

INTERNATIONAL Solar

A PV MANAGEMENT MAGAZINE



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Market: UK subsidy changes
Grid Parity: When will we reach it?
Solar Awards: Winner's announced

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editor's view

By david ridsdale, editor-in-chief

Solar growth sees utility concerns raised

A RECENT CASE in the USA highlights the growing concerns utility and energy providers are having regarding solar deployment and how it interacts with the grid. Some sites are making more solar than they need so are sending the rest of it back to the grid and receiving payment for it. The companies who traditionally have had a strangle hold on grid distribution have no plans on how to deal with energy from solar in a system that has classically been a one way street for energy distribution.

The case sees Ohio utility companies complaining that solar users take advantage of the grid but do not pay for this and the companies are forced to pass on the costs to energy users without solar. While not everyone will agree with the cost redistribution the situation does raise a growing concern amongst energy companies around the world. Subsidies are paid when energy is put onto the grid but if it overtakes the local need, as occurs in Germany every summer, then the energy companies have no room to sell their product as the renewable energy comes first.

Such an economic showdown from powerful energy companies with lobby money to burn could be a huge problem for the renewable energy providers as a whole but the sheer success of renewable energy in recent years puts governments in a love/hate relationship with the technology and the political ramifications from traditional election donors. Critics of the energy companies suggest the behemoths are blocking progress while the energy companies talk of protecting their hard built assets and distribution methods.

The sad thing is they are acting as if it is a surprise and that they are the victims of a government supported programme of



subsidy based competition. The truth is the traditional energy companies felt that their monopolies were well protected and chose not to act on the growing desire for renewable energy sources. They chose to ignore the early growth or leave the renewable sector as an area where the profit took too long. They have been caught behind the eight ball as the technology and global market growth took them by surprise.

Whatever the past the future of energy is going to need solutions and not just new methods of billing the consumer for energy. The goal is for cheaper and sustainable energy and consumers will get sick of footing the bill for energy companies losing their market share due to a slow reaction to sustainable and renewable energy growth.

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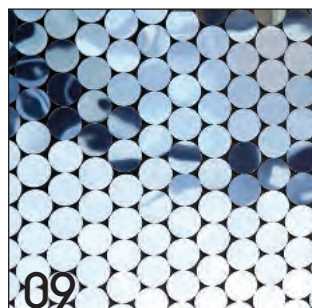
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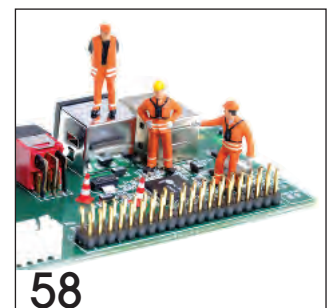
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SPI Solar announce purchase agreement of 360MW

SOLAR POWER, INC. has announced that its subsidiary, SPI Solar Power Suzhou Co., Ltd. ("SPI Meitai Suzhou") has entered into a framework purchase agreement with ZhongNeng GuoDian New Energy Development and Investment Jiangsu Co., Ltd. ("ZhongNeng New Energy"), with the intention to acquire six PV projects currently under construction in China, and another framework purchase agreement with ZhongNeng GuoDian Green Ecological Cooperation and Development Jiangsu Co., Ltd. ("ZhongNeng GuoDian"), with the intention to acquire the equity interest in ZhongNeng New Energy.

"We are pleased to announce these agreements and our intention to acquire the six PV projects, comprising a total of 360 megawatts ("MWs") in China, and ZhongNeng New Energy, a proven PV project development platform with an excellent pipeline," said Xiaofeng Peng, Chairman of SPI.

"By adding these projects to our portfolio and acquiring this development company, we expect to increase our scale and future cash flows and expand our development capabilities in key strategic regions, strengthening SPI Solar's leading position



as one of the largest PV development companies in this market."

SPI Meitai Suzhou intends to acquire the six projects under construction in China from ZhongNeng GuoDian, including a 40 MW project in Chifeng City, 60 MW in Kezuo County, 50 MW in Shangdu County, and 30 MW in Chayou County, all in Inner Mongolia, as well as a 130 MW project in Zhongwei City, Ningxia and 50 MW in Yanyuan County, Sichuan. Grid connection for these projects is expected to take place from the end of 2014 to the middle of 2015.

SPI Meitai Suzhou will pay a deposit of RMB140.0 million (U.S. \$22.9 million) in cash by November 20, 2014 to secure the agreement. The final purchase price for the six projects will be decided after further due diligence when the projects are completed.

SPI Solar intends to acquire the 100% equity interest in ZhongNeng New Energy at an aggregate purchase price of RMB100.0 million (U.S. \$16.3 million), consisting entirely of SPI's ordinary shares; 49% of the total consideration, or RMB49.0 million (U.S. \$8.0 million) will be determined based on the Renminbi-to-U.S.-dollar exchange rate and closing price of SPI's ordinary shares of U.S. \$2.35 per share on October 22, 2014, or approximately 3.4 million ordinary shares, and 51% of the total consideration, or RMB51.0 million, will be based on the five-day averages of the trading prices of SPI's ordinary shares and Renminbi-to-U.S.-dollar exchange rates prior to the closing date of the acquisition.

Subject to the terms and conditions of the framework agreements, SPI Meitai Suzhou and ZhongNeng New Energy will enter into a definitive purchase agreement for the purchase of the six projects by March 31, 2015, and SPI Meitai Suzhou and ZhongNeng GuoDian will enter into a definitive purchase agreement for the acquisition of ZhongNeng New Energy within five days thereafter. SPI Solar plans to acquire more PV projects using SPI Meitai Suzhou as an investment platform.

The race is on for N-Type solar supremacy

INEO SOLAR POWER'S (NSP) N-type bifacial monocrystalline cell, recognized for its high efficiency, has been recently launched at the PV Taiwan 2014 exhibition in Taipei. Taiwan is a key player in the manufacturing of high-efficiency solar cells.

The N-type mono cell is likely to become the next-generation high-efficiency mono cell, replacing the current mainstream P-type mono cell in the future, said Corrine Lin, an analyst at EnergyTrend, a division of the Taiwan-based market intelligence firm TrendForce. Currently, the PERC production process, with less capital investment than the N-type mono cell process, can boost cell efficiency from 19.2%-19.4% to 20%-20.2% using P-type mono cells, Lin said. But since

N-type mono cells currently have an energy conversion efficiency of 22%, they surpass P-type mono cells' efficiency target easily. Therefore, N-type mono cells are expected to become the next-generation mono cell. Additionally, the N-type mono cell's initial light induced degradation (LID) is close to 0%. It is also able to generate electricity well under dim lighting and achieve higher efficiency.

SunPower, Panasonic, and Yingli were initially the only N-type mono cell mass production manufacturers, but other international brands are now entering the market fast. Those new entrants include Silevo, which was recently acquired by SolarCity, LG Electronics and Mission Solar. Given their prowess in the solar cell market, Taiwanese firms are expected to

excel in the production of N-type mono cells. NSP, Motech and Inventec are the new N-type mono cell entrants among Taiwan firms. The front side of NSP's N-type bifacial cell presented in the exhibition can reach efficiency of 20.4%, while the contribution of the back side is 20%, meaning the total conversion efficiency is 24.5% and can produce 60-cell modules that reach 330Wp of power. Motech also plans to become capable of delivering N-type mono cell products to their clients next year.

Although prospects for N-type mono cells are good, there are obstacles they must overcome before they can enter the mainstream solar market. "Buyers in the solar energy market expect products to be low cost but high value," Lin said.

World's first all white solar module released by CSEM

CSEM has announced the world's first white solar module. This technology is particularly attractive to the building industry where solar elements can blend into a building's skin and become virtually hidden energy sources. Applications in the consumer goods sector are also expected.

Currently, the market lacks photovoltaic (PV) products specifically designed to be integrated into buildings. Most PV modules, built to maximize sunlight absorption, appear blue-black.

This appearance, caused by the presence of cells and connections, is visually unaesthetic and this complicates the acceptance of PV by professionals.



For decades architects have been asking for a way to customize the colour of solar elements to make them blend into a building's skin. White is a particularly interesting color as it is widely used for its elegance, versatility, and fresh look.

Despite of this demand, no one was ever able to realize a truly white solar module; naturally believing that it was impossible as most of the light is reflected, contrary to the requirements of all solar panels. CSEM has developed a new technology to make white solar modules, with no visible cells and connections, a reality in today's market.

It combines a solar cell technology able to convert infrared solar light into electricity and a selective scattering filter, which scatters the whole visible spectrum while transmitting infrared light. Any solar technology based on crystalline silicon can now be used to manufacture white, and coloured, modules.

The technology can be applied on top of an existing module or integrated into a new module during assembly, on flat or curved surfaces. Besides its main application in BIPV, other fields such as consumer electronics (laptops), and the car industry are expected to show significant interest.

Global utility scale PV surpasses 30GW

FIGURES released by utility solar authority Wiki-Solar.org show that global capacity of utility-scale PV generating capacity is now 30.3GW. This means that 2014, which opened with a capacity of 21.5GW, will be the fifth consecutive record year for the sector. South Africa has now joined the elite top ten countries for large-scale solar, following the commissioning of the 75MW De Aar 3 project in August. The installed capacity of utility-scale power plants in the leading countries at the end of September was:

“Grid-feeding solar generation continues to dazzle, with records being broken all over the place”, says Wiki-Solar’s Philip Wolfe. “Our figures show the USA has become the first country to achieve 7GW of utility-scale PV capacity. Meanwhile the UK will probably top 2GW, when the completed projects are all entered onto the register.”

“Japan and Chile continue to climb the table and, with substantial capacity still under development, will be vying for top-ten places before long.”

Country	No. of Plants	Capacity MW _{AC}
United States	407	7,083.8
China	245	6,518.3
Germany	281	3,468.0
India	196	2,203.2
United Kingdom	250	1,948.2
Spain	172	1,683.4
Italy	86	901.3
Canada	72	896.8
France	63	819.3
South Africa	20	679.7
Thailand	68	644.9
Ukraine	19	490.2
Japan	24	475.5
Chile	12	460.3
Romania	18	286.1

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Solar glass prices tipped to stabilise

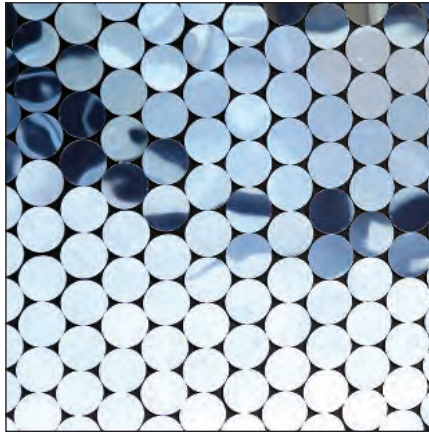
AFTER FALLING by about 50 percent from 2009 through 2014, pricing for solar glass is set to commence a rebound starting next year, as anti-dumping duties levied by the European Union go into effect on Chinese suppliers.

Average global pricing for glass used in photovoltaic (PV) solar is expected to fall to \$4.60 per square meter this year, down from \$10.40 in 2009, according to IHS Technology. However, pricing will begin to stabilize and begin a long-term increase starting next year. By 2018, solar glass pricing will increase to \$5.90 per square meter, up 11 percent from the low point this year, as presented in the attached figure.

“The sharp drop in solar glass prices during the last five years was the result of massive oversupply in the market,” said Karl Melkonyan, solar research analyst at IHS Technology. “Chinese government subsidies on solar glass caused domestic suppliers to increase production and exports. However, the European Union’s move to impose countervailing duties on solar glass imported from China will limit supply in the market, leading to an expected increase in prices.”

IHS has released a new report entitled “Module Innovations to Create Opportunity for PV Materials Market” from the Power & Energy service at IHS. In 2010, imports accounted for only 7 percent of total solar glass supply in Europe. This share grew to 30 percent in 2013. For 2014, more than 90 percent of imports will come from China, up from 35 percent in 2010. This means that in 2014, Chinese manufacturers will account for 27 percent of total solar glass supply in Europe, up from 2.5 percent in 2010.

Encouraged by government subsidies, many Chinese glass manufacturers entered the solar glass segment and started an aggressive pricing strategy in overseas markets, following a similar pattern to China’s participation in the module space. The price undercutting caused a strong oversupply and price collapse in the market.



High imports from China led to lost profits and shutdowns of factories for European solar glass producers.

In response, the European Union in May imposed five-year tariffs on solar glass from China. The EU imposed countervailing duties on solar glass imported from China in a range of about 3 to 17 percent, depending on the level of subsidy that a solar glass company received from China.

Glass shippers

IHS estimates the global demand for flat glass—the parent category of solar glass—in 2013 was 47.6 million metric tons. With an estimated 55 percent share, China dominates flat glass supply. Europe follows with a 16 percent share.

The Asia-Pacific region is forecast to remain the largest and fastest-growing market for solar glass during the next five years. However, only a few first-tier suppliers from China will provide what customers consider to be high-end products. In other developments in solar glass, the global market share of anti-reflective coated (ARC) solar glass in 2018 is projected to reach 85 percent.

Anti-reflective coatings increase module power output and lower the cost-per-watt, which is the key value measure for any solar-power-generating system. After a weak 2012, the fast-recovering PV market has also contributed to a strong demand for solar glass with AR coating, with about 50 percent growth during each of 2013 and 2014.

GTAT Chapter 11 affects Meyer Burger US production

MEYER BURGER TECHNOLOGY has announced that its production capacities at the Colorado Springs, CO/USA site, previously expanded expressly for a project with GT Advanced Technologies Inc. (GTAT), are being adjusted in connection with GTAT’s motion for protection under Chapter 11 of the United States Bankruptcy Code.

On October 6, 2014, GTAT, a customer of the Meyer Burger Group, submitted a motion in accordance with Chapter 11 of the US Bankruptcy Code at the U.S. Bankruptcy Court in New Hampshire. The associated legal proceedings are still ongoing and will probably extend over several months. Meyer Burger Group is unable to comment on the ongoing legal proceedings. Over the preceding 12 months, the Meyer Burger Group has increased its personnel at the site for a specific project with GTAT in the area of slicing sapphire with industrial diamond wire saws.

From the legal proceedings to date and customer discussions, Meyer Burger assumes that GTAT will be unable to continue the project as planned. The Board of Directors and Management of the Meyer Burger Group have therefore decided to reduce the Colorado Springs capacities built up expressly for this project with immediate effect, leading to a workforce reduction of 105 persons at this site.

After the workforce reduction, Meyer Burger will still employ around 200 persons at its Colorado Springs site, who will continue to safeguard the US business in slicing solutions and diamond wire technology for the solar industry, sapphire industry and other industrial sectors.

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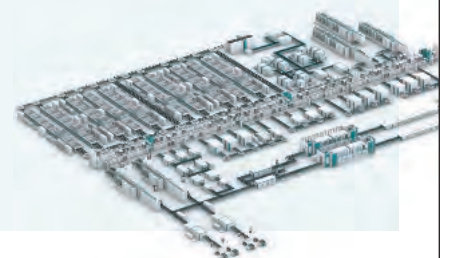
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Australian Government under fire for renewable changes

SLASHING THE RENEWABLE ENERGY TARGET (RET) as proposed by the Federal Government would smash the value of projects that are already operating, and potentially expose the government to massive compensation claims by those affected, new analysis by law firm Baker & McKenzie reveals. The report Financing impacts of amendments to the Renewable Energy Target examines the risks that are likely to arise should the government's proposal to cut the target be implemented, and how this would impact financial and contractual arrangements for existing and future large-scale renewable energy projects.

The report also examines the issues and complexity associated with designing and implementing any compensation regime to compensate existing renewable energy projects. While the Federal Government has repeatedly assured the industry that changes to the RET would not affect existing investments, its position announced last Wednesday made no reference to compensation to off-set the retrospective hit on existing investments that would result from its proposed 64 per cent slashing of the current scheme. Clean Energy Council Acting Chief Executive Kane Thornton said it was not only future projects and jobs that were on the line if the RET was slashed.

"A change to the policy would result in financial impairment and a substantial risk that existing projects and businesses would collapse, as well as inflicting damage on Australia's reputation as a safe place to invest," Mr Thornton said.

"This report shows that a cut in the target of the scale proposed by the government would have far reaching and damaging consequences, and also that ensuring adequate compensation would be an complex and expensive task.

"The finance for every renewable energy project is significantly different, and compensation or transitional assistance would need to be different for each and every project."



Mr Thornton said over \$10 billion worth of investment had been made in large scale renewable energy projects, and those investments were made based on the legislated 41,000 GWh target.

"The legislated policy provides the revenue to underpin the investments in renewable energy projects out to 2030, but this revenue would collapse if the RET is cut, smashing the companies which invested based on its long-standing bipartisan support," he said.

"Moving the goal posts so significantly on investors would result in massive asset devaluation, job losses and business closures, and send a signal to international investors that Australia is closed for business. The future viability of existing renewable energy projects is highly dependent on a strong, bipartisan policy."

The main findings of the report are as follows:

- Any substantial reduction of the RET will lead to renewable energy certificate prices being substantially lower than prices modelled for operating and future projects for the purposes of equity and debt financing.

- Any substantial reduction to the RET will trigger a review of existing funding arrangements by lenders. The cost of capital for equity is likely to be higher, reflecting the higher cost.

- There are likely to be challenges to any legislative change made to the RET which results in adverse impacts on renewable energy operators and developers.

- Any compensation and transitional assistance regime will need to be designed for the specific financial arrangements of each and every renewable energy project.

- Designing compensation or transitional assistance will involve significant inherent complexities and policy issues that could potentially undermine the overall effectiveness and efficiency of a reduced RET.

- There is a risk for the Australian Government that the policy objective of achieving even reduced targets might not be met because of the impacts resulting from sovereign risk associated with a reduction to the RET.

- The vast majority of existing projects will be up for refinancing over the period 2016-2018. Existing projects might not be able to meet the minimum financing requirements based on the revised set of risk assumptions and parameters.

New material converts heat and light to energy

A MULTIDISCIPLINARY engineering team at the University of California has developed a new nanoparticle-based material for CSP plants designed to absorb and convert to heat more than 90 percent of the sunlight it captures.

The new material can withstand temperatures greater than 700 degrees C and survive many years outdoors in spite of exposure to air and humidity. The work, funded by the U.S. Department of Energy's SunShot program, was published recently in two separate articles in the journal *Nano Energy*. By contrast, current solar absorber material functions at lower temperatures and needs to be overhauled almost every year for high temperature operations.

"We wanted to create a material that absorbs sunlight that doesn't let any of it escape. We want the black hole of sunlight," said Sungho Jin, a professor in the department of Mechanical and Aerospace Engineering at UC San Diego Jacobs School of Engineering.

Jin, along with professor Zhaowei Liu of the department of Electrical and Computer Engineering, and Mechanical Engineering professor Renkun Chen, developed the Silicon boride-coated nanoshell material.

The novel material features a "multiscale" surface created by using particles of many sizes ranging from 10 nanometers to 10 micrometers. The multiscale

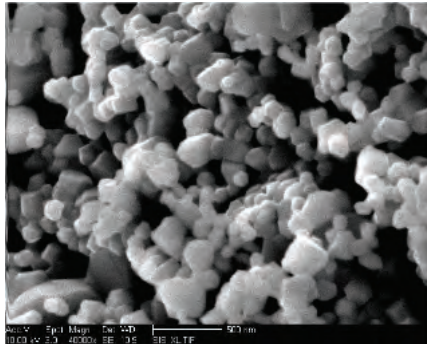


Image: Engineers at UC San Diego have developed a nanoparticle-based material for concentrating solar power plants that converts 90% of captured sunlight to heat.

structures can trap and absorb light which contributes to the material's high efficiency when operated at higher temperatures.

Traditional power plants burn coal or fossil fuels to create heat that evaporates water into steam. The steam turns a giant turbine that generates electricity from spinning magnets and conductor wire coils. CSP power plants create the steam needed to turn the turbine by using sunlight to heat molten salt.

The molten salt can also be stored in thermal storage tanks overnight where it can continue to generate steam and electricity, 24 hours a day if desired, a significant advantage over photovoltaic systems that stop producing energy with the sunset. One of the most common types of CSP systems uses more than

100,000 reflective mirrors to aim sunlight at a tower that has been spray painted with a light absorbing black paint material. The material is designed to maximize sun light absorption and minimize the loss of light that would naturally emit from the surface in the form of infrared radiation.

The UC San Diego team's combined expertise was used to develop, optimize and characterize a new material for this type of system over the past three years. Researchers included a group of UC San Diego graduate students in materials science and engineering who recently joined the faculty of the University of Nevada, Las Vegas. The synthesized nanoshell material is spray-painted in Chen's lab onto a metal substrate for thermal and mechanical testing. The material's ability to absorb sunlight is measured in Liu's optics laboratory using a unique set of instruments that takes spectral measurements from visible light to infrared.

Current CSP plants are shut down about once a year to chip off the degraded sunlight absorbing material and reapply a new coating, which means no power generation while a replacement coating is applied and cured. That is why DOE's SunShot program challenged and supported UC San Diego research teams to come up with a material with a substantially longer life cycle, in addition to the higher operating temperature for enhanced energy conversion efficiency.

