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David Ridsdale
Editor in Chief

Focusing on business

The international solar industry has moved into the next stage of its evolution regardless of how many wish to protest that it is moving away from subsidies and support too early. Most of the concern and protest is occurring at a local level from companies who over extended their debt based on assumptions related to subsidies. The rest of the industry is moving on with the understanding that solar is a global business and awareness is required not only at the local level and that global changes impact dramatically.

Some of the global changes are not so easy to spot but have an impact on day to day business regardless. The state of the global economy is an obvious area where issues outside the industry impact the daily decisions. A less obvious global marker would be the ongoing trade battle between the US and China (page 34 this edition) which has divided the industry in both countries. What is interesting about this situation is that it has come about from voices claiming to speak on behalf of the industry. The CASE and CASM groups in the US alone both claim to be speaking on behalf of the industry. I see too many groups around the world claiming to speak on behalf of an industry and then hear many in the industry disagreeing with them.

Much like the companies who rushed into every new region once subsidies were announced there has been a steady rise in the number of associations and institutions and groups all claiming to be speaking on behalf of the industry. Scratch the surface and we find that each group is actually pushing a particular agenda rather than speak on anyone's behalf. Many of these groups have been started by individuals who saw a financial opportunity just the same as companies that thought they were discovering the new gold rush.

The current change in economic support will ensure that the 'chancer' companies will fall by the side (sadly so will some excellent technologies and companies), the same cannot be said for the excessive number of associations and groups claiming to support the industry. I have warned before and advise again, take care of who is speaking on your behalf and make sure you speak up against them when their self interest is obviously of greater concern than any industry issues. There is a great deal of money to be made in creating such groups and the solar industry is currently in a dangerous position where too many groups will begin to compete for their side of the argument to keep in business.

These are the groups that lazy governments then go to and often end up as main advisors leading to decisions that affect your business operations. There is no need to look far to see examples of government action based on the view of a minority claiming to be speaking on behalf of the majority. SolarWorlds use of the US legal system to push trade restrictions on China is a prime example. There seems to be more industry support and acknowledgement on the side against their claims and yet the government pursued the minority view with vigour. Of course even that action was part of a broader political agenda.

Allowing others to speak on your behalf is fine as long as you understand the consequences of their words and whether they are truly speaking in your interest.

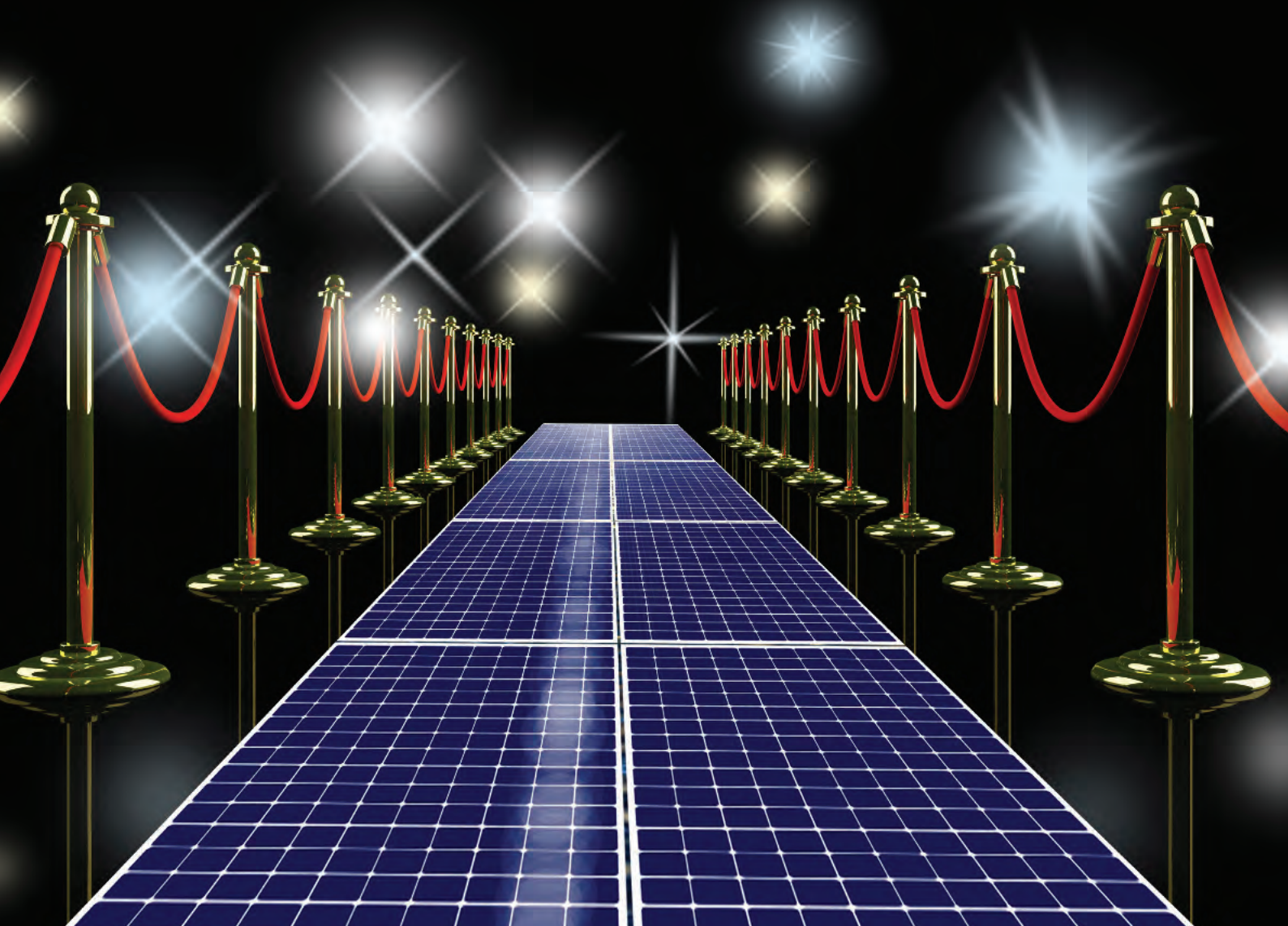
David Ridsdale

solar awards 2012

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A key criteria for developing and increasing solar power for everyday use is interoperability with current energy systems. With larger solar farms coming into play it is essential that the correct guidelines exist to ensure compliance and therefore growth

21 Impact on PV from the WEEE directive

The European wide waste electrical and electronic equipment (WEEE) directive comes into play and companies will need to be on top of the new regulations. The rules may not be as encompassing as some would think and recycling for the future is one area to consider

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All industries are interconnected and energy is one area that impacts on all others so being aware of overall trends can provide positive intelligence for future opportunities. One of the world's leading technology futurists discusses some key technologies of the future

27 Thin glass potential

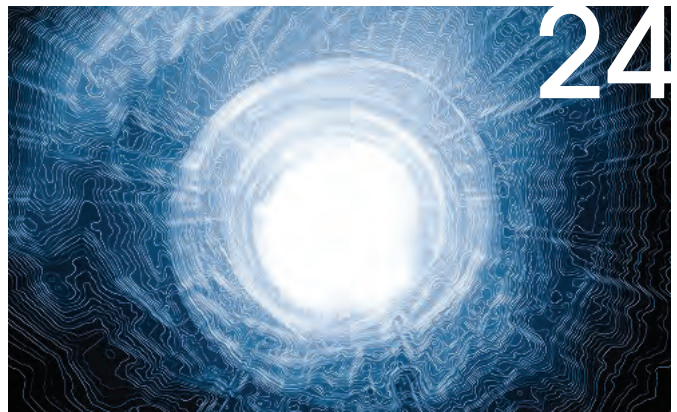
In the solar world the discussion tends to focus on silicon or thin film but there are more manufacturing options available to the industry. Glass is being produced in thinner and more flexible varieties opening up new opportunities to savvy manufacturers

34 Trade wars

The fallout from SolarWorld's accusations of Chinese product dumping continues with China replying in kind with trade restrictions of their own. What is more fascinating is how the process has divided the US solar industry with many groups claiming to speak on the industry's behalf

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Formula 1 is considered one of the most energy wasting activities of the human species so it is positive news that the Lotus team has completed a solar installation



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Think beyond equipment.

Calyxo increases total capacity of CdTe

CALYXO GMBH is investing in a second production line with a capacity of 60MW at Bitterfeld/Wolfen. Calyxo currently operates a 25 MWp production line with over 150 employees at the manufacturing plant and will ramp the total capacity at the end of 2012 to 85 MW.

The capital for the expansion will be provided by a bank loan and cash from the technology inventor Solar Fields, LLC, who took over ownership of Calyxo GmbH in February 2011 from their former partner Q-Cells SE. Solar Fields invented the technology while a resident at the University of Toledo Incubation Center.

“Based on recent good results in production with modules of 80 Wp and higher we decided to increase the capacity of our the low-cost atmospheric deposition process. We are confident, that Calyxo will reach costs clearly below 0,8 USD/Wp end of 2012 and that a CdTe production in the core of Europe will make sense for our customers”, said Dr. Florian Holzapfel, CEO.

The production line will produce the 2011-introduced CX3 product, which was especially designed for hot and humid environments and differentiates substantially from competing CdTe offerings, ensuring long-term stable energy output even under extreme conditions.

In these conditions, installation of the same size (MWp or KWp) with the Calyxo technology can provide up to 10% more energy than crystalline installations, driven by the superior temperature behaviour of Calyxo modules.

“Recently we have published data showing the excellent performance and stability of the Calyxo product under hot and humid conditions based on our unique laminate design” said Michael Bauer, Calyxo’s CTO.

These advances will lead to midterm production costs of less than 0.50 USD/Wp which may be the lowest in the world. Costs this low allow for an LCOE



forecast of less than 0.10 USD/KWh for electricity generated by Calyxo PV systems. Based on current market information, Calyxo is going to be the only meaningful CdTe producer in Europe from 2013.

Calyxo GmbH, founded in 2005, produces thin-film solar modules based on cadmium telluride (CdTe) technology. After the company split from Q-Cells in February of 2011, the former technology provider Solar Fields took over Calyxo GmbH and invested in a second production line with a capacity of approx. 60 MWp, which will commence production in 2012.

Calyxo currently manufactures an annual power generation capacity of 25 MWp at their production facilities Bitterfeld/Wolfen-Thalheim.

Do solar and wind offset fossil fuel?

RENEWABLE ENERGY TECHNOLOGIES do not offset fossil fuel use in the United States according to a new environmental book, *Green Illusions* by University of California - Berkeley visiting scholar Ozzie Zehner. According to the author, building more solar cells and wind turbines could accelerate fossil fuel use unless nations take other steps to avoid a rebound effect. Many energy researchers assume that building solar cells and wind farms will displace coal use and lower CO2 levels. Zehner explains that subsidizing renewable energy merely expands energy supplies, which exerts a downward pressure on prices.

