-market



PASAN
MEASUREMENT SYSTEMS

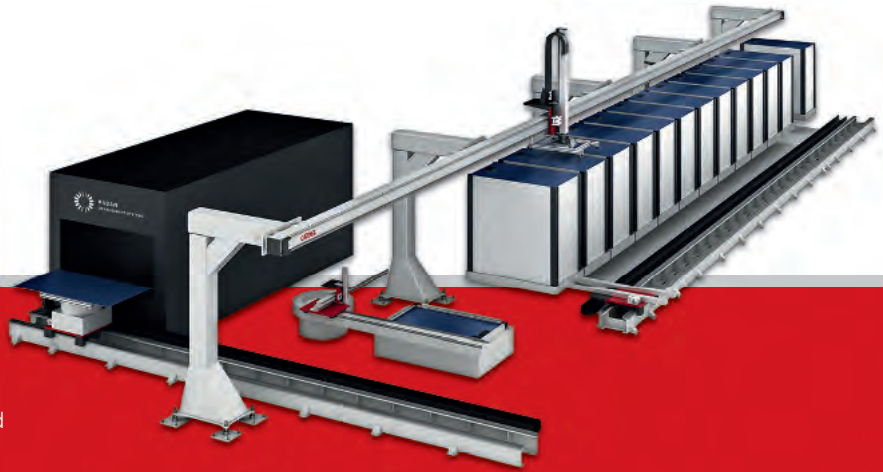
Tested, Certified, Best in class – Pasan

First class sun simulators
Pasan is the world reference for measurement equipment in the photovoltaic cell and module production. Our unrivalled technology in power measurement turns directly into your profit.

Solar award winner 2009, 2010. TüV Rheinland certified.


Certificate

A member of Meyer Burger Group



Pasan SA
Rue Jaquet-Droz 8 / CH-2000 Neuchâtel / Switzerland
Phone +41 (0) 32 391 16 00 / www.pasan.ch

PV Module Prices Dive Again in July as German Rush Ends

PV MODULE prices continued a downward trend in July, falling by more than 2 % over June's average prices and 44 % down annually, according to the latest monthly module price report from IMS Research. PV module prices had enjoyed a short period of stability in June due to high demand in Germany and Italy, but have begun to decline in the second half of 2012.

According to the report, average prices of crystalline PV modules purchased from distributors increased by almost 3 % in June, driven by high demand in Germany, the world's largest PV market. Demand peaked in Germany in June, as developers rushed to connect systems by 30th June, before the 'grace-period' under the previous and more attractive feed-in tariff (FiT) rates expired.

The resulting slowdown in demand following Germany's 'grace-period' deadline, and the

bleak outlook for demand in the 2nd half of the year in Europe, meant that module prices slipped again in July by 2.4 %, as shown in the results of IMS Research's monthly survey. Chinese Tier-1 module prices declined by almost 3 percent, whilst the largest decline came from Western suppliers, whose prices declined by over 5%.

"PV module prices enjoyed a period of stability in June, but are under pressure as demand has weakened in the 2nd half of the year," commented Sam Wilkinson, senior analyst of IMS Research's PV Group. "Supply of PV modules still far exceeds demand, and suppliers are continuing to engage in fierce price competition."

Despite module prices declining through last year, IMS Research found the outlook for prices for August to be more positive and, on average, industry buyers and sellers expected prices to increase by 0.3 % in August. Expectations varied by company type with module suppliers and integrators forecasting a further small decrease, whilst distributors expect a small increase.

"PV module suppliers' margins are already low and in some cases negative, and the ability to lower prices is limited until they can make significant improvements to their cost structures," concluded Wilkinson.

Asia Pacific to Stimulate Surge in PV Demand

PV DEMAND from the Asia Pacific (APAC) region is forecast to grow by 80% Y/Y during 2H'12, driven by Q4'12 demand at the 5.3 GW level, according to new research featured in the NPD Solarbuzz Asia Pacific Major PV Markets Quarterly.

While major European markets have historically fuelled strong year-end PV demand, Q4'12 will represent a transition phase within the PV industry, as demand becomes increasingly global and further diversified across new and emerging PV regions.

According to Wolfgang Schlichting, Research Director at NPD Solarbuzz, "Strong growth in APAC and other emerging PV markets is providing new impetus for companies active within downstream PV segments. However, in established PV markets, the short-term business environment will remain challenging for the remainder of 2012, with continued reductions in incentive policies and uncertainties due to the on going trade disputes."

Growth across APAC has already provided a significant boost to overall Q2'12 demand. The region showed more than 60% Y/Y growth, reaching 1.4 GW and compensating for the softening in demand across established markets. In particular, PV market demand in China grew by over 300% in Q2'12 to reach 0.6 GW, stimulated by deadline requirements for the completion of Golden Sun PV projects.

Another APAC country providing new downstream opportunities is Japan. Combined with the year-end projects planned within China and India, the new Japanese Feed-In Tariff (FIT) program is now setting up Q4'12 as a quarter of potentially massive PV demand pull across the APAC region. Over 50% (or 5.3 GW) of calendar-year 2012 APAC demand is forecast to occur in Q4'12.

However, this boom at year-end in APAC provides both challenges and risks for module suppliers, balance-of-systems providers, and project developers. PV demand within many APAC regions continues to be characterized by highly-competitive pricing with low-margin returns. In addition, any delays in project financing could lead to oversupply at year-end ahead of a seasonally-driven downturn in Q1'13, when

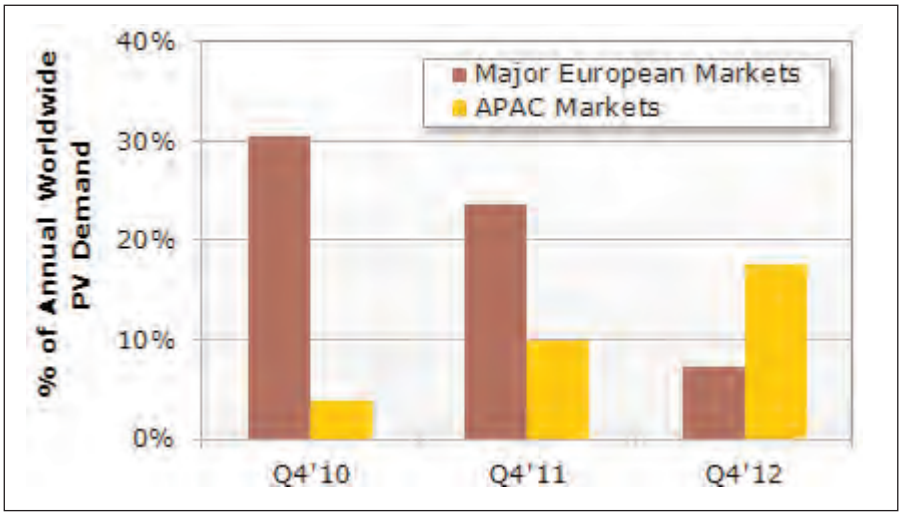


Figure 1: Shift in Q4'12 Demand from Major European Markets to the APAC Region Source: NPD Solarbuzz European PV Markets Quarterly and Asia Pacific Major PV Markets Quarterly

APAC demand is forecast to decline to just 2.1 GW.

Despite the expiration of the federal cash grant in the US, the North American PV market grew 50% Y/Y to 1.4 GW in 1H'12. The Renewable Portfolio Standard (RPS) continues to be a key driver in North America, accelerating deployment of utility-scale projects, not only in California and Arizona, but also Illinois. Driven by RPS compliance requirements, the US market is forecast to add 1.2 GW of ground-mount PV systems in 2H'12, representing 60% of the second-half US demand, according to the NPD Solarbuzz North America PV Markets Quarterly.

The European PV market grew 32% Y/Y during 1H'12 to 8.5 GW. However, incentive reductions in Germany, Italy, and other major European PV markets continue to erode the demand-share previously commanded by these former PV market leaders. Growth opportunities within Europe are forecast to shift to emerging markets during the next couple of years, including Austria, Denmark, Israel, and various countries in the east and southeast of Europe.

Over the coming quarters, the global PV market will remain highly competitive with existing PV manufacturers under extreme pressure to expand into the downstream channels as a perceived higher-margin segment. "The ability to adjust quickly to changing market conditions arising from sudden policy changes, trade action, or competitive strategies will become essential for industry participants," added Schlichting.

Swiss reduce tariffs

DETEC in Switzerland has announced a 15% decrease in average rates of remuneration for for new PV installations with effect from 1 October 2012. This lowering of tariffs, the third since the beginning of the year, is linked to the fall in prices of photovoltaic modules on the European market.

Falling sales of photovoltaic modules in Germany led to a further decline in prices in recent months. DETEC decided to reduce by 15% the average rate of pay CPP new photovoltaic installations with effect from 1 October 2012. This measure, the third of its kind since the beginning of the year is added to the lower standard 8% on 1 January 2012 (in accordance with the Ordinance on energy, Appendix 1.2, art. 4.1) and extraordinary decline of about 10% on 1 March 2012.

The rate of compensation RPC for new installations and will, on average, from 36 to 31 ct. / KWh (range 21.6 to 42.8 ct / kWh depending on the nature and size of the installation. Early 2013, the rate of compensation again automatically decline of 8%. Due to the large uncertainties regarding the evolution of prices of modules, the adequacy of the rates of compensation will be regularly reviewed by the DETEC.

Scope of the new pay rates for photovoltaic RPC adaptations of the PRC with effect from October 1, 2012 are not applicable to photovoltaic installations that have already been the subject of a positive decision, even if the installation is put into service after 1 October 2012.

Maximise your results

More than
20 years Swiss Quality
and Experience

Connect to the net with SolarMax!

Solar plants are just like football: only the result counts. And the inverter is the champion that can make the difference.

SolarMax has been developing and marketing grid-connected solar inverters for more than 20 years. We provide top-class Swiss Quality: Our products stand out through optimum efficiency, maximum yields and absolute reliability. In addition, our Service Center will support and advise you throughout the entire life span of your plant.

Go for the champions. Get SolarMax on your team.

SolarMax®
SWISS QUALITY

www.solarmax.com

New lab based record for OPV

PHILLIPS 66 South China University of Technology (SCUT), and Solarmer Energy, Inc. have successfully set a new world record in power conversion efficiency for polymer-based organic photovoltaic (OPV) cells. The 9.31 percent efficiency was certified by the Newport Technology & Application Center's Photovoltaic Lab in Long Beach, Calif.

"The breakthrough in efficiency offers a good opportunity for the commercialization of the organic photovoltaic technology," said Dr. Byron Johnson, manager of Sustainability Technologies at Phillips 66. "This marks an important milestone for the industry and has the potential to deliver truly low cost energy for the world."

The new record was achieved as a result of collaboration between Solarmer's materials development team; the Alternative Energy group at Philips 66 Technology led by its director, Dr. Ting He; and Prof. Hongbin Wu's research group at SCUT. The champion cell utilized a new polymer jointly developed by Solarmer and Philips 66, combined with the interface technology developed at SCUT's Polymer Optoelectronic Materials and Devices.

"Our interface technology results in a marked improvement in OPV cell efficiency and is compatible with the roll-to-roll process, which is critical for manufacturing high efficiency and low-cost OPV cells on a large scale," said Prof. Wu.

OPV is lightweight, has a better performance in low light and is easier to manufacture — making it a potentially cost-effective renewable energy technology on par with current conventional energy technologies.

"Solarmer remains steadfast in its mission to bring OPV technology to the market, and continuously breaking new ground is essential to achieving this goal. We are confident of breaking the 10 percent efficiency mark very soon," said Woolas Hsieh, president and co-founder of Solarmer. "Solarmer is building an ecosystem to cover the entire OPV value chain. Forming partnerships is the smartest and probably the only way to go forward. The company is now focusing its efforts in manufacturing technology with the goal of delivering the first OPV products in 2013."

Surviving a changing industry

The global solar industry has become competitive very quickly and solar module manufacturers are encountering hurdles on the way to a healthy balance sheet. Many are struggling to meet customer demands while maintaining cost reduction programmes. The changing dynamics and inevitable consolidations begs the question of how can manufacturers ensure survival in today's unforgiving solar market. Geoffrey King, Market Manager of Renewable Energy, Saint-Gobain Solar was happy to tackle some questions on the issue.

Q From a broader level of observation, what major challenges are confronting the solar industry?

A The main challenge facing the industry as a whole is the recent influx of industry players. As the marketplace becomes larger, it inherently becomes more competitive. For instance, the explosive growth in module manufacturing, particularly in countries like China, has created an overcapacity issue, wherein the supply of modules outpaces demand and places downward pressure on pricing. Therefore, manufacturers may struggle to cover their costs and remain profitable. In addition, government subsidies for new solar installations are expiring or in danger of not being renewed in Europe and the US. Fewer subsidies to fund new installations could reduce demand for new modules and limit sales opportunities for module makers.

These two factors are creating a highly competitive environment for module manufacturers who must deliver high-quality products at a lower price point to meet the demands of solar energy producers that have less spending flexibility.

Q How are these global challenges affecting different regional markets?

A The issue of overcapacity and falling prices is significantly impacting module manufacturers in China. While rapid growth of the nation's solar industry has made it the global centre for PV manufacturing, accounting for more than 50 percent of worldwide module production, this growth has also contributed to module overcapacity and strained the profitability of manufacturers in the area. As a result, many module makers are implementing short-term solutions, investing in companies abroad through partnerships and acquisitions to enhance profitability. Measures are also being taken to facilitate the long-term stability of China's solar sector. The recently passed Feed-In Tariff for solar power is designed to strengthen the industry in the long run by encouraging domestic demand for modules used in commercial or home installations.

The US solar industry has also grown quickly over the past few years with a greater emphasis on installations over module manufacturing. According to a report by the Solar Energy Industries Association and GTM Research, the country saw the installation of 1,855 megawatts of capacity in 2011, doubling 2010 numbers. But the industry is not without its challenges. Recent demand for solar power has been partially fuelled by government incentives. December's expiration of the Renewable Electricity Production Tax Credit (PTC) as well as the expiration of other regional subsidies may tighten the purse strings of solar power producers in the future. As a result, the relatively young market must learn quickly to stand on its own two feet.

As other regional markets take off, Europe's solar sector is reaching maturity. Subsidy cuts in Italy, Germany, Spain and the UK may slow demand for modules as regional manufacturers combat challenges presented by the downward pressure on pricing. However, module production continues. Though the output levels are smaller compared to China, manufacturers are focused on cutting operational costs with the design of cutting-edge facilities featuring highly-automated lines.

Q How will solar module manufacturers survive these challenges?

A Reducing production costs and enhancing efficiency are two paths to overcome these hurdles. Module manufacturers can stamp out costs by decreasing material waste, operational inefficiencies and labour intensive tasks in production and maintenance.

Inefficiencies don't just accumulate added cost in association with downtime and slower production cycles; they can also hinder brand integrity. For example, today's fast-paced marketplace requires module makers to respond quickly to customer needs for larger orders or new designs. Inefficiencies slow turnaround time, making it cumbersome for manufacturers to increase output or generate custom solutions on-demand. To fare well in this market, module makers must accommodate new customer needs and fill orders fast. Eliminate inefficiencies and it will be significantly easier to meet new production goals.

Q What are the strategies or tools module manufacturers should utilize to eliminate costs and inefficiencies to succeed?

A Module manufacturers must utilize the right materials to help them reach their cost-cutting goals and improve efficiency. For example, SolarBond Frame Tapes are a labour reducing alternative to silicone sealants for adhering modules to frames. They ensure an instant bond, eliminating the curing time required by traditional silicone solutions. The application is also fast and clean, leaving no material waste due to sealant overflow and requiring no extra man-hours for cleaning.

SolarBond Membrane, used in the vacuum PV lamination process is another option in cost reduction options. The membrane's blend of polymers offers high levels of durability and flexibility for a longer service life than comparable solutions. As a result, manufacturers will require fewer replacements,

significantly reducing maintenance costs and minimizing downtime on the production lines.

Module manufacturers will also look to optimize efficiency and reduce labour costs in the long run with more automated lines. For these advanced operations, new solutions are available to keep up with the cycle speed. Saint-Gobain Solar also offers SolarBond InFrame, an intelligent, innovative and instant solution for solar module framing. Applied warm in a single continuous motion, the frame ensures accuracy and high immediate bonding after contact with the frame. When used with Saint-Gobain's single-piece frame can help manufacturers reduce material costs further by eliminating three out of four corner keys traditionally required to hold four-piece frames in place.

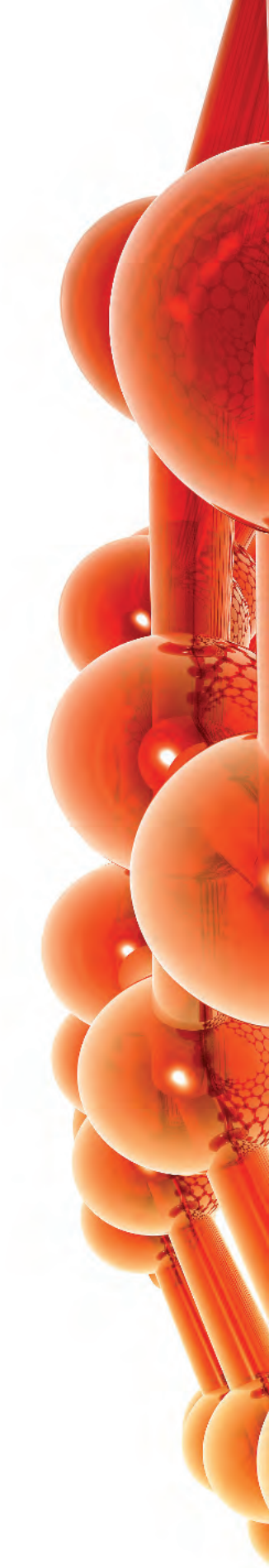
Q In a global solar market destined to see more companies merge, how will regional players compete with larger, more globally established module manufacturers?

A Companies with a smaller, more regional presence generally know their local markets better than foreign companies, for example. Leveraging this knowledge is important to maintain local market share, while growing global presence is also important to ensure survival in future. Partnering with a supplier that combines global resources with local support and a broad range of cost-saving solutions can offer additional opportunities for such companies.

For example, Saint-Gobain global support helps customers evaluate different framing technologies and ensure the implementation of the tools best suited to a given operation. This support can empower module manufacturers to ensure plants are running at capacity, optimizing output and ultimately saving costs.

Defect free nanocrystals

New defect-free nanocrystal film process developed at MIT could enable better solar cells, biosensors and LED displays as well as foster basic physics research according to David L. Chandler at MIT's News Office.



Films made of semiconductor nanocrystals — tiny crystals measuring just a few billionths of a metre across — are seen as a promising new material for a wide range of applications. Nanocrystals could be used in electronic or photonic circuits, detectors for biomolecules, or the glowing pixels on high-resolution display screens.

They also hold promise for more efficient solar cells in the future.

The size of a semiconductor nanocrystal determines its electrical and optical properties. But it's very hard to control the placement of nanocrystals on a surface in order to make structurally uniform films. Typical nanocrystal films also have cracks that limit their usefulness and make it impossible to measure the fundamental properties of these materials.

Now, researchers at MIT say they have found ways of making defect-free patterns of nanocrystal films where the shape and position of the films are controlled with nanoscale resolution, potentially opening up a significant area for research and possible new applications.

"We've been trying to understand how electrons move in arrays of these nanocrystals," which has been difficult with limited control over the formation of the arrays, says physicist Marc Kastner, the Donner Professor of Science, dean of MIT's School of Science and senior author of a paper published online in the journal Nano Letters.

The work builds on research by Moungi Bawendi, the Lester Wolfe Professor of Chemistry at MIT and a co-author of this paper, who was one of the first researchers to precisely control nanocrystal production. Such control made it possible, among other things, to produce materials that glow, or fluoresce, in a range of different colors based on their sizes — even though they are all made of the same material.