SunEdison picks up 15MW in India

SUNEDISON has announced that it has won 5 solar photovoltaic (PV) projects totalling 150 megawatts (MW) from Karnataka Renewable Energy Development Limited (KREDL) as announced by the Government of Karnataka. SunEdison or SunEdison affiliates, including Yieldcos, are envisioned as the ultimate owner(s) of these solar projects, and will sell the electricity generated to various entities via Power Purchase Agreements (PPA's).

"This is yet another milestone in the



journey of SunEdison in India to build a strong pipeline of projects that will be developed and commissioned in the coming years," said Pashupathy Gopalan, president Asia Pacific Operations, adding that the PPA's are likely to be signed in

the next two to three months. While 44 developers responded to KREDL's tender for 500 MW of grid-connected solar power plants, SunEdison's 150 MW represents the largest share awarded to any single company.

Following SunEdison's recent announcement of a Memorandum of Understanding (MOU) for 5 gigawatts (GW) with the Rajasthan Government, this award solidifies SunEdison's position as the clear leader in India's rapidly growing solar market.

Hanwha Q-Cells To build 800MW facility In Malaysia

GERMAN HEADQUARTERED Hanwha Q CELLS has announced that it will build a large-scale module factory at its existing site in Cyberjaya, Malaysia. The new facility will include four production lines and automated equipment for the company's high performing solar modules totalling a capacity of 800MW.

After currently increasing its capacities in cell production, the investment in a new module production again highlights Hanwha Q CELLS' consistent growth path and positive business outlook. Given the growing cell capacity and production volume, the largest European PV provider according to shipments now adapts its module production capacities accordingly. The amount of investment has not been disclosed.

In August, Hanwha Q CELLS announced to increase its total production capacity to more than 1.5 GW by the end of the year. Furthermore, Hanwha Q CELLS has been strongly expanding its business and expects 2014 shipments between 1 and 1.2 GW as well as positive full-year-figures. Detailed financial figures about revenue or profit have not been disclosed.

Charles Kim, CEO of Hanwha Q CELLS, said: "By building module facilities of 800 MW at our site in Malaysia, Hanwha Q

CELLS takes the next step in becoming one of the globally leading companies in the photovoltaics industry. The new factory will strengthen our position to satisfy the heightened demand of our customers. We offer top-quality modules, applications and complete power plants "Engineered in Germany" as well as long-term partnership and financial stability."

The construction of the module production facility at the Cyberjaya site will start in early 2015. Hanwha Q CELLS will start to move in the production equipment in parallel. The new production lines are planned to be ready for a first test production in Q3 2015 and expected to reach full utilization by early 2016.

Further strengthening the combination of German engineering with international mass production "The new module fab in Cyberjaya is the logical next step in carrying forward the company's international setup of R&D and mass production," said CEO Charles Kim.

By partly insourcing and at the same time increasing overall total module production capacities, Hanwha Q CELLS is further strengthening this combination of German engineering and quality with competitive and flexible international mass production in their Asian facilities.

Capital Dynamics offload 1/4 billion dollars of US solar assets

CAPITAL DYNAMICS, a global private asset manager, announced that it has entered into an agreement to sell its U.S. Solar Energy Fund assets to TerraForm Power Inc. for approximately USD 250 million.

Through the sale, which is expected to be completed by the fourth quarter of 2014, Capital Dynamics will deliver a monetization opportunity for its U.S. Solar Energy Fund investors. Capital Dynamics, with a multi-national team of investment professionals, will continue to invest in clean energy infrastructure opportunities throughout the world.

Capital Dynamics' U.S. Solar Energy Fund portfolio is comprised of 39 solar energy productions assets across 5 U.S. states generating more than 75 MW of power. Capital Dynamics led all aspects of the Fund's investment process, from deal origination, negotiations and structuring to overseeing late-stage project design activities and ultimate construction and operation of the projects. The U.S. Solar Energy Fund reached a final close in June 2012 and was named the largest renewables infrastructure fund raised globally that year.

"I am pleased that the sale of our U.S. Solar Fund assets achieves our goal of realizing risk-adjusted returns for our investors and we look forward to working with TerraForm Power on other opportunities in the future," said Stefan Ammann, CEO of Capital Dynamics.

"We were an early mover in the U.S. solar market and we will work to build on this advantage by continuing to identify and grow opportunities in clean energy infrastructure on behalf of our investors."





Empowering the people

Solar International recently had the opportunity to interview Roberto Forlani CEO of Power Clouds. The Company is currently at the centre of an innovative project of photovoltaic energy production, operating in over 110 countries and involving over 53,000 people. Roberto tells David Ridsdale why this project has the potential to involve ordinary people in large scale energy production.

solar winner

awards 2014

Q Describe the success of PowerClouds in Europe to this date?

A I have always believed in innovation and excellence when creating a business. These core values made Power Clouds the unanimously acknowledged leader in solar energy within Europe and to back up my proud statement I can offer facts and figures that no other business has produced in such a short period of time. As of today, Power Clouds can boost more than 53,000 participants in more than 112 countries and 15 shared solar power plants for a total value of \$60 million.

This represents a unique participatory system of renewable energy production from citizens around the world. Power Clouds allows anyone who owns a solar panel anywhere in the world to lease the panel to the business. Power Clouds then pays the solar panel owner a monthly fee for 20 years. The hope is that from these participatory solar farms, the global grid will be fed with clean energy and create the first worldwide network of photovoltaic systems – ideally the planet's largest energy source.

The output from the 15 shared solar power plants is estimated around 555 million KWh (for an average of 30 years). Such production will determine a reduction of Co2 emissions of over 270, 000 tons, which is the equivalent of planting 7 million new trees. We came up with this data using a governmental tool namely the US Greenhouse Gas Equivalencies Calculator of the US Environmental Protection Agency.

We are just back from Romania, where over 20 million USD have been invested in less than a year in order to create a network of five large solar plants located

between Scornicesti and Nucet. The business is not only keen on clean energy production and profit but also on the creation of societal good. Such goals have been appreciated by authoritative voices in the media world like Forbes, which has given us great attention over the last months often defining Power Clouds as social innovator in the field of renewable energy.

Q What has been your headline achievement over the past year?

A Power Clouds can boost many achievements with regards to business expansion yet I strongly believe that the headline achievement is the prestigious Business Project Development prize we have been awarded by Solar International Award. We collected the prize on the 23rd of September in Amsterdam, capital of one of the most progressive countries in the field of renewable energy. This all could not be possible without restless work and a team of dedicated professionals thus I can safely say that this is the most genuine achievement of all.

Q Why is this project important?

A The innovative approach brought about by Power Clouds in the arena is the production of green energy which has been made possible by empowering local populations in managing solar plants. The importance of Power Clouds is thus not merely connected to doing business alone but most importantly to the first interconnected project of energy production.

No other business envisioned a structure which benefits suppliers and consumers at global scale and I believe this is a very crucial first step towards sustainability on

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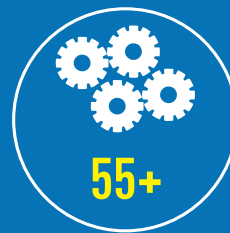
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both economic and environmental level.

Q To what extent are you involved in first line on the UN Climate Change campaign ?

A Innovation is our core value and for us it is crucial to participate and speak up on climate change and greenhouse effect. For this reason, we strongly share the views of world leaders like President Obama and UN Director General Ban Ki Moon who are some of the most authoritative voices within the debate. Our collective efforts at Power Clouds not only produce outstanding results on a large scale but they also generate awareness within young people about these crucial challenges. We are acting as business players but also as social innovators and educators within society.

Q How similar is Rifkin's model to Power Clouds?

A Jeremy Rifkin is a guru within the industry and we follow his activism for years now. When he refers to an ideal model of shared energy production he indirectly portrays the major traits of Power Clouds, namely a business which acts as catalyzer of human potential in the production of photovoltaic systems. We strongly believe Rifkin's model is to be considered a theoretical part of what Power Clouds implements in reality and for this reason, we can safely define ourselves as players with an unprecedented success.

Q What are your commitments toward the global community?

A We take social responsibility and giving back to the community very seriously as we believe that everyone

should have the chance to have a better life. We pledged to contribute and donate solar panels to a school in Romania (Scornicești) as well as to another school in Zambia for the creation of one of the World for People schools worldwide. By empowering communities with our technological expertise we contribute to make the world a bit better than we found it.

Q What are your ambitions for the next year or so? Are you looking to expand into other territories?

A We envision very ambitious plans for our business and we are currently engaged in different business expansion activities. We have several areas pinned on our map but Japan is most likely to be our next target country, where we are installing new solar panels in different parts of the nation. Seeing the huge enthusiastic support shown by Romanian local authorities, we are confident of a co operation outside Europe with other governments and institutions.

Q How did you become involved in Power Clouds?

A I conceived Power Clouds long before it was an actual business reality. Throughout my academic studies in Electronics engineering and my interest towards ecology I became passionate about entrepreneurship too.

I then took over a leadership role within one of the most important photovoltaic suppliers in Europe and since then I started thinking about a revolutionary way to operate in business.

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Roberto Forlani did his undergraduate studies in Mechanical Engineering during which his passion for automation and electronics emerged and excelled in academia. Once graduated with distinction with a dissertation on Fuzzy Logic Applications in Power Systems .He was then awarded another scholarship within the field of 'Power Automation Systems'.

Over this time Roberto discovered his entrepreneurial spirit fuelled by the desire to change the world, working as consultant of judges and other carriers for the assessment of electromagnetic emissions of the BTS station for mobile network.

In 2004, thanks to his experience with the electronics systems of power, industrial automation and his fond interest in ecology he started his journey within the construction of small photovoltaic plants. Roberto was noticed by a renowned Italian supplier of photovoltaic converters which operates all over the world. Along with his team, Roberto became a strategic partner for the technical assistance and the set up of big photovoltaic plants across the globe as well as consulting on creating production systems of renewable energy.



Educational payback

Power Clouds has placed itself on the front line to promote education worldwide. Their latest project involves funding a second solar plant that will make World for People School fully independent energy-wise in Zambia.

POWER CLOUDS is supporting educational projects in various countries around the world. After opening the first solar plant in a school in Scornicesti (Romania), Kitwe is the next destination for Power Clouds is committing to educational projects by creating solar plants to power schools in various countries worldwide joining efforts with World for People Foundation. After winning the prestigious Business Project Development prize awarded by Solar International, Power Clouds is now expanding its activities to philanthropy.

The synergy between World for People and Power Clouds is born out of a shared sense of advocacy for education. As a matter of fact, the World for People School is the first project under the World for EDU initiative created in partnership between World for People, Wor(l)d and the local charity in Kamatipe which built the school with just over \$500K in donations. The school is composed by 16 classrooms and currently attended by around 940 primary school pupils. After a year long research trips on site, World for People has decided to take the lead of the school and it will contribute to the education of the pupils and eventually positively affecting the over 15,000 inhabitants of Kamatipe.



After selecting the project amongst a large number of applicants World for People Foundation will take over the management of the school with the aim of turning it into an experimental project to equip pupils with the best educational tools. By joining efforts with the Foundation, Power Clouds will install a 20 KW solar plant to make the school fully independent in 2015.

“ We are very happy for the support of Power Clouds. Our utmost priority-stated World for People Foundation Chairman Mr. Alfonso Galdi- is to provide the highest quality education;

education to shape the world into a better place. As Special Envoy for Global Education of United Nations Gordon Brown argued that “We need education first, education foremost, education forever. This project was conceived during a critical time, especially this year which marks the 50th Independence anniversary of Zambia. With less than 500 days left to the 2015 target date for achieving the United Nations’ Millennium Development and ‘Education for All’ goals, there are still 58 million children not receiving schooling and 250 million children who are still illiterate even after four years of schooling.”



On the other hand, Power Clouds CEO Mr. Roberto Forlani argued that “the business establishes itself as catalyser of social change in educational frameworks. We like to be a business that makes a dramatic change by empowering individuals with the biggest tool available to humankind: education. Our solar plants are donated in order to supply schools with clean, renewable solar energy in order to make them fully independent. The commitment of Power Clouds is not aimed at offering a respectable business model but also to set an example for businesses concerned with ethical principles of Corporate Social Responsibility. Joining efforts with World for People Foundation we hope to give our very best to institutions and schools around the world.

Mere economic profit is not our main goal: our mission is to power facilities and empower young people with green energy, equipping schools with fully functioning solar plants. Only once this dream is fulfilled we will consider our mission accomplished. Human capital lasts longer than economic profit and that’s what Power Clouds is about: investing in people and resources instead of money”.



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Innovative futures



Solar PV technology came to prominence as a path to cheaper energy for all but ended up increasing market share as a financial offering. Jamie Evans, Managing Director and Head of U.S. Eco Solutions for Panasonic discusses how solar is set for success as new solar solutions shed light on savings.

GOING GREEN is key to success for many reasons. For starters, there's the growing buzz around corporate social responsibility. For organizations looking to demonstrate their commitment to a cleaner world, installing solar panels is a no brainer. It positions them as pioneers of sustainability – crucial among today's environmentally-conscious society.

Yet, while implementing renewable energy is often considered a top priority, there's one thing every organization recognizes – it must be economically viable. As early adopters have come to see, solar panels

have proven to reduce electricity costs. With volatile and rising energy costs eating into profits and operating budgets, having an understanding of how solar power can offer stable, long-term financial savings and a steady return on investment has helped many organizations manage their energy spend. In many cases, simply avoiding the most common mistakes can provide a path to successful solar solutions.

A double edged sword

Solar is good for the planet, public perception, and pocketbooks, so what's the hold up? Unfortunately, even when the intention to go solar is strong, making the

final decision to push forward with these projects is not always an easy one. Yes, in the long run solar will help companies save money, but unexpected upfront costs associated with many installations can dampen the excitement about overall savings.

At the start of the solar boom, high equipment costs were the leading deterrent. Modules and inverters added significant expense to any project.

Thankfully, those costs have dropped upwards of 60 percent since

2011. Despite this significant decrease in panel prices, many organizations still balk at the cost and complexity associated with financing and monetizing solar assets. This is especially the case now that programs like the highly regarded Section 1603 Federal Grant Program, which had simplified project financing and stimulated a good deal of investment in renewable energy, have expired, leaving many in charge of sustainability decisions uncertain about immediate financial benefits.

In fact, financing and monetizing solar assets could be considered the most difficult aspects of solar project development. This is particularly the case for small organizations with limited operating histories. The financial structures can be complicated and many companies lack the intricate understanding to monetize tax credits and depreciation benefits needed in a post-Section 1603 Federal Grant

Program environment. In addition, while Power Purchase Agreements (PPAs) have grown in popularity, the challenges associated with negotiating, structuring, and financing these deals can frustrate potential customers.

Too many people at the party

A lot of the friction and lost dollars in present day deals can be attributed to the inefficiency of dealing with multiple third-parties throughout each phase of solar development. Most traditional models require a partner for development, a different one for finance, another for installation, etc. Each of these groups brings their own set of advisors, motivations and baggage to an installation, only complicating matters further. It's like the old saying goes – there are just too many cooks in the kitchen. These non-equipment,

non-labor costs can pile up fast. This is especially the case when it comes to the legal aspects of more complex financial structures. Successful projects require an ability to navigate and negotiate with teams of attorneys representing multiple constituencies. Lack of efficiency can result in delays and legal costs that can quickly erode project margins and returns.

So, while panel and equipment prices have decreased, arranging permits, accounting, appraisals, legal counsel and audits for multiple parties are now the



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main source of friction and inefficiency – deals stall, PPA need to be re-negotiated, and investors walk away as they see their returns erode.

New wave of solar solutions

To help streamline this fragmented process and ultimately lower costs, a new wave of solution oriented platforms has entered the renewable energy industry. Instead of moving from one third-party to the next, organizations can now join forces with fully integrated providers.

Through these strategic partnerships, executives now have access to an end-to-end solution that includes the design, engineering, procurement, construction, financing, commissioning, operation, and long-term maintenance of solar assets.

In particular, bringing the legal and contractual expertise under one roof with the right specialists proves extremely valuable. Once the first deal is structured, developing the second and third become significantly easier – everyone understands the key points. The same can be said on the development side

of the process. Instead of working with multiple developers, it's more efficient if organizations secure a partner who can either handle that side of the process internally or find a reliable partner to bring on board and negotiate the development economics up front. These models simplify the process for customers, creating a single point of contact for every aspect of the project rather than involving multiple individual vendors, all of whom expect to somehow participate in the project economics.

Ultimately, integrating the solution and working with one experienced partner to get the project completed brings with it a sense of familiarity and simplicity that can save months of time and hundreds of thousands of dollars in administrative costs, which can drastically impact PPA prices and project margins.

These single-partner solutions also provide a cleaner interface for organizations. Senior level executives only have to deal with one or two trusted individuals at their level that are driving the process forward.

A global environment

So how is this new wave of solar solutions playing out across the globe? From country to country, the differences can really vary – every jurisdiction is unique. Whether the country has national, regional or state level utilities, partners have to determine the particular process with each and how predictable they will be.

In addition, different corporate, contract, and financial structuring elements regarding project entities need to be considered. Emerging markets can also present unique challenges if there are fewer solar experts and processes in place.

But while turnkey solutions face distinct challenges in each individual country, their streamlined approach offers clear benefits to those they do reach. Whether in Mexico or Canada, England or Brazil, streamlining the process allows more solar projects across the globe to come to life – efficiently and cost effectively.

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Renewable auctions

The UK market has grown to become one of the top ten markets for solar and PV but is still at the early stage of industry growth when compared to Germany or the fast growing Asian PV markets. The Government continues to change the goalposts with the recent changes forcing large scale to compete directly with other energy alternatives.



The UK Government has announced its latest changes to renewable energy support in the UK. This is not the first time the UK Government, or indeed any Government has changed energy subsidies, but the UK remains one of the few European markets that has not retrospectively changed subsidy support. This is not for a lack of trying but the last time they tried to make such changes they lost the subsequent court battle.

They have been more cautious in making changes since that court loss but are finding themselves on a similar path when they announced the intention to close the Renewable Obligation Certificate (RoCs) scheme that provided large scale PV installations with a guaranteed income but will now close two years earlier. The alternative is a Contract for Difference (CfD) scheme where potential renewable energy projects will be auctioned off to the lowest bidder. A set price will be announced that companies will compete against.

A number of UK players have taken umbrage at the latest changes as company plans are made based on Government policies and such changes undermines investor confidence in a sector. There is currently a case in play that challenges the UK

Government decision but the consultation has gone ahead and the Government has confirmed

Budgeted auction

The first positive from the recent announcements was that renewable electricity projects will compete for £300 million in support this autumn. An increase of £95 million from the indicative budget published in July.

The funding for Contracts for Difference, which the Government claims will provide long-term certainty for investors, will be a cornerstone of the Government's reforms to the electricity markets, designed to drive investment in a new generation of clean, secure electricity supplies.

Low-carbon electricity projects will compete at auction for the contracts, which will deliver new capacity much more cheaply than through the previous arrangements, resulting in hopefully lower bills. It's estimated that the reforms to the electricity markets will mean that average annual household electricity bills are around £41 lower over the period 2014 to 2030 than decarbonising without these changes.

The increased budget will be split between different types of technologies:

Established technologies, such as onshore wind and solar, will compete for up to £65 million in support, reflecting the fact



that these technologies are already more competitive. Less established technologies, such as offshore wind and marine, will share in up to £235 million, demonstrating the Government's commitment to helping these technologies become as competitive as the more established low carbon generation sources.

The projected spend of the budget remains within the Levy Control Framework, which caps the costs to consumers of Government energy policies.

Energy Secretary Ed Davey said at the CfD launch, "We are transforming the UK's energy sector, dealing with a legacy of underinvestment to build a new generation of clean, secure power supplies that reduce our reliance on volatile foreign markets.

"Average annual investment in renewables has doubled since 2010 – with a record breaking £8 billion worth in 2013. By making projects compete for support, we're making sure that consumers get the best possible deal as well as a secure and clean power sector."

The budgets for next year's auction will be confirmed in 2015, but £50 million more has already been indicated for established technologies, with significant further funding potentially available to fund further projects, including Carbon Capture and Storage, by 2020-21.

Davey's excitement is not shared by the renewable energy industry with Renewable Energy Association (REA) Chief Executive Dr Nina Skorupska stating, "What should really worry consumers and Ministers alike is that the main CfD scheme doesn't work for many technologies, doesn't deliver value for money and doesn't help new entrants enter the market.

"The CfD allocation process is still too risky and complicated for most of the renewable energy independents and SMEs that are trying to break into the UK's consolidated energy market. Biomass developers in particular are struggling with flawed rules on implementing combined heat and power, whilst solar companies now cannot fall back on the existing Renewables Obligation.

"In both the short term and the long term, Ministers have failed to deliver value for money. In the short term, the cheaper, more established technologies have been given

less than a quarter of the available budget in the first round. In the longer term, the younger, less established technologies will struggle to achieve cost reductions without measures to ensure they can access the market."