“This brings us right back to where we started: high demand and insufficient supply,” says Zehner. “Historically, we’ve filled that added demand by building more coal-fired power plants, not fewer.”

“We create an energy boomerang,” Zehner remarked. “The harder we throw energy into the grid, the harder demand



comes back to hit us on the head. More efficient solar cells, taller wind turbines, and advanced biofuels are all just ways of throwing harder.”

This counterintuitive boomerang effect is supported by a growing body of research. For instance, a recent paper in *Nature Climate Change*, by University of Oregon professor Richard York, analyzed 50 years of energy data and found no evidence that wind or solar energy production offsets fossil fuel use. In order to avoid the boomerang effect, Zehner argues that nations will have to institute

socioeconomic innovations rather than technical ones. *Green Illusions* details five necessary prerequisites in order for renewable energy production to offset fossil fuel use:

1. Low per-capita energy consumption
2. An energy tax scheduled to increase over time
3. A binding long-term plan to improve building and equipment efficiency
4. Legislation that prioritizes walkable and bikeable neighbourhoods over car culture
5. Universal healthcare and a strong human rights record

Today some nations meet all of these prerequisites while others meet some.

“The US meets none,” remarks Zehner. “In fact, countries such as the USA, with dismal efficiency, sprawling suburbs, a growing population and high rates of consumption, renewable technologies do the most harm as they perpetuate energy-intensive modes of living.”

PV powers into French grid

THE power plant controller skycontrol has been installed in a PV installation that feeds directly into France's 63 kV high-voltage grid. Drawing from experience in the control of utility-scale PV plants connected to medium-voltage grids, Berlin-based company skytron energy fine tuned the plant controller of the 34 MWac PV power plant in the south-west of France to the stringent grid connection specifications of RTE, the French transmission system operator.

The four plant sections spaced from each other as far as 30 kilometres require active compensation of the reactive power load caused by long cable lines. Another trying task is the injection of reactive power into the grid for voltage stabilization, and this even at nights when no power is being generated. This is ensured by meticulously adapted control algorithms and phase-shift capability of the inverters. A further important aspect: frequency control makes sure that the frequency stays within the predefined characteristics and power generation is throttled in the event of over frequency. During on-site commissioning and on-grid test runs, the controller was finely tuned to follow a comprehensive plant simulation model.

"First we were a little apprehensive. For everybody involved, these control requirements meant treading new trails", admits Gerald Freyemann, Technical



Manager of GP Joule, the EPC contractor for the entire project. "But our minds were quickly set at rest by the flexibility of the controller."

Following this successful completion of controlled PV power feed-in, skytron energy GmbH is now installing another power plant controller in a 40 MWp project in the south-east of France, this time injecting into RTE's 225 kV grid.

"We are happy at the growing importance of PV power plants connected to France's high-voltage grid. With the provision of PV power we make an important contribution to grid stability," said Marco Wirnsberger, MD of skytron energy.

aleo solar AG closes plant in Spain

ALEO SOLAR will close its plant in the Spanish village of Santa Maria de Palautordera by the end of this year, at the latest. The Supervisory Board of aleo solar AG has approved the corresponding decision of the Management Board.

"Against the background of global overcapacity and ongoing price war on the photovoltaic market, the ultimate objective is to utilise our capacity of 280 megawatts in Prenzlau. We have to concentrate the production of aleo modules at our main plant", says York zu Putlitz, Chief Executive Officer and Chief Financial Officer of aleo solar AG. The 92 employees of Santa Maria de Palautordera plant are affected by the closure of this location. The company shall immediately approach the works

council to negotiate a social compensation plan for the employees.

"I regret that the company can no longer employ the workers in Spain", says zu Putlitz. "The only alternative to closure would have been a substantial increase in the capacity at Santa Maria de Palautordera."

This could not have been implemented economically due to the global overcapacity in module production. The plant in Spain has a production capacity of about 20 megawatts. The Spanish photovoltaic market, which had already collapsed in 2009, has come to a complete standstill since the Moratorium for Renewable Energy Incentive Programmes of January 2012.

Masdar PV supplies modules in Northern India

THE emerging solar market in India represents an important sales area for Masdar PV, the innovative producer of large-area thin-film photovoltaic products. Recently, a ground-mounted solar park with a total capacity of 1MW was built in Roorkee, about 180 kilometres north of New Delhi. Around 11,000 thin-film modules from Masdar PV are now feeding electricity from a renewable resource into the local power grid there. Metro Frozen Pvt Ltd is the park's operator and the investor.



Masdar PV's well tested, 1.4 m² large a-Si modules are in use in the plant, covering an area of about 25,000 m² in the Indian district of Haridwar, two-hours drive south from the Himalayas. It was above all the products' characteristics, particularly advantageous in conditions like those on the Indian subcontinent that won over the plant's Indian investor and operator. The local conditions play directly to the strengths of Masdar PV's technology, because the thin-film products from Masdar PV provide constant energy yields even in diffuse light conditions and high ambient temperatures. So the new solar park can produce green energy for around 2,600 households, thus contributing to a secure and decentralized power supply for the region.

Masdar PV GmbH develops and produces innovative thin-film solar products and solutions. The company is part of the Masdar Power business unit and is a 100 % subsidiary of Masdar, Abu Dhabi's multifaceted initiative for innovative renewable energy technologies, launched and owned by Mubadala Development Company.

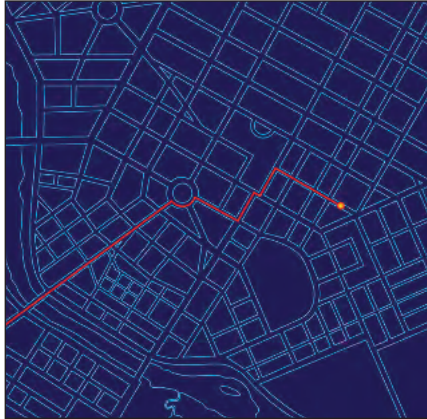
U.S. PV manufacturing consortium begins National CIGS PV Roadmap

THE U.S. Photovoltaic Manufacturing Consortium (PVMC), an industry-led collaboration headquartered at the College of Nanoscale Science and Engineering (CNSE) of the University at Albany in New York that is designed to accelerate next-generation solar photovoltaic (PV) technologies, has selected a trio of leading solar industry executives to guide development of the first-ever U.S. CIGS PV Roadmap.

Dr. Alain Kaloyeros, Chair of PVMC and Senior Vice President and CEO of the College of Nanoscale Science and Engineering, said, "Through the leadership and vision of Governor Andrew Cuomo, and the critical investment by the U.S. Department of Energy, New York is leading the national effort to accelerate the deployment of efficient and cost-effective solar energy through the development of innovative CIGS technology. The engagement of three leading solar executives is an important step forward in enabling PVMC to deliver the nation's first-ever CIGS PV Roadmap, and we look forward to their guidance and participation in this important endeavour."

Dan Armbrust, CEO of PVMC and President and CEO of SEMATECH, said, "One important objective of PVMC is to build leadership around road maps to establish the disciplines of financial and cost modeling, strategic planning and other long-term activities for CIGS PV manufacturing and applications. PVMC will take a lead role in bringing in the entire industry supply chain to collaborate in defining critical challenges and potential solutions for over the next decade."

Spearheaded by CNSE and SEMATECH as part of the U.S. Department of Energy's (DOE) SunShot Initiative, PVMC is targeting a reduction in the total installed cost of solar energy systems by 75 percent over the next decade. The CIGS PV Roadmap aims to provide a congruent plan for the national CIGS industry, including module and systems manufacturers, suppliers, and end-users, that will identify common challenges and define the areas of technical developments needed to sustain and



advance a competitive U.S. photovoltaic industry.

Dr. Larry Kazmerski, Dr. Joseph Laia, and Dr. Richard Swanson will serve as co-chairs for the groundbreaking effort, which will include participation from all sectors of the photovoltaic industry and support the development and growth of advanced solar PV-related manufacturing processes throughout the United States.

"The National CIGS PV Roadmap effort is a vital initiative, bringing together all sectors of the photovoltaic industry to identify critical challenges and coalesce industry direction and market leadership," said Dr. Joseph Laia. "I am delighted to be selected co-chair of the CIGS PV Roadmap. I look forward to providing guidance on solutions-driven initiatives that tackle top industry concerns on the technical barriers, manufacturing processes, and business challenges associated with CIGS thin-film solar PV."

"I am honored and excited to be working with my co-chairs and the roadmap team to help DOE further define and clarify the role CIGS can play in our energy future," said Dr. Swanson. "We'll be building on earlier PV roadmap initiatives, and collaborating with partners from industry, universities, and government to help set the direction for this promising renewable energy technology."

Serving as the champions for the U.S. CIGS PV Roadmap, the co-chairs will direct the activities and decisions of the Roadmap Executive Steering Committee (RESC) and guide roadmap working groups addressing six focus areas

relevant to the entire industry, including roll-to-roll; rigid glass; metrology; modules and packaging; substrates and materials; and reliability, certification, and test.

Dr. Kazmerski is Director of the National Center for Photovoltaics at the National Renewable Energy Laboratory (NREL), where he has led NREL efforts in measurements and characterization for more than 20 years. Kazmerski has published more than 310 journal papers in the areas of solar cells, thin films, semiconductor materials and devices, surface and interface analysis, scanning probe microscopy, nanoscale technology, high-temperature superconductivity, and semiconductor defects, and is a three-time recipient of the R&D 100 awards for novel measurement and characterization devices.

Dr. Laia most recently served as President and Chief Executive Officer of Miasole. Prior to Miasole, he was Group Vice President of Metrology at KLA-Tencor, responsible for all of KLA's eight wafer metrology businesses, and served as Chief Executive Officer of Blue29 LLC, a subsidiary of KLA Tencor Corp. He has over a decade of national laboratory experience and spent a number of years in semiconductor capital equipment companies. He holds 10 patents, has published 25 papers, and has edited one book in the area of materials processing.

Dr. Swanson founded SunPower Corporation to develop and commercialize cost-effective photovoltaic power systems in 1991, and currently serves as its president emeritus. Along with his students and co-workers, Swanson has published more than 200 articles in journals and conference proceedings, as well as several book chapters.

In 2002, Swanson received the William R. Cherry award by the IEEE for PV contributions, and was elected to the National Academy of Engineering in 2009. Most recently, Swanson received the Economist's Innovation Award for Energy and Environment, the 2010 IEEE Jun-ichi Nishizawa Medal, and the Karl Boer Solar Energy Medal of Merit.

Trina ranks first environmentally

TRINA SOLAR has been ranked No. 1 globally for environmental and social performance in the 2012 Solar Scorecard, an award system established by the Silicon Valley Toxics Coalition ("SVTC").

SVTC's Solar Scorecard, now in its third year, aims to improve PV manufacturers' environmental practices and responsibility for the environmental impacts of its manufacturing processes so that the solar industry can be considered a truly clean and green industry.