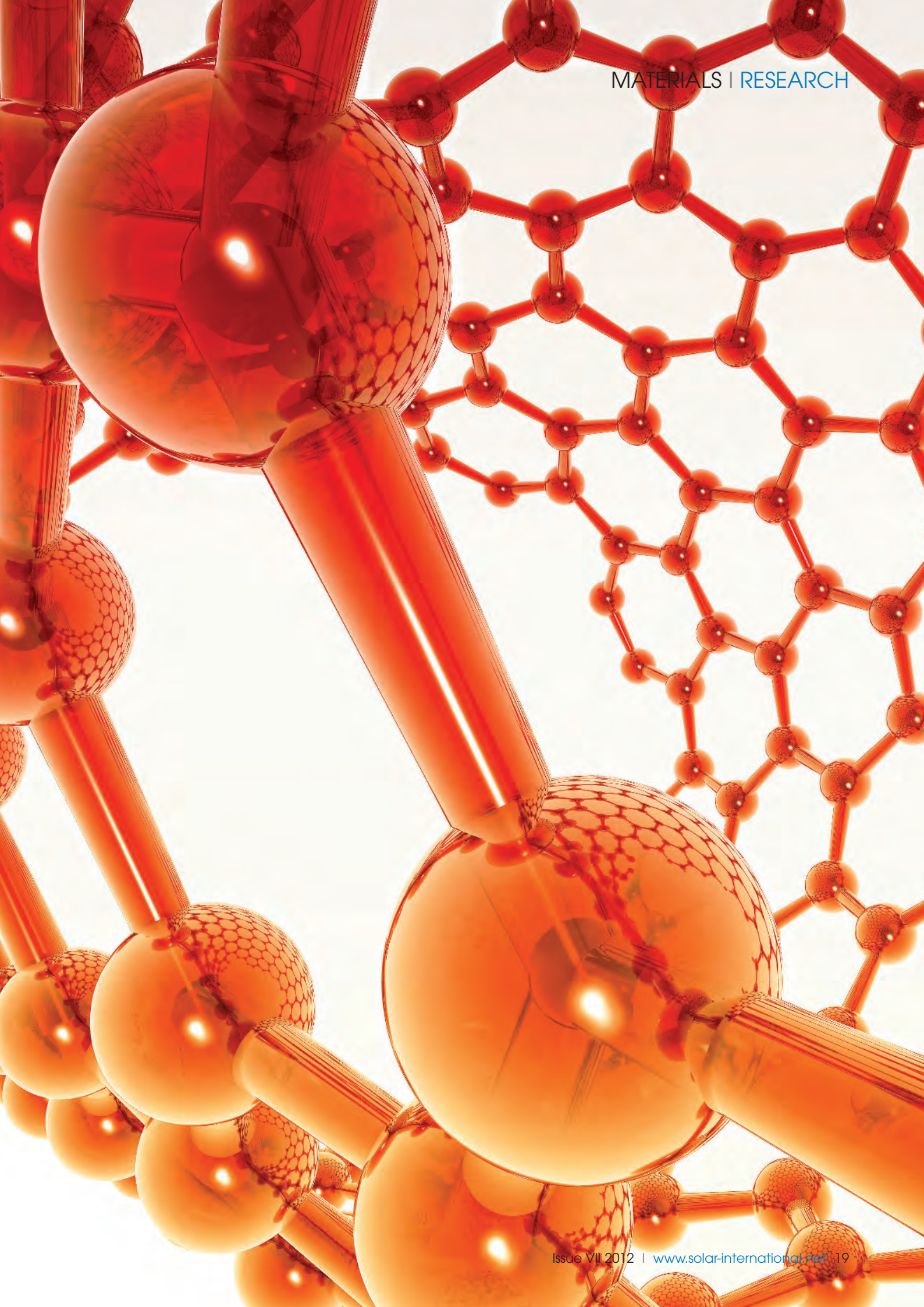
In the initial phases of the new work, postdoc Tamar Mentzel produced nanoscale patterns that emit invisible infrared light. But working on such systems is tedious, since each fine-tuning has to be checked using time-consuming electron microscopy.

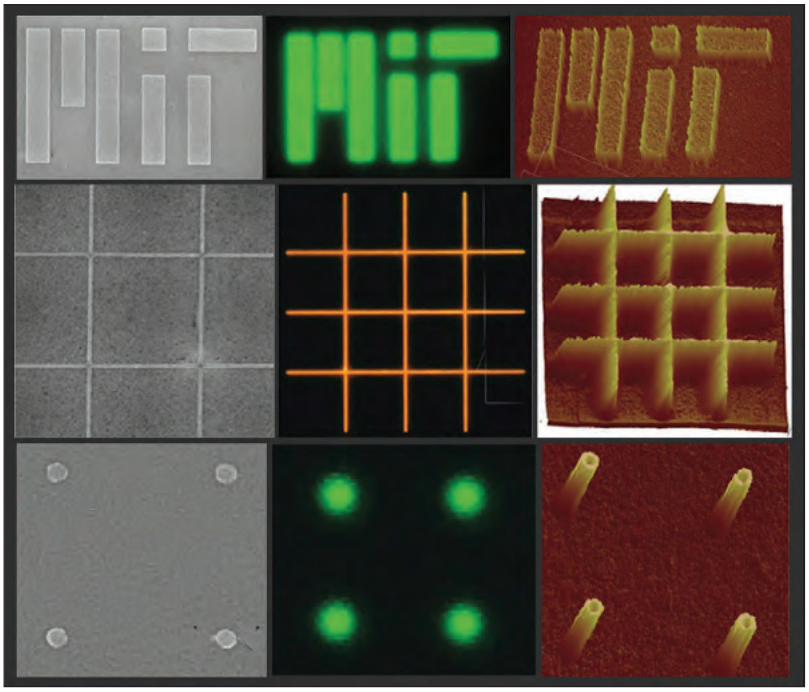
So when Mentzel succeeded in getting semiconductor nanocrystal patterns to glow with visible light, making them visible through an optical microscope, it meant that the team could greatly speed the development of the new technology.

"Even though the nanoscale patterns are below the resolution limit of the optical microscope, the nanocrystals act as a light source, rendering them visible," Mentzel says.

The electrical conductivity of the researchers' defect-free films is roughly 180 times greater than that of the cracked films made by conventional methods.

In addition, the process developed by the MIT team has already made it possible to create





Images of nanopatterned films of nano crystalline material produced by the MIT research team. Each row shows a different pattern produced on films of either cadmium selenide (top and bottom) or a combination of zinc cadmium selenide and zinc cadmium sulfur (middle row). The three images in each row are made using different kinds of microscopes: left to right, scanning electron microscope, optical (showing real-color fluorescence), and atomic force microscope. Images courtesy of Mentzel et al, from Nano Letters

patterns on a silicon surface that are just 30 nanometers across — about the size of the finest features possible with present manufacturing techniques.

The process is unique in producing such tiny patterns of defect-free films, Mentzel says.

"The trick was to get the film to be uniform, and to stick" to the silicon dioxide substrate, Kastner adds.

That was achieved by leaving a thin layer of polymer to coat the surface before depositing the layer of nanocrystals on top of it. The researchers conjecture that tiny organic molecules on the surface of the nanocrystals help them bind to the polymer layer.

Such nanocrystal patterns could have many applications, Kastner says. Because these nanocrystals can be tuned not only to emit but also to absorb a wide spectrum of colors of light, they could enable a new kind of broad-spectrum solar cell, he says.

But Kastner and Mentzel's personal interest has more to do with the basic physics involved. Since the minuscule crystals behave almost like oversized atoms, the researchers aim to use the arrays to study fundamental processes of solids in lieu of the ability to work with atoms directly Mentzel says.

The success of this technique has already enabled new research on how electrons move in the films.

Such materials could also be used to develop sensitive detectors for tiny amounts of certain biological molecules, either as screening systems for toxins or as medical testing devices, the researchers say.

Douglas Natelson, a professor of physics and astronomy at Rice University who was not involved in this work, says, "The challenge in the past has been achieving thin, uniform films, patterned at high resolution, with good contact between the nanocrystals and no cracking."

"The MIT team's approach, he says, "while deceptively simple in appearance, accomplishes all of these objectives."

Natelson adds: "I think this is a very nice achievement. The fluorescence images showing the nanopatterned films are eye-popping, particularly for those who know how tough this is."

The research was supported by the U.S Army Research Office, the Department of Energy and Samsung.

Since the minuscule crystals behave almost like oversized atoms, the researchers aim to use the arrays to study fundamental processes of solids, Mentzel says. The success of this technique has already enabled new research on how electrons move in the films

See you at the EU PVSEC 2012

27th European Photovoltaic Solar Energy Conference and Exhibition

The most inspiring Platform for the global PV Solar Sector

Messe Frankfurt, Germany

Conference 24 - 28 September 2012 • Exhibition 25 - 28 September 2012

www.photovoltaic-conference.com • www.photovoltaic-exhibition.com

Flexible interconnect viewing

Flexible solar cells require conductive adhesives to enable energy flow as traditional processes are ineffective for the technology. To ensure interconnects are stable manufacturers need to cut samples for testing preparation. Heiko Stegmann of Carl Zeiss Microscopy discusses how focused ion beam techniques can provide a damage free method to inspect flexible solar cells interconnects.

Thin-film photovoltaics can be deposited not only on glass or metal, but also on flexible plastic substrates. Such flexible solar cells are lightweight, bendable and durable, which make them ideal for portable power applications and use in aeronautics. For their production, roll-to-roll processing can be used, which significantly reduces manufacturing costs.

However, flexible solar cells cannot be interconnected with standard wiring techniques. They cannot withstand soldering temperatures, and rigid interconnects on flexible substrates will warp and break. Therefore, conductive adhesives are being developed for flexible and printable interconnection. Their flexibility, adhesion and conductivity need to be optimized by tuning composition and curing procedure. Examination of the microstructure of these interconnects by scanning electron microscopy (SEM) is an essential tool for such process optimization and failure analysis.

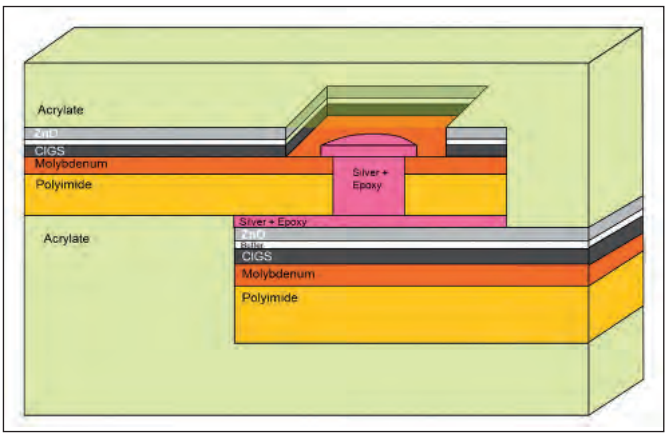


Figure 2. Schematical drawing of the composition of the flexible solar cell sample

Damage Free Viewing

SEM analysis of flexible solar cell interconnects requires target preparation of structures that are deeply buried under substrate and passivation material. Conventional mechanical cross-sectioning using cutting, grinding and polishing devices is problematic on these soft composite material samples. It often causes deformation and delamination, even if the samples were additionally stabilized by plastic embedding. Focused ion beam (FIB) milling does not cause such problems, but conventional liquid metal ion source FIBs have much too low milling rates for the very large volumes of material that have to be removed. Even recent plasma ion source FIBs that achieve up to 20 times faster milling cannot finish such deep cross-sections in an acceptable time [1].

Ablation with a pulsed micro-focus laser is a potential replacement for mechanical devices and FIB in large volume target preparation. It provides material removal rates that are comparable with mechanical methods, and orders of magnitude higher than those of FIB. For instance, to remove 0.3mm^3 of silicon, a 30 kV gallium FIB at a typical milling rate of 2.7 μm^3 / s at 10 nA beam current will need approximately 3.5 years, while a pulsed laser will remove the same amount of material in only 5 min at an ablation rate of 106m^3 / s [1]. However, cross-sections produced by a laser show a heat affected zone (HAZ) as well as high surface roughness which, depending on the type of laser used, may both amount to several micrometres.

FIB must still be used to remove the HAZ and polish the region of interest before high resolution imaging or nanoanalysis can take place. Therefore, the specimen must be transferred between a standalone laser system and the FIB or FIB / SEM tool, sometimes repeatedly. Exact positioning of the ablation

Figure 1. Previous Page
The AURIGA Laser allows precise and fast target preparation of samples for microscopy and nano-analysis.

Figure 3. Laser cross-section of a flexible thin film solar cell module (top left). The contact area of interest was FIB polished (top right and bottom left) and SEM imaged to examine the contact interface (bottom right)

pattern and retrieving the region of interest after each sample transfer are troublesome with such a setup. Due to these inefficiencies, the use of lasers for microscopic sample preparation has not yet found widespread use.

Combined Solution

Carl Zeiss Microscopy offer a combined tool to deal with the industry requirements. The AURIGA Laser combines the excellent ablation rates of pulsed micro-focus laser ablation with the high accuracy and versatility of a ZEISS AURIGA FIB/SEM system in a single tool (Fig. 1). This allows precise target preparation and characterization of deeply buried features in an efficient way.

Ablation with a scanning nanosecond pulse UV 355 nm diode-pumped solid state laser (TRUMPF Laser Marking Systems AG) [2] takes place in a processing chamber separated from the main chamber in order to protect the instrument's vacuum system and detectors from the large amounts of particles and gaseous substances produced during laser ablation. Fast sample transfer between SEM or FIB position and laser processing position with automatic target retrieval provides a seamless workflow. Arbitrarily shaped ablation patterns with individually assigned laser parameter sets can be defined in the software and are cut within minutes, followed by gallium FIB polishing, SEM imaging or other SEM based analytical methods in the same instrument.

Case Study

In the example presented here, deeply buried contact interfaces in a flexible copper indium gallium selenide (CIGS) solar cell on polymide substrate with silver flake loaded epoxy resin interconnects and an acrylate encapsulation (Fig. 2) were to be imaged.

An attempt at classical metallographic cross-section preparation by embedding, grinding and polishing resulted in large area layer delamination. Obviously, the forces exerted on the layer stack were too strong, making it impossible to discern actual contact detachment from preparation artifacts.

In order to similarly cross-section a whole contact with the gallium FIB, removing the necessary amount of material would have taken several days. Pre-sectioning the specimen with a precision diamond saw to reduce FIB milling time also resulted in severe distortion and delamination of the layers.

The optimum laser parameters to be used with this kind of sample (power, pulse frequency, scan speed, defocus, and number of repeats) had been determined beforehand on dummy samples of identical composition

Fig. 3 shows the result of using rapid laser ablation followed by FIB milling in the AURIGA Laser. The contact region of interest on the sample was identified in the SEM image, and a predefined ablation rectangle (2.5 x 1.0mm^2) was positioned across a complete contact directly in the same image. The optimum laser parameters to be used with this kind of sample (power, pulse frequency, scan speed, defocus and number of repeats) had been determined beforehand on dummy samples of identical composition. Subsequently, the sample was transferred to the laser processing chamber (30 s). Via an automated registration procedure, the system software transformed the target coordinates to the coordinate system of the laser.

The ablation pattern was executed (2 min) with the processing chamber evacuated, resulting in a 1 mm deep laser trench through the encapsulation and the complete functional stack down into the substrate. The sample was then immediately transferred back to the main chamber of the AURIGA (30 s), where the interface of interest, located approximately 700 μm below the apex of the contact hill, was identified in the SEM image. A 30 μm wide part of this interface was polished with the 30 kV gallium FIB at 10 nA beam current.

Finally, the contact interface thus exposed was SEM imaged at high resolution. During the whole procedure, the sample did neither leave the tool nor the vacuum.

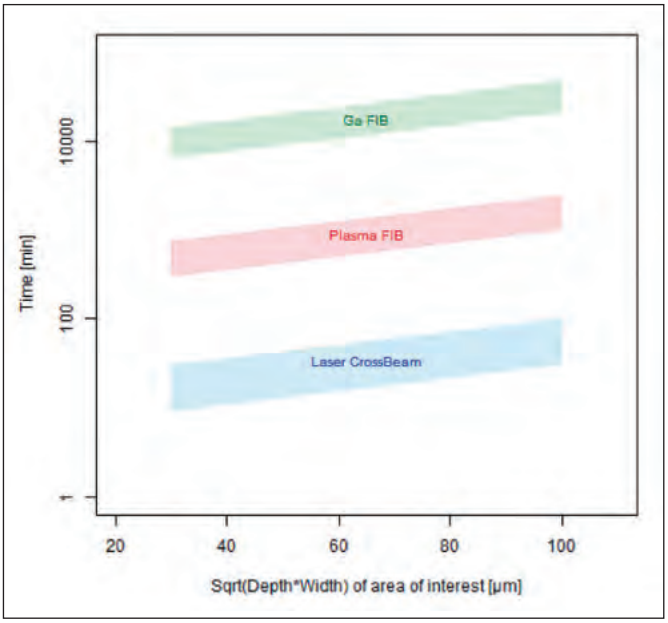


Figure 4. Comparison of total preparation times using different methods for producing a 30 x 30 μm^2 to 100 x 100 μm^2 cross-section of a feature located 800 to 1200 μm below the sample surface1

Conclusion

The above example shows that target preparation of contact interfaces in flexible solar cells that cannot be done with mechanical or pure FIB preparation is easily possible using our integrated combination of pulsed microfocus laser and FIB / SEM tool. The AURIGA Laser overcomes the limitations of conventional techniques for target preparation of flexible solar cells by providing a significantly improved workflow over setups that use separate laser and FIB systems.

For illustration of the gain in process speed, Fig. 4 shows calculated time durations for target preparation of a 30 x 30 μm^2 to 100 x 100 μm^2 cross-section of a feature located 800 to 1200 μm below the sample surface, comparing the AURIGA Laser, plasma FIB and conventional gallium FIB.

From this comparison it becomes clear that even though time has to be invested to remove the laser induced HAZ by FIB, the superior material removal speed of the pulsed laser results in vastly reduced total preparation times for deeply buried features.

Acknowledgements

We would like to thank Dr. R. Rosenkranz and Y. Ritz of the Fraunhofer Institute for Nondestructive Testing IZFP, Dresden branch, for sample supply, preparation and analysis. All images are courtesy of Yvonne Ritz, Fraunhofer IZP

References

[1] M. Petzold et al., Proc. 60th IEEE Electronic Compon. and Technol. Conf. (ECTC):1296-1302 (2010).
[2] S. Martens et al., ASME J. Electronic Packaging 131(3): 1-6 (2009).

Metal Futures

Existing photovoltaic (PV) metallization techniques are far from optimal across the three incumbent technologies - crystalline silicon (x-Si), copper indium gallium (di) selenide (CIGS), and cadmium telluride (CdTe) - resulting in efficiency loss, high cost of metallization materials, and low yields. With the push for cost reductions across the entire PV value chain, optimization is needed. Fatima Toor Ph.D. of Lux Research Inc. provides an overview of innovations in metallization techniques which address key metallization issues.

Photovoltaic (PV) industry is going through a turbulent phase, where upstream profit margins are dwindling due to oversupply and flat demand. It is more important than ever to reduce production costs across the entire production value chain to improve profit margins even if today's compressed average selling prices linger.

In this context, existing metallization processes and techniques for the three incumbent technologies, crystalline silicon (x-Si), copper indium gallium (di)selenide (CIGS), and cadmium telluride (CdTe), are far from optimized, with room for improvement in terms of cost, production yield, and cell efficiency.

Within this landscape some of the key industry issues are as follows.

Silver paste-based screen printing is the most common metallization technique for x-Si and CIGS cells. However, with an expected increase in the silver price in the coming years - a corresponding 400% increase has been seen in the last decade - silver use during metallization needs to be reduced or be replaced completely with a cheaper metal. Moreover as x-Si wafers get thinner than 140 μm existing contact metallization processes are inherently flawed.

For CdTe, sputtered copper-based back contacts are the most common, where copper is the p-type dopant for CdTe. However copper has a tendency to diffuse through the CdTe crystal grain boundaries and cause cell degradation over time. The copper diffusion into CdTe gets worse at high temperatures. Therefore there is a need for alternative copper-free back contacts for modules

to be used in hot climates regions some of which represent the industry's highest growth rates.

Conventional stringing and soldering of cells during module integration hurts production yields because they cause mechanical stress in x-Si wafers. As back contact x-Si cell designs become part of the PV infrastructure and as wafers get thinner, stringing-free integration will become necessary.

Innovative solutions

Companies, government laboratories and university groups alike are developing innovative metallization solutions that address issues in the existing PV metallization infrastructure. Some of these innovative approaches will be adopted earlier by the PV industry while others will experience inertia:

While three approaches for copper metallization - plated copper, copper paste and copper mesh - are being developed, prospects vary greatly. Plated copper will require process and infrastructure change and will experience industry inertia for adoption, while copper pastes will be the fastest to be adopted by the industry if they can prove durability.

Copper mesh is a promising metallization option for CIGS cells but for x-Si where the mesh is not compatible with a required high temperature firing step. Copper-based conductive backsheets as an alternative to stringing and soldering will also become popular for back-contact cells.

Nickel phosphide (Ni2P) offers the most promising route to copper-free back contact for CdTe cells because it offers low cost and durable metallization. In this technology phosphorus diffuses into CdTe to provide p- doping while nickel provides the metallization.

This technology has been patented by GE recently, which is planning to invest in CdTe module technology through PrimeStar Solar.

Non-contact printing techniques, in particular, inkjet printing, will become important as the x-Si wafer thickness decreases below the 140 m barrier. Inkjet will come at around 40% cost premium over screen printers so the PV manufacturers will have to weigh in the cost advantage of improved yield, reduced silicon cost and capex.

Tomorrow's PV winners will be those companies that can reduce their production costs in $/W and maintain sustainable profit margins.

Across the three incumbent PV technologies - x-Si, CIGS, and CdTe - metallization is a key materials-driven driver for higher efficiencies, reduced production costs and improved yields.