The REA has been urging the Government to implement different financing measures for several months, but Ministers have not listened, so they are now encouraging political parties seeking a renewable future to commit to long term reforms in their manifestos.

Budget changes

The Government is able to increase the CfD budget because the latest estimates of the overall costs of other policies, in particular the Renewables Obligation (RO), are lower than expected. This was a surprise to many in the solar industry as it was the reason given for cutting short the RO programme.

The Government has stated some money has also been held back to manage the risk of overspending from other policies and for future auctions. This further indicates the difficulty in providing accurate assessments for future costs.



The Government also confirmed that the Renewables Obligation will close to new large-scale solar above 5MW from 1 April 2015. There will be a grace period to protect projects that had made significant financial commitments by 13 May, when the consultation on the change began. They intend to consult on an additional grace period to protect projects on track to commission before 1 April 2015 against the risk of missing the RO closure date due to delays in getting connected to the grid.

After consulting the industry, the eligibility criteria have been amended so that they are better aligned with the practicalities of solar project development processes. The Government is also changing the way it supports rooftop-mounted solar power, in line with the Solar Strategy.

This includes changes to the Feed-in Tariff Scheme (FiTs), with a new degression band for solar installations over 50KW, which will help to protect existing levels of financial support for this type of rooftop-mounted solar, as well as consulting on changes that would enable businesses and other organisations to take their panels and FiTs with them when they move premises.

Splitting the pot

This year's CfD budget will be split between technology pots. Within each pot technologies will compete against each other, but less established technologies are not expected to compete against the established technologies.

Pot 1 (established technologies): £50m for projects commissioning in 2015/16, and an additional £15m (i.e. £65m in total) for projects commissioning from 2016/17 onwards.

Pot 2 (less established technologies): £155m for projects commissioning from 2016/17 onwards, and an additional £80m (i.e. £235m in total) for projects commissioning from 2017/18 onwards.

Pot 3 (biomass conversion): No budget released in 2014.

The projects that win the auction will receive 15 year contracts - meaning that the total spend per year for contracts allocated in the first allocation round this autumn will be up to £300m.

In April the Government published a Solar Strategy that set out the actions that Government is taking in partnership with the industry to ensure that the solar sector continues to grow. It included a focus on deploying more solar panels on the top of commercial, industrial and public sector buildings. By attempting to change industry focus the Government has of course upset the companies that were doing well at the ground mounted installations.

Continue consultation

The Government has announced further consultation to tighten aspects of the new plan and will publish decisions as soon as possible after the consultation closes on 24 October 2014, following careful consideration of consultation responses and evidence received.

Subject to this consultation and Parliamentary approval, and any state aid requirements, they intend to implement a decision on the RO through an amendment to the Renewables Obligation Closure Order 2014, with the aim of the changes coming into force on 1 April 2015.

An argument made by several respondents to the May 2014 consultation on proposed changes to financial support for solar PV and by industry representatives at stakeholder engagement events was that introducing early closure of the RO for new large-scale solar PV creates a "cliff-edge" for projects after which no RO support will be available.

It was argued that the risk of missing the 31 March 2015 deadline would dissuade investors from committing investment to projects that were genuinely planning to commission in the final quarter of 2014/15. Industry argued that the single biggest uncertainty for

projects in the run up to the RO closure deadline would be grid connection delays.

The Government is therefore considering an additional grace period to protect projects against the risk of missing the early RO closure date due to delays in getting connected to the electricity grid, where the delays in securing connection are outside of the developer's control.

However, the Levy Control Framework (LCF) impact of offering a grace period is uncertain and there is a need to gain a better understanding of the possible impacts of such a grace period.

Robert Goss, MD, Conergy UK, one of the top five biggest builders of solar farms in Britain, and who participated on DECC's Solar Strategy taskforce last year, commented on the announcements, "As we move towards grid parity it is entirely reasonable to cut back on the support mechanism for solar.

In June this year, the average size of a British solar farm was only 4MWp, so after the handful of larger projects have been built, it will be business as usual on the many good sites still available.

Fears of rural industrialisation proved to be unfounded, and most communities in Britain would prefer a solar farm tucked away behind the hedgerows, to a nuclear power station or new housing estate. The ROCs are well-understood by investors and there is plenty of work to do for companies with aggregated smaller sites on low grade land.

Spreading construction around will also help more farmers than with recent concentrated developments, and Conergy will continue to acquire new projects across the country.

For larger 5MW+ solar farms, the window of opportunity is closing on ROC builds, and we recommend investors and developers close quickly, even with the Government's assurances on late grid connections, as we simply don't know what kind of weather we'll get this winter.

Looking ahead, CfDs are more attractive to investors than the ROCs, as they offer greater security, and we will bid in the first CfD auction to test the process for our customers and investors.

Overall for the British solar industry, the cost of finance is falling, as is the cost of build and installation, and that is thanks to the strong incentive structures that have been put in place. In distributed generation, falling costs will always be more important than the kinds of incentives and protections sought by the coal, gas, nuclear and wind industries."

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Material assurance

As solar heads towards a subsidy free market place there is a growing awareness of reliability and accuracy for manufacturers. Having the correct materials achieving the desired goals is paramount to module success and an awareness of the material along the entire value chain will become increasingly important. Solar International spoke to Zwick about how materials testing ensures quality in solar modules and components.

SOLAR ENERGY represents one of the fastest growing segments of the alternative energy markets. According to NPD Solar Buzz, world solar PV power capacity grew by a record 9,000 megawatts (MW) in the 1st quarter of 2014 and is expected to grow to over 50,000 MW by the end of 2015.

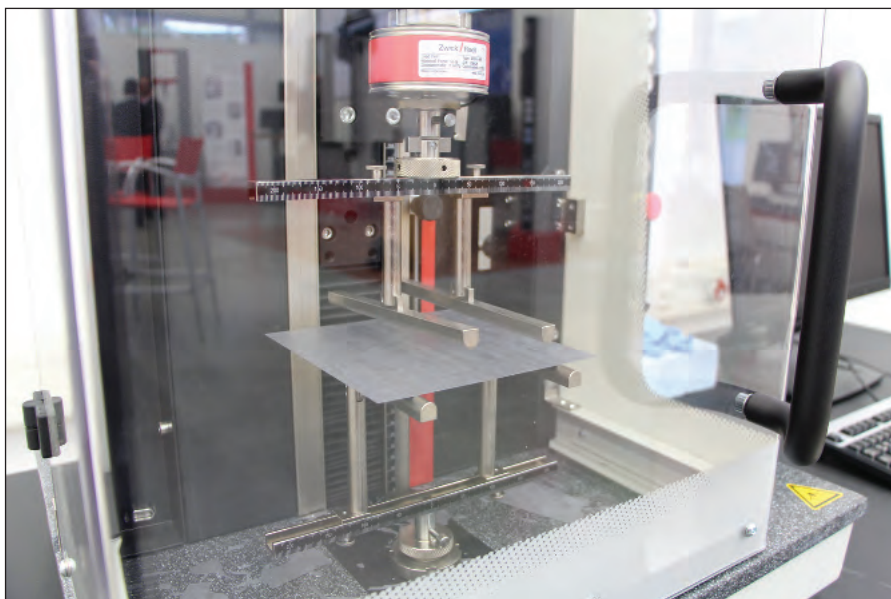
Solar cells or photovoltaic (PV) cells are electrical components that convert the radiant energy contained in sunlight directly into electrical energy. The drive to continually increase the performance of solar components while reducing costs has established the need for quality assurance testing.

Solar components are divided among several principal types based on materials used and manufacturing techniques, including thick film, thin film and organic. Thick film solar cells are comprised of mono-crystalline or poly-crystalline silicon.

Thin film solar cells incorporate similar crystalline silicon wafers and layers of gallium arsenide, cadmium telluride or copper indium-sulfur-selenium compounds. Organic solar cells are made using plastics and organic molecules that have semiconducting properties. The plastic used in organic solar cells has low production costs in high volumes.

The testing requirements for different types of solar cells may differ considerably based on the type of solar cell. Different technologies often result in fundamentally different designs and testing methodologies.

Solar cells are usually embedded in an EVA film in order to isolate them electrically. Protection from the elements is provided by a glass plate on the front and a Tedlar film on the back. Electrical connections are made with soldered joints. An aluminum frame combines the individual components into a solar module and provides attachment points for mounting.



A safety enclosure cabinet protects lab personnel and maintains the integrity of the testing space

“A complete suite of tests on solar modules typically includes tests on the wafers, glass, frame, film, solder joints and junction boxes,” said Matthias Volz, Solar Industry Manager for Zwick/Roell, a supplier of materials testing equipment and software.

R&D Testing

During research and development it is necessary to fully characterize the mechanical and climatic properties of the materials as well as the electro-physical properties of the cells.

The primary goals of testing include increasing the efficiency of photovoltaic cells and reducing the volume of material required to produce them. Materials must also be tested to assure durability and suitability of the materials

for specific uses. Testing during the product development cycle supports the development of process improvements and may contribute to a reduction in manufacturing cost.

Various mechanical tests are employed to determine the suitability and durability of the materials including strength tests on the glass, plastic or metal backing materials and wafer strength tests. Multi-layer composites require adhesion, peel and shear tests. Assessments of tear strength of the ribbon busbar joint and other mechanical joints are also commonly applied.

Testing of solar cells during production is performed primarily for quality control purposes. Testing routines must be developed for each step of the process with close attention paid to temperatures, contact pressures, dwell times, joining forces and tightening torques for fasteners.

Some tests are destructive in nature. At the change of product or material batch, components are removed on an individual basis and tested to destruction. An example of a destructive test is the removal of a string as part of a “tear test” to check the soldering process.

Non-destructive tests are also used including optical inspection of the wafer for breaks and optical tests on the soldered ribbons to ensure the soldering process was performed correctly. Laminate testing is performed optically to ascertain whether the lamination is free of bubbles. A check of the module is performed visually to make sure none of the components has been damaged. Finally, electrical tests check the performance of the cells.

IEC, EN test standards

A variety of international standards have been created to support the testing process. IEC or EN 61215 is utilized for thick layer modules and IEC or EN 61646 for thin layer modules. These standards describe a wide variety of climate and mechanical tests.



A puncture testing setup includes a collection tray to capture broken glass

The module is said to have passed the test if no major visible damage is apparent and the performance output and insulation properties have not changed significantly from the beginning of the test. The 61215 and 61646 standards are considered a mark of quality for crystalline PV modules and are required by most international funding authorities.

The 61215 test is designed to be rigorous, as solar modules must withstand up to 25 years outdoors in varying geographic regions throughout the world. This particular test can take up to five months to complete. The batch of modules must pass environmental tests involving UV radiation and prolonged exposure to high temperatures and humidity. Mechanical loading and torsion tests simulate hail and stone impact. The 61646 standard is also wide ranging, involving sunlight (UV), climate extremes and mechanical loading factors that simulate hail, snow and wind suction.

Various tests based on EN 1288 are focused on determining flexural strength of glass in buildings. The addition of supplementary standardized testing equipment can be used to make the testing process faster and remove outside influences.

Solution based

Zwick offers a four-point flexure kit for testing wafers, individual chips or components. The kit contains two bending beams with adjustable compression dies and can be utilized with a load cell (Fmax 10N). The anvils and bending rollers can be rotated freely. Rubber overlay strips are provided for placement between the specimen and anvil.

Also available is a kit to support double ring flexure tests on flat specimens. The kit includes support and loading rings, a collection tray and safety panel for protection from glass splinters. Centering strips are also provided to assure accurate positioning of specimens.

Tests on performance of high strength adhesives used in production of PV modules include ISO 614 non-destructive test for shipbuilding and marine structures and EN 1464 and 1465. The tests support the determination of the mechanical characteristics of different silicone bonding materials.

“Silicone adhesions should remain absolutely reliable even with high temperature fluctuation and strong light irradiation,” said Volz.

Mechanical joints such as the ribbon busbar must be tested to determine tear strength of the individual soldered connections. A specialized peel test kit from Zwick is designed to support the testing of solar modules, enabling both 90° and 180° peel tests. The kit includes a linear unit and support table with laterally adjustable clamping strips. A cable pulley guide system for the support table ensures that the pull-off position is always exactly in line with the tensile axis of the testing machine. The support table with clamping strips can be moved to a vertical position via an integrated 20mm connection.

Mechanical test equipment

The base testing platforms must be able to measure small forces necessary to test lightweight materials such as plastic

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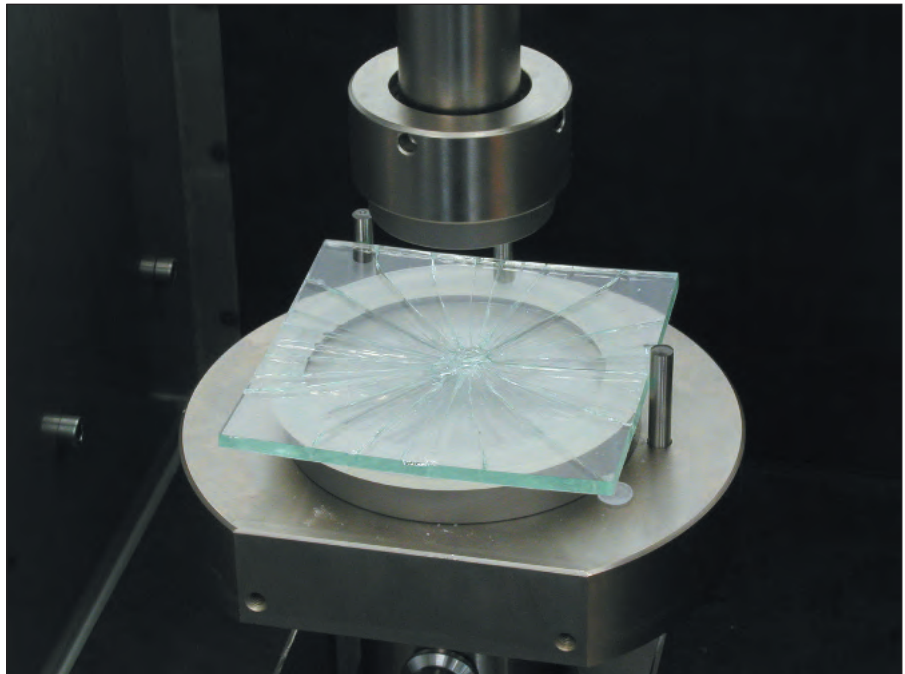
or silicon. The ZwickiLine and ProLine systems from Zwick are designed to offer a stable platform with fast set up and changeover for multiple tests.

The ZwickiLine is a flexible, compact and cost-efficient testing solution for a wide range of materials and components. This testing machine is equally ideal for research and development and for routine quality assurance testing. ProLine systems represent the ideal suite of testing machines for function tests on components and standard tests on materials and were designed primarily for standardized tests. Intelligent features within the intuitive testXpert II measurement and control software work in concert with ProLine systems to deliver efficiency gains without sacrificing performance.

Development and manufacture of the ZwickiLine and ProLine, including all mechanical, electronic and software components, together with the comprehensive range of accessories, takes place at Zwick's production facility in Germany, enabling optimum matching of all items, Volz said.

Software support

The application of intelligent software and digital machine control assists in making



Results of a puncture test on toughened safety glass in accordance with ISO 614 Form A and B

the entire testing process faster and more accurate. Zwick's testXpert II provides the first intuitive testing software that guides the operator through the test.

The flexible modular tool program can quickly and cost effectively be expanded for additional testing requirements. The test curve is always visible, allowing visual

monitoring during the test. Data transfer to CAQ networks is already accounted for in the Zwick programs, eliminating the need for hardware re-programming.

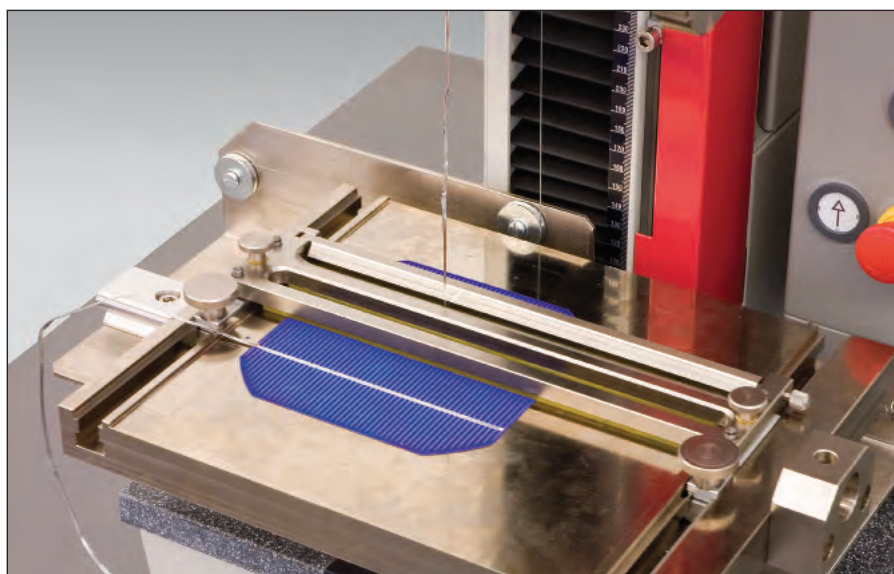
"The combination of dedicated test software with pre-programmed routines, the Zwick test machines and specialized solar cell testing fixtures can provide highly accurate and reliable test solutions for R&D and production, said Volz.

"The customer receives a complete solar cell testing machine from Zwick, covering all the principal mechanical tests," he said. As demand for photovoltaic platforms continues to increase, it is anticipated that the volume of testing will rise.

Turnkey systems that support the complete mechanical testing requirements of solar cells lend substantial value to manufacturers seeking differentiation in an increasingly competitive global marketplace.

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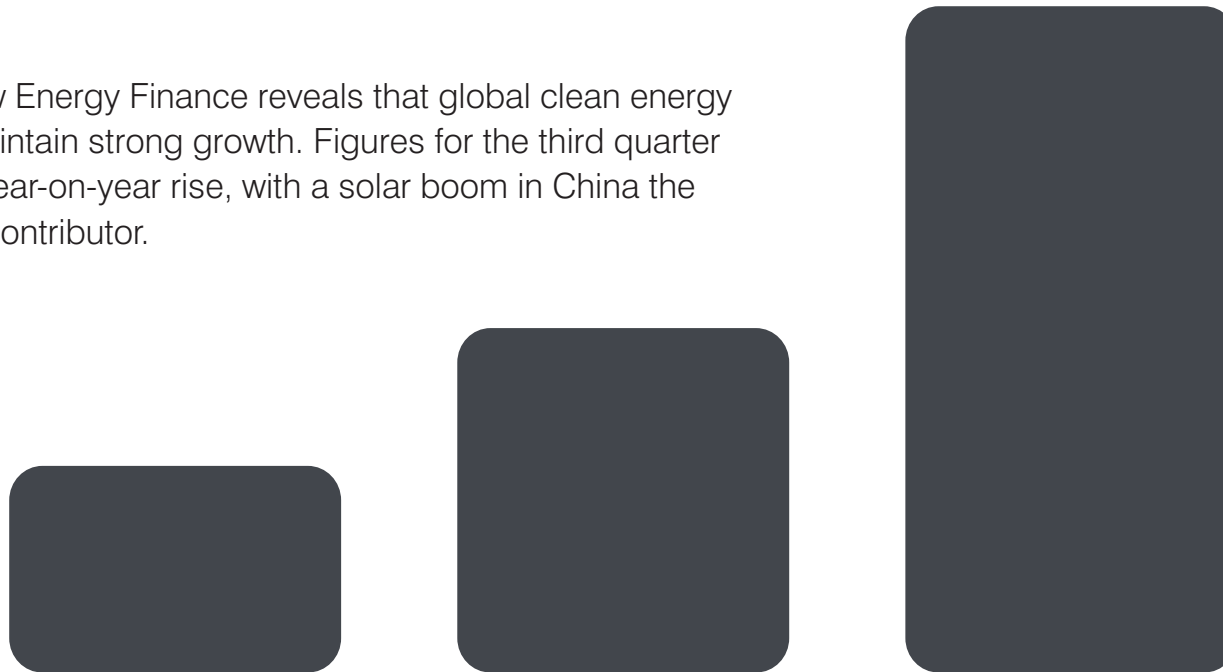


A specialized test rig for determining tear strength of the ribbon busbar joint

CLEAN ENERGY

investment on the rise

Bloomberg New Energy Finance reveals that global clean energy investments maintain strong growth. Figures for the third quarter show another year-on-year rise, with a solar boom in China the biggest single contributor.



WORLD CLEAN ENERGY INVESTMENT in the first three quarters of this year was 16% ahead of the same period of 2013, at \$175.1bn, making it almost certain that 2014 will produce a bounce-back in dollars invested after two years of decline. Figures published by Bloomberg New Energy Finance, based on its real-time data transactions and projects, show that clean energy investment in the July-to-September quarter was \$55bn, up 12% from the \$48.9bn achieved in Q3 2013. The third quarter is generally weaker than the second quarter, as it was this year, with the Q3 total 16% down on a strong \$65.2bn in Q2 2014.