The Scorecard is a resource for consumers, institutional purchasers, investors, and other decision makers who purchase PV modules from responsible product stewards. The Scorecard reveals how companies perform on SVTC's sustainability and social justice benchmarks to ensure that the PV manufacturers protect workers, communities, and the environment. Survey specifics covered areas such as extended producer responsibility and takeback, supply chain monitoring and green jobs and chemical-use and life cycle analysis and disclosure.

"We are very proud of our top ranking in this leading environmental survey, which reflects sustainability improvement efforts from all our operating areas," said Mr. Jifan Gao, Chairman and CEO of Trina Solar. "As PV Solar adoption expands into new markets and regions, we are committed to adding innovation and value both inside and outside the module, which includes our EHS and Corporate Social Responsibility practices."

Donauer Solartechnik completes PV plants in South Africa

DONAUER SOLARTECHNIK is commissioning a photovoltaic plant on the roof of the University of the Witwatersrand in the South African city of Johannesburg. The plant will deliver an annual yield of around 2,800 kilowatt hours and is a part of a project to provide environmentally friendly electricity for two educational institutions on location.

In cooperation with a German project developer and a South African installation company, Donauer was able to provide both educational facilities with reliable and sustainable electricity. A first solar plant was furnished by Donauer for the Mafa Max Motloung Secondary School in Delmas, located 70 kilometres away. It was connected to the grid on the 28th December 2011.

Its expected annual yield is approximately 3,000 kilowatt hours, which are used for a combination of feed in and own consumption. Since its commissioning a few months ago, the plant has already generated so much energy that the electricity costs of the school could be reduced by 40 per cent. The photovoltaic plants should help the pupils and students sharpen their awareness of renewable energies by learning interactively. With the help of data loggers, PCs and laptops, the students will be able to take over monitoring the plant and evaluating the data.

The pupils in Delmas can also access their plant monitoring system and learn,

hands-on, how to deal with the new technologies. Thanks to this practical and understandable example, they find out how solar energy can significantly contribute to providing their country with energy.

To date, coal-fired power plants have generated around 90 per cent of the energy South Africa consumes.

Nonetheless, the present energy supply cannot serve the rapidly increasing demand due to the economic boom and progressing electrification. Again and again, electricity outages occur.

"Sustainable showcase projects in the solar sector are needed to demonstrate the enormous potential of solar energy in South Africa", says Benedikt Böhm, regional sales manager at Donauer. He summarises, "Important for the coal-mining region in Delmas is, moreover, that the young generation, above all, can see in photovoltaics an alternative to conventional sources of energy. For this, Donauer places great emphasis upon integrating local project partners, who are an important key to successfully implementing projects."

With a solar irradiation value of up to 2,500 kilowatt hours per square meter, the region on the Horn of Africa belongs to the sunniest areas on the earth. Currently, the South African government is primarily supporting large-scale solar power plants.





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German solar installations to move from parks to rooftops

EUROPE is set to dominate the own consumption segment, with growth of up to 150 GWp by 2020. More than half of all installed solar capacity worldwide could be for own consumption by the end of the decade, according to a recent McKinsey study. Germany is already the global frontrunner in solar power, accounting for approximately half of the world's photovoltaic capacity.

"Those companies who survive the current consolidation wave will experience a bright future. Especially the rooftop segment and downstream business models are expected to drive the industry forward," stated Tobias Rothacher, photovoltaic industry expert at Germany Trade & Invest in Berlin.

The global solar industry is experiencing growing pains as prices and margins continue to fall. At the same time demand is likely to increase by an additional 400 to 600 GWp of photovoltaic capacity worldwide by 2020, according to the



McKinsey report "Solar power: Darkest before dawn". Especially the business-to-customer segment for own consumption is creating opportunities for innovative downstream companies that offer comprehensive installation and service packages.

"Germany has supported own consumption of solar power for years. The coming grid parity era is ushering in an era of new business opportunities. We expect Germany to continue to be the top business location, as innovations and industry standards are developed here," continued Rothacher.

First Solar and Intermolecular announce joint program

FIRST SOLAR and Intermolecular announced an agreement aimed at accelerating the roadmap for First Solar's cadmium-telluride (CdTe) photovoltaic (PV) technology. Under a newly signed collaborative development program, First Solar will leverage Intermolecular's High Productivity Combinatorial (HPC) platform in the development of its advanced, CdTe-based, thin film PV manufacturing technology. Technical work is to be performed jointly at Intermolecular's San Jose, Calif., facility and in First Solar's research and development labs.

"We are excited to engage in this collaboration with Intermolecular," said Raffi Garabedian, First Solar CTO. "Further improving our CdTe conversion efficiencies remains a strong lever to reduce the cost of solar energy. We evaluated Intermolecular's HPC platform

and team in a trial collaboration."

First Solar set a new world record for CdTe PV solar module efficiency in January 2012, achieving 14.4 percent total area efficiency. In July 2011, the company set a world record for CdTe PV cell efficiency at 17.3 percent. Both records were confirmed by the U.S. Department of Energy's National Renewable Energy Lab (NREL).

Craig Hunter, Intermolecular's senior vice president of Global Sales & Marketing, commented, "Leveraging our HPC platform to accelerate the PV roadmap is central to our mission at Intermolecular. The deal with First Solar represents validation of that proposition, particularly given the extensive technical due diligence the First Solar team conducted prior to entering into this agreement."

imec and Kaneka announce solar breakthrough

KANEKA and imec report a large area (6 inch semi-square) heterojunction silicon solar cell with a certified power conversion efficiency of 22.68% with an electroplated copper contact grid on top of the transparent conductive oxide layer. This breakthrough is achieved at Kaneka Osaka lab using Kaneka's copper electroplating technology which is based on imec's state-of-the-art copper electroplating knowhow.

To realize the top grid electrode in heterojunction silicon solar cells, silver screen printing is the preferred technology in the PV (photovoltaic) industry. However, a drawback of this technology is the difficulty to lower resistivity and to thin the metal line in silver screen printed contacts. As a result, efficiencies remain below optimal and cost remains relatively high. Replacing the screen-printed silver with electroplated copper overcomes the disadvantages of silver screen printing, enabling higher efficiencies and reduced fabrication costs.

Kaneka's Photovoltaics European Laboratory is located at the imec campus in Leuven (Belgium), with access to imec's state-of-the-art PV infrastructure. The collaboration between Kaneka and imec has led to the improvement of Kaneka's thin-film solar cells and the development of next-generation heterojunction cells. This development of large area Cu-plated heterojunction silicon solar cells is an important step towards a fab-compatible process on large area module integrated solar cells. Kenji Yamamoto, General Manager of Kaneka's Photovoltaics European Laboratory says that "Kaneka is proud to have achieved this result which was made possible through the initial developments made by imec."

Jef Poortmans, Director PV technologies at imec: "We are excited that we could support Kaneka in developing this breakthrough results. They prove the capabilities of copper metallization for next-generation solar cells and strengthen our believe that in the future copper will play an important role in high efficiency and sustainable solar cell technology."

Canadian Solar provides PV research

Canadian Solar announced the delivery of 1 MW of high efficiency ELPS solar modules for a research and testing plant, installed by Nordwest Solar, in the German area Emsland. In various zones of the 3 hectare-sized solar park located in Werlte different characteristics of solar modules will be tested in order to achieve new insights to efficiency increase. Construction is planned to start in June. The PV plant is one of the first projects in Germany where Canadian Solar's ELPS technology will be installed.

The research and testing plant with a capacity of MW was initiated by Institut für Erneuerbare Energien GmbH & Co. KG (IEE), 3N-Kompetenzzentrum Niedersachsen Netzwerk Nachwachsende Rohstoffe and the municipality Werlte. Due to their delivery reliability Großhandelszentrum für Photovoltaik Redpoint Solar GmbH was selected as supplier for the system

components of the solar testing field. Right from the planning stage of this challenging project and the installation of the i.a. ELPS solar modules of Canadian Solar the IEE relies on experience and competence and cooperates with Nordwest Solar Energiesysteme GmbH, one of the leading companies in the PV industry.

"The Northern part of German is incorrectly seen to be less interesting for PV installations. We want to show which advantages result from lower temperatures and therefore a lower decrease of performance of the modules. Thus we have chosen the technologically leading Canadian Solar modules with the new ELPS technology," said Jörg Klingenberg (IEE). Canadian Solar's ELPS cells feature a Metal Wrap Through (MWT) design, and can absorb 3% more light per cell. ELPS modules deliver up to 7% more electricity than similar



configuration conventional solar modules.

"Increasing efficiency is the most important topic for the solar industry. With our ELPS technology we made a big leap as our most recent In-house test showed results of 21.1 percent efficiency with our proprietary mono ELPS solar cell. We are very pleased that this technology will be used in Werlte," said Dr. Shawn Qu, Chairman and CEO of Canadian Solar.

Off grid solar using existing infrastructure

They are a ubiquitous sight in Uganda. Radio masts, powered by noisy, smelly Diesel generators. Solar powered cellular services is an idea that will not only help the mobile carriers cut the emissions from the expensive Diesel fuel by more than 90%, but the solar power will also be used to provide green electricity to adjacent settlements.

In a pilot study conducted with their German partner Kirchner Solar Group, the Gesellschaft für Internationale Zusammenarbeit (GIZ) will develop a marketing concept for solar power in the private sector. This could turn hundreds of radio masts in Uganda into lighthouses shining their light into remote villages. GIZ is a German federal initiative that seeks to implement sustainable solutions around the globe.

80% of Uganda's 34 million people live off farming. More than 27 million live in rural areas where only 3% of all households have electricity. The lack of electricity hinders the growth of small service providers and craftsmen. It also restricts the rural population's lifestyle. Every evening millions of huts are illuminated by petroleum lamps. These lamps pollute the air with carcinogenic substances and are

expensive to operate. One kw hour produced by petroleum burners, small Diesel generators or batteries is far more expensive than solar power. A farmer depending on subsidies who only thinks ahead from harvest to harvest will find it hard to plan ahead and save money to purchase currently available solar solutions.

The idea behind the new approach is for the mobile carriers to become the main customers and village households become the small customers.

The solar power provider has a mobile carrier as a guaranteed key customer – the Airtel company already accepted the deal. Some radio masts in remote regions adjacent to settlements are selected in a pilot project to serve as connection points for solar electrification. The solar power provider will supply energy to the radio mast while at the same time selling solar power to surrounding households. The power is to be sold by a prepaid meter system: the customer only pays as many kilowatt-hours that they can afford. GIZ Uganda builds on an approach already applied by Insensus in a cooperation project with GIZ to produce wind-solar energy in Senegal.

Kirchner Solar Group, a company running 12 locations worldwide, has been operating in Uganda since 2008 and has set up four shops, one production plant and a training center near the town of Kampala.


Since 1999, the GIZ has been active in Uganda's on behalf of the German Ministry of Economic Cooperation and Development (BMZ). The "Development Program for Renewable Energies and Energy Efficiency (PREEEP)" has long-standing relations with the BMZ and with relevant authorities, such as the Rural Electrification Authority. The concept of off-grid rural electrification has already been politically positioned.