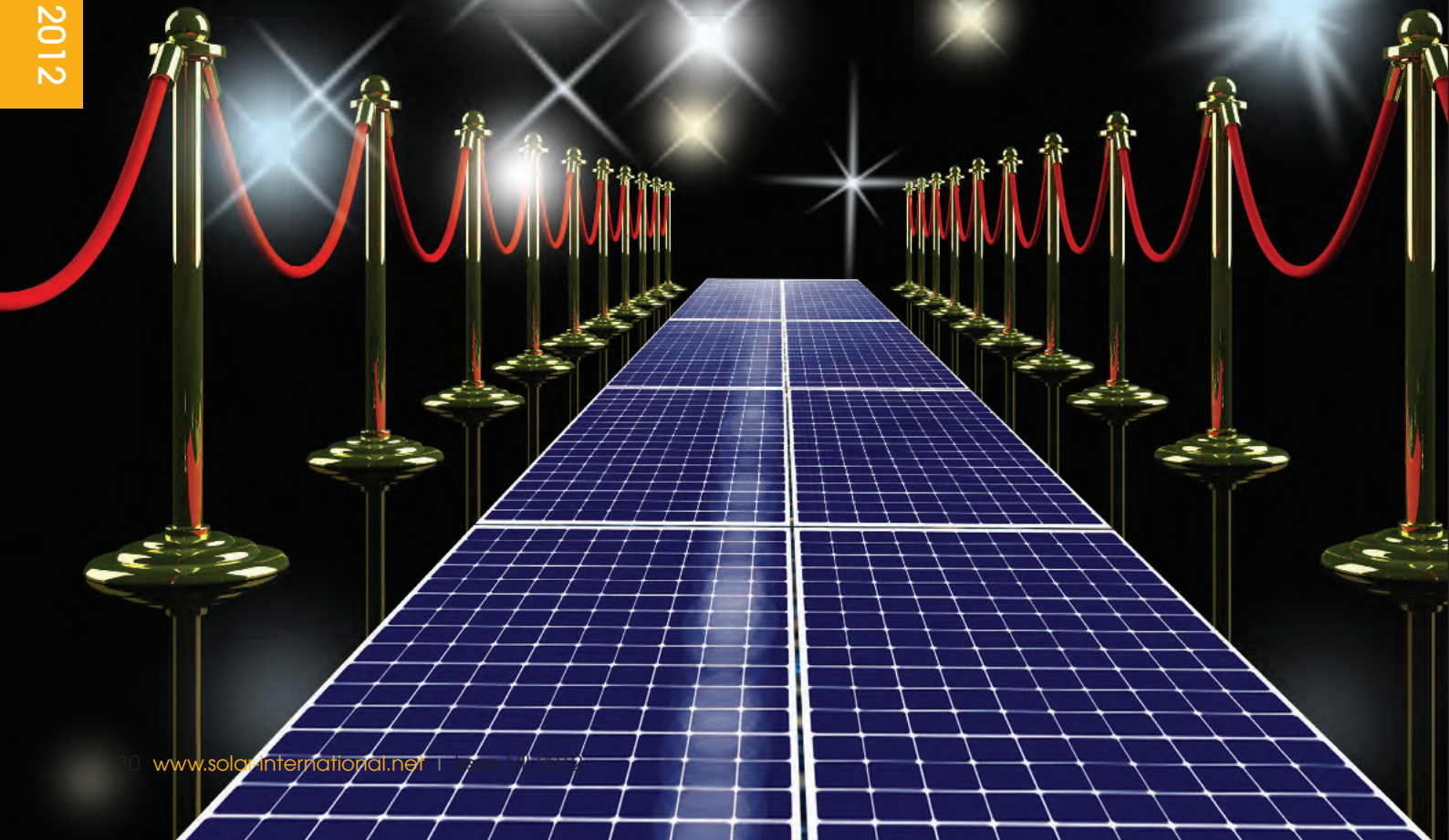
Further information on the complete report can be found at Lux Research.

awards 2012

solar

Solar Industry Awards 2012 Shortlist

SOLAR AWARDS SHORTLIST 2012



PV MATERIALS ENABLING AWARD

Heraeus
SOL200 Series

Saint Gobain Solar
SolarBond® InFrame

Solar Junction
SJ 3 Cell

THIN FILM INNOVATION AWARD

Intermolecular Inc
HPC Workflow

SoloPower
CIGS Technology

The NSG Group
TCO thin-film coatings

University California LA (UCLA)
Low-Cost Polymer Solar Cells by Solution Processing

University of Wisconsin-Madison
Solar Tracking

SILICON INNOVATION AWARD

AEG Power Solutions
Thyrobox™ PI

MEI LLC
FlashDry Polysilcion and Material Drying

SAS
Aegis® Wafer for Silicon Photovoltaic Products

SYSTEM INTEGRATION AWARD

ARRAY POWER
Sequenced Inverter

Molex Inc
SolarSpec™ Smart Junction Box

Solar-Log
Power Management for PV Plants

Yamaichi Electronics
'Eco-Si' Junction Box

PV TOOL AWARD

DEK SOLAR
Apollo

EDWARDS www.edwardsvacuum.com
GXS dry pump

PASAN MEASUREMENT SYSTEMS
DragonBack™

NanoFocus, Inc.
μsurf solar

PV PROCESS AWARD

Despatch INDUSTRIES
DriTech Dryer

LayTec in-line GmbH
X Link in-line metrology system

LEVITECH
The Levitrack™ ALD system

Sika®
Sikasil® AS-780

PV BALANCE OF SYSTEM

ARRAY POWER
ArrayPower Sequenced Inverter™

Esmolo
MPS ProtectionBox™

SolarBridge
The SolarBridge Pantheon™ microinverter

ENERGY USAGE ENABLING AWARD

ARRAY POWER
ArrayPower Sequenced Inverter™

Locus Energy LLC
Virtual Irradiance

SolarBridge Technologies
Pantheon II integrated microinverter

Solar-Log
Power Management for PV Plants

INDUSTRY DEVELOPMENT AWARD

Dunmore Corporation
SmoothStart

Locus Energy LLC
Virtual Irradiance

SMA SOLAR TECHNOLOGY
SMA Solar Technology AG
Life Shines Brighter

Tigo Energy
Anti-Theft System

Upsolar
Upsolar Module Lifecycle Assessment

MODULE MANUFACTURING INNOVATION AWARD

Solar Junction
SJ 3 Cell

Silevo, Inc.
Triex Solar Technology

Suntech Power International Ltd
HiPerforma™

Westinghouse Solar
INSTANT CONNECT™ Solar Panels

RURAL ELECTRIFICATION DEVELOPMENT AWARD

AUTARCON GmbH
Integral solutions for water purification

Phaesun
Pico PV Systems

Steca Elektronik GmbH
Solar refrigerator/freezer

PROJECT DEVELOPMENT AWARD

Mobisol
Mobisol-plug in the world

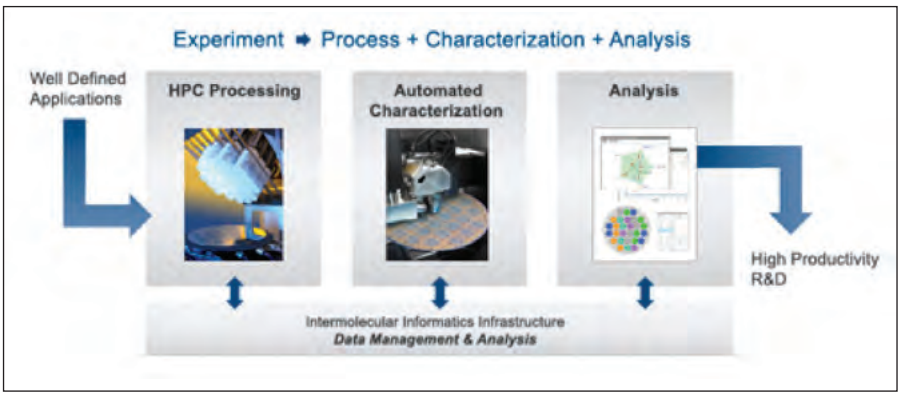
Phaesun
Rural Electrification with Plan Ethiopia

THIN FILM INNOVATION AWARD

Intermolecular Inc

HPC Workflow

High Productivity Combinatorial HPC™ Workflows Experimental data is the lifeblood of innovation. It is the only objective proof of whether new materials and device structures are ready to move into production and ultimately into the hands of consumer.



Intermolecular Inc, HPC Workflow

Traditional R&D is no longer cost-effective for today's leading-edge semiconductor and clean-energy devices. Such devices use nanometer-scale material structures with properties that depend on interactions with adjacent materials.

Because these interactions cannot be predicted by theory extensive experimentation is required to prove what really works. To make matters even more complicated multiple device materials must be optimized simultaneously because traditional sequential experimentation cannot identify interdependencies that limit device function. As a result thousands of experiments are required to evaluate possible combinations – and each experiment must include processing characterization and analysis to obtain useful data. This is why the cost-benefit ratio of traditional R&D is becoming unsustainable – and why Intermolecular developed its High Productivity Combinatorial (HPC™ R&D platform.

By conducting dozens or hundreds of experiments in parallel and using advanced information technology to pinpoint the most promising results the HPC platform provides quick learning for our customers working in the semiconductor and clean-energy industries.

Applying HPC technology to rapid prototyping of complete PV devices dramatically speeds the pace of development for next generation low-cost high-efficiency solar cells and panels. CIGS (copper indium gallium selenide materials and their earth-abundant cousin CZTS (copper zinc tin sulfur are both excellent examples of promising materials for clean energy. By applying HPC technology we can rapidly prototype integrated devices that employ these complex material systems – and dramatically speed the pace of development for low-cost/high-efficiency solar cells and panels.

HPC workflows turbocharge the experimental process with site-isolated parallel or rapid-serial processing of experimental materials. HPC characterization tools are throughput-matched and automated data analysis and reporting quickly sort through copious experimental data streams. Each workflow enables rapid and efficient exploration of the relevant process and integration space and produces the exact data types (e.g. physical electrical needed to drive materials discovery and integration.

Every development program faces unique technical challenges. This is why Intermolecular's High Productivity Combinatorial (HPC™ workflows are customer-specific. These workflows typically combine: HPC and non-HPC process equipment Automatic characterization using HPC-enabled metrology tools fully optimized procedures and An Informatics data-management system with customized analytics. The workflows provide the capability to rapidly perform the necessary experiments measure and screen the results and manage and analyze the vast amount of data collected. By asking and answering only those questions that are absolutely necessary at each stage of development we help our customers move rapidly and cost-effectively towards a solution that meets their process or device requirements. This approach delivers exceptional competitive advantage by providing a robust production-worthy solution with significantly reduced development time costs and risk.

SoloPower

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)

SoloPower, CIGS Technology

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.

The NSG Group

TCO thin-film coatings

Thin-film module manufacturers need to maximize module efficiency while maintaining performance guarantees that meet an expected 25-year lifetime and above. However, cost reduction requirements mean more economical coating solutions in high-volume applications are desired.
The NSG Group is a supplier of transparent conductive oxide (TCO) coated glass for thin-film photovoltaic applications. Its 'TEC' product range is a group of products, including a comprehensive range of TCO coated glass, optimized to suit a variety of thin-film photovoltaic technologies.
With different haze and conductivity levels, the product range is designed to offer flexibility in TCO coatings to thin-film module producers' individual requirements.

The TEC products offer a range of conductivity, morphology and haze requirements to help maximize module efficiency. The durable online pyrolitic coating gives the products a virtually unlimited shelf-life, making them easy to transport, store, handle and process, therefore reducing costs and lead times. The coated products are also resistant to high processing temperatures and can be fully tempered, toughened or heat strengthened without any damage to the coating, and without any drop in performance.

The multi-layer TCO coating stack offer robust sodium blocking properties, ensuring the module performance is unaffected by sodium migration from the glass superstrate.

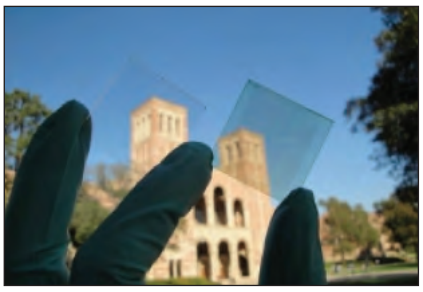
University of Ca;ifornia Los Angeles (UCLA)

Low-Cost Polymer Solar Cells by Solution Processing

UCLA researchers have developed a new transparent solar cell that is an advance toward giving windows in homes and other buildings the ability to generate electricity while still allowing people to see outside. The UCLA team describes a new kind of polymer solar cell (PSC) that produces energy by absorbing mainly infrared light, not visible light, making the cells nearly 70% transparent to the human eye. They made the device from a photoactive plastic that converts infrared light into an electrical current.

Polymer solar cells have attracted great attention due to their advantages over competing solar cell technologies. Scientists have also been intensely investigating PSCs for their potential in making unique advances for broader applications. Several such applications would be enabled by high-performance visibly transparent photovoltaic (PV) devices, including building-integrated photovoltaics and integrated PV chargers for portable electronics.

Previously, many attempts have been made toward demonstrating visibly transparent or semitransparent PSCs. However, these demonstrations often result in low visible light transparency and/or low device efficiency because suitable polymeric PV materials and efficient transparent conductors were not well deployed in device design and fabrication.



A team of UCLA researchers from the California NanoSystems Institute, the UCLA Henry Samueli School of Engineering and Applied Science and UCLA's Department of Chemistry and Biochemistry have demonstrated high-performance, solution-processed, visibly transparent polymer solar cells through the incorporation of near-infrared light-sensitive polymer and using silver nanowire composite films as the top transparent electrode.

The near-infrared photoactive polymer absorbs more near-infrared light but is

less sensitive to visible light, balancing solar cell performance and transparency in the visible wavelength region.

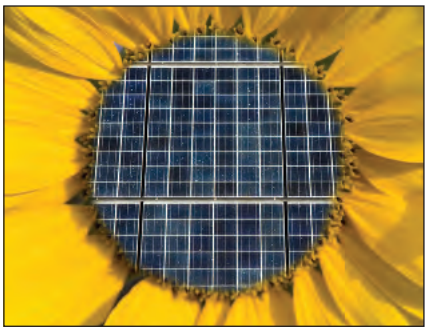
Another breakthrough is the transparent conductor made of a mixture of silver nanowire and titanium dioxide nanoparticles, which was able to replace the opaque metal electrode used in the past. This composite electrode also allows the solar cells to be fabricated economically by solution processing.

With this combination, 4% power-conversion efficiency for solution-processed and visibly transparent polymer solar cells has been achieved.

University of Wisconsin-Madison

Solar Tracking

UW-Madison engineering professor Hongrui Jiang looked to sunflowers to help find more efficient ways to harvest solar energy.



Unlike other "active" solar systems that track the sun's position with GPS and reposition panels with motors, electrical and computer engineering professor Hongrui Jiang's concept leverages the properties of unique materials in concert to create a passive method of re-orienting solar panels in the direction of the most direct sunlight. His design employs a combination of liquid crystalline elastomer (LCE), which goes through a phase change and contracts in the presence of heat, with carbon nanotubes, which can absorb a wide range of light wavelengths.

"Carbon nanotubes have a very wide range of absorption, visible light all the way to infrared," says Jiang. "That is something we can take advantage of, since it is possible to use sunlight to drive it directly."

Direct sunlight hits a mirror beneath the solar panel, focused onto one of multiple actuators composed of LCE laced with carbon nanotubes. The carbon nanotubes heat up as they absorb light, and the heat differential between the environment and inside the actuator causes the LCE to shrink. This causes the entire assembly to bow in the direction of the strongest sunlight.

As the sun moves across the sky, the actuators will cool and re-expand, and new ones will shrink, re-positioning the panel over the 180 degrees of sky that the sun covers in the course of the day. "The idea is that wherever the sun goes, it will follow," says Jiang.

In Jiang's tests, the system improved the efficiency of solar panels by 10 percent, an enormous increase considering material improvements in the solar panels themselves only net increases of a few percent on average. And a passive system means there are no motors and circuits to eat into increased energy harvest.

"The whole point of solar tracking is to increase the electricity output of the system," says Jiang.

The materials driving Jiang's design have only been available in the past few years, so for now, he and his team are researching ways to refine them for use driving larger solar panels, where the net energy gain from his system will be the greatest. Eventually, Jiang hopes to see huge industrial solar farms where fields of photovoltaic solar panels shift effortlessly along with the sunflowers that inspired him.

SYSTEM INTEGRATION AWARD

ARRAY POWER

Sequenced Inverter

The ArrayPower Sequenced Inverter is the first solar module-integrated DC-AC inverter designed for the commercial-scale market.

While a variety of inverters are available on the market at the central string and module levels a clear need has emerged for a module-integrated inverter with a feasible price point for commercial-scale solar electric systems – one of the fastest-growing sectors of the solar energy market around the world.

The Sequenced Inverter combines the performance of a micro-inverter at a price point on par with string inverters.

The Sequenced Inverter is the first to create the three-phase output required by commercial and industrial buildings ensuring the product meets both the performance and price needs of this market segment.

With the Sequenced Inverter ArrayPower 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 equaling cost savings during any maintenance routines over the lifetime of a solar electric system.

Molex Inc

SolarSpec™ Smart Junction Box

Molex Incorporated’s SolarSpec™ Smart Junction Box is making it easy for manufacturers of solar photovoltaic (PV) panels to provide their products with module-embedded safety and monitoring functions, as well as convenient, safe and dependable connection facilities.

The modular concept allows maximum flexibility and easy upgrade of PV-panel functionality, since the electronic PCB always resides in the removable Junction Box cover, This smarter system not only facilitates lean solar manufacturing processes on a manual or automated assembly line, but also ensures easy access to key components should repair or replacement is ever required.

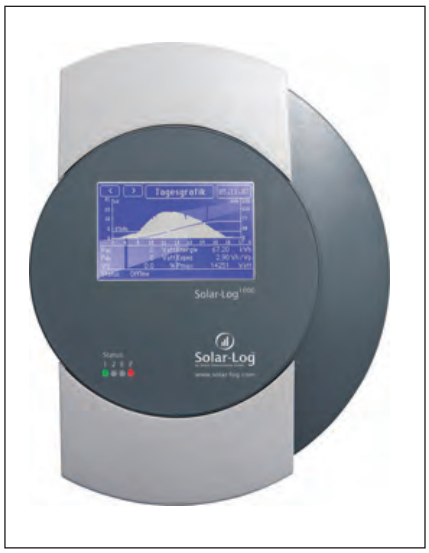
The Smart Junction Box is based on the original two-part SolarSpec™ Junction Box from Molex featuring a base attached directly to the solar PV panel and a removable cover assembly. Functionalities include system safety, shut-off and arc detection, security monitoring and theft protection, performance tracking on output levels and panel efficiencies, remote diagnostics and power optimization.

SolarSpec Junction Boxes can be supplied with optional Solder Charge™ technology for use in conjunction with high-speed assembly processes that provide consistent quality for every termination. A locking mechanism requiring a specialized tool to release secures the top cover to the base, providing total protection against accidental contact with live parts.

Solar-Log™
by Solare Datensysteme GmbH
MAXIMIZED SUNPOWER

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

Yamaichi Electronics

‘Eco-Si’ Junction Box

Yamaichi Electronics cost-effective ‘Eco-Si’ junction box uses hermetic sealed over-moulding technology to provide greater sealing and long-life, even in extreme conditions. Crystalline solar modules are widespread and increasingly more cost-effective to manufacture requiring lower cost components to take advantage of module manufacturing price declines. To reduce the costs for module production, fully automated production lines are increasingly in use.

The Eco-Si junction box permits simple automation techniques using guide rails and large areas for transport by suction through a robot arm. However, continued advancements in junction box operating lifetime are required

The Eco-Si junction box is the first junction box for photovoltaic modules

with an IP protection class of IP68. This permits the safe operation of the solar module even under the harshest of conditions.

This high protection class was achieved by the consistent use of the hermetic sealed technology. With this technology, the junction box is not composed of individual 'failing parts.' Instead, the cables and electronic of the junction box are over-moulded in a single highly efficient work step.

This over-moulding process gives the junction box its shape and ensures absolute freedom from leaks.

The Eco-Si is also designed for system voltages of 1500V, allowing higher voltages for future standards requirements.

PV PROCESS AWARD

Despatch INDUSTRIES

DriTech Dryer

Despatch's innovative DriTech is a revolutionary new dryer for advanced drying of all metallization pastes. The new dryer utilizes hybrid heating technology which enables decoupling solvent and binder burnoff in the solar cell metallization process.

The environmentally friendly tool includes Despatch's integral point-of-generation VOC Thermal Oxidizer, providing maintenance free VOC abatement. This critical component is fundamental to Despatch's back end of line thermal solution which ensures consistent drying efficiency in addition to low facility and tool contamination at each process step.

Historically drying has been an undervalued process step in solar cell metallization. Little attention has been paid to the science of drying and what conditions are necessary for effective, efficient and repeatable drying as well as VOC management and separation of solvent and binder removal.

Most cell manufacturers understand the negative effects of inconsistent peak firing, but few are aware that the root cause can be traced back to incomplete drying. Drying deficiency and inconsistency in production environments have led to inconsistent firing and lower overall yields.

Additionally, a growing complexity and diversity in paste drove requirements for a more robust drying solution.