China continues to perform

The highlight of the third quarter was a leap in Chinese solar investment to a new record of \$12.2bn, up from \$7.5bn in Q3 2013 and \$8bn in Q2 2014. China is building a large number of utility-scale photovoltaic projects linked to its main transmission

grid, and Bloomberg New Energy Finance forecasts that its solar installations will total 13-14GW in 2014, nearly a third of the world total.

There were other strong investment figures in Q3 from Japan, at 8.6bn, up 17% from the same quarter in 2013, with solar again the dominant renewable energy source. Other countries showing a bounce in investment in the latest quarter were Canada, France and India, while there were significant projects financed in a number of new markets, including Myanmar and Sri Lanka.

Michael Liebreich, chairman of the advisory board at Bloomberg New Energy Finance, commented, "It is heartening to see investment heading for an up-year in 2014 after two down-years, thanks in large part to the greatly enhanced competitiveness of solar, and to some extent wind.



Countries showing a bounce in investment in the latest quarter were Canada, France and India, while there were significant projects financed in a number of new markets, including Myanmar and Sri Lanka

Investment deals

Among the eye-catching asset finance deals of the July-to-September period were \$1.1bn for the 231MW Shizen Energy Setouchi PV project in Japan, an estimated \$850m for the 530MW Huanghe Hydropower Gonghe Longyangxia PV plant phase two in China, and \$642m for the 60MW Dublin waste-to-energy project in Ireland.

Public market transactions included a \$620m secondary share issue by Chinese PV manufacturer Hareon Solar Technology, a \$577m initial public offering by US renewable energy generator TerraForm Power, and a \$305m issue by Spanish wind turbine maker Gamesa Corporacion Tecnologica. The biggest venture and private equity transactions were \$250m for Mexican wind developer Zuma Energia, and \$80m for Chinese LED lighting specialist Lattice Power.

A regional breakdown of clean energy investment showed the continuing troubles of the sector in Europe, where just \$8.8bn was committed last quarter, the lowest figure for over eight years, down from \$12.1bn a year ago. There was a notably weak total from the UK, at \$789m, down from \$3.1bn a year earlier as policy uncertainties took a toll. Germany was at \$1.5bn compared to \$1.6bn in Q3 2013, and Italy at just \$262m compared to \$1bn, reflecting the impact on investor confidence of retroactive cuts in support for existing solar projects. France saw a rise to \$1.4bn from \$951m in Q3 2013.

The US saw clean energy investment of \$7.3bn in Q3 2014, well down from \$10.7bn in Q2 but up from \$5.7bn in the third quarter of last year. Overall Chinese clean energy investment was \$19.9bn in Q3, up from \$15.1bn a year earlier, while India's investment totalled \$2bn, up from \$1.3bn. Canadian investment was \$1.9bn, up from \$1.3bn, and Brazil's was \$863m, up slightly from \$830m but still one of that country's weakest quarterly figures for many years.

Luke Mills, associate, clean energy economics at Bloomberg New Energy Finance, said, "The third quarter data owed a lot to solar in China and Japan. We would expect to see a broader range of countries and technologies attracting investment in the billions of dollars in the fourth quarter, traditionally the busiest of the year for clean energy."

"However, there is no room for complacency because clean energy investment of between \$200bn and \$300bn a year is not large enough to herald the rapid transformation of the power system that experts say is required if the world is to see a peak in CO2 emissions around 2020. There is still too much policy instability holding back investor confidence."

The Q3 2014 figures showed global asset finance for clean energy projects such as wind farms, solar parks and geothermal plants reaching \$33.3bn, up slightly from \$32.8bn in the third quarter of last year. Investment in small-scale projects such as rooftop solar was \$18.3bn, up from \$13.9bn a year earlier, while equity capital raised by specialist clean energy companies on the public markets was \$2.7bn, up from \$2bn in Q3 2013. Venture capital and private equity investment was \$918m in Q3 2014, up from a multi-year low of \$592m in the same quarter of 2013.

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ENGINEERED
IN GERMANY

PERC CELL
EFFICIENCY
20.5 %

PECVD
VERTICAL
COATING
SYSTEM

LASER
ABLATION
SYSTEM

As one of the world's leading technology providers in the photovoltaic industry, with production and R&D facilities in Europe and Asia, Manz offers a full range of single equipment or totally integrated production lines.

Enable high efficiency cell concepts at the lowest CoO with our advanced PECVD Coating technology for front and back side passivation of crystalline solar cells, and with our fully automated Laser Ablation system for local contact opening of rear passivation layers.

Boost your PERC cell efficiency levels now with Manz high-tech equipment and achieve efficiency levels up to 20.5%.

OUR TECHNOLOGY FOR HIGH EFFICIENCY CELL CONCEPTS

ADVANCED PRODUCTION SOLUTIONS FOR SILICON SOLAR CELLS

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Submit your **Lab & Fab** article

Research is the foundation for the growth of the solar industry.

If you want to highlight the important breakthroughs that you make, submit your latest research stories to either:

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It is imperative that Solar International remains a timely resource for this industry, so we are interested in highlighting recent work reported in academic papers.

Therefore, only consider writing a short piece highlighting your work if you have a journal paper that has been accepted and about to appear in press, or a paper that has been published within the last two months.

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PV MATERIALS ENABLING AWARD

The Heraeus Photovoltaics Business Unit

SOL9620 Series and SOL9621 Series

THE SOL9620 Series and SOL9621 Series represent Heraeus' latest pastes that enable cell manufacturers to further increase their c-Si cells' conversion efficiencies to an industry-leading level and beyond. The development of these two products are for customers with slightly different LDE applications and processing; however both pastes provide superior cell efficiencies while lowering customers' cost per watt.

The SOL9620 Series is an ultra-light doped emitters [ULDE], with doping concentrations down to $1 \times 10^{20}/\text{cm}^3$. The SOL9620 Series has demonstrated the highest performance during customer testing, particularly on monocrystalline wafers. Relative to the SOL9610 Series on $110 \Omega/\text{sq}$. monocrystalline wafers, the SOL9620 Series demonstrated an 80% reduction in contact resistance; approximately a 3mV increase in Voc; and up to 0.25% absolute efficiency gains.

The unique chemistry of SOL9620 Series also enables the ability to be fired through different combination of passivation layers and at a relative lower peak temperature than standard firing temperatures. This is ideal for PERC applications. The SOL9621



Andreas Henning, Global Technical Service Manager and Benson Yan, Vice President and Global Sales Manager of the Photovoltaics Business Unit at Heraeus

Series has demonstrated great results for regular emitter and LDE applications. When tested against Heraeus' SOL9610 Series on $85 \Omega/\text{sq}$. multicrystalline wafers, customers experienced higher electrical performance: a 50% reduction in contact resistance; a 1 – 2 mV increase in Voc; and greater than 0.10% absolute efficiency gains. The SOL9621 Series

provides customers with a flexible and robust process window, which aids in providing a lower manufacturing cost. SOL9621 is also highly recommended for the 1st and 2nd layer of double printing applications with customers confirmed efficiency gain greater than 0.10% over the best commercially available double printing pastes.



THIN FILM INNOVATION AWARD

First Solar

Thin Film Module Technology

SINCE THE COMPANY'S INCEPTION in 1999 First Solar has demonstrated thin-film cadmium telluride (CdTe) innovation. Developed in the United States, First Solar now has the only thin-film module technology that is proven more efficient and less costly than conventional crystalline silicon (C-Si Photovoltaic) PV modules.

First Solar has dedicated research and development toward exponential innovation with multiple records for research cell efficiency increasing from 16.5% to today's record 20.4% and improving module efficiencies year over year. First Solar currently holds the world record in CdTe research module 17% and research cell efficiency 20.4% using organic and acquired technology. First Solar has demonstrated repeated successful innovation cycles converting these historical technology developments by effectively scaling the advancements into more than 8GW of high volume production.

First Solar's thin-film technology addresses the global issue of identifying an efficient cost effective and sustainable alternative energy source that competes with traditional energy sources today. First Solar has lowered the cost of solar electricity by developing utility-scale PV solutions utilizing thin-film technology

competitive with conventional energy sources. First Solar has achieved economies of scale through its innovative fully integrated manufacturing process which produces a thin-film PV module from a sheet of glass in less than 2.5 hours while using less energy water and semiconductor material than conventional crystalline PV's production process. The semiconductor material used has the highest theoretical efficiency of any known PV material. Combined with the lowest inherent manufacturing costs CdTe presents the greatest opportunity for solar electricity to change the way the world is powered.

Superior spectral response in humid climates - Superior temperature coefficient in hot climates - Industry-leading long-term reliability and durability - Smallest carbon footprint - Lowest life-cycle water use - Fastest energy payback time.

First Solar has executed an IP-based innovation strategy using both internal and acquired device technology and has combined it with unique manufacturing technology to achieve over a decade of documented improvements culminating in 17% record PV research module efficiency. First Solar has built on the success of core technology and invests heavily in accelerating research and development.



Christopher Burghardt, VP Business Development and Sales, Europe at First Solar



SILICON INNOVATION AWARD

MANZ AG

PERC Production Solutions

TO MEET GLOBAL MARKET'S soaring demand for high-efficiency solar cells and lower manufacturing costs, Manz AG offers industry-leading solutions for crystalline solar-cell (cSi) production which yields high conversion efficiencies of up to 20.5%.

The new-generation production technology deploys Manz's VCS 1200 vertical vacuum coating system to deposit dielectric passivation layers on the rear of cells, together with the firm's LAS 2400 laser ablation technology, enabling cell manufacturers to achieve large-scale production of high-efficiency cSi solar cells at lowest Cost of Ownership. The fully automated and maintenance-friendly tools boast a smaller footprint and improved efficiency over competitors' systems. They can be used for both mono- and multi-crystalline solar cells.

Manz offers customers the necessary equipment and processing technology to convert standard cell production lines to manufacture the higher-efficiency PERC cells. Manz's VCS 1200 system uses a completely new technology for vertical processing, with a throughput of 1,200 wafers/hour. Thanks to its powerful plasma source and a new carrier system, the coating process leaves no pin marks or flakes on the wafers – a problem of many competitors' systems. In addition,



Dr. Sebastian Gatz, Head of Development cSi Solar and Dieter Manz, CEO of Manz AG

VCS 1200 enables single-side deposition of PECVD-layers without wrap-around of deposition on the other side. Manz's high performance PECVD process technology achieves optimum reproducibility and the industry's highest degree of cell efficiency and uniformity. Alongside the VCS 1200 system, Manz's LAS 2400 laser ablation system provides a simple,

precise and high-throughput solution for local contact opening of rear side passivation layers.

Being a one-stop process, laser ablation offers the lowest cost of ownership for this step in cell production and offers safe wafer handling with the industry's lowest breakage rates.



SYSTEM INTEGRATION AWARD

SKYTRON ENERGY GMBH

Skylog Data Logger System

SKYLOG is a powerful data acquisition system for large-scale photovoltaic power plants using high-performance industrial grade components. skylog has been designed with robustness and versatility in mind. Furthermore skylog is a highly modular system allowing a wide choice of applications.

Communicating with string and central inverters as well as measurement units like energy meters, weather sensors, etc., using any of the standard bus technologies (CAN, RS422, RS485, Ethernet, Modbus, SunSpec), skylog can read and save one-minute data values from a variety of terminal devices, irrespective of make.

skylog's unmatched close connection path to the inverters is fully utilized by skytron's comprehensive plant control algorithms especially for the unique frequency support by providing balancing power feature which uses a one second bidirectional data exchange to the PV plant's actuating elements.

skylog's integrated uninterruptable power supply (UPS) provides power to all other monitoring components supplied by the CAN bus cable, ensuring dependable operation even in the event of a power failure. In locations having unreliable internet connections, local data storage



is secured up to 4 weeks by skylog's substantial data buffering capacity. Besides skylog is equipped with an industrial router. This allows the use of DSL, UMTS or satellite communication in order to forward current plant information to the plant supervision platform PVGuard or to other performance analysis tools.

skylog therefore forms an indispensable component as it is an elementary part of the skytron real-time monitoring, control and supervision system for utility-scale PV installations.

Torsten Schlaaff, Director Hardware Development & Operations at Skytron



PV TOOL AWARD

InnoLas solutions GmbH

ILM-2 Laser Machine

INCREASING CELL EFFICIENCY is the most effective way to reduce the cost of solar power, and PERC (Passivated Emitter and Rear Contact) is one of the technologies that meet the balance between manufacturing cost and efficiency.

InnoLas used its 15 years of experience in laser processing for the PV industry to design the cost effective ILM-2 production platform for lowest maintenance costs and best Cost of Ownership in the market. The ILM-2 platform is further optimized for easy integration into existing production lines and reduces handling steps if integrated e.g. via conveyor interface prior to a screen printer line or directly after a passivation tool. Alternatively, it can be combined with an InnoLas high speed automation system and operated as a stand-alone tool. The output can be adjusted between 1,600 and 3,600 wafers per hour at an excellent uptime of >96%.

InnoLas Solutions sees increasing demand for PERC solutions that can be adapted flexibly to current and future production line designs and requirements. The company designed the ILM-2 as a modular machine concept that can be

used as a stand-alone or in-line system, with the option to use different laser sources. The ILM-2 offers our customers a future-proof 24/7 production solution with an excellent uptime.

This high volume production machine to open the passivation coating of PERC cells by a laser lift off process.

A local BSF and rear contacts are formed by controlling the interaction of the laser beam and the Si material at high process speed. The optimized laser and optical parameters of the system together with a new innovative dash pattern layout lead to a higher efficiency of solar cells compared to state of the art PERC process schemes.

Previous laser processes suffered from low throughputs and high cost due to limited process speeds as well as imperfect passivation layer openings. The ILM-2 comprises an improved laser and optical setup which allows perfect control of the contact opening at the highest process speed.

For the first time a novel dashed line pattern layout was enabled at high process speed enabling cell efficiency.



Markus Nicht, CEO of InnoLas

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PV PROCESS AWARD



Diamond Wire Management System (DWMS)

DIAMOND WIRE MANAGEMENT SYSTEM (DWMS) is an enhanced wire winding system uniquely designed and available for Meyer Burger diamond wire saws. The DWMS is marketed under the name of DW288 as an integrated option of the successful DW288 platform for mono and multi silicon wafering in the PV industry. During cutting the wire is wound and unwound on spools on each side of the wire web respectively.

Without DWMS the aggressive wire is wound directly onto the storage spool on overlapping windings and can therefore damage itself. The innovative DWMS design separates the spool into a supplier (storage) part and a working part. On the working part the wire is wound in non-overlapping windings with a minimal pitch. This completely eliminates wire to wire contact and therefore maintains the critical sharpness of the wire.

The DWMS extends the lifetime of the diamond wire because it eliminates the wear of the diamond wire which only occurs in the work piece itself. As a consequence the wire consumption which is the most important cost driver within the wafer slicing process is lowered tremendously. The wire winding system of the diamond wire saws is enhanced



Sylvère Leu, CIO and Joel Peguiron, Physicist Waferline & Waferflow at Meyer Burger

by dividing the spools on both sides of the wire web into a supplier (storage) and a working part. Before starting the cutting/pilgrim mode fresh diamond wire is transferred from the storage part via the wire web onto the working part of the spool (on the wire supplying side of the web). During the wafering process itself, the wire is wound back and forth in non-overlapping windings without wire to wire contact.

The wire management systems of all wire saw suppliers are direct derivatives of wire

management systems for slurry based cutting. Wires for slurry based systems are non-aggressive bare wires.

Such wires can be wound and unwound onto conventional spools in overlapping windings with no harm occurring to the wire itself. With the DWMS wire to wire contact is avoided and the diamond wire wears only in contact with the silicon it is cutting. The DWMS is the first wire management system developed for the specific requirements of diamond wire based wafering.

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PV BALANCE OF SYSTEM



VarioString: Isolated Dual Channel High Voltage MPPT

VARIOSTRING is a high power, isolated, dual channel MPPT solar charge controller for off-grid systems and battery based energy management systems up to 105kW. It is compatible with all battery technologies (lead-acid, lithium-ion, NiCd, etc.) due to its programming options for the charge cycle. Its fast and accurate algorithm ensures an MPPT efficiency of more than 99%.

The ability to arrange the dual MPPT inputs independently or in parallel (with max 600Voc) or in series (with max 900Voc) allows the VarioString to be used in a wide variety of PV configurations. While battery based MPPT solar charge controllers are typically used for off-grid applications, increasingly the DC-coupling of PV is used in battery based energy management systems with connection to the grid to increase system stability and system efficiency for energy consumed when the sun is not shining.

The VarioString responds to the need to decrease BOS costs, increase flexibility and modularity of BOS components and at the same time increases system performance and overall energy yield. The VarioString has been designed to meet the needs of battery based management systems. The high voltage DC input allows for longer



Julie Studer, Comms Designer at Studer

strings of PV modules, much like is common with standard grid-tie inverters, which decreases the BOS costs and greatly simplifies installation. The fully programmable 4-step battery charger extends the life of batteries which reduces O&M costs and the amount of batteries being disposed of. The VarioString makes it possible to create flexible residential PV systems with only one device. Studer had the forethought to create a product with high power and high efficiency for different PV arrays.

The VarioString allows for up to 900 Vdc maximum open circuit voltage with the dual MPPT inputs in series, which is the highest PV voltage allowable of any device in its class.

The VarioString responds to the toughest requirements in efficiency in solar installations. It also reduces the system costs by accepting PV strings up to 600 or 900Vdc. This allows for a more simple installation and reduces the installation time and material costs: reduction in cable cross-section and length, absence of junction box and string fuses.

The VarioString contains dual MPPT inputs for a total flexibility in PV array configuration (in series, in parallel or independent). It allows for up to 900 Vdc maximum open circuit voltage with the dual MPPT inputs in series, which is the highest PV voltage allowable of any device in its class.

The VarioString has 120A max battery charge current.

It has the capability of connecting up to 15 PV panels in parallel on the same battery bank for a total PV array capacity of up to 105 kWp. The full isolation between PV and battery allows for any grounding scheme.



ENERGY USAGE ENABLING AWARD

SolarEdge Technology

Smart Energy Management Solution

THE SOLAREEDGE SMART ENERGY MANAGEMENT SOLUTION includes a feed-in limitation feature that enables PV system owners to maximize self-consumption while maintaining compliance with local grid regulations and installation standards.

The average size of a PV system is trending upward allowing owners to minimize grid consumption throughout the day. However this boom in PV generation has also altered the structure of grid operations prompting a number of countries to put in place regulations that limit the amount of PV power that can be delivered to the grid – some have even banned PV systems from feeding into the grid altogether.

In many cases customers cannot justify the economics of a PV system purely for self-consumption or are forced to reduce the size of their desired system to avoid exceeding the local feed-in limit.

By enabling customers to dynamically manage the amount of PV power produced so that the power fed into the grid never exceeds the limit the SolarEdge

feed-in limitation unlocks a new level of operational flexibility for system owners. SolarEdge's feed-in limitation is integrated directly into the inverter firmware ensuring it maintains the output power limit set forth by the utility at all times.

For the first time PV system owners can easily maximize self-consumption when loads are high then feed into the grid when the loads are low without violating local regulations and procedures.

SolarEdge's feed-in limitation feature dynamically adjusts PV power production ensuring that power output to the grid does not exceed the pre-set limit thus enabling larger installations and increasing the potential of PV power for self-consumption. The feed-in limitation feature quickly and precisely adjusts PV power output to the grid even during rapid changes in load consumption and power production.

SolarEdge's Smart Energy Management system can be easily retrofitted into previously installed SolarEdge inverters and is fully compatible with both single- and multi-inverter systems.



Janna Mirck, Sales Manager at Solar Edge



MODULE MANUFACTURING INNOVATION AWARD

LG Electronics Deutschland GmbH

MonoX ACe

THE MonoX ACe from LG Electronics is a breakthrough by combining solar module and inverter for an alternating current (AC) power output (220 V). 1. The high-efficiency solar module rated 300 W has included an inverter/micro-inverter which is permanently installed at the back side of the module.

This inverter directly converts the direct-current (DC) power from the solar module into alternating current (AC) power. 2. With the inverter on the backside the known junction box with the bypass diodes is also included and can be saved in production. 3. The usual installation of an external micro-inverter is not necessary any more as it is already integrated in the junction box of LG's AC module

The innovative approach of the new LG Electronics AC Solar Module differentiates in 3 ways. a) For the string inverter design the solar module with the lowest current determines the performance of the string. With the micro-inverter each solar module contributes its own maximum performance to the system. b) With the micro-inverter there is no need to spend material, costs, and time to install the individual inverter for the module as it is already permanently installed at the



module. c) The micro-inverter of the LG Electronics AC Solar Module can deliver from the DC input power (280 W) the same amount of AC output power (280 W), the world best output power. d) LG Electronics provides the total solution (i.e. module + integrated microinverter) and fully warrants the total system.

This reduces purchasing complexity for LG Electronics customers as a "one stop shop."