BMZ plans to support the pilot project because they pursue the goal to foster local power supply: when you multiply the approximately 1,000 people that can be supplied per radio mast by the number of remote off-grid radio masts in Uganda, the result is a potential of up to 250,000 people that could be given access to electricity this way. This could alleviate the harsh conditions of the rural population and improve the production possibilities for rural entrepreneurs, which in turn translates into jobs.

Grid compatibility for stability



The increasing numbers of decentralised, weather-dependent solar photovoltaic (PV) farms are presenting a challenge to grid stability. Given this, the grid compatibility of these solar PV farms must be certified before the plants can be connected to the grid. Dieter Rosenwirth, Dipl. Ing. of TÜV SÜD Industrie Service provides background information about the certification process, the criteria and new guidelines and directives.



The announcement of Germany's revised Renewable Energy Sources Act (EEG 2012) in February may have been one of the reasons why the operators of distribution grids have been flooded with applications for the connection of new solar PV farms this year. While feed-in tariffs have been further reduced, these cuts have been less extensive than originally planned. And since prices of PV modules are going down while the efficiency of the modules is going up, solar PV plants remain an interesting option for investors and home owners. Last year alone, the operators of distribution grids paid around 16 billion euros in feed-in tariffs to owners of solar PV plants.

However, these new power generating plants also pose a challenge for grid stability. The power output of the PV modules is highest between 11 am and 5 pm, i.e. the period with the most intense solar radiation. While this – except at weekends – admittedly often coincides with high energy demand, the power output is affected by weather fluctuations and therefore not always reliable. To ensure that solar PV plants will contribute to the stability of our electricity grids, we need to test their electrical characteristics and the components that make up these plants. Once connected to the grid, solar PV plants must perform similarly to conventional, industrial-scale power stations and offer the same fault ride-through performance.

What needs to be certified?

Basically, the relevant guidelines and directives demand that all technical components of the generating plant contribute actively to maintaining stability of the grid voltage and frequency. However, power generating units and plants are subject to different directives and guidelines depending on the grid into which the electricity is fed. At present, photovoltaic plants are connected either to the low- or medium-voltage grid depending on their capacity. They do not yet play a role for high-voltage grids.

Criteria for connection to the medium-voltage grid

Connection to the medium-voltage grid is governed by the Medium Voltage Directive of the German Association of Energy and Water Industries e.V. (Bundesverband der Energie- und Wasserwirtschaft, BDEW). Photovoltaic plants in this high-capacity range must undergo grid compatibility certification if their apparent power exceeds the threshold of one megavolt-ampere. Apparent power comprises the active power fed into the grid and the 'reactive power' of the plant. While reactive power is needed for grid operation, it is not subject to remuneration.

The second criterion for determining whether a plant is subject to certification is the length of the cable leading from the installation to the point of common coupling (PCC). Long cables can significantly impact on the plant's behaviour at the PCC. Given this, the applicable regulation requires certification if the

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cable system is over 2 km long, even if the apparent power at the medium-voltage grid is below 1 MVA. This provision also applies if the plant and its cable system up to the PCC are located on the same premises, such as a large industrial company or an airport.

Criteria for connection to the low-voltage grid

At present the regulations do not require power generating units or plants connected to the low voltage grid to be certified. Connection to the low-voltage grid is governed by various standards and a specific application code. Following revision of the “Generators connected to the low-voltage distribution grid” guideline, issued as an application guideline by the FNN (the forum network technology/network operation in the VDE), additional demands are now made with regard to aspects including the behaviour of these plants in the case of frequency fluctuations in the grid. Given this, these power generating plants no longer act as passive power distributors but are required to play an active role in the electricity grid. However, retrofitting of existing plants will not be necessary for the time being.

Certification by TÜV SÜD – what does it involve?

Grid-compatibility certification is a further criterion governing eligibility for the feed-in tariff guaranteed under Germany’s Renewable Energy Sources Act (EEG). There are two different

types of certificates: the power generating unit (PGU) certificate that is issued for the individual inverters as confirmation that they are compatible to the grid, and the power generating plant (PGP) certificate that confirms that the performance of the entire plant is in conformity with the standards.

Certification of the inverter

Before the start of the certification process, the plant owner compiles all relevant documents and submits them to an accredited certification body such as TÜV SÜD. The certification body now reviews the documentation for completeness and plausibility. Based on this review, the certification experts will assess whether the power generating unit (PGU, in the case of photovoltaic systems, the inverter, is in conformity with the requirements. Conformity assessment is carried out in accordance with the technical guidelines of the FGW, the German public association of the renewable energy sector, and includes analysis of the active power output, control systems and decoupling control as well as grid impact (FGW-TR8).

Subsequently, the certification professionals validate the simulation model of the PGU in accordance with FGW-TR4. This grid calculation model enables steady-state load flow analysis and the simulation of symmetrical and asymmetrical faults. A summary report then informs the owner of the plant whether all relevant standards, directives and requirements have been fulfilled. The certification body only issues a PGU certificate if there are no concerns that the generating unit has the characteristics required for grid connection.

A critical factor for ensuring rapid certification is the availability of the required documents and simulation model. In the case of inverters – the power generating units of photovoltaic systems – this is not always ensured. Manufacturers who are insufficiently familiar with the certification process and the applicable

Criteria for power generating unit (PGU) certification

- A manufacturer’s certificate of the specific data of the PGU in accordance with FGW-TR3
- A detailed technical description of the PGU
- The complete documentation, including reports of measurements and type approval in accordance with EN 17025 by an accredited testing laboratory
- A simulation model of the PGU including a description of the model in accordance with FGW TR4
- The measured data underlying the test report in accordance with FGW TR3
- Component certificates in as far as relevant for PGU certification
- Declarations of conformity and technical descriptions by the manufacturers of other relevant operating equipment (e.g. control systems, protection devices)
- A minimum of a single-line diagram of the PGU
- Evidence of a certified quality management system in accordance with EN ISO 9001 for the manufacture of PGU

standards and directives in particular often fail to provide the required documentation and simulation model. Consequences include delays and unscheduled retrofitting measures which may jeopardise timely project completion and the profitability of the plant later on. Given this, the most sensible approach is to obtain impartial expertise as early as possible to counter possible risks in the planning stage before they turn into problems.

Certification of a power generating plant

The plant certificate builds on completed PGU certification and checks the interoperability of the entire plant and its performance in the grid. Similarly to unit certification, the experts develop a data model which also includes the operating equipment and the utility network at the point of common coupling. The model is based on the project-specific PGU certificates and the calculation model, a single-line diagram of the solar farm and a diagram of its control system (“decoupling control”). Also reviewed within the scope of this process are the wiring diagrams of the medium-voltage systems, the data sheets (owners of solar farms / owners of distribution grids) and the technical data of the cables, transformers and operating equipment used, such as switchgear, controllers or dynamic reactive power compensation.

Plants may not be connected to the grid without the PGP certificates. The grid owners require the certificate to ensure that the plant as a system is compatible to the grid. Given this, the certification experts consider all power generating units and components up to the point of common coupling. After the parties have clarified detailed questions, the entire power generating plant, its components and a simplified model of the utility grid at the point of common coupling are simulated on the computer. Using special grid software, the experts carry out the required calculations in accordance with FGW-TR8. These simulations are aimed at verifying that plant behaviour is in conformity with the rules and regulations and form the basis of a detailed conformity report in which the experts summarise the test results.

For the certificate to be issued, all documents (see info box 2)

Criteria for power generating plant (PGP) certification

- The data sheets of the solar farm owners and the grid operators
- The project-specific unit certificates and simulation models
- A single line diagram of the power generation plant
- Wiring diagrams of the medium-voltage systems;
- Documentation of the control system and decoupling control
- A diagram of the control system of the power generating plant
- The control concept of the reactive and active power supply
- Certificates and declarations of conformity for operating equipment
- Technical data of cables, transformers, controllers, control panels and other components



must have been submitted to the accredited certification body and reviewed for completeness and plausibility there, and all technical requirements must have been fulfilled in simulation.

After the plant has been installed and taken into service the certification body carries out final approval, which is a prerequisite for the feed-in tariff under Germany’s Renewable Energy Sources Act. Have all components been installed in accordance with the requirements and as set forth in the certificates? For the certification experts to issue the final declaration of conformity, all documents required for placing the plant into service, other records and wiring diagrams as well as the ongoing operation of the plant must be in compliance with the rules.

Electrical characteristics and grid stability

The electrical characteristics of the photovoltaic plants must impact positively on grid stability. In concrete terms this means that photovoltaic plants must have suitable systems, enabling them to react to changes in the grid. Another critical factor involves the system support services that must be provided by the power generating units.

These services include reduction of the feed-in of active power as specified by the grid owner and the generation or consumption of reactive power depending on the voltage in the grid. The plants must further satisfy low-voltage ride-through requirements. This means that plants must remain connected to the grid even in case of faults and short circuits unless these faults occur in their cable branch. In addition to the above, the plant must supply additional reactive power during the fault. Short circuits resulting in voltage drop also may not render the plant unstable or result in its disconnection from the grid.

However, supplying the power generating plants with grid-stabilising characteristics will not be sufficient in the future to guarantee grid stability.

To balance out the fluctuations in the amount of energy fed into the grid by renewable sources, we will firstly have to massively expand our grid infrastructure. Secondly, reserve and control power are important, as indeed are more energy storage facilities over the medium term.

Pumped-storage hydroelectricity is currently the only means of energy storage. Possible solutions in the future include compressed air energy storage or a vehicle-to-grid (V2G) system, i.e. a system in which an overtaxed electrical grid can draw energy from a group of cars, and then recharge them at times when energy is in abundance.

Conclusion

The grid compatibility of photovoltaic systems is becoming more and more important. The complex certification process should be mastered with the help of qualified experts. To avoid costly rework or retrofitting measures, the aspect of grid compatibility and the required certification should be considered right from the plant's design stage. TÜV SÜD's experts provide support in ensuring a targeted and efficient certification procedure.

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Excursus: Hazard potential and operational risks

In addition to grid compatibility certification, which assesses the interoperability of the entire electrical architecture, owners must also identify plant-specific risks at an early stage to take appropriate risk-prevention measures. Photovoltaic systems connected to the grid are power plants, and their hazard potential consequently differs little from that of other technical plants.

Most damage to photovoltaic plants is caused by inexperienced installation. Covering or dismantling of lightning protection systems and inadequate securing of cable routing may cause considerable fire-safety hazards. The required inverters form another critical point; they must be installed and operated under the environmental conditions specified by the manufacturer.

The aspect that the plant and its cable system are exposed to all kinds of weather conditions over years should also be taken into account.