The DriTech's hybrid heating technology enables the tailoring of the thermal profile to the specific paste. Harmonized infrared heating and the innovative application of airflow create the conditions pastes need for efficient, repeatable drying and release of solvents where they can be captured and eliminated.

Temperature, airflow and integrated point of generation abatement in the dryer all play critical roles in VOC evolution without overheating the paste, managing the volatile's without smoke, fumes and condensation, and efficient and repeatable drying at fast belt speeds.

There is no dryer available today that comprehensively addresses the drying process in a way that effectively decouples it from the co firing process and eliminates VOC contamination and personnel exposure.

Where competing drying technologies have proven deficient, the DriTech has demonstrated efficient and repeatable drying that is so critical to a stable furnace environment and consistent peak-firing temperatures. The integrated VOC Oxidizer has set the standard for VOC abatement using point-of-generation incineration technologies that do not pollute the fab or the environment.

Safe and efficient destruction of VOCs eliminates the need for handling and disposal of hazardous by-products. The concept of green products producing green products is fully realized in the DriTech, which offers a fab and environmentally friendly solution to drying technology.

LayTec in-line GmbH

X Link in-line metrology system

LayTec has developed an in-line device for monitoring the degree of cross-linking in EVA laminates in close cooperation with Fraunhofer USA. The method is based on the measurement of physical properties associated with the level of cross-linking.

Benefits:

- Eliminate scrapping of laminates
- Easy integration in existing lines
- 2D product quality control
- Process control of lamination
- Multi-point measurement capability
- Sturdy design for industrial application

The in-line version is based on highly robust industrial grade embedded system protocols and can be directly connected to production systems and SPC databases by a large variety of protocols along with clear user visualization for quick on-line inspection.

The lamination process is the most critical production step of module manufacturing. Currently a major issue why modules fail in the field is due to bad EVA cross-linking caused by difficulties during the vacuum lamination process itself or unstable EVA foil materials.

This system replaces the common and coarse gel content test. The LayTec X Link system ensures a perfect lamination process which is critical to high-quality modules as cross-linking quality and uniformity impact is essential in terms of quality over time.

It analyses the response of the laminated EVA back sheet combination. Placed directly after the laminator, the tool gives

direct feedback to the lamination process for the adjustment of heating zones and exposure times. LayTec X Link improves lamination yield by real-time control and gives a detailed proof of the long-term stability of PV modules thereby increasing bankability.

Lecvitech, The Levitrack ALD system

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.

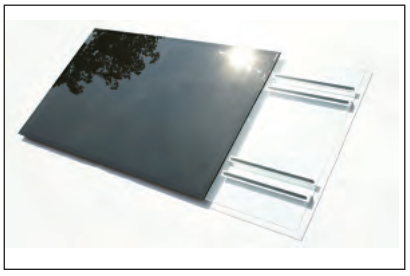
These cells are designed such that in the no reaction of precursors takes place inside the system other than on the wafer surface. Other contributing factors are operation under atmospheric conditions (no vacuum chambers load locks or pumps easy automation (no carriers the lack of moving parts (except 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.

Sikasil AS-780

The Sikasil AS-780 is a high performing two component Silicone designed for in-process bonding of backrails or other mounting devices to PV modules and CSP mirrors. This product is unique compared with other bonding technologies in the market. It combines the exceptional long term performance of a structural Silicone used in the façade industry with the process ability of a high tack and high initial green-strength adhesive. This product follows the demand for cost and material savings simplified production processes and secured long term performances to reduce the overall PV system costs. To reduce these overall costs the industry looks more and more into alternative fixation solutions like backrail or mounting interfaces.

So far there was no technology available which meets both the process ability and the desired long term performance. But to assure a well performing solar system in production and in the field both characteristics are required. On one hand there are existing tape solutions which enable a fast processing and handling but the long term performance and needed tolerance compensation is very limited. On the other hand the long term durability can be provided by Silicone technologies but they are very limited in the process as they need pre-fixation devices and/or larger buffer zones for curing.



Due to the high initial green-strength of the Sikasil AS-780 the bonding application can be integrated into the production lines with a fast handling

afterwards. Therefore no large buffer zones for curing or pre-fixation devices are required anymore. Next to this with the pasty-like consistence and geometry of bead application the tolerances between the modules or mirrors and the mounting device can be easily compensated. The long term durability is assured with this Silicone technology which meets the requirements of the most severe standard for structural bonding in facades the EOTA ETAG 002.

Until now there has been no adhesive or bonding technology available which meets all this demands in one. With the Sikasil AS-780 Sika AG has developed a world innovation in structural in-process bonding technology. This new Silicone technology is ahead of standard Silicones if it comes to initial green-strength and strength development combined with a structural bonding performance of the cured material.

PROJECT DEVELOPMENT AWARD

Mobisol
Plug in the world

Mobisol aims to electrify the rural population in developing countries with combining solar energy and mobile banking to make payment and maintenance for Solar-Home-Systems as easy as possible.

The goal for 2012 is to install 1000 Solar-Home-Systems in rural off-grid households in Kenya and Tanzania, which will become the biggest privately funded rural electrification project in East Africa. This will allow rural and semi-urban households to have lighting, use small electric appliances and improve their general living conditions. Children will have longer study hours, noise and air pollution are prevented. Kerosene lamps and Diesel generators are replaced and health problems same as carbon emissions are therefore largely reduced.

The households can use the systems to fund their own businesses such as barber shops and mobile phone charging stations. This will let customers to refinance their systems and open income generation opportunities for people formally not having access to reliable energy and who largely depend on expensive fossil fuels as their main energy source.

The commitment will be realized due to an innovative approach of the technical design of the project and the successful implementation on a local level together with reliable local partners.

All solar panels are connected to a GSM modem and therefore it is possible to communicate with every system through a web based database. This allows for remote monitoring of the system and will diagnose all sorts of possible system failures, before they actually occur.

The mobisol controller, which is also connected to the GSM modem, makes it possible to lock the system in case the payment has not been fulfilled.

The mobile banking service is widely used throughout target region, in Tanzania for example with partner M-PESA. This makes a personal collection of the credit repayments obsolete, otherwise a big hurdle for similar projects.

Mobisol SHSs are available in four different sizes to match the varying electricity needs and payment abilities of different customer groups.

The smallest is a 20W system able to provide enough electricity to light two rooms and charge one mobile phone a day. The biggest is 200W which can power multiple lights, a stereo, a laptop/TV and even an efficient refrigerator. The solar system is completed with several LED light bulbs, a portable torch, a mobile phone charger, BOS-components (balance of system) such as wiring and switches and an inverter to also allow the use of appliances running on AC (alternating current). The function of the system is to provide light and electricity to supply household and small business

Appliances
Unlike other SHS on the market, the Mobisol SHS may be purchased together with a sound service package. On the one hand, customers do not have to pay for the system upfront but pay it off as they use it over a period of 3 years.

Additionally, technical services, consisting of free maintenance and repair throughout the same period ensures the usability of the system.

Mobisol, Plug in the world

Phaesun, Rural Electrification with Plan Ethiopia

Since commencing operations, the Mobisol product has been developed and pilot programs are currently in progress in Tanzania and Kenya. In October 2011 the first systems were installed. In total, 200 systems have been installed in Tanzania and Kenya to date.

The successful pilot phase has been designed to test and demonstrate the capabilities of the Mobisol Solar Home Systems. The pilot has demonstrated the viability of the business case and the acceptance of the M-Pesa billing system by the user whilst allowing technical refinement of the design. The installed systems are sending real time data, allowing local technicians to observe the performance of the solar panel and battery.

The payments made by customers are recorded on the database, allowing the systems to be locked and unlocked based on the payment amount. This first pilot phase was run to collect as much feedback from the customers as possible, to adapt the technical part of the Mobisol product.

The second pilot phase starting in September 2012 will be focusing on building up supply chains directly from the producers but as well will experiment with different ways of distribution channels. The goal of the second pilot phase is to understand and optimize the supply chain, finding the right financial structure for the micro-finance (down payment/instalments) and develop a distribution network for the implementation of a several thousand systems in 2013.

The first pilot phase took place in Tanzania and Kenya with the aim of collecting data and learning from two similar but different countries. The second pilot phase will concentrate on the Arusha region with 800 systems installed until end of 2012, for the Nakuro region another 200 installations are planned.

They will celebrate the 1000th system installation in December 2012.

Phaesun

Rural Electrification with Plan Ethiopia

Plan International works in the field of Rural Electrification in Ethiopia and has a holistic approach including the development of local infrastructure, the set-up includes educational institutions such as schools and training centres and health stations, as well as capacity building. As part of their activities they provide solar off-grid power supply to public institutions. Phaesun in cooperation with the local partner Lydetco PLC provided the equipment and installed the systems.

Photovoltaic technology was selected as the only viable energy source for several reasons. The national electricity grid does not reach many rural areas. The use of diesel generators is not encouraged owing to the scarcity of fuel, noise factor, environmental problems and high price of transport of the fuel to far flung remote sites. Additionally the operation and maintenance cost of generator sets is problematic.

Special challenges
The challenge to successfully implement these systems was mainly the remoteness of the sites. Transportation of the equipment and installation crews was a challenge but was safely and efficiently carried out by local partner Lydetco PLC.

Location
7 sites in Shebedino District, Southern Region, Ethiopia

System components
- 94 x Istar Solar Module Istar 100W
- 82 x Hoppecke power.bloc Battery 12V/100 Ah (C10)
- 5 x Solar Charge Controller Outback FLEXmax FM 60
- 6 x Solar Charge Controller Steca Tarom 245
- 12 x Inverter Steca Solarix PI1100
- 293 x Energy Saving Lamp 13 W with Sundaya Lamp Shade
- 64 x Energy Saving Lamp 9 W with Sundaya Lamp Shade cabling, mounting structure and accessories.

PV BALANCE OF SYSTEM AWARD

ARRAY POWER

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.

Array, Sequenced Inverter™

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 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.

Esmolo

MPS ProtectionBox™

Esmolo Ltd, the Swiss based company has solved one of the most discussed problems of the photovoltaic industry and reacts to the urgent demand of fire fighting associations around the world. Esmolo MPS ProtectionBox™ Esmolo Ltd. brings a new generation of intelligent junction boxes to protect photovoltaic modules. The extensive Esmolo Module Protection System (MPS) protects photovoltaic modules against fire, overvoltage and lightning and against theft.

In case of fire, photovoltaic installations continue to produce dangerous voltage levels and can not be shut down easily. This is a danger for owners and fire fighters in case of fire.

After different accidents involving fire fighters, the German Firefighting Association (DFV) urged the photovoltaic

industry to offer technical solutions for safe fire fighting.

Esmolo Module Protection System (MPS) is an innovative electronic protection system for pv modules offering a solution to the problem of the life-threatening electric shocks fire fighters could be exposed to.

Compared to other solutions of different providers, Esmolo Module Protection System (MPS) does not cut the connection between modules and inverter – whereby parts of the installation still continue to produce dangerous voltage – the module itself is short-circuited. Furthermore the system does not need to be switched off manually, it works automatically and inverter independent on the module-level – and therefore much more effective.

The electronics of the Esmolo Module Protection System (MPS) is embedded in the junction box of the photovoltaic module and thanks to sensors; the system identifies itself if a fire occurs. In this case the module will be immediately short-circuited and other modules of the installation will be informed by radio signal without any delay. By transmitting the signal to the other modules, the whole installation is shut down immediately – like in a domino effect. In addition the shutdown procedure can also be activated manually by pressing an emergency button.

Overvoltage and lightning protection
In addition to fire protection, Esmolo Module Protection System (MPS) also offers the protection of bypass diodes and cells in case of overvoltage and lightning.

According to test results the system was still working properly after induced peak currents even up to 720A at a peak lightning current at 44kA. Without Esmolo Module Protection System (MPS) such levels would definitively damage the module.

Protection against theft
Another increasing problem is theft of photovoltaic modules. Because a stolen photovoltaic module equipped with Esmolo Module Protection System (MPS) cannot be reused in a new place of installation, it becomes unusable and therefore useless for a thief. A reactivation can only be done by the owner of the module.

According to Esmolo, 50% of all potential damages can be avoided by equipping modules with Esmolo Module Protection System (MPS). As 50% of all damages are caused by fire, overvoltage, lightning and theft, all these damages could be avoided by a simple and economic protection system and there with protect the investment of the installation as well as the involved persons.

SolarBridge Pantheon™ microinverter

SolarBridge

SolarBridge Pantheon™ 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 PantheonTM 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 a 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. The SolarBridge PantheonTM microinverter makes this possible. Featuring a highly reliable patented architecture the Pantheon arrives at a job site already installed on every PV module. Combined with 24/7 module-level monitoring and a web-based management system the SolarBridge AC Module System is a reliable solution on the market.

INDUSTRY DEVELOPMENT AWARD

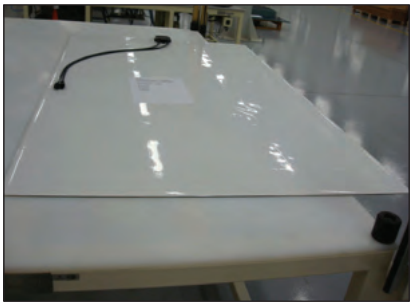
Dunmore Corporation

SmoothStart

Dunmore Corporation’s SmoothStart program is an engineering service offered by the company through purchases of Dunmore high-performance engineered film / foil products. The program places one of Dunmore engineers on the

customer's production floor at no additional cost. The Dunmore engineer supplements the customer's in-house engineering expertise, contributing knowledge and experience to help negotiate complicated production issues in industries such as solar photovoltaics.

The SmoothStart program will provide customers with on-site expertise based on Dunmore decades of experience incorporating its products into lamination recipes in industries such as solar pv. Dunmore engineers will use this knowledge to help customers start their production runs sooner and significantly reduce material waste.



In some cases, such as photovoltaic backsheet production, it's not just the material that's important but how you put it together. Having an engineer on site to launch a new production run with Dunmore material can reduce material waste by tens of thousands of dollars and make necessary adjustments to lamination recipes in days instead of weeks.

SmoothStart is Dunmore most recent initiative to help customers integrate products Dunmore into their manufacturing processes with minimal cost and interruption. Most companies include basic consulting with their products - advice on temperature and pressure, for example - but typically having an engineer on site would cost the customer extra. Dunmore is looking to create relationships with their customers' engineers so they get the full value from using the company's products.

Locus Energy LLC

Virtual Irradiance

Virtual Irradiance provides highly accurate solar irradiance data in real-time without the need for expensive on-site hardware. Data is available in 30-minute intervals at a 1 km resolution throughout continental North America and the

In order to fully understand the performance of a solar power project it is necessary to collect information on the amount of solar irradiance that was available to the project. Larger solar power systems often collect irradiance data in the field using costly specialized instrumentation such as a pyranometer or reference cell.

These irradiance measurement devices are expensive and are often cost prohibitive to deploy for residential or light commercial systems.

As with any physical hardware these sensors can break or experience downtime and require maintenance to remain properly calibrated. Wide-scale deployments of hardware magnify the problems and costs mentioned. Virtual Irradiance alleviates the need for physical instrumentation to measure solar irradiance at residential or light commercial sites and compliments the physical sensor data at larger sites by providing high-accuracy solar irradiance estimates remotely. Virtual Irradiance estimates solar irradiance in real-time at a 30-minute time interval.

Leveraging Locus Energy's archives of solar production and environmental conditions data Virtual Irradiance can retroactively create a historical record of solar irradiance estimates.

SMA SOLAR TECHNOLOGY

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

SMA Solar have launched their first end-user marketing campaign in the UK. The photovoltaic market has changed dramatically in the UK over the past five years and with the ever changing 'feed-in tariffs' so has end-user perceptions. SMA has developed a series of cross-media initiatives with the overall aim to raise public awareness of the importance of photovoltaic technology and the role of the inverter plus dispel the myths surrounding renewable solar energy and the feed-in tariff.

SMA identified that when it comes to solar energy most householders focus their attention on choosing the panels however it is the quality and efficiency of the inverter that determines how much energy is produced. So whether householders are looking to mitigate the impact of climate change or reduce the cost of their energy bills choosing the right inverter is crucial if they want a high performing system. That is why SMA Solar UK created Life Shines Brighter - a simple concept built on the premise that with more electricity to use and sell householders can enjoy the things in life that really matter.

What, exactly, is novel about the product / process or innovation?
Firstly a unique integrated campaign that educates the householder into the benefits of PV as a lifestyle choice and sound investment in today's sceptical and uncertain market. When we researched the available communications to end users there was no component manufacturer communication directly to end users purely just to distributors and wholesalers.

Therefore the main messages were cost points and technical jargon which completely switched off the end user homeowner. We recognised a need to educate the benefits of a PV lifestyle and worked with a specialist agency to develop a campaign targeted to educating and providing tools that allowed homeowners to discuss a PV system with an installer and help make the best educated choice.

The tone of voice is removed from technical language allowing the end user to discover the benefits and what to look for in choosing the best performing system regardless of cost or price. We believe this is unique in the inverter category and in the UK as a manufacturer of system components.

SMA UK has also made the unique step of entering B2C marketing and advertising rather than the traditional B2B standard approach that exists in the UK market today. We have backed this up by providing sales tools to the smaller installer so they can use the communications and tools to aid their selling approach to end users.

Tigo Energy

Anti-Theft System Enabled by the PV-Sentry Device

Tigo Energy's Anti-Theft system is a theft prevention and monitoring device for solar arrays integrated in to their industry leading solar optimization suite. In addition to the benefits of an optimizer alerts will be sent out to first responders the moment a circuit is tampered with on an array and the owner will be notified the system can also trigger lights and alarms onsite. In Tigo Energy's integrated Smart Module designs (with leading panel manufacturers the module goes into lockdown mode when removed from the site and cannot be activated without a specific code from the owner. This theft prevention is a critical component in large-scale ground arrays as PV burglary is becoming an increasingly large trend around the globe.

This product addresses the widespread issue of PV theft in residential commercial and utility solar installations. We need to protect the value of solar installations to continue generating renewable energy.

According to a recent study by US specialist insurer SolarInsure the past few years has seen a significant increase in solar panel robbery. Solar thefts grew by 15% in 2009 compared with the previous year and some believe that figure has risen by 15% each year since 2002.

Tigo Energy offers an anti-theft system that features PV-Sentry which constantly monitors an array to ensure line continuity. If a circuit is broken the system immediately sends an alert to first responders. When paired with smart modules this system prevents the module from being used anywhere else if it's been stolen.

Tigo Energy has built security functions into its solar system management software that can send alerts to solar system owners when a panel is disconnected. Tigo Energy is the first to integrate anti-theft capabilities into solar optimization technology.

A chip embedded in the panel communicates wirelessly with a central monitoring unit. If this communication is interrupted the panel is automatically deactivated and the system sends out alerts. The deactivated panel cannot be brought online in another location without a special security code.

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.

MODULE MANUFACTURING INNOVATION AWARD

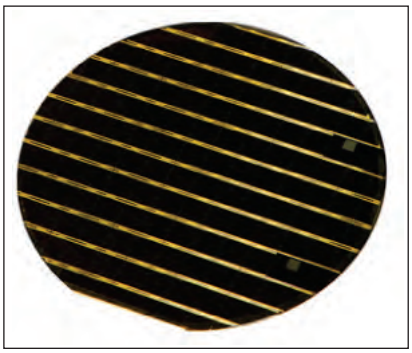
Solar Junction

SJ 3 Cell

Many multi-junction solar cell technologies are lattice mismatched and therefore have defects within the cell. Additional material is used to try and buffer the defects which results in stunted

efficiency gains and reliability issues. Solar Junction's technology is lattice matched resulting in higher performance yield reliability and lower cost.

Solar Junction has successfully produced III-V multi-junction solar cells using dilute nitrides reaching high-efficiencies. The material substrates used by the company allows for a tunable and lattice-matched structure that has not been obtained by others.



Solar Junction's cells incorporate the company's proprietary adjustable spectrum lattice-matched A-SLAM™ technology which enables the company to more optimally partition the solar spectrum. This enables bandgap tunability over the solar spectrum to maximize the absorbed sunlight within the CPV modules while enabling lattice-matched pathway to solar cell efficiencies beyond 50% within the decade.

This technology leads to maximum efficiency and greater reliability. It is a sustainable technology that leads to a roadmap of continual efficiency gains and innovation without changing the fundamental structure of the cell which is not true for other multi-junction solar cell providers.

Solar Junction breaks with multi-junction innovations by continuing on a lattice-matched path leading to higher efficiencies and higher reliability. The cell structure maintains pure while other companies are using innovations that use different processes that do not maintain a lattice-matched structure.

Solar Junction standard cell achieved 40.9% efficiency in January 2011 which was tested and verified by the National Energy Laboratory (NREL. The cells submitted where standard design production cells and manufactured entirely in-house on its production line in San Jose. CA. February 2011 Solar Junction reached a 41.4% efficiency on a production cell again validated by NREL.

The cell submitted for testing was also a standard commercial-ready production cell. It is significant because it was not a champion cell gain but a product that could be introduced straight into a customer's line. In April 2011 Solar Junction broke the World Record in cell efficiency.