Jong Won Park, Chief Engineer and Arianne Bischoff, Head of EU Marketing at LG Solar



INDUSTRY DEVELOPMENT AWARD

Rexel

Solar Energeasy

SOLAR ENERGEASY is a global program launched by Rexel to raise awareness and understanding of solar PV and make the installation and maintenance of solar panels easy for both the consumer and the electrical installer via a user-friendly online platform. What makes this solution unique is that it is the first end-to-end Solar PV package for both the installer and the consumer with a guarantee on the generation potential from a range of quality rooftop solar panels - or your money back!

The consumer portal of the Solar Energeasy platform allows homeowners to simulate the generation potential of their future installation online, translate it into revenue, and calculate their CO₂ emission savings and the equivalent in number of trees planted. They can also use the site to find a trustworthy installer close to home and request a quote online. Through the professional portal, electrical installers can provide consumers with a more detailed and accurate survey of their generation potential, allowing them to offer a guarantee that if the electricity generation falls below 90% of that forecast, Rexel will reimburse the difference. This is not only reassuring for the customer but also provides a compelling sales argument for the electrical installer.

They can also use the portal to make clients aware of dedicated financing solutions* that have been made available via Rexel's trusted financing partner, as well as offer additional services such as the cleaning and maintenance of solar panels. These additional services allow installers to offer an end-to-end comprehensive package to their clients, making the installation of solar 'easy'.

Installers who subscribe to the platform are added to a Solar Energeasy database to receive requests for quotation from potential customers living in their local area. They also have access to e-learning modules, keeping them up-to-date on the latest techniques, and are provided with administrative assistance to help them manage the complete process and follow their customers' financing applications.

With rising electricity prices many homeowners have installed or are considering installing solar power as an alternative source of energy.

Many people still fall short of installing solar panels because they do not know where to turn for advice. It is hoped that Solar Energeasy will build trust in the sector and help people overcome such reservations by adding certainty to the process of installing rooftop solar.



David Shapiro, Senior VP, Marketing & Business Development at Rexel

Solar Energeasy has been trialed in Belgium since June 2014, for which it has won the Solar Industry Development award in the Solar Industry Awards 2014. Following its success in Belgium, it has also been launched in the UK, with further roll outs planned globally.

* in the UK, eligible installers must be authorized by the FCA (Financial Conduct Authority) to offer finance to consumers.



RURAL ELECTRIFICATION DEVELOPMENT AWARD

Phaesun GmbH

BOSS - Business Opportunities with Solar Systems

OFF-GRID SOLAR POWER SYSTEMS can be an important factor to support rural development in areas that are not connected to the electricity grid. Most projects and concepts for rural electrification target the basic infrastructure needs such as the electrification of hospitals schools local administrations and private households.

But the commercial sector is another very important area of activity since prospering commercial activities are essential for the economic development of rural communities and therefore also contribute to social development. Common names for energy solutions for the commercial sector are productive use of energy or Business Opportunities with Solar Systems (BOSS).

As a system integrator the company Phaesun in cooperation with local partners and component manufacturer is developing and implementing different complete solar kits that can be used for income generation in rural non-electrified areas.

These solar powered systems for commercial use range from solar powered



Dirk Gutzeit, Product Manager at Phaesun

systems for daily services such as hair cutting TV and cinema mobile phone charging cooling and freezing of food and drinks to food processing such as juice squeezing and grain milling. Services in rural areas in developing countries are often poorly developed due to the lack of electricity access. The processing trade is often concentrated on urban areas. Off-Grid solar power systems offer a unique opportunity to implement new services in non-electrified rural areas and ensure that further process units will remain in the hands of locals.

These are examples how Phaesun BOSS-Kits are used: Solar phone charging

station to enable shop-owners to recharge mobile phones for a fee in areas without grid power= Income for the shop owner. Savings in time and money for mobile phone owners. Solar refrigeration kit to offer cool drinks and to preserve food at grocery stores restaurants etc= Additional income for the entrepreneur and better service for customers. Solar grain mill to mill the grain at the place of production = Higher margin for farmers. By combining many different off-grid solar systems a solar market place can be created that can influence the daily life and prosper of entire communities.

The concept only makes sense if the technical solutions are designed with high quality components and are well adjusted to local needs and climatic conditions. Therefore Phaesun cooperates with local partners in the target areas on the one side for the adjustment of the sets and with component manufacturers on the other hand to select and apply the best fitting components.

Phaesun brings in its expertise in the design of Off-Grid PV Kits including all components such as high quality solar modules batteries and electronics in combination with the most efficient loads.

solar winner

awards 2014

SOLAR AWARD FOR EXCELLENCE: PRODUCT

TS-Space

Unisim Compact Solar Simulator

THE 'UNISIM COMPACT' solar simulator provides the close-match spectra of our standard dual source 'Unisim' solar simulators in a low cost and compact form for bench top applications. The system provides a stand-alone instrument including front panel controls, a complete IV measurement system as well as a pneumatically controlled shutter and enclosure mechanism for easy, tool-less maintenance. This instrument is the first of its kind.

With high efficiency multi junction solar cells requiring a close match spectrum in order to achieve the most accurate calibration and results some research laboratories have been forced to use crude single source instruments for small scale research applications where only a relatively small beam size is required. Many research groups are also limited by physical floor space or budget.

The Unisim Compact makes the world leading close-match spectrum which TS-Space Systems is known for available in a bench top form and at a low cost whilst retaining all the salient features our customers love about our standard Unisim range. This opens up a world class instrument to a range of researchers who were previously limited to basic single source simulators.

The Unisim Compact comes as a stand alone instrument with a full IV measurement system and built-in source meter. The dual source optics features our pioneering highly stable metal halide arc lamp and standard quartz halogen lamps which can be controlled and shuttered via the front panel. An intensity indicator is also built into the system in order to monitor lamp light levels.

The requirement of a close-match spectrum for accurate measurement of multi junction solar cells is well known. TS-Space Systems has pioneered not only the close-match multi source solar simulator, but the first ever quad-source solar simulator and the use of metal halide arc sources for a highly stable, continuous beam.

The award winning 'Unisim' range of solar simulators are used in RandD work as well as 24/7 production facilities and are regularly cited in the latest photovoltaic research literature.

The 'Unisim Compact' takes the salient features of these proven and popular simulators and packs them into a convenient bench top form factor for use in University or small research applications. The pneumatically operated, easy-maintenance enclosure houses a



Chloe Harrison and Bill Williams Jr of TS Space

dual source, 2-zone solar simulator which combines metal halide and incandescent sources via a proprietary filter system to give an AM0 close-match spectrum (AM1.5 drop-in filter sets are available).

The standard system includes an embedded source meter with complete IV measurement system (Computer, comms interface, IV software, MS Excel), relative irradiance indicator for monitoring lamp intensity and a pneumatic shutter.



TURNKEY SUPPLIER AWARD

Panasonic Eco Solutions

End-to-end Solar Solution

MOST AGREE that renewable energy is crucial to our future. While electricity rates across the country continue to increase solar panels become more affordable and viable than ever.

Yet at a time when green technology is gaining popularity and prices are decreasing many remain hesitant to take the first step toward solar energy fearing a complex time consuming and expensive process awaits.

To avoid the headache of dealing with multiple vendors sustainability officers facility owners developers and power purchasers can simply join forces with a trusted partner – Panasonic Eco Solutions.

Panasonic has developed a comprehensive integrated end-to-end solution that brings solar projects from concept and finance to installation and maintenance under one roof simplifying the process of going solar. As a “one stop

shop” for going solar this solution helps organizations attain renewable energy – effectively and efficiently.

Traditional solar models often require the involvement of different third-party vendors at each phase of development. From the start facility managers and Sustainability Officers must engage with one firm for concept another for financing yet another for installation and the list goes on. Partnering with multiple vendors causes solar projects to become disjointed and inefficient resulting in cost increases missed deadlines and frustration.

In addition dealing with multiple contracts production guarantees and product warranties can cause worry about reputation and brand image. Sustainability officers facility owners developers and power purchasers don't have to be burdened by the aggravation of dealing with multiple parties at each step of the solar process.

The Panasonic Eco team facilitates solar projects at every phase of development streamlining the entire process and serving as a viable strategic partnership for a wide range of organizations. With Panasonic's comprehensive integrated turnkey model organizations ensure solar success avoid unnecessary stress and save time and money. For a wide range of organizations Panasonic provides the solution they need to fulfil social responsibility goals and reduce utility costs.

Panasonic Eco are the only company to bring all phases of solar project development from finance to design installation to maintenance under one roof backed by a production guarantee. And because of its reputation of reliability and financial stability Panasonic alleviates a customer's worries about dealing with multiple vendors of questionable reliability stability and ability to cooperate with one another to complete projects on schedule and on budget.

solar winner

awards 2014

SOLAR AWARD FOR EXCELLENCE: INNOVATION

DEK Solar

DEK SOLAR'S commitment to solar cell metallization innovation – both from a product and process perspective makes the company a worthy recipient of the Solar Award for Excellence in Innovation.

DEK Solar's high-accuracy Eclipse and Apollo metallization platforms, along with the company's VectorGuard Fine Line Stencil were the basis for the award win and have all previously been recipients of industry accolades and contributors to record-breaking cell efficiencies.

Apollo continues to enable next-generation, high-efficiency cell processes such as print-on-print and manufacturers are increasingly turning to the platform to confidently expand existing manufacturing capacity.

A small-footprint, future-proofed metallization platform, Apollo offers solar cell manufacturers quality, precision and yield levels with exceptionally low cost of ownership.

With +/- 10 μm accuracy at 2 Cpk, a low breakage rate of less than 0.15% and guaranteed performance upheld

by a standard three-year warranty that is offered on all DEK Solar platforms, Apollo is the benchmark for effective cell metallization on any substrate with wafer alignment capability that supports multiple process techniques.

The modular and scalable Eclipse platform is capable of producing up to 4,000 wph and, equipped with zero-edge-contact handling technology, has breakage rates of less than 0.15%. Apollo, which has been designed for solar cell operations that require repeatability, accuracy and high performance in a small-footprint, single-line configuration, boasts accuracy of +/- 10 μm @ 2 Cpk and is equally impressive.

To enable low silver paste consumption and maximum cell efficiency, DEK Solar developed its Fine Line Stencil technology, which delivers superb uniformity and high aspect ratios for exceptionally flat and uniform lines, with extremely thin, sub-40 μm line print capability.

All of these innovations made it easy for the judging panel's decision to name



Darren Brown, Alternative Energy Global Business Manager and Richard Wilshire, Head of Solar Engineering and Product Development at DEK

DEK Solar the winner of the Excellence in Innovation category.

DEK Solar Director, Brian Lau, who accepted the award, on behalf of the entire team. "Though our customers are already acutely aware of DEK Solar's enabling expertise, it is tremendous to have our work exposed to the wider solar community with this distinct honour."



SOLAR AWARD FOR EXCELLENCE: INDIVIDUAL

Steve Andrews, CEO of SolarAid

OVER 600 MILLION PEOPLE in Africa (two thirds of the population) live without access to grid electricity. When the sun sets, they either live in the dark, making any kind of productive activity -like doing homework – impossible; or they probably use a kerosene lamp.

Kerosene lamps are a terrible technology that are made from recycled tin cans, filled with kerosene (paraffin) which is burnt using a small wick. There is so much wrong with these lamps it's hard to know where to start. They are dangerous – often causing fires and burns that claim people's lives. They are polluting – filling people's lungs with black smoke (estimated by the World Health Organisation to be the equivalent of smoking 2 packets of cigarettes per day).

They provide poor light, making it hard for children to study at night. And maybe worst of all, they are brutally expensive to run. A typical rural African family spend 20% of their budget on kerosene for lighting. In the West, we spend less than 1% of the household budget on lighting.

SolarAid is a British charity that seeks to eradicate the kerosene lamp from Africa



Steve Andrews, formerly of SolarAid

by the end of this decade. The charity runs a social enterprise, SunnyMoney, which sells solar lights in six African countries: Kenya, Tanzania, Malawi, Zambia, Uganda and Senegal.

Solar lights are clean, safe and bright. A customer buying one stops using kerosene lighting and saves an average of \$85 per year; money they spend on more food, more schooling for their children and inputs for their small farms.

Steve Andrews led SunnyMoney from being a small start-up company selling a few hundred solar lights per month to

becoming the largest last mile seller of these products on the continent of Africa; growing to 75,000 lights per month in July 2014. SunnyMoney is now recognised in both the international development and renewable industry community and is inspiring further investment in solar power for Africa. This has been possible because of the strategic direction and focus Steve brought to the organisation.

Steve led the SolarAid and SunnyMoney teams in capturing the ambition of what is known as a BHAG (Big Hairy Audacious Goal): the eradication of the kerosene lamp from Africa by 2020.

Steve Andrews has won the Solar Award for Excellence for an individual for his efforts in taking a great idea and making it one of the solar success stories worth celebrating.

In August 2014, Steve left SolarAid and has subsequently decided to start a new privately funded company selling solar lights in Africa. Called NewLight Africa, Steve's new company will actually sell a range of clean energy technologies that will change the lives of many of the world's poorest people.



PROJECT DEVELOPMENT AWARD



Power Clouds Project

Power Clouds Pte Ltd are the company behind an innovative solution for the development of photovoltaic through the direct and bottom-up involvement of the people. Anyone is free to buy a solar panel and rent it out to the company contributing to the production of green energy that protects the planet.

The same company carries out the plants and ensure through an extensive network of activities including energy production a fixed monthly income for 20 years for those who take part in the project.

The concept behind Power Clouds is seen as an alternative to traditional financing ways for the photovoltaic stations construction and at the same time leads to the direct involvement of a large number of people (40000 participants in the first year).

Through the collective participation the project redistribute equitably costs and gains on the participants related to the development of solar projects and makes people protagonists of the climate change challenge.

Power Clouds are currently the only company which develops and manufactures large photovoltaic projects involving ordinary people who care for the environment and through the investment initiative they are able to get a fair economic benefit.

The projects cornerstone is the Power Clouds innovative vision of the developments possibilities of the photovoltaic systems. Ordinary people from all over the world are directly involved buying a solar panel.

The new Power Clouds conceptual proposal arises as a viable alternative to traditional financing ways for the construction of photovoltaic stations. Power Clouds at the same time contributes to spread renewable energy in the world.

For further details see *page 14* of this edition of Solar International



Roberto Forlani, CEO of Power Clouds



SOLAR AWARD FOR EXCELLENCE: COMPANY

First Solar

First Solar entered the solar market in 1999 with a focus on thin film technology at a time when silicon based solar modules held a superior market share. Despite the market turmoil that sometimes surrounds the solar and PV industries First Solar has continued on a path of excellence that is hard to match anywhere in the world.

First Solar was the first PV company to produce 1GW in a single year as well as the first to break the \$1/watt manufacturing cost barrier. They hold multiple world records for CdTe thin film solar module (17%) and cell (21%) efficiency. Long before most companies First Solar implemented a global PV module recycling program

The company has developed as if it was always slightly ahead of the curve. After initially selling product into Germany, where their first customer bought their entire first year of product, First Solar could see the European financial models that were effective and set up a broader

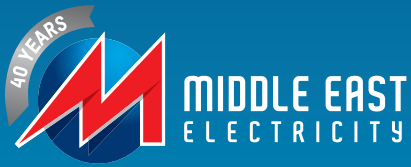
approach in their home country of the US where they developed world's largest contracted solar project pipeline of 3GW+ and facilitated the financing for ~2GW (representing ~\$9 billion). They have also developed advanced grid integration, plant control, forecasting, and energy scheduling capabilities.

With over 9 gigawatts (GW) installed worldwide, First Solar has continued to remain one of the jewels in the global PV industry. With stronger competition from newer markets, there have been some predicting the demise of the company but the opposite occurred as First Solar moved from strength to strength.

First Solar's leadership in renewable energy is a result of expertise and nearly 15-year track record of manufacturing, developing, financing, engineering, constructing, and operating the world's leading sources of sustainable, solar energy, making them worthy winners of this year's award.



Christopher Burghardt, VP Business Development and Sales, Europe at First Solar



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Middle East update

Last year Michelle T. Davies, Partner and head of Clean Energy & Sustainability at Eversheds provided Solar with an excellent overview of the growing PV opportunities in the Middle East. Michelle is joined by Matthew Gibbs, Associate at Eversheds to provide an update on what has changed for solar in the region.

SINCE WE LAST WROTE FOR SOLAR at the end of 2013 much has changed in the development of the Middle East solar and PV markets. Saudi Arabia did not take its renewables White Paper forward, the Dubai Electricity and Water Authority released its 100MW solar RFP to pre-qualified bidders and Jordan's Ministry of Energy and Mineral Resources launched a 3 round direct proposals process, closing on round 1, extending round 2 and cancelling round 3.

There has also been substantial growth in the development of distributed energy and wheeling projects in countries such as Jordan, where the end consumers are procuring their own clean energy supply at a set price. Whilst the incentive for the push towards renewable energy varies throughout the MENA region, the chief driver for all nations is to meet their future energy needs. For the oil and gas rich countries like Saudi Arabia and the UAE,

the spur behind renewable energy policies has been the desire to utilise oil and gas reserves for export rather than domestic consumption. So long as there is arbitrage between export prices and the cost of renewable energy, it is a logical step.

For those countries reliant on imports to satisfy their energy requirements (Jordan and Morocco for instance), the motivation behind renewables is energy security. Regional political instability has meant this is a particular concern for these nations at the moment, due to the potential disruption to oil and gas supplies.

Something which is frequently forgotten is that MENA nations also have targets to hit under the Kyoto Protocol (which they have all signed up to) and for that reason they must start seriously thinking about their carbon footprints. The MENA region still has the ability to develop into a significant renewable



energy market. It has high levels of solar irradiation making solar projects especially attractive; it also has the necessary wind conditions to make wind technology a feasible option.

According to the International Renewables Energy Agency, in 2012, across the MENA region investment in renewables rose by 40% to \$2.9bn. In addition, it is estimated that up to 2025, the value of the projects due to be rewarded is estimated to be in the region of \$162bn.

The implementation of a renewable energy programme can also create jobs. This is an additional motivating factor and is especially significant in nations with mounting unemployment and anxiety about the instability this can cause. Nevertheless, the progress of renewable energy projects has not developed as swiftly as hoped. Aside from the continuing political volatility

affecting certain MENA nations, if renewable energy is to become a real alternative to fossil fuels in the region, there are numerous obstacles which must be overcome. Recent activity has helped to consolidate our understanding of what these challenges are and the best way to face them.

Obstacles facing renewable energy development

Domestic energy price distortion

The means by which energy is priced domestically is a real issue. The huge supplies of oil and gas in many parts of MENA has meant domestic energy prices are distorted. Current renewable energy pricing methods together with the policy of supplying low cost energy has meant it is not straightforward demonstrating the actual economic benefits of renewables.



Distributed energy and land ownership

In countries which have energy security problems, distributed and wheeled energy presents a fantastic solution. However, the impact of regulatory restrictions on the sale of electricity have to be considered. Often the ability to sell electricity is limited to state owned or governed distribution, supply or utility companies. In order for distributed energy to become a viable solution, there is a need for independent producers to have the ability to sell power.

Additionally, land ownership has been problematic in certain jurisdictions (Saudi Arabia for instance). Nonetheless, companies are finding ways around this by, for example, doing projects with municipalities or large corporates with significant land ownership, or with real estate companies experienced in local land issues.

Increasing awareness

There is a general lack of knowledge of the benefits of renewable energy. This is especially prevalent in oil and gas rich countries where, justifiably, there is an uneasiness about moving towards what is seen by some as unsure and untested technologies, from secure conventional energy resources. This view is however

changing quickly and we have seen a noticeable shift in attitude as decision makers, funders and companies have grown accustomed to how renewable energy projects operate. They are also becoming familiar with the relevant risk mitigation strategies and the potential the sector has. What is currently occurring in Jordan and Morocco will likely have a much wider impact and should assist with the changing of this mind-set.

Connectivity

Another genuine concern is the ability of grid networks to cope with the intermittence of renewable energy output, which is more prevalent with wind than with solar technologies. Renewable energy programmes must take an integrated approach to generation - of which connectivity is an essential part - if they are to thrive.

Emphasising socio-economic benefits and market incentives

A comprehensive approach is required to overcome the difficulties discussed above. Firstly, it is important to emphasise the long-term socio-economic benefits of renewable energy in order to gain the necessary political support. Benefits include less pollution, job creation and a reliable electricity supply, especially for those households who do not currently benefit from the same.

The genuine economic benefits of investing now in substantial renewable energy programmes must be reiterated; particularly in countries with vast conventional energy reserves, as well as the climate to sustain solar and wind technologies. The demand for energy in those nations is continually increasing and there will be a considerable negative impact upon revenues from oil and gas exports as reserves fall and consumption rises.

Investing in renewable energy projects now will help to meet present and future energy requirements and offset decreasing revenues. Dubai and Abu Dhabi are currently considering significant roof top solar programmes; the PR impact this could have should not be overlooked. Underlining market incentives that produce actual socio-economic benefits for all should help to develop a real desire for renewables.