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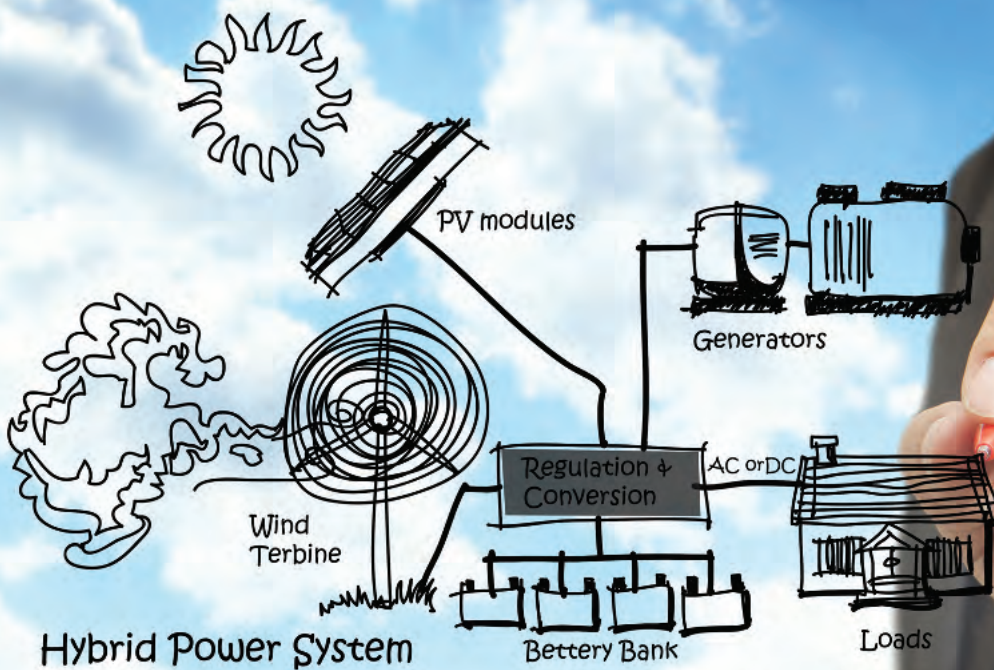
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Impact on PV from WEEE

The WEEE directive, (Waste Electrical And Electronic Equipment), is set to come into force and will impact all PV and solar manufacturers wishing to manufacture or sell in the EU. Despite fears in some quarters there may not be a need for PV companies to provide a complete take back program for solar and PV products according to consultants take-e-way GmbH.

Effects of the WEEE Recast on PV manufacturers and importers will begin to impact all European companies and will include a number of changes.

As soon as the revised directive of the European Parliament and of the council on waste electrical and electronic equipment (WEEE directive) is binding for all manufacturers and importers of solar and PV modules, the producers will need assistance in particular when implementing the German version of the WEEE directive, the Electrical and Electronic Equipment Act (ElektroG).

After the implementation of the "WEEE2" in the European Union, the requirements and obligations are required before selling solar and PV modules. This will be required not only when recycling but will continue for many years of operation.

Germany in particular will require PV manufacturers and importers to provide a guaranty that they are protected from insolvency for the expected sales volume. Companies will also be obliged to maintain comprehensive reporting and registration obligations. It will also be necessary to provide an extensive

With its two approved manufacturer's warranty systems take-e-way is a full service provider and one of the most important suppliers on the German markets with a share of 36 percent of all manufacturers registered

waste disposal network in order to be able to process possible recycling requirements in a manner that complies with the law.

Potential solution

German company take-e-way GmbH represents the interests of more than 2400 small and medium-sized companies throughout the value chain. Their efforts include lobbying at the political level in cooperation with the Verband zur Rücknahme und Verwertung von Elektro- und Elektronikgeräten (VERE e.V.) (Association for the Return and Recycling of electric and electronic Devices) founded in 2003. This organisation is made up of suppliers, manufacturers, trade associations and individuals to implement of the ElektroG in Germany. With the largest number of members it is a strongly supported system. Members require two approved manufacturer's warranty systems making take-e-way a full service provider and one of the most important suppliers on the German markets with a market share of 36 percent of all manufacturers registered in the field according to the Electrical and Electronic Equipment Act (ElektroG).

Companies such as take-e-way process provision and disposal orders on behalf of its connected customers every day.

To do so, take-e-way maintains a nationwide network of certified treatment plants which show efficient handling of worn out PV modules.

Consultation at hand

Organisations such take-e-way GmbH and the Association for the Return and Recycling of electric and electronic Devices (VERE e.V.) are a valuable resource for companies needing to keep up with

changing political and industry regulations.

The main focus of take-e-way and VERE are:

- Implementation of the WEEE directive and the Electrical and Electronic Equipment Act (ElektroG): Obligations of manufacturers and importers of solar and PV modules as soon as the WEEE directive begins. The Electrical and Electronic Equipment Act (ElektroG) will be binding for them.
- WEEE amendments: Most important modifications of the WEEE directive particularly with regard to PV modules.
- Solutions for the PV industry: Recommend course of action for the processing of solar and PV modules within the established logistics and recycling infrastructure in Europe.
- Recycling of solar and PV waste: Professional recycling of solar and PV modules in the framework of the current technical possibilities. take-e-way and VERE will inform how far the existing processing plants are adaptable to the new material flow of "photovoltaic modules".
- The German WEEE implementation – 7 years of Electrical and Electronic Equipment Act (ElektroG): Presentation of the optimum solution with regard to costs, administrative efforts, logistics and recycling of solar and PV modules using the example of the German Electrical and Electronic Equipment Act (ElektroG).

No full return required

Oliver Friedrichs, manager of the take-e-way GmbH, states: "The recycling and taking back of PV and solar modules can be handled via established logistics and recycling systems in Europe. Implementing the Electrical and Electronic Equipment Act (ElektroG) offers the option of cost-efficient processing of the obligations to the manufacturers.

However, it is necessary to make sure that the worn out modules are undamaged as far as possible when they are taken back. To do so, it is necessary to check if it is possible to arrange for a proper collection group for PV modules at the transfer points. For instance, gathering and transportation can be performed on stake pallets."

"When implementing the WEEE directive it is important to reduce the administrative burden and for rapid registration of the manufacturers as a basis of legal sales and the participation in manufacturer warranty and recycling systems according to performance. To do so, take-e-way provides smart problem solutions for small and large companies.", explained Friedrichs.

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Tomorrow's Technology Trends

While most technology companies tend to view their business from the microcosm of their own efforts, the truth is all industries are interlinked and impact each other whether in terms of infrastructure, supply or business approach. One of the world's most sought-after keynote speakers at corporate events, futurist Dr. Patrick Dixon gives his take on tomorrow's technology trends with a guide to highlight potential solutions for industry as well as potential challenges for global companies.

When Dr. Patrick Dixon really wants a vacation, he chucks his cell phone into a bucket of water. Seriously. "I live in a very virtual world," says Dixon, interviewed via Skype in London. Although trained as a physician, he works as a futurist – a business consultant who specializes in global change strategies. Being a futurist requires neither a crystal ball nor tea leaves. Instead, says Dixon, the author of 15 books on management and trends, "I'm constantly sampling humanity's stream of consciousness."

In his relentless quest to stay ahead of the curve, Dixon taps into both traditional and social media, including tweets, YouTube, the

Financial Times, blogs, New Scientist magazine and even LinkedIn updates. Along the way, he keeps his finger on the pulse of such hot topics as environmental sustainability and the drive for business innovation.

Dixon credits another crucial source of information that helps shape his views: the companies with which he works. "I lecture or consult in many different nations every year, and to many different industries. In each case, I work with people who are creating the future, people on the front edge of innovation. They give a perspective that is much sharper than what you would get from other sources."



About the author

Dr Patrick Dixon is an author and business consultant, often described as a futurist. In 2005 he was ranked as one of the 20 most influential business thinkers alive according to the Thinkers 50 (a private survey printed in The Times). He is Chairman of the trends forecasting company Global Change Ltd, founder of the international AIDS agency ACET, and Chairman of the ACET International Alliance.

According to a recent study, 30 percent of British trucks carry nothing at all on their routes.

“Even more shocking,” Dixon says, “many thousands of trucks carry identical polymers in opposite directions and on the same roads.” Polish polyethylene is being trucked to the U.K., while British polyethylene gets trucked to Germany. If chemical suppliers coordinated their routes, he says, more than 100 million kilometers (60 million miles) of trucking could be saved every year in Europe alone. Dixon’s latest book, *Sustainability: How Innovation and Agility Will Save the World* (2010), details dozens of ways companies have found to become greener. Even the most profit-focused companies have realized that the fastest way to grow is to look after the environment,” he says. “Reducing global warming saves money. That’s why the green tech revolution is advancing so fast.” New fuel-conserving inventions are springing up everywhere, from winglets on airplane wings to nanotechnology that reduces friction inside car engines. In fact, Dixon says, “many of the most exciting innovations are invisible.”



Innovation impacts all

Moreover, the way that innovation occurs is shifting. In the past, corporate innovation teams used to lock themselves away until they were ready to apply for a patent. Now, Dixon says, “many of the biggest innovations are happening more openly.” Companies such as Hewlett-Packard, GlaxoSmithKline and IBM are using open innovation tools, sometimes giving a problem to several universities to crack or even turning to social media. “Many of the world’s greatest challenges are too complicated to be solved by any one company’s research department.” Certainly, the past can help predict the future in certain ways, Dixon observes. Today’s pension crisis, for example, was set in motion decades ago by Europe’s declining population. “The trouble is,” he says, “that there are big shifts taking place for which we have no history.”

Global warming may indeed bring challenges humanity has never before faced. Yet Dixon says companies that are nimble and entrepreneurial can take advantage of upheaval. “The world can change faster than the time it takes for you to organize a board meeting, so you have to plan ahead. In crisis there is opportunity,” he says. “That’s the lesson of history. Some of the greatest fortunes have been made at times of economic meltdown or war or chaos. Companies need leadership teams that are able to make a big leap.”

In facing the future, the real key to success is agility, Dixon says. “It’s always having Plan C, because Plan B is not enough. Every sensible leader has at least two backup strategies.”

And perhaps two cell phones.

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So what does the future hold?

Dixon predicts major progress in green technologies. This moment in history is one of extraordinary opportunities, he says, because concern about the environment is driving both government policy and consumer demand. “Consumers expect their companies to produce products that are greener but no more expensive,” he says. “And they’re getting those products, because innovation can deliver both.”

Looking more specifically at the polymer industry, he believes the future could bring carbon reductions through improvements in transportation efficiency.

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Thin glass updates

While glass is seen as a viable substrate for solar and PV applications the industry often approaches such technical options from the limited view of their own needs not realising that technology that may assist continues to move forward in creating thinner and more flexible glass. The advances made in this area will directly translate to providing the solar and PV manufacturing future needs.

Increasingly tighter requirements on heat insulation by law and constantly increasing energy prices are driving forward the trend towards triple glazing in architecture. A constructive opportunity to counter the associated increased weight of glass is presented by the use of thin glass.