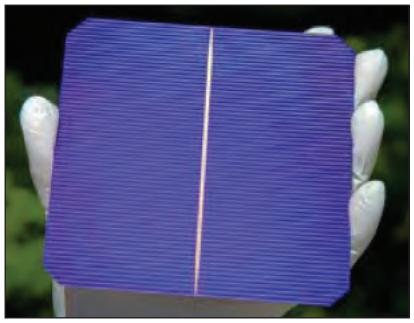
At 43.5% efficiency Solar Junction has retained the world record for the past year and continues to strive to make additional technology improvements to reach higher efficiency percentages. The cell tested by NREL was once again a standard 5.5mm x 5.5mm production cell.

Silevo, Inc.

Triex™ Solar Technology

Silevo, Inc., a solar cell innovator and photovoltaic solar module manufacturer, was founded by leading executives and engineers from the semiconductor industry.

The Silevo proprietary Triex™ technology 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 tunnelling oxide layer – all in a single solar module. Powered by breakthrough "tunnelling junction" architecture, these three materials together enable the Triex module to deliver high efficiency, competitive module costs, and optimal energy harvest.



Triex's "silver free" technology also eliminates the use of costly silver pastes that traditional c-Si device manufacturers rely on for electrodes – typically the second highest priced material in a module after silicon itself.

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. Silevo is currently producing modules in pilot production, manufacturing Triex cells that demonstrate between 20 – 21 percent conversion efficiency on full-size substrates with proven production materials.

The Triex technology roadmap shows headroom for up to 24 percent conversion efficiency in commercial products. As well, Triex yields cell temperature coefficients of -0.22%/C, which will enable thin film module like energy harvest in real world service environments.

Suntech Power International Ltd

HiPerforma™

Suntech's HiPerforma 245 watt module utilizes the company's Pluto cell processing technology, which features a proprietary metalization process for shading reduction on cell surfaces, allowing the cells to absorb more electricity.

Suntech says that its 60-cell HiPerforma multicrystalline module offers 2% to 5% more power per watt peak over time, due to superior spectral response and high shunt resistance.

Suntech's Pluto technology, which is used in the HiPerforma multicrystalline module, features a front surface metalization process that creates grid contacts thinner than 30 microns wide, and is made from copper instead of silver.

Suntech believes that this reduces shading on the cell surface, allowing the cells to absorb more sunlight, and claims that this improves cell performance by 10% compared to traditional screen-printed PV cells.

Westinghouse Solar

INSTANT CONNECT™ Solar Panels

INSTANT CONNECT™ Solar Modules - from Westinghouse Solar makes installing solar power systems faster and easier. Building on the Westinghouse Solar legacy of innovation, including the industry's first grooved solar panel frame, first integrated racking, wiring and integrated grounding solution, and the first fully integrated UL approved AC solar panel, INSTANT CONNECT™ technology delivers the world's first fully integrated "Plug-and-Play" AC & DC solar panels.

With panel prices declining to historic lows, the unfortunate reality is Balance of System and labour costs have grown from 30% back in 2001 to nearly half the system cost in today's market. As a result, installers profit has been significantly reduced and the practice of designing and installing a solar power system has remained relative unchanged for decades. The opportunity to lower BOS costs and restore margins removes much of the resistance that factors into today's rate of PV marketing penetration.

Westinghouse Solar's INSTANT CONNECT™ is the first product to change the way solar in designed and installed. By integrating the racking, wiring grounding and inveduct to change the way solar in designed and installed. By integrating the racking, wiring grounding and inverter directly into each panel, INSTANT CONNECT™ eliminates 80% of the har By integrating the racking, wiring grounding and inverter directly into each panel, INSTANT CONNECT™ eliminates 80% of the hardware required to design and install a solar power system and reduces the amount of installation labour by 50%, helping to restore profit margins for installers.

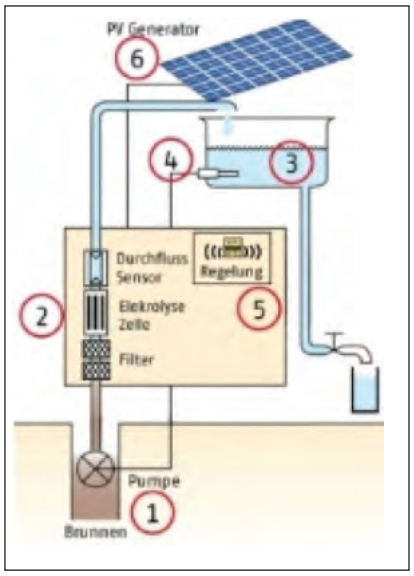
RURAL ELECTRIFICATION DEVELOPMENT AWARD

AUTARCON GmbH

Integral solutions for water purification

SuMeWa|SYSTEM offers a solution for the decentralized drinking water treatment. Within a matter of minutes the systems are ready to pump, treat and safely disinfect microbial contaminated fresh water.

How it works
The functional principle of SuMeWa|COMPLETE, a stand-alone-solution for decentralized drinking water treatment, is described in the following:
Freshwater is lifted with a submersible pump from depths of up to 70 m.
After the filtration process, chlorine is produced electrolyticall from salts that occur naturally in the water.



In the reservoir the disinfected water is safely stored. From here it can be tapped or distributed via a central piping network. The water quality is continuously monitored.

Depending on the water quality the control unit adapts the disinfection process and sends all operational parameters online for remote control. Due to the included solar photovoltaic modules SuMeWa|COMPLETE works energetically self-sufficient and is independent of any infrastructure. Batteries are not required.

Phaesun

Pico PV Systems: Mozambique School Project

A PicoPV system is defined as a small PV-system with a power output of 1 to 10W, mainly used for lighting and thus able to replace unhealthy and inefficient sources such as kerosene lamps and candles. Depending on the model, small ICT applications (e.g. mobile phone charger, radio) can also be added. PicoPV systems are powered by a small solar panel and use a battery which can be integrated in the lamp itself.

PicoPV systems offer a wide range of advantages: easy installation (Plug & Play), user-friendly application, low investment costs, little maintenance required, high degree of expandability and flexible use.

The prices are generally within the payment capacity of most rural people in developing countries.

Mozambique School Project
Project description
The goal of the project was to provide a reliable lighting solution for the school of Pessene. Therefore a set of PicoPV systems (Ulitium Lightkits) of the manufacturer Sundaya were installed at the school house to provide light for evening classes and for the directors office.

Additional Lightkits were installed at the neighbouring houses which accommodate the teachers.
The standard Ulitium 200 Lightkit is an energy-efficient lighting installation designed for one room, it consists of a solar panel and an LED-lamp with integrated battery that are directly connected by a hub box with bayonet plugs.

Due to the simple plug and play technology the systems can be easily extended and several Lightkits can be combined to provide a lighting solution for an entire house.

Why was PV selected?
Although the village of Pessene is located less than 50 kilometres away from the Mozambican capitol Maputo, the national electricity grid does not cover the area. For lighting purposes petrol lanterns and candles are normally used.

Due to the efficient LED lights of the Ulitium lamps, the small stand alone photovoltaic systems provide a unique comfortable solution to light small private rooms as well as large classrooms. The Ulitium systems are easy to operate and do not require continuous maintenance. The use of PV is quite unknown in rural Mozambique.

Due to the simple features and the low maintenance needs, the Ulitium Lightkits are best suitable for lighting purposes in rural areas.

The battery pack and the management electronics are housed inside each Ulitium lamp, thus a centralized controller and battery which need tedious maintenance is not necessary.

The Ulitium lamps are leading as far as illumination and energy efficiency are concerned. The Ulitium 200 lamp has an illumination of 240 lumen with a nominal power of 1,8W. This means a lumen efficiency of 133 Lm/W.

Steca Elektronik GmbH

Steca PF 166 and Steca PF 240: Solar refrigerator/freezer

The Steca PF 166 and Steca PF 240 are efficient DC energy-saving refrigerators. They can be used as either a refrigerator or a freezer. The Steca PF 166 and Steca PF 240 are fully programmable. The inside temperature and each of the other configuration values can be set by the user. They are therefore perfectly suited for all DC applications including even the refrigeration of medicines in hospitals.

Thanks to the latest A+++ energy efficiency class, together with optimal electronic control and an RPM control of the compressor, it is possible to ensure that the energy is used extremely efficiently. This leads to significant cost reductions.

This product stands out for its user-friendliness, thanks to a large digital display with setting options, the highest standards of quality and reliability and a long service life.

The refrigerator or freezer is easy to clean as it has a sealing plug on the bottom for draining water. This maintenance-free appliance can work with an input voltage of either 12 V or 24 V.

Product features
- A+++ energy efficiency class
- Fast cooling due to compressor speed control
- Freezer runs on a 70 W photovoltaic module in most climates
- Automatic detection of voltage
- Temperature fully programmable
- Adjustable refrigerator or freezer function
- Suitable for all DC applications
- Low maintenance and easy to clean
- Lock with two keys
- Suitable for mobile use
- Auto-dimming for reduction of own consumption.

inter solar

connecting solar business | INDIA

November 6–8, 2012

India's Largest Exhibition
and Conference for the Solar Industry
Bombay Exhibition Centre, Mumbai

350 Exhibitors
20,000 sqm Exhibition Space
10,000 Visitors

www.intersolar.in

A new roadmap for space solar cells

Today's conventional triple-junction cells seem to offer little room for improvement, with average production efficiencies hovering just below 30 percent. But this can be increased by ten percentage points with a switch to six junction cells incorporating two dilute nitride layers, say Simone Missirian, Jeff Allen, Vijit Sabnis and Homan Yuen from Solar Junction.

Growth of the terrestrial solar industry hinges on reductions in energy costs. One way to do this is to manufacture cells that are more efficient than their predecessors, but cost no more to make. This can either boost the power produced by a solar power system of a given price – or allow a smaller, cheaper-to-build system to generate the equivalent power of its forerunners.

At Solar Junction, headquartered in San Jose, California, we have increased the efficiency of triple-junction cells for concentrating photovoltaic (CPV) systems, which are designed to track the position of the sun across the sky and focus sunlight on cells with mirrors or lenses. Our cells feature high-quality InGaAsNSb junctions, and can deliver an record-breaking efficiency of 43.5 percent at 925 suns (figures that have been verified the National Renewable Energy Laboratory). This new benchmark for photovoltaic performance is the result of our novel materials technology, which we call A-SLAM (adjustable spectrum lattice matched). It will achieve far more than just netting an efficiency record efficiency benchmark – it is already the foundation for a flexible multi-generational roadmap to reach 50 percent conversion efficiency and beyond.

The core technology that we have developed can also bring a new level of efficiency to solar cells deployed on commercial and military satellites. We are adapting our technology to address these markets, which place a premium on high efficiency and high reliability.

Today's satellite market

The vast majority of satellites launched today are powered by triple-junction solar cells with average efficiencies of just below 30 percent. These feature three junctions, connected in series, with progressively narrower bandgaps from the top to the bottom junction.

This arrangement – traditionally a germanium bottom junction, and middle and top cells made from InGaAs and InGaP, respectively (see Figure 1) – divides the solar spectrum, making good use of the available energy by increasing the voltage delivered by the solar cell, and significantly improving the efficiency when compared to a single junction solar cell. Increasing the efficiency of solar cells for space applications is quite beneficial, as it enables higher power production and ultimately allows the satellite manufacturer to make a number of favourable economic trade-offs. For instance, higher efficiency solar cells allow the use of a smaller, lower-mass solar array to meet a given power requirement.

The cost to launch a satellite is of the order of $10,000 per pound, so this reduction in solar array mass leads to a significantly lower launch cost. Alternatively, higher efficiency cells can generate more power and enable the satellite to carry a higher-value payload, such as a greater number of transponders. This leads to a higher revenue stream for the satellite operator and improved return-on-investement for the asset. Unfortunately, the traditional architecture of space cells

CSS-jobs.net

Dedicated exclusively to compound semiconductor, silicon semiconductor and solar recruitment

To find the right professionals with the training and experience tailored to your industry can be difficult

To be the market leader you need the best people working for you

By using CSS-Jobs.net you can reach 100,000 industry professionals globally

Find your new recruit today from the lab to the fab to the boardroom through **CSS-Jobs.net**

E: info@css-jobs.net
W: www.css-jobs.net

Supported by

CS COMPOUND SEMICONDUCTOR · 化合物半导体 CS COMPOUND SEMICONDUCTOR · CHINA · 化合物半導體 CS COMPOUND SEMICONDUCTOR · TAIWAN · solar international · solar UK · 太阳能国际 solar China · CSS jobs.net

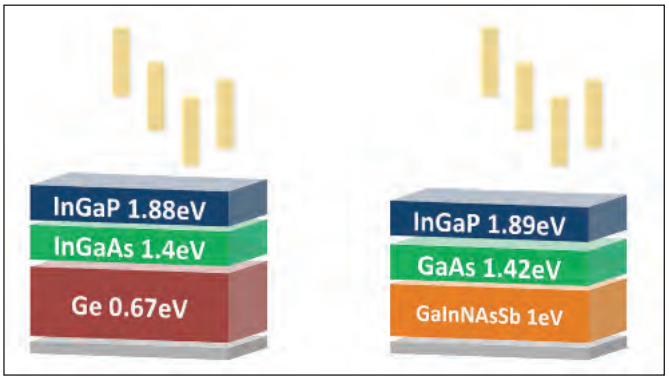


Figure 1. Conventional triple junction cells (left) have a germanium bottom junction, an InGaAs middle junction and a InGaP top junction. Solar Junction's triple-junction cells (right) replace the germanium cell with one built from GaInNAsSb

(the combination of InGaP, GaAs and germanium) has reached technological maturity, and during the last few years conversion efficiencies have stagnated at the 28.5-29.5 percent level. A new materials system is required to meet the ever-increasing power requirements of next generation satellites and resume the historical rate of progress – an annual increase in absolute efficiency of about 1 percent.

Dilute nitrides

The superior efficiencies of our cells stem from the switch from a germanium junction to one built from InGaAsNSb (see Figure 1 b). This increases the bandgap of the low energy cell from 0.67 eV to 1.0 eV and leads to a greater energy harvest of incoming photons. Higher efficiency results from an increase in output voltage while maintaining adequate current through the junction. Building a bottom junction from a dilute nitride subcell is not a new idea. Throughout the previous decade numerous research institutes and commercial entities tried to do just this, but there were never able to grow dilute nitride junctions with sufficient material quality for high-performance photovoltaics. These failures drove the industry to abandon dilute nitrides in favour of the inverted metamorphic (IMM) approach.

The IMM has showed promise in terms of efficiency improvements, however, that is only one part of what makes a technology attractive for space. Unlike CPV, lower system costs are achieved with large area cells, and the cells must also withstand exposure to ionizing radiation without suffering catastrophic loss in performance. What the space market does share with the CPV industry is sensitivity to cost and low tolerance for technology risk. This presents several challenges for IMM technology; it is tricky to produce, involving the growth of epitaxial layers in reverse order, incorporation of thick strain-relief layers, and epitaxial lift-off and wafer bonding to realize the 1eV subcell. This complex fabrication adds significantly to manufacturing costs, and the space industry is concerned over the use of lattice-mismatched materials that may exhibit accelerated degradation under the extreme thermal stress environments in space. Solar arrays on commercial satellites can experience temperatures below –170°C and as high as 100°C for thousands of cycles. What's more, there are complications associated with integrating the cell into industry standard solar arrays, and this creates a large and potentially unacceptable risk for the space power market.

We have succeeded where so many others have failed, thanks to a breakthrough in materials technology. This has resulted from exploiting the advantages of MBE, combined with proprietary hardware modifications and process IP. Our efforts at developing processes to grow high-quality InGaAsNSb have borne much fruit – this dilute nitride is truly a remarkable material. When properly grown, it possesses a continuously variable bandgap ranging from 0.8 eV to 1.4 eV while remaining lattice matched to the materials above and below. Lattice matching is an incredibly important attribute for cells targeting the space environment.

This industry is very conservative, with long duration on-orbit performance of deployed cells used as the ultimate assessment for reliability. As of today, all radiation-hard multi-junction solar cells that power spacecraft are lattice matched. The variable bandgap of InGaAsNSb enables the design of a device with up to six junctions, including two from different compositions of dilute nitride.

Extending the number of subcells increases the device's overall efficiency, and has enabled us to put together a re-defined and realistic multi-generational technology roadmap working towards higher and higher efficiencies for cells designed for use in space (the AM0 spectrum).

Optimising for powering satellites

Manufacturers of solar arrays for satellites use large area cells that are 26 cm^2 to 30 cm^2 in size, which are shaped in a manner that maximizes wafer utilization while maintaining the highest cell efficiency (see Figure 2). These cells have a relatively large active area, and in order to combine acceptable yields with competitive costs, manufacturers must use very well controlled production techniques that deliver incredibly low defect densities. If there is one single catastrophic defect present on

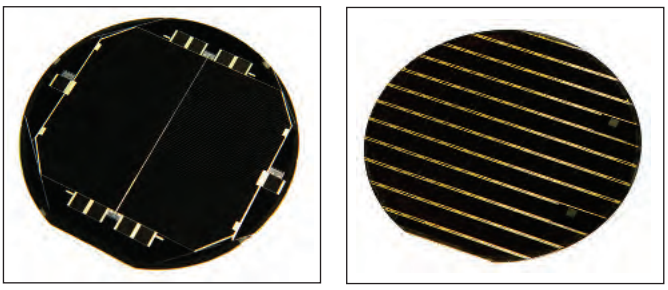


Figure 2. Solar Junction's wafers processed with CPV cells have an area of 0.7 cm^2, far less than that of space cells, which are 24 cm^2 in size. The CPV wafer has approximately 100 cells while the space configuration has only two cells per wafer (or in some cases, one cell per wafer)

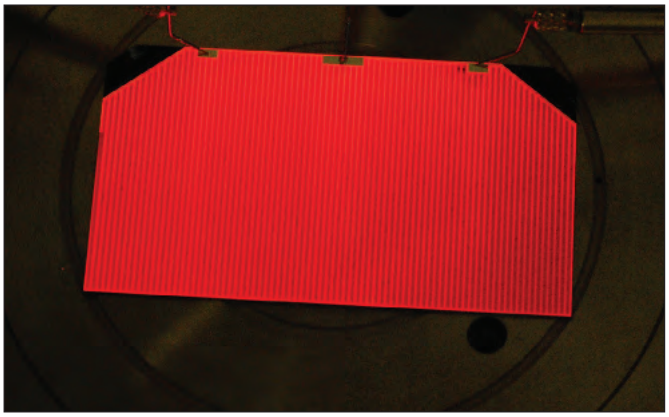


Figure 3. Biasing the top junction so that it produces electroluminescence enables assessments of the uniformity and material quality of this junction

the wafer, due to either epitaxial growth or subsequent processing, the space format will suffer a 50 or 100 percent yield loss, compared to a hit of just 1 percent for the smaller area cell built for concentrating photovoltaic systems.

High quality epitaxial growth is essential for the production of uniform, consistent multi-junction cells. MBE has many strengths when compared to MOCVD, including the ability to produce better layer uniformity, fewer defects, and more abrupt interfaces with lower impurity levels. Biasing one of our 24 cm^2 space cells so that it produces electroluminescence from the top junction highlights the qualities of MBE (see Figure 3). This layer produces highly uniform emission, and there are very few dark spots, which are indicative of shunts in the epitaxial layers.

Our cells have a conversion efficiency of 29-30 percent (AM0 spectrum), and their voltage output is higher than that of the incumbents' present-day production cells, thanks to the higher voltage of the dilute nitride sub-cell (see Figure 4). This plot also highlights opportunities for further cell improvement, such as optimisation of the fill factor, which for the cells produced to date were impaired by a sub-optimum top grid metal design.

To be considered for use on spacecraft, solar cells must demonstrate reliable, high efficiency operation in a space environment. This means that multi-junction stacks must be able to withstand constant exposure to radiation over the 15-year operational life of the satellite. Device degradation in this environment largely results from bombardment by ionizing radiation causing dislocations in the lattice structure.

Designers of solar arrays account for this degradation by using thicker radiation shields and adding more cells to the array, increasing both weight and cost of the satellite. This is required to ensure the array can deliver enough power to operate the payload and bus subsystems through the entire operating life of the satellite. What these designers are looking for are solar cells that not only exhibit a high initial efficiency, but also show a minimal and predictable shift in performance with accumulated radiation exposure. In addition, they want to employ devices that still deliver high power at the end of 15 years on orbit. Any solar cell technology that exhibits rapid performance loss when exposed to a high radiation environment is simply unacceptable. Extensive testing reveals that our cells exhibit excellent tolerance to high radiation exposure. They appear to perform as well as those of commercially available triple-junction solar cells from Boeing-Spectrolab and Emcore Corporation under bombardment from doses of radiation commonly used to evaluate solar cells destined for spacecraft use (see Figure 5). This exposure exceeds the damage expected from 15 years of operation in a geostationary orbit.

These results demonstrate that the radiation performance of our dilute-nitride-containing solar cells is more than sufficient for long-term operation in the harsh environment of space. In addition, they reveal that at the lower fluence, our device retains more of its initial power than that of the incumbent's solar cells. We are now pursing several low risk pathways to optimize the radiation performance of our cell.