Developing renewables programmes, policies and legal frameworks

Governments must focus on putting in place the necessary policies and incentives to help mitigate the market distortion which is currently acting as a drag on renewable energy progress in the MENA region. Creating clear legal and regulatory frameworks, policies, procurement programmes and incentives

Land ownership has been problematic in certain jurisdictions (Saudi Arabia for instance). Nonetheless, companies are finding ways around this by, for example, doing projects with municipalities or large corporates with significant land ownership, or with real estate companies experienced in local land issues

specific to the renewable energy sector is vital. Although a majority of countries in the area have made progress towards establishing policies and the legal and regulatory frameworks essential to supporting renewable energy development, their extensiveness varies considerably across the region.

The knock on effect of this is that it creates ambiguity for those companies attempting to access the MENA domestic energy markets.

Leading the way in this respect is Jordan, as it has developed a clear renewables programme. This programme includes a feed-in tariff structure and specific laws to specifically support the sector.

Additionally, it has set out a flexible tender process under which renewable energy projects can be developed in response to Government tenders or proposed directly to the Government by developers. On-site generation is also promoted. Investors have expressed a great deal of interest in Jordanian renewable energy projects, primarily due the certainty created by the well-defined programme there. Investors also see Jordan as a passage towards other potentially more lucrative - but currently less active - MENA markets, such as Saudi Arabia.

Debt financing – encouraging signs

The ability to find debt financing for projects also fluctuates markedly throughout the region. The countries without significant natural resources typically have somewhat lower credit ratings

than those countries that do. This impacts upon the capacity of some banks and financial institutions to provide assistance. An important role will be played by the development banks, export credit agencies and multi-laterals.

Vitality, a number of these bodies have already shown a willingness to invest in the region, including to nations with lesser credit ratings. For example, both the European Investment Bank and the International Finance Corporation have provided a considerable amount of debt to facilitate the funding of projects in Jordan and Morocco.

Conclusions

Overall, although there are obvious challenges facing the MENA renewable energy sector, the progress demonstrated over the last two years is promising. This is highlighted by the fact that according to the International Energy Agency's World Energy Outlook 2012, the share of power generated through renewables is set to climb from just 2% in 2010, to 12% by 2035.

When considered in conjunction with estimates by the World Bank that by 2040, the total investment needs of MENA's energy sector will exceed \$30bn a year – or about 3% of its projected GDP – this is extremely encouraging. Our opinion, based principally on the drivers which make renewables a credible solution, is that the region represents a market on the brink of success.

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The top five things that cause inverter failure

One of the most neglected electrical products used in industrial automation is the humble inverter. Rarely is a piece of equipment so straightforward and reliable that process engineers forget it exists. Jonathan Wilkins, marketing manager of obsolete and spare industrial automation parts supplier, European Automation, explains why even the most resilient components sometimes fail and what to do when this happens.

INVERTERS, DRIVES, VSDs, variable speed drives, variable frequency drives – the category of products used to control an electric motor's speed and thus reduce energy usage in a variable speed application has more names than Prince. Although, I suppose when you think about it, he only has three really, if you include his decision in 1993 to become known by a symbol instead of a word.

Power inverters can be completely electronic or combine mechanical effects with electronic circuitry.

Since inverters convert DC electricity from batteries, solar panels or fuel cells into AC electricity, the applications they



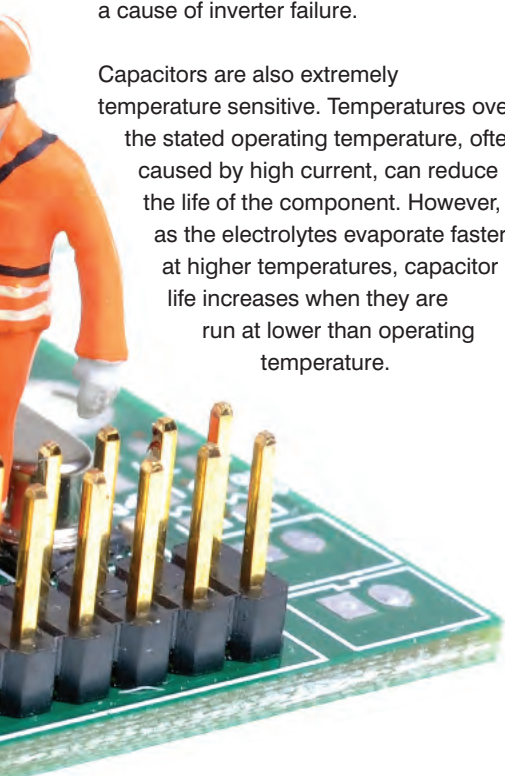
can be used in are extremely diverse. Electric motors are used everywhere in industry, including in the food and beverage sector for anything from fans, ventilators or conveyor belts to pumps and refrigeration vans. That being said, it's obvious how inverter failure or breakdown can cause production interruptions and significant financial losses.

The most common cause of failure or malfunctioning for inverters is an improper installation, often a combination of not following the user manual recommendation and selecting inappropriate cable type, gauges or in line fuses. Once you've passed the installation test and your product is up and running, there are a few things you will want to look out for.

Capacitor wear

The first reason for inverter failure is electro-mechanical wear on capacitors. Inverters rely on capacitors to provide a smooth power output at varying levels of current; however electrolytic capacitors have a limited lifespan and age faster than dry components. This in itself can be a cause of inverter failure.

Capacitors are also extremely temperature sensitive. Temperatures over the stated operating temperature, often caused by high current, can reduce the life of the component. However, as the electrolytes evaporate faster at higher temperatures, capacitor life increases when they are run at lower than operating temperature.



Happily, keeping a consistent maintenance regime and regularly replacing capacitors avoids most problems caused by wear and tear.

Overuse

We mentioned how sometimes process managers might forget about inverters. This happens more often than you think. Using inverters beyond their operating limit, either by choice or due to oversight or lack of knowledge, can contribute to inverter bridge failure. Using any component at a rating higher than its operating limit will decrease its lifespan and lead to failure, so avoiding this issue simply comes down to checking that all inverters are being run correctly.

Over- and under-voltage

The next two issues that can cause inverter failure are over-current and over-voltage. If either current or voltage increases to a level that the inverter is not rated for, it can cause damage to components in the device, most frequently the inverter bridge. Often this damage will be caused by the excess heat generated by the spike in voltage or current.

Over-current can be avoided with fuses or circuit breakers, but avoiding over-voltage can be tricky. Sometimes voltage spikes are man-made, but they can also be caused by lightning or solar flares, which are difficult to avoid if, like us, you live on planet Earth.

Ultrasonic vibrations

The final problem on the list is one that contributes to the mechanical stress placed on an inverter. Ultrasonic vibrations originating in the cores of inductive components cause friction, adding to the unwanted heat generated by the device and further damaging components in the inverter.

As with any electrical equipment, maintenance is the key and mustn't be overlooked. With time, electrical

connections tend to loosen or corrode. If the inverter is still functional, a maintenance manager might be tempted to simply ignore these signs of wear and tear. However, as the saying goes, it's better to be safe than sorry, so cleaning the terminals in the battery box, fuses and the inverter connection at least once every six months is crucial.

Furthermore, the cleaning process has to be performed correctly, or it might end up doing more damage than good. Ideally, a wire brush and grease dissolvent agent should be used. After cleaning and maintenance is complete, a protective sealant must also be used on all battery terminals.

When deciding which protective coating to use, avoid grease-based ones, because they tend to attract contaminants like dust, which leads to an increased decay of the connections, while also hiding the degradation from further visual inspections.

Although correct installation and maintenance can significantly prolong the lifespan of inverters, when failure does happen, there are a few routes you can take. Especially for older or obsolete models, it might be worth considering the purchase of a refurbished part.

Purchasing carefully refurbished parts from trusted suppliers is an excellent way to minimise your costs and ensure your operation is up and running in no time. When European Automation buys a drive for future re-sale, we repair or refurbish it so it's completely problem-free.

So, don't suffer in silence. If you are baffled by a broken drive, confused by the countless ways to control an electric motor or even just perplexed by Prince's name choices, get in contact with European Automation. We promise not to change our name to a symbol.

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Is the end in sight for renewable subsidies?

Rapidly falling costs of solar and wind mean that these technologies could soon be competitive against conventional coal or gas power stations, potentially ushering in a new era of unsubsidised renewables. James Cox, Principal Consultant and Anser Shakoor, Senior Consultant, of consultant and engineering group Pöyry examine when such changes might occur, and what the implications could be.



GRID PARITY occurs when an emerging technology such as wind or solar can produce electricity at the same levelised cost as buying power from the grid. This has long been regarded as the 'holy grail' of the renewables industry, as when grid parity is reached, market forces (rather than subsidies) would drive large scale deployment.

However, given that different consumers pay different prices for electricity, there are different definitions of grid parity, depending on what price is compared:

Retail grid parity occurs when the levelised cost of wind or solar falls below the retail price of electricity (for example, the price at which a typical household buys electricity). Since the retail price includes transmission and distribution costs, retail margins, as well as taxes and often renewables subsidies, the price paid is high and reaching grid parity is hence easier.

Wholesale grid parity occurs when wind or solar becomes competitive with wholesale price and with large-scale power generation – such as gas, coal or nuclear power stations. Since the wholesale price is much lower than the retail price, this requires the cost of renewables to fall further.

Although retail grid parity will be reached sooner than wholesale parity (and in some countries has already been reached) many of the advantages may be short-lived as they stem from the way in which the fixed costs of the system (such as the cost of the grid) are shared. For example, a move to charging grid fees for consumers based on peak consumption (per kW) rather than on energy (per kWh) would quickly remove much of the advantage that solar gains. Equally, a move to charging based on time of day rather than average monthly or quarterly prices may quickly erode many benefits of selling surplus electricity back to the grid.

For this reason we focus this article on wholesale grid parity, as the point when solar or wind can compete with conventional power stations is likely to be transformative.

Where might grid parity happen first?

Grid parity of renewables technologies is geography specific as:

- Available wind and solar resources differ significantly across different locations;
- Installation and operating costs of wind and solar vary from location to location; and
- Electricity prices vary by country or region depending on relevant generation mix, fuel and carbon prices, and short-run marginal cost of marginal generators in the system.

In Europe, there is much more sun in the south, and wind in the north, so we would expect these to be the dominant factors driving grid parity. However, the cost of electricity is also crucial, as whether a country has a system dominated by hydro (leading to low prices) or gas (currently leading to high prices) is vital. Thus a country with high electricity costs and excellent solar or wind resource is likely to be first for large-scale deployment of solar or wind without subsidies.

When might grid parity be reached?

We have conducted a detailed analysis to assess when wind and solar will reach grid parity across Europe by applying our state-of-the-art electricity market model BID3. BID3 is the leading European electricity market simulation software¹ for modelling the dispatch of all generation on the European network.

Country specific wind and solar output profiles based on wind speed data of a 20x20 km grid and solar radiation data of a 30x30 km grid were applied. A pragmatic learning rate of these renewable technologies was also considered. Furthermore, our analysis is centred on wholesale electricity prices based on Pöyry analysis.

Solar PV achieves wholesale grid parity ahead of onshore wind, while offshore wind and solar CSP would not reach grid parity during the analysis period spanning 2014 – 2040. Assuming falling capital costs, countries in Southern Europe will first attain grid parity for solar PV, primarily due to high solar irradiance. Spain would achieve solar PV parity as early as 2021 followed by Portugal (2022) and Italy (2025 to 2032 depending on specific region). 5% higher capex for solar PV would delay the grid parity by one to three years as represented by the upper value

of the grid parity range in the figure. Onshore wind is expected to achieve wholesale grid parity in a very limited number of countries before 2030. In case of relatively lower onshore wind capex, Ireland will achieve grid parity in 2020 followed by Great Britain in 2021 primarily due to high achievable onshore wind load factors in these countries. A 10% higher onshore wind capex would delay the grid parity by two to four years as represented by the upper value of the grid parity range in the figure. In Turkey, grid parity is gained for solar PV (2018) and onshore wind (2019) ahead of any other European country due to higher wholesale electricity prices in the country.

Note that uncertainties involving cost (capex and opex) of renewable technologies and fuel (coal, oil and gas) as well as carbon prices can accelerate or delay the time when grid parity is expected to be reached.

Implications of reaching grid parity

Reaching grid parity for a given renewable technology means that it can now compete with other conventional technologies, mainly coal and gas-fired power stations, without subsidies. This could lead to accelerated deployment of such a technology provided there are no investment, supply chain, policy or regulatory constraints.

Based on our analysis, we have found that on achieving grid parity an additional 220GW of solar PV mostly in Southern Europe and 40GW onshore wind across Europe can be built in

the absence of above mentioned constraints. So what prevents even higher deployment of renewables? One of the main factors is that of revenue cannibalisation: as the share of renewables rapidly grows in a system, it puts a downward pressure on wholesale electricity prices. In particular, large amounts of solar PV can depress prices during the midday peak so that they fall below night-time prices. In the most extreme scenarios, the wholesale price drops to zero during the day – the strongest possible signal that no further solar is required on the system.

While the above factors lead to lowering the wholesale electricity prices, large penetration of wind and solar can also result in curtailment of surplus wind and solar energy when the sum of intermittent generation and other must-run generation in the system at a given time exceeds concurrent demand. Consequently the achievable load factors of wind and solar will reduce associated with loss of revenues. Such situations are more likely to occur in systems with very limited energy storage facilities.

At high penetration of renewables due to the combined effect of falling wholesale electricity prices and reduced (achievable) load factor of wind and solar, a threshold level of these technologies will be reached beyond which further addition of wind and solar capacity will not allow adequate revenues to self-sustain.

Conclusions

A system where wind and solar become competitive with wholesale market prices will mark a massive shift in the evolution of these technologies. We would expect to see large-scale deployment (unhindered by changes in regulation or government



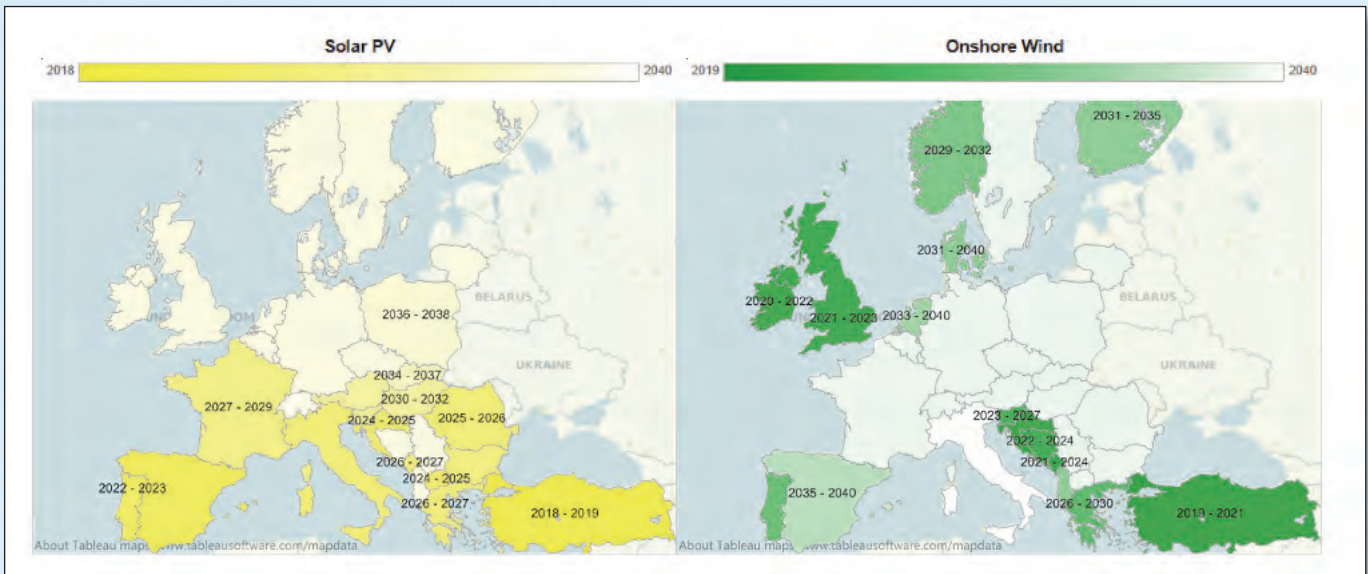


Image: Maps of Europe showing when grid parity may be achieved

whim), with solar mainly in southern Europe and onshore wind in Northern Europe.

Although factors such as planning permission and public acceptance may reduce deployment, the ultimate cap on deployment levels would be the capture price effect – by building more wind or solar, they reduce prices and hence become uneconomic. Ultimately, the goal of wholesale grid-parity of renewables remains a long way off, and unless there is a further shift in capital or deployment costs, most large-scale renewables

deployment in the next 20 years will remain subsidised. “A system where wind and solar become competitive with wholesale market prices will mark a massive shift in the evolution of these technologies.”

For further information on the complete report contact Pöry or the publishers

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Reference

1. BID3 simulates all 8760 hours per year, with multiple historical weather patterns, generating hourly wholesale prices for each country for each future modelled year, and dispatch patterns and revenues for plants in Europe.





Stand alone success

Despite the impressive growth of solar and PV the industry is still in its infancy and the potential for growth is only just being realised. Sustainable and stand alone energy solutions are going to be a large growth area and technologies are being developed to meet the needs. Solar International spoke with Zev Rosenzweig, the CEO at AORA Solar who explained the company hybrid power system.

AORA is the developer of the Tulip Solar-Biogas Hybrid Power System, a flexible solution that can supply uninterrupted green power 24 hours a day. Each Tulip produces 100 kW of electricity and 170 kW of heat energy as a by-product, making it uniquely suited for small-scale, off-grid applications for agriculture, healthcare, manufacturing, industrial, and municipal use. The Tulip may be built standalone or in multiple units linked together into a centrally controlled power plant for increased output

Q Solar and PV industries around the world are evolving towards more sustainable models not so reliant on subsidy. Some PV opportunities have possibly sat on the back burner while the focus was on silicon based cells and panels. Do you feel this has had any impact on off-grid applications and has the changing market direction affected your area of expertise?

A AORA is involved in small-scale CSP. We were always aware that we were playing in a niche market and that has not changed much in the last few years. We do have a better definition of our niche: off-grid power for users who need power 24/7.

Q As a developer of hybrid PV energy solutions do you feel the future for PV involves interactions with other technologies?

A Again, our technology is CSP hybrid. We depend on efficient generation of bio-gas to power our turbines during non- solar hours. There are several emerging bio-gas technologies that use heat to accelerate the process and we generate waste heat as part of our power generation cycle, so this would be a natural plus for us.

Q Could you please tell us about your technology and how it provides 24 hour coverage?

A Our technology is based on using concentrated reflected solar heat to drive a gas turbine with pressurized hot air. (A gas turbine is a turbine that runs on hot air, which is a gas, rather than on steam as in most CSP plants). As a consequence, our generators do not require water, another scarce resource in many places on earth. Our units are small, sized at 100kW nominal power, which is ideal for a village in the developing world. The system is modular, so as the village grows in population or in economic sophistication, they can add additional units which will function together. The small size means that the source of power is near the user, so the hot air by-product can be utilized for making hot water or cooling using absorption chilling. Only a local grid is required as the electricity is used at the “doorstep” of the plant – it does not to be transported and is not a burden on infrastructure.



Q CSP technologies have had a bit of negative press with some suggesting it is now too expensive. Can you elaborate on whether you feel this has any truth and how your solutions maintain a cost effective approach?

A CSP is definitely more expensive than PV and I believe it will continue to be so. But CSP holds out the promise of storage that is very expensive with PV using megawatt hour size batteries. So while CSP is more expensive watt for watt, it may be cheaper than PV for a specific application. This is especially true when CSP can function as a hybrid, as in AORA's technology.

Q What sort of environments do you feel Aora's products are best suited?

A High DNI, off-grid, village size, needing power 24/7 or close to it. If there is an application for the waste heat, that improves the economic analysis.

Q How can hybrid technologies help solar become a more accepted power source in the global energy mix?

A Hybridization means flexibility. You cannot be more flexible than a jerry can of gasoline. So being hybrid brings renewable energy to a higher level of acceptance.

Q Can you please tell us more about the types of alternative fuels that can be used to power the gas turbine?

A It will run on almost any liquid or gaseous fuel with sufficient caloric value to generate the necessary heat.

Q What benefits can a 24 hour operation offer a grid connected installation?

A 24 hour green energy vs. 24 hour coal generated grid power. Clearly, there is less benefit where a grid exists as explained above. However, for example, there are more than 65,000 villages throughout India without a grid connection, and, in such a vast country, combined they contain almost twice as many people as live in the United States, showing the scale of the challenge.

These people cannot operate refrigerators on a regular basis because they have no power at night. So a woman spends all her time cooking meals for the day, never able to store food and create free me. If there is refrigeration, the wife of the family can work part time outside the home, increasing prosperity etc.

Q AORA states it is committed to finding energy solutions whilst reducing environmental impact. How has the company achieved this?

A We have gone from considering natural gas as our ideal hybrid fuel to working to perfect a bio-gas based solution.