Glass is an ideal material for application in building shells. The transparent material can be used in a variety of applications and – irrespective of the type of finishing – fulfills individual functions. Modern insulation glass offers reliable heat insulation and solar protection, prevents high noise pollution and also, if required, corresponds to the highest safety levels. In addition, individual design highlights can also be achieved through the use of glass. The elementary functions of glass products in the building shell also include heat insulation. In view of the increasingly tighter legal requirements placed on architectural heat insulation and the rising energy prices, in recent decades the glass industry has been continually further developing its products and has achieved considerable improvements in efficiency.

Increasing requirements

The limits of physics can, however, not be overcome even with the use of perfected glass formats and highly functional coatings. In the case of double (insulation) glazing, which has been used over decades, the limit has already been reached with a heat transfer co-efficient (Ug-value) of 1.0 W/m²K. To satisfy the current heat insulation requirements by law, this value is absolutely sufficient, but not for future requirements. According to the European Union Energy Performance of Buildings Directive - EPBD), which came into force in 2010, as early as January 2021, only “nearly zero-energy-buildings” are to be erected in the private construction sector, in other words buildings, which require almost no external energy supply. For new buildings, which are used by the authorities as the owners



The trend towards triple insulation glazing and ever larger units is leading to high glass weights and placing greater requirements on the installation team. Photo: Messe Düsseldorf

on an owner-occupier basis, this requirement will already apply two years earlier. As poorly insulated existing buildings account for a large part of high building energy consumption, here too the minimum requirements for heat insulation applying to new buildings have to be satisfied for larger restoration projects and new extensions.

In order to fulfill the expected high requirements placed on energy efficiency in buildings, insulation glazing will also have to achieve even better results in future. The glass industry is therefore increasingly relying on triple insulation glazing. With

U values of up to $0.5 \text{ W/m}^2\text{K}$, in the past this functional glazing was previously mostly fitted in passive housing. In the last five years sales of high-insulation glazing have, however, risen dramatically, because when it comes to glazing, an increasing number of building owners are relying on high energy efficiency – even if their buildings have not reached the level of passive housing.

According to the German Flat Glass Manufacturers' Association (Bundesverband Flachglas e.V.), in the period from 2008 to 2011 alone, the share accounted for by triple insulation glazing of total glazing sales in Germany rose by around 10% to over 50%. For the current year the association already expects a share of around 60 percent. And the upward trend will continue further.

“We are convinced that the market share will grow to over 90 percent. This trend is being accelerated by the forthcoming Energy Savings Ordinance (Energieeinsparverordnung - EnEV), which will probably prescribe the use of triple insulation glazing”, explains Dipl.-Oec. Jochen Grönegräs, Executive Director of the German Flat Glass Manufacturers' Association (Bundesverband Flachglas), and Managing Director of the Multi-Pane Insulating Glass Quality Association (Gütegemeinschaft Mehrscheiben-Isolierglas).

Triple glazing in the Scandinavian countries Sweden and Finland along with Austria and Switzerland has a very high market share and similar trend perspectives as those in Germany. In view of the current trend, the specialist world is in agreement: at least in central and northern Europe the triple structure of insulation glazing is set to become a successive standard.

In parallel with the increase in energy efficiency, in the residential as well as commercial construction sector, the trend towards ever larger glass units is continuing. Architects and building owners want to have an open room ambience for their buildings with the maximum amount of daylight incidence and highest degree of external views. In winter the glazing should also ensure solar energy generation.

Higher glass pane weight

Both the current trends basically present no problem for the insulation glazing manufacturers. The know-how and technology involved in the manufacture of corresponding products are available. The problematic nature of climatic burdens (suction and pressure effect on glass panes and the edge seal), which is increasingly a feature of triple insulation glazing due to the larger inter-pane volume, can be overcome. What is problematic, however, is the increasing weight of the glass panes. By



At glasstec 2010, with their 18 x 3.3 metre triple insulation glass pane (10/18/10/18/10), insulation glass manufacturer Henze Glas showed which glass dimensions can now be realized. Photo: Messe Düsseldorf

The insulation glazing manufacturers must gear their in-house processes to the heavy glass panes, while transportation becomes more expensive because the maximum loading capacity for trucks is already reached with fewer units and the fittings manufacturers have to deliver extremely durable solutions

comparison: a glass pane measuring one square meter, designed as double insulation glazing with 2 x 4 mm and 16 mm inter-pane gap, weighs 20 kilograms. The same format as triple insulation glazing in the 4/12/4/12/4 format already weighs 30 kilos. The increase in weight by 50 percent has far-reaching consequences.

The insulation glazing manufacturers must gear their in-house processes to the heavy glass panes, while transportation becomes more expensive because the maximum loading capacity for trucks is already reached with fewer units and the fittings manufacturers have to deliver extremely durable solutions. In the window sector this presents a special challenge, because in this area the aim is to develop high-load bearing fittings which can reliably hold the heavy elements in place over decades, whilst at the same time conveying a filigree impression.

Even at this stage, fittings systems are already reaching their limits in this balancing act between the requirements. On top of this the frame profiles for facades and windows also have to be adjusted to take the high weights.

The installation and fitting teams are particularly affected by the increased weight of the construction elements. For them the trend towards triple insulation glazing means a considerably increased burden. "The weight is enormous. Particularly in old buildings when no technical aids can be used, the burden is striking and personnel are clearly called upon much more than before", reports Martin Gutmann, Master of the Federal Glaziers' Guild, who goes on to say: "If you are unlucky, you also have to do with triple sound-proof or burglary-proof glazing, then the weight of the glass panes is even higher." The situation is also made more difficult by the increased weight of the thermally optimized frame profiles.

Thin glass as a solution concept

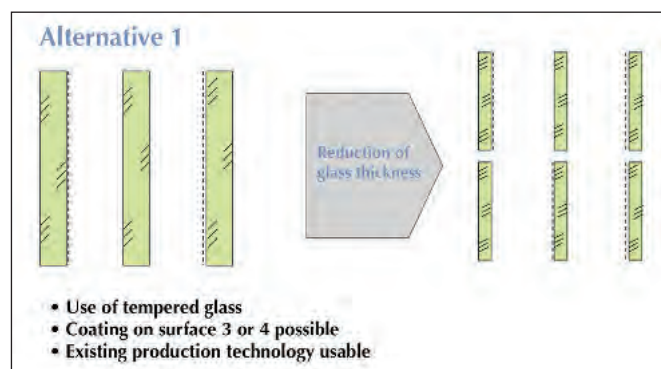
In view of this extensive problem area, the glass industry, insulation glazing manufacturers and research institutes are working intensively on solutions. Their aim is to reduce glass pane weight without cutting down on its energetic functionality. The development of light, high-insulation vacuum glass, which has been on-going for years now, has still not really moved forward sufficiently for it to be used in classic window and facade construction. However, use of the very thin glass panes is already practical in flat roof-top windows in standard sizes. A further possible solution is light, transparent synthetic film and

plates, which are aimed at replacing the central pane in insulation glazing. Whether this technology will assert itself on a broad front depends on the practicality and durability of the products as well as on their acceptance by the end- customers.

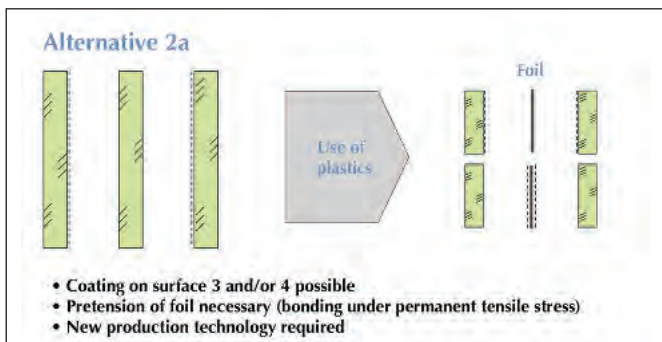
The application of thin glass appears to be the most potentially successful. As early as 2004, architect Prof. Stefan Behling, who for some years now has been presenting the latest trends and developments from the glass industry in the "glass technology live" special show as part of the leading international glass trade fair glasstec, declared: In the flat-screen sector thin glass is becoming part of a revolution.

At some stage perhaps whole walls, ceilings and floors will be able to change." In the area of entertainment and communication electronics, his forecast relating to modern smartphones and also products such as Apple's iPad, which are almost exclusively operated using thin glass touch-screens, has long since become reality. In addition, the current development tendencies on the insulation glass market confirm that Stefan Behling is right with his expectation for the architecture sector.

Today, windows incorporating triple insulation glazing are already available on the market, and are no longer produced using triple 4 mm, but triple 3 mm-thick heat-treated glass panes. This means a weight reduction of one quarter. And even thinner glass is possible. In the insulation glass sector, industry tests are already underway using hardened glass in the 3/2/3 mm format.



One way to reduce the surface weight of triple insulation glass is to reduce the glass thickness. Graphics: ift Rosenheim



The weight can also be reduced by the use of synthetic film in the inter-pane space. Graphics: ift Rosenheim

Machine manufacturer Liseac recently received the 2012 Austrian State Prize in the “Research and Innovation” category in recognition of its special pre-stress technology. It enables the manufacture of flexible and robust glass in a thickness of only 2 mm without optical distortions. According to the company, the light thin glass is outstandingly suited for use in modern architecture. When it comes to the thin glass used in insulation glass theme, critics point the increased breakage risk of the thinner glass panes. Their objection: although the glass is lighter through the reduced thickness of the individual planes, at the same time edge breakage risk is increased. The supporters of thin glass in contrast point to the higher durability of the thermally hardened glass.

Joint research project

In order to explore the possibilities of weight reduction in multi-pane insulation glazing on a well-founded, secure basis, the renowned Rosenheim Institute of Window Technology (Institut für Fenstertechnik - ift Rosenheim), in cooperation with the German Flat Glass Manufacturers’ Association (Bundesverband Flachglas), has launched the “Energy-efficient multi-pane insulation glass – Investigations into technical measures aimed at the reduction of glass pane weight” project.

The aim of the project is to investigate which measures can be used to reduce the surface weight of multi-pane (insulation) glass and the effects resulting from this. Dipl.-Phys.

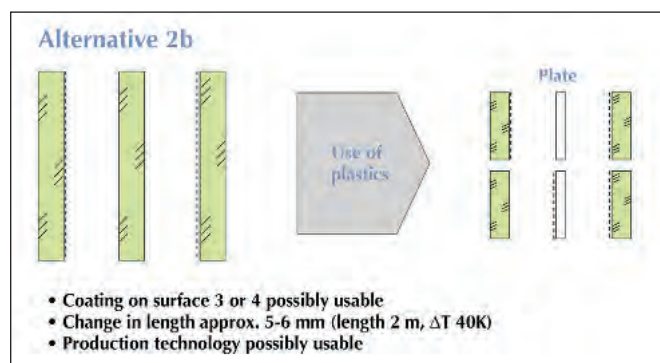
Norbert Sack, Head of Research and Development at the ift and project director, explains in this connection: a reduction in the

surface weight of triple insulation glazing is desirable and would in principle be possible through the use of thinner glass or transparent plastics. Thinner glass could be used in all three levels, i.e. on the outside, the room side as well as the central pane of triple insulation glazing.” He said that within the framework of the project, however, no general investigation of all the principle factors was possible.