Our expectation is that the normalized remaining power factor will quickly improve to in excess of 85 percent when exposed to the equivalent fluence of a 15-year geostationary orbit mission. Hitting this goal will make our technology far superior to any other high efficiency approach.

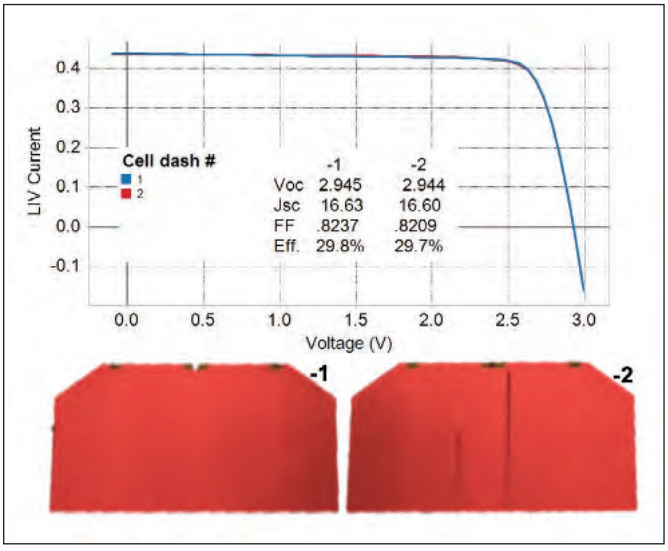


Figure 4. Current-voltage sweeps for two Solar Junction 24 cm^2 cells fabricated on the same wafer reveal the improvement in voltage afforded by the dilute nitride subcell. This pair of novel triple-junction cells have an open circuit voltage of 2.85 V, approximately 200 mV higher than that of present day space cells. The current-voltage plots for the two cells are virtually indistinguishable, illustrating the high degree of intra-wafer uniformity achieved in the epitaxial growth and cell processing. Electroluminescence images also reveal the high degree of uniformity within the cells, and from cell to cell

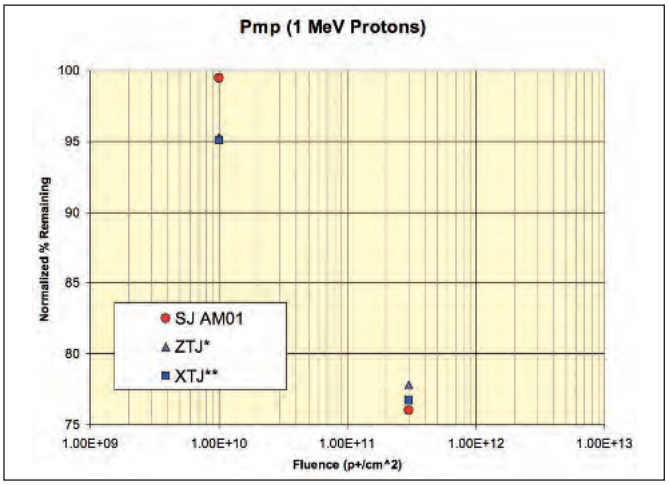


Figure 5. Results for cells from Solar Junction (SJ AM01), Boeing-Spectrolab (XTJ) and Emcore Corporation (ZTJ) under exposure to proton radiation at 1MeV energy and several fluences, the highest being $3x10^{11}$ p+/cm^2 (note that the data for Emcore and Boeing Spectrolab is taken from published radiation performance for commercially available triple junction solar cells). Exposure to the cells is more than the equivalent damage expected from 15 years of operation in a geostationary orbit. The normalized remaining power factor for an early development-stage, dilute-nitride-containing solar cell that is not fully optimized for radiation exposure is measured at 76 percent after an exposure of $3x10^{11}cm^{-2}$, and is equivalent to the best available technology in the market

Pathways to higher efficiency

It has taken us little more than a year to produce cells that deliver an equivalent performance to the products of leading triple-junction suppliers. This rapid, tremendous progress stems from the incorporation of a high quality 1eV subcell, which we expect to soon enable an average production efficiency of 32 percent (AM0) for the InGaP/GaAs/InGaAsNSb device. Although impressive, this superior triple junction is just the beginning of what is possible with our dilute nitride technology. We have developed a roadmap that will enable sustained performance improvement by incorporating additional subcells into the lattice-matched architecture. This will ultimately lead to a six-junction configuration with anticipated AM0 efficiency of over 40 percent.

All of the steps required to go from a triple-junction cell to a six-junction variant are relatively simple and straightforward (see Figure 6 for an overview). They begin by building the existing design on a germanium substrate with an active 0.67eV subcell. This active junction, which will be similar to those presently used in commercially available triple-junction products, will increase the voltage produced by the solar cell and propel efficiency to the 35-36 percent range. One tremendously attractive feature of this particular design is that it is a drop-in replacement (equivalent form, fit and function) for today's 29 percent efficient triple-junction cells. This will be our 'go to market' product for the space segment

Our five-junction design involves the addition of aluminium to the InGaAs subcell to shift the bandgap slightly, plus a switch from one dilute nitride junction to two – the 0.99 eV junction used in the four-junction cell is replaced by two with energy gaps of 0.93 eV and 1.18 eV. Forming these should be very straightforward, because today we regularly grow photovoltaic-quality. InGaAsNSb materials with bandgaps from 0.88 eV through 1.4 eV. The final node of this roadmap focuses on the addition of a higher bandgap top cell, alongside adjustments to the bandgap of several others to optimise overall performance. This enables proper allocation of the spectrum throughout the device.

Modifications include the incorporation of aluminium in the top two junctions to enable better harvesting of the high-energy portion of the solar spectrum. This should enable cells for space to hit 40 percent, an efficiency milestone for the photovoltaic industry that will equip satellites with more power and allow them to carry out more tasks than they do today.

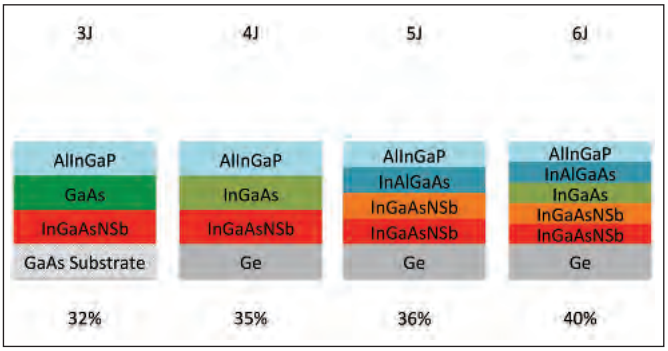


Figure 6. Solar Junction has a roadmap that promises to propel cell efficiency to 40 percent through the addition of extra junctions

Further reading
M. Green et al. Prog. Photovoltaics 19 568 (2011)
Ptak et al., J. Vac. Sci. Technol. B, 955 (2007)
Kurtz et al. Appl. Physics Lett. 400 (2000)
King et al . Proceedings of International Conference on Solar Concentrators for the Generation of Electricity or Hydrogen (2005)
Geisz et al. Appl. Phys. Lett. 023502 (2007)
King et al. Prog. Photovoltaics (2011) (proceedings of 26th EU PVSEC)
Cornfeld et al. Proceedings of 2010 IEEE PVSC,
Boeing-Spectrolab XTJ datasheet, http://www.spectrolab.com/DataSheets/cells/PV%20XTJ%20Cell%205-20-10.pdf

Earth abundant record efficiencies

IBM has set a world record for photovoltaic energy conversion efficiency with earth-abundant materials. Teodor Todorov and David Mitzi of IBM Research photovoltaic scientists outline the results.

Energy from the sun reaching the earth's surface amounts to several thousand times our global consumption of electricity. Yet electricity from photovoltaic (PV) solar cells currently contributes significantly less than one percent of worldwide production. Of the numerous existing PV technologies, none so far have combined the virtues of being highly efficient, cheaply scalable and made with abundantly available materials.

IBM's Materials Science team has partnered with Solar Frontier, Tokyo Ohka Kogyo (TOK) and DelSolar to develop an efficient and affordable PV cell made of abundant natural materials. So far, the tests of our Cu2ZnSn(S,Se)4 (made of readily available copper, zinc, and tin, and referred to as CZTS) thin-film devices have achieved a world-record PV solar-to-electric power conversion efficiency of 11.1 percent (10 percent better than any previous reports) for this class of semiconductors. And it can be manufactured by simple ink-based techniques such as printing or casting.

What makes CZTS better

Currently, the most widespread PV semiconductors, made of crystalline silicon, are abundant and highly efficient. They're in panels used for everything from home electricity to the International Space Station. However, they have extremely high material purity requirements (>99.9999 percent!), and the wafers are typically cut from large solid ingots and wired in series to form PV modules – making it expensive and difficult to upscale.

Other thin-film chalcogenide materials used in PV cells, such as Cu(In,Ga)(SSe)2 (CIGS) and CdTe, have been developed to a performance level close to that of silicon, with inherently more scalable processing. They are directly deposited on large-area, low-cost substrates such as glass, metal or plastic foil. While CIGS and CdTe are easy to integrate into buildings and consumer products, their compounds contain rare and expensive elements that increase cost and limit their manufacturing levels to less than 100 Gigawatts per year (worldwide continuous electricity consumption is 15 Terawatts – 150 times greater than the level of what these CIGS can produce).

Our CZTS PV cells could potentially yield up to 500 GW/year – getting closer to the Terawatt levels of renewable electricity the planet needs.

The focus of our joint-development team remains to further increase this device efficiency and transfer the technology to environmentally-friendly, high-throughput industrial manufacturing. The hope is that within several years this new class of photovoltaic materials will begin to contribute to the wider availability of lower-cost solar electricity.

CS International Conference

Incorporating CS Europe

www.cs-international.net

4th-5th March 2013 Sheraton Frankfurt, Germany

Chaired by

Dr Andrew Nelson, IQE
President and Chief Executive Officer
Conference Chair

Keynote speaker

Dr Wilman Tsai, Intel Corporation
Program Manager of Technology Manufacturing
III-V CMOS for High Performance and Low Power Logic Devices

Featuring

Asif Anwar, Strategy Analytics
Director Strategic Technologies Practice
What is the Future of GaAs Microelectronic Manufacturing

Dr Markus Behet, Dow Corning Corporation
Global Market Segment Manager Power Electronics
Large Diameter SiC and GaN/Si Substrates for Power Electronic Applications

Bryan Bothwell, TriQuint Semiconductor
Strategy and Business Development Manager
Maximizing Gallium Nitride Product Solutions and Foundry Services for Advanced RF Design Success

Michelle Bourke, Oxford Instruments
Senior Product Manager
MEMS – Entering a New Growth Cycle

Daniel Cline, Lux Research Inc
Senior Analyst
WBG Devices Electricity Grid Opportunities

Dr Simon Fafard, Cyrium Technologies Inc
Chief Technical Officer
Novel Solar Cell Technology

Malcolm Harrower, Indium
Sales Manager Europe
An Overview of the CS Building Blocks – Indium, Gallium and Germanium

Dr Schang-jing Hon, Epistar Corporation
Associate Vice President
High-Voltage LED for General Lighting Application

Allan Jaunzens, Evatec
Marketing Manager
Presentation TBC

Dr Rainer Krause, Soitec
Director Smart Cell Incubator Unit
PV Chip Development

Dr Michael Lebby, Translucent Inc
General Manager & Chief Technology Officer
Challenges & Opportunities of Using Epitaxial GaN, GeSn, & Rare Earth Oxides on Large Format Silicon Wafers for Power Electronics, Solar, & Lighting

Platinum Sponsors

AIXTRON

evatec process systems

EVG®

LAYTEC in-situ metrology

OXFORD INSTRUMENTS The Business of Science®

Temescal

YOLE Développement

Bringing together leading Compound Semiconductor industry insiders

Gain a comprehensive overview of the entire compound semiconductor industry-the must attend event for 2013 is the 3rd CS International conference in Germany, at the Sheraton Frankfurt on **4th-5th March 2013.**

Delegates will have the unique opportunity to network with leading industry professionals of the III-V chip making industry, interact with suppliers and industry experts who will deliver the latest research, business models, and insights.

Noriyuki Matsubara, Panasonic Europe
Dry Etching and Photolithography Engineer
Dry Etching Technology for III-V Devices

AJ Nadler, RF Micro Devices *(RFMD)*
General Manager, R&D and Engineering
Gallium Nitride for High Voltage Power Electronics

Pars Mukish, Yole Développement
Market & Technology Analyst
New Trends in LED Industry: A focus on China and GaN-on-Si LEDs

Dr Philippe Roussel, Yole Développement
Business Unit Manager
GaN vs SiC in Power Electronics - Status and Roadmap to 2020

Dr Vijit Sabnis, Solar Junction
Vice President, Technology
Really High Efficiency Triple-Junction Solar Cells

Dr Frank Schulte, Aixtron
Vice President
Presentation TBC

Dr Ertugrul Sönmez, MicroGaN
Director, Business Development
Addressing Emerging Power Market

Dr Elisabeth Steimetz, LayTec AG
Director Marketing and Sales
In-Situ Monitoring - The Key to MOCVD Production Process Control and Yield Enhancement

Gunnar Stolze, Oclaro Inc
VP Global Sales Industrial and Consumer
High Power Lasers

Dr Thomas Uhrmann, EV Group
Business Development Manager
Wafer-Level Packaging of Compound Semiconductor Devices

Gregg Wallace, Temescal
Managing Director
Fundamental E-Beam Coating Collection Efficiency & Paths to Improvement

Professor Tao Wang, Seren Photonics
Scientific Advisor
Improving LED Performance

Dr Tudor Williams, Mesuro Ltd
Senior Systems Engineer
Improving RF Measurements

Dr YiFeng Wu, Transphorm
Vice President, Product Development
Status of Wide Bandgap Power Electronics

Erwin Ysewijn, Azzurro
VP Sales & Marketing
GaN on Si. Large Size High Voltage Wafers showing Superior Electrical Performance and Volume Production Track Record

All speakers and presentations are subject to change

Please visit www.cs-international.net for further information
or register at: www.cs-international.net/registration

Gold Sponsors

CS CLEAN SYSTEMS · DOW CORNING · EAG Evans Analytical Group · IQE · INDIUM CORPORATION · MATERION · RFMD · S3Alliance · Translucent · united monolithic semiconductors

Rural viability

One of the key early drivers for the global solar industry was to ensure electricity was accessible and available to all. The industry has now progressed to focusing more on the stocks and shares part of the economy so many assume working in isolated and rural areas means no profits for companies wanting to participate.
A number of programmes around the world have been providing information and feedback that such claims are nonsensical and for companies wishing to expand their global reach rural electrification is an economically viable business direction whilst saving lives. **Simon Rolland, Secretary General of the Alliance for Rural Electrification** presents a case study from Cape Verde that demonstrates isolation and need does not equal charity.

While you were probably having a normal day's work, on Thursday, 16 February, a small village in Africa experienced its first 24 hours of electricity.

Monte Trigo is a small village in Santo Antão, Cape Verde's most westernmost island. The 60-family community is only reachable by boat and is completely dependent on fishing and its trade with nearby villages. The need for ice, which so many of us take for granted, it's a matter of survival for the inhabitants of Monte Trigo. They need it for conserving their fish as they have constant and frequent five-hour boat trip to the Sao Vicente Island (nearest main island) for ice purchase. It is a far from efficient process that uses precious time that could be used in other activities.

A reliable and clean source of energy, which would give way to a long-term sustainable and affordable electricity service, would not only respond to the extreme necessity of ice production, but also other basic needs like lighting, communication and community services.

Let there be light

It was in response to these needs that local entities came together to finance and develop an off-grid solar energy project. It was financed under the ACP-EU Energy Facility programme, lead by local water company "Aguas de Porta Preta" (APP), in consortium with the local Municipality ("Câmara Municipal de Porto Novo", CMPN) and others entities.

The facility installed in Monte Trigo is a Multi-user Solar micro-Grid (MSG) based on a photovoltaic generator, a storage battery, an electricity monitoring, control and power conversion equipment and a LV distribution grid.

The 27.3 kWp PV generator is mounted on a wooden pergola that provides shade to the village's schoolyard for added value to the community as shown in inset picture on the next page.

The PV power plant is based on a DC-bus configuration and MPPT charge controller, while the storage is done in two 48 V batteries with a total capacity of about 370 kWh. Two dual inverters, with a rated power of 7.000 kVA each, convert the DC electricity into 230V, 50Hz AC which is finally delivered through an 800m aerial distribution line to the 60 final end-users.

Among them there is a school, a church, a kindergarten, a health centre, a satellite DVB TV system (also visible in picture 1, on the left) and three general stores.

The previous genset will now be used as a backup supply and, if needed, to also charge the batteries, with the dual inverters operating in parallel with it.

Main picture: Pico de Fogo, Cape Verde, Africa
Inset: The 27,3 kWp PV pergola in Monte Trigo – Cape Verde (Photo: APP)

The challenges of controlling energy demand

Some of the major challenges of a rural electrification project using renewables are related to the users' understanding of what is involved in the technology, its service, operation and maintenance.
Generally speaking, concepts such as the sustainable and rational use of solar and the implications of the different charging level of the batteries are not easy to be understood, making it a challenge to introduce them in the end-users' daily habits.

To address this, the concept of Energy Daily Allowance (EDA) was introduced in the Monte Trigo project.

In the project, EDA makes the demand control more intelligent and flexible and introducing communications between the power plant's supervisory control and the individual electricity dispensers/meters of each user in the micro grid. The EDA must identify the requirements for user acceptance. It is used as a key design value and it is fundamental from a social point of view because it responds to users' needs more accurately and guides them through the management of energy use and energy budget.

Furthermore from a technological stance, it enables components like batteries and inverters to operate within their specified range.

The energy service

The Monte Trigo project's service was set-up using a mixed private/public-utility concept, in which CMPN and APP will be directly responsible for the service management and O&M of the facility.

Tariff collection is based on fixed monthly rates related to the EDA and it has been established within the population's capacity to pay. This will not only sustain operation and maintenance, but will also partially payback the capital costs.

An example of the adopted tariff options in Monte Trigo is reported in the table 1:

The operation and maintenance activities are organised in order to involve local users and village habitants and are structured on a three level concept: final users; fist-level O&M up keeper user; and second-level O&M technicians.

Energy demand type	Energy Daily Allowance [Wh]	Power limit [kW]
Very Low	825	0,55
Low	1100	0,55
Medium	1650	1,1
High	2200	1,1
Very High	3300	1,65

Table 1. Example of tariff options for Monte Trigo.

A moment of the training of local O&M personnel (Photo: TTA)

The first level includes the users themselves, as they are the first component of a successful and durable service. The objective is not only to support them in maintaining their home installation, but make their behaviour and habits in electricity consumption more efficient.

The second level includes a team of trained users, responsible for the basic daily operation, maintenance and, in case of specific alarm and issues, reporting.

Finally, the operator's technical personnel are the focal point for problem-solving, ensuring substitution when end-of-life is reached, as well as for specific maintenance and overall activities.

To ensure the successful implementation of this approach, training and capacity building sessions where performed previous and during commissioning activities in all three levels. They included theory and practical demonstrations to the O&M responsible users as well as to the project developers (APP, CMPN) personnel.

In the same way, the final users where trained to understand the dispenser/meter operation and to follow good habits typical of a PV generation-based electricity service. Practical demonstration where performed, directly involving the users. They responded in an contagiously enthusiastic way.

Monte Trigans were surprisingly well prepared to accept the basic concept introduced to them and in very few days they started to efficiently manage their energy allowance.

Strong partnerships

As with any successful rural electrification project, Monte Trigo involved many partners in different parts of the globe working together. In isolated communities such as this one, the quality of the different elements of the system gains a new importance, so involving the right (and experienced) companies is essential.

Monte Trigans were surprisingly well prepared to accept the basic concept introduced to them and in very few days they started to efficiently manage their energy allowance

In this case, the project involved mainly three companies: Trama TecnoAmbiental (TTA), ATERSA and Studer Innotec. The design and implementation were managed by TTA, on behalf of the developers. Founded in 1986, TTA is an international consulting and engineering firm working in the field of renewable energies, environmental projects and technology development in many developing countries.

The A-130P modules, one of the mid-power range principally used for off-grid project, were supplied by ATERSA. Each of the 214 modules installed contains 36 polycrystalline cells. ATERSA also designed a special pergola to aid the installation of these modules in the local school and supplied the batteries, regulators, converters and all the structures required for installation of the system.

Configuration and testing of the inverters

User charging her tariff (Photo:TTA)

Training session for final users (Photo: TTA)

Studer Innotec was contacted by TTA at an early stage of the project as the two companies had already successfully collaborated on other rural electrification projects. With 25 years of experience from independent energy solutions, Studer Innotec provide TTA with support for developing the concept of Monte Trigo new electrical grid.

Due to the planned design, concept and size of the micro-grid, the Xtender inverter-charger, XTH 8000-48, was chosen to supply a flexible management of the energy production and consumption. This system made up by two partially independent micro-grids with separate solar panels and battery banks. However, both grids are able to share excess energy with the other, thus ensuring an optimal use of the produced solar energy. The flexibility of the Xtender inverter-chargers from Studer Innotec, enables client-specific system configurations.