We will also be beginning a concerted effort to lower the cost of our product and at the same time incorporate as much recycled material as possible to lower our overall environmental footprint.

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Swedish student enables easy direct PV to boilers

A SIMPLE "SMART CONTROL" BOX invented by a PhD student at Lund University in Sweden has made it possible to connect solar panels to your boiler - without making any changes to the existing hot water system.

"With current technology, if you want to install a solar panel and connect it to your hot water tank, you'd have to throw out your old boiler and get an entire new system", explains Ricardo Bernardo, now an assistant senior lecturer at Lund University.

Most hot water tanks only have two pipe connections, which isn't enough for existing methods of connecting solar collectors.

Bernardo's patented solution, however, uses the two existing pipe connections, but instead controls them with an add-on "smart control" box, meaning there is no need for more connections or pipes. The system has the same performance by simply using the two connections in a more efficient way.

The technique makes connecting solar collectors to a boiler up to 40% cheaper, and saves between 60-80% energy, depending on solar radiation levels.

It also means that it only takes around four years to pay for the initial installation through energy cost savings, increasing the long-term cost-saving incentive for households.

With 50 million hot water tanks for domestic use in Europe alone, the potential for replacing traditional energy sources with renewable energy is significant.

Following a report from the International Energy Agency (IEA) predicting that solar power could be the world's largest power source by 2050, Bernardo's simple solution could be one step in the right direction.

The box, SolarFlex, is currently being installed by Bernardo's company Efficax Energy at several locations in Sweden.

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Reducing cost of solar to encourage ubiquity

ONE OF THE MOST COMMON COMPLAINTS about solar power is solar panels are too expensive to be worth the investment. Researchers have responded by making solar cells, the tile-like components of solar panels that absorb and transfer energy, more efficient and longer lasting. But even the longest living solar cells that most effectively convert sunlight to energy will not become common if they are prohibitively expensive.

Professor Yabing Qi, the head of the Energy Materials and Surface Sciences Unit at the Okinawa Institute of Science and Technology Graduate University, has a different idea: make solar cells using a type of semiconductor called perovskite materials, which are, in Qi's words, "dirt cheap."

If solar cells are cheap enough, Qi reasons that people will want to use them for the payback in energy savings. Now Professor Qi and members of his research unit have developed a new method for making perovskite solar cells worthy of attention, and The Royal Society of Chemistry published their findings September 5, 2014 in their journal, *Energy & Environmental Science*.

Qi's new method uses hybrid deposition to create perovskite solar cells, made from a mixture of inexpensive organic and inorganic raw materials. In addition, his solar cell is about a thousand times thinner than a silicon solar cell, and therefore uses far less material. Qi estimates that for the same price, he could either buy raw materials to build 1000 square meters of his solar cell, or he could buy about 20 wafers of crystallized silicon, to build 0.16 square meters of traditional solar panels.

In contrast, the hybrid deposition process uses less energy to produce a solar cell at a far lower temperature. In fact, Qi

envisions manufacturing the new solar cells using a low-cost printing process. The process would deposit the materials onto thin sheets of PET plastic quickly to make quantities of cheap solar cells. Qi does not yet know the limits of his hybrid cells, but optimists in his field hope that they could reach 20% efficiency.

This means that that the solar cells will convert 20% of the energy they absorb from the sun into energy, which is comparable to the best silicon solar panels on the market. The extremely thin perovskite cell that Qi and his lab designed measures merely 135 nanometers and reaches an efficiency of 9.9%.

Because these films are semitransparent, Qi hopes to use them on windows, as a sort of lightweight set of blinds. "It will be a window and at the same time it will be a solar cell," he says. "Some of the light could go through and the rest will be absorbed. Then, a certain percentage of the absorbed light will be converted to electricity."

If solar cells are cheap enough, consumers will reap almost immediate benefits even if the solar cells are not the most efficient, because their savings on air conditioning and electricity will offset the expense.

"If it's so cheap that it is like wallpaper, then you might as well use it," said Qi. "It's like a free gift. It's an investment with a lot of payback."

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AIRLIGHT ENERGY, a Swiss-based supplier of solar power technology has partnered with IBM Research to bring affordable solar technology to the market by 2017. The system can concentrate the sun's radiation 2,000 times and convert 80 percent of it into useful energy to generate 12 kilowatts of electrical power and 20 kilowatts of heat on a sunny day.

The High Concentration PhotoVoltaic Thermal (HCPVT) system, which resembles a 10-meter-high sunflower, uses a 40-square-meter parabolic dish made of patented fibre-based concrete, which can be moulded into nearly any shape in less than four hours and has mechanical characteristics similar to those of aluminium at one-fifth the cost. The inside of the parabolic dish is covered with 36 elliptic mirrors made of 0.2-millimeter-thin recyclable plastic foil with a silver coating, slightly thicker than the



IBM and airlight team up for sunflower shaped CPV

wrapper chocolate bars are packaged in, which are then curved using a slight vacuum. The mirrored surface area concentrates the sun's radiation by reflecting it onto several microchannel liquid-cooled receivers, each of which is populated with a dense array of multi-junction photovoltaic chips—each $1 \times 1\text{-cm}^2$ chip produces an electrical power of up to 57 watts on a typical sunny day. The mirrors and the receiver are encased with a large inflated transparent plastic enclosure to protect them from rain or dust. The enclosure also prevents birds and other animals from getting in harm's way.

The photovoltaic chips, similar to those used on orbiting satellites, are mounted on micro-structured layers that pipe treated water within fractions of millimetres of the chip to absorb the heat and draw it away 10 times more effectively than with passive air cooling. The 85-90 Celsius ($^{\circ}\text{C}$) hot water maintains the chips at safe operating temperatures of 105°C which otherwise would reach over $1,500^{\circ}\text{C}$. The entire system sits on an advanced sun tracking system, which positions the dish at the best angle throughout the day to capture the sun's rays.

The direct hot-water cooling design with very small pumping power has already been made commercially available by IBM in its high-performance computers, including SuperMUC, Europe's fastest supercomputer in 2012.

"The direct cooling technology with very small pumping power used to cool the photovoltaic chips with water is inspired by the hierarchical branched blood supply system of the human body," said Dr. Bruno Michel, manager, advanced thermal packaging at IBM Research.



An initial demonstrator of the multi-chip solar receiver was developed in a previous collaboration between IBM and the Egypt Nanotechnology Research Centre. With such a high concentration and based on its radical design, researchers believe that with high-volume production they can achieve a cost of two to three times lower than comparable systems.

Airlight Energy has spun off a new company called Dsolar (dish solar) to market, license and sell the HCPVT system globally. Dsolar has licensed several patents from IBM in the area of hot-water chip cooling.

"With the HCPVT we are ushering in a new generation of solar energy technology," said Dr. Gianluca Ambrosetti, Head of Research, Airlight Energy with responsibilities for building the new spinoff. "Not only is the system affordable, but it will create jobs where it is installed because many of the materials will be sourced locally. We expect to partner with firms around the world to bring a commercial version to market by 2017."

Based on its current design, scientists estimate that the operating lifetime for the HCPVT structure is up to 60 years with proper maintenance. The protective foil and the plastic elliptic mirrors will need to be replaced every 10–15 years depending on the environment, and the photovoltaic cells need replacing every 25



years. Throughout its lifetime the system will benefit from design and manufacturing improvements.

The HCPVT system can also be customized with further equipment to provide drinkable water and air conditioning from its hot water output. For example, salt water can pass through a porous membrane distillation system, where it is vaporized and desalinated. Such a system could provide 30–40 liters of drinkable water per square meter of receiver area per day, while still generating electricity with a more than 25 percent yield or two kilowatt hours per day—a little less than half the amount of water the average person needs per day according to the United Nations, whereas a large multi-dish installation could provide enough water for a town.

By means of a thermally driven sorption chiller, cool air can also be produced. A sorption chiller is a device that converts heat into cooling via a thermal cycle applied to a liquid or solid sorption material. Adsorption chillers, with solid silica gel adsorbers and with water as a working fluid, can replace compression chillers, which place a burden on electrical grids in hot climates and contain working fluids that are harmful to the ozone layer.

Although absorption (liquid sorption) systems are already available for combination with the HCPVT system, they provide

less cooling output compared to low-temperature driving heat for the adsorption (solid sorption) systems under development at IBM. The systems can also be customized with a transparent back for urban installations.

Initial HCPVT systems will be made available with non-optimized predecessor distillation and sorption cooling systems. Systems with optimized desalination and sorption cooling technologies require an additional two to three years of development with additional partner companies.

Airlight Energy and the IBM Corporate Service Corps (CSC) will team up to donate a HCPVT system to two deserving communities. Each winning community will receive a prototype HCPVT system from Airlight Energy, and be eligible for pro bono enablement and transformation support from IBM Corporate Service Corps.

Applications from communities will be open in 2015 and the winners will be announced in December 2015, with installations beginning in late 2016. Scientists at Airlight and IBM see the HCPVT system providing energy to locations around the world.

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ZSW breaks CIGS efficiency record

THE CENTRE FOR SOLAR ENERGY AND HYDROGEN RESEARCH BADEN-WÜRTTEMBERG (ZSW) has set a new world record in thin-film photovoltaics. Scientists in Stuttgart achieved 21.7 percent efficiency with a solar cell made of copper indium gallium diselenide (CIGS).

ZSW succeeded in bringing the record back to the institute with this cell's performance. Swedish researchers achieved a new best mark in June, which has now been surpassed by 0.7 percentage points. The progress underway in the southwest of Germany is helping to make solar power more affordable.

This record-setting performance in Stuttgart extends the CIGS cell's lead over multicrystalline solar cells, which still dominate the market, to 1.3 percent. "Our advances once again confirm the tremendous technological potential of CIGS thin-film photovoltaics," says Michael Powalla, ZSW board member and head of the Photovoltaics division. "The lab data show that further efficiency improvements will be possible in the years ahead. This could drive down the cost of CIGS technology even more sharply."

The record-setting cell has an area of 0.5 cm², a standard size for such tests. It was manufactured in a laboratory coating plant by way of a co-evaporation process that is highly reproducible in the lab: The scientists made more than 40 cells with efficiency ratings topping the 21 percent. This would indicate that the method lends itself to industrial manufacturing and could be readily scaled up to mass production. The Fraunhofer Institute for Solar

Energy Systems ISE confirmed results.

"We are accustomed to the industry in Baden-Württemberg setting records, but this world record is something special," says Baden-Württemberg's Minister of Finance and Economics Nils Schmid. "The excellent research being done at ZSW is a key prerequisite for innovations like this. The roughly four million euros in basic funding flowing to the ZSW every year from the state is money well spent."

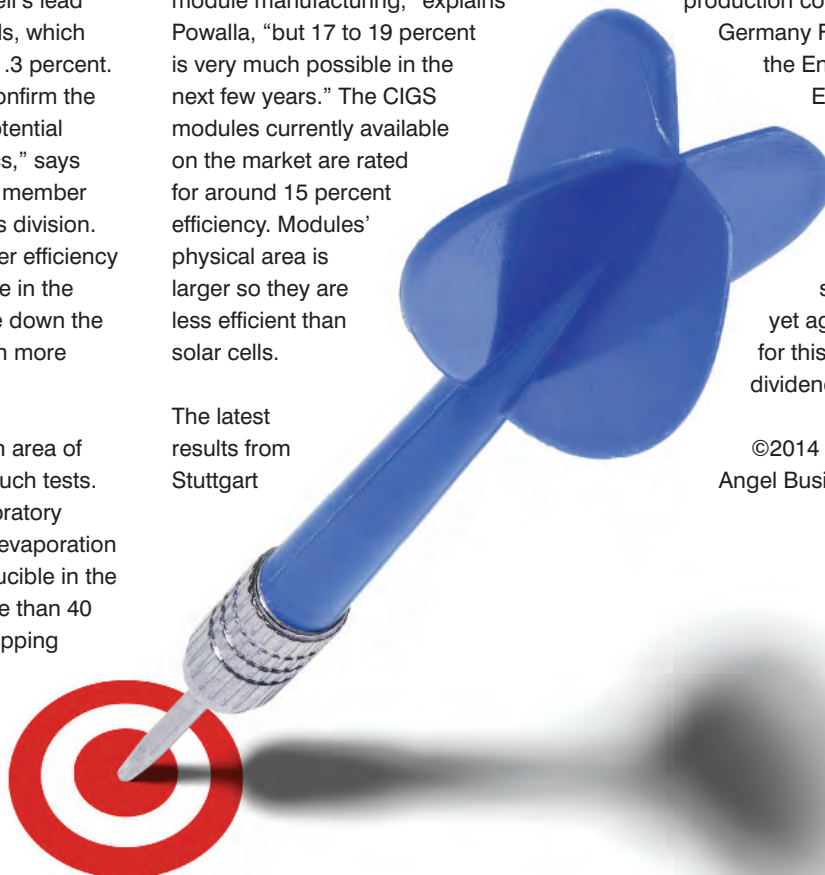
Solar cell efficiency is one of the most powerful drivers in reducing the cost of solar energy. The rating indicates how much of the sun's incident light is converted into electrical energy. "It will probably take some time for this efficiency increase to make its way into module manufacturing," explains Powalla, "but 17 to 19 percent is very much possible in the next few years." The CIGS modules currently available on the market are rated for around 15 percent efficiency. Modules' physical area is larger so they are less efficient than solar cells.

The latest results from Stuttgart

improve the chances of CIGS thin-film technology gaining a much larger market share. This is good news for Manz AG. The ZSW licensed the technology to and developed it jointly with this industry partner. The Reutlingen-based company exclusively markets a turnkey manufacturing line for producing CIGS thin-film solar panels and now aims to move this efficiency boost out of the lab and into the factory. The idea is to make CIGS solar systems economical and affordable practically anywhere in the world.

Thin-film cells' coating is measured in micrometers, so they consume far less material and energy in the making than standard solar cells and are sure to have a major impact on cutting future production costs. This is why the Germany Federal Ministries for the Environment and for Economic Affairs and Energy as well as the state of Baden-Württemberg provided funding. As the ZSW's record-setting efficiency rating yet again attests, the support for this research is paying dividends.

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Joule and Scatec develop JV for solar fuel

JOULE, a developer of solar conversion of CO₂ into liquid fuels, has announced that it has entered into a memorandum of understanding (MoU) with Scatec Solar ASA, an independent solar power producer. In the MoU the parties have agreed to initiate a process to reach specific terms for a partnership, to support the roll-out of Joule production plants featuring photovoltaic power.

“This is a first-of-its-kind opportunity to merge the strengths of solar power and solar fuel, and we are excited to be among the first international supporters of this groundbreaking industry-changing production platform.”

Joule’s proprietary, reverse-combustion process allows significant reductions in overall carbon footprint by using solar energy to convert waste CO₂ directly into infrastructure-ready, carbon-neutral fuels. By closing the carbon cycle, Joule’s fuels enable a sustainable form of combustion. The use of photovoltaic power for plant operations is expected to reduce Joule’s

system-level carbon footprint even further, netting more than a 90% improvement over conventional fuel production and setting the stage for truly sustainable mobility.

The terms of the MoU anticipate that Scatec Solar ASA will become preferred supplier and operator of photovoltaic power installations for Joule plants, with an initial deployment goal of up to 25,000 acres (~10,000 hectares) and a power requirement of 2 gigawatts. A deployment of this scale would generate up to 625 million gallons (~15 million barrels) of ethanol or 375 million gallons (~9 million barrels) of diesel per year, while consuming about 4 million tonnes of industrial waste CO₂ annually in the process.

“We have found an ideal strategic fit with Scatec Solar, who brings a turnkey solution for photovoltaic power along with a shared vision for sustainability,” said Paul Snaith, President and CEO of Joule. “With ever-increasing global attention on

the consequences of climate change, we have an opportunity to produce transportation fuels with the lowest-known carbon footprint – using solar energy both as a feedstock and a power source. This relationship exemplifies our approach to building an ecosystem of like-minded partners with complementary expertise, which in turn will fast-track the availability of CO₂-neutral fuels to a planet in urgent need of scalable solutions.”

“We continually seek to leverage our experience and know-how in developing new market applications for solar energy, and a partnership with Joule achieves just that,” said Raymond Carlsen, CEO of Scatec Solar ASA. “This is a first-of-its-kind opportunity to merge the strengths of solar power and solar fuel, and we are excited to be among the first international supporters of this groundbreaking industry-changing production platform.”

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PV is consistently better than expected

PV SYSTEMS IN GERMANY are regularly generating higher yields than expected. An investigation by Fraunhofer ISE links these higher yields to an upward trend in solar radiation, pointing out that the current radiation level in Germany is considerably higher than the average values of the last 30 years. As these average values have generally been used in yield predictions up to now, actual PV system yields are exceeding their forecasts by approximately five percent, making them more cost-effective than anticipated. To take this effect into account, Freiburg researchers have adapted their quality assurance services for PV systems and are now basing their yield predictions on solar radiation data from the last ten years.

Up until now, experts have based their solar resource assessments on the assumption that possible radiation levels in the future will not significantly differ from the average values of the last few decades. However, solar radiation is undergoing long-term trends – known as »global dimming and brightening« – which cause average radiation values to change over time. These changes are caused by

factors such as increases and decreases in air pollution and the concentration of aerosols in the atmosphere.

In collaboration with ETH Zurich and Germany's National Meteorological Service (DWD), researchers at Fraunhofer ISE have conducted scientific research on the extent to which past average values deviate from today's radiation levels and how these deviations will impact yield predictions for solar installations. The team analyzed DWD's radiation measurement data (spanning from 1951 to 2010) on selected locations in Germany. The results show that solar radiation has been increasing since around the mid-1980s (brightening), with current radiation levels at the locations under observation measured at around five percent higher than the average value between 1951 and 2010.

Annual deviations in solar radiation from the average value in Germany between 1951-2010 (moving average: black line). Linear trend of the dimming and brightening phase: green/blue line. The 30-year average value is lower than the current level of radiation. The 10-year

average value is only slightly lower than the current level of radiation.

These findings prompted researchers at Fraunhofer ISE to analyze yield predictions for PV power plants being monitored by the institute, which uncovered similar deviations between past yield assessments and actual radiation and yield measurements. "Relying on average radiation values from the past 30 years causes a systematic underestimation of actual PV system yields in Germany by around five percent," said Björn Müller, project leader at Fraunhofer ISE. "We expect that other regions experiencing the brightening effect are seeing similar underestimations."

The investigation results are now methodically included in Fraunhofer ISE's yield predictions. In order to more realistically assess investments in future PV system projects, the quality assurance specialists have decided to use a modified data base for their yield predictions. They now use satellite derived solar radiation time series from the last ten full years, which depict the increase in solar radiation, thus reducing underestimations caused as a result of this. "Our yield forecasts are based on satellite data from the past decade, which enables us to determine the profitability of PV systems more effectively than before," said Klaus Kiefer, head of the department Quality Assurance PV Modules and Systems at Fraunhofer ISE.

"They provide an improved decision support, for example when buying or reevaluating a PV power plant. Conducting further analyses when reevaluating PV systems can also help to significantly reduce investment risks."

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Solar cell stores its own power

A PATENT-PENDING DEVICE invented at The Ohio State University is the world's first solar battery. In the journal *Nature Communications*, the researchers report that they've succeeded in combining a battery and a solar cell into one hybrid device. Key to the innovation is a mesh solar panel, which allows air to enter the battery, and a special process for transferring electrons between the solar panel and the battery electrode. Inside the device, light and oxygen enable different parts of the chemical reactions that charge the battery.

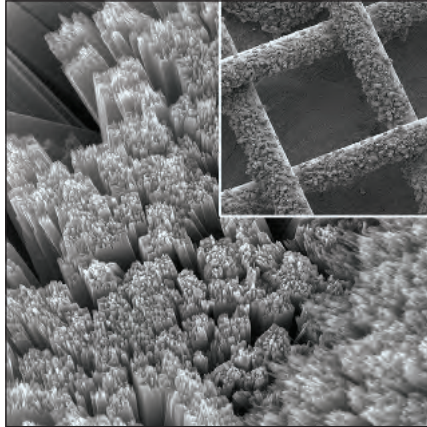
The university will license the solar battery to industry, where Yiying Wu, professor of chemistry and biochemistry at Ohio State, says it will help tame the costs of renewable energy.

"The state of the art is to use a solar panel to capture the light, and then use a cheap battery to store the energy," Wu said. "We've integrated both functions into one device. Any time you can do that, you reduce cost."

He and his students believe that their device brings down costs by 25 percent. The invention also solves a longstanding problem in solar energy efficiency, by eliminating the loss of electricity that normally occurs when electrons have to travel between a solar cell and an external battery. Typically, only 80 percent of electrons emerging from a solar cell make it into a battery.

With this new design, light is converted to electrons inside the battery, so nearly 100 percent of the electrons are saved.

The design takes some cues from a battery previously developed by Wu and doctoral student Xiaodi Ren. They invented a high-efficiency air-powered battery that discharges by chemically reacting potassium with oxygen. The design won the \$100,000 clean energy prize from the U.S. Department of Energy in 2014, and the researchers formed a technology spinoff called KAir Energy Systems, LLC to develop it.



Researchers at The Ohio State University have invented a solar battery -- a combination solar cell and battery -- which recharges itself using air and light. The design required a solar panel which captured light, but admitted air to the battery. Here, scanning electron microscope images show the solution: nanometer-sized rods of titanium dioxide (larger image) which cover the surface of a piece of titanium gauze (inset). The holes in the gauze are approximately 200 micrometers across, allowing air to enter the battery while the rods gather light. Image courtesy of Yiying Wu, The Ohio State University.

"Basically, it's a breathing battery," Wu said. "It breathes in air when it discharges, and breathes out when it charges."

For this new study, the researchers wanted to combine a solar panel with a battery similar to the KAir. The challenge was that solar cells are normally made of solid semiconductor panels, which would block air from entering the battery.

Doctoral student Mingzhe Yu designed a permeable mesh solar panel from titanium gauze, a flexible fabric upon which he grew vertical rods of titanium dioxide like blades of grass. Air passes freely through the gauze while the rods capture sunlight.

Normally, connecting a solar cell to a battery would require the use of four electrodes, the researchers explained. Their hybrid design uses only three. The mesh solar panel forms the first

electrode. Beneath, the researchers placed a thin sheet of porous carbon (the second electrode) and a lithium plate (the third electrode). Between the electrodes, they sandwiched layers of electrolyte to carry electrons back and forth.

Here's how the solar battery works: during charging, light hits the mesh solar panel and creates electrons. Inside the battery, electrons are involved in the chemical decomposition of lithium peroxide into lithium ions and oxygen.

The oxygen is released into the air, and the lithium ions are stored in the battery as lithium metal after capturing the electrons. When the battery discharges, it chemically consumes oxygen from the air to re-form the lithium peroxide.

An iodide additive in the electrolyte acts as a "shuttle" that carries electrons, and transports them between the battery electrode and the mesh solar panel. The use of the additive represents a distinct approach on improving the battery performance and efficiency, the team said.

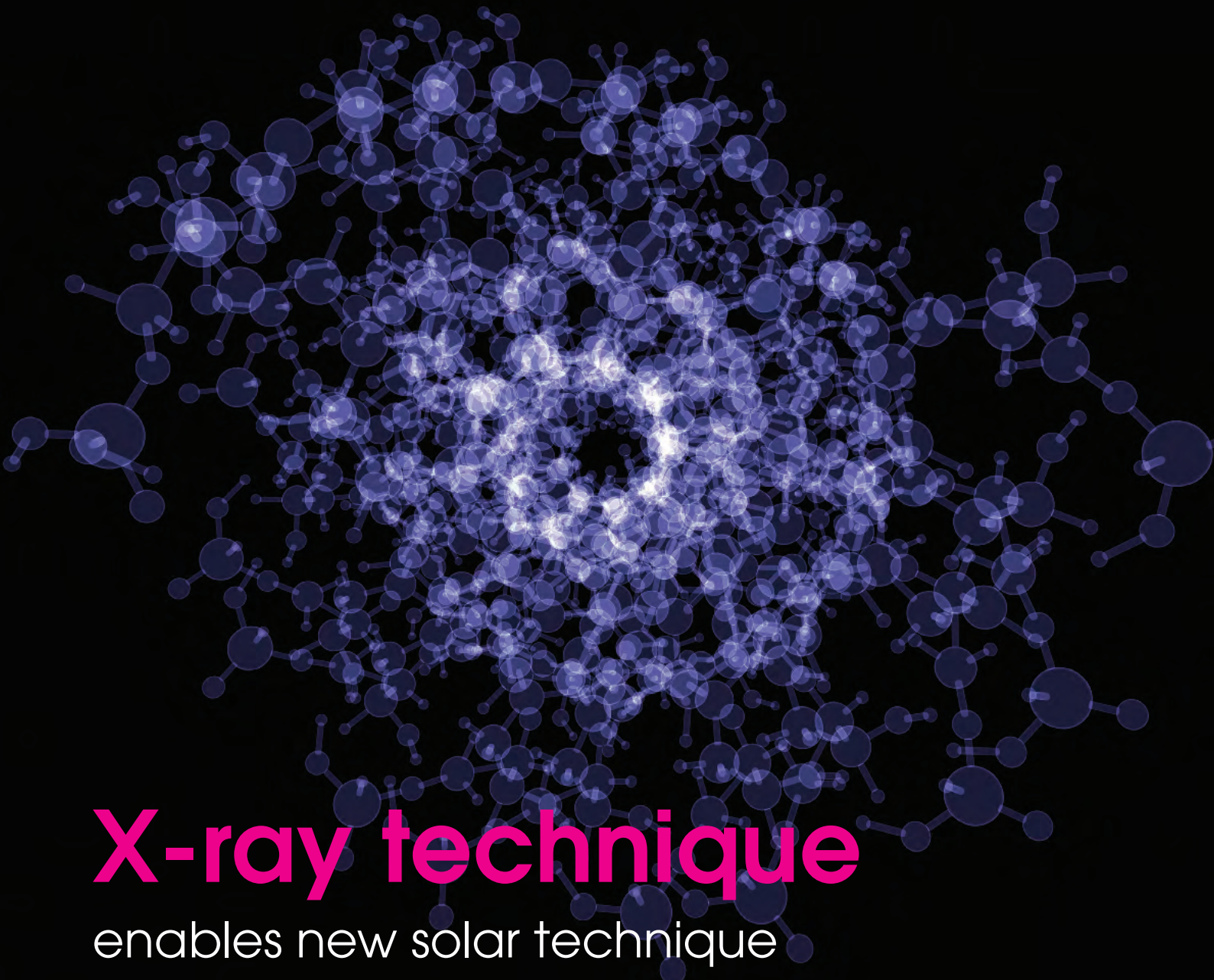
The mesh belongs to a class of devices called dye-sensitized solar cells, because the researchers used a red dye to tune the wavelength of light it captures.

First they used a ruthenium compound as the red dye, but since the dye was consumed in the light capture, the battery ran out of dye after eight hours of charging and discharging—too short a lifetime.

So they turned to a dark red semiconductor that wouldn't be consumed: hematite, or iron oxide—more commonly called rust.

Coating the mesh with rust enabled the battery to charge from sunlight while retaining its red color. Based on tests, Wu and his team think that the solar lifetime will be similar to current batteries.

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X-ray technique

enables new solar technique

THE SHARP X-RAY VISION of DESY's research light source PETRA III paves the way for a new technique to produce cheap, flexible and versatile double solar cells. The method developed by scientists from the Technical University of Denmark (DTU) in Roskilde can reliably produce efficient tandem plastic solar cells of many metres in length, as a team around senior researcher Jens W. Andreasen reports in the journal *Advanced Energy Materials*.

The scientists used a production process, where the different layers of a polymer (plastic) solar cell are coated from various

solutions onto a flexible substrate. This way, the solar cell can be produced fast and cheap in a roll-to-roll process and in almost any desired length - up to several kilometres long single solar cell modules have already been manufactured.

However, the energy harvesting efficiency of this type of solar cell is not very high. To increase the efficiency, a DTU team around Frederik C. Krebs stacked two such solar cells onto each other. Each of these absorbs a different part of the solar spectrum, so that the resulting tandem polymer solar cell converts more of the incoming sunlight into electric energy.

But the multilayer coating presents several new challenges, as Andreasen explained: "Lab studies have shown that already coated layers may be dissolved by the solvent from the following layer, causing complete failure of the solar cell." To prevent redissolution of the first solar cell, the scientists added a carefully composed protective intermediate coating between the two solar cells.

The protective coating contains a layer made of zinc oxide (ZnO) that is just 40 nanometres thick - about a thousand times thinner than a human hair. To check shape and function of the protective

coating and the other layers of the tandem solar cell, the scientists used the exceptionally sharp X-ray vision of DESY's research light source PETRA III that can reveal finest details. "The solar cell structure is very delicate, consisting of twelve individual layers altogether. Imaging the complete structure is challenging," explained co-author Juliane Reinhardt from DESY's experimental station P06 where the investigations were made. "And the sample was just two by four microns in size."

Still, with the brilliant X-ray beam from PETRA III, the researchers could peer into the layer structure in fine detail, using a technique called 3D ptychography. This method reconstructs the three-dimensional shape and chemistry of a sample from the way it diffracts the incoming X-rays. For a full 3D reconstruction a great number of overlapping X-ray diffraction images have to be recorded from all sides and angles. The advantage of ptychography is that it yields a higher resolution than would be possible with conventional X-ray imaging alone. And in contrast to electron microscopy, X-ray ptychography can also look deep inside the sample.

"With 3D ptychography, we were able to image the complete roll-to-roll coated tandem solar cell, showing, among other things, the integrity of the 40 nanometres thin zinc oxide layer in the protective coating that successfully preserved underlying layers from solution damage," said DESY scientist Gerald Falkenberg, head of the experimental station P06. "These are the 3D ptychography measurements with the highest spatial resolution we have achieved so far. The results show that with the correct formulation of the intermediate layer, the

underlying solar cell is protected from redissolution."

The investigation paves the way to a possible industrial application of the new technique. "In a complex multilayer device like a polymer tandem solar cell, the device may fail in multiple ways," Andreasen pointed out. "What we were able to see with 3D ptychography was that the preparation of the substrate electrode combines the good conductivity of a coarsely structured silver electrode with the good film forming ability of a conducting polymer that infiltrates the silver electrode and forms a smooth surface for the coating of the subsequent layers." This is what allows the coating of very thin layers, at very high speeds, still forming contiguous layers, without pinholes.

Looking into the complete structure can also provide valuable information for a possible optimization of the device and the production process. "In principle we make the devices without knowing what the internal structure looks like in detail. But knowing the structure tells us which parameters we can modify, and which factors are important for the device architecture, for example the special type of substrate electrode, and the formulation of the intermediate layer," Andreasen explained. "We were now able to verify that we can coat contiguous, homogeneous layers, roll-to-roll from solution, at speeds up to several meters per minute.

We have shown that roll-to-roll processing of tandem solar cells is possible, with all of the layers roll-coated from solution, and that it is only possible using a specific formulation of the intermediate layer between the two sub-cells." The resulting

polymer tandem solar cell converts 2.67 per cent of the incoming sunlight into electric energy, which is way below the efficiency of conventional solar cells. "The efficiency is low, compared to conventional solar cells, by a factor of 7 to 8, but one should consider that the production cost of this type of solar cell is several orders of magnitude lower than for conventional solar cells.

This is the particular advantage of polymer solar cells," explained Andreasen. "Furthermore, this is the first example of a roll-to-roll coated tandem solar cell where the efficiency of the tandem device actually exceeds that of the individual sub-cell devices by themselves."

PETRA III produces extremely brilliant X-rays using fast electrons from a powerful particle accelerator. The particles are accelerated to nearly the speed of light and send down a magnetic slalom course. In each bend, the electrons emit tiny X-ray flashes that add up to a narrow and extremely bright X-ray beam.

Deutsches Elektronen-Synchrotron DESY is a German accelerator centre and one of the leading in the world. DESY is a member of the Helmholtz Association and receives its funding from the German Federal Ministry of Education and Research (BMBF) (90 per cent) and the German federal states of Hamburg and Brandenburg (10 per cent). At its locations in Hamburg and Zeuthen near Berlin, DESY develops, builds and operates large particle accelerators, and uses them to investigate the structure of matter. DESY's combination of photon science and particle physics is unique in Europe.

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Journal Reference

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Research project for renewables integration into European energy

NEW INITIATIVE for the large-scale integration of grids and of renewables sources into Europe's energy mix has been announced, with nearly 40 leading organisations from research, industry, utilities, transmission systems operators announcing their united goal to find the BEST PATHS to deliver affordable, reliable power in Europe from "coast to coast".

AN AMBITIOUS RESEARCH PROJECT which will be funded by the European Commission, BEST PATHS, will focus on the development of high-capacity transmission networks needed to meet Europe's long-term energy goals and incorporation of renewable energy sources.

The project unites expert partners around five large-scale demonstration areas focused on ensuring increased network capacity and system flexibility – incorporating innovative transmission systems and industrial solutions to link offshore wind farms and improve the interconnections of the power grid.

Project coordinator, Mr. Vicente González López of Red Eléctrica de España (REE) addressed the opening of a new challenge for the European power industry: "It goes beyond the intrinsic complexity of the individual developments proposed, since the project is going to require an effort of coordination to jointly analyse the results of each individual demonstrations and evaluate their combined impact in the European power system of the future."

Describing the actors working to deliver this ambitious project, Mr. González López said, "Thirty-nine key players have joined together to deliver a substantial change to the power grid's capacity and flexibility. They represent the entire chain of innovation in Europe, from universities

and research centres generating new knowledge, the power industry developing new products, Transmission Systems Operators and utilities, specifying their needs of new industrial solutions to allow the grid to better serve society."

Bridging the gap from often remote renewable electricity production to high-load consumption centres, BEST PATHS will focus on developing inter-operable

multi-terminal High Voltage Direct Current grids; innovative upgrading and repowering existing AC corridors; and superconducting high power links.

The experimental results of BEST PATHS will be integrated into European impact analyses to show the scalability of the solutions and will be made available as soon as 2018 to benefit replication across the pan-European transmission network and electricity market.



Carbon nanotube breakthrough shows solar promise

Lighter, more flexible, and cheaper than conventional solar-cell materials, carbon nanotubes (CNTs) have long shown promise for photovoltaics. But research stalled when CNTs proved to be inefficient, converting far less sunlight into power than other methods.

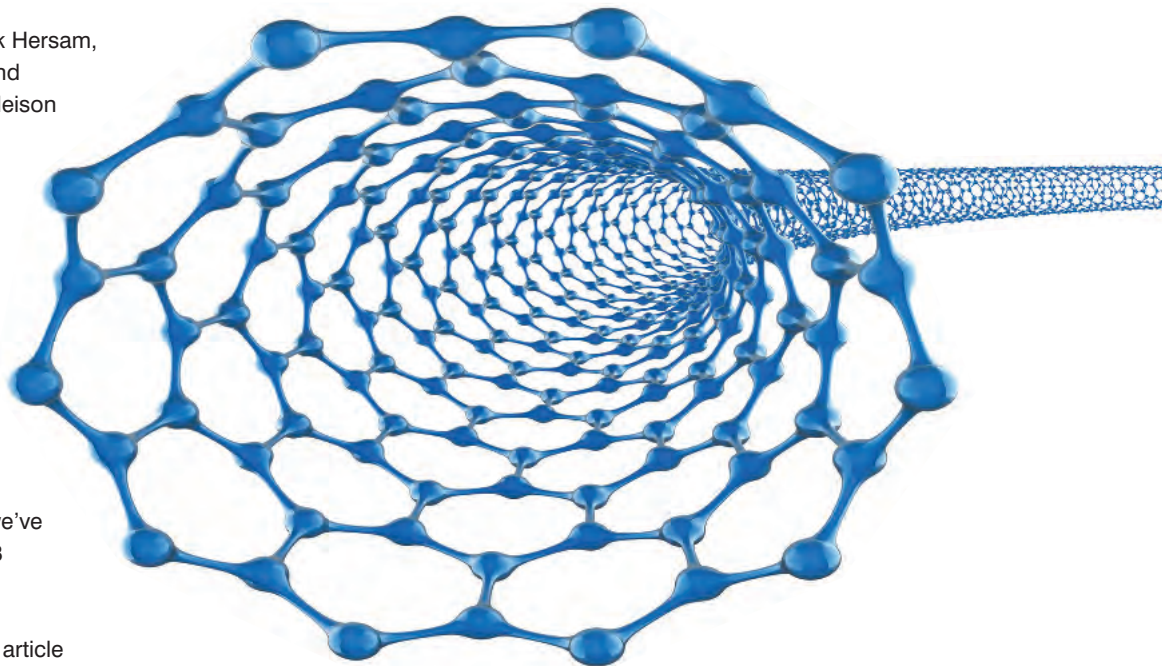
A RESEARCH TEAM led by Mark Hersam, professor of materials science and engineering and the Bette and Neison Harris Chair at the McCormick School of Engineering, has created a new type of CNT solar cell that appears twice as efficient as its predecessors. It is also the first CNT solar cell to have its performance certified by the NREL.

“The field had been hovering around 1 percent efficiency for about a decade; it had really plateaued,” Hersam said. “But we’ve been able to increase it to over 3 percent. It’s a significant jump.”

The research is described in the article “Polychiral Semiconducting Carbon Nanotube-Fullerene Solar Cells” in *Nano Letters*. The secret lies in the CNTs’ chirality, which is a combination of the tubes’ diameter and twist. When a thin sheet of carbon is rolled into a nanotube, several hundred different chiralities are possible. In the past, researchers tended to choose one particular chirality with good semiconducting properties and build an entire solar cell out of that one.

“The problem is that each nanotube chirality only absorbs a narrow range of optical wavelengths,” Hersam said. “If you make a solar cell out of a single chirality carbon nanotube, you basically throw away most of the solar light.”

Hersam’s team made a mixture of polychiral, or multiple chirality, semiconducting nanotubes. This maximized the amount of photocurrent



produced by absorbing a broader range of solar-spectrum wavelengths. The cells absorbed near-infrared wavelengths, a range that has been inaccessible.

While this is major progress for CNT solar cells, they still lag behind other materials in efficiency. Silicon, for example, can be 15-20 percent efficient, but it is more expensive to manufacture. “If you look at our performance, there’s certainly a big jump,” Hersam said. “But there’s more work to be done. We still have to advance this technology by a factor of three to five.”

Hersam said the next step is to create polychiral CNT solar cells that have multiple layers. Each layer would be optimized for a particular portion of the solar spectrum and, thus, absorb more light. He said they might also incorporate

other materials, such as organic or inorganic semiconductors, to complement CNTs.

“What we’d like to do is absorb every photon from the sun and convert it into electricity,” he said. “In other words, we’d like to have a solar cell that has an absorption spectrum perfectly matching solar light. We’re on a path toward that goal.”

Journal Reference:

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Green light for solar powered ambulances

YORKSHIRE AMBULANCE SERVICE NHS TRUST in the UK has been awarded a grant from the Department for Transport Clean Vehicle Technology Fund to install solar panels on emergency vehicles across the region. The Trust was awarded £166,000 to fit the equipment on 175 of its rapid response vehicles (RRVs) as part of a Government initiative to reduce the impact of exhaust fumes. Yorkshire Ambulance is looking to roll out the solar-powered vehicles from November 2014.

RRVs are often strategically located across the region on standby awaiting the next emergency call and currently staff are required to keep the vehicle engine running at all times to power vital electrical systems. The solar panels will power everything electrical in the vehicle and prevent car batteries from going flat when stationary. They will also reduce emissions when RRVs are on standby as the engine can be switched off whilst they are waiting for the next call.

Alexis Keech, Environmental and Sustainability Manager for Yorkshire Ambulance Service NHS Trust, said: "We are delighted to have been awarded this funding to trial this equipment.



"South Central Ambulance has already trialed and installed this technology and have reaped a reduction in emissions from eliminating the need to constantly run their engines.

"Not only does it allow us to reduce the carbon footprint of our organisation and contribute to the Government's work to reduce emissions, it will also reduce our fuel costs meaning we can re-invest the savings into frontline services and patient care."

The Trust operates a diesel fleet which travels over 40 million kilometres a year. The introduction of this new technology means that engines can be switched off when waiting for the next emergency which will reduce CO2 emissions by 720kg per vehicle per year and 17kg of NOx per vehicle per year.



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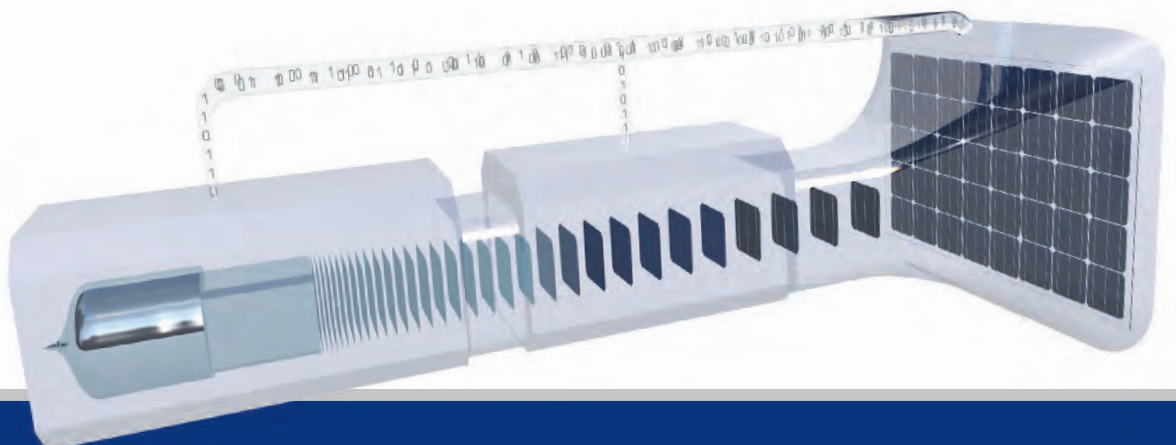
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