On the contrary, decision-making bases for an assessment and future implementation should be developed. BF Executive Director Jochen Grönegräs adds: “We have included an assessment programme especially for 3 x 3 mm format insulation glass in the project in order to increase awareness for this theme. If the calculation bases are taken into account, it is definitely possible to manufacture insulation glass in the 3 x 3 format.”

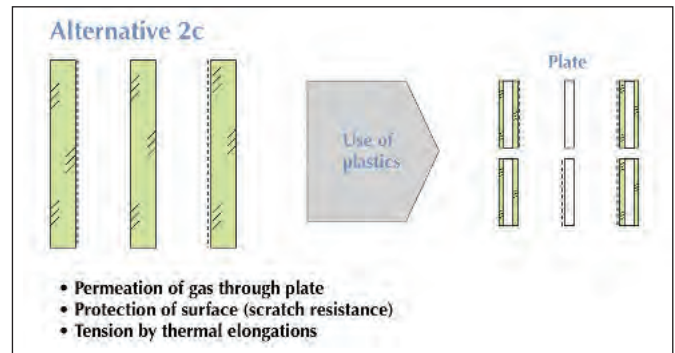
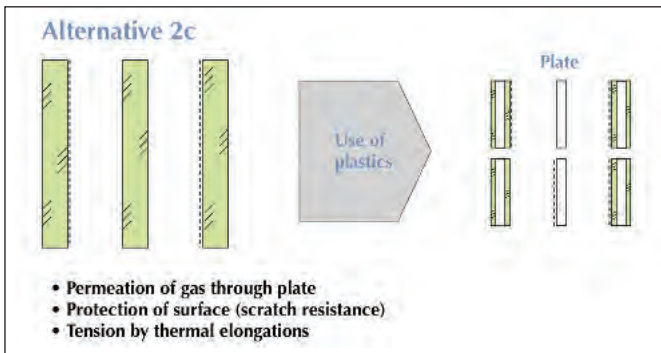
In view of the relevant heat insulation (Ug-value), total energy transmission (g-value) and translucence (V) values, insulation glass using thin glass comes closest to matching the values of conventional triple insulation glass. And in the area of sound-proofing too, the integration of sound-proof film or varying glass thicknesses ensures a high level of protection.

While the trade world is still conducting an intensive discussion on the advantages and disadvantages of using thinner glass, individual insulation glass manufacturers are pressing ahead in the competition for optimized insulation values. Even at this stage, on the Internet you can find references to quadruple insulation glazing, which with 3 mm-



An alternative to synthetic film is the positioning of plastic plates in the inter-pane space. Graphics: ift Rosenheim

In view of the relevant heat insulation (Ug-value), total energy transmission (g-value) and translucence (V) values, insulation glass using thin glass comes closest to matching the values of conventional triple insulation glass. And in the area of sound-proofing too, the integration of sound-proof film or varying glass thicknesses ensures a high level of protection



A further way to reduce weight lies in the use of plastic plates in the inter-pane space in combination with integrated, laminated plastics in the inner and outer pane of the insulation glazing. Graphics: ift Rosenheim

The overview shows the varying surface weights of differently structured triple insulation glass. Graphics: ift Rosenheim

thick glass, is designed to deliver an Ug-value of 0.3 W/m²K. A questionable development, because this format once again brings us back to the starting problem. The quadruple pane is just as heavy as today's conventional triple glass with standard format.

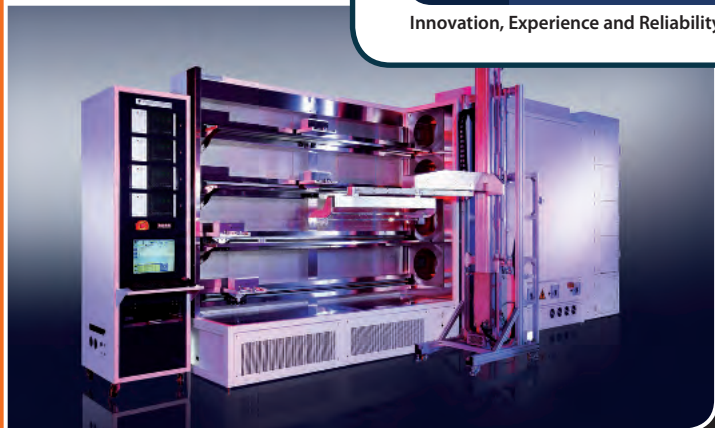
According to the manufacturers, the life cycle of these modules is clearly higher than those modules based on film laminates. In addition, due to the higher mechanical rigidity, we can forego the enclosing aluminium frame. As a result, the thin glass modules are also suitable for the increasingly significant building-integrated installation of photovoltaic elements.

Thin glass in photovoltaics

In the solar energy sector too pre-stressed thin glass is already being used to reduce the weight of glass-glass modules.

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Renewable rankings worldwide

Solar and PV is but a part of a larger push for sustainable renewable energy around the world, and how the overall market behaves will impact greatly on solar and PV as they contribute a large share of renewable goals. A new report from USA based NRDC (Natural Resources Defence Council) reports on which countries.

Production of renewable energy in the USA has increased by more than 300 percent in the past decade, but the United States still lags far behind Europe and Indonesia and is only slightly ahead of Mexico in the percentage of electricity it gets from renewable sources, according to a new report from the Natural Resources Defense Council.

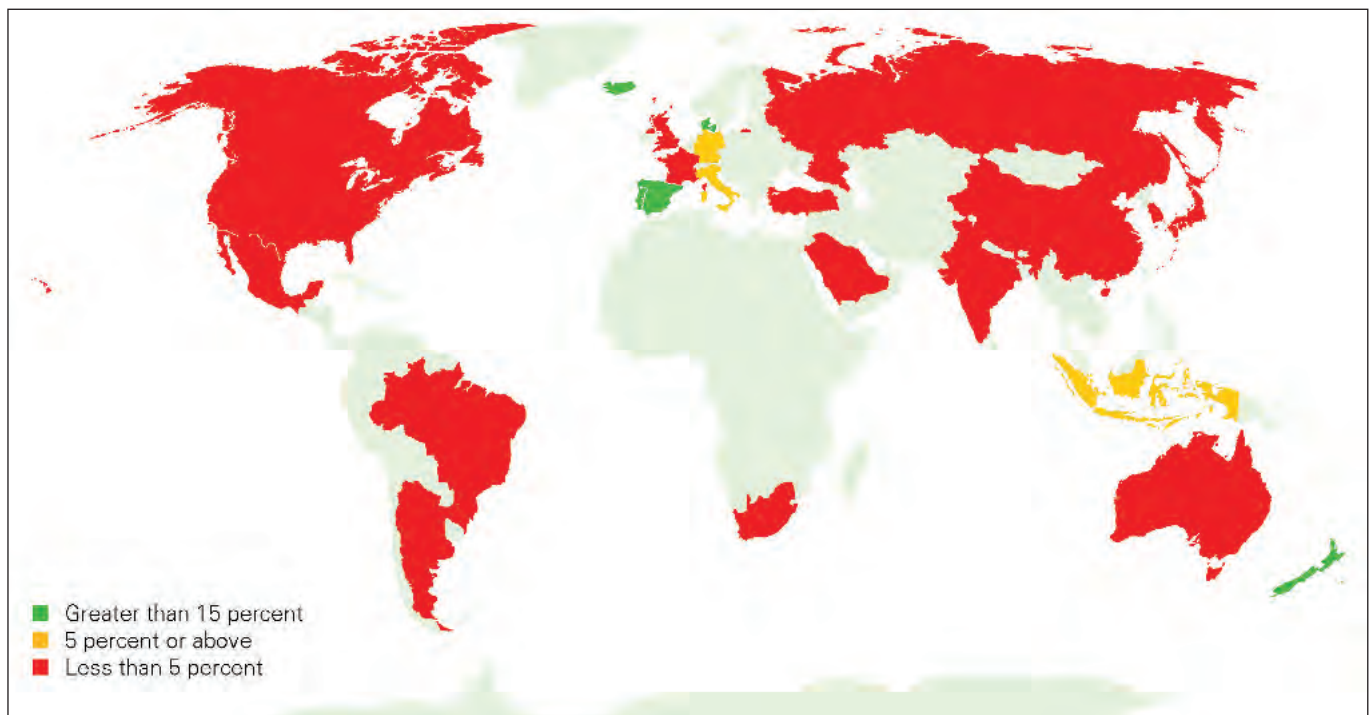
European countries, led by Germany, get more of their electricity from wind, solar, geothermal and other renewable sources than any other region in the world, NRDC's global renewable energy scorecard shows. The United States got about 2.7 percent of its electricity from renewables in 2011, making it No. 7 among G-20 member countries. Renewable energy is expected to be a major issue at the upcoming Rio+20 Earth Summit in Brazil. NRDC is advocating for countries to adopt policies to increase the percentage of electricity they get from renewable sources to 15 percent by 2020. Already some smaller, non-G-20 countries such as Spain, New Zealand and Iceland get more than 15 percent of their energy from renewable sources. Favourable governmental policies and strong private-sector investments have helped to increase the availability of renewable energy in the United States

and elsewhere, according to Jake Schmidt, NRDC's International Climate Policy Director.

"Unfortunately, the very policies that have increased our renewable energy supplies and reduced our dependence on dirty fossil fuels are now under fire in the United States and elsewhere. That's not just a threat to the thousands of new jobs being created by the renewable energy industry, but also a threat to our health, our environment and our planet. At the Earth Summit, civic and corporate stakeholders must commit to do more to increase electricity production from renewable sources," Schmidt said.

"A global agreement to spur this deployment would be helpful," he added. "But it is more important that key actors come to Rio+20 with individual country commitments to increase the amount of renewable energy to 15 percent of total electricity by 2020— more than doubling what is predicted under current trends."

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Numbers represent G20 country rankings. Renewable energy in this figure includes wind, solar, geothermal, tidal, and wave. Source: NRDC, 2012; U.S. Energy Information Administration, 2012; Bloomberg New Energy Finance, 2012.

The Coalition for Affordable Solar Energy (CASE) represents one half of the USA solar debate and have joined other American solar industry associations and suppliers in calling for the US and Chinese governments to engage in a constructive dialogue to avert a destructive global trade war in the solar industry.

CASE's comments come amidst news reports that China-based companies and India-based companies are seeking anti-subsidy and anti-dumping investigations against companies entering their markets from the US and other countries. Such investigations would follow a process similar to the current US government investigation, instituted by firms producing PV modules in the US including, German-owned SolarWorld, which recently resulted in the preliminary application of significant US tariffs on Chinese solar cells.