Project Outcome

From the first days of operation, the local authorities, but most of all, the Monte Trigo population demonstrate a great satisfaction for the new 24-hour electricity service. The village's habits started to easily adapt to this new quality of life and the changes it brought.

Major changes are already changing the live of this community: one user already has bought his first refrigerator (and it is a A+ energy rating!) and local workers brought in a welding machine from the nearby village to fix a structure with a default. It was the first time they could use something like this in the village.

It is expected that with the two ice machines, capable of up to 500 kg/day production using peak of the day, surplus generation will improve the commercial activity on which the village sustains its economy.

CPV: on-grid or off-grid?

Richard Sammut, Business Development Manager at Circadian Solar discusses global opportunities for CPV and seeks to provide some perceptive logic to the discussion of where CPV fits into the overall market potential.

Concentrated photovoltaics (CPV) holds much potential for unlocking clean energy in countries that are 'sun rich'. This essentially applies to the area either side of the equator, the so-called 'Sunbelt', that has long hours of reliable, intense, direct sunlight. However, even in these areas where CPV offers key performance and commercial advantages, there is much debate over how CPV will achieve market acceptance and become a prime energy source for the Sunbelt.

One of the key questions boils down to whether CPV can address both the on-grid and off-grid electricity markets. Given the huge differences in requirements between on and off-grid electricity, there is a challenge for CPV suppliers to prove the technology's credibility and to gain deployments. How and where will CPV gain early market traction? What are the "killer apps" that CPV can exploit?

CPV and on-grid electricity

Put simply CPV is a strong technology for both a useful off-grid power supply and for the backbone of grid electricity provision in the Sunbelt. However, for on-grid markets the market drivers are far more straightforward than off-grid markets. For off-grid deployments there is often a strong motivation for reducing the carbon footprint of power supplies, and reducing emissions. However, for grid-connected markets for any new technology to be considered it must be cost competitive with current energy sources.

However, it is important not to forget that CPV is still at a very early stage of development. The simple fact is that currently, given the levels of real world CPV deployments the industry is not yet benefitting from the advantages of economies of scale necessary to compete with grid electricity. This is a crucial factor,

and one that can only be solved with further technical developments, further deployments on both small and large scales, increase in the scale of manufacturing to bring costs down, and increased willingness from developers and users to give more consideration to CPV. For instance, many governments have committed to increasing the level of renewable energy in their energy mix, but achieving that will be difficult without supporting policies. Where there are supportive policies, it is much easier for investors to back renewable energy projects and thereby increase the usage of renewables for that country. This creates a virtuous circle of policymaker, investor and supplier where there is a win-win-win scenario for all.

For policymakers it is easy to assume that feed-in-tariffs alone will provide the incentive to the energy sector and investors to pursue large scale renewable projects. In fact feed-in-tariffs have quite a narrow impact - supporting renewable projects simply at the point of deployment. This in turn has a knock on to risk averse investors who see the opportunity to invest in companies, technologies and products that are furthest along in their development and therefore best-placed to take advantage of the tariffs in the short term.

Instead, early stage support is critical in enabling renewables companies to prove their 'bankability' to investors further down the line to support greater manufacturing and wider deployments. There are several options of what this early stage support could look like in practice - with schemes such as 'investment matching' put forward. What is clear though is that it is required if the renewables industry is to expand, and if governments are serious about growing the renewables mix of their energy supplies.

This, clearly, is a long term process. It is a process that we at Circadian Solar fully expect to progress however, and within a few years when economies of scale have been achieved we have no doubt that CPV will be competing on price with grid electricity, with carbon-free electricity. So if on-grid CPV remains a long term goal, what of the short term?

Off grid - the market opportunity

In the near term off grid deployments present the biggest opportunity for CPV. Apart from anything else much of the Sunbelt is rural, remote and does not have access to grid electricity. For example, according to a recent World Energy Outlook report, electricity access in sub Saharan Africa is only 26%, the lowest worldwide. This statistic is even worse for the rural areas, where the poorest communities tend to live, and where the estimate is as low as 8%. In these areas there is great reliance on diesel generators to produce electrical power, for schools, hospitals, irrigation, mines, water works and so on.

For those that do have access to grid electricity, issues with grid stability and reliability, as well as power supply rationing are well known. So, even though an increasing number of electrification programmes are aiming to provide access to electricity for a larger proportion of the Sunbelt's populations, off-grid generation will continue to be essential for a very large proportion of domestic, commercial and industrial users for many years to come.

A basic micro-desalination unit – the size of an average washing machine, requires 800 Watts of electricity to produce 1,000 litres a day. This is enough for a family's daily needs. A single CPV unit could power four of five of these machines, providing an energy efficient, affordable power source

For most off-grid power generation around the world the main option remains diesel generation, despite the expense and logistics of running them. Generating electricity using diesel engines is far from ideal. It is expensive, noisy and it leaves a high carbon footprint. In addition, steady power generation demands regular supplies of fuel, with additional economic and environmental costs for transportation over large distances.

Why CPV?

Solar power offers the potential for cheap, reliable, carbon-free power. Moreover, the high efficiency levels of CPV make it highly suitable for widely distributed micro-generation installations. Despite Western reservations about micro-generation, the technology has obvious and immediate benefits for the developing world. For example, a basic micro-desalination unit, the size of an average washing machine, requires 800 Watts of electricity to produce 1,000 litres a day. This is enough for a family's daily needs. A single CPV unit could power four of five of these machines – providing an energy efficient, affordable power source.

And CPV can achieve this at a far lower price than diesel. Whereas the initial cost of a solar power system is higher than a diesel generator of the same power rating, the fuel from the sun is free. In order to compare the economic case of generating electricity from diesel with CPV, we need to look at the total cost of generating each unit of electricity over the system life, best summarised as the levelised cost of electricity (LCOE).

The LCOE for diesel generated electricity varies greatly from country to country, because there is a wide range in the cost of diesel fuel, but it is typically in the range 50-100¢/kWh. By contrast, the LCOE for CPV in the countries having good levels of direct sunlight is currently 15-30¢/kWh. Furthermore, this is rapidly reducing, as CPV efficiency improvements are realised and economies of scale are achieved. Over the next five years or so, CPV LCOE will come down below 10¢/kWh.

So clearly there is a huge opportunity in off-grid deployments, not just for CPV, but also for renewables in general. However, CPV has several advantages over the other competing technologies. Unlike concentrated solar thermal power (CSP), photovoltaic technologies generate electricity directly from the sunlight. More importantly, CPV does not consume cooling water. CPV systems also produce more watts per area of solar panel and maximise energy production per hectare compared with conventional PV systems. In addition, the energy consumed in manufacture of CPV systems is less than a third that of conventional PV systems. A further major advantage of CPV over PV for off-grid installations is that the performance degradation of silicon. PV at high temperatures is far greater than for CPV. This means that a CPV system will produce more electricity than a silicon. PV system of the same rating in hot and sunny locations.It is also important not to ignore the support and maintenance requirements for any power generation. Systems designed for a long lifecycle and that require minimal and simple maintenance are most suitable, these are both properties of CPV systems.

Off-grid applications for CPV

There are a number of potential applications for off-grid applications of CPV systems. As mentioned earlier, water desalination has great potential for CPV, but there are far more potential off-grid applications. For example, CPV installations can provide power during the day for hospitals and schools that are either too remote to have access to grid electricity or suffer from the poor stability and reliability of the grid they are connected to. Not only would this reduce the running costs of those hospitals

and schools, it would give them a vital stability to their electricity supply. The telecoms industry, particularly the mobile telecoms industry, is growing rapidly in Africa, and elsewhere in the Sunbelt. These mobile networks need transmission masts to be positioned throughout the area supported by the network. Each mast needs a supply of power with minimal maintenance. Diesel generators are not very suitable for this telecoms application, because the fuel tanks need filling upregularly. Apart from the occasional simple cleaning of the lenses, CPV is maintenance free, so CPV could be a strong enabler for the spread of mobile communications to more remote areas.

More industrial applications exist for CPV too. Mines tend to consume a significant proportion of the available electricity from the grid. They also make use of very large diesel generators, so that the mining companies' electricity and fuel bills are amongst their biggest costs. CPV could be used to supplement the electricity used by mines for uses such as lighting, air conditioning and ventilation. CPV has the potential to provide a consistent supply for these uses, reduce the electricity and fuel bills of the mining companies, and ease the strain on the electricity grids in the process.

Moving beyond specific commercial applications, CPV has the potential to provide electricity for small villages in rural locations, enabled by the rapidly decreasing CPV system cost. The advantages that CPV systems consume no water during operation and require virtually no maintenance should make them an attractive option over diesel generators for providing power to small, remote communities.

Why not CPV?

Ultimately there is a huge advantage to linking CPV to specific functions such as water treatment and desalination plants and the others mentioned above. These projects make excellent demonstrations to showcase the benefits of CPV. In an industry that needs to boost its profile, demonstrate effectiveness and encourage greater investment, this is the kind of venture that many developers look to as an indication of performance, reliability and bankability. It creates something of a virtuous circle where greater investment leads to greater penetration, which in turn leads to lower-costs, encouraging further deployment.

In many ways this is far more important than the raw efficiency ratings and technical specs. Indeed, having CPV systems out in the real world generating electricity is the best way for CPV to overcome the hurdles on the path to it becoming a significant part of the energy mix of countries in the Sunbelt. In time, whether the deployment is for on or off-grid electricity, the question will no longer be "why CPV?", but "why not CPV?"

The telecoms industry, particularly the mobile telecoms industry, is growing rapidly in Africa, and elsewhere in the Sunbelt. These mobile networks need transmission masts to be positioned throughout the area supported by the network. Each mast needs a supply of power with minimal maintenance

Rural experience provides background

OutBack Power Technologies is a privately held company in the USA that specializes in advanced power electronics for renewable energy, back-up power and mobile applications. The company has established itself in harsh environmental conditions and applications where product reliability is paramount. Philip Undercuffler, Director of Product Management and Strategy spoke to Solar International about global energy needs and trends

Q How did you come to be involved in the Solar industry?

A I got my start in the industry in the early '90s when my wife and I built our home off-the-grid in New Mexico. That led to a position with a small electrical contractor business specializing in solar photovoltaics, where I obtained my Journeyman's and Electrical Contractor's licenses. I joined Dankoff Solar where I provided technical support to other installers and designers; that developed into a role at Conergy leading a sales team focusing on the battery-based and off-grid markets. Later, I moved on to product management, a role that I now enjoy at OutBack Power. I strive to bring my experience and expertise as a system owner, installer, tech support, sales and distribution professional to developing the best product for our market and customers.

Q The solar and PV industries are about providing energy alternatives but the last few years has seen PV sold as a financial product rather than an energy solution. Do you feel that recent overcapacity in industry growth has helped or hindered the overall industry?

A I view the fact that solar is being sold as a financial product as a key bellwether indicator that the industry has indeed arrived at true financial parity with other energy sources. After all, there's only so much the industry can grow if a PV purchase exists only as a "vote with your checkbook" type of purchase, where the customer is paying a premium above market rates in order to assure a green energy supply. The market really takes off when homeowners, businesses and investors see a PV purchase not as green-washing but as good solid business sense – when it is at the point where someone is fiscally stupid not to put their money in a PV power system. This has been a long-awaited point, and it speaks to the value of renewable energy.

As to the overcapacity issue, this has both helped as well as hindered the industry. The specific impact varies based upon your location in the chain, but in general I would say that it helps those at the end of the chain – the time has never been better to be installing or purchasing a PV system. For those on the other end, however, it's a brutal time, with the majority of companies selling below costs, trying to protect themselves from an ever-devaluing inventory, and at best trying to ride it through on single-digit margins.

Q A key element of developing renewable energy solutions is their ability to effectively integrate into contemporary energy delivery systems. Are there major hurdles to introducing solar and PV energy sources into existing infrastructure?

I believe we are at the early stages of PV transitioning from being viewed by the utilities as an external agent that they have to grudgingly abide to an asset that can help them stabilize and support the grid. The requirements for VAR support, low voltage ride-through and other utility-positive assets is the beginning. However, for renewable energy to achieve the levels of penetration that we require as a global solution, we need to somehow address variability; the current structure for forecasting and wheeling power demand will be hard-pressed to keep up with a low percentage of renewable energy generation, much less what will happen when we hit high percentages. AR-N-4105 is one step in this process, but it can't be the last.

Q How important are off grid power solutions in developing solutions to grid connection issues?

A If by that you mean systems utilizing energy storage as a stabilizing force to homes on the utility grid, I believe this will be an important aspect, although certainly not the only one. However, this road could take many directions. At

Under the Patronage of H.H. General Sheikh Mohammed bin Zayed Al Nahyan Crown Prince of Abu Dhabi and Deputy Supreme Commander of the UAE Armed Forces

WORLD FUTURE ENERGY SUMMIT

Abu Dhabi 15 - 17 JANUARY 2013

Hosted by: Masdar A MUBADALA COMPANY

15 - 17 January 2013, Abu Dhabi National Exhibition Centre

Your Access to Unrivalled Business Opportunities in the Alternative Energies and Sustainable Technology Industries

As the unique global meeting place bringing future energy business, policy and technology together, we give you access to:

- World leaders in policy from over **70** countries
- **40** renewable energy project developers
- **150+** world class speakers
- Over **3,000** decision makers
- **650** leading technology suppliers
- **700** media representatives

New for 2013 - Discover more about the critical water-energy nexus, as WFES runs in conjunction with the new International Water Summit.

Powering
the Future of
Energy Innovation

Contact us now to book your space

For exhibition booking and sponsorship opportunities, contact Claude Talj on +971 50 452 8168 or claude.talj@reedexpo.ae

80% BOOKED

Platinum sponsors

TOTAL

Host of

ADIREC 2013 ABU DHABI

Supported by

IRENA International Renewable Energy Agency

Co-located event

INTERNATIONAL WATER SUMMIT Abu Dhabi 2013

Organized by

Reed Exhibitions

ELSEVIER

PART OF ABU DHABI SUSTAINABILITY WEEK 2013

www.abudhabisustainabilityweek.com

a minimum, battery-based systems will be used to provide stability on an inward-looking basis – to provide stable, reliable power to a home or business no matter what chaos was occurring on the utility side. However, on a broader, more far-reaching scale, battery-based systems could be part of a solution to stabilize the grid by alternately absorbing excess renewable energy generation and supporting surges on the utility grid and making up for momentary generation shortfalls.

Q OutBack Power has been a strong supporter of developing industry standards within the solar and PV industries. What standards do you feel need to be developed?

A What is the best way to determine the best standards and how can the solar and PV industry ensure the best standards are reached rather than a standard based on the biggest company as occurs in some other industries? One of the biggest challenges is the lack of standardization and harmonization in standards. As renewable energy has grown in visibility and impact, there have been huge increases in the standards applied to the industry. At OutBack Power, we welcome standardization and are committed to the global market. The biggest challenge to be faced is the fractured state of the market in regards to certifications and standards.

Q Some people believe an inverter is just an inverter. How would you respond to such a statement?

A The inverter is the most important component in the system. Even in a grid-tied system where the demands on an inverter are very straightforward and linear, the reliability and MPPT tracking algorithm of the inverter are key – after all, an inverter that is down has an efficiency of zero, and an inverter that can't track the array leaves valuable energy on the roof. However, in the demanding world of a battery-based application, the quality of the inverter truly comes to the forefront. Loads are dynamic and the ability of the inverter to respond to changing conditions, spikes, surges and reacti`ve loads is critical. Even more important is the ability to stack multiple inverters together to support larger loads and systems, and for the inverters to work in unison as a team, no matter the dynamic conditions.

Case Study

Energy solution provides company growth

Malankara Plantations Limited, founded in 1910, is the first Indian-owned public rubber plantation company. The building complex of Malankara Plantations is an 86-year-old structure and is historically registered, classifying it as "heritage" status in India and making its preservation mandated by the state. The plantation is located in a tropical region where temperatures range from 28 C to 32 C.

The office complex located on the plantation houses 45 people. Its largest power consumers are 18 tons of air conditioning, followed by several water pumps, three packing machines, IT/networking and lighting. Ninety-five percent of the energy load occurs during the day, and the tariff cost on electricity is on trend to continue to increase 6.5 percent in the next few years. Additionally, the cost of diesel fuel has increased 50 percent over the past five years.

Previously, the building was positioned to move off-grid as it had some back-up generation, but it was connected to a private power grid owned by a local maharaja.

The complex has experienced frequent blackouts over the past few years due to power shortages on the electrical grid, which forced the company to increase diesel generator operation. Since the building had heritage status, it required an engineered solution that wouldn't make any alterations or disturbances to the original structure. Management of Malankara Plantations Limited wanted an energy solution that would handle the daily electricity demands required for an office building in a hot climate, as well as one day's back-up power capability to prevent blackouts and mitigate disruption to business activities, since the majority of the load occurs during the business day.

Objectives

- Install a renewable energy generation system and reduce power intake from the grid.
- Preserve the historic office complex structure by engineering an aesthetically-acceptable solution that provides reliable energy without affecting the building's structure.
- Ensure uninterrupted power supply for the offices with backup power.
- Mitigate emissions caused by diesel generator operation.

Solution

Previously, the Malankara Plantation examined several renewable energy solutions and off-grid strategies, such as diesel generation or back-up energy generation. However, the Indian government emphasized solar PV installations incentivized with capital subsidies of 90-Rupees per watt up to

a maximum of 30 percent of the project cost. Malankara Plantations executives decided to install solar arrays on a space-frame structure on four columns cantilevered over the roof, which would not disturb the building's architecture and preserves its heritage status. TeamSustain executed the system design, engineering, installation and commissioning of the power plant using OutBack Power's advanced and efficient power electronics.

The project's solar arrays consist of 25kW modules in space frames, comprised of thin-film PV elements. The solar is powered by three-phase 27kW array of nine OutBack GVX 3048 off-grid inverters, selected for their modular design, field serviceability, reliability and durability.

Malankara Plantation also installed OutBack's FLEXmax 80-charge controllers with maximum power point tracking (MPPT) capability, which tracks the maximum charging current possible, providing 30 percent higher yield compared to conventional charge controllers, and the OutBack MATE3 System Display and Controller to remotely program and monitor the OutBack system.

The charge controllers were additionally equipped for temperature compensation to facilitate proper charging of the battery bank, thus resulting in longer battery life.

Benefits

- Energy cost savings payback in fewer than five years
- Independence from an unreliable grid, with the office complex functioning solely on self-generated solar power.
- First Net-Zero Energy building in India
- Reduction of up to 47 tons of carbon emissions per year
- Capability to sell excess electricity generated back to the grid, making the complex an energy-plus building.

"We chose OutBack products for the Malankara Tea Plantation because of our personal experience with their reliability in tropical climates with extreme temperatures," said George Mathew, vice president of TeamSustain, an OutBack Power distributor and one of India's leading system integrators.

OutBack's rugged systems delivered uninterrupted power and cut diesel emissions for air conditioning and other major energy loads. Despite regular power cuts in the surrounding grid, the Malankara Tea Plantation has been able to stay online with clean, solar backup power and maintains historic heritage status which has only being possible with the renewable energy solutions developed specifically for the needs of the plantation now and in the future.

Asia's largest event on renewable energy

6th RENEWABLE ENERGY INDIA 2012 EXPO

India Expo Centre, Greater Noida
National Capital Region of Delhi, India
7 - 9 November 2012

Solar PV | Solar Thermal | Wind
Bio Fuels | Bio Mass | Small Hydro Power
Geothermal | Energy Efficiency

Supported by

Government of India
Ministry of New & Renewable Energy

Ministry of POWER
GOVERNMENT OF INDIA

Knowledge Partner

ERNST & YOUNG
Quality In Everything We Do
Ernst & Young Pvt. Ltd.

Supporting journal

solar international
A PV Management Magazine

Organiser

UBM

Rajneesh Khattar | +91 98717 26762 | rajneesh.khattar@ubm.com

www.renewableenergyindiaexpo.com

CODE: REWIN06

*Register using the above Code to win a Conference Pass
*before 31st July 2012

Australia's carbon reaction

Allen & York Australasia take a look at what the Australian government is planning to achieve with its series of Clean Energy bills and how it will impact markets and employment opportunities for renewable energy including solar. .

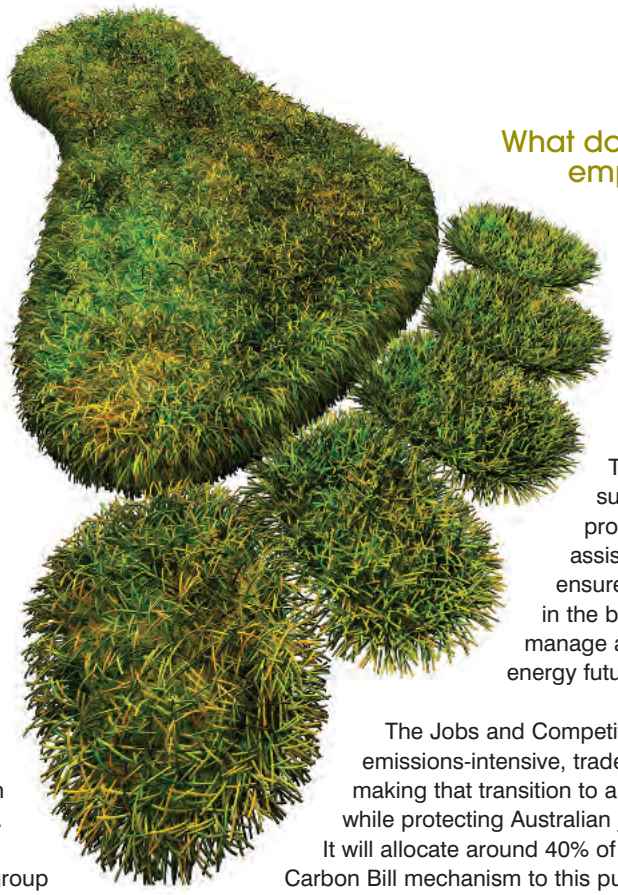
The Australian Government passed the Clean Energy Bill in 2011 which states that the carbon price will be paid by liable entities, such as companies which have facilities that emit 25,000 tonnes or more of carbon pollution per year. This carbon price began in July 2012 and this means that around 500 entities will have mandatory liabilities under the carbon pricing mechanism. Australia has one of the highest ratios of carbon output to population in the world.

To determine liability, the carbon pricing mechanism will draw on information reported under the National Greenhouse and Energy Reporting System, an established measurement system for greenhouse gas pollution developed under the Howard Government. However, the carbon pricing mechanism will not apply to agricultural emissions and legacy emissions from landfill facilities.

This would mean if your organisation falls as a liable entity, the Bill calls for a fixed carbon price for three years, starting at $23 (AUD) per tonne of carbon pollution.

This scheme intends on providing a cap on carbon pollution within Australia. These proposed caps are intended to guarantee reductions in carbon pollution and efficiently enable Australia to achieve the long term target of an 80% reduction from 2000 levels by 2050, removing more than 17 billion tonnes of carbon pollution out of the atmosphere between now and 2050.

The Bill makes provision for the Australian carbon pricing mechanism to interact with credible international efforts to reduce carbon pollution. This gives liable parties access to a broader range of opportunities to lessen their payment amount, which helps contain costs and helps promote international action on climate change. However, only robust, environmentally credible international units are allowed to be used for compliance.



Carbon Tax controversy

There is a mixed reception of the Carbon Price in Australia. The opposition climate action spokesperson Greg Hunt is trying to reinvent economics and history to claim that a carbon price is unnecessary for the success of renewable energy in Australia.

Hunt proclaims that "the new tax will raise every family's cost of living, it will make every job less secure but it won't help the environment". Australia's mining firms, airlines, steel makers and energy firms are among those expected to be hardest hit by the Clean Energy Bill and are most likely to agree with the views of the opposition.

The implications of the Carbon Tax has meant a windfall for renewable energies such as solar and PV technologies as companies look for ways to reduce carbon emissions and the subsequent tax burden.

Meanwhile, it has also been argued by a group of almost 300 Australian companies, called Businesses for a Clean Economy, that the carbon price scheme will drive innovation and keep the country internationally competitive.

Responding to Greg Hunts views that the Carbon Tax will raise the cost of living; the Treasury estimates the Carbon Tax will only add about 0.7% to consumer prices in 2012-13 and that there are compensation packages in place worth $AUD15bn over the first four years, that will be delivered in the form of tax cuts and welfare and pension increases.

What does it mean for employment

The Government proclaims that there is nothing more important to families than having a job. It intends to take special measures to support jobs and keep Australia competitive internationally.

Therefore, it has been suggested that there will be provision for certain industry assistance measures, which will ensure that Australian industries are in the best position possible to manage a smooth transition to a clean energy future.

The Jobs and Competitiveness Program will assist emissions-intensive, trade-exposed industries in making that transition to a low-emissions economy, while protecting Australian jobs and competitiveness. It will allocate around 40% of the revenue raised by the Carbon Bill mechanism to this purpose. With the aim to underpin a successful energy market transition and maintain investment in new energy sources and infrastructure. The good news is that the Government will seek to close around 2000 megawatts of highly polluting generation capacity by 2020.

The opportunities remain strong for renewable energy options as the Australian government continues to seek ways to reduces the country's carbon footprint.

It has also been argued by a group of almost 300 Australian companies, called Businesses for a Clean Economy, that the carbon price scheme will drive innovation and keep the country internationally competitive. Responding to Greg Hunts views that the Carbon Tax will raise the cost of living; the Treasury estimates the carbon tax will only add about 0.7% to consumer prices in 2012-13 and that there are compensation packages in place worth $AUD15bn over the first four years, that will be delivered in the form of tax cuts and welfare and pension increases

To promote your Products and Services cost effectively to all our buyers and specifiers,take advantage of the Sources of Supply section. A Sources of Supply entry is effective, and an easy way of promoting your products and services for the full year. Additionally your entry will be seen at major exhibitions and events throughout the year. **For further information, please contact:**
Shehzad Munshi on: T: +44 (0)1923 690 215 E: sm@angelbcl.co.uk
Entries in Sources of Supply @ £1,500 per heading per year.

SOURCES OF SUPPLY

Adhesive Tapes/Bonding

High Performance Technical Adhesive Tapes

High Quality Bonding Solutions for the Solar Industry

Frame bonding for modules, junction box mounting

Thin film back rail mounting, cell fixing and laminate fixing

Hi-Bond Tapes Ltd
T: +44(0)1536 260022
F: +44 (0)1536 260044
E: sales@hi-bondtapes.co.uk
W: www.hi-bondtapes.com

Furnaces

SEMCO ENGINEERING
OVER 20 YEARS EXPERIENCE & PROVEN EXPERTISE

New, upgrade and refurbishment of **Horizontal Furnaces**

Using patented processes, we reach higher uniformity, doubling the throughput on processes for :
- Phosphorous and Boron Doping (LYDOP®)
- Very Thin Oxidation (LYTOX®)
- Pure H_2 Annealing (LYSINTER®)

Equipment and Processes for MEMS Applications

Wafer Transfer & Furnace Automation

SEMCO Engineering, FRANCE
Tel : +33.467.610.990
Fax : +33.467.526.963
Email : info@semco-engineering.com
Web : www.semcoeng.com

Gas (High Purity) Process Control

Bionics Instrument

Gas detection systems

selective & reliable detection systems for toxic, corrosive and flammable gases

Bionics Instrument Europe B.V.,
Maxwellstraat 7,
1704 SG Heerhugowaard, The Netherlands
Tel. :+31 72 5765630
Fax. :+31 72 5721818

www.bionics.net

Semiconductor Equipment

BERLINER GLAS
Photonics • Systems

Advanced Chucking Solutions

Electrostatic Chucks
Single or double side chucking
Extreme contact area reduction
High clamping force
Chucking/de-chucking time down to 0.1 sec.
Uni- or bipolar customer designed electrodes

Vacuum Chucks
Wafer chucks up to 12" wafer size
Several separated vacuum segments
Anti-sticking coating
State-of-the-art flatness performance

Many years of experience

www.berlinerglas.com
chucks@berlinerglas.de
Phone +049 30 60905-0
Fax +049 30 60905 100

Fan Filter Units

ENVIRCO™
CORPORATION
Innovators in clean air technology

- Mac10 Original Fan Filter Unit (AC)
- Mac10 IQ Intelligent Fan Filter Unit (EC)
- FFU control systems (AC and EC)
- STD, Room side replacement Filter and motor versions
- Stock service
- Ducted Terminal Filters

Fax +44 (0) 1962 840465
Fax: +44 (0) 1962 828619
E-Mail: rflaherty@airsysco.com
Web: www.envirco.com

Furnaces

THERMCO SYSTEMS

MEMS, PV, LED and Carbon Nano Tube systems

Bench style R&D Furnaces

- Atmospheric and LPCVD processing
- Wafer sizes up to 200mm
- Manual or automatic wafer loading
- Mini furnaces with 1-4 tubes per stack
- Process guarantees for all processes

Thermco Systems
A Division of Tetreon Technologies Ltd
Tel: +44-1903-891700
Fax: +44-1903-893888
WWW: Thermcosystems.com

Metals

GoodFellow

For Metals & Materials for Research & Industry

Pure Metals, Alloys, Polymers, Ceramics, Composites and Compounds

Goodfellow Cambridge Limited
Huntingdon, UK
Tel: +44 1480 424 800
Fax: +44 1480 424 900

E-mail: info@goodfellow.com
www.goodfellow.com

Vacuum Equipment

HIDEN ANALYTICAL

Solutions in Mass Spectrometry and Surface Analysis Worldwide

- Plasma Characterisation
- UHV Surface Analysis
- Gas Analysis
- RGA

www.HidenAnalytical.com
t: +44 (0)1925 445225
f: +44 (0)1925 416518
e: info@hiden.co.uk

Furnaces

AMTECH
TEMPRESS®
The expert source in horizontal furnace technology

- Horizontal Diffusion & LPCVD Furnace Systems
- Atmoscan Processing Tool and Ibal Furnace Automation

Amtech Tempress Systems, Inc.
Brugstraat 2
8181 VH Heerde
The Netherlands

Tel: +31-578-699200
Fax: +31-578 693693
Email: sales@tempress.nl
Website: www.tempress.nl

Furnaces

THERMCO SYSTEMS

Horizontal Diffusion and LPCVD Furnace Systems by Thermco Systems.

All major processes supported for use in **PV, MEMS, LED and Semiconductors** applications

- New systems for production or R&D
- Automation and wafer transfer
- New PC based TMX Control system with data collection, SPC and recipe management tools.

Thermco Systems
Tel: +44-1903-891700
Fax: +44-1903-893888
WWW: Thermcosystems.com

RF-/DC-/MF-Power Supplies

SEMCO ENGINEERING
OVER 20 YEARS EXPERIENCE & PROVEN EXPERTISE

E-CHUCKS
COULOMBIC TECHNOLOGY

Applications
PVD / CVD
Long Etch / RIE
Metrology
Ion Implant

Features
Custom design from 3" up to 12"
Operating temperature -250°C up to 650°C
Polarities monopolar / bipolar / multipolar
Clamping / unclamping <2sec
Embedded heater capability
Plug & Play design
Reworkable

SEMCO ENGINEERING, FRANCE
Tel : +33.467.99.47.47
Fax : +33.467.99.47.48
Email : e.chuck@semco engineering.com
Web : www.semcoeng.com

Wet Benches

arias
wet benches & more

arias gmbh

- wet process equipment
- laminar flow units
- chemical supply systems
- acid and caustic cabinets

www.arias.de
Phone: +49 (0) 2304 971 12-0

Solar-Fabrik provides solar for African schools

Solar-Fabrik is sponsoring solar systems for schools in Ghana and Burkina Faso

SUMMER 2012 sees Solar-Fabrik AG offer its support to two school projects in Africa in the form of sponsorship. The installation of the two solar systems with modules from Solar-Fabrik brings 1400 students into contact with modern solar technology and also contributes to improving the living and educational conditions in the African states. A technical school in Nyakrom, Ghana, received a system with an output of 9.2 Kilowatts (kW). At another project in the neighbouring state of Burkina Faso, a 1.6 kW system was installed at the Yalegtenga Village School.

Solar-Fabrik sponsors projects conducted by students and young people on the topic of photovoltaics on an ongoing basis, as well as projects for schools or medical facilities in Africa. For these projects, the company provides solar modules from the manufacturing plant in Freiburg. “Off-grid solar power systems are an effective instrument for sustainable development, particularly in the sunny regions of Africa. Here, we are glad to help them to help themselves,” explains Sofie Roeder, Sponsoring Officer at Solar-Fabrik AG. “In 2012, we have supported two projects which enable and facilitate the use of solar technologies for the students in a special way.”

In At the Nyakrom Senior High Technical School in Nyakrom, southern Ghana, 1200 students can obtain a qualification which enables them to study for a degree. Solar-Fabrik provided the school with 74 modules with a total output of 9.2 kW. An 8.5 kW system was installed on the school site, whilst a small 750 watt system was installed on a second building. The conception of the project within a partnership was crucial for gaining the commitment of Solar-Fabrik: As the initiator, the International Solar Energy Research Center ISC Konstanz e.V. found a partner in the Landesgymnasium für Hochbegabte (State Grammar School for the Highly Gifted - LGH) in Schwäbisch-Gmünd, Baden-Württemberg. 9 students of the LGH aged between 13 and 18 were trained by the ISC Konstanz in different subject areas: in the physics of the solar cells, in project management and in the planning and dimensioning of photovoltaic (PV) systems. Following their training, they then carried out the project in Ghana themselves under the guidance of the ISC Konstanz. The German students passed on their knowledge to a partner group from the school in Nyakrom and developed a syllabus for teaching about photovoltaics which can be used in the school and for other projects in the future.

A Freiburg initiative was realized early in 2012, when an island system with an output of 1.6 kW was installed at the Yalegtenga Village School in Burkina Faso. For this project, Solar-Fabrik AG provided 15 solar modules. To help with the acquisition of the remaining system components, as well as meeting challenges in construction, transport and assembly, further project partners were found.

The partners were able to put the system into operation at the end of March. Using the battery-stored solar energy generated, the students now have light to do their homework at school in the evening. Soon, an evening school with literacy courses for women should be opened.
The Freiburg-based society Solarenergie für Afrika (Solar Energy for Africa) put up half of the remaining costs - they were financed from the proceeds of the sale of African mangoes and from donations from the society.

Gilligan's Island gets a solar makeover

New solar array provides energy to continue marine biology research

THE SCENIC ISLAND made famous by the popular 1960s television series Gilligan's Island is going solar: Coconut Island, or Moku o Lo'e, is home to the Hawaii Institute of Marine Biology of the University of Hawaii, which recently signed a Power Purchase Agreement (PPA) with SolarCity to provide the island's marine biology institute with renewable solar electricity for the next 20 years.

SolarCity will provide the University of Hawaii with solar electricity at a discount to current utility rates, easing budget uncertainties from fluctuating electricity rates. PPAs for renewable energy are gaining popularity in Hawaiii, where abundant sunshine makes them a natural fit for utilizing clean energy.

SolarCity has begun to install a series of photovoltaic (PV) solar systems on the rooftops of buildings housing the University's Marine Biology Institute. The solar systems will consist of solar panels with approximately 260 kilowatts (kW) of generation capacity, providing a significant portion of the Institute's energy needs.

"By giving organizations the ability to pay less for solar electricity than they pay for electricity generated by fossil fuels, we're making clean power more accessible," said Jon Yoshimura, director of government affairs for SolarCity.

"The University of Hawaiii is setting an example for other educational institutions by taking a forward-thinking approach to its energy needs while shifting the school to homegrown solar electricity," he continmued.

SolarCity, a leading provider of clean energy services, operates in Hawaii from a local office in Mililani and offers an end-to-end customer experience by providing custom design, free installation, online monitoring, and maintenance throughout the duration of the PPA.

This project is an important step for the University toward developing and demonstrating solutions for the challenges of the 21st century. Tom Apple, chancellor of the University of Hawaiii at MÇnoa, said, "This is an important step towards our goal of having 25 percent of campus-wide energy use supplied by renewable sources by the year 2020."

A Greener North Australia

The Daly River community in the Northern Territory will be less reliant on diesel thanks to a new project targeted at increasing solar penetration in remote towns and communities.

One of the iconic rocks of the Devil's Marbles in remote outback of Northern Territory, Australia.

AUSTRALIAN SOLAR INSTITUTE (ASI) Executive Director Mark Twidell said ASI is providing $500,000 to the Northern Territory's Power and Water Corporation to investigate ways to increase solar energy generated electricity in Daly River.

"In partnership with the local community and Charles Darwin University, PWC will undertake a feasibility assessment and develop a Solar/Diesel Mini-Grid Handbook, paving the way for roll out across the Territory," Mr Twidell said. "There are over 52 isolated diesel mini-grids throughout the Northern Territory, servicing remote indigenous communities that could benefit from this project and solar's clean, readily available electricity." Power and Water Corporation General Manager Remote Operations Darryl Day said it will aim to increase solar penetration on the Daly River grid through two mechanisms: generator optimisation and load management.

"We will challenge traditional operating principles of diesel generators, such as the need to keep a minimum diesel input, to optimise the solar output," Mr Day said. "Through load management, we will work to show solar output can be matched to consumer demand in real time, increasing its attractiveness as an alternative to diesel.

"Our learnings will be recorded in a hand book that will help utilities to make informed project planning and design decisions." Mr Twidell said mini-grid solar systems are often located in areas with optimal solar resources, and can provide reliable power at a price competitive with diesel.

"Ultimately this project will reduce reliance on diesel generation, reduce remote community vulnerability to rising diesel fuel costs and improve energy security," Mr Twidell said.

The Australian Solar Institute is a $150 million commitment by the Australian Government to develop photovoltaic and concentrating solar power technologies. By 1 January 2013, ASI will join the Australian Renewable Energy Agency, part of the Australian Government's $17 billion commitment to renewable energy.

solar international

Editor-in-Chief David Ridsdale
T: +44 (0)1923 690210 E: david.ridsdale@angelbc.com
Director of Solar & Semiconductor Publishing: Jackie Cannon
T: +44 (0)1923 690205 E: jackie.cannon@angelbc.com
Sales Manager: Shehzad Munshi
T: +44 (0)1923 690215 E: shehzad.munshi@angelbc.com
Director of Logistics: Sharon Cowley
T: +44 (0)1923 690200 E: sharon.cowley@angelbc.com
Design & Production Manager: Mitchell Gaynor
T: +44 (0)1923 690214 E: mitch.gaynor@angelbc.com
Subscriptions Manager: Debbie Higham
T: +44 (0)1923 690220 E: debbie.higham@angelbc.com

Published by: Angel Business Communications Ltd (London Office). Hannay House, 39 Clarendon Road, Watford, Herts WD17 1JA, UK

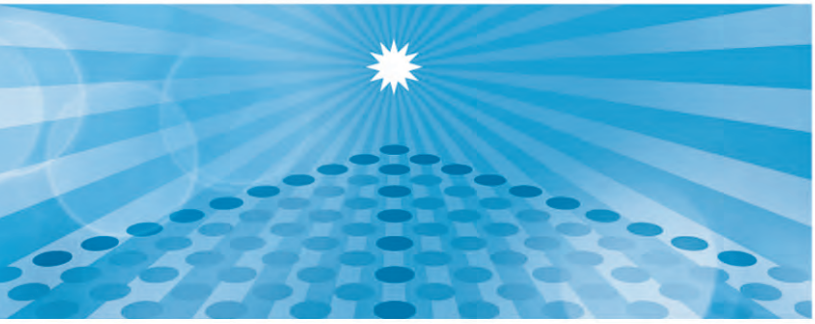
USA Representatives: Tom Brun, Tom Brun Media
T: 724 539-2404, E: tbrun@brunmedia.com
Janice Jenkins, Tom Brun Media.
T: 724 929-3550, E: jjenkins@brunmedia.com
Amy Rogers, Tom Brun Media.
T: 678 714 6775, E: arogers@brunmedia.com

China Representative: Parker XU, Unionbandy Limited,
T: 86-755-83753881, E: xp@unionbandy.net

Directors:
Bill Dunlop Uprichard – CEO
Stephen Whitehurst – COO
Jan Smoothy – CFO
Jackie Cannon, Scott Adams, Sharon Cowley, Sukhi Bhadal

Registered Office:
Angel Business Communications Ltd (Coventry)
Registration Number: 1972952

SEMI® | PV Group



Advancing Photovoltaic Manufacturing and Growing Solar Markets

PV Group advances PV manufacturing standards, connects PV supply chain stakeholders, and advocates our members' interests on global opportunities, shared challenges and critical manufacturing issues that impact innovation, promote investment, and growth in the solar market. Today, PV Group serves the global PV manufacturing supply chain with an international network of trade events, international standards development, public policy initiatives, research, and information that work together to expand opportunities in solar energy for our members and contribute to the overall growth of the industry.

STANDARDS • EHS • MARKET DATA • ROADMAPPING • PUBLIC POLICY • EVENTS

SEMI PV Group is a proud co-organizer of the PV Production and Technology Halls at Intersolar Europe and Intersolar North America.

Visit www.pvgroup.org for more details.

semi | PVGroup

Heraeus

Our commitment to PV is unmatched. We are about more than providing industry-leading silver pastes. We leverage the resources of a global, Fortune 500 company with over 160 years of tradition. We innovate and cultivate new ideas through strategic investment in R&D. We develop diverse technologies that create enduring value for our customers.

For more than 40 years, Heraeus has been a leader in the development of thick film metallization pastes. Today, we draw on this experience to deliver innovations that increase performance and lower costs.

We are Heraeus Photovoltaics...Stable. Reliable. Sustainable. Just like the sun.

Visit our booth at these upcoming trade shows:
27th EU PVSEC (2012)
September 25 - 28 • Hall 3.0, Booth G16

PV Taiwan
October 3 - 5 • TWTC Hall 1, Booth A0822

Heraeus Photovoltaics Business Unit
www.pvsilverpaste.com

China | Singapore | Taiwan | Europe | Americas