"Unless cooler heads prevail, American solar companies could face even more direct and collateral damage than the 30% tax

imposed on many of them last month," said Jigar Shah, president of the Coalition for Affordable Solar Energy. "Already polysilicon companies in China are seeking retaliatory tariffs against US polysilicon manufacturers.,".

Everyone is not in agreement

Two of the largest US solar energy materials suppliers, DuPont and Dow Corning, also came to the defence of free and global trade. These companies are not CASE members, but are both concerned about growing trade tensions in solar energy.

David B. Miller, President of DuPont Electronics and Communications, stated, "A well-developed global supply chain has helped the production of PV panels to reach significant efficiency and economics of scale, bringing quality and durability up and prices down. This is good for global consumers, and

good for the expansion of solar energy, creating jobs in the materials supply chain, much of it based here in the US, and for PV installers here in the US and elsewhere. It is important that trade be both free and fair, and important that countries resolve any trade disputes in ways that minimize disruptions in this important PV supply chain."

Similarly, Robert D. Hansen, President and CEO, Dow Corning Corporation, said, "The opportunity for solar technology to provide clean, renewable, domestically generated energy, as well as economic value and jobs is so great, that there are opportunities for all countries to benefit significantly. Trade discussions in fast-growth, new technology industries like solar, which also offer a tremendous amount of social



Trade war continues

Last year the USA arm of German solar company SolarWorld instigated a USA investigation into Chinese dumping of solar panels. Now both countries are engaged in accusing the other of price manipulation and punitive judgements are now taking effect and trickling into other industries. The process has divided the US industry, frustrated the Chinese but turned into a boom for other regions. Some are now calling for dialogue to put some rationale to what could become a full blown trade war.

benefit to the world, are best served by government and business leaders collaborating to develop free, fair and constructive trade policies which enable and foster growth and cooperation.”

CASE also applauds a recent statement by the US Solar Energy Industry Association (SEIA), an American solar industry association representing thousands of American solar companies, which expressed concern about the trade fight and called for a constructive dialogue and engagement between the US and China.

Rhone Resch, president and CEO of SEIA, issued a statement saying, “The escalating trade conflict in the global solar industry will ultimately hurt the entire market at a time when solar energy is on the cusp of widespread adoption. Companies from all nations will be the ultimate losers. Exporters will find fewer and fewer destinations for their products. Large project developers and local installers will find it more and more difficult to source products and consumers will see solar energy as a less competitive source of electricity. This is an absolutely unacceptable outcome.”

In addition, the Semiconductor Equipment and Materials International (SEMI), a global industry association representing thousands of semiconductor companies, has made a similar plea to reduce tensions and trade barriers.

“The current trade dispute is just one instance of growing trade barriers that are proliferating and encumbering the deployment of renewable energy. Other trade and market barriers have arisen in areas related to investment, government procurement, local content requirements and conflicting standards and certification requirements.

PV solar and other renewable energy industries must begin the long and difficult process of developing a comprehensive and holistic world trade agreement that promotes free and open trade and accelerates adoption of renewable energy,” SEMI said in a statement.

Determined beliefs

SolarWorld has so far steadfastly refused to come to the table to help diffuse the destructive solar trade war. In a recent statement, Gordon Brinser, president of SolarWorld Industries

America Inc., rejected calls to seek constructive bilateral solutions, saying that, “We do not need talks and we do not need deals.”

CASE has taken SolarWorld to task after recent public comments by Brinser at an International Trade Commission hearing suggested SolarWorld was selling product below production cost in an effort to maintain market share. This appears to be the exact behaviour SolarWorld is accusing China based companies of. Many of the subsidies provided to SolarWorld typify the supply-side subsidies that could be targeted by future trade investigations, such as government-backed loans for SolarWorld exports to India, SolarWorld’s partnership with the Qatar government on a new polysilicon



facility and SolarWorld’s receipt of more than US\$100 million in direct industrial subsidies in Germany.

“Governments around the world ---have provided the solar industry with support as a bridge to help the industry mature and stand on its own feet. In particular, Germany has played a leading role in helping SolarWorld and the global solar industry become what it is today,” said Jigar Shah.

“SolarWorld’s participation would be welcomed in seeking a constructive end to this destructive episode,” said Jigar Shah. “Instead of raising taxes to offset subsidies, let’s create a global

free trade agreement in clean tech that ensures open market access and a level playing field for everyone. All solar industry leaders want to see a trade war averted. It's past time to move forward and put our industry first."

Numerous industry analysts have pointed to the huge increase in silicon and solar cell production capacity, which has outpaced growing demand, as responsible for the rapid drop in global solar cell and module prices. Solar manufacturers around the world, not just in the United States, are confronted with extremely competitive cell and module price pressures in the current oversupply environment.

Punishing trade

Despite CASE's and other protests the Government decided to increase punitive import tariffs on the Chinese solar market of 30 percent or more after ruling China had dumped cut-price solar panels into the U.S. market. The main concern from other solar companies is that the move will drive costs upward. CASE is now pushing for the government to reduce the tariffs before they are finalised stating the outcome is actually a blow to many US companies within the solar value chain. This view seems to be supported by most of the US and global associations despite claims that the government is responding to the US solar industry.

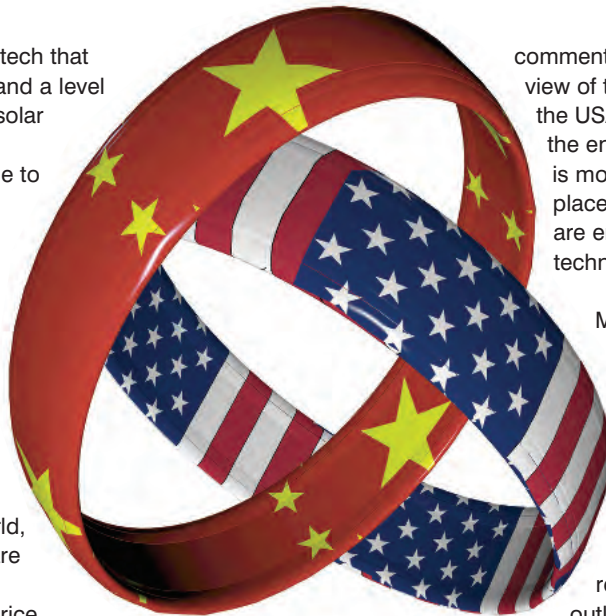
Unsurprisingly Chinese based companies rejected the ruling and outcome. Brinser has been unrepentant in his pursuit of what he calls an imbalance in global trade opportunities and recently recommended the government revise the US trade response claiming that China is amassing a new magnitude of economic might and its central planners increasingly target pivotal U.S. industries. Brinser states he believes China is responsible for problems facing the US manufacturing industry.

More specifically, Brinser recommended that the government:

- Use its new Interagency Trade Enforcement Unit to closely monitor import data for early signs of market distortions spurred by foreign governments.
- Look hard at ways to preserve an open, transparent process for trade cases but in fewer steps and less time.
- Aggressively find ways to anticipate and halt circumvention of trade remedies and theft of intellectual property.
- Bring legitimate cases for industries that are too small or injured to afford them.
- Shed light on foreign companies that raise capital on U.S. exchanges and then withhold audit information from securities regulators.

A global view

This view is certainly not universally shared with some



commentators suggesting Brinser has a fairly narrow view of the global market and the issues he feels the USA is facing are no more than the reality for the entire global solar industry. The truth is there is more supply than demand in the global market place creating a situation where all companies are ensuring their product is economically and technically attractive to consumers.

Many industry commentators are now suggesting that the on going trade concerns between China and the USA will in fact lead to larger problems and delay progress in the introduction of renewable energy. Despite Brinser's claims of USA disadvantage a new report has revealed that the US has actually closed in on China in the race to be the lead investor in renewable energy, with a 57% leap in its outlays to \$51 billion. Some of this investment is in the form of subsidies or tax trades and it will be interesting to see if China decides to pursue more USA activities using the same argument that Brinser is determined to see the US government follow. One of the dominant features of the renewable energy report was the finding that PV module prices fell by close to 50%. This global fact is enough to see the changing company dynamics that Brinser is trying to pin on Chinese policy. Another key factor has been the changing attitude from governments in terms of support due to austerity requirements brought on by a stressed economy.

Despite the on going trade battles the clash between the USA and China has served to help other areas receive unexpected interest in their own markets and offerings. Solar companies in Taiwan are one example of increased business, especially from the USA, as they are not affected by the trade dispute. While the USA and China continue their war of attrition many other areas are getting on with the process and benefitting from the distraction. Europe remains the key market at the moment and many companies are seeing a potential opening into the future markets of China and the USA.

Germany and Italy have seen massive booms in rooftop instalments as a direct result of the falling solar prices. There has also been an increase in CSP projects in Spain despite rumours of the technology's demise. Italy, Germany and Japan all saw greater investments in small scale projects than the USA and China and smaller countries, like the UK and Australia, also saw significant investments that lower prices have inspired.

It often seems that the focus on China and the USA allows countries like India to slightly ride under the radar of scrutiny and the region actually had the fastest rate of expansion of renewable investment than anywhere else in the world. The USA and China would do well to remember they are part of a global market and the increasing focus on local concerns and issues is likely to see the competition creep up on the outside lane in the race to develop long term sustainable PV companies.

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Formula 1 moves to solar

TRINA SOLAR has announced the completed installation of a new photovoltaic system at the headquarters of the Lotus F1 Team in Enstone, Oxfordshire, England. The rooftop system provides clean solar energy for the new Lotus F1 Team simulator. Installation was completed in under two days and way ahead of schedule.

Trina Solar's cooperation with the Lotus F1 Team is a partnership of like-minded companies, both in pursuit of innovation, teamwork, speed and high performance. "We have been working with Lotus F1 Team for nearly three years now and this latest deployment of our technology is the next step in the team's drive towards renewably sourced energy," said Ben Hill, Head of Trina Solar Europe.

Module installation, which would otherwise take about five days, was in fact completed in less than two days thanks to the innovative Trinamount system. The Trinamount drop-in mounting solution eliminates the use of long rails and reduces the number of parts needed, thus significantly bringing down installation time and cost. "This deployment represents the synergy of innovation and speed for both companies," added Hill.

The installation is capable of producing some 33,000 kWh of electricity over the course of a year, thus



mitigating against the team's overall carbon footprint at the rural Oxfordshire site. The power output covers about three quarters of the simulator's energy needs. The new centre is equipped with cutting-edge technology and allows the Lotus F1 Team to reproduce lifelike driving conditions for research and optimisation without putting a real car on a racetrack.



Patrick Louis, Lotus F1 Team CEO, commented: "This installation of a Trina Solar PV system reflects our continued commitment to renewable energy.

The PV array provided by Trina Solar provides significant energy generation that fits our surrounding environment. Lotus F1 Team is committed to promoting and supporting initiatives that ensure that our activities contribute to a greener future for society."